An Augmented Keynesian Macroeconometric Model

of the Guyanese Economy, 1960-1988

by

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ABSTRACT

Of the four MDCs in the thirteen-member Caribbean Common Market, Guyana is perhaps the only country that does not employ macroeconometric models in the management of her economy. Part of the explanation for this is certainly the relative absence of such models—no more than five models are in existence, all of which were built as part of academic research programs. This dissertation extends the narrow macroeconometric base by building an Augmented Keynesian Model (AKM) of the Guyanese economy. The model is "augmented" in the sense that, while its core is grounded on Keynesian principles, it attempts to build on the shortcomings of regional models by: (a) drawing upon other schools of economic thought besides Keynesian; (b) including the monetary sector in a more systematic manner; (c) assigning a role to expectations; (d) specifying feedback loops in greater detail; and (e) benchmarking against a competing export-led model (ELM).

As a preliminary step, a detailed review of the Guyanese economy is undertaken to ensure that the AKM incorporates the structural features of the economy and to bridge the gap for an analysis of the economy over an extended period. Relevant empirical literature in the region is reviewed partly to guide and inform the modelling-building effort and partly to provide a rough a synthesis of the published literature in the Caricom area.

The resulting AKM, comprising 14 behavioral equations and 47 identities, is estimated and evaluated over the period 1960-1988. In terms of the historical simulation runs, *ex post* forecasts, turning point and long-swing accuracy of the two major economic cycles since 1960, the evaluation statistics scored the AKM way ahead of the competing ELM. Finally, an encompassing-related test, recently developed by Fair and Shiller, is used to gauge whether "quasi" *ex ante* forecasts of the AKM contain information not contained in the ELM. The result indicate that the AKM essentially encompasses the benchmark model, although the latter contains useful information for forecasting investment not contained in the main model.

For my Father
who made it possible

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The encompassing-related test of the models was added at the suggestion of Professor Gordon. I thank him very much for this.

My children, Shivani and Christopher, were always a source of inspiration and, of course, disruption - mixing up my papers and demanding to use the computer for playing games. Last, but not least, I owe a great debt to my wife, Bhu, who rarely complained and cheerfully shouldered many additional responsibilities, including proofreading most of the text for the final version of the dissertation.

The usual disclaimer - holding myself responsible for all errors, omissions, and conclusions - applies.

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CHAPTER I

Introduction

Carl F. Christ (1993), writing in the March/April issue of the Federal Reserve Bank of St. Louis' Review, observes that "The goal of economic research is to improve knowledge and understanding of the economy, either for their own sake, or for practical use" (p. 71). While it may not be difficult to argue that this dissertation straddles both goals of economic research, it is nevertheless essentially a piece of academic research with a practical aim: to convey to the Guyanese authorities that econometric models are a useful, if not indispensable, tool for the management of a modern economy. It does this by demonstrating that the Augmented Keynesian Model (AKM) built by this study simulates and forecasts the data generating process of the Guyanese economy quite accurately.

Such an endeavor is particularly opportune given the fact that Guyana is perhaps the only large Caricom[1] country that does not engage the services of macroeconometric models. The are several reasons for this but the most important is certainly the dearth of

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[1] The acronym Caricom stands for the Caribbean Common Market, founded in August 1973 as a follow-up to the Caribbean Free Trade Association (CARIFTA). In terms of geography, history, economics and culture, Caricom is a relatively homogenous region, comprising the following 13 member countries: Antigua/Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, St. Kitts/Nevis, St. Lucia, St. Vincent and Grenadines, and Trinidad and Tobago. The principal objectives of Caricom are: trade liberalization within the group, custom union, economic integration, promotion of industrial development and foreign policy coordination.

macroeconometric models itself. My research shows that only three such models of the Guyanese economy have been constructed, estimated and simulated, all part of academic research. I believe that one way of convincing the authorities of the utility of these models is the actual existence and demonstration of the validity of many such empirical models. The idea is that the tool should be readily available in abundance if it is to be used in the important tasks of policy-making and economic management. This belief provides part of the rationale for the modelling effort undertaken by this study and, indeed, in the scheme of things, academic research precedes practical application.

Aside from their predominant Keynesian orientation, there are four distinguishing features - shortcomings, in effect - of previous modelling efforts in the region, including Guyana. These are: (a) the superficial treatment of the monetary/financial sector; (b) the absence of a role for expectations; (c) the non-benchmarking, in general, of models developed; and (d) feedback channels in the domestic economy have not been well specified.

While the present model also incorporates a Keynesian core, it draws heavily upon three other traditions in economics: Post-Keynesian, structuralist and monetarist schools of thought. This wider theoretical perspective accounts for the name given the model: the Augmented Keynesian Model (AKM). These alternative schools of thought are reflected in the consumption function, the inflation equation and the demand for money function. Some attempt is also made to redress the identified shortcomings of previously published models in the region.

The monetary/financial sector is an integral part of the model. Disturbances in this sector are transmitted to the rest of the economy through linkages to consumption, investment and inflation, which, in turn, feed back to other equations of the model. Expectations enter the model through the rate of inflation and anticipated money supply. Weak rational expectations have been assumed, modelled according to an appropriate ARIMA process. The AKM is benchmarked against an alternative Export-led Model (ELM), the second most dominant approach to modelling in the region.

The AKM comprises 14 stochastic equations and 47 identities. There are stochastic equations for consumption, investment, government revenue, government expenditure, imports, exports, the demand for money, inflation, expectations, potential output and depreciation. The AKM was benchmarked against a competing alternative export-led model comprising 26 equations of which 9 are stochastic. The principal results from the estimation of the model are:

- Trend consumption and changes in wealth are the most important factors in the determination of private consumption. The rate of unemployment did not prove to be significant. The error-correction term indicates that deviations from actual consumption takes, on the average, about two years to correct.

- Investment is heavily demand-driven, as gauged by the accelerator variable. Important supply factors include the level of capital stock, the import of capital goods and relative prices; the latter produces a large dampening effect upon investment despite the high dependence on imported capital goods. In short, both supply and demand factors are important to the determination of the level of investment.

- The Aghevli-Khan (1978) hypothesis that government expenditure adjusts to its desired level more rapidly than government revenue is supported by the Guyanese data. The objective counterpart of this is the widening fiscal deficit, a prominent feature of post-Republic Guyana. The income effect on government expenditure and revenue is positive and significant. In both cases the long-run elasticities are not significantly different from unity, as expected.

- The three categories of imports - consumer goods, raw materials and intermediate goods, and capital goods - are all heavily dependent upon the capacity to import and thus the availability of foreign exchange. Relative prices have a strong dampening impact upon imports, the heavy dependence of the economy on imports notwithstanding. A 1 per cent rise in disposable income is estimated to inflate consumption imports by a similar magnitude. A 1 per cent increase in capacity utilization exerts a 2 per cent stimulus on the imports of raw materials and intermediate goods. This category of imports, as well as capital goods, is constrained by a change in the fiscal deficit. Finally, a 1 per cent change in investment sends capital imports up by just as much.

- Price expectations, inflation, and the expected nominal rate of exchange are not significant variables in the determination of real balances. Experiments with several specifications show that a buffer stock model, containing real wealth, actual interest rates, a one-period lag of the dependent variable and unanticipated nominal money supply, best fits the data. The estimated relationships are also stable, judging from the results of the Chow test.

- The monetarist explanation of inflation is not strongly supported by the Guyanese data. The expansion of this model to include the "structuralist" variables of imported price and wages add further support to this finding. These variables result in (a) a considerable fall in the sum of the coefficients of the lagged money term, and (b) the real output term in the monetarist equation becoming insignificant. The data provide much more support for an equation based on the theory of markup pricing, supplemented by two excess demand variables.

- Given the poor state of the country's capital stock, depreciation charges can be expected to grow over time. The linear time trend in the equation for depreciation does not support this presumption.

The estimated results of the benchmark ELM, comprising 26 equations of which 9 are stochastic, are:

- Output is a crucial determinant of government revenue. Every 1 per cent increase in output results in almost a 2 per cent rise in revenue. Both output and the fiscal deficit are important to government expenditure, explaining about 94 per cent of the variation of this variable.

- A 1 per cent increase in income induces a 2 per cent rise in consumption imports. The magnitude of this coefficient seems unreasonable in view of the severe restrictions on imports since the late 1970s. Relative prices exert a dampening effect, much larger than that obtained by the AKM.

- The single most important determinant of capital goods imports is the inflow of capital: a 1 per cent increase calls forth a 2 per cent rise in such imports. GDP is also of considerable importance, suggesting a linkage between capacity and capital imports.

- GDP is the single most important determinant of the import of raw materials and intermediate goods, producing a coefficient of 1.7. The AKM, which uses capacity utilization, found a greater dependence - with a coefficient of 1.9. Capital inflow exerts a major stimulus on this category of imports in the export-led model. Relative prices in the AKM have a greater impact on the import of raw materials and intermediate goods.

- In congruence with the basis thesis of the export-led model, the estimate of the output equation shows that exports provide a big boost to output: other things being equal, every 1 per cent rise in exports lifts output up by 0.8 per cent. Taxes do not appear to be a major constraint to output in Guyana. Together these two variables explain 90 per cent of the variation of output. For purposes of comparison, St. Cyr and Charles (1992), in their export-led model of Trinidad and

Tobago, obtained a coefficient of 1.15 on exports while taxes in their equation have a positive impact on output.

- The accelerator variable in the function for domestic investment is crucial. A 1 per cent increase accelerates investment by 1.5 per cent, much higher than the estimate obtained by the AKM. As expected by the export-led model, foreign capital inflow impacts heavily upon investment, which can be taken as an indication of the dependence of the economy on external capital.

- Inflationary expectations are the most crucial determinant in the inflationary process, according to the export-led model. A similar finding was produced by the AKM, although both models use different methods of obtaining values on inflationary expectations. After one year, a one percent change in the money supply drives prices up by 0.28 per cent; the impact of foreign prices is slightly smaller. Wages have only a marginal impact on the inflationary process.

In terms of model performance, the AKM appears to dominate the ELM on a number of dimensions. For the historical simulation run, the ELM produced root-mean-squared percentage errors for investment, depreciation, government revenue and expenditure which are more than twice those for these same variables in the AKM. Using gross domestic investment, the evaluation of the turning point accuracy revealed that the AKM missed or generated as extras zero troughs and 2 peaks. On the other hand, the ELM missed or generated as extras 8 troughs and 6 peaks. The long-swing accuracy, also done for investment, indicates that the AKM simulated the data equally well in both the upswing and downswing of the economy since 1960, a superior performance than the ELM. The out-of-sample ex post forecasting exercise demonstrates that (a) the ELM suffers a slower rate of deterioration as the forecast horizon is extended, and (b) for both the one-period and two-periods forecasts, the ELM recorded much higher root-means squared percentage errors. Finally, the encompassing-related test demonstrated the dominance of the AKM in "quasi ex ante" forecasting, although it also establishes that the ELM does contain information for forecasting investment not contained in the AKM.

A deliberate and concerted effort has been made to model a realistic representation of the Guyanese economy. This provides the rationale for discussion of the performance of the economy, its structural features, saving and investment, the balance of payments and the problem of the debt in Part 1 of the dissertation.[2] Of course, a model can be built in a vacuum but this is like dancing a tango solo: it is a lot easier, but it is incomplete and ultimately unfulfilling. Among other things, the discussion underscores the importance for (a) equations that attempt to explain the behavior of "key" sectors of the economy, including the important role of the government since the mid 1970s and the monetary sector; (b) the clear establishment of linkages; and (c) the inclusion of institutional/policy constraints into the model.

Since 1977, the Guyanese economy has been gripped in a protracted crisis from which has yet to extricate herself. Production of all major commodities has declined drastically as did per capita income which never surpassed the US$600 mark. With a population of 800,000 in 1988, income per inhabitant was only US$400, down from the peak of US$540 in 1980. Indeed, according to the World Bank (1990b), Guyana has the lowest per capita GNP in the Caricom region.

The three principal *structural* features of the economy inherited from colonialism remain firmly entrenched despite the declaration in 1970 by the previous government that the country would follow a socialist path to development. These are:

High Degree of Openness: The economy was founded as an export enclave and it has yet to throw off the fetters of heavy export dependence. In 1948 exports accounted for 34 per of GDP, rising to 60 per cent in the period 1980-88. Similarly, imports as a share of GDP grew

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[2] Another reason for length of Part 1 is that no such detailed review of the economy over an extended period exists.

from 39 per cent in 1948 to 70 per cent during 1980-88. An important feature of the Guyanese economy, therefore, is that, while it is heavily dependent on foreign trade, it is more import-dependent than export-dependent. The very high foreign-trade dependency thus provides a ready conduit for the transmission of upheavals in the international economy to the domestic economy.

High Commodity Concentration of Exports: The enclave-type Guyanese economy is heavily dependent upon three commodities - bauxite, sugar and rice - for a large portion of its export earnings. More importantly, this heavy dependence upon a narrow commodity bundle has risen, not declined, over time. In 1951, about 55 per cent of the value of total merchandise exports derived from rice and sugar but by the end of the 1970s this statistic rose to over 80 per cent, with the addition of bauxite. In the 1980s the reliance upon these three commodities decreased moderately, mainly because of the virtual cessation of bauxite production and not because of any fundamental change in the structure of production.

High Investment Ratio: Among developing countries, Guyana boasts one of the highest rates of investment. Throughout the 41 years between 1948-88 the investment share (investment/GDP) fell below 20 per cent only 9 times. For the last decade the country has been investing an average of 30 per cent of her GDP. By comparison, the average for Latin American and Caribbean countries during 1980-89 was about 20 per cent of GDP. In the case of Barbados, Jamaica, and Trinidad and Tobago, the other three MDCs of the Caricom region, the ratio of investment to GDP was 19.6, 21.7 and 24.4 per cent during 1981-86, respectively.[3] The relatively high investment rate in Guyana is a precondition for productive activities, a major share of which has to be made in infrastructure. The core of the country's productive apparatus is so situated that it has to be protected from both the sea in front and from flood waters on the west. Of importance here, too, is the fact that the country has a very high capital/output ratio, which is partly a reflection of the necessity for heavy investment as

[3] For a more detailed discussion of investment in Guyana, see Chapter 4. The World Bank (1990a) contains a brief discussion of savings and investment in member countries of the Caricom region.

well as her heavy dependence on foreign trade, most of it in primary commodities. How is this high level of investment financed? A considerable portion of it, over three-quarters, was financed by foreign borrowing during 1975-88. Thus, in addition to import and export dependence, there is a third dependence: dependence upon foreign capital to close the saving-investment gap.

Three other additional features have become evident in the post-independent period:

The Dominant Role of the Public Sector: For most of its history the Guyanese economy was driven by private initiative with minimal interference by the state. This, however, was dramatically altered shortly after independence in 1964. After Guyana became a Cooperative Socialist Republic in 1970, the Government embarked upon an ambitious nationalization program and by the end of the 1970s all major foreign enterprises in agriculture, manufacturing, transport, distribution, engineering and banking were taken over. At the same time the role of the central government expanded rapidly - in social services, housing, investment, mushrooming government ministries, the military, and so on and by the beginning of the last decade about 80 per cent of the economy was owned and controlled by the public sector. The domestic private sector was deliberately reduced and constrained through counter-productive government policies.

The Twin Deficit: This refers to the recurring and persistent fiscal deficit and the deficit on the current account of the balance of payments—indicators of a fundamental macroeconomic imbalance. While both deficits existed since the 1950s, they have become regularized and very pronounced since the 1970s. During 1948-75, the fiscal deficit averaged 5.4 per cent of GDP, but ballooned to 48.8 per cent during 1975-88. Similarly, the current account deficit as a percentage of GDP increased from an average of 8 per cent in 1948-59 to about 27 per cent in the last decade, which meant that the country's external indebtedness could only have increased. In a nutshell, although the problem of the twin deficit predated independent Guyana, it because much more burdensome and recurring during the post Republic era.

Monetization: During the 1960s, M1 grew at about 5.2 per cent a year; M2 increased at twice that rate; and the fiscal deficit averaged 5 per cent of GDP. These relatively calm rates gathered considerable momentum in the 1970s, reaching record levels during 1980-88: both M1 and M2 grew by 22 per cent a year, while the deficit reached an average of 58 per cent of GDP. The growth of money was clearly stimulated by the magnitude of the deficit, especially so because of the growing difficulty of obtaining external funding which meant that the government increasingly turned to the banking system. Indeed, in 1983 the bank of Guyana was effectively muzzled in that its authority to contain government borrowing was removed.

A review of the literature on macroeconometric models and other empirical studies is undertaken in various chapters of Part 2 of the dissertation. Chapter 9 discusses the principal approaches to modelling in the region; identifies outstanding modelling issues; and briefly reviews the main features of individual models. The empirical results of these studies are discussed at the beginning of the remaining chapters in Part 2. There are two reasons for the review of the literature. First, it serves to guide and inform the present model-building effort and, second, it is intended as an *ad hoc* synthesis of published empirical research in the region. To my knowledge, a synthesis/review of such studies in the region does not exist.

There are three approaches to macroeconometric modelling in the Caricom region (a) Keynesian, (b) export-led, and (c) two-sector. The most widely used approaches are the Keynesian and export-led approaches, with the basic distinction being the treatment of exports. Within the Keynesian framework exports are generally treated as a stochastic variable while export-driven models assume that exports are determined exogenously. The third approach, which could be called the two-sector approach, is basically an extension of monetarist analysis to open economies. A common premise of all approaches is that the regional economies are very open and that this should be prominently featured in any modelling effort.

Empirical work, including macroeconometric modelling, in the region has encountered several problems. An important issue concerns the data - its quality and length of the series. For most series, the starting point is 1960; i.e., there are about 30 data points on each series. The way various series are measured is not clear nor is the method of data collection. In the case of Guyana, the quality of the data actually declined in the 1980s (World Bank, 1986). The quality of the data is undoubtedly an important reason why macroeconometric models have not been taken seriously in the region.

One pervasive feature of empirical work in the region is the failure to deal with serial correlation. The continuing presence of this problem casts a serious shadow on the reliability of estimates obtained and could jeopardize the use of empirical models, macroeconometric or otherwise, in the region. Considerable work has been done on aggregate money demand relations but a number of unsettled issues remains. First, while the linear homogeneity postulate is taken as sacrosanct in other places, Caribbean researchers have questioned its validity, although the evidence seems to point in favor of its acceptance. The point, however, is that it is necessary to test this assumption against the data before attempting to specify the demand for money function. If the data do not support the homogeneity postulate, then the left-hand variable in the function must be in nominal terms. There is, secondly, some uncertainty as to whether the appropriate left-hand variable should be a narrow or broad monetary aggregate. To avoid this predicament, some researchers have used both M1 and M2. As in other countries, the latter may be more appropriate since the traditional relationship between M1 and output may not exist anymore, given the spate of financial liberation and innovation to which the region has not been immune.

What should the scale variable in the demand for money function be? This is another unsettled issue and some researchers (Coppin, 1991, for example) have argued that the scale variable should not be selected *a priori* in the context of an open economy. Possible candidates include expenditure, wealth, imports, income, the sum of imports and exports. Other issues include the appropriate opportunity cost variable and the need to test the temporal stability of the estimated relationships. The latter has been a much neglected area.

Empirical work in the region must pay greater attention to the actual specification of the equations themselves. There is, for example, a need for a common agreement as to which key behavioral variable (or portion of it) should be kept exogenous. Many equations are rather simplistic, usually with only one or two explanatory variables, which may or may not be appropriate. Frequently, these equations have a very low D.W. statistic which is indicative not only of serial correlation but, more importantly, of misspecification. In other words, both the range and the specific explanatory variables themselves are areas of concern. Should the function be linear or log-linear? Should it be in levels of first differenced? Are the variables stationary? With a binding time constraint and/or data problems, I have tried to consider at least some of these issues in this dissertation.

PART 1 - THE ECONOMY

Part 1 contains a review of the performance of the Guyanese economy during the 1948-88 period. Two major economic cycles have been identified: a long upswing from 1948 to 1975 and a downswing for the rest of the period. The structure of the economy, savings and investment, government revenue, expenditure and the fiscal deficit, the balance of payments, and the problem of the debt, both internal and external, are examined in some detail. The discussion is principally intended to inform the model-building effort, undertaken in Part 2, as to the structural, institutional and cyclical features of the economy. In addition, any useful model of the economy must be able to duplicate these cycles reasonably well.

CHAPTER 2

The Performance of the Guyanese Economy

Guyana was thought to be the location of the fabled city of El Dorado whose streets were supposed to be paved with gold. This magnet opened up the colony to the marauding attempts of anyone who dared to brave the Amazon. Today, almost 400 years later, the country remains open, not to dreams of fabulous and instant riches, but to the rhythm of the international business cycle, the effects of which have been accentuated by domestic policies over the last two decades or so. And although there have been "golden periods," there is nothing in the performance of the economy over the last two decades to suggest even the slightest semblance of gold.

The discussion that follows shows that during the 41 years between 1948 and 1988, the economy was characterized by two relatively long cycles: an upswing lasting until 1975 and a pronounced downswing from which the economy has yet to extricate herself. In what follows I attempt to highlight the principal dimensions of this crisis through a consideration of several major macro-economic indicators.

The Shrinking Economy

During the 41 years between 1948-88 real GDP[1] grew by an average of 1.8 per cent but this average figure masks the considerable degree of fluctuation of the growth rate, both nominal and real, of GDP (chart 1). During this time the growth rate of real GDP wandered between 11.0 and - 13.6 per cent, establishing the upper and lower bounds of the growth trajectory. What is interesting is that the actual growth path was characterized by "wobbles" up-down movements that were stretched out over time.

Over the entire period, GDP registered negative rates of growth 12 times: 6 during the 29 years between 1948-75 and 6 during the 13 years between 1976-88. Actually, this periodization is quite appropriate. The first period, 1948-75, was in, in effect, the upswing of a long cycle which was characterized by robust rates of growth, exceeding 3 per cent in 16 years and averaging 3.4 per cent during the entire period. The robust growth of the Guyanese economy was aided by a number of factors, including extensive investment in, and maintenance of, infrastructure, a literate population supported by a reputable educational system, domestic policies that facilitated the productive sectors and abundant natural resources. During these twenty-eight years, the impressive growth record was punctuated only six times by negative values. The deepest, 12.4 per cent in 1963, was the result of a long general strike over labor legislation when almost one-half million mandays were lost. It is

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1 All variables in Part 1 are in nominal terms, except per capita GNP and the rate of growth of GDP. Data used by this study have been obtained from numerous sources. The nominal values for all pre-1960 data series have been taken from David (1969); Kundu (1963, 1963a); O'Loughlin (1959); Odle (1976); United Nations (1980); and World Bank (1953). Post-1960 nominal data have been obtained from the Statistical Appendices of various reports by the World Bank (1973, 1981, 1982, 1984, 1985, 1986, 1990b, 1990c, 1991,1992); the International Monetary Fund (1990, 1992); the Bank of Guyana (1990); and Thomas (1984, 1988). To obtain the real values of variables, nominal variables have been deflated by the Consumer Price Index (CPI), base 1987. A consistent CPI series with 1987 as the base was obtained by rebasing series with various base years, using standard procedures. (For a discussion of the methodology, see Karsten, 1990, Ch. III). The choice of 1987 as the base year is consistent with World Bank (1991).

In sourcing tables and charts throughout this study, this footnote will be referred to if the data are obtained from all or most of the studies cited here, otherwise the specific studies will be given.

Chart 1 - Nominal and Real Growth Rate of GDP, 1949-1988

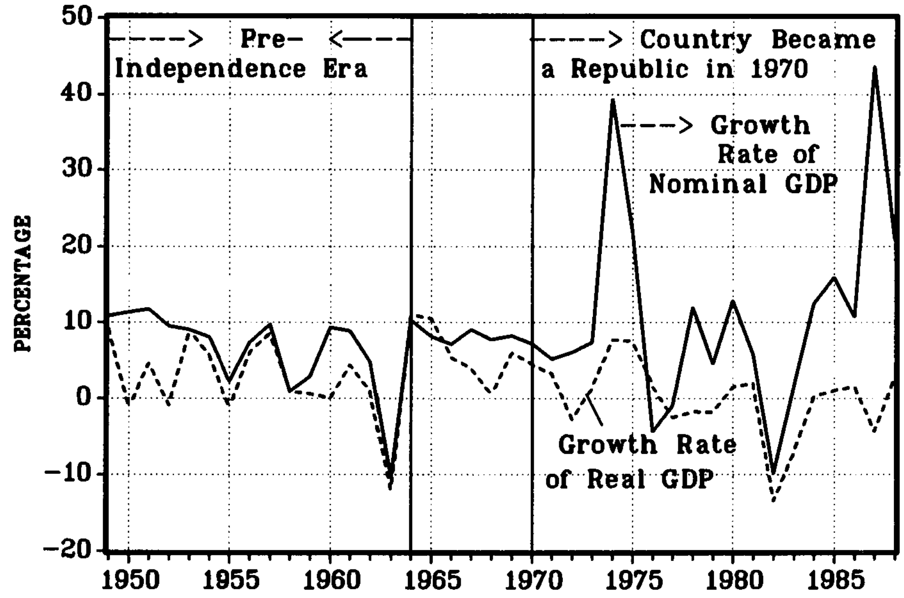
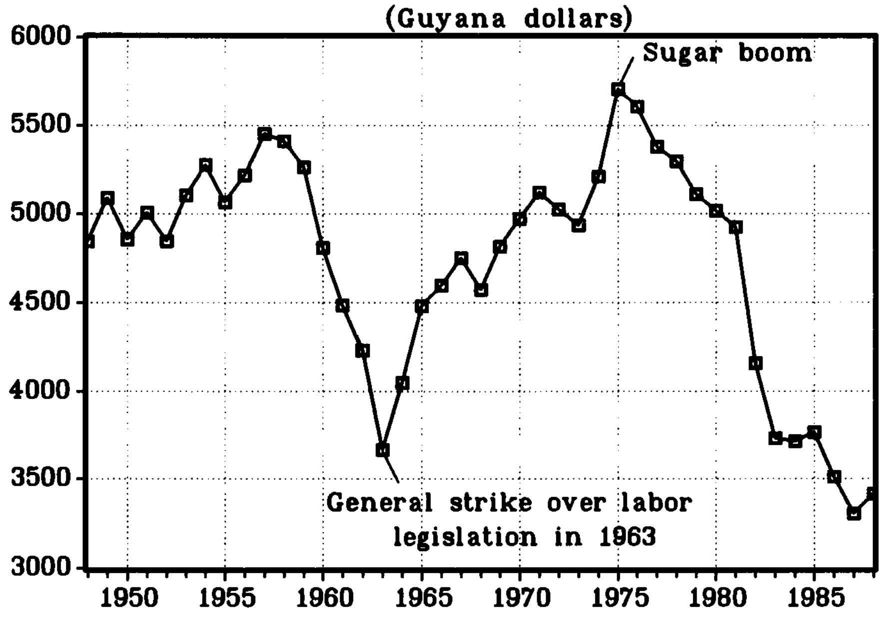


Chart 2 - Real Per Capita GNP, 1948-1988 (Guyana dollars)



Sources: Footnote 1, p. 15

remarkable that GDP continued growing despite serious riots over the budget proposals in 1962 and an explosion of racial violence during the sugar workers' strike in 1964. The fleeting sugar boom (1974-75) brought high real growth rates of over 7 per cent a year - rates which have not been seen since the country became an independent nation in 1966.

The second period, 1976-88, the long downswing, was a particularly dismal period in terms of economic performance, with real GDP declining by an annual average rate of 1.6 per cent. The downturn of the economy began immediately after the short-lived sugar boom and was a time when negative growth became an entrenched feature: half of the negative rates of growth during the 41 years occurred in these 13 years of the downswing. After three straight years (1977-79) of contraction in real terms, GDP grew anemically for the following two years. In 1982 real GDP fell by 13.6 per cent - the largest decline in the 41-year period - as output of the major export commodities declined steeply coupled with an increasingly unfavorable terms of trade. Indeed, in 1982 total merchandise exports amounted to $755 million compared to $969 million in the previous year, representing a decline of 22 per cent.[2] The brief revival during 1984-86 was too feeble to regenerate the engines of growth. Thus since 1976 the Guyanese economy has been contracting in real terms, gripped as it is in a prolonged and deep crisis.

The shrinking economy may be seen more graphically in terms of real per capita GNP (at 1987 prices) which, excluding the troubled years of 1962-64, increased almost steadily for about twenty five years (chart 2). The highest level of GNP per inhabitant, almost $10,000, was recorded in 1975, the peak of the sugar boom. From thereon a steady decline began and by 1981 GNP per person was about $5,200. In the following year per capita GNP dropped by about 25 percent to $3,773 and continued to contract for the rest of the decade. In fact, during the latter half of the 1980s GNP per inhabitant was some 40 per cent less than what it was in the late 1940s and early 1950s. In other words, as the decade of the 1980s drew

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[2] Throughout this dissertation, all amounts refer to Guyana dollar, unless otherwise indicated.

Chart 3 – Annual Rate of Inflation, 1948– 1988

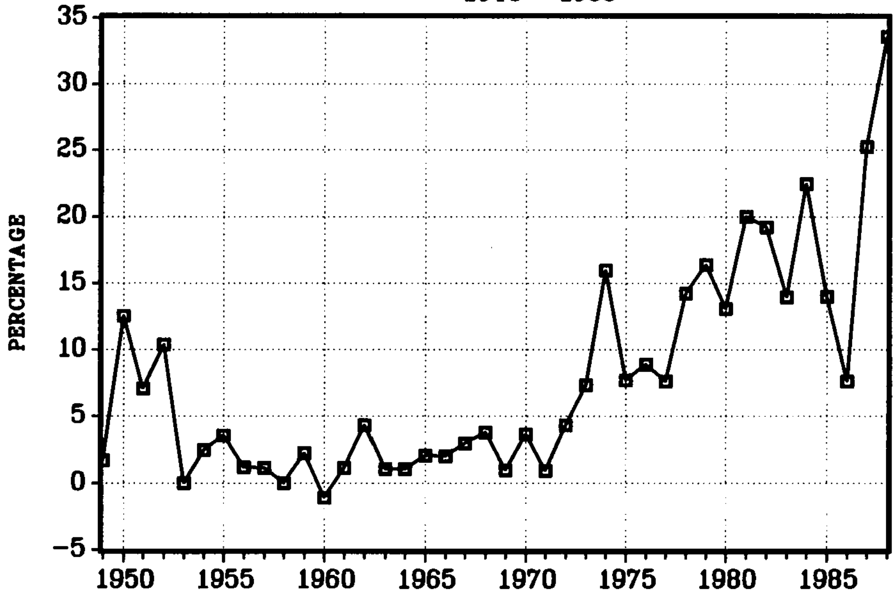
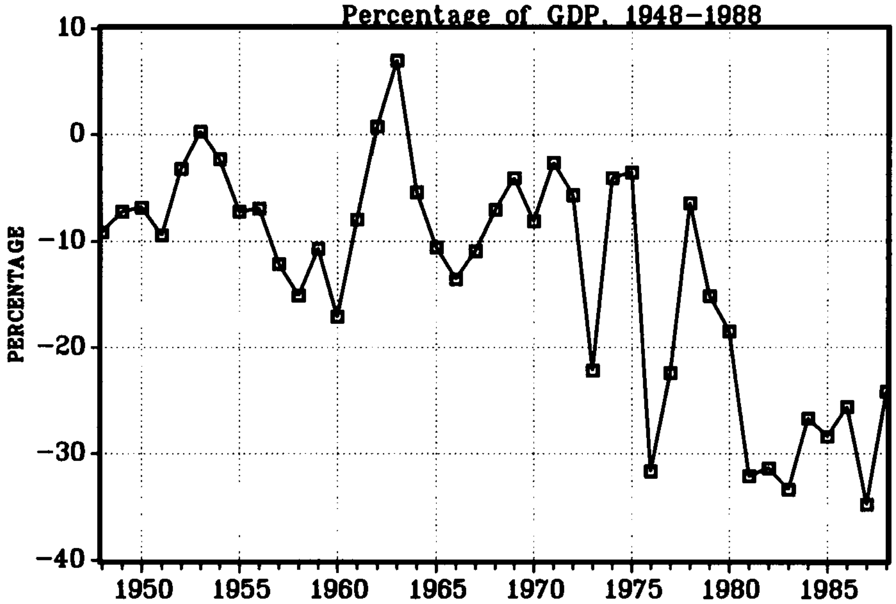


Chart 4– Current Account Balance as a Percentage of GDP, 1948–1988



Sources: Footnote 1, p. 15

to a close, the living standards of the Guyanese population was far below what it was 35 years ago. This is most certainly a traumatic experience for a population accustomed to a much higher standard of life.

Inflation, having declined from a peak of 13 per cent in 1950, settled down to modest rates between 1953 and 1972, averaging only 1.9 per cent annually (chart 3). Low rates of inflation were characteristic of other Caribbean countries during this period. By contrast, during 1978-88, or most of the downswing, inflation was the scrooge of the Guyanese economy: more than 18 per cent per annum. Even so, as will become clearer later, the official rates of inflation have been considerably underestimated. Nevertheless, such unusually high rates of inflation were especially devastating to business and the poor who now constitute a large sector of the population.

A final barometer of the country's economic health may be seen in the behavior of the current account balance (chart 4) on the balance of payments. The country is not generally known for running a current account surplus - in fact, during the 41 years this happened only three times: 1953, 1962 and 1963. But it is the behavior of the deficit on this account that is revealing. As a share of GDP, the deficit on the current account averaged only 5.8 per cent between 1948 and 1956. In the following year the pace quickened and remained at a relatively high level for the next 4 years, averaging 13.8 per cent per annum. However, this period, 1957-60, was one of heavy capital investment in the bauxite industry. The years 1962-63 registered a current account surplus which was due to the intense social unrest which disrupted productive activities and led to a loss of confidence by investors. Investment and hence imports thus declined. The oil crisis of 1973 produced the largest current account deficit thus far in the country's history: $139.3 million or 21.6 per cent of GDP but this was quickly dampened by the sugar boom in the following two years. The next 13 years, 1976-1988, experienced particularly high current account deficits, averaging 24.6 per cent of GDP. The largest deficit ever recorded was in 1987, totalling $1,187 million or 35.4 per cent of GDP (chart 4). The current account balance thus confirms the periodization above: relatively good performance during 1948-75 but deteriorating considerably for the rest of the period. The promise and subsequent crash of the Guyanese economy was also noted by Worrell (1987:204) who writes:

> Although they both had serious problems of unemployment and uneven distribution of resources, Jamaica and Guyana were the countries [of the Caricom countries] with greatest promise in 1970. Each country had a good record of recent growth, encouraging market prospects for its exports, unexploited natural resources, and some of the skills needed for the development process. These proved to be the two countries turning in the worst performance, with real income per head in 1984 falling below that for 1970, by a considerable amount in Guyana's case.

Continuing economic difficulties combined with political problems led to an ever-increasing exodus of Guyanese abroad. In fact, the country's population, standing at 800,000 in 1989,[3] is now believed to be decreasing in absolute terms, mainly because of out-migration.[4] Recently, the French (1991:A2 L), writing in the New York Times, observed that:

> ... every flight that leaves here (Guyana) these days carries away 20 Guyanese emigrants, part of an estimated 5 percent of the population that is now thought to be leaving each year.

Clive Thomas (1988), a respected Guyanese and Caribbean economist, points out that the rate of migration was conservatively estimated at over three-quarters of the natural population increase. He writes "Less conservatively, estimates indicate an absolute decline in the population since 1975" (p. 256).

The plight of the country, which trails closely behind Haiti with a per capita income of US$340 in 1989, is best summed up by French who wrote that "In 27 years of rule by the

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[3] Between 1980-89, only 40,000 persons were added to the population. It is not surprising, therefore, that the rate of growth of the population declined from 0.68 per cent in 1980 to 0.13 per cent in 1989, according to official figures (World Bank, 1991: 288-89.)

[4] The reliability of official population statistics, including those of the World Bank and the Government, are widely questioned. See Clive Y. Thomas (1989: 138, 140).

People's National Congress, Guyana has been driven from breadbasket of the Caribbean to contender for the title of the hemisphere's poorest nation" (French, 1991). Similarly, the World Bank (1992:1) observes that "Guyana is one of the poorest countries in the Southern Hemisphere, having a per capita income of only $360 in 1990."

In a fact-finding mission to Guyana in October 1990, the Caribbean Conference of Churches found a depressing "psychological mood" among Guyanese which found expression in "a powerful and pervading sense of hopelessness and sadness." Three main factors have contributed to this: a racial factor, a political factor and an economic factor. As regards the latter, the mission notes that "... a clinching factor has been the economic collapse. The country's physical infrastructure is in a state of advanced decay," (Carib News, Vol. IX, No. 453, New York, May 28, 1991:36). The 1980s, in particular, was a period in which most of the country's physical capital, infrastructure, and human capital stock have been squandered and/or devastated, seriously constraining production from the supply side.

What is evident from this discussion is that the economic optimism of pre-Republic Guyana collapsed into an economic malaise. Closer examination reveals that the crisis is essentially one of production and not marketing, as would be shown in the next section. As the crisis lingered on, the outward trek of skilled manpower swelled; a feeling of hopelessness pervaded the society, with its inevitable negative impact on morale; and capital stock, and thus productive capacity, contracted. In short, the Guyanese economy has been spiralling downwards since the mid 1970s and there is apparently no hope of arresting this trend, at least up to the end of the sample period.

Falling Production

At the heart of the prolonged economic crisis is the rapid decline in the production of two of the three major export commodities. What was the basic cause for severe the shortfall of production? The analysis below argues that internal factors were the principal reason for declining sugar production and the rather tepid increase in rice production. In the case of bauxite, the drastic reduction in output was brought about by both internal factors and a loss of market share.

Major Export Commodities

Available data on sugar production show that output enjoyed a relatively smooth and high growth rate from the early 1940s to 1960. Output continued at a high level for the next 20 years or so although it fluctuated considerably and then inclined downwards for the rest of the period (chart 5). In quantitative terms, the output of sugar averaged 256.9 tons per year during 1940-88, although there was considerable fluctuation around this average as shown by a standard deviation of 62.8 and a range of 138.5 to 368 tons (table 1). During the last decade output averaged 242.1 tons which was only 78 of the average level in the 1970s. More importantly, it is apparent that output became much more stabilized at this lower level as its standard deviation fell to 47. The decline in the output of sugar accelerated after 1982, averaging 230 tons per year or only about 72 per cent of what it was in the 1970s. In 1988 output was basically at the level of 1940.

Rice production increased rapidly between 1940 and 1966, especially during the last nine years of this period—years that rice production received a considerable boost from the government of Dr. Cheddi Jagan. Indeed, Dr. Jagan's Administration was called the "Rice Government" and by implication a government that favors the Indo-Guyanese population who produces almost all of the nation's output of rice. The next ten years experienced a slower and

Chart 5 – Production of Sugar and Rice, 1948–1988

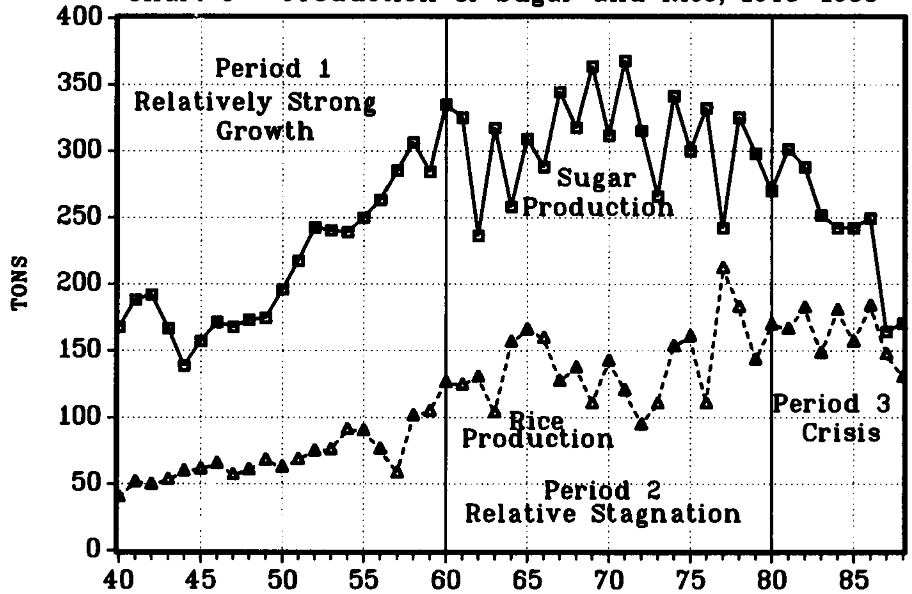
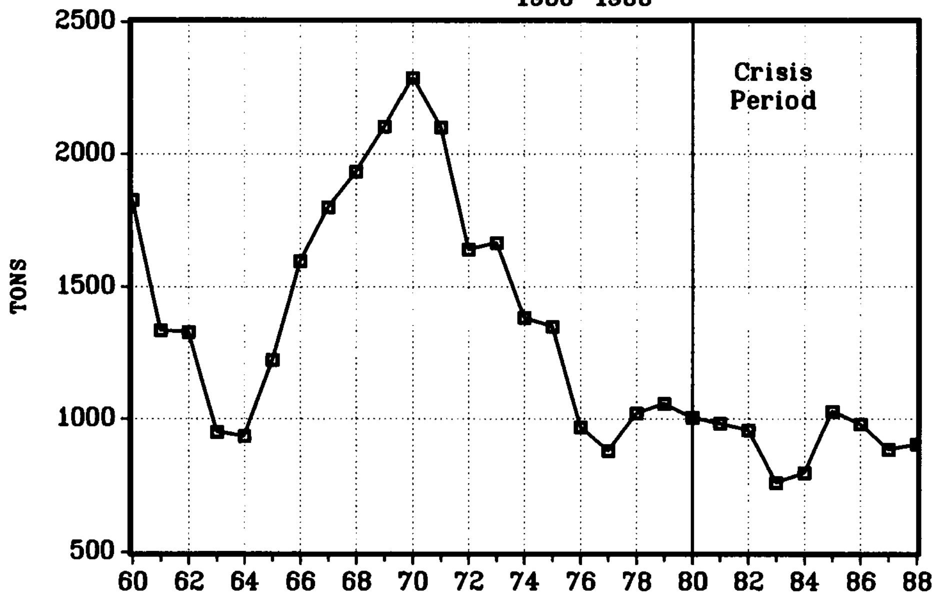


Chart 6 – Dry Metal Grade Bauxite Production, 1960–1988



Sources: Footnote 1, p. 15

oscillating rate of growth, although output remained at relatively high levels (chart 5 and table 1). From then until about 1985 the output of rice reached even higher levels but declined in the closing years of the decade. In general, then, it can be said that the production of rice, unlike sugar and bauxite, continued to grow for about 45 years before succumbing to the Guyanese "blight," as locals put it, in an attempt to place the major blame for the crisis on the PNC[5] regime (more on this later).

The most severely affected industry is that of bauxite, which has been the largest export earner since the 1960s. The three most important grades of bauxite produced by Guyana are dried metal, alumina and calcine bauxite. The output of dried metal grade bauxite, after a sharp fall in the early 1960s, grew steeply until 1970 and declined almost as steeply for the next seven years; the deterioration continued until the end of the 1980s, but at a diminished pace. In fact, since 1981 the output of metal grade bauxite has, in general, been below 1,000 tons, which is 40 per cent of the average level achieved between 1965-76 (chart 6 and table 1). Production of calcined bauxite also grew at a high rate between 1960-75, which was followed by declining output until 1983. But after the brief spurt in 1984-85, the downward slide continued until the end of the decade. The lower levels of output in the 1980s, particularly towards the end of the decade, were only about 64 per cent of the levels recorded in the previous decade (chart 7 and table 1).

Alumina, refined from crude bauxite and the gem of the Guyanese bauxite production, commands relatively high export prices. Rising from 130 tons in 1961, production fluctuated between 200-300 tons per year until 1978 after which it remained at greatly depressed levels for the next three years. Then in 1983 production nosedived to an all time low of 93 tons but the worst was yet to come: for the rest of the decade production plummeted to zero (chart 7 and table 1)! Thereafter, the alumina plant was closed down (Thomas, 1988).

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[5] The People's National Congress (PNC) came to power under suspicious circumstances in 1964 and remained in government until October 1992, when it was defeated in what was billed as the first democratic election in 30 years.

Table 1. The Three Principal Export Commodities: Mean Output, 1940-1988
('000 of tons)

		Mean	Std. Dev.	Max. Value	Min. Value
Sugar	1940-88	256.9	62.8	368.0	138.5
	1940-49	169.5	14.9	191.8	138.5
	1950-59	252.4	33.3	306.4	195.7
	1960-69	309.2	38.9	364.0	236.0
	1970-79	309.8	56.3	368.0	242.0
	1980-88	242.1	47.0	301.0	242.0
Rice					
	1940-88	113.8	45.6	211.5	39.4
	1940-49	56.0	8.2	67.5	39.4
	1950-59	79.5	15.8	104.1	57.5
	1960-69	133.7	20.7	165.0	103.0
	1970-79	142.5	36.1	211.5	94.0
	1980-88	162.2	18.4	183.2	130.0
Metal Grade Bauxite					
	1960-88	1,299.7	446.6	2,290.0	761.0
	1960-69	1,503.4	410.3	2,105.0	935.0
	1970-79	1,435.7	485.1	2,290.0	879.0
	1980-88	922.3	93.4	1,028.3	761.0
Calcined Bauxite					
	1960-88	536.9	136.4	778.0	310.0
	1960-69	456.3	106.4	644.0	317.0
	1970-79	680.5	68.7	778.0	568.0
	1980-88	466.9	87.7	591.6	310.0
Alumina					
	1961-88	245.0	60.8	312.0	93.0
	1961-69	252.6	53.8	298.0	130.0
	1970-79	264.6	46.9	312.0	159.7
	1980-82	157.2	59.9	211.5	93.0

Sources: See footnote 1 on page 15.

Chart 7 - Alumina and Calcined Bauxite Production, 1960-1988

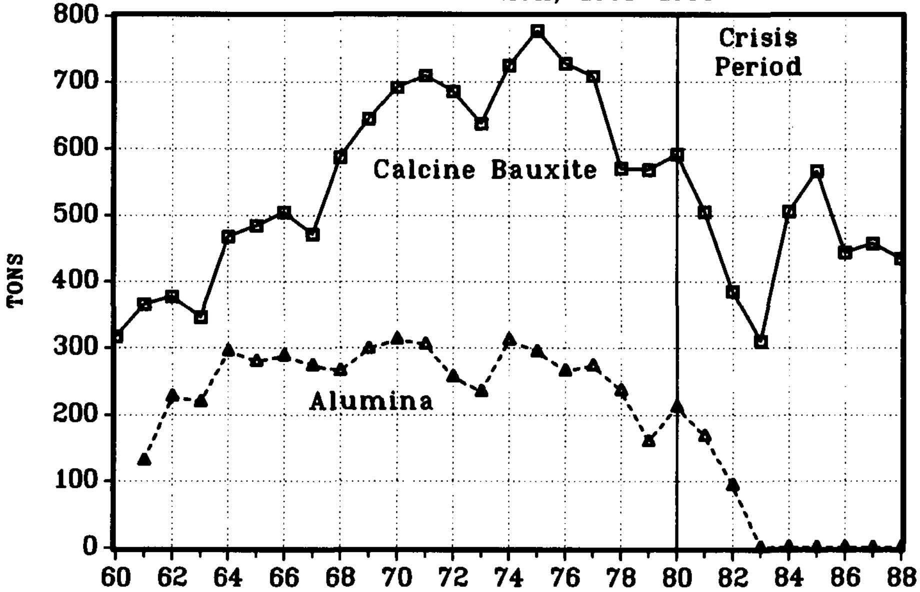
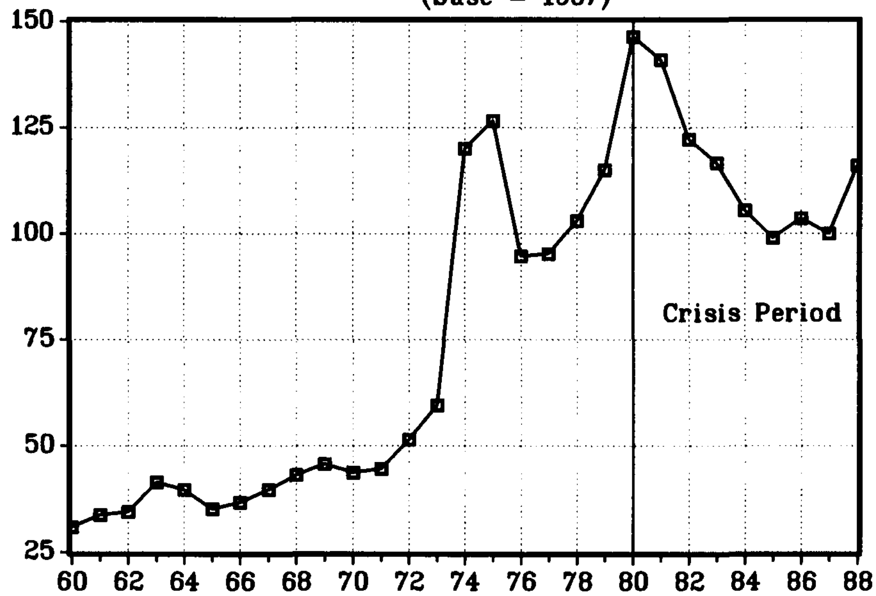


Chart 8 - Export Price Index, 1960-1988 (base = 1987)



Sources: Footnote 1, p. 15

From the foregoing discussion and the accompanying charts 2.5 to 2.7, it can be seen that the production of rice and sugar moved through three periods since 1940. The first, 1940-60, was characterized by relatively strong growth as the outputs of both commodities increased steeply (chart 5). The second period, spanning the two decades between 1960 and 1980, was distinguished by relative stagnation and frequent oscillation of output, almost on a yearly basis. The third period, i.e., the decade of the 1980s, was one of decline and crisis, especially for sugar. The production of bauxite, the third major export, did not reach significant levels until after 1960, but depressed levels of all grades of bauxite were evident in the 1980s. Indeed, in the case of alumina production ceased altogether as from 1983.

Did the export demand for Guyana's three main export commodities negatively affect domestic production in a substantial way? At a first level, consider chart 8, which is a graph of the (consolidated) export price index. In general, the index indicates increasingly favorable export prices during 1960-80, especially during 1973-80. For the rest of the sample period, 1981-88, the index began to decline but for most of the time it may be said that export prices were still favorable. In other words, the export price index does not convey an impression of an export price squeeze strong enough to depress output to the low levels of the last decade.

Now consider table 2 which shows relevant data on world export of rice, sugar, bauxite (which includes calcined and metal grade bauxite) and alumina. According to the data, world export of both rice and sugar have, in general, increased. Compared to the 1970s, the average world export of rice and sugar in the 1980s was, respectively, 35 and 1.3 per cent higher. Other things being equal, rising exports of these commodities should provide a stimulus to domestic production,[6] which did not happen at least for sugar, bauxite and alumina. The average yearly output of sugar in the 1980s was 22 per cent below the level of the previous decade, while the drop was steeper for all three grades of bauxite - more than 30 per cent in each case. The only major export commodity that recorded higher average output in the 1980s

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[6] About one-third of Guyana's rice production is exported. Sugar is a predominantly export-oriented crop, with 90 per cent of the output destined for foreign markets.

was rice, which was 8 per cent higher than the average level recorded in the previous decade.

Table 2. World Export of Aluminum, Rice and Sugar, 1971-1988

('000 of tons)

	Mean	Std. Dev.	Max. Value	Min. Value
Sugar				
1971-88	18,024	1,713	21,836	16,214
1980-88	18,261	950	20,314	17,048
Rice				
1971-88	9,266	1,316	11,818	7,767
1980-88	12,466	682	13,093	11,433
Bauxite[a/]				
1960-69	19,550	3,472	25,449	15,682
1970-79	31,841	3,089	35,201	27,489
1980-88	32,527	2,877	38,624	29,913
Alumina				
1960-69	1,574	822	3,293	704
1970-79	5,789	1,147	7,299	3,809
1980-88	7,721	819	8,888	6,306

Note: The average world output of rice and sugar during 1961-65 was 254,550 and 56,753 thousand tons respectively.

a/ Bauxite includes calcined and metal grade bauxite.

Sources: FAO (1980, 1989, 1992) and UNCTAD (1984, 1985, 1988, 1991)

Might Guyana's production of these commodities decline because she was a high cost producer and thus unable to compete in the open world market?[7] Guyana is indeed a high cost sugar producer and, in fact, the sugar industry is only competitive at highest yields (Reca,

[7] Guyana's share of the world market for both rice and sugar is minuscule, accounting for an insignificant share of world exports (FAO, 1984). In the case of sugar, domestic production accounts for less than one-third of one per cent of world production (Inter-American Development Bank, 1981).

1982; World Bank, 1992). On the other hand, the country has a considerable comparative advantage in the production and export of rice: "Even under very restrictive assumptions, the CV of the country [in rice production] stands out distinctively" (Reca, 1982). The country also has a strong comparative advantage in the production of bauxite, particularly the high-value, high-grade, calcined bauxite.[8]

It turned out that neither the volume of world export nor cost considerations posed any significant difficulties to Guyana's export of rice and sugar: both commodities were exported to protected markets. Some 80 per cent of the country's total sugar exports is absorbed by the protected European Community and the US markets, both of which pay premium prices. But during the latter part of the 1980s, Guyana found herself unable to satisfy both of these markets (Thomas, 1988; World Bank, 1990a; Caribbean Insight, 1992). The bulk of the country's export of rice is destined for the Caricom region, with Jamaica and Trinidad and Tobago, absorbing as much as 90 per cent (Inter-American Development Bank, 1981). This report also noted that "There is a permanent excess demand for Guyana's rice in the CARICOM countries" (p. 71) where the price paid is "in excess of two-thirds above the world level" (Thomas, 1988:256).[9] Like sugar, Guyana's rice enjoys preferential access to the European Community (World Bank, 1992). But despite this potentially lucrative markets, Guyana was unable to adequately service them (Thomas, 1988).

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[8] Guyana's calcined bauxite is superior in quality to that of any of her major competitor. Brazilian bauxite has a finer particle size and hence prone to processing losses, while Chinese bauxite has a higher variability in aluminum oxide content (World Bank, 1992). As of 1985 Guyana was the eight leading bauxite producer of noncentrally planned economies, accounting for a little more than 3 per cent of total bauxite production. Even so, it is quite probable that the country had some impact on the bauxite market. Until 1981, when Guyana was ranked as the fifth major producer of calcined bauxite, her share of the world market was closer to 6 per cent and Guyana was ranked fifth (McCoy, 1989).

[9] Guyana's favorable position in the Caricom is partially due to the tariff exemption which she enjoys as a member country (common external tariff is 15 per cent), but other factors such as its proximity, which implies lower transportation costs, and a relatively high growth of rice consumption in the region are also important.

Given the above, it seems reasonable to argue that the production of both rice and sugar was not affected in any significant way by external demand. In fact, the decline of the sugar industry was essentially the result of internal, supply, factors, including (a) the deterioration of management capability as skilled managers migrated to foreign countries (World Bank, 1990a; Worrell, 1987); (b) labor unrest (World Bank, 1990a); (c) lack of foreign exchange that prevented needed re-investments to maintain the industry's assets (World Bank, 1992); (d) renewal of aging growths (ratoons) of sugar cane has not been carried out on schedule, with the result that 40 per cent of the sugar cane acreage is populated with fifth or older ratoons, with low yields (World Bank, 1990a); (e) subsidy on domestic sales which meant that until 1984 sugar was sold below cost of production, incurring large deficits to the sugar industry (World Bank, 1990a). A serious effort to redress the management problems was initiated in 1989 when the Government turned over the administration of the industry to Booker Tate, a subsidiary of the industry's previous owner (World Bank, 1992).

The Inter-American Development Bank (1981) places the blame for stagnation of the rice industry, given its potential, on internal constraints, not export market demand. These constraints include infrastructural bottlenecks, particularly deteriorating drainage and irrigation systems, labor shortages, low yield because of stagnating technology (World Bank, 1992), shortages of spare parts which are particularly severe given the high degree of mechanization in the industry and excessive government involvement (World Bank, 1990a; Inter-American Development Bank, 1981). While actual production of rice paddy is primarily in the hands of the private sector, the Guyana Rice Board (GRB), until the early 1980s, managed virtually every aspect of the sector, including input and output marketing, storage, milling, extension, research and credit distribution. Price and marketing controls increasingly taxed the sector, with the principal beneficiary being the GRB. The implicit taxation of paddy production imposed by controlled prices averaged 24 per cent from 1980-88. These problems prompted the World Bank (1992) to observe that many government interventions in the past decade were detrimental to the rice sub- sector.[10]

A principal reason for the poor performance of the bauxite industry is weak market conditions (World Bank, 1986). Two major factors have contributed to this—the general slowdown in the world steel industry which is the major consumer of calcined bauxite and loss of market share. Up to 1979 Guyana commanded about 85 per cent of the calcined bauxite market, operating as a monopoly through rationing supply to its customers. In the mid-1970s, China entered the high value refractory bauxite market and gained a significant share through aggressive pricing and sales efforts. As a result, Guyana's share of the market dropped to about 45 per cent by 1984. Marketing problems have been compounded by the entry of Brazil into the calcined bauxite market, but Guyana is apparently fighting back, having hired an external marketing agency. Nevertheless, despite unfavorable market conditions and the consequent loss of revenue, the bauxite industry did not take adequate steps towards adjustments and by the early 1980s serious financial problems developed. These were dealt with through increasing indebtedness and drastically cutting investment and long-term maintenance.

By the mid-1980s the financial problems, deriving mainly from a loss of market share, were compounded by serious difficulties on the production side. These include deteriorating mining and processing plant and machinery and equipment; lack of access to technological improvements; shortages of spare parts; gradual depletion of existing mining deposits; relative overstaffing which resulted from Government policies (World Bank, 1986); industrial relation conflicts derived from overmanning and deteriorating compensation; and a steady erosion of managerial and technical manpower capabilities due to the exodus of skilled manpower from the country. These supply side difficulties led to a steady contraction of production, increasing unreliability in the quality of output and high operational costs given the very nature of the bauxite industry—it is characterized by a very high fixed cost structure stemming from the

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[10] Poor pricing policies are also responsible for the decline in the profitability of rice production although aggregate production is quite inelastic to prices (World Bank, 1992).

capital-intensive nature of the operation, which has been compounded by poor cost controls. Falling production, rising costs and a poor quality product led to a loss of market share, which fell to about 30 per cent by the end of the sample period.

In sum, the decline of the once dominant Guyanese bauxite industry is the result of both supply and demand factors; i.e, it is basically a crisis of both production and marketing. Both sets of difficulties have been exacerbated by the fact that, after nationalization, Guyanese found themselves with an industry that they know very little about. Indeed, in 1991 the Government invited the two US companies that had their operations nationalized in the seventies to consider returning to Guyana by acquiring the Linden and Berbice operations.

Other Commodities

The crisis was confined not only to these major export commodities as is evident from table 3. The picture, in general, is one of deterioration, with the exception of fish and pork. Between 1970-88, the output of beef, poultry, eggs and shrimp declined by an annual average of more than 2 per cent. The output of timber, an important source of foreign exchange earnings, fell by 1.25 per cent a year during the same period, despite the presence of vast forestry resources. The cumulative movements of negative rates of growth of these commodities obviously add up to a massive impact over a relatively long period of time. For example, the outputs of beef and eggs in 1988 were only about one-half of what they were in the early 1970s. For poultry, shrimp and timber the cumulative decline was more moderate but even so none of them attained more than 72 per cent of the level reached in 1970. On the other hand, very rapid growth was recorded in the production of pork and shrimp; both more than doubled during the period.

The fate of the poultry industry is closely tied to the local production of stockfeed. Both industries grew briskly until 1981 after which a rapid decline began. During 1981-85 the output of stockfeed was only about one-half of the level achieved in 1974-80. The decline of the poultry industry was even more pronounced.

Other miscellaneous manufacturers also performed poorly. These include edible oil, soap, margarine, bacon and ham, sausages, flour, cigarettes, matches and garments. In general, the manufacturing sector contracted sharply in the 1980s, principally because of the shortage of foreign exchange, government policies and power outages.

Table 3. Mean Annual Rate of Growth of Other Commodities, 1961-1988

Commodity	1961-73	1974-79	1980-85	1985-88	1980-88	1970-88
Beef	1.03	-15.01	0.0	6.83	1.83	-3.76
Pork	...	4.25	-8.51	34.66	8.76	6.96[a]
Poultry	...	10.25	-22.07	-1.38	-10.82	-2.39
Milk	...	...	...	2.36[b]	...	...
Eggs	...	10.26	-0.89	-31.32	-14.58	-4.64[a]
Fish	7.28[c]	6.42	13.85	9.58	8.25	6.58
Shrimp	12.38	-8.09	-1.08	11.96	-1.32	-2.06
Timber	1.44	-6.65	-2.27	-5.36	-1.99	-1.22

[a] 1974-88
[b] 1984-88
[c] 1964-73
... data not available

Sources: Calculated from World Bank (1973, 1981, 1986,1992)

Box 1. The Two Economic Cycles in Perspective

Indicator	Full Period 48-88	Upswing 48-75	Downswing 76-88
Average growth of real GDP (%)	1.8	3.4	- 1.6
Growth of real per capita GNP	- 1.3	2.6	- 9.3
Real per capita GNP (G$, 1987 prices)	5,525.0	5,848.0	4,830.0
Growth of population	1.8	2.3	0.7
Population ('000)	629.0	563.0	770.0
Inflation	8.1[a]	3.8[b]	16.6
Interest rate (commercial bank lending rate)	9.1[c]	6.0[d]	12.9
Rate of exchange (G$ to US$)	2.7	1.9	4.1
Central Govt. current account deficit	- 6.5	0.7	- 22.4
Overall fiscal deficit as a % of GDP	- 18.5	- 5.4	- 46.8
BOP - current account deficit as a % of GDP	- 13.1	- 7.3	- 25.4
Growth of M1	14.3[e]	11.3[f]	17.8
Growth of M2	16.0[e]	13.2[f]	19.2
Growth of domestic credit	21.4[e]	14.7[f]	26.8
Growth of credit to the government	30.3[e]	29.5[f]	31.2
Growth of credit to the private sector	13.8[e]	8.5[f]	20.0
Investment as a % of GDP	24.4	21.5	30.7
Public sector share of investment (%)	61.3[c]	43.3[d]	83.5
Private sector share of investment (%)	38.7[c]	56.7[d]	16.5
Gross National Saving as a % of Investment	47.6[g]	66.4[h]	15.9
Gross National Saving as a % of GDP	11.2[g]	14.5[h]	5.8
Growth of internal debt		16.5[i]	22.4
Internal debt as a % of GDP		9.4[i]	159.8
Growth of external debt	16.2[j]	17.4[k]	14.3
External debt as a % of GNP	156.7[l]	35.8[m]	273.6
External debt as a % of exports	209.8[c]	64.3[d]	388.7
Total debt service charges as a % of exports	11.5[n]	4.9[o]	16.5
Export Price Index, base = 1987	78.8[c]	51.7[d]	112.1
Import Price Index, base = 1987	53.6[c]	25.9[d]	87.8

Sources: Footnote 1, page 9.

Notes: a = 1950 - 88; b = 1950 - 75; c = 1960 - 88; d = 1960 - 75; e = 1961 - 88; f = 1961 - 75; g = 1954 - 88; h = 1954 - 75; i = 1953 - 71;j = 1956 - 88; k = 1956 -75; l = 1955 - 88; m = 1955 - 75; n = 1966 - 88; o = 1966 - 75;

CHAPTER 3

Structure of the Economy

One of the most distinguishing features of the Guyanese economy is its narrow production base, a feature solidly entrenched over the last 150 years. The main commodity bundle comprises rice, sugar and bauxite, with the latter two geared primarily to export. Agriculture accounts for about one-quarter of the economy, but since the early 1970s the government sector has grown rapidly and by the end of the decade it was almost as big as the agricultural sector. Mining and quarrying, also of considerable importance, declined steadily in the 1980s. Both the manufacturing, and engineering and construction sectors averaged about 8 per cent of GDP during the entire period (1952-88). The domestic economy is also characterized by the lack of a capital goods industry of any significance. Against this background, it is not surprising that the inter-sectoral linkages in the economy are not strong.[1]

[1] The analysis in this chapter is premised upon data drawn from several sources which are given in footnote 1 of Chapter 2, p. 9.

The Narrow Production Base

From the very inception, economic activities in Guyana were geared towards the export market in Europe. At first a variety of crops were grown but the production base, such as it was, quickly narrowed to cotton, coffee, tobacco and sugar and by the end of the eighteenth century the colony was well-established as an exporter of staples (Adamson, 1972; Mandle, 1973). Between 1789 and 1802 the export of sugar climbed by 433 per cent, of coffee by 233 per cent and of cotton wool by 862 per cent. This period was in fact a 'golden age' of 'legendary profits' (Adamson, 1972) and for a short time it was a place where instant fortunes could be made— as close as one could ever get to El Dorado.[2]

By 1807 the boom was practically over for its 'engine', slave labor, was effectively stalled as slavery was prohibited after January 1, 1807. This, together with a higher slave death rate than birth rate, resulted in an absolute decline of the slave population. The economic response to this was to narrow the production base even further and by the early nineteenth century both cotton and coffee declined rapidly while sugar expanded. By the 1840s Guyana's narrow production base was solidly entrenched. Farley (1956) argued that sugar was chosen because of its relatively favorable price in the international market—it was widely demanded in Europe, both as sweeteners and for use in the condiments industry. This choice also marked the rise and dominance of the planation around which both economic activities and social intercourse centered. But it was also a choice to which the economic well-being of the country was tied and to which it is still bonded.

Even today, 150 years later, the export-type economy has been preserved but the commodity bundle on which it was based has expanded to three: sugar, rice and bauxite/alumina. Sugar, which in 1880 was responsible for 88 per cent of the total export

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[2] The 1980s was the only other time that the shadow of El Dorado was glimpsed. This was the period when the underground economy became firmly established and many new millionaires were made, as observed in the Chapter 4.

value of the colony, a figure that soared to 93 per cent three years later, is no longer the dominant export earner but is still of considerable importance to the economy in terms of contribution to GDP, employment, inter-industry linkages, political mileage, etc. But while the stranglehold of sugar was broken, the basic export character of the economy was retained as the three main commodities contributed about 84 per cent of the value of merchandise exports between 1956 and 1988 (chart 9). Indeed, as may be seen from this chart, the country has become more dependent on these three commodities since it became a Cooperative Republic in 1970—these three commodities now accounted for 86 per cent of export earnings. Clearly, the export dependency of the economy is still firmly in place, despite the socialist policies (rhetoric) of the government then in power.

A second and related structural feature of the economy is its high degree of openness or domination from outside.[3] In 1948 the export of goods and non-factor services stood at 37 per cent of GDP (current market prices), rising to 57 per cent during 1960-73. For the next several years, 1974-81, this figure climbed to about 66 per cent, declined considerably until 1986 and finally shooting upwards for the rest of the period (chart 10.). The same behavior is evident for imports of goods and non-factor services which, rising from 47 per cent of GDP in 1952, averaged over 60 per cent per year during 1960-73. For the 1980s, imports averaged 70.2 per cent of GDP.

Two things are now unambiguously clear. First, both indicators show an increasingly open economy and, second, the import ratio is much greater than the export ratio, which is an indication of the heavy dependence of the economy on imported goods. In recent years the heavy and rising dependence of the economy on imports was accentuated by the rising oil bill, owing to price increases and a higher rate of investment by the public sector, thus swelling

3 At least three definitions of openness are found in the literature, one identifying openness with imports, another with exports and a third one with imports plus exports, all expressed as GDP ratios (Afxentiou and Serletis, 1992). If the last definition is used, then in 1987 there were only five other countries in the world (Singapore, Hong Kong, Botswana, Maldives and Lesotho) that were more open than Guyana (GATT, 1989).

Chart 9 - Export of Rice, Sugar and Bauxite as Percentage of Merchandise Exports, 1956-1988

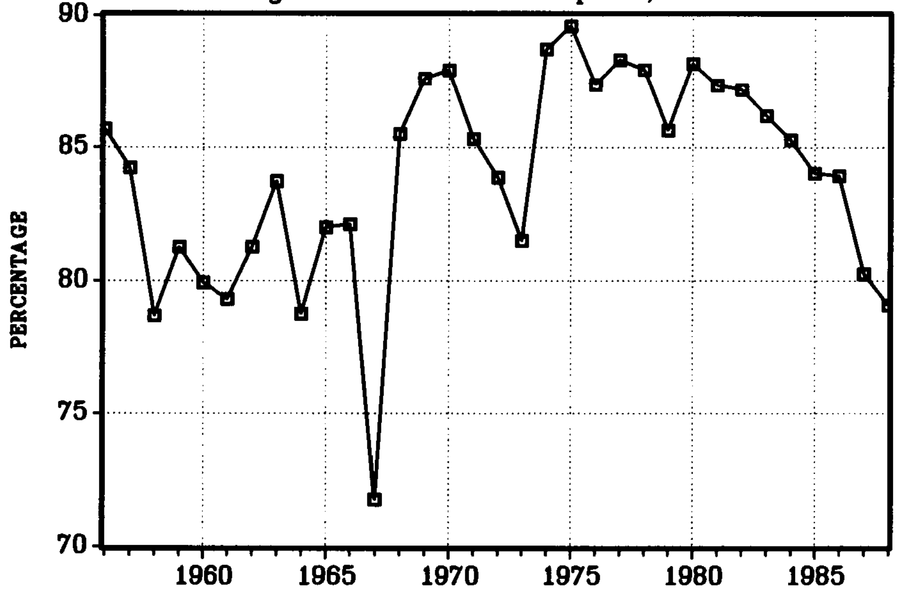
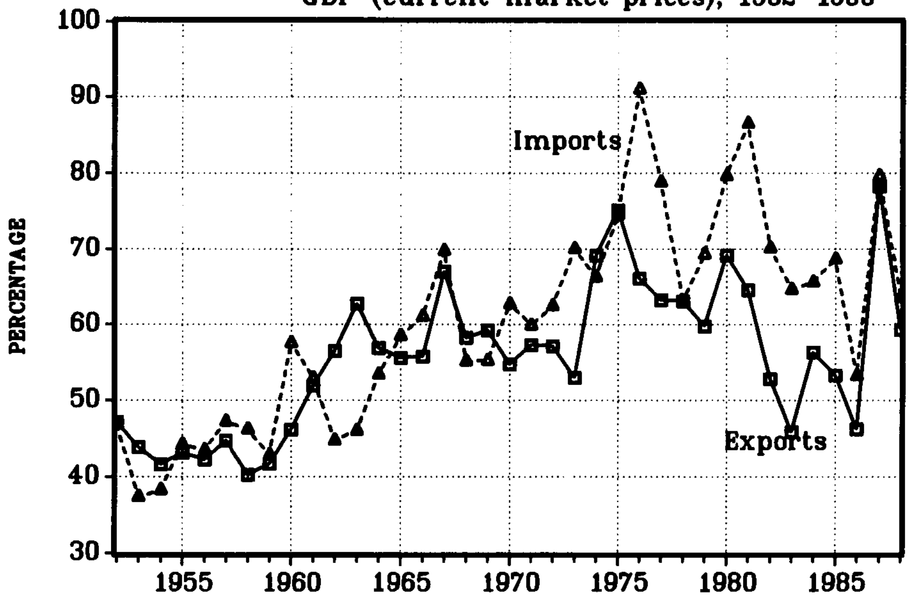


Chart 10 - Imports and Exports as Percentage of GDP (current market prices), 1952-1988



Sources: Footnote 1, Ch. 2, p. 15

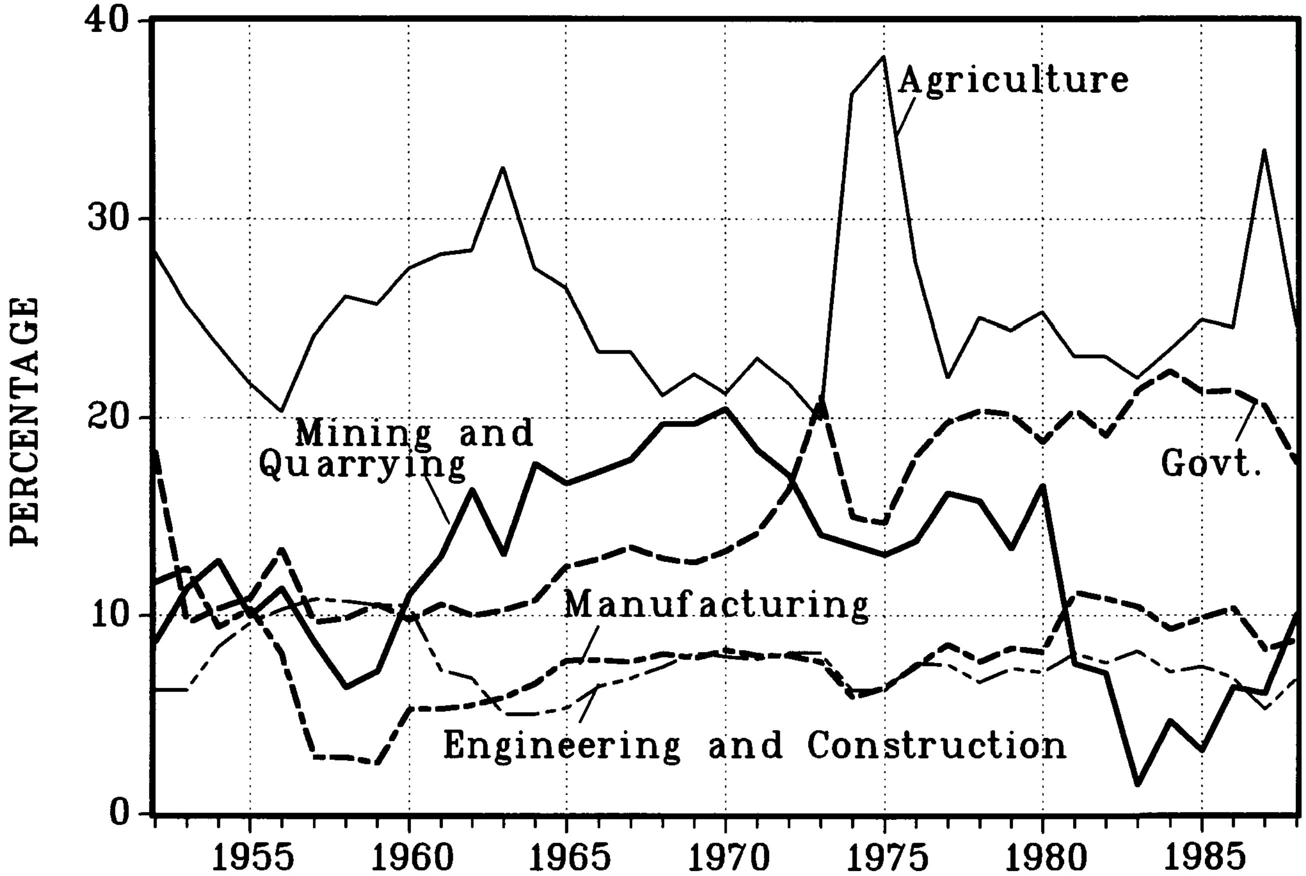
import demand for capital goods. Even though consumer imports have been seriously constrained or restricted outright since the mid-1970s, this was not enough to contain the burgeoning import ratio. The high degree of openness is compounded by both a high commodity and a high market concentration of exports. Over 80 per cent of the value of merchandise export earnings are provided by rice, sugar and bauxite/alumina (chart 9), as pointed out above. A large portion of rice is still being exported to a protected Caribbean market; bauxite/alumina are destined for North America, principally the United States and Canada; and sugar mainly goes the EEC under preferential arrangement, otherwise it is doubtful if the industry could survive.

Sectoral Share of the Economy

The sectoral composition of the economy over the period 1952-88 shows some interesting features. Agriculture, comprising rice, sugar (production and processing), livestock and other crops, is still the dominant economic activity, averaging about one-quarter of GDP during the 37-year period. This average statistic covers up the relative instability of the sector,[4] which ranged between 19.9 and 38.2 per cent of GDP (chart 11). While this wide fluctuation is driven by the fact that agriculture is export-oriented, it is also the result of poor domestic policies, particularly pricing policies, which almost destroyed the rice subsector (World Bank, 1992). Expensive and modern infrastructure facilities have been allowed to deteriorate considerably, posing a serious constraint to rice and other crops in particular. In fact, given the tremendous investment, particularly in rice, the relative importance of agriculture was expected to increase sharply but this did not happen.

[4] The term "instability" is used rather loosely here to mean the variability of the agricultural sector as a ratio of GDP. Thomas (1984:30) notes that the "instability" of the sector, in terms of investment, export prices, incomes and employment, derives from the "production and export of primary products in capitalistically organized world markets."

Chart 11 - Relative Size of Sectors, 1952-1988



Source: Footnote 1, Ch. 2, p. 15

The rising share of the government in the economy is also depicted by chart 11. Prior to independence in 1966, the government sector was no more than 11 per cent but from 1965 it began to increase rapidly and by 1976 it accounted for 20 per cent of GDP. In fact, by 1973 the share of this sector in GDP was second only to agriculture. From a peak of 22.3 per cent in 1984, the sector gradually began to contract for the next three years. Continually deteriorating economic conditions and pressure from the Bretton Woods Institutions eventually forced the government to 'free up' the economy and during the closing years of the decade the sector had contracted to the size it was in the mid-1970s.

Mining and quarrying, constituting essentially the bauxite industry, stood at 20.4 per cent of GDP in 1970. The sector exhibited considerable growth in the 1960s as this was a time of great expansion and capitalization in the bauxite industry. Indeed, it may be said that the 1960s were the heydays of the Guyanese bauxite industry, in terms of its relative size in the economy. From 1970 the fate of the industry seemed to have been written for the next two decades: one of spectacular decline as may be seen readily from chart 11 (see also charts 6 and 7 of the previous chapter). Since 1981, aside from 1988, mining and quarrying did not constitute more than 7.5 per cent of GDP. Worrell (1987) observed that the bauxite industry possessed considerable potential, evidenced by the fact that during 1964-74 it was the single largest contributor to GDP. During the 1980s, however, the entire mining and quarrying sector lagged behind sugar, manufacturing, government and even engineering and construction.

The manufacturing sector[5] is made up of a few large public entities and many small private firms. The sector is comprised entirely of light industries engaged in food processing, textiles and garments, footwear, refrigerators cigarette, matches, soft drinks, candies, pharmaceutical, beer and run. For the 30 years between 1960-88, the manufacturing sector

5 Pre-1960 data on the manufacturing sector may not very reliable because they include sugar and rice processing, although the error is likely to be relatively small as these two activities account for a very small portion of this sector. Following Thomas (1984:32-33), the data from 1960 to the end of the period studies treat these two activities as part of the agricultural sector since a very primary state of processing is involved.

contributed about 7.9 per cent of GDP but during the last decade its share has risen to about 9 per cent.[6] The fact that the sector continued to grow over the last decade despite numerous problems[7] is an indication of considerable potential, given Guyana's natural resources, low wages[8] and an open economy (World Bank, 1992).

Finally, the engineering and construction sector, which may be taken as a proxy for the capital goods industry, was, in general, of greater relative importance in the pre-independence period (chart 11). From about 1962 the sector contributed some 8 per cent of GDP, although its share has slipped during the last half of the 1980s. Nevertheless, it is fair to say that the sector, in terms of its share of GDP, remained relatively stable in the post-independence era.

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[6] In terms of growth, the data indicate that during the downswing of the economic cycle, the sector grew the fastest: 3.5 per cent a year. But this is true only if the dramatic growth of the mining and quarrying sectors in 1984 and 1986 is included. In these years the manufacturing sector grew by 229 and 103 per cent respectively! The remarkably high growth in 1984 resulted from the severe fall in bauxite production in 1983.

[7] According to the World Bank (1992), these include policy-induced constraints, shortage of skilled labor, intermittent power supply, a deteriorated transport network, poor water quality, unreliable telecommunication service.

[8] With the huge devaluations in 1991 (in 1990 the average exchange rate of the Guyanese dollar per US dollar was 39.53; in December 1991 it was 122), the relative cost of labor in Guyana is one of the lowest in the world (World Bank, 1992).

The Unintegrated Structure of the Economy

Almost two decades after nationalization of all major foreign enterprises, the economy is still disorganized in the sense that inter-sectoral linkages are relatively weak and productivity among sectors very uneven.

Table 4. Real Growth Rates of Sectors
(Percentages)

Sector	1961-88	1961-69	1970-79	1980-88
Agriculture	2.1	0.4	5.6	-0.1
Construction	1.2	3.1	1.5	-0.8
Manufacturing and Processing	3.0	5.0	3.0	-1.1
Mining and Quarrying	1.9[a/]	11.9	-0.9	23.3[b/]
Services	1.5	2.5	3.2	-1.4
GDP	1.1	3.3	1.7	-1.8

a/ A positive rate of growth for the mining and quarrying sector during 1961-88 resulted from the extremely high rates of growth in 1984 and 1986. It will be recalled from the discussion in Chapter 2 that bauxite production experienced a precipitous drop in 1983 and 1985. If these four unusual years are excluded, then during the entire period the mining and quarrying sector contracted by 15.3 per cent.

b/ If the unusual years in a/ above are excluded, then the mining and quarrying sector declined by 17.2 per cent during 1980-88.

Source: Computed from World Bank (1973, 1984, 1986, 1992)

In an economy with relatively important inter-sectoral linkages, sectoral growth rates would be more or less even but this is not true of an open, enclave-type economy such as Guyana. Table 4 above shows that not only are there wide differences in growth rates among sectors but sectors themselves have demonstrated significant temporal differences. Inter-sectoral rates of growth in the 1960s ranged from 0.4 per cent for agriculture to 12 per cent for mining and quarrying. These wide inter-sectoral differences persisted in the following decade but narrowed considerably in the 1980s, although all sectors contracted (see note b/ of table 4). Time variations in sectoral rates of growth is also considerable, especially for mining and quarrying. This particular industry is most isolated from the rest of the economy as its entire output of raw material is exported. These wide differences in the rates of growth of the various sectors can be taken as an indicator of the rudimentary input-output relations present in the Guyanese economy.

The unintegrated structure of the economy could also be observed from the unevenness of productivity among sectors. In 1960, construction, engineering and housing was the most productive sector, with a productivity of approximately 19 times that of the least efficient sector (manufacturing). By 1970 the mining and quarrying sector was 6 times as productive as the construction, engineering and housing sector. Even by 1981, the latest year for which data on employment are available, these wide differences in productivity continued to be a feature of the economy. Perhaps even more striking is the temporal difference in productivity within the same sector: in 1981 the agricultural and manufacturing sectors were five times as productive as they were in 1960 (table 5). A principal reason for the growth of productivity between 1960 and 1981 is use of capital-intensive techniques, particularly in mining and quarrying, and agriculture. The slowdown in productivity of the mining and quarrying sector during 1970-81 resulted from the severe difficulties that confronted the bauxite industry (see previous chapter). The degree of export-orientation is also a factor in the explanation of the productivity gap among sectors: in periods of booming export markets productivity is driven up while it is driven down when export prices become unfavorable.

Table 5. Sectoral Productivity[1]
(G$ at current factor cost)

Sector	1960	1970	1981
Agriculture	1,150	1,570	6,122
Mining and Quarrying	4,800	15,655	15,538
Manufacturing	1,034	2,050	5,912
Construction, Engineering and Housing	19,450	2,556	11,000

[1] Productivity is defined as the quotient of sectoral output and labor employed

Sources: (a) World Bank (1973), Tables 1.7 and 2.1;
(b) ---------- (1985), table 2.1; and
(c) Bishop, D. *et al* (1982), pp. 12-13.

The Absence of an Indigenous Capital Goods Industry

Having nationalized all multinational firms in the 1970s, Guyana could no longer rely on foreign investment as the engine of technological advance. Given the importance of a capital goods industry in promoting economic development, two options were open to the country: (a) develop its own capital goods industry or (b) ensure that the agricultural sector was sufficiently dynamic to allow for the importation of needed capital goods. On both counts the country failed (Mandle, 1982). Indeed, technological stagnation and the continuing enclave nature of the economy were important reasons for the dismal performance of the major export commodities, as we observed earlier. As a consequence, there is presently no capital-goods industry of any significance in the country, aside from some replacement parts produced by The Guyana National Engineering Corporation, mainly for the sugar industry. The absence of such an industry represents a serious supply-side constraint to economic development.

The share of imported capital goods (and thus technology) in domestic investment is considerable. During 1958-64 about one-quarter of the value of imports consisted of capital goods (David, 1969:34). Even more striking, the import of capital goods accounted for over 75 per cent of the value of gross domestic investment during 1966-71, which is much higher than in Jamaica and Trinidad and Tobago (Jainarian, 1976). Until about 1976 capital goods (excluding intermediate goods) continued to constitute some one-third of merchandise imports and about 70 per cent of gross domestic investment, but as from 1977 these shares began to decline sharply, becoming more pronounced in the first half of the 1980s (table 6). The economic crisis, obviously, impacted upon investment and thus productive capacity. In other words, a compression of imports directly translated into depressed levels of investment and thus productive capacity, constraining the future growth of the economy.

Table 6. Share of Capital Goods Imports in Total Merchandise Imports and Gross Domestic Investment, 1960-1988

Year	Merchandise Imports (G$M) (1)	Capital Goods (G$M) (2)	Gross Domestic Investment (G$M) (3)	(2) as % of (1) (4)	(2) as % of (3) (5)
1960	147.6	52.5	82.4	35.6	63.7
1961	146.5	46.9	76.4	32.0	61.3
1962	126.4	34.9	55.6	27.6	62.7
1963	118.2	28.2	50.9	23.9	55.4
1964	150.5	44.8	53.6	29.8	83.6
1965	180.4	54.3	80.6	30.0	67.3
1966	205.5	66.5	92.8	32.3	71.6
1967	250.2	93.0	109.8	37.1	84.7
1968	212.8	65.8	102.3	30.9	64.3
1969	234.4	70.4	103.8	30.0	67.8
1970	266.8	97.0	121.9	36.4	79.6
1971	264.7	79.2	105.1	29.9	75.4
1972	294.9	86.7	118.9	29.4	72.9
1973	382.1	127.2	175.5	33.3	72.5
1974	567.3	146.5	252.1	25.8	58.1
1975	812.1	261.0	392.6	32.1	66.5
1976	927.2	302.9	469.4	32.7	64.5
1977	804.3	226.4	363.3	28.2	62.3
1978	711.2	153.5	278.0	21.6	55.2
1979	810.1	145.9	497.0	18.0	29.3
1980	1010.1	192.5	494.0	19.1	39.0
1981	1236.4	216.9	501.0	17.5	43.3
1982	841.2	140.7	361.0	16.7	39.0
1983	744.9	144.0	314.0	19.3	45.9
1984	820.7	117.2	456.0	14.3	25.7
1985	1088.9	280.9	698.0	25.9	40.2
1986	983.4	218.2	871.0	22.2	25.1
1987	2260.4	536.8	1025.0	23.7	52.4
1988	2156.0	431.0	890.1	20.0	48.4

Sources: World Bank (1973, 1984, 1990, 1991)

Nationalization - Changing the Ownership Structure of the Economy

Until the early 1970s, the Guyanese economy was based essentially on private enterprise and two of the three dominant *productive* sectors - sugar and bauxite - were owned and controlled by multinational corporations in Canada, the United States and Britain. A large section of distribution and public transport was also in the hands of foreign companies, while all commercial banks in the country before 1970 were branches of international banks.[9] These banks were the most important institutional source of *short-term* credit, most of which went to commercial, industrial and agricultural purposes, all of which did not promote the *long-term* development of the colony. Commercial banks did not invest any significant amounts in infrastructure and, perhaps for reasons having to do with risks, did not engage in much business with the domestic private sector. Nor, for that matter, were there much scope for lending to the "foreign" private sector for major foreign enterprises in the colony were well supplied with their own working capital or raised the necessary funds in London while colonial government enterprises were financed directly by government. The neglect of the *domestic* private sector, the preference for short-term lending, the absence of a bill market or any substantial money market and the weak demand for credit by foreign enterprises and the government meant that commercial banks were forced to seek investment opportunities outside of the colony. This explains why a major part of local private saving was channelled outside

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[9] As of 31 December 1969, there were five commercial banks: Barclays (16 branches); The Bank of Baroda (2 branches); The Royal Bank of Canada (11 branches, one of which was a mobile branch); Chase Manhattan (1 branch); and The Bank of Nova Scotia (1 branch). The Guyana National Co-operative Bank (GNCB) was established on February 24, 1970, by Government as part of its program to foster cooperativism in the "Cooperative Socialist Republic of Guyana."

As the private sector became increasingly marginalized - because of the government's socialist policies - private foreign banks closed their doors and the banking sector as a whole became state-dominated. By 1991, according to the World Bank (1992), the banking sector comprised three commercial banks and two non-commercial banks. The commercial banks are: the GNCB with 40.4 per cent of total assets; the Bank of Baroda, owned by the state-owned Bank of India, with 5.6 per cent of the assets; and the bank of Novia Scotia, owned by a private Canadian bank, with 2.9 per cent of the assets. The two non-commercial banks are: the National Bank of Industry and Commerce and the Guyana Bank for Trade and Industry, with 33.7 and 17.4 per cent of total assets respectively. There are no indigenous privately-owned banks in the country.

of the colony.

Soon, however, the ownership structure of the economy was to rupture dramatically. In 1970, four years after independence, the government declared Guyana a Cooperative Socialist Republic. This declaration, according to Clive Thomas (1984), implied certain policy initiatives, including the nationalization of foreign property in the country. The principal firms in the bauxite industry were nationalized in 1972 followed by import trade, public transport, alcohol and drug manufacturing, TNC-operated foundries and shipyards, and significant sections of distribution and communications. In 1976 the sugar industry was nationalized and by 1977 about 80 per cent of the economy rested in the hands of the public sector.[10] Much later, in the 1980s, foreign-owned banks were also taken over. Along with nationalization, there was a radical change in the country's foreign policy as the Burnham Government sought to make a clean break with colonialism. The country was now set on a socialist path to development.

By implication, the rapid expansion of the public sector meat that the private sector had to contract. Indeed, by the early 1980s the private sector was considerably reduced and flourished mostly in the underground economy. The diminution of the private sector could also be observed from its investment share, which, between 1971-88, was 30 per cent less than what it was during 1960-70. This issue - relative share of investment - will be taken up in more detail in Chapter 4.

Did nationalization fundamentally alter the structural features of the economy? Mandle (1982) argued that the fundamental change in the ownership structure of the economy served to consolidate the ruling government control of the state apparatus since in all state-owned enterprises traditional hierarchical methods of decision-making remained unchanged. Workers' participation in decision-making as in former socialist countries, such as Yugoslavia, were virtually foreclosed. Instead managerial positions vacated by the departing foreigners have

[10] Other sources estimated that the public sector was at least 85 per cent of the economy by the early 1980s. See Mandle (1982) and Hintzen (1985)

been filled by Government supporters, a situation which Mandle characterized as '... the emergence of a state-based managerial class' (p. 114). Similarly, Percy Hintzen (1985: 137) observes:

> Thus, the regime's programme of nationalization served to eliminate the direct participation of foreign capitalist investors in the Guyanese economy while maintaining intact the *external structure of relations* with international capital. In effect, it put the ruling regime, through its control of the state, as the sole mediator between international capital and Guyanese society (My emphasis).

Clive Thomas (1984:255) went further when he said that:

> As events have shown, nationalization in Guyana aided the expansion of the state bureaucratically, ideologically and militarily and in so doing, increased the capacity of the ruling PNC to assert its various forms of authoritarian control over civil society.

It is difficult not to agree with Mandle, Thomas and Hintzen that nationalization did not alter the fundamental enclave character of the economy: but for the dismantling of the ownership structure of the productive system, all the other features of the enclave economy have remained virtually unchanged. Indeed, almost two decades after nationalization of the "commanding heights" of the economy, sugar, rice and bauxite/alumina, supported by cheap labor and services, still constitute the foundation of the economy (see the discussion in Chapter 2). In effect, this means that the changes introduced by the then ruling PNC government were mainly related to the appropriation, control and distribution of the economic surplus generated by the export sector, without altering the essence of the structure through which the surplus has been historically generated. Agriculture is still of preponderant importance; the unevenness of productivity and the absence of any significant inter-sectoral linkages; the virtual non-existence of an indigenous capital goods industry; and the heavy dependence upon outside sources for exports, imports, finance and technology continue to endure. In short, the openness of the economy, its vulnerability to exogenous factors and its productive apparatus remain largely unaltered as observed in the previous chapter.

While nationalization did not alter the heavy export bias of the economy, it did introduced a new internal logic: the dramatic growth of the public sector as is evident from three indicators. First, as already noted, over 80 per cent of the economy was owned and controlled by the state. Second, Central Government Expenditure (current plus capital) rose dramatically, moving from $79.6 million in 1964 to $175.8 million in 1970 to an estimated $3.9 billion in 1988—a seventeen fold increase. In relative terms, Central Government expenditure grew from 23.8 per of GDP (at current prices) in 1964 to 113 per cent two decades later, then falling to 94 per cent in 1988. Third, the share of public sector in gross capital formation increased from 40 per cent in 1968 to about 80 per cent in 1979. As from 1971, the share of the public sector in gross fixed capital formation exceeded that of the private sector. Indeed, since 1972 the public sector accounted for about two-thirds of total domestic investment.

CHAPTER 4

Savings and Investment

The Saving-Investment Gap

For most of the postwar years, Guyana has maintained a rate of gross domestic investment of at least 22 per cent of GDP (at current market prices), a relatively high rate for a developing country of her per capita income bracket[1] (chart 12). Equally true too, the country has historically relied on external funding for a relatively large share of investment. During 1948-51, for example, about 61 per cent ($66.8 million) of the capital investment was financed by external sources, comprising grants, loans and private direct investment. Almost $50 million, or 45 per cent, of gross capital formation during this period was attributed to foreign direct private investment, a substantial part of which represented re-invested profits. As others have noted (see, for example, World Bank, 1953) and as we have observed earlier, local private savings were being invested outside the colony, which meant that the greater portion of private investment was financed by external sources.

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[1] The gross domestic investment rate in 1988 was 18 per cent for low-income economies (excluding China and India), 25 per cent for middle-income economies, and 23 per cent for lower-middle income countries. The investment ratio in Latin America and the Caribbean was 20 per cent during 1980-89 (World Bank, 1990d).

Today domestic savings are no longer invested abroad but the financing gap has actually widened. Two factors are responsible for this: a substantially higher rate of investment since nationalization; and negative gross national saving since 1981 (World Bank, 1986, 1992) resulting mainly from growing deficits on the current operations of the public sector. As a result, Guyana continues to rely heavily on external funding, particularly donor assistance. Thus between 1981-83 about 60 per cent of the public sector investment program was funded by external resources (World Bank 1984).

Gross national saving[2] was more than sufficient to cover investment only in two year - 1962 and 1963 - since 1954 (the first year for data on savings in this study). This landmark was more the result of an unfavorable investment climate than plan. The year 1962, as noted earlier, was marked by the budget protest while 1963 was a very troubled year in terms of dispute over labor legislation and widespread strikes. The result was a loss of confidence in a private-enterprise dominated economy, leading to a fall in investment. During the 22 years between 1954 and 1975, the saving-investment gap - i.e., the excess of investment over saving - averaged about one-third of investment (chart 13). For the rest of the period, 1976-88, the gap grew considerably, averaging over 80 per cent of investment expenditure. Indeed, the country began to dissave since 1981. The following points thus emerge from this short discussion:

(a) a sustained high rate of investment;

(b) a large discrepancy between saving and investment; and

(c) as a consequence of the two foregoing points, heavy reliance on external sources and the banking system to close the saving-investment gap.

[2] Gross National Saving is defined as Gross Domestic Savings plus (a) net factor income and (b) net current transfers. See World Bank (1990), table 2.4.

Chart 12 – Investment as a Share of GDP, 1948–1988

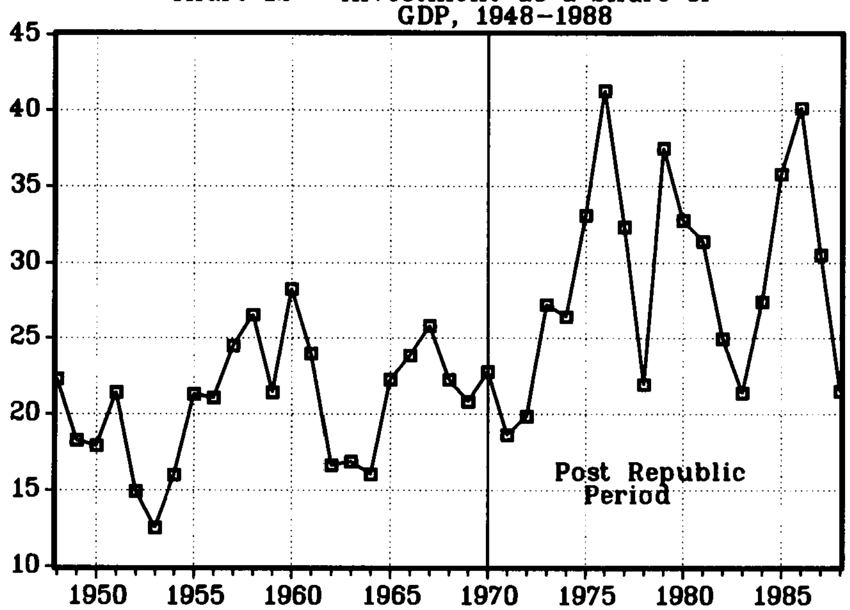
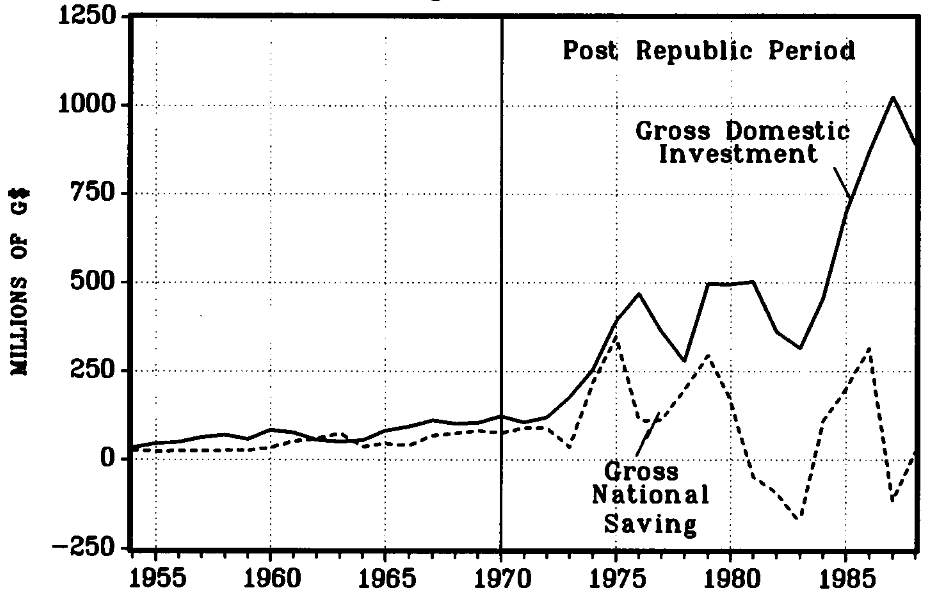


Chart 13 – Saving and Investment, 1954–1988



With a persisting and growing saving-investment gap, the question may be asked as to why the country continued to pursue an unsustainable rate of investment. The answer, or rather part of it, has to do with the location of the country's productive activities: economic rationale dictated that most of the economic activities, and hence population, should concentrate along a narrow coastal strip, which is constantly under the threat of the sea on the east and flood water from heavy rains in the west (the interior). Heavy capital investment in *infrastructure* and maintenance is therefore a precondition for production. Coupled with this need, heavy investment was undertaken in the export sector. The bauxite/alumina industry - from extraction to processing - is highly capital-intensive because of the nature of the industry itself. The drive towards more capital-intensive operations in the sugar industry stemmed from increasing costs of production and competition from lower costs producers. Operations such as land preparation, tillage, drainage and its maintenance, and transport of cane from field to factory were all mechanized to save on labor costs. The trend towards mechanization in the rice industry, which began shortly after the Second World War, runs very deep and today this industry is undoubtedly the second most capital-intensive - after bauxite - as all operations, with the exception of sowing, are no longer performed by labor. Indeed, it is often said that rice farming is heavily tractorized (David, 1969), a graphic reference to the significant mechanization at both the preparation and harvesting stages.[3] In addition, the government has also invested heavily over the last three decades in huge drainage and various land development schemes, most of which were primarily intended to benefit rice farming. Paradoxically, despite the considerable capital investment by the private sector prior to 1970 and by the public sector thereafter, many government policies were actually a disincentive to production, rice in particular (Reca, 1982; World Bank, 1992). The result was a poor utilization and deterioration of heavy capital investment.

[3] For a discussion of origin and development of mechanization in the rice industry, see (David, 1969; Sutherland, 1976; Hanley, 1975; and the Inter-American Development Bank, 1981).

The high level of both infrastructure and production investment was, particularly in the last decade, poorly maintained. To make matters worse, many public sector capital investment projects were simply misguided and over ambitious, never completed or operated well below the capacity which is required to make them viable. The huge and expensive hydroelectric project at Upper Mazaruni was abandoned after millions of dollars were spent; the textile factory was built by the Chinese on technology outdated long ago and without any firm solution for the supply of cotton; and the glass factory, located near the airport where it is bombarded by sonic booms, never went into any sizable production. In addition to misuse, public sector investment programme in the 1970s and early 1980s was based on an optimistic assessment of the availability of resources and it "... failed to consider the constraints of the economy's managerial (manpower) and absorptive capacity." (World Bank, 1984:20). Thus all major projects encountered delays in implementations, unfavorable international price developments and higher than expected risk contingencies charged by contractors (World Bank, 1984). The result was sizeable cost overruns which caused capital expenditures to rise rapidly. Because of these factors, the real value of capital formation was much less than what the absolute magnitude suggests, even when allowance is made for inflation.

The Marginal Efficiency of Capital

During the period 1949-88 Guyana's incremental capital-output ratio (ICOR)[4] was 2.62, with a standard deviation of 7.66, indicating extreme variability. In general, however, the marginal efficiency[5] of capital was rather high as in developing countries as whole the ICOR

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4 The implicit ICOR can be computed readily by dividing total investment by the incremental output (GDP). For a discussion of the ICOR see, among others, Thirlwall (1983:120-22). The importance of the ICOR is that it gives planners some indication of the investment requirements necessary to support a certain rate of growth of GDP.

5 The ICOR - or the reciprocal of the productivity of capital - $(I/\Delta O)$ - is a very approximate measure of the efficiency of capital for two basic reasons. First, it assumes that all increases in output is attributable to increases in capital, which is not true. Precisely of this reason the actual ICOR as defined in footnote 4

is about 4.[6] A brief scrutiny of Chart 14 indicates that much of the variability of the ICOR is confined to 1955-59 and 1976-83. The first period was one of very high investment in the bauxite industry and transportation. The period 1976-83 was one in which the economy performed particularly poorly with a capacity utilization rate of less than 40 per cent (Thomas, 1988; World Bank, 1986). In fact, during this eight-year period, the ICOR registered negative value three time, prompting the World Bank (1986) to comment that the marginal efficiency of capital in Guyana is very low. This was also a period of huge projects, poorly planned and executed, many of which were abandoned. For the rest of the period studied, 1984-1988, the efficiency of investment approached more normal levels.

The ICOR can thus be said to move through four main periods: 1949-1954 in which the nation's investment was highly productive; 1955-1975 in which investment remained relatively productive; 1976-83 in which marginal efficiency of capital was at its nadir; and 1984-1988 when efficiency approached the level of the first period. These short time partitions of the ICOR makes it difficult to calculate long-run growth paths. Chart 14 also shows the three- and five-periods moving average of the ICOR in an attempt to eliminate noise. In general, both moving averages display the same periodization, the only difference being that the amplitude of the fluctuations has been compressed, a direct result of a smoothened series.

One other point about the ICOR should be mentioned. It is that its value since 1970 has been, in general, higher than the pre-1970 period when the major portion of the economy was in the hands of the private sector. This means that investment was utilized less efficiently

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is usually adjusted for increases in other factors of production. Second, the ICOR is dependent on the level of activity while investment is much more stable. Thus in periods of recession the ICOR will tend to be higher because output will be depressed. On the other hand, the ICOR will be relatively low in the upturn of the cycle. In attempting to calculate the ICOR, therefore, the stage of the business cycle must always be borne in mind (Thirlwall, 1983).

6 The ICOR for Kenya during 1985-89 was 4.6 and for Chile it was 4.7 during 1961-89 (World Bank, 1990, 1990e).

Chart 14 – The ICOR, 1948–1988

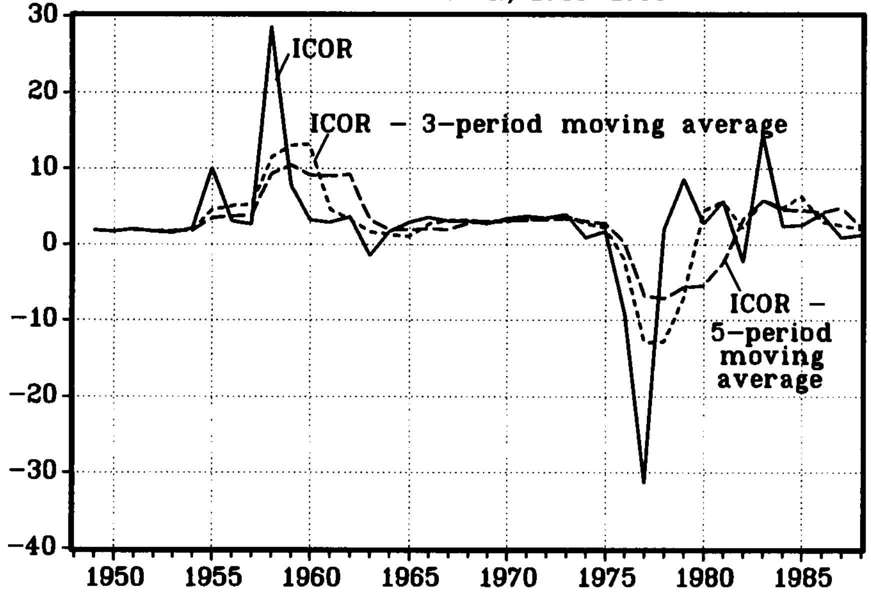
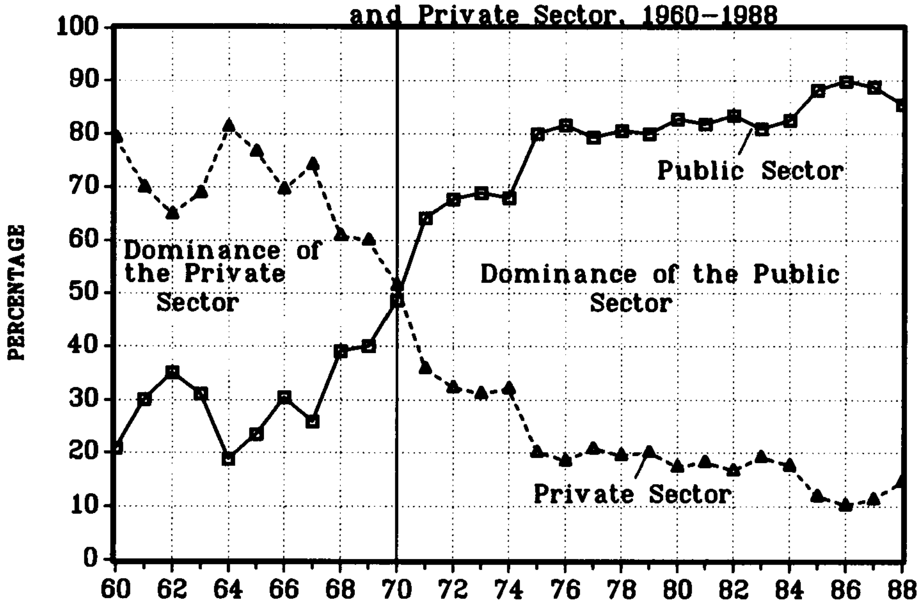


Chart 15 – Fixed Investment: Share of Public and Private Sector, 1960–1988



Sources: Footnote 1, Ch. 2, p. 15

during the period when the public sector expanded rapidly, which coincided with the downswing of the economic cycle.

Finally, consider the division of investment between the public and private sectors (chart 15). For the period 1948-51 the World Bank (1953) estimated that as much as 78 per cent of the colony's capital formation occurred in the private sector while 22 per cent took place in the public sector. Capital investment by the private sector increased rapidly between 1957 and 1960: heavy investment in manganese mining, construction of an alumina plant (with a capacity of 300,000 tons of alumina per annum) at a cost of $65 million and investment in the transportation sector. During these four years gross domestic investment averaged over 25.2 per cent of GDP - some 82 per cent of which was attributable to the private sector - compared to about 17.5 per cent in the previous five years (1952-56). As private investment tailed off, total investment followed suit even though large expenditures by the government were channelled into land development in the early 1960. David (1969:38) writes in this regard that "This then provides the fundamental explanation for the downward trend of the ratio of investment to Gross Domestic product, observed in recent years.".

While fluctuating, the share of private investment trended downward during the 1960s and at an accelerating pace as the decade drew to a close. By 1970 investment from the public and private sector was relatively the same and in the following year a watershed was established: for the first time in the country's history public investment exceeded that of the private sector (chart 15). From then the investment stimulus, and thus the dynamic of the economy, shifted to signal the predominance of the public sector and the "withering" away of the private sector in Burnham's Cooperative Socialist Republic. The private sector was deliberately reduced through such means as nationalization, pricing, bureaucracy and red tape, foreign exchange policies, etc., all of which were designed to make private investment unattractive (Worrell, 1987). By the middle of the 1980s, public investment was almost five times as large as that of the private sector; by 1985-88 it was six times as large.

CHAPTER 5

Government Finances

Revenue, Expenditure and the Fiscal Deficit

The *overall* balance of the central government is defined here as the difference between its revenue and expenditure on the current and capital accounts. The single most important point is the emergence of an *overall* deficit in 1954 which persisted until the end of the sample period.

In general, the financial position of the government during 1940-53 was sound with a surplus on the overall balance occurring ten times. The first deficit on the consolidated accounts was recorded in 1945, the year when the government began to play a more active role in the economy. The deficit in 1954 (about 2 per cent of GDP) was caused by a sudden surge in capital expenditure; indeed a surplus was recorded on the current account. The year 1954 is important for two other reasons: (a) it was the beginning of a deficit on the *capital* account that did not disappear for the rest of period, and (b) it saw the emergence of an *overall* deficit that recurred until the end of the period studied. A persistent deficit on the *current* account did not appear until 1976. In the main, therefore, the size of the overall deficit was principally due to the deficit incurred on the capital account (table 7 and chart 16).

Table 7. The Fiscal Deficit as a Percentage of GDP, 1948-1988

	Mean	S.D.	Maximum	Minimum
Period: 1948-88				
Deficit on the Current Account	- 6.55	13.96	14.32	-44.87
Overall Deficit	-18.50	23.96	0.34	-95.19
Period: 1948-75				
Deficit on the Current Account	0.80	2.82	14.34	-1.47
Overall Deficit	-5.35	3.76	0.34	-13.62
Period: 1976-88				
Deficit on the Current Account	-22.37	15.32	- 4.75	-44.87
Overall Deficit	-46.81	24.70	-12.92	-95.19

Sources: Footnote 1, Ch.2, p. 15

The emergence of the overall deficit the year after Dr. Cheddi Jagan's Government[1] took office in a country still under colonial (British) control has much to do with his socialist leanings (Jagan, 1975). This specific political orientation caused foreign aid to be considerably reduced; business became apprehensive and a capital flight was started. As the overall deficit grew the colony teetered on the brink of a financial collapse in 1961, which was aggravated by an urgent need for $15 million to meet certain extra-ordinary expenditures. It was in these difficult times that Mr. Nicholas Kaldor was invited to propose means to reform the tax structure. His proposals formed the basis of the 1962 budget that proved to be the most explosive in the country's history.

1 For a discussion of the years when Dr. Cheddi Jagan was in Government, from 1953 to 1964, see Jagan (1975).

Chart 16 – Central Government: Fiscal Balance as a Percentage of GDP, 1948–1988

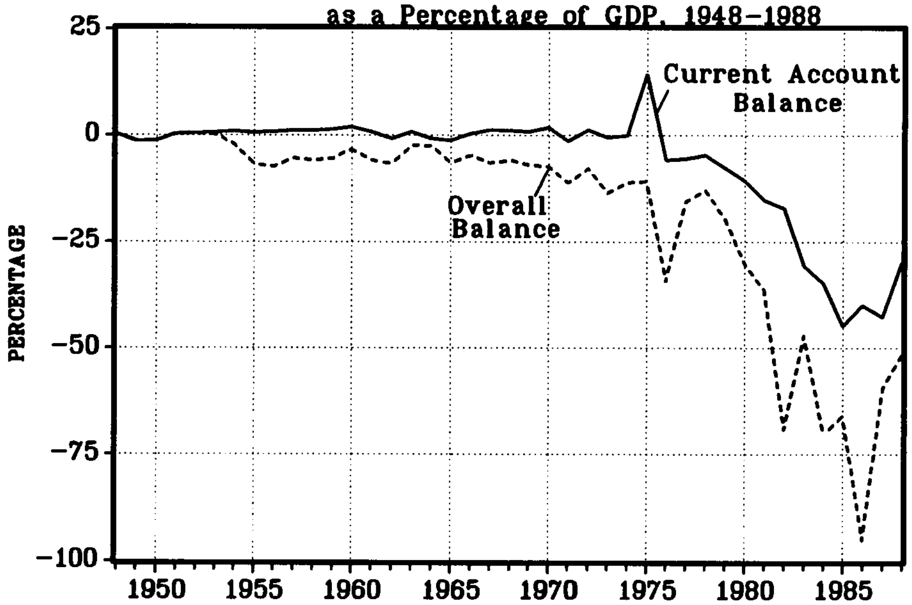
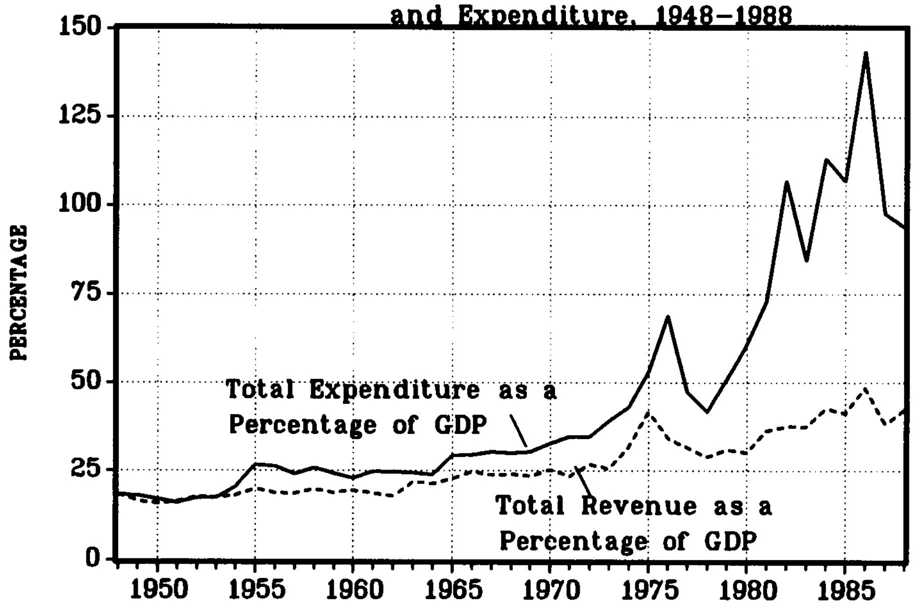


Chart 17 – Central Government: Total Revenue and Expenditure, 1948–1988



Sources: Footnote 1, Ch. 2, p. 15

After the demise of Dr. Cheddi Jagan's government, engineered by the CIA and Britain, the Peoples' National Congress (PNC), led by Mr. Burnham, took office in 1964 (Jagan, 1954, 1975). The inflow of external funds immediately increased and both current and capital expenditures grew, pulling upward the overall deficit which reached 11 per cent of GDP in 1971. But it was the aberrant sugar bonanza of 1974-75 that set off a spending spree the effects of which are perhaps still being felt as capital and current expenditure in 1974 increased by 22 and 86 per cent respectively over the previous year (World Bank, 1981). During this time the government began to boost employment (to party supporters) and to invest in grandiose projects such as the ill-fated Upper Mazaruni hydro project. In fact, these huge capital investment projects were mainly responsible for the huge jump in capital expenditure in 1975: $299.4 million compared to $106.9 million in the previous year, or an increase of 180 per cent.

The end of the boom in 1976, the continued growth of both current and capital expenditures (chart 17) and the acquisition of the financial assets of nationalized enterprises were the principal reasons for an overall deficit of 35 per of GDP in 1976. During the next four years measures were implemented to contain the growth of expenditures and to boost revenues under the tutelage of the IMF. The IMF stabilization program of 1978 especially affected non-salary current expenditures, subsidies to the private sector and central government capital expenditures and hence capital formation which was drastically reduced. Such cuts implied in practice the slowing down or stopping of the implementation of large investment projects for irrigation, roads and social services started earlier on. In consequence, the overall deficit of central government improved slightly (from $176 million in 1977 to $164 million in 1978), due in large part to a stagnation of the current account and a decline in capital expenditure.

The short-term improvements of 1978 were not sustained as the rapid growth of revenues was wiped out by a faster growth of expenditures. Thus the increase of revenues by 24 per cent during 1978-80, primarily because of higher company and consumption taxes, was nullified by a 45 per cent growth of expenditure during the same period. This growth in total expenditure was generated by (a) capital expenditures which more than doubled as activities in major investment projects were resumed, moving from $106 million in 1978 to $300 million in 1980; and (b) transfers to public sector corporations which more than tripled, rising from $16.6 million in 1978 to $54.8 million in 1980. Thus despite the general reduction in consumer subsidies in the context of the 1978 adjustment program,[2] the overall central government deficit rose from 13 to 30 per cent of GDP between 1978 and 1980. The period of the big fiscal deficits had arrived.

Government current revenues were given a boost in 1981 following the introduction of mid-year tax measures, resulting in an increase of revenues by 24 per cent over the previous year. On the other hand, both current and capital expenditures grew rapidly—by about 31 and 20 per cent respectively; the increase of the former reflects in part the effects of a sharp rise in interest payments. These circumstances led to the largest central government overall deficit so far: $584.6 million or 36.6 per of GDP. In 1982 workers were retrenched from the traditional public sector in an attempt to protect public finances from further deterioration. Unfortunately, this was mere cosmetics for employment in the public enterprises was increased, salaries of selected staff were jacked up and large sums were paid out in retrenchment compensation payments (World Bank, 1984). Thus personal emoluments declined by only 1 per cent over 1981 (from $228 million in 1981 to $226 million in 1982). On top of this, current revenue declined by about 2 per cent, well below what was budgeted, mainly because of lower receipts from import duties and consumption taxes which, in turn, were but a mere reflection of the decline in imports and hence economic activity. In the final analysis, another landmark was set in 1982 as the overall deficit (of the central government) peaked at 69.4 per cent of GDP ($1,003.1 million).

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2 The domestic prices of sugar and rice almost tripled, while public utilities (including transportation, electricity, telephone) rose significantly. Through these price adjustments and controls on operating costs the current account surplus of the public corporations improved by about 52 per cent between 1978 and 1980.

For the rest of the decade capital expenditure declined drastically at first, leaped upwards in 1986, fell just as steeply and then recovered in 1988. On the other hand, current expenditure grew steadily. In consequence, new records were set, as the overall deficit reached 95 per cent of GDP in 1986.

As the deficit widened, it was increasingly financed with bank borrowing which swelled interest payments obligations, especially in later years. In 1980, according to the World Bank (1986), interest payments constituted 27 per cent of central government current expenditures and absorbed 36 of the current revenues. These proportions, already high, continued to grow and by 1985 they were, respectively, 50 and 92 per cent. Thus the financial performance of the public sector and its increasing demand for credit to finance the deficits were, in effect, major determinants of the movement of domestic credit, the internal debt and monetary aggregates, particularly during the 1980s.

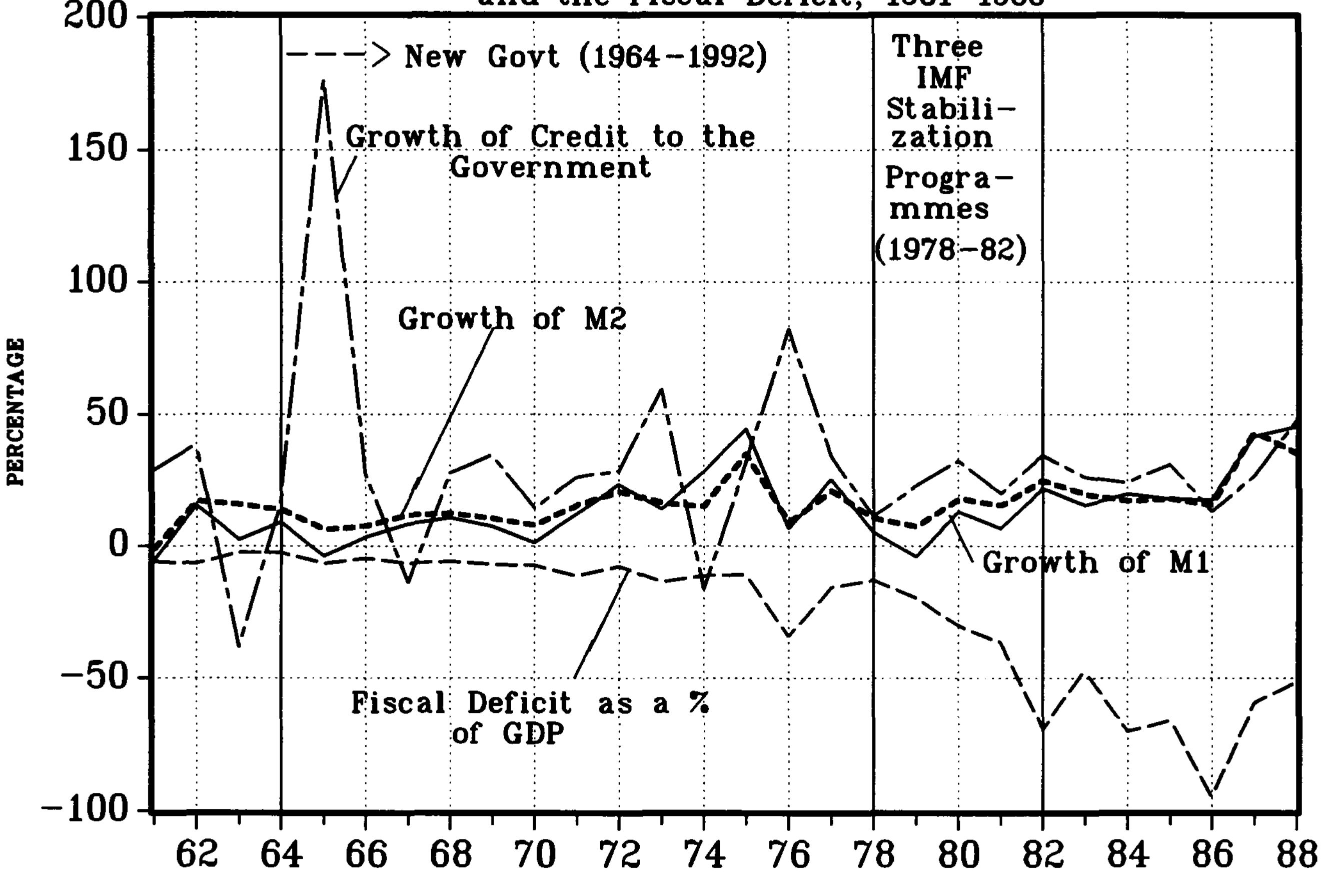
CHAPTER 6

The Growth of Money and Credit

A close examination of chart 18 will reveal two things: (a) the similarity of the time profiles of the growth rates of narrow (M1) and broad (M2) nominal money supply, and (b) the considerable gyration of the rates of growth of both aggregates around an unmistakable upward trend. A closer examination shows that both aggregates, especially M1, grew relatively slowly during the decade of the 1960s: M1 grew rather erratically at about 5.2 percent while M2 increased on the average at about twice this rate (table 8). Throughout the 1960s the fiscal deficit averaged 5 per cent of GDP while total domestic credit grew by 13 per cent per annum. Credit to the government expanded by 33 per cent yearly but this was because of a huge increase of 178 per cent in 1965, one year after the PNC was in government. Although in absolute terms the increase was modest (from $3.8 million in 1964 to $22.6 million in 1965), it could safely be said that the era of big government had arrived.

The relative calm of the 1960s abruptly gave way to faster rates of growth in the 1970s and by 1974, when nominal M1 and M2 rose by 24 and 15 per cent, respectively, it was apparent that the Central Bank had lost control over the money supply (to be discussed in greater detail below). The following year witnessed explosive growth - in fact, the highest growth of M1 (44 per cent) and M2 (34 per cent) so far. Between 1970-77, the fiscal deficit was about 14 per cent per year, while credit to the government jumped to an average of 32 per cent.

Chart 18 - Some Critical Indicators: Money, Credit and the Fiscal Deficit, 1961-1988



Sources: IMF (1990), World Bank (1973, 1984, 1986, 1992)

Table 8. Growth of M1, M2 and Credit and the Fiscal Deficit as a Percentage of GDP, 1961-1988

	1961-69	1970-77	1978-82	1983-88	1980-88	1961-88
M1	5.19	19.35	8.50	26.16	22.04	14.32
M2	9.98	17.12	14.78	24.36	22.56	15.96
Fiscal Deficit	5.43	14.05	33.82	64.88	58.41	25.70
Total Dom. Credit	13.31	23.41	23.59	27.86	27.85	21.15
Cr. to the Govt.	33.29	32.47	24.01	28.01	28.28	22.73
Cr. to the Prv Sector	7.78	6.72	20.40	26.97	25.26	13.84

Sources: Footnote 1, Ch. 2, p.15.

In an effort to bring the situation under control, three Standby Arrangements were negotiated with the IMF between 1978 and 1982. These pushed down the rate of growth of real M1 to an annual average 9 per cent (table 8). On the other hand, while the fiscal deficit (as a percentage of GDP) was contained in the first two years of the program, it got out of control in 1980 and by 1982 it was almost 70 per cent of that year's GDP. Small wonder, therefore, that the government resorted to the banking system. Indeed, in countries such as Guyana with undeveloped capital markets, the only way that deficits of this magnitudes can be financed is through money creation/central bank credit. The credit binge was also noticed by the World Bank (1982:10) when it wrote that "[D]uring 1979-81 credit expanded rapidly as the public sector resorted to the banking system to finance about two-thirds of its overall deficits." For these three years, credit to the government increased by 25 per cent annually (chart 18).

As the fiscal gap ballooned, the rate of growth of M1, M2 and credit followed suit (table 8). For the five years between 1983-88, M1 grew at an average rate of 26 per cent, slightly more than the rate of growth of M2. But the steepest growth in the money supply occurred during 1987-88 when M1 and M2 grew, respectively, by a yearly average of 43.3 and 38.8 per cent. The growth of currency in circulation also exploded as notes in circulation increased by almost 600 per cent between 1978 and 1988 (Stabroek News, Sunday

September 12:8). These were also years of very high deficits - over 45 per cent of GDP - and high rates of growth of credit to the government (48 per cent in 1988).

Like M1, M2 and the fiscal deficit, credit to the government and total domestic credit rose by about 28 per cent annually during 1983-88. The rapid expansion of credit in the 1980s was principally attributable to credit to the government, although credit to the private sector grew at a slightly smaller rate. How is this possible? Because the volume of credit to the government was simply overwhelming: on average, it was 7.4 times that granted to the private sector.

Was the monetization of the deficit a causal factor for the swift expansion of credit and thus the money supply? I have made no formal attempt to establish a relationship but aside from the simultaneous and rapid growth of the deficit, credit and money supply pointed out above (casual empiricism), two other points are to be noted: (a) interference with the autonomy of the Bank of Guyana (BOG), the country's Central Bank; and (b) some empirical evidence that the expansion of the monetary base is essentially due to the expansion of credit (Bourne, 1989).

The question may be raised, firstly, as to why BOG allowed the money supply to grow so rapidly. The BOG, set up by Act No.23 of 1965, was established as an autonomous institution. Among other functions, it was charged with the maintenance of a stable currency and monetary management.[1] The BOG was, however, unable to discharge these functions effectively as its autonomy was infringed. The Stabroek News (Sunday September 12, 1993: 8) writes that "Its [BOG] monetary management has largely been dictated by the political

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[1] The Bank of Guyana was established by Act No. 23 of 1965, one year after the colony gained independence from Britain, with the principal objective of "... fostering monetary stability and promoting credit and exchange conditions conducive to the growth of the economy" (Bank of Guyana Act, 1965, Section 5)

authority of the day."[2] Indeed, it noted that the then Prime Minister, Forbes Burnham, is reported to have said that since the Bank was set up by an Act of Parliament, it should be sensitive to what the government thought and wanted.[3] Further, Mr. Burnham questioned the role of foreign commercial banks in the country and wanted to know whether the role of these banks was "consistent with our development trust" (Stabroek News, Sunday September 12, 1993:8). Evidently, the role of the Central Bank was now linked to the agenda of the government: its autonomy was now infringed. Stabroek News (Sunday September 12, 1993:8) also argued that with the pursuit of socialism, no friends in the West and no help from the Socialist Bloc, the Bank became the source of finance to the government. "There was no restriction or let up and the Act was amended as necessary to facilitate the expansion of the money supply and the financing of the Government deficit." In her History of the Bank of

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2 This quote is taken from Part 3 of a 4 part series on central banks, with specific focus on the Bank of Guyana.

3 Economists and practitioners in the area of monetary policy generally believe that the degree of independence of central banks from other parts of government affects the rates of expansion of money and credit and, through them, important macroeconomic variables, such as inflation and the size of the budget deficit (Chukierman *et al* 1992). Based on a study of 72 countries over four decades, Chukierman *et al* (1992:353) found, among other things, that "Legal independence is inversely related to inflation in developed, but not in developing, countries. In developing countries the actual frequency of change of the chief executive officer of the bank is a better proxy for central bank independence".

How does one measure independence? Chukierman *et al* (1992) developed three indicators of actual independence, one of which is the turnover rate of the Central Bank Governor. More specifically, they argue that a rapid turnover of central bank governors indicates a lower level of independence and possibly creates dependence. This is so because the political authorities will "... at least have the opportunity to pick those who will do their will" (p. 363). However, this does not necessarily imply that low turnover is associated with a high level of central bank independence "... because a relatively subservient governor may stay in office for a long time" (pp. 363-64).

The turnover of the Governor of the Central Bank in Guyana has certainly been low. The longest tenure has been that of Mr. Patrick Matthews, who was appointed in 1975, having previously served as Banking Manager. Mr. Matthews remained in this position until his death in September 1991. It would appear, however, that the turnover was low because the Governor allowed the Bank to be influenced by the Government. Indeed, the Stabroek News (Sunday September 12, 1993:8) notes that the Bank apparently "... went along willingly with the political directorate and indeed in January of 1972 the then Governor William D'Andrade reported to the Board that the Bank's policies had been informed by the government's objectives underlying the disastrous 'feed, clothe and house the nation' programme." Further, the fact that the government amended the Bank's Act and imposed its will upon it is a clear indication that the independence of the Bank was not respected.

Guyana, Danns (1990) observed that "general monetary policy matters seemed not to be a concern in the late 1970s and throughout the 1980s .... this period accorded with a period when the Bank was not in active control of monetary and other policies."[4] Indeed, Danns points out that the period 1976-88, the entire downswing, was one of accommodative monetary policy, when central bank credit to government became the greatest sources of monetary base expansion in the Guyanese economy.

In fact, in 1983 the Bank of Guyana was effectively muzzled in that its authority to contain government borrowing was removed. Decision on central bank credit to the government was then vested in the national legislature, which was dominated and controlled by the government. The Central Bank was thus only able to exercise control over the private sector, via its control over the commercial banks. However, given the size of the public sector and the magnitude of central government borrowing, the Central Bank was in no position to effectively control the money supply. For example, in the 1960s, the private sector accounted for almost three-quarters of total domestic credit but by 1977 this statistic shrunk to 15 per cent of the credit and declining further (12 per cent) in the 1980s.

Secondly, Bourne (1989), examining the monetary base (which comprises domestic credit and international reserves), concluded that government indebtedness to the Central Bank was the principal reason for the expansion of the monetary base in Guyana (and Jamaica). In fact, Bourne found that in Guyana's case the balance of payments led to contractions in the monetary base but these contractions were more than offset by the expansionary effects of government indebtedness. His conclusion is particularly important and is worth quoting: "The fiscal situation of the governments and their creditor relationship with the central bank are

4 This quote from Stabroek News of 12 September, 1993, is taken from Donna Danns (1990) *The History of the Bank of Guyana*. This book was published to mark the 25th anniversary of the Bank of Guyana. Stabroek News, an independent weekly, is not affiliated to any of the political parties in Guyana. It is also significant to note here that the Board of Directors, the policy making organ of the BOG, although mandated to meet once every month, did not have any meetings for six straight years from 1984 (Stabroek News, Sunday September 5, 1993:8).

evidently central to the behavior of Caribbean money stock" (p. 284).[5]

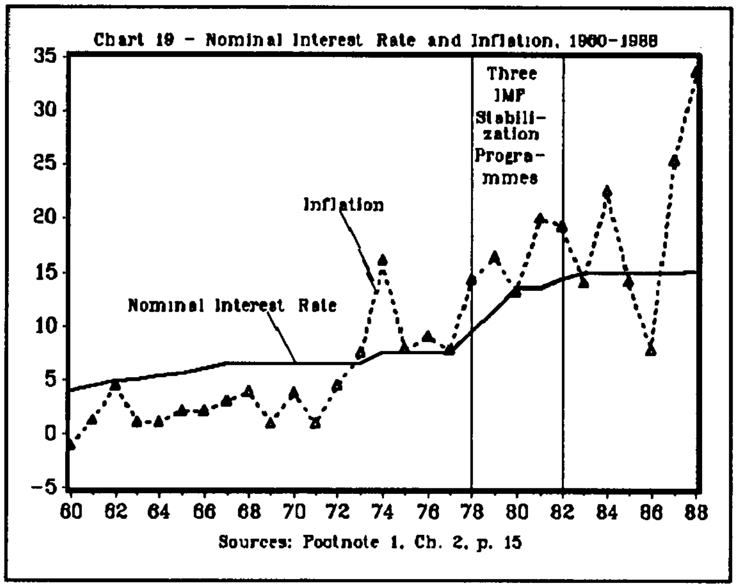
This credit over-indulgence was particularly evident during the long downswing. On the demand side, there was a prodigious need for credit by the government. On the supply side, conditions were created to satisfy the demand. First, the autonomy of the BOG was infringed and monetary policy became politicized. Second, the capacity of the Bank of Guyana to extend credit to the public sector was enhanced by the import payment deposit scheme introduced in 1978 and by various amendments to its Act. Finally, commercial banks became more liquid as investment opportunities to the private sector declined because of government policies and lack of foreign exchange. Time and saving deposits of the private sector grew significantly, reflecting, in addition to the decline of investment opportunities, the decline in the availability of consumer goods and the increased parallel market activity. For these reasons, the commercial banks had no outlets other than the purchase of treasury bills.

There is another supply-side factor that should be mentioned. It is the so-called "financial repression,"[6] a term used to refer to artificially low levels of the rate of interest (at least in the official financial sector) and the attendant distortions of financial intermediation, saving and investment. Chart 19 below on the right is enlightening in this respect for two reasons. First, it shows that the rate of interest was very stable at below 7 per cent until 1977 and well above the rate of inflation: this was thus a period of positive real interest rates. Second, although the nominal rate of interest rose to higher levels after 1978, it was below the

5 Bourne (1989) found that during 1974-86 changes in the money multiplier (narrow and broad) were not a significant source of monetary expansion in Antigua, Dominica, St. Lucia, the Bahamas, Belize, Guyana, Jamaica, and Trinidad Tobago. Liburd and Tempo (1989:136), studying the OCES countries, concluded that "Changes in the monetary base were the predominant influence [on changes in money supply], both on its trend and on its variance."

6 See, for example, Giovannini and Melo (1993), which is a very recent study of the effects of financial repression on government finances. A considerable literature exists on "financial repression," including "interest rate repression." For a quick discussion of the main issues involved, see Fry (1988). An administered (as against market) interest rate that misallocates resources and hampers financial sector development, is usually referred to as repressed interest rates (Leite and Sundararajan, 1990).

rate of inflation for almost the entire period. That is, negative real rates of interest obtained during the major part of the long downswing. This "repressed" level of the real rate of interest meant that the government could borrow on very soft terms. It was, in other words, an inducement to borrow. Indeed, Giovannini and De Melo (1993:594) characterized financial repression as a situation which "... allows government to finance themselves at artificially low interest rates." This would seem to be the case with Guyana.



Sources: Footnote 1, Ch. 2, p. 15

We have established that the money supply - both narrow and broad - expanded rapidly, at least from the mid-1970s. Does this mean that there was excess supply of money? If so, how did it impact on the level of prices?. Chapter 15, which deals with inflation, will examine the issue of the impact of an excess supply of money on the level of prices.

Some evidence in support of the existence of excess money supply can be seen from the ratio of M2 to GDP: since 1983 the amount of broad money in supply exceeded GDP, which is an unusual situation.[7] At its peak in 1988, M2 was 130 per cent of that year's GDP. It seems likely, therefore, that the economy has been operating with excess liquidity (World Bank,1986). Further, the M2-to-GDP ratio can be taken as an approximate measure of the real size of the banking sector[8] because it offers a rough indication of the flow of loanable funds (Gillis, *et al*, 1983:332). The magnitude of this ratio would imply a very active banking sector, which is confirmed by the rapid growth of credit as we have already pointed out. It implies, as well, a move towards financial liberalization, where positive real interest rates obtain - this, however, was not the case as we have already seen. In other words, the simultaneous occurrence of an unusually high M2-to-GDP ratio, an active banking sector, swift growth of credit, negative real rates of interest, a lax Central Bank and a decline of real income (GDP)—all point to the existence of an excess supply of money in the Guyanese economy during most of the downswing.

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[7] According to Gillis *et al* (1983:332), the ratio of M2 to GDP "... during the 1970s has been typically no more then 12 to 15 per cent in very poor countries, rising to an average of about 30 to 40 per cent in middle-income countries and between 70 and 100 per cent of GDP in such industrial countries as the United States, Canada, France and Japan." Even in countries such as Malaysia, Singapore and Thailand, the ratio of M2-to GDP was only 60-90 per cent in 1992. In general, however, the magnitude of this ratio is a function of several factors, including the level of economic development and the degree of financial liberalization (including liberalization of interest rates).

[8] This ratio, M2-to-GDP, is also used as a measure of financial depth (Tseng and Corker, 1991).

CHAPTER 7

Balance of Payments

A prominent characteristic of Guyana's BOP is the chronic and long-standing deficit on the *current account balance*. During the 41-year period between 1948-1988 only three years - 1953, 1962 and 1963 - did the current account balance show a surplus (chart 20. Note: negative magnitudes in this indicate a deficit, while positive magnitudes show a surplus). The surplus in all three years derived from the strong performance on the visible trade balance,[1] which, in turn, was driven by both favorable developments in the external markets and poor domestic climate which discouraged imports. The persistence of such a long-standing current account deficit is another indication of the dependence of the economy on external trade and of a fundamental imbalance of its productive structure.

Until 1956, the current account balance as a percentage of GDP remained in the single digits. The double digit deficit during 1957-60, averaging 13.8 per cent, was not a cause for concern as it came about from heavy capital investment in the mining and quarrying sector. Indeed, the current account balance returned to a more respectable position as soon as the investment was over.

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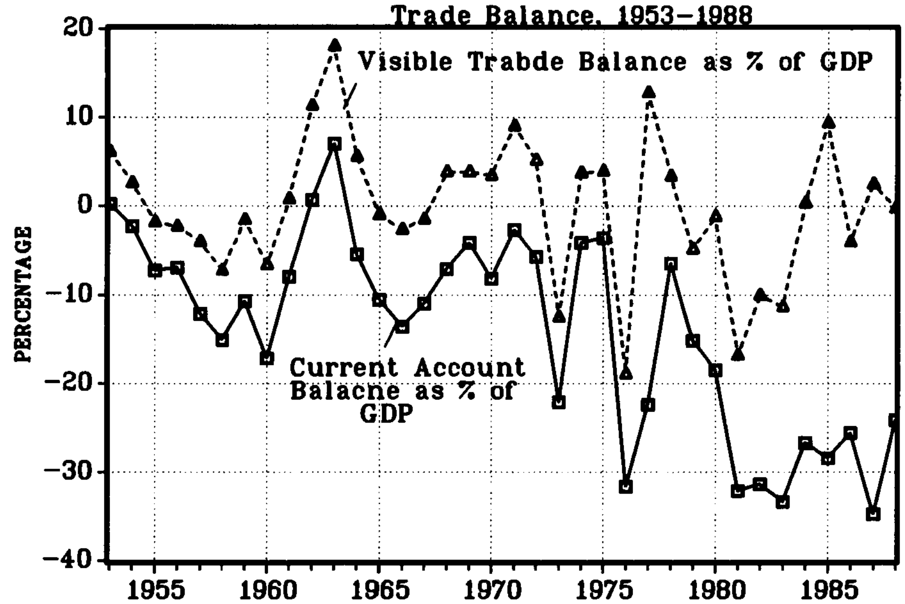
1 Visible trade is trade in goods, defined as the difference between merchandise imports and exports.

The surplus in the troubled years of 1962-63 resulted from a shortfall of merchandise imports which amounted to $118.2 million in 1963, almost 20 per cent below the level of 1961. During the short-lived sugar boom of, 1974-75, the deficit dropped to an average of 3.8 per cent. In fact, there was a surplus on the visible trade balance in both years but this was wiped out by the outflow on net factor services which increased by almost 25 per cent in 1975 over the previous year. From 1979 to the end of the period the current account deficit was never below 15 per of GDP and during the latter part of the last decade it was above 25 per cent.

In general, a surplus on the current account balance (taken as the sum of the visible and invisible accounts) can be traced to a surplus on the merchandise (visible) trade balance large enough to overcome a deficit on net factor and non-factor services. A surplus on the visible trade balance is usually the result of favorable export prices, especially for bauxite/alumina and sugar (as the sugar boom of 1974-75 dramatically demonstrates), increased production of tradables and/or fairly stringent demand management policies. A surplus on this account occurred 18 times during the 36-year period (1953-88). For the other years the deficit incurred was below 8 per cent of GDP with the exception of 1973, 1976, and 1981-83. The deficit of 13 per cent in 1973 reflects the increased price of imports, which jumped by 30 per cent over the previous year, as a result of the first oil shock: the visible trade account moved into negative $81 million dollar from a surplus of $31 million in 1972. This was a major cause for huge current account deficit (22 per cent of GDP) recorded in that year, the largest in the country's history thus far.

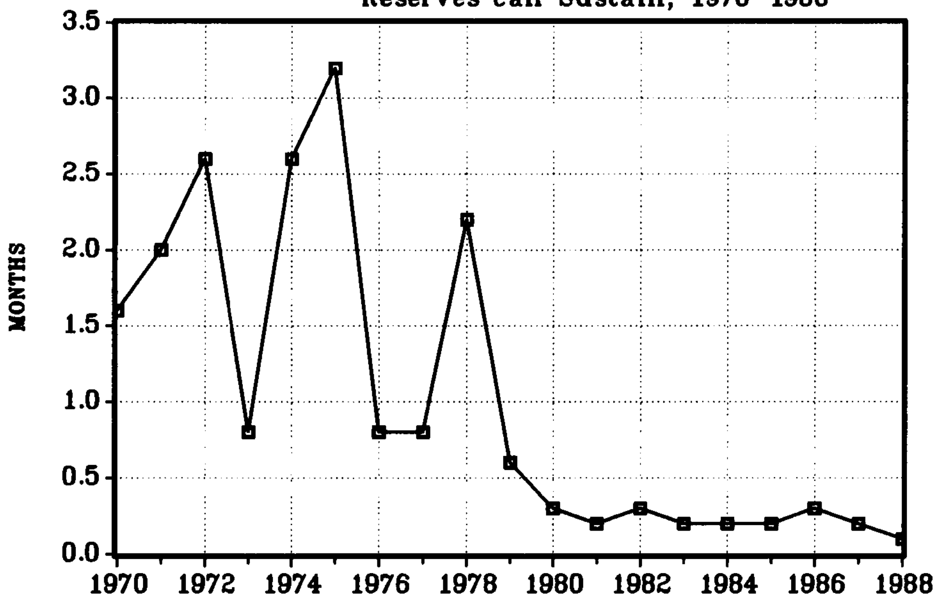
Thus, aside from unusual years, it seems evident that the invisible balance (net factor services, net non-factor services and net official transfers) was the principal cause of the burgeoning current account deficits, particularly since 1976. Throughout the period reviewed, the invisible balance remained in the red—this is implicit from chart 20 as the widening gap between the curves can only be attributed to the invisible balance. It is estimated that when these "invisibles" are factored into the current account equation the deficit on the merchandise

Chart 20 - Current Account and Visible Trade Balance, 1953-1988



Sources: Footnote 1, Ch. 2, p. 15

Chart 21 - Months of Imports that International Reserves can Sustain, 1970-1988



Sources: Calculated from World Bank (1986, 1992) trade balance is magnified by a factor ranging from 0.6 to 8.0, excluding unusual years when the scaling factor was as high as 900. The data indicate that in the 1980s the drag of the invisible balance was even more pronounced. The single most crucial item in the invisible trade balance is net factor services, which consistently recorded negative amounts during 1960-88 (table 9). Over the entire period, slightly under three-quarters of the deficit on the invisible balance was due to net factor services, which basically comprises interest on the external debt and investment income, with the latter being rather small. Non-factor services accounted for the second largest share of the invisible balance. Current transfers, essentially constituting repatriated income from Guyanese abroad, represented the smallest drain and in fact has been positive in the 1980s.

Summarizing, we note that the current account may be taken as the sum of the visible and invisible balances. The latter, recording a recurring deficit since 1960, is a principal contributor to the deficit on the current account balance. In turn, the deficit on the invisible balance is primarily due to the payment of interest on the external debt and investment income.

Table 9. The Invisible Trade Balance, 1960-1988
(millions of United States dollars)

	1960-69	1970-79	1980-88	1960-88
Net factor services	-174.2	-207.4	-710.7	-1,092.3
Net non-factor services	-25.2	-121.8	-267.4	-414.4
Net current transfers	-9.9	-24.0	-37.0	3.8
Invisible trade balance	-209.3	-353.2	-940.4	-1502.8

Source: Calculated from World Bank (1973, 1984, 1986, 1992), table 3.1

One of the immediate effects of the worsening current account balance was the contraction of international reserves which, not unlike a vicious cycle effect, is fed back to production, depressing it even lower, through the high import-dependence of the economy. As an indication of the constraint on imports, it is illuminating to examine "reserve capacity," defined as the availability of (gross) reserves in terms of months of imports of goods and services.[2] In 1970 there was enough reserves for 1.6 months of imports which, with the exception of 1973, improved to 3.2 months at the height of the sugar boom in 1975. For the next two years international reserves were insufficient to cover even one month's worth of imports. After soaring to 2.3 months in 1978, the reserve position remained dismal to the end of 1988. In fact, throughout this ten-year period, it was meaningful to talk about the availability of reserves only in terms of weeks, not months (chart 21).

The question of the financing of the growing current account deficit in the face of vanishing foreign exchange leads directly to the issue of external debt, a topic taken up shortly. The World Bank (1991) classifies financing on the capital account of the balance-of-payments under three categories: (a) net long-term capital comprising direct investment, net long-term loans, and other long-term capital; (b) net other capital comprising short-term capital (including SDR allocations), net errors and omissions, and capital transactions not included elsewhere; and (c) changes in reserves which comprise the net change in the country's holdings of international reserves from transactions on the current and capital accounts. An examination of these categories will therefore indicate how the current account deficit was financed.

In the 1960s the inflow of long-term capital (net) was more than sufficient to cover the current account deficit. The excess, together with other capital inflows, resulted in a net inflow of $38 million into the country (table 10). By the 1970s, long-term capital inflows were only about 64 per cent of the current account deficit. The gap was closed by drawing on other capital inflows and by running down reserves. For the decade as a whole, there was a financing gap of $63 million. In three years, 1980-82, the country amassed a cumulative

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2 "Reserve capacity" is arrived at by dividing the country's international reserve by the average value of monthly import. Monthly import for any given is arrived at by dividing total imports by 12.

While "reserve capacity" is not a standard index, it does offer a good insight into the seriousness of the import constraint confronting the economy. The idea for this index and the accompanying chart 7.2 on page 77 is taken from World Bank (1984).

current account deficit of $453.3 million but only 44 per cent was financed by the inflow of long-term capital. Not only was heavy demand placed upon reserves, but increasing resort was made to short-term credit. Then for the rest of the 1980s, funding the deficit was done entirely by the use of other capital financing (including short-term credit) for a reverse flow of long-term capital began in 1983, amounting to a total of $173.6 million during 1983-89. This mode of financing of the current account deficit not only built up a massive external debt; it also fundamentally altered the term structure of the debt by making increasing use of short-term credit.[3] In the final analysis, the future of the economy was mortgaged as the country found itself unable to service its external debt. Indeed, in 1985 the IMF declared Guyana ineligible for further credits as the country was unable to service its external obligations.

Table 10. Financing the Current Account Deficit, 1960-1989
(millions of US dollars)

Period	(1) Current Account Deficit	(2) Long-term Capital	(3) Other Capital Inflows	(4) Financing Gap	(5) (2) as % of (1)
1960-69	- 147.7	166.9	18.5	- 37.7	113.0
1979-79	- 497.4	316.9	117.7	62.8	63.7
1980-82	- 453.3	199.6	192.4	61.3	44.0
1983-89	- 830.8	- 173.6	1,031.9	28.0	- 20.9

Sources: World Bank (1973, 1991), table 3.1 and pp. 290-91 respectively.

Note: Column (4) is equal to (2 + 3) - (1). A negative sign on column 4 indicates an inflow of capital in excess of the current account deficit. Column (5) expresses long-term capital flow as a per cent of the current account deficit.

[3] This fundamental dilemma - that as the economy deteriorates the flow of capital on favorable terms (primarily from official sources) progressively dries up and resort is made to borrowing under increasingly harsher terms (primarily from commercial sources) - imposes an in unsustainable debt service obligations upon many developing countries. Indeed, it is this choke-hold and not a continuing credit binge that is one of the major obstacles to economic recovery in countries such as Guyana, as a perusal of the World Debt Tables will confirm (World Bank, 1990c).

CHAPTER 8

The Problem of the Debt

Internal Debt

To begin, it is necessary to preface the discussion with the observation that the pre-1965 period is distinguished by the fact that the country did not have a central bank, which meant that no portion of the deficits was financed by borrowing from a central bank or by monetization. The rest of the discussion is based on the data given in table 11.

As far as the growth of the internal public debt is concerned, the period during 1952-60 was rather tranquil except for the two huge blips. The internal debt remained unchanged at $6.42 million during 1952-55, a remarkable feature in the country's post war history. Abruptly in 1956, as if to compensate, it jumped to $9.3 million, an increase of 37 per cent, mainly because of heavy investment in the mining industry and in transportation during the latter part of the decade, with much of central government capital expenditure invested in infrastructure support. The other big jump occurred in 1959 when the stock of internal debt almost doubled what it was in the previous year to allow the government to commence heavy land development works in 1960.

Table 11. Summary Data on the Internal Public Debt, 1952-1988

Period	Rate of Growth	Percentage of GDP	Interest as a Percentage of Rev.	Interest as a Percentage of Exp.
1952-60	13.1	4.2	...	...
1961-63	12.5	7.4	...	...
1964-74	21.1	21.1	...	...
1975-83	29.4	113.5	26.3	36.6
1984-88	13.2	244.6	95.0	48.2

Sources: Calculated from World Bank (1953, 1984, 1992); Thomas (1984, 1988); and Bank of Guyana (1990).

... Data not available

Between 1961-63 the growth of the internal debt proceeded at a rapid pace of more than 10 per cent a year. Suddenly, in 1964 it declined by 12.9 per cent, the largest decline in the post war period. In 1965, when central government capital expenditure increased considerably, the stock of internal public debt rose by almost 60 per cent. By this time the debt stock was $41.6 million, which is more than a six-fold increase from its level in 1952. After the establishment of the Bank of Guyana in 1965, the internal debt continued to grow at a rapid rate and in 1970, for the first time in the country's history, it passed the $100 million mark. But even at this level it was not a drag on the economy as service charges in 1970 (principal plus interest) was a mere $8.1 million or about 6 per cent of both central government revenue and expenditure.[1]

[1] It is more useful to express service charges on the internal debt as a percentage of government revenue and/or expenditure, rather than as a percentage of GDP/GNP. This measure permits some insight into the ability of the government to service the internal debt.

In the pre-independence period, 1952-64, the internal debt was less than 9 per cent of GDP, moving to double figures in 1965. By 1976 the internal public debt was already half the size of GDP and for the rest of the sample period it was larger than GDP.

The period 1975-1983 was one of rapid accumulation of the internal public debt, with the rate of growth averaging 29 per cent per year. In 1978 the internal public debt surpassed the one billion dollar mark but by this time interest payments were already becoming burdensome, absorbing 26 and 22 per cent of central government revenue and expenditure respectively. These statistics continued to worsen during 1984-88. Indeed, during this period service charges were as large as central government revenue.

For the rest of the 1980s, the growth of the internal debt stock moderated, averaging only 13 per cent per year. Nevertheless, even at this rate, the magnitude of the internal debt stock rose steeply, reaching $7.4 billion in 1988 or about 4.6 times what it was at the beginning of the decade. At the end of 1988 the per capita internal debt (nominal) averaged $10,000, more than twice GNP (nominal) per inhabitant.

The rising internal debt, according to Guidotti and Kumar (1991), is a source of concern for two main reasons. First, a sizeable domestic debt leads to sharp increases in debt-service payments as we have already noted, which, in turn, depresses public sector investment. In fact, in times of economic austerity, investment is one of the first items of government expenditures to be reduced because (a) its reduction does not immediately result in a reduction of welfare and (b) it leads to a reduction in imports and is thus helpful to the current account. The long-term impact, however, of falling investment is to depress the rate of economic growth even further. The data indicate that gross domestic investment fell from $469.4 million in 1976 to $314 million in 1983, while the deficit on the current account balance declined steadily from $360 million in 1976 to $211 million in 1979.

The second reason for concern over a rising internal debt is that it fuels the inflationary process. Guidotti and Kumar argued that it is not unusual for the growth of the domestic debt burden to be accompanied by a high rate of inflation which, according to the authors, averaged more than 200 per cent a year in some heavily indebted countries. In Guyana's case such high rates of inflation did not prevail: official data indicate that the rate of inflation averaged about

18 per cent during 1978-88 but this may be a considerable underestimation, as will be discussed in Chapter 15.

External Debt[2]

The following issues on the country's external debt stock (EDS) is based principally on data contained in World Bank (1984, 1986, 1990c, 1991). Supporting summary data are given in table 12.

(a) Throughout the sample period, the private sector did not incur any external debt. The entire debt stock was incurred by the central government, non-financial public enterprises and the Bank of Guyana. In general, the country's EDS grew rapidly, exceeding 10 per cent for 19 out of the 36 years between 1955 and 1988. There were only two years (1967 and 1988) in the entire period when the EDS recorded negative rates of growth.

(b) By the end of 1952 the colony had amassed an external outstanding debt stock of G$30.56 million, amounting to 17.2 per cent of that year's GDP (G$178.3 million). Nevertheless, because of the easy conditions under which the colony borrowed, debt servicing did not present a problem. The huge rate of growth of the EDS during 1956-59 is due to rapid growth in the first and last years of this period, following heavy investment in the bauxite industry.

2 Following tradition, all amount in this section are in terms of United States dollars, unless otherwise indicated. According to the World Bank (1990c), the total external debt stock (EDS) consists of public and privately guaranteed long-term debt, private non-guaranteed long-term debt, the use of IMF credit and estimated short-term debt. In other words, the EDS comprises three components: (a) long-term debt; (b) short-term debt; and (c) IMF credit. Note that the EDS refers to amounts disbursed and outstanding, expressed in US dollars converted at the official exchange rate (World Bank, 1991:.x).

(c) The EDS grew modestly in the 1960s, averaging 5.6 per cent per year. During the period 1972-81, two factors were mainly responsible for the rapid growth of the external debt stock: a series of nationalization between 1972-77 and spending on prestige projects between 1976-81. For this 9-year period the external debt grew by an annual average of 21.2 per cent. At the end of 1981, the stock of external debt was estimated at $868 million, almost 5.5 times its size in 1972.

Table 12. Some Indicators of the Total External Debt Stock, 1956-1988

Period	Growth Rate of EDS	EDS as a Percentage of GNP	EDS as a Percentage of Exports	Debt Service as a Percentage of Exports
1956-59	27.7	21.0	...	...
1960-69	5.6	31.8	51.0	4.9[a/]
1972-81	19.2	101.4	148.8	13.2
1982-88	10.2	396.9	561.8	16.5[b/]

a/ Covers 1966-69 b/ Covers 1976-88
Sources: Calculated from World Bank (1953, 1984, 1986, 1990c)

(d) The EDS continued to grow at very modest rate (10.2 per cent) during 1982-88, probably because of the difficulty encountered in borrowing abroad. By 1988, the end of the sample period, the EDS was $1.68 billion.

(d) How severe was the debt overhang? Basically, the 1950s and 1960s did not strain the capacity of the country as the EDS was well below one-third of GNP. By 1976, this statistic reached 93 per cent and in the following year the EDS became larger than GNP. In 1982 the EDS was more than doubled GNP and five years later it was more than six times the country's GNP. And for the entire 1980s as a whole, the EDS was about four times the size of GNP.

(e) Seen in terms of another common measure, the EDS already exceeded the value of exports in 1973. Aside from 1974-75, the sugar market boom, the external debt stock outpaced export earnings for the rest of the sample period, peaking at 6.4 times export earnings in 1988.

(f) A more analytic measure of debt-carrying capacity, given by the ratio of debt service (amortization plus interest charges) to exports, reveals a grim picture. Throughout 1966-75, such charges, though fluctuating, did not consume more than 7 per cent of export earnings, but from 1976 until 1986 the country was faced with double-figures debt-service charges. The most difficult period was the five years between 1979 to 1984, when the debt-service/export ratio varied between 21 and 29 per cent. Indeed, the World Bank (1990c) listed Guyana as one of the severely indebted low-income countries (Volume I:121).[3] No other Caricom country is included in this group of 26 countries.

(g) The composition of the long-term debt (not EDS) changed rapidly during the period of massive nationalization in favor of obligations contracted from commercial sources, although the situation was reversed in the 1980s. Long-term debt from private, commercial, sources peaked at 44 per cent of total long-term debt in 1976 and remained well beyond 23 per cent for the rest of the period (World Bank, 1990c).

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[3] The World Bank (1990c) classifies severely indebted countries according to income range: severely indebted low-income countries (SILICs), severely indebted middle-income countries (SIMICs), moderately indebted low-income countries (MILICs) and moderately indebted middle-income countries (MIMICs). Severely-indebted countries are defined as countries in which three of the four key ratios are above critical levels. These ratios and their critical levels are debt to GNP (50 per cent), debt to export of goods and all services (275 per cent), accrued debt service to exports (30 per cent) and accrued interest to exports (20 per cent). Moderately-indebted countries are defined as countries in which three of the four key ratios fall in the following ranges: debt to GNP (30-50 per cent), debt to export of goods and all services (165-275 per cent), accrued debt service to exports (18-30 per cent) and accrued interest to exports (12-20 per cent)

(h) The country began short-term borrowing in 1977; prior to that date, the entire external debt stock was long-term in nature. Short-term borrowing increased rapidly, particularly between 1982-85, and by 1988 it stood at about 38 per cent of the external debt stock. Seen in historical perspective, by 1988 the short-term debt accumulated by the country was 8.7 times larger than what it was when this type of borrowing commenced 11 years earlier.

(i) As a result of points (g) and (h) above, the share of EDS owed to private, commercial sources expanded considerably, since, in addition, the entire short-term debt was contracted from these sources. Indeed, since 1984 over one-half of EDS was owed to private, commercial creditors.

(j) The growing share of long-term debt contracted from commercial sources was the principal reason for the greater burden on "average" new commitments: higher rates of interest, and shorter maturity and grace periods. Indeed, during the 18-year period, 1970-88, the average rate of interest from commercial sources was 9.9 per cent, which is more than 2 times the rate on new commitments from non-commercial sources.

(l) Data on the conditions under which short-term loans, incurred from private sources in their entirety, are not available. Since, however, the terms of such loans are more burdensome than long-term loans, it is surmised that the term structure of total obligations to commercial sources is in fact much harsher that implied by (j) above.

PART 2 - THE AUGMENTED KEYNESIAN MODEL

Part 2 commences, in Chapter 9, with a review of the approaches to macroeconometric modelling in the Caricom region, discussing general problems and issues and reviews, albeit briefly, published models. The modelling methodology and the advances of the Augmented Keynesian Model (AKM) built by this study over previous models in the region are the focus of Chapter 10. Chapters 11 through 16 are concerned with the specification and estimation of the principal behavioral equations for the AKM: consumption and investment, the government sector, imports and exports, money, inflation, and potential output and depreciation. Each chapter, with the exception of Chapter 16, begins with an empirical review of previously (published) work in the region and then moves on to the principal task: specification and estimation of equations for the AKM. The AKM will be benchmarked against an Export-led Model (ELM), the second most dominant modelling approach in the region. This model will be specified and estimated in Chapter 17. The full structure of both models, including definition of variables, is provided in Annexes 1 and 3.

CHAPTER 9

Macroeconometric Modelling in the Caricom Region: Review of the Literature

Introduction

The principal focus of this review is on **macroeconometric** models[1] in the Caricom[2] region. Given that not many such models exist in the region, the review is complemented by a discussion of other relevant regional econometric studies. This peek into the literature is

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1 The focus here is on **published** models of the 15 regional economies actually available to the author. The review is therefore not exhaustive. The models available are Carter (1970) and Manhertz (1971) of the Jamaican economy; Jarvis (1990), Ganga (1990) and Khayum (1991) of the Guyanese economy; St. Cyr (1981), Persaud (1979), Hilaire, Nicholls and Henry (1990) and St. Cyr and Charles (1992) of the Trinidad-Tobago economy; Boamah (1985) of the economy of Barbados; Holder and Worrell (1985), Worrell and Holder (1987) of the economies of Barbados, Jamaica and Trinidad-Tobago; Bourne and Nicholls (1990) of the economies of Trinidad and Tobago and Barbados; and McIntyre (1986) of the OECS countries.

From the literature it would appear that many other models have been constructed at the University of the West Indies, the Research Departments of the Central Banks, Statistical Bureaux and planning entities. As far as I am aware, the majority of these models have not been published and are thus not readily available. It might also be appropriate to point out that, in addition to macro-economic models, regional researchers have done several empirical studies on single macroeconomic aggregates, such as money and interest rates.

2 Henceforth "Region", "Caribbean" and "Caricom" are used interchangeably in the review. It is obvious from this that the word "Caribbean" is used in a much more restricted way than its modern usage suggests.

intended to guide and inform the present model-building effort and to make a modest contribution towards bridging the gaping need for a survey of econometric studies in the Caribbean region.

There are basically three approaches to macroeconometric modelling in the region, each based on a specific perception of the economy. These are: the Keynesian, the export-led and the two-sector model. All three approaches incorporate the fact that the regional economies are very open, although the export-led and two-sector model takes account of this feature more rigorously.

Empirical studies in the Caricom region are seriously constrained by the poor quality of the data and the small number of data points on any given series as serious macroeconomic accounting goes back only to the mid 1950s. Unless the problems of serial correlation and model specification are dealt with more rigorously, they could undermine the incipient interest in macroeconometric model by policy makers and managers of the economy. These and other issues are discussed in the section on general observations.

To my knowledge, four macroeconometric models of the Guyanese economy have been published, all as part of academic research. These are Paul (1978), Jarvis (1990), Ganga (1990) and Khayum (1991); the latter three models are discussed in the section on Guyana. All four models are in the Keynesian tradition, although the latter two are more eclectic in that they are premised on a combination of economic schools of thought.

The three first published macroeconometric models in the Caricom region are those by Carter (1970), Manhertz (1971) and Persaud (1979). These models firmly adhere to Keynesian principles and may be considered the first generation models in the region. Other, later models of this genre incorporate open economy principles. Export-led models and two-sector models followed later, embodying a different view of the working and dynamics of the economy. The section dealing with studies in other Caricom countries takes up these models.

Approaches to Macroeconomic Modelling in the Caricom Region

Over the last twenty-five years or so sporadic efforts have been made at constructing macro-economic models in the region as intellectual exercises but practical application of these models dates back only to the 1980s. Caribbean researchers have spared no effort to ensure that their models reflect the real, living, dynamic economy but, as so often happens in economics, divergent views have emerged as to the modelling approach that best captures the essence of the economy.

The first and by far the most popular approach draws its inspiration from Keynesian theory, the core of which is the IS-LM construct. Models built in the region have generally employed the closed economy version of the IS-LM construct.[2] The distinguishing feature of Keynesian-type models (the fixed-price IS-LM models) is that aggregate (effective) demand variations determine the level of economic activity. In turn, aggregate demand is determined by substitution of demand components into the overall equilibrium condition; that is, as an identity. In other words, prices are taken as given and there is simply not much of an equilibrating role for them. A central concern of some of the early models in the region was the considerable importance attached to the marginal propensity to consume out of disposable income and by implication the marginal propensity to save.[3] This reflects the crucial role of demand stimuli within the Keynesian framework.

Until recently, modelling along the Keynesian lines has been much more "pure" in the Caribbean than in other developing countries that began to experiment with econometric modelling at an early date (India, Greece, Israel, Korea) or in developed market economies.

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2 Khayum (1991) is a notable exception. His model of the Guyanese economy is based on the open economy version of the IS-LM construct.

3 After all, modelling in the region was only repeating history:early forecasting models of developed economies were based on the consumption function. In general, these models either ignored monetary and financial relations or introduced them in a very primitive way (Minsky,1986).

Supply side influences have been minimized in the region; exports have in some cases assumed to be exogenous, as also part of investment. These modifications may be seen, in part, as attempts to deal with the special features of the regional economies.

In general, present day Keynesian-type models, particularly as implemented in developed economies,[4] did not exclude supply-side influences such as prices, wages, labor supply and employment. In fact, in these economies a typical Keynesian model can be expected to contain equations for consumption, investment, imports, exports, government sector, a production function, wages, employment, labor supply, real money supply, domestic prices and even export prices. In some cases, the model determines both absolute and relative prices, which explains why demand decomposition is frequently complemented by decomposition on the supply side.

More recent studies (see, for example, Ganga, 1990, and Khayum, 1991) within this framework, while retaining the Keynesian orientation, have attempted to introduce two kinds of innovations: (a) elements of other theories when deemed appropriate, and (b) open economy macroeconomics, in recognition of the open nature of the regional economies. In other words, the "pure" Keynesian approach is now being diluted and the models in this tradition are becoming rather eclectic. Indeed, Ganga (1990:4) writes that his model "... is eclectic and incorporates interactions from the demand and supply sides, including the foreign sector." Khayum (1991) is also clear that his model takes into consideration both supply and demand factors.

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[4] As observed in the previous footnote, the very early models of developed economies were also relatively simple constructs. Indeed, the history of econometric modelling shows a progression from the simple to the complex, in the sense of being a more adequate representation of the economy and incorporating many more relationships and feedback effects. Among several references on the history of macroeconometric modelling, see Bodkin, Klein and Marwah (1991) for a comprehensive discussion.

The second major approach to macroeconomic modelling in the region locates the internal dynamic of the economy in the export sector which, according to this approach, determines overall performance. Models of the export-led genre find theoretical support in the dependency school of thought, of which the region is a pioneer. But while there is extensive theoretical support for the export-led model, to my knowledge only two empirical implementations of it have been published. These are St. Cyr (1981) and St. Cyr and Charles (1992).

For analytical purposes, these two dominant approaches may be distinguished by the manner in which exports are treated and the extent to which supply-side influences are taken into account. The export-led approach perceives the economy as very open, deeply integrated into the world economy, almost leading an enclave existence. From this perspective, exports, for which the productive apparatus of the economy has been structured and shaped with colonialism, are determined by external factors. This is, in fact, the ultimate justification for the exogenous treatment of exports by this approach. Modelling exports in this manner confers upon it the ability to perturb the economy exogenously, with the source of the perturbation external in origin. Exports, clearly, are the dynamic force that drives the economy.

An exogenous increase in exports cannot, however, induce unmitigated expansion in the domestic economy. Sooner or later, the demand-induced expansion is constrained from the supply side, via labor shortages, rising prices and the high import-dependency of the productive apparatus. Supply-side constraints kick in because of demand-induced pressure on prices and import requirements, even assuming that the productive capacity exists. It is in this way that equilibrium, albeit at a higher level, is restored in the economy following an export perturbation.

The Keynesian approach, on the other hand, usually treats exports as an endogenous variable, being a component of aggregate demand. This determination of exports within the overall system does not rule out its external impetus. In this case, however, the stimulus comes from exogenous prices, upon which exports are dependent, among other factors.

A third approach, which does not find wide representation - particularly in theory but less so in practice - among Caribbean economists, attempts to bridge this divide, viewing the economy as a two-sector organism: a tradable and a nontradable sector. Essentially an extension of monetarist analysis to the open economy, the prices of goods in the traded sector are set on the world market while the prices of non-traded goods are determined by domestic demand and supply. The sectors are linked via prices, wages and the cost of credit (production in both sectors relies heavily upon bank finance) and the domestic economy is open to foreign influences via interest rates and capital inflows, besides exports. While this approach emphasizes the supply side of the economy, it allows for a much richer interaction between real and monetary variables in the economy, compared to the other two approaches. Another important feature of the two-sector approach is the prominence given to the monetary sector, which normally contains stochastic equations for credit and interest rates. That is, of course, not unexpected, given the theoretical underpinning of this model.

The two-sector modelling strategy is a rather flexible device in that the purpose of the model determines which of the sectors play the dominant role. In both Worrell and Holder (1987) and Boamah (1985) this role is accorded to the tradable sector while in Holder and Worrell (1985) it is the non-tradable sector that is the core of the model.

To my knowledge, the only published examples of the two-sector models are those of Worrell (1981), Holder and Worrell (1985), Worrell and Holder (1987) and Boamah (1985). The "model" by Worrell is more in the nature of a descriptive model, although appendices A and B contain, respectively, equations for exports and price formation. The 1987 study by Worrell and Holder is not a macro-economic model but an attempt to explain price formation in small open economies for which a two sector (tradable and non-tradable) approach was employed. Boamah was also not interested in modelling the economy as a whole but instead, adopting the two-sector approach, he attempted to explain wage formation, employment and output in the Barbadian economy. Thus the only full-blown two-sector macroeconometric model of the economy as a whole is that of Worrell and Holder (1987).

Evidently, there is not much empirical support for the export-led and the two-sector models. In fact, all published empirical implementations of these models have been done by only a few scholars: to my knowledge, only two models in each of these approaches have been published, and all of them have basically involved the same authors.

Some General Observations

Econometric model-building is a relatively new field of endeavor in the Caricom region. McIntyre (1986:177) notes, "[T]he model-building approach to economic analysis is still relatively underdeveloped in the Caribbean and in the case of the OECS economies no previous attempt at modelling these economies have been found."[5] Actually, modelling-building efforts in the Caricom region began in the 1970s, with the publication by Carter (1970) of a macroeconomic model of the Jamaican economy. Carter's aim was to provide a macroeconomic structural description of the economy, with statistically estimated parameters. He was clear that the model was not intended to "... serve as any kind of forecasting or predicting device, nor as any vehicle for policy prescription" (p. 180). Other such early efforts include Manhertz (1971), Persaud (1979), Gafar (1977) and Paul (1978).[6] In general, however, these early efforts at modelling the economy were "... simply attempts to reproduce and project forward the mechanism under which the economic system actually functions, rather than to re-define the parameters of its operation under specified conditions" (Brown and Brewster, 1974:50).

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5 "OECS" is the abbreviation for the Organization of Eastern Caribbean States, which comprises Antigua, Monsterrat, St. Kitts-Nevis, Grenada, St. Vincent, St. Lucia and Dominica. The OECS is part of the Caricom Region.

6 The model by Paul has not been published.

The models constructed in the 1980s, while continuing the approach of those in the previous decade, were richer in theory, drawing upon neoclassical, Keynesian, dependency/structuralist and monetarist. Most of these models, still theoretical constructs for they have not been engaged in practical service, were not so much interested in modelling the behavior of the economy as a whole but were principally concerned with policy analysis, stabilization issues and forecasting. That is, contrary to the observation of Brown and Brewster (1974), recent models are interested in the behavior of the economy in response to changes in key macroeconomic variables and/or policy instruments. From this standpoint, it can be said that modelling during the last decade or so endeavors to characterize the regional economies structurally, as well as to change the equilibrium configuration of these economies. This "trajectory" provides a firmer foundation for modelling and it is likely to continue into the future.

A second issue concerns the extent to which models are used to manage the economy. It would seem to me that usage is a function of several factors but two crucial ones are, in descending order of importance, (a) the existence of an abundant number of models and (b) continuity of the modelling effort over a relatively long time period. As we have already noted at the beginning of this chapter, not many macroeconometric models exist in the region. In fact, no more than 15 (published) such models of the 15 regional economies are in existence. The region's record on point (b) is also not strong. Academic research on macroeconomic models dates back to less than twenty five years but actual use of these models as a guide to chart the course of the economy is of even more recent origin, probably beginning sometime in the early 1980s. To a large extent, these factors explain why macroeconometric models are not widely used in the region.

Probably the only country in the region that regularly uses a macroeconometric model is Barbados. The Barbadian Central Bank forecasts the behavior of key variables on a quarterly basis by projecting real output sector by sector.[7] Output is divided into tradables and non-tradables. The former is arrived at via an implicit derived demand, based on the tradable sector as the engine of growth, although the nature of this relationship is not clearly specified. Prices are obtained by comparing expected foreign price trends with the relationship between local and foreign prices observed in the recent past. From the estimates of output and prices, income is obtained, from which expected imports, government revenue, monetary accumulation and credit demand are derived. Once government expenditure policies are hypothesized, the balance of payment implications of the projected output path can be charted.

The Research Department of the Central Bank of Trinidad and Tobago has undertaken several modelling efforts as well, most of which have not been published (Hilare, Nicholls and Henry, 1990); these models analyzed the behavior of the government sector, balance-of-payments, consumption and price determination, monetary sector, the labor market and wage determination, and investment. It is presumed that, since these models have been formulated by a premiere central institution, they may have been put to some practical use, however limited. From the published literature available to the author, it does not appear that macroeconometric models have been officially used in Jamaica, although this is highly unlikely to be the case. Macroeconometric models have not been used by the LDCs of the region, as observed by McIntyre (1986).

It is almost certain, however, that Guyana is one of the (possibly two) MDCs in the Caricom region[8] that does not employ any formal econometric model in the management of her economy. The reasons for this include the shortage of equipment and appropriate software,

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[7] The discussion of this model draws heavily upon Worrell (1987) since I have been unable to locate any literature on it.

[8] The other MDCs in the Caricom region are Jamaica, Barbados, Trinidad and Tobago, and Guyana. That Guyana continues to be classified as an MDC in the Caricom region is somewhat of a curiosity. Since at least 1973 Guyana continues to have the lowest per capita income (at 1988 constant US$) in the entire region. Perhaps, the classification hinges more on inertia and geographical size rather than on wholly economic criteria.

the data poor quality and the shortage of trained personnel in government service as continually deteriorating economic conditions and the consequential general apathy of the populace have led to an exodus of skilled Guyanese.[9] But perhaps the most fundamental constraint is the virtual non-existence of econometric models and the lack of appreciation of the utility of these models by those responsible for economic decision-making.

A third and very important issue confronting the modelling effort relates to the unreliability of the data, due essentially to measurement problems, inconsistency between the theoretical variables and their practical counterparts and the extent of coverage. The problem of data quality is not, however, a general problem but seems to vary with general economic conditions and the level of economic development. Thus the quality of the data from Barbados, Trinidad and Tobago, and possibly Jamaica, are of a higher standard. At least in the case of Guyana, the quality of the data has trended downwards (World Bank, 1986).

The immediate outcome of poor data quality is that the results of empirical research are viewed with suspicion. The problem of data quality is compounded because (a) for most series only annual data exist; and (b) serious macroeconomic accounting in the region began only to the mid-1950s, which means that only about 35 data points are available for most series. These issues negatively impact upon the credibility of macroeconometric modelling and are perhaps another reason models have been used in only a limited way in the region as yet.[10]

Fourth, perhaps one of the most common and long-standing problems characterizing Caribbean econometric research is the widespread presence of serial correlation and the failure to deal with it. In fact, the problem is so endemic that it would appear **not** to be of much

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[9] Some Guyanese economists who have done econometric modelling work and who no longer reside in the country include Bourne, Ganga, Khayum, Jarvis and Paul.

[10] Of course, besides poor data quality, results are also influenced by the structure of the model itself, including the theory underlying the model, the vector of explanatory variables, functional specification, the specification of dynamic adjustment mechanisms and even the estimation technique.

importance.[11] Given the lack of computing power in the early days and the level of disaggregation - early models tended to be very much disaggregated but yet simple as many equations rarely contain more than two explanatory variables -, the failure to correct for serial correlation is perhaps understandable. But there is little reason for the continuing failure to initiate corrective action today, given the ready availability of computers and powerful econometric packages.[12] Since an unacceptable D.W statistic may be pointing to model misspecification, in addition to detecting serial correlation, there is clearly much work to be done in econometric modelling in the region. And unless greater attention is paid to this problem, the results of econometric research in the region can be regarded with little more than curiosity as far as the practice of the management of the economy is concerned.

Several equations of the models reviewed employ the log-linear formulation, which seems to capture in a more realistic manner the behavior of the underlying variables, in addition to providing a constant-elasticity formulation.[13] Several of the equations of the models reviewed contain insignificant variables, an undesirable practice from a modelling standpoint. This practice apparently stems from the specific modelling methodology employed or rather the lack of it. It would seem that once a theory is translated into an econometric specification, the estimate is accepted as final. Little attempt is made to loop back from econometric specification to theory, to determine, firstly, if the specification is correct and, secondly,

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[11] For a good overview of the abuse of statistical criteria in econometric research in the region, see Watson (1987). These criteria include the D.W. statistic, the t-statistic and the R^2. Watson notes that the t-statistic cannot be considered as coming from a Student distribution when (a) the error term is serially correlated; (b) the model is misspecified; (c) lagged endogenous variables appear among the regressors; and (d) the regressors are measured with errors.

[12] One notable example of the few times when researchers in the region worry explicitly about the problem of serial correlation is that of Worrell and Holder (1987:239) who were concerned with "... some uncertainty about the presence of serial correlation, which would render the estimated elasticity coefficients unreliable." However, they dismiss their concern with the statement that "[O]ur inferences depend on the assumption that serial correlation is absent in all these doubtful cases ..." (p. 239).

[13] This formulation is sometimes used to control for heteroskedasticity, especially when the variable in question has a trend component. (See, for example, Maddala, 1992:220).

whether the theory is wrong if poor estimates are obtained.

The "specific-to-the-general" approach to modelling predominates Caribbean econometric research. Alternative modelling approaches proposed by Sargan (1964) and his students (the general-to-specific methodology), Leamer (1978), Sims (1980) or Zeller (1971) have not been employed, nor have recent techniques such as unit roots and cointegration. In short, both the approach and techniques used are standard; econometric tools now becoming fashionable have not been applied. It must be recognized, however, that these new techniques were developed only in the last decade and are not yet widely used even in developed countries. Indeed, the present study, to a large extent, is also guilty of the non-application of these newer tools of econometrics.

There are also many unsettled issues, relating primarily to research on the demand for money. These include the applicability of the homogeneity postulate; the appropriate left-hand variable (narrow or broad money) in the demand for money function; the appropriate scale variable in an open economy; and the appropriate opportunity cost variable, given that interest rates in the region have largely been administered. The issue as to whether the money supply is endogenous or exogenous is also one on which a general consensus is absent, although, given the very open nature of the economies in the region, the evidence seems to support the endogeneity argument. As far as I am aware, all the studies of the demand for money in the region estimates a standard long-run or partial adjustment. Other approaches, such as the error-correction model or the buffer stock model, have not be tested.

Research on the consumption function has, in the main, employed the Keynesian consumption function. Only one published study (Hilaire *et al*, 1990) tested the permanent income hypothesis. The studies on inflation have sought to demonstrate that the principal causal factors are foreign prices as well as domestic factors. Not unsuprisingly, the standard formulation contains a mixture of monetarist and structuralist variables.

Finally, regional macroeconometric models either omit inadequately treat (a) the government sector, (b) the monetary sector, (c) expectations, (d) specification of linkages in the economy, and (e) benchmarking—i.e., comparing model performance against a benchmark model.

Studies of the Guyanese economy

As is also true of other developing countries, the absence of macroeconometric models in practical use in Guyana does not necessarily mean that such models do not exist. In fact, it is almost trivial to note that work on theoretical models over a period of time precedes application.[14] My research indicates that the first model of the Guyanese economy was built by Paul in 1978, a project which he undertook for his PhD dissertation.[15] Paul's basic purpose was not to model the economy but to study the impact of stabilization policies during 1960-81. The model, comprising 39 equations, 25 stochastic and 14 non-stochastic, includes equations for population, labor, output, income, government expenditure, the external sector, price/wage and the financial sector. One distinguishing feature of this early model is the determination of output by both supply and demand factors; the crucial role of imports in the adjustment process is also considered at some length.

Jarvis (1990), also for his PhD dissertation,[16] constructed and estimated a 17-equation macroeconometric model of the Guyanese economy for the period 1957-76. A typical Keynesian model, it emphasizes the demand side of the economy, comprising behavioral equations for consumption (private and government), investment, imports (disaggregated into

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14 Minsky (1986) notes that in developed economies models were first constructed as academic exercises. Only sometime later were they used as forecasting instruments and as a tool for policy analysis.

15 Paul's model will not be discussed in any detail because it is not readily available.

16 Jarvis's PhD dissertation, completed in 1982, was published in 1990.

food, intermediate goods, and machinery and manufactured goods), exports (disaggregated into food and others), tax revenue and price. The overwhelming focus on the real sector of the economy and the exclusion of the monetary sector (apparently because of data unavailability) detracts from the utility of the models as there is no linking mechanism between the two sectors.

His multiplier analysis indicates that an increase in indirect taxes would increase government revenue which, in turn, positively impacts upon government spending and thus GNP. In fact, Jarvis found that a one million dollar "tax infusion" (p.46) would result in a 3 per cent growth of nominal GNP. While a positive, direct connection between indirect taxes and GNP might be controversial, the magnitude of the relationship, as found by Jarvis, is debatable as his model only marginally covers the period when a huge portion of the economy was owned and controlled by the government.

Jarvis was also interested in structural change but the way he tested for this was not entirely appropriate—he did not employ the usual Chow or other formal tests for structural break in the estimated relationship. First, he simply notes that installment credit had a significant impact on private consumption expenditure and this is apparently interpreted as a "break" in the pattern of private consumption. Second, with the declaration of the country a Cooperative Socialist Republic in 1970, the Government expressed its intention to make a clean break with the past. Jarvis tests this claim by adding a dummy variable to each equation in his model. The results show that "... no equation reflected this break with the past" (p.32). He interpreted this as support for Clive Thomas's claim that the structure of the productive apparatus of the economy remained essentially unchanged since the country because a Republic. The Government, on the other hand, argued that the ownership of this apparatus has changed dramatically. This is certainly the case but the argument was no more than a hedge since the real issue is about structure and not ownership (this issue is discussed in greater detail in Chapter 3).

Six years later, further econometric work on the Guyana economy was taken up by Ganga (1988), also for his PhD dissertation.[17] Like Paul, Ganga's main purpose was to study quantitatively the impact of stabilization polices during 1966-85. Continuing his econometric work, Ganga (1990) developed what he termed a "Macro-Economic Model of the Guyanese Economy" for the period 1966-85. This aggregative model contains 7 behavioral equations which determine output, gross fixed capital formation, private consumption, treasury financing requirements, imported inputs, exports and inflation; there are also 6 identities and definitions which determine money supply, balance of payments, national income and overall equilibrium. Like Jarvis (1990), Ganga accounted for the monetary sector by a single direct behavioral equation - inflation -, although in terms of identities he presented a much more developed account.

Ganga's model is also essentially in the Keynesian tradition, with a heavy focus on the real sector. The link between the real and monetary sectors runs from a chain starting from money supply. The bridge is provided by the equation for inflation, which is then linked up to the equation for treasury financing requirements. It is in this way that disturbances are transmitted from the monetary to the real sector and vice versa. The equation for treasury financing (TFR) requirements is stated as -

$$(9.1) \qquad TFR = t_0 + t_1\Delta\log(Pc)_{t-1} + t_2\log(IDE) + t_3\Delta\log(YS) + t_4D_2$$

[17] This model by Ganga will not be discussed because it is not readily available to me.

where Pc is the consumer price index (base = 1975), IDE is the implicit deficit,[18] YS is GDP and D_2 is a dummy variable for abnormal government capital transfers to the public sector. Ganga does not offer any definition of TFR but this concept seems to be equivalent to borrowing by the government [see his equation (8b)] and is perhaps the same as the fiscal deficit.

As far as the link between the two sectors is concerned, the crucial term in (9.1) is the lagged rate of inflation which, according to the estimates obtained by Ganga, "... confirm the hypothesis that government revenues lagged behind government expenditures in the face of rising prices" (p.18), suggesting a growing deficit (IDE) over time. Inflation, in turn, is dependent upon the change (logarithmic) in current and lagged money supply, among other factors. The linkage is, therefore, from money supply--->inflation--->TFR--->GDP. Since the money supply is defined in the context of an open economy (domestic credit plus changes in international reserves) it is fair to assume that the loop also runs back from GDP to money supply, as is apparent from his identities (8c) and (9).

The logic of the Ganga model may be readily illustrated. Assume an exogenous rise in foreign capital inflows, which increases the availability of foreign exchange and improves the balance of payments. Rising foreign exchange "... is expected to reach all endogenous variables in varying degree" (p. 12). In actual fact, an increase in net capital flow impacts upon the economy via two routes. The first traces a path as follows: net capital inflow--->foreign exchange--->imports---> output-->exports--->income--->investment. The second channel,

[18] In endnote 7, Ganga defines the implicit deficit (IDE) as -

$$IDE = TDR - TGE$$

where TDR is the time trend of government revenue and TGE is 'allowable' expenditure. According to Ganga, TGE is calculated from TDR by taking the ratio of actual expenditure to trend revenue in a base year and applying the ratio to trend revenue in each year.

Is the fiscal deficit (IDE) a behavioral variable? Or is it best modelled as an identity, defined as the difference between government expenditure and revenue? It seems to me that the latter is more appropriate.

assuming non-sterilization, runs from net capital inflow--->net foreign assets of the central bank--->money supply --->consumption--->price level--->treasury finance requirements. As Ganga points out, "... a once-and-for-all increase in net capital inflow may simultaneously affect the balance of payments and fiscal deficit" (p. 14). In other words, the effect of a net capital inflow begins from the balance of payments and concludes at this starting point, affecting both real and monetary variables in the course of its circular flow.

Several other features of Ganga's model may be noted. First, it is a real system as all variables are measured in real terms, which makes it particularly attractive for evaluating real growth. Second, all equations are specified in the double log (log-linear) form. The estimation of a log-linear function allows the dependent variable to react proportionately to a rise or fall in the explanatory variables, implying a constant elasticity for the estimation period; it also minimizes the problem of heteroskedasticity. A third feature of the Ganga model is that all but the inflation equation have an adjustment mechanism based on the Cagan-Nerlove process whereby the actual value of the variable adjusts to the desired level. This feature makes the model a short-term model, although the long-term elasticity coefficients can be readily calculated.

The Ganga model also incorporates the structuralist thesis that the growth of output is constrained not only by domestic labor and capital but also by the availability of foreign exchange and hence imports. The openness of the Guyanese economy is captured by making (a) output dependent upon imports; (b) both fixed capital formation and imports dependent upon the availability of foreign exchange; and (c) exports dependent upon output. The chain of causation is typical of demand-driven models. Finally, the model, while covering the period 1966-85, does not adequately take account of the predominance of the public sector as only the treasury financing requirements of the government is modelled. In other words, aside from the behavioral equation for TFR, the model does not specify other channels through which the large government sector impacts upon the economy.

One of the conclusions of the model is that "market forces did not play an allocative role in the economy" (p. 25), which is to be expected in an economy dominated by the public sector. Ganga also found, among other things, that increased government spending is important to economic growth, lower rates of inflation and viable balance of payments. Jarvis (1990), it will be recalled, obtained a similar result from his model. Consistent with his results, Ganga notes that tight monetary and fiscal policies and devaluations were harmful to growth and unable to restore internal and external balances. This is a conclusion which is diametrically opposite to the standard IMF prescription.

The most rigorous and well-thought out modelling attempt of the Guyanese economy is that of Khayum (1991), who begins by pointing out that previous modelling attempts in LDCs have either concentrated on the demand or supply side of the economy. One of the potential difficulties of this approach is the inability of tracking down the source of causation when both demand and supply factors influence an outcome. Khayum's solution is to adopt an integrated strategy in which both demand and supply factors are considered within a single framework. This approach draws on three traditions within economic theory: the IS-LM system which provides the basis for the aggregate demand function; the neoclassical tradition which provides the foundation for the analysis of the supply side of the economy; and the Keynesian framework which furnishes the basis for the balance of payments equation. In other words, Khayum's model is the extension of the closed IS-LM model to the open economy (the IS-LM-BP model).

The model, covering the period 1960-84, attempts to incorporate three main ideas: (a) the open nature of the economy, which is captured in the output, investment, import and export equations, (b) the inclusion of structural and institutional factors which impinge upon the decision-making process, and (c) the ability to address issues of adjustment to macroeconomic imbalances and other policy issues. The output equation in the Khayum model is unique in the sense that it is the only model of the Guyanese economy which has energy supply as an explanatory variable: it is, in fact, a solid attempt to account for an important supply side constraint to output in Guyana (all energy is imported), as the two oil crises dramatically illustrated.

Private investment and inventory are treated as exogenous variables in the Khayum model. The rationale for the latter derives from the unpredictability of events such as the weather and strikes, which exercise a heavy impact on all major productive activities. Private investment is not modelled endogenously because it is determined by the parent companies of the "foreign dominated production sector" (p. 115) as part of their global investment strategies prior to 1970 and the uncertain investment climate confronting the private sector for the rest of the sample period. Hence, Khayum's investment function (p.116) relates only to the public sector.

The model comprises three sectors: expenditure, monetary and production. The former sector contains equations for personal consumption, investment, government consumption expenditure, exports and imports. There are two equations in the monetary sector—a behavioral equation for the demand for real money balances and a definitional equation for money supply, defined as being equal to the sum of net domestic credit and net foreign assets. The production sector is made up of equations for production, labor demand and the supply and demand for imported inputs. Khayum argued that, because of limited foreign exchange, the amount of imports used is determined on the supply side, constrained by the capacity to import. Hence his equation 5.14 (p. 122):

(9.2) $$CIM = CIM^{s} \leq CIM^{d}$$

Basically, this equation says that actual imports of intermediate and capital goods (CIM) is equal to the constrained supply of this category of imports (CIM^s), which is less than the actual demand for this type imports (CIM^d).

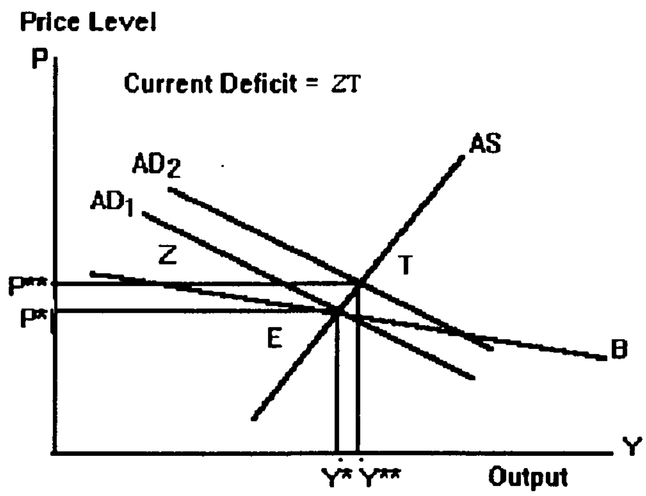
Since Khayum is interested in the analysis of output, the price level and the balance of payments, the basic structure of his model is reduced to three equations: an aggregate demand equation, an aggregate supply equation, and a balance-of-payments equation. These equations are derived by manipulating the system of equations and making use of the open economy expenditure identity ($Y \equiv C + I + G + EX - IM$). From this the IS (good market equilibrium) and the LM (monetary equilibrium) curves are derived. Now the solution to the IS-LM construct, which combines goods market and monetary equilibria, generates the AD (aggregate demand) function as a relationship between the domestic price level and domestic output, given the rate of exchange, foreign prices, other exogenous influences, and some fiscal and monetary parameters.

The slope of the IS function is likely to be high, given the low interest elasticity of investment demand and a high income elasticity of import demand. The LM curve also has a steep slope because of the insensitivity of money demand to administered interest rates. The AD curve is likely to have a greater slope than the IS and LM curves from which it is derived. Shifts in the AD curve can occur as a result of changes in exogenous variables, such as changes in the exchange rate, domestic credit, the public sector deficit, import capacity and the import price level.

The AS (aggregate supply) curve is derived by substituting the factor use equation into the production equation to get an output and price level relationship, given the wage rate, the exchange rate, foreign prices, energy supply, and capacity to import intermediate and capital goods. Khayum argues that "... because of the nature of the production determining forces in the economy, it [the AS curve] is relatively steep with all other variables given" (p. 130). Variables that shift the AS curve are, in a nutshell, those that affect cost of production, such as the exchange rate, import price level and the wage rate.

With regard to the external sector, Khayum concentrated on the current account of the balance of payments. There are two reasons for this: (a) net capital inflows are assumed to be exogenous since exchange control and administered interest rates severed any relationship between domestic and foreign interest rates; and (b) substantial decline in net capital inflows during the 1970s and the predominant influence of the current account on the overall balance of payments. Equilibrium in the external sector - the B curve - is then achieved when total exports exactly equals total imports. The negatively-sloping B curve indicates that an increase in income worsens the trade balance but this can be offset by a fall in the domestic price level. The B curve shifts because of changes in the export price level, import capacity, exchange rate, import price level, the public sector deficit and domestic productive capacity. Given that the functions for AD, AS and B are linear, overall equilibrium may be shown diagrammatically as below. Equilibrium is attained at point E (chart 22).

Chart 22 - The Effect of an Increase in the Money Supply



Source: Khayum (1991), p. 134

Khayum then considers, in theory, the impact of shocks to the system, both external and internal. The conclusions are standard conclusions one would expect from an IS-LM-BP model. Consider, for example, an exogenous increase in the domestic money supply. This will shift the AD line to the right and, starting from an initial equilibrium at point E, a new short-run equilibrium will be established at T. Given a steep AS line, the rightward movement of the AD line will produce a relatively large increase of the domestic price level and a small increase in output. The new short-term equilibrium is established at point T. This, in turn, is likely to result in a current account deficit. See chart 22 above.

A more rigorous analysis of the impact of exogenous variables is also developed in mathematical terms. For the purposes in which Khayum is interested, the analysis is developed for the endogenous variables Y, P and B. The exogenous variables considered are the exchange rate (e), fiscal policy (DE), monetary policy (M), import capacity(IC), and the import price level (P_i). The results of the analysis are shown in the table 13 below.

Table 13. Effects of Changes in DE, e, IC, M,and P_i on Y, P and B

	dDE	de	dIC	dM	dP_i
dY	+	?	?	+	?
dP	+	+	-	+	+
dB	-	?	?	-	?

Source: Khayum (1990:137).

The mathematical properties of the model, data collection and measurement issues, sampling and probability assumption are discussed in some detail, as is the mathematics of the impact of external shocks. The model (i.e., the reduced three-equation model) is estimated using OLS, as well as TSLS in order to avoid the problem of simultaneity bias and overidentification. Forecasting and simulations runs are done as well.

Despite the three theoretical traditions underlying the model, the IS-LM framework, as should be evident from the above discussion, exercises an overwhelming influence. As a consequence, the shortcomings of this theoretical edifice also carries over to the IS-LM-BP model; the critiques of the latter are well-known and will not be discussed here.[19] One example suffices to illustrate the point. One of the goals of the model, namely to incorporate structural and institutional factors, poses a difficult challenge: how to incorporate them in a meaningful way in the model. As Khayum himself confessed, "... a potential weakness of the model is that the choice-theoretic explanations of the institutional aspects considered remain beyond the scope of this study ..." (p. 114), which amounts to a dismissal of the problem. In the final analysis these factors are reflected in the slope of the IS and LM, and hence the AD, curves.

Studies of Other Caricom Counties

Perhaps the first full-blown published macroeconometric model of a regional economy is that of Carter (1970) who observed that his model of the Jamaican economy, covering 1959-66, "... belongs to a well-known class of models, the members of which have the common characteristics that they provide a macroeconomic structural description of an economy, with statistically-estimated quantitative parameters" (p.178). Carter's reference is to the Keynesian type models. He declares that his model shows how the Jamaican economy "...reacts to exogenous factors such as exports and tourism, and how the fiscal system relates to the sectors of economic activity" (181), but it is not intended to "... serve as any kind of forecasting or predictive device, nor as any vehicle for policy prescription" (p. 180). Carter is careful indeed in this initial modelling effort for, given that the model shows the reaction of the economy to an exogenous perturbation, it is almost natural to move to the next logical step: forecasting/policy prescription.

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[19] For a brief look at the shortcomings of the IS-LM-BP model, see Williamson (1983).

There are 22 behavioral equations and 11 definitions and identities in the model. Sixteen of the behavioral equations contain only one argument; the rest have two explanatory variables each. The behavioral equations explain merchandise imports (food, non-food consumer goods, capital goods, and intermediate goods), imports of non-factor services, gross factor payments, private consumption, non-mining fixed investment, manufacturing GDP, income from government enterprises, taxes on corporate profits, excise taxes excluding petroleum, import duties excluding petroleum, other indirect taxes, taxes on personal income, subsides, savings from depreciation, undistributed corporate profits, foreign owned profits, and dividends. The rather disaggregated and uncomplicated nature of the model is a noted feature of first-generation models in the Caricom area.

The simulation of the model, judging from the plot of actual and fitted values, seems to yield good results (performance statistics were not computed by Carter), with the exception of the "... tendency of the model to over-amplify somewhat the swings in the economic time series" (p. 192). This would suggest that the model is not strong on turning point accuracy.

Carter points out three important conclusions of his modelling efforts. First, there is apparently a break in the consumption function around 1964, when the MPC out of disposable income was above unity! The jump in the consumption function was caused by the indulgence in hire-purchase: during 1963-64 there was a "...massive increase in credit extended to the private sector" (Carter, 1970:183). Second, the non-mining fixed-investment function is highly sensitive to earnings from tourism, which was used as a proxy for confidence in the local economy. It is interesting to note that, as far as I am aware, this is the only effort in the region to make investment dependent on an unobservable variable (confidence). Carter recognized that his investment function does not conform to any generally acceptable theory (its explanatory variables are credit and earnings from tourism) but it "... successfully picks up the turning points...," although it "... does not reflect the full intensity of the swings in the investment cycle" (p. 186), a rather peculiar behavior. Finally, the model shows that there is a very high elasticity of food imports with respect to private consumption. Two reasons explain this: (a) consumption of tourists and (b) the classic case of the inability of the agricultural sector to meet the demand for food products.

One year later, Manhertz (1971:199) produced ".. an exploratory operational model for the Jamaican economy." The model, drawing on both Keynesian and neoclassical theories, was also disaggregated, comprising 24 stochastic relationships and 18 definitions and identities. There are behavioral equations for private consumption (nondurables, durable goods, food including beverages, services), private investment (fixed investment, and inventory), export of tourist services, imports (food, consumer goods, intermediate goods, and investment goods), monetary sector (demand deposits, time deposits, currency holdings, and interest rate on commercial bank loans), government expenditure (central government consumption, local government consumption, and government capital formation), government revenue (personal tax, tax liability on corporate profits, and indirect business tax), employment in the private sector, manufacturing output and retail price.

Among other uses, Manhertz felt that his model could be "... used as an instrument to observe various multiplier effects and the likely results of policy alternatives" (p. 220), directly suggesting that the model is suitable for policy simulation and forecasting. While "ex-post extrapolations" were done for the components of GNP (consumption, investment, government expenditure, exports and imports), Manhertz notes that "... no attempts were made to extensively evaluate the forecasting capacity of the model" (p 220), apart from printing the charts of the actual and estimated series of the components of GNP, a rather serious shortcoming considering the principal task (forecasting) assigned to the model.

Supporting Carter, Manhertz found that "consumer instalment credit" appreciably influenced the consumption of all commodities, including services, except food and beverages. The sum of the MPC of the disaggregated consumption function is 0.98, indicating that almost any increment in disposable income went to consumption, which supports the presumption that the MPS in Jamaica has been traditionally very low. The equation for earnings on tourism shows that the number of "tour-days" is not a major factor in earnings from the industry. On the other hand, a one per cent increase in accommodation will boost earnings by 5.21 per cent. In other words, it is not the length of the tourist season but the availability of adequate accommodation that is the principal determinant of earnings. Interestingly, the estimate of the food import equation shows that disposable income, with a coefficient of 0.08, is not a strong explanatory factor, which is rather surprising for Jamaica and contrary to what Carter found. On the other hand, private consumption expenditure (coefficient: 1.59) is a crucial determinant of other consumer goods import.

Drawing on the Klein-Goldberger model of the United States, Persaud's (1979) "model" of the Trinidad-Tobago economy is a set of 11 behavioral equations and 4 identities aimed at the explanation of aggregate demand. There are few feedback channels and loops among this simple and straightforward collection of equations for private consumption, investment, imports (disaggregated into consumption imports, crude importation, mainly of petroleum, and capital goods) and exports.

Persaud did point out, however, that the limited and poor quality of the data did not permit a more involved model. Indeed, it is precisely because of this shortcoming that supply was not modelled stochastically; rather, it entered exogenously in order to allow the determination of equilibrium. The labor market, the financial sector the and government sector have been omitted. The Persaud "model" is, therefore, not a model of the behavior of the economy but rather of the behavior of the components of aggregate demand. Given this, Perasud's claim that the model "... provides a macro-economic structural description of the economy" (p.389) is somewhat exaggerated.

One of Persaud's important findings is that the external sector (import and export) must be included in any model of the Trinidad-Tobago economy if a reasonable quantitative description and estimates are desired. This conclusion followed from the examination, although not in great detail, of two other models which excluded the external sector. Of course, this finding points to the importance of the large petroleum sector, which imports crude materials and exports refined products.

These three foregoing pioneering models are all deeply rooted in the Keynesian tradition, the modelling paradigm that ruled the roost earlier on. The logic that constitutes their core is thus basically the same: the economy is propelled into motion by demand forces. These were the first modelling efforts of the regional economies and, if they are seen in that light, their shortcomings can be understood.

Perhaps the only published econometric study of the OECS states[20] - macroeconometric model or otherwise - is that of McIntyre (1986) who observed in his opening paragraph that "... no previous attempt at modelling these [OECS] economies was found" (p. 177). McIntyre's aim is to "... formulate a relatively simple macroeconomic model that is relevant to the OECS countries. Specifically, his model attempts to analyze the interrelationships between merchandise trade, the monetary sector and the real sector" (p. 177). The focus is on merchandise trade rather than balance of payments for two reasons: (a) given the dependent nature of the OECS economies, merchandise trade is not only more important, but it is directly related to the real sector; and (b) no consistent set of data exists on balance of payments over the sample period, 1972-82.

Prior to the formulation of his model, McIntyre examined the money supply process in the OECS states. He began by pointing that in an open economy the money supply (M) is dependent on net foreign assets of the banking system (NFA) and domestic credit expansion (DC):

$$(9.3) \quad M = NFA + DC$$

[20] For a definition of this acronym, see footnote 5, p. 95.

Since

$$(9.4) \quad B = \Delta NFA$$

where B is the balance of payments deficit or surplus. A change in the money supply can be written thus:

$$(9.5) \quad \Delta M = B + \Delta DC$$

Domestic credit expansion, McIntyre notes, is an important feature of the adjustment process in the Eastern Caribbean Central Bank (ECCB) area.[21] The monetary base can be written as,

$$(9.6) \quad MB = NFA + DCCB$$

where DCCB is net domestic credit extended by the central bank. The money multiplier framework relates the monetary base to the money supply thus:

$$(9.7) \quad M = mMB$$

where m is the money multiplier. Hence any changes in the monetary base will induce changes in the money supply.

McIntyre points out that, unlike many other developing countries where public sector indebtedness to the central bank dominates movements in the monetary base, in the ECCB countries the fiscal deficits of member states are financed only in a small way by central bank credit to the government. This means that movements in the monetary base are not likely to be due primarily to changes in central bank credit to the governments. Rather such changes

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[21] The ECCB area is composed of the same group of countries as the OECS since the ECCB is the central bank of the OECS countries.

come about largely from changes in the net foreign assets of the central bank; i.e, by the balance of payments. In this way the money supply, and thus money demand, is largely endogenous.

The model comprises behavioral equations for imports, exports, private expenditure (government expenditure is treated as an exogenous variable), money demand and the price level, in addition to 2 identities (total expenditure and nominal income). The equation for expenditure is worth mentioning for, as far as I am aware, the only other macroeconometric model to contain such an equation is the export-led model by St. Cyr (1981). McIntyre formulates the expenditure equation as follows:

$$(9.8) \quad PE = a_0 + a_1 (M^s - M^d) + a_2 Y, \quad \text{with } a_1, a_2 > 0$$

where PE is private expenditure, $(M^s - M^d)$ is excess nominal money supply, and Y is nominal income proxied by GDP. All other equations are standard formulations for small, open economies.

What are the implications of the model? McIntyre argues that the most important conclusion derives from monetary imbalances. The existence of a monetary imbalance sets up reactions which alter expenditure and the domestic price level. In turn, these induce changes in income and foreign trade and thus the balance of payments. The balance of payments is affected because an expansion in money supply increases expenditure which increases imports. Moreover, the ensuing impact on the domestic price level affects relative prices which further increases imports and depresses exports.

Two major policy implications emerge from this scenario. First, the authorities must maintain some control of the money market to avoid monetary disequilibrium. In this regard, the authorities must endeavor to determine the stability, and hence predictability, of the money demand function. Some control of the money supply is also necessary to match money demand. Second, the authorities must be able to control total expenditure at levels that do not encourage substantial increases in imports and thus contribute to balance of payments disequilibrium. These two policy implications are closely related as tight monetary control alters expenditure and thus imports.

The first major (published) macroeconometric model of the Trinidad and Tobago economy designed specifically to assist policy makers in forecasting and analyzing alternative policy packages was done by Hilare *et al* (1990). It attempts to accomplish this task by taking into account certain key relationships of the Trinidad-Tobago economy, viz: (a) the prominence of oil exports; (b) the importance of government oil revenue and government expenditure in the economy; (c) the relationships between the government budget, oil exports and the money supply; and (d) the importance and role of imports as a leakage from the circular flow of income. There are 34 equations in the model, of which 17 are behavioral and 17 identities. In all, there are 53 variables, 34 of which are endogenous while the remaining 19 are predetermined.

This comprehensive model touches on all sectors of the economy, with equations for government revenue (separate equations for oil revenue, import duties, personal income taxes and other revenue), government expenditure, the monetary sector (money supply, net domestic assets of the Central Bank, net foreign assets of the Central Bank, money demand), price formation, exports (separate equations for oil, and manufactured exports), imports (separate equations for consumer goods, capital and intermediate goods, and services), consumption, labor demand and wage rate. The model, resting on neoclassical and Keynesian premises, relies on feedback effects from which it derives its internal consistency. For example, as the exercise on within-period shocks demonstrates, a rise in government capital expenditure directly feeds back upon GDP which in turn impacts upon taxes, current government expenditure, consumption, saving and imports, the money supply and the level of prices.

The modelling of the monetary sector is unusual in two ways. First, it is one of the few models in the region that includes equations for the monetary sector. Second, the approach to the modelling of the sector is interesting, comprising five equations, one of which is a definition; these will be discussed in greater detail in Chapter 13.

The authors found that the historical simulations and forecasts performed well, except for money supply and price determination. The model was used to trace economy-wide repercussions of changes in key policy variables. In one scenario it demonstrated the impact of a policy involving a combination of government expenditure restraint and a devaluation with a fall in oil prices. According to the authors, the model produced one surprising result: a price decline of oil could cause the domestic price level to rise. The chain leading to this result runs from the current account balance to the government budget to the money supply and finally to prices.

The final Keynesian-type model discussed here is that of St. Cyr and Charles (1992) of the Trinidad and Tobago economy over the period 1965-85. Actually, in this paper the authors also constructed an export-propelled model. One of the reasons for constructing, estimating and simulating two models based on different approaches was to make "... a contribution to the literature on short term econometric modelling and to the debate among Caribbean economists on the causal direction in the economic process in these small, open economies" (p. 189). The implicit assumption of the paper is that the more relevant model structure (Keynesian-type versus export-led) will simulate the data with smaller errors.

The demand-driven model is based on work done by the Latin American and Caribbean Institute for Economic and Social Planning (ILPES), suitably adapted to represent the structural features of the economy of Trinidad and Tobago. In fact, the following modifications were made to the ILPES formulation: (a) disaggregation of the production and employment functions; (b) the price equation emphasizes the role of import price in domestic price formulation rather than distinguishing between the agricultural and industrial prices; (c) the crucial importance of crude oil production and international prices was built into the model; and (d) the tax and revenue functions were adjusted to better reflect the country's fiscal system.

The complete model comprises six blocks of 37 equations, including 15 identities. There are 54 variables of which 17 are exogenous. There are equation blocks for supply, demand, the public sector, balance of payments, prices, wages and money, and employment/unemployment. According to the authors, "... the model approximated fairly closely to the actual data" (p. 191), a conclusion based on historical simulation and the estimates of the individual equations. A number of policy simulations were also done from which the following conclusions emerge: (a) the model is not responsive to marginal changes in the exchange rate; (b) as expected of the Trinidad-Tobago economy, variations in the price and quantity of crude oil have a strong impact on the fiscal and payments balances; (c) the model is relatively sensitive to variations in nominal exports; (d) the model is fairly responsive to public sector investment but this tends to worsen the fiscal balances and to be inflationary; (e) constraining the foreign exchange reserve position tends to depress economic performance but gives a measure of protection to both payments and fiscal balances; and (f) as is typical of demand-driven models, the coefficient of consumption out of income determines the responsiveness of key variables.

No indication is given as to whether the equations have been estimated individually or as a system of simultaneous equations, although it seems that the former method has been used. In any event, the authors' claim (p. 191) that autocorrelation is not a problem is questionable: of the 14 equations for which the D.W. is given (pp. 194-95), 8 of them have values for this statistic of less than 1.6, which suggests the existence of positive autocorrelation. In the main, it would seem that the adjusted R^2 was the primary concern of the authors. Finally, while no indication is given as to whether the equations have been specified in linear or log-linear form, it is necessary to point out that in almost all of the equations the constants have very high values. It might be possible that some of the equations are underspecified.[22]

While theoretical work on the export-led model in the region dates back to the 1960s, the first empirical implementation, as far as I am aware, was that of St. Cyr (1981). The core assumption of the model is that the Trinidad-Tobago economy is driven by exogenous exports. In this scenario, the balance of payment "... mirrors what happens to export earnings" (p. 113). Investment is geared to enhancing export capacity and, since the bulk of the capital goods is imported, this weakens the balance of payments initially. The imbalance is restored later as exports rise.

The money supply is determined in the context of the open economy, with the principal determinant being the balance of payments. St. Cyr argued that the role of net domestic credit, the other determinant of the money supply, in this process was limited by (a) the limited credit-granting powers of the Central Bank to the government; (b) reserve ratio management; and (c) the ineffectiveness of credit policies in a period of growing net foreign assets, which characterized Trinidad and Tobago for much of the 1970s.

Money supply, in turn, determines aggregate demand by making credit more readily available to purchase imported inputs. A rise in aggregate demand, therefore, calls forth a greater supply of imports, which takes the form of rising final goods, intermediate inputs and capital goods. Since the money supply comprises net foreign assets held by the Central Bank and net domestic credit, St. Cyr argues that the foreign exchange necessary to finance increased imports is already available, with "... the foreign exchange for meeting the cost of imports being already contained in the augmented supply of money" (p. 115).

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22 The comparative performance of this model against the export-led model will be discussed later.

As presented, the export-led model suggests a systematic tendency to stability as rising exports lead to rising imports through the mechanism of the money supply. In the long-run, however, the growth of imports negatively impacts upon the balance of payments, which restrains the money supply from taking an explosive path. This is particularly true in a fixed-exchange rate regime when foreign prices are stable and the international monetary system well-behaved. However, rising import prices trigger off domestic inflation, which is also being pushed forward by increasing wages as workers struggle to maintain real income. The increased money supply feeds the price-wage spiral. Rising inflation leads to a sellers' market as the government introduces import restrictions. The mark- up inevitably rises, adding more fuel to the price-wage spiral. The underlying logic may thus be summarized as follows: if, from an equilibrium position, there is an exogenous increase in exports, this strengthens the balance of payments. Given the balance of payment-money connection, the money supply rises, pulling prices and wages upwards. As expenditure increases, so do imports, thereby restoring equilibrium.

Twelve years later St. Cyr and Charles (1992) constructed, estimated and simulated another export-propelled model comprising nine equations of which three are identities. As in the earlier model, the direction of causation in Caribbean-type economies is from export performance to imports, domestic output, government revenue and employment. From this standpoint, and unlike the earlier model described above, import, production and government revenue drive the system when export volumes and export and import prices are given exogenously.

As observed above, a primary purpose for the export-led model is to compare its performance with a demand-driven (Keynesian) model. The RMSEs from historical simulations of the four endogenous variables common to both models are given by table 14 below.

Table 14. St. Cyr and Charles (1992): RMSE for the Export-led and Demand-driven Models

Variable	Export-led - RMSE	Demand-driven - RMSE
Imports	0.108	215.022
Domestic prices	0.052	0.061
Real average wage	0.073	1.208
Level of employment	0.023	0.021

Source: St. Cyr and Charles (1992:196, 204).

The conclusion on comparative performance is: "By comparison with the large ILPES [that is, the demand-driven, Keynesian-type] model the export driven model performs at least as well" (p. 202). It is difficult to pick a convincing winner from the simulation exercise although the export-led model clearly outperforms the ILPES model for imports and real average wage. Further tests, such as ex ante forecasting and encompassing tests, are necessary to demonstrate a convincing performance advantage.

The debt crisis of the 1980s promoted further econometric research in the region. Bourne and Nicholls (1990) developed an econometric model to analyze the debt service capacity problems of small Caribbean economies with large but undiversified external sectors, narrow production structures, and heavy reliance on the public sector for the generation and diffusion of economic activity. The model, a block recursive system comprising groups of simultaneous and recursive equations, consists of five major blocks, namely fiscal, income-expenditure, output, employment and foreign trade blocks. The model was applied to the economies of Barbados and Trinidad-Tobago, the sample period being 1968-1987.

The model is of the export-propelled genre, being driven by exports and international debt. As the authors note, "[C]hanges in foreign exchange receipts, through exports and net inflows of foreign debt, generate changes in domestic expenditure, employment and income through the direct impact of foreign exchange receipts on the fiscal accounts and on imports of raw materials and capital goods" (p.50).

To judge the adequacy of the model, dynamic simulations were done. From the graphs of actual and simulated values of the endogenous variables, it seems that the model does a fairly good job at duplicating turning points. The Theil inequality coefficient and its decomposition does not reveal any major problem. In general, however, the fit of the model was better for Barbados than for Trinidad-Tobago.

The model was used to investigate the impact of varying debt payment obligations on the economies studied. Three shocks were analyzed: (a) a 25 per cent reduction in debt payment obligations; (b) a 25 per cent increase in debt payment obligations; and (c) a 125 per cent increase in debt payment obligations. The principal lessons from this simulation exercise provide confirmation of widely-held beliefs. First, overall activity in small island economies, such as Barbados and Trinidad-Tobago, can be severely depressed if there is a sudden and large increase, say over 25 per cent, in debt service payments. National income and output contracted severely in both economies while employment levels and investment remained depressed. In short, there was a serious reversal of economic growth. Second, debt relief stimulates investment and economic growth, but the trade balance deteriorated from the strong expansionary response of imports relative to exports. The authors note that this response probably points to the need for debt relief to be accompanied by domestic polices that restrain the rapid growth of imports. This conclusion was reached by simulating a 25 per cent reduction in debt service payment. Finally, small, highly specialized, open economies have very limited real debt-servicing capacities.[23] As a corollary, debt relief "... can be instrumental in engendering economic revival" (p. 81).

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[23] Bourne and Nicholls (1990:80-81) define real debt service capacity "... as the capacity of an economy to honor its external debt obligations without depressing its economic growth rate, employment levels and creating other serious macroeconomic problems."

To explain price formation in small, open economies, Holder and Worrell (1985) used a model that employed the tradable/non-tradable dichotomy. The non-tradable sector is the core of this model; it is here that domestic prices interact with external factors to determine the price level. In other words, the model allows for effects from the price and output of tradable goods to the price of non-tradables. In addition to the impact of foreign prices on the inflationary process, the authors also allowed for the effects of domestic factors such as exchange rate changes, wage policies and monetary expansion.

The model includes 15 equations, 7 of which are behavioral for tradable and non-tradable goods, the price of non-tradables, domestic interest rate, the change in monetary liabilities, real imports and wages. The results point to the crucial role of foreign prices in domestic price formation, with the foreign price index contributing about "... one-third to the domestic price formation" (p. 420) in Barbados, Jamaica and Trinidad and Tobago. Domestic polices - exchange rate changes and trade protection - which affect the local price of traded goods have an impact similar to that of foreign prices. Rising domestic interest rates are inflationary only in Barbados; wages are an important determinant of prices only in Jamaica; and exogenous increases in real income are not inflationary in any of the three countries.

Continuing their work, Worrell and Holder (1987) constructed a similar two-sector model to analyze stabilization questions in small open economies. More specifically, the model, short-term in outlook, gauges the reaction of domestic output, prices and the balance-of-payments to policy changes and foreign economic conditions. The policy variables are government expenditure, the central bank discount rate and the reserve requirements of commercial banks. Foreign influences impact upon the economy via three channels: (a) interest rates in the international markets through equations in the monetary sector; (b) the prices of tradables in the equation for tradables; and (c) the flow of foreign capital in one of the equations for the balance-of-payments sector. There are 12 behavioral equations and 5 definitions and identities, comprising 4 blocks for output, the monetary sector, government sector and the balance-of-payments.

Drawing on the tradable-non-tradable dichotomy, the authors argue that the short-run macroeconomic aim of the model justifies the focus on the **product market.** Moreover, in small, open economies the level of domestic production has no effect on the price of tradables; rather, the level of output in this sector depends entirely on supply conditions in the international market. Accordingly, it is assumed that the demand for tradables is infinitely large and domestic production capacity of tradables is infinitesimal in relation to the export market. As is customary with studies of small, open economies, the supply of tradables responds positively to the exogenously given price. On the other hand, the output of non-tradables depends on the interplay of supply and demand factors - i.e, equilibrium for the non-tradable sector is defined by the domestic market. Worrell and Holder write the equations for the output of tradable (Q_t) and non-tradable (Q_n) goods as follows:

(9.9) $Q_t = f_1(p_t, s, r_1)$

where the first partial derivatives of $p_t > 0$ and $s, r_1 < 0$

(9.10) $Q_n = f_2(y, p_n/p_t, r_1, Q_n(-1))$

where the first partial derivatives of $y, Q_n(-1) > 0$ and $p_n/p_t, r_1, < 0$.

The variables in (9.9) and (9.10) are defined as follows:

Q_t	=	output of tradable goods
Q_n	=	output of non-tradable goods
p_t	=	price index of tradable goods
p_n	=	price index of non-tradable goods
s	=	cost of raw materials
r_1	=	cost of bank finance for production
y	=	national income

The monetary sector, to be discussed in greater detail in Chapter 13, provides the channels through which fiscal and external payments disequilibria affect output via the cost of finance. In the fiscal sector, government expenditure is an exogenous variable, but government revenue varies with national income. The government borrows from the commercial banks and any shortfall between expenditure and revenues is financed by the central bank. The final block of the model, balance of payments, contains behavioral equations for imports, the change in international reserves and wages.

The model, presumably estimated by TSLS, lends itself to several inferences; some of these will be discussed in various chapters of Part 2. No forecasting or simulation exercise has been done, a rather peculiar omission since the model is intended for forecasting. There is, therefore, no ground on which forecasting performance can be evaluated since the estimates of individual equations, regardless of overall fit, offer little insight into forecasting performance.

The model by Boamah (1985), as pointed out earlier, is not a full-blown macroeconometric model. Rather it seeks to explain the process of wage formation, employment, tradable and non-tradable output in the Barbadian economy. The output of tradables (QT) is a function of the price of tradables (PT), the domestic interest rate (rd), unit labor cost in the traded sector (ULCT), and the ratio of the nominal value of imports of capital and intermediate goods (MKI) to the import price index of capital and intermediate goods (PKI). That is,

$$(9.11)\quad QT \;=\; F_6(PT,\ rd,\ ULCT,\ MKI/PKI)$$

with the first partial derivatives of the terms in parenthesis being: PT, MKI/PKI $>$ 0 and rd, ULCT $<$ 0. Boamah's equation for tradable output is somewhat similar to that of Worrell and Holder's (9.9), except that (9.11) envisages a role for unit labor cost and the real value of capital and intermediate goods; the cost of raw material as in (9.9) is excluded. The output of nontradables, defined as goods not traded on the international market, is determined by internal demand and supply conditions. More specifically it is dependent on real domestic expenditure (DE), the relative price of nontradable to tradable (PN/PT) and a trend variable which is intended as a proxy for exogenous influences such as population changes (Boamah, 1985, p. 120). That is,

(9.12) QN $=$ F_6(DE, PN/PT, T)

where the first partial derivatives of DE, T > 0 and PN/PT < 0. Unlike Worrell and Holder (1987), Boamah did not see a role for the output of lagged non-tradables nor the cost of working capital in (9.12). In other words, Boamah's equation for non-tradables relies much more strongly on current demand and supply conditions since lagged responses are apparently not important.

The logic of Boamah's model is as follows. Suppose that there is an exogenous increase in the price of tradable goods. Then the real wage in this sector declines (although it is not clear how this happens), resulting in rising demand for labor in this sector to meet the increased supply of tradable goods. But there are also spill over effects to the non-tradable sector as the increase in the price of tradables would also cause price, employment and output in the non-tradable sector to rise. As a result, the overall level of domestic price would increase under the pressure of rising prices in the tradable and non-tradable sectors. This rising level of domestic price and falling rate of unemployment would eventually lead to increased wage demands. As real wages increase, the demand for labor in the two sectors will be moderated and eventually, the economy may settle down at higher levels of PT, PN, QT, QN, wage rate and domestic price level.

CHAPTER 10

The Rationale for the Augmented Keynesian Model

On Macroeconometric Modelling

"... the economist exists in a stochastic environment" [Smith, 1969:81].

All models are, in actual fact, artificial constructs for they seek to reduce the description of phenomena to a set of stylized relationships which approximate the observed facts. By their very nature, therefore, models are intended to be no more than close representations of reality. This does not, however, detract from the utility of (macro) models as Klein and Young (1982:1) observe in their opening sentence: "There is no doubt that modelling is here to stay.". Indeed, models are being used by governments, by businesses and by virtually every field of economic analysis where decisions must be based on the uncertain future.

Macroeconometric models, combining macroeconomics and econometrics, are intended to be approximations of the unknown, but true, underlying system of the economy. These models capture **aggregate** relationships and are thus subject to the difficulties raised by the problem of aggregation from the individual to the economy as a whole. Because of this and other reasons, the correspondence between these models and the real word (economy in our case) will not be exact. This is why the emphasis is on stochastic models, which explicitly accommodate the stochastic nature of the correspondence. Note, however, that it is the model rather than the economy which is stochastic. The stochastic component of the model is captured by a disturbance term,

(10.1) $y = \mathbf{X}\boldsymbol{\beta} + u$

where y is an n x 1 column vector of observations on the explained variable; **X** is an n x k matrix of observation on the explanatory variables; u is an n x 1 column vector of errors; and $\boldsymbol{\beta}$ is a k x 1 column vector of parameters to be estimated. Without the disturbance term, u, (10.1) embodies an exact **deterministic** relationship; with the disturbance term, it is said to be **stochastic**. According to Kennedy (1992), the disturbance term is justified in three ways: (a) specification errors, (b) measurement errors; and (c) human indeterminacy. It is the econometrician who employs the stochastic specification as in (10.1) above and not the economist. The later would omit the disturbance term and specify a deterministic relationship such as C = f(Y), where consumption is taken to be an exact (deterministic) function of income.

Given that macroeconometric models are mathematical representations of the aggregate behavior of the economy as captured by macroeconomic variables, how are such models formulated? In the traditional approach to econometric modelling, model formulation begins with economic theory which postulates relationships and hypotheses that are represented by equations in the model. It is appropriate to cite Fair (1984:10-11) on the use of theory in model construction:

... If the aim is to use theoretical models to guide the specification of an empirical model, the issue is how many restrictions one can expect theory to provide regarding the specification of the equations to be estimated. In practice, the primary role of theory has been to choose the variables that appear with nonzero coefficients in each equation. (Stated another way, the primary role of theory has been to provide "exclusionary" restrictions on the model, that is, to provide a list of variable **not** to include in each equation.) In most cases theory also chooses the signs of the coefficients. Much less often is theory used to decide things like the functional forms of the estimated equations and the length of the lag distributions (emphasis in original text).

In other words, economic theory provides the guidelines for the econometric models; frequently, it also provides a priori expectations. The practice of macroeconometric modelling is distinguished by a certain degree of eclecticism (i.e., an admixture of different schools of thought but in a non-ad hoc way). This is not unsurprising for three reasons. Firstly, the fact that these models are complex, many-equations contraptions, requiring equally many-sided theoretical underpinning, has of necessity drawn on the various schools of thought - neoclassical, New Classical, monetarist, Keynesian, New Keynesian, Structuralist, etc. To an extent, competing bodies of economic theory complement one another by building on each other's weaknesses, which amounts to an admission that, at least in practice, no single theory has all the answers. Secondly, models are regularly revised and updated in order to improve their accuracy and reliability. In the process it is not unusual to draw on alternative schools of economic theory that seem to offer a better explanation of the component being modified. Thirdly, it might be too difficult to test a particular theory associated with a given school. The upshot is that an alternative theory associated with a different school might be called into service. For these reasons, the purity that separates alternative economic traditions at the level of theory gives way to a blend of pluralism in empirical work.

The fact that macroeconometric models are very rarely completely driven by any specific body of economic theory is best expressed by Blanchard and Fischer (1989:505) who write that:

> In analyzing real world issues, almost all economists are eclectic, drawing on different models for different purposes ... Often the economist will use a simple *ad hoc* model, where an *ad hoc* model is one that emphasizes one aspect of reality and ignores others, in order to fit the purpose for which it is being used.

Blanchard and Fischer note that some well-known examples of *ad hoc* models include Lucas (1973), Barro and Gordon (1983) and Sargent and Wallace (1981). It would be preferable to have a model informed by a body of theory unifying all economists, but this is a far-flung dream. From this perspective, applied economists have little choice but to be eclectic.

Aside from economic theory and statistical data, econometric modelling requires two other things: (a) a method that allows for the expression of economic theory using the statistical data (in practice, a theory of estimation stemming from econometric theory); and (b) a "know-how", which tells us how to apply the estimation theory to the statistical data, and how to decide whether this application has been successful.

The rest of the discussion focusses on "know-how" as there is no point in discussing the techniques of estimation since such a discussion can be found in any textbook on econometrics. The problem of "know-how" is to apply an estimation method which combines the statistical data, the economic theory and the statistical theory in such a way as to lead to the "best" model from the point of view of explaining the structural features of the economy or in forecasting them, or both. It is, in brief, the problem of methodology. Several competing methodologies are presently available. These include (a) the traditional methodology, generally associated with the Cowles Commission for Research in Economics; (b) vector autoregressions, using little economic theory; (c) the LSE methodology, using both economic theory and time series methods; and (d) the Leamer methodology, using economic theory and Bayesian techniques. Our focus is on the approach pioneered by the Cowles Commission as this is the methodology employed by this study.[1]

Basically, the traditional approach begins with theory, restates it in the form of estimable equations, the parameters are then estimated, evaluation statistics obtained, estimated parameters are checked to see if they correspond to theoretical expectations; if not, the process loops back to the beginning. The theory itself might also be examined. The final step is to interpret the result of the model and explore their policy implications.[2] In practice, this approach is characterized by specification searches in an effort to obtain the "best" model. That is, the search begins with a specific equation which is tested against the data and modified until the "best" equation is obtained. Modification might include addition/deletion of variables, different functional forms, different deflators, or even changing the sample period in extreme cases. It is for this reason that this approach is accused of excessive data mining or the problem of using a fixed data sample in some sequential manner to arrive at the final model specification.

Several other features of this approach are worth noting: (a) zero restrictions on parameters of variables that do not appear in any given equation of the model as the quote from Fair (1984) makes clear; (b) the parameters are invariant in time - that is, the model repeats itself for each t as it is conditional only on the values of the variables, and not time; (c) the parameters are structurally invariant - that is, they are invariant with respect to changes in the variables of the model, but not to movements of those variables not appearing in the model; (d) it is known *a priori* which variable is a cause and which is a result of the relation - that is, the causal ordering of the variables - endogenous or exogenous - is known in advance; and (e) positive conclusions from the model are conditional on the assumed relationship being

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[1] This approach to econometric modelling, the oldest in the profession, has been under attack for some time now. For a quick guide to the concerns raised, see the papers in the volume edited by Granger (1990). See also Paldam (1993), although the latter deals with a broader subject: the difficulty of testing economic theories, regardless of the methodology. For a vigorous defence of the Cowles Commission Approach, see Fair (1993).

[2] A good diagrammatic illustration of this methodology is given in Spanos (1986:16).

correct in its choice of variables, lag length and the estimated coefficient having the signs expected for them from the economic theory being modelled.

Features of the Augmented Keynesian Model

From the review of the literature in Chapter 9, several key features of macroeconometric models in the region can be identified:

(a) their Keynesian orientation;

(b) minimal treatment of the financial sector;

(c) the linkages among variables and sectors of the domestic economy have not been well specified.

(d) account has not been taken of the role of expectations; and

(e) in general, their performances have not been benchmarked against an alternative model.

The model formulated and estimated in this study also has Keynesian principles as its core, but in addition it draws on three other traditions in economics: Post-Keynesian, structuralist and monetarist in its attempt to explain the complexities of a developing economy. This wider theoretical perspective accounts for the word "Augmented" in the name of the model - Augmented Keynesian Model (AKM). The crucial feature of Keynesian models is that the level of overall activity is determined by variations in aggregate demand, with prices playing a passive role.

The broader theoretical perspective - and thus an unavoidable degree of eclecticism - breathe into the model a richer dynamic, enabling it to obtain insights into key features of the economy that would otherwise remain hidden. For example, I would argue that the inflation equation, drawing on the Post-Keynesian theory of mark-up pricing, captures the complex dynamics of inflation more cogently than, say, a simple neoclassical or monetarist function. The mark-up theory is specified in such a way that it explicitly takes account of taxation and the cost of working capital on the rate of inflation. Many researchers of Third World economies, including Taylor (1983), have pointed out that the cost of working capital is particularly important to production and thus inflation in developing, capital-constrained economies. Moreover, the theory of mark-up pricing, which is also a crucial element of the structuralist theory of inflation, captures, to an extent, the distributional conflict between the markup and the wage rate. Another insight offered by this wider theoretical perspective relates to the consumption function which attempts, among other things, to test the structuralist proposition that there is a highly inertial quality to consumption (Gordon, 1991). A final example is the demand for money function which attempts to show that the inclusion of a buffer-stock variable in the equation is crucial to the explanation of the demand for money in Guyana.

The present modelling effort of the Guyanese economy is much more comprehensive than any previous effort, as may be seen from table 15 at the end of this chapter. The model contains 14 behavioral equations for consumption, investment, imports, exports, the demand for money, potential output, depreciation, government revenue, government expenditure, expectations and inflation; there are also 47 identities. The model is so constructed that both the government and monetary sectors are accounted for in a more integral and inclusive manner compared to previous models of the Guyanese economy.

An important feature of the model being built is that it endeavors to represent the **structural** features of the Guyanese economy as faithfully as possible, a feature not broadly represented by either Jarvis (1990) or Ganga (1990). Indeed, this is the ultimate justification for Part 1 of this dissertation, which, among other things, discusses the main features of the Guyanese economy. The effort to model a realistic representation of the economy is done at three levels: (i) equations that attempt to explain the behavior of key "sectors" of the economy;

(ii) the clear establishment of linkages; and (iii) inclusion of institutional/policy constraints into the model.

As we have seen in Part 1, after the country became a Co-operative Socialist Republic in 1970, there was a deliberate and concerted effort to change the ownership configuration of the economy. By the latter half of the 1970s, it was estimated that the government owned and controlled about 80 per cent of the economy, an abrupt and dramatic reversal of an economy dominated by private enterprise from the very inception. Of the three previous modelling attempts of the Guyanese economy, it is Jarvis who tried the most to take account of this fact. The effort was, however, rather limited, focussing only on direct and indirect taxes and government consumption. Ganga (1990) believed that the government sector could best be modelled on the basis of a behavioral equation for "treasury financing requirements" (TFR) and an identity for total government spending. While no definition of TFR is offered by Ganga, it does seem to be equivalent to borrowings by the government. Khayum relegated the role of the government sector only to consumption by government.

The position taken here is to formulate stochastic equations for total government revenue and expenditure and an identity for the fiscal deficit. Given the predominant importance of the government in the economy since the mid-1970s, any change in its activities will immediately impact upon the economy. It is for this reason that the two behavioral equations are couched within a partial adjustment framework so as to explain both short and long-term impacts. Total government expenditure - comprising current and capital, including consumption expenditure - is related to the overall level of economic activity, the fiscal deficit and expenditure in the previous period. Revenue by the government (total) is explained by the overall level of economic activity and revenue in the previous period. The deficit is the excess of expenditure over revenue. The single most ubiquitous characteristic of the deficit is its tendency to recur from 1954 to the end of the sample period. The level of economic activity is proxied by GDP, which enters as an identity, as in most Keynesian models.

In this specification, any disturbance in government activities affects both the "real" and monetary sectors. In the "real" sector the channel of influence runs from the government sector to other components of GDP and back to the starting point. Take, for example, an increase in government revenue, stemming from an increase in indirect taxes or levies on imports/exports. This directly affects both government expenditure, most likely in a positive direction. However, rising activities in this sector do not automatically lead to rising output, depending on the deficit. This is because the model postulates that a widening deficit constitutes a dampening influence on imports, particularly raw materials, intermediate and capital goods, and thus exports and investment. The net effect on overall output depends on the direction of the stimulus to the components of GDP which, in turn, feeds back to the government sector, thus closing the chain.

Obviously, perturbations in the government sector also disturb the monetary sector through their impact on the money supply and hence the demand for money. Disturbances to the government sector derives, for example, from Central Bank credit bridge the widening deficit. Domestic credit and the balance of payments impact upon the monetary base. In turn, any disturbance in the monetary sector is transmitted to the "real" sector, through linkages between the two.

The monetary sector, as noted earlier, has been treated in a rather perfunctory way in macroeconometric modelling in the region, including Guyana. This a serious shortcoming, given that the regional economies are all considerably monetized. The present model attempts to reflect this fact through the inclusion of a monetary sector which contains three behavioral equations and three identities. The behavioral equations explain inflation, aggregate broad (M2) money demand and "money surprises." Disturbances in the monetary sector are transmitted directly to the rest of the economy through linkages to the consumption, investment and inflation equations, which, in turn, are linked to other equations of the model.

In addition to these features, an attempt has been made to deal with a number of unsettled issues in monetary research in the region. As discussed more fully in Chapter 15, these are: (a) the homogeneity postulate, which has been questioned by some researchers in the region; (b) the appropriate monetary aggregate (narrow or broad); (c) the appropriate scale and opportunity cost variable; and (d) the stability of the estimated relationship, which is a much neglected issue in the region.

The internal linkages of the AKM - point (c) on page 134 - is best understood by considering how the model deals with an exogenous shock which may be internal or external in origin. Examples include a change in domestic credit, export prices or capital inflows on the BOP. Consider an exogenous rise in the prices of exports, the impact of which can be clarified with the aid of figure 1 at the end of this chapter. In line with received theory, this stimulus will call forth an increase in the quantity of exportables, especially so given the nature of the country's exports and its high dependence on these commodities. Rising exports can only be accommodated if imports move in the same direction. The net effect of the co-movement of imports and exports will determine the position on the current account of the BOP. In the short-run a positive stimulus is expected, which will be transmitted to the rest of the economy through (a) the connection between the BOP and the money supply and hence the demand for money function; and (b) increased import capacity.

Rising prices of exports also generate a sequence of internally-induced reactions. As capacity utilization is pushed up to service a higher level of exports, employment rises, positively impacting on disposable income and wealth and hence consumption. Rising GDP - resulting from increases in its constituent components - directly affects the government sector by boosting revenue and expenditure. Whether the final impact of this sector dampens or stimulates overall economic activity depends upon the fiscal deficit. If there is a tendency to monetize the deficit - and evidence suggests that this has been in the case in Guyana -, then, in accordance with the monetary approach to the BOP, any additional credit creation will ultimately leak out abroad. This negatively impacts on the BOP and thus imports, exports and output. The dampening effect of this scenario is compounded by the fact that the deficit itself constricts imports. The crucial role of the government sector on overall economic activity is thus clear.

Eventually, the economy will settle down to a new and higher equilibrium in the short run as determined by the effect of the BOP, the government sector and the behavior of prices. Sooner or later, however, the pressure on domestic resources resulting from the increase in export prices will eventually provoke the inflationary process, depending upon whether the economy was operating near full-employment equilibrium and near full capacity utilization when the shock was registered. Whether or not the short-run equilibrium is shifted to a higher plain in the long-run depends upon the intensity of the shock, its permanence (i.e, whether it is a short memory or long memory process) and conjunctural events in time.

The present model also attempts to take account of certain institutional features and policy variables of the Guyanese economy. These have always posed a problem to econometric modelling, namely how to account for them in a quantitative framework. The approach adopted here is based on a two-pronged strategy. The first is to use dummy variables as in the equations for government revenue and expenditure, private consumption, consumption imports and imports of raw materials and intermediate goods. In the case of the government sector, the dummy variables are intended to account for a unique feature during the sample period: the short-lived boom of the sugar market during 1974-76, which distorted the values of many key macroeconomic variables, including GDP. The significant deterioration of the welfare of the Guyanese people since 1977 provides the rationale for the dummy variable in the consumption function. The intention is to test the hypothesis of a structural break in the function. Guyana is completely dependent on imports of oil which have represented a heavy drain since the first oil crisis in 1973. To take account of the burden of this category of imports since then, a dummy variable is added to the equation for imports of raw materials and intermediate goods.

The second approach relates to the rate of interest which has been administered and remained fixed for a relatively long period of time. Nevertheless, since the cost of working capital is an important consideration to a developing economy such as Guyana, the rate of interest is included as one element of the mark-up over the direct cost of production in the inflation equation. In other words, the use of the Post-Keynesian/structuralist approach to modelling inflation provides a ready way to account for the cost of working capital in a situation of administered interest rates.

The role of expectations in macroeconometric modelling in the region has been a much neglected area. From the published literature in the region, only Ganga (1990) assigned a role to expectations, postulating that inflation depends, among other things, on expectations of inflation, with the latter proxied by the rate of inflation in the previous period. In this formulation, inflationary expectations are essentially static.

This study, in assigning some importance to the role of expectations, assumes that economic agents form expectations on nominal rate of exchange, inflation and anticipated money supply. In modelling the formation of expectations, the approach is experimental in that it embraces static expectations, adaptive expectations and weak rational expectations. The various experiments demonstrate two important results: (a) in all cases, expectations-augmented equations produced a superior performance over the expectations-free equations; and (b) weak rational expectations, modelled for all variables as an appropriate ARIMA process, produced the best results. It seems likely, then, that expectations are clearly of importance to the decision-making process of economic agents in Guyana.

The only published model that benchmarks its performance is that of Jarvis (1990). This is always a necessary step in the model validation process for two reasons: (a) it provides evidence on comparative performance, and (b) it offers an idea of the properties of the models. Usually, the competing model selected for testing (that is, the benchmark model) is a watered down version of the main model itself, called a naive model. Recently, researchers have also been using VAR models as benchmarks, although this approach will not be pursued here.

This study moves away from tradition and compares the performance of the Augmented Keynesian Model with an Export-led Model (ELM). The justification for this is that, in addition to providing the usual benchmarks, this approach is expected to offer some insight into the relative merits of the two main modeling strategies the region. Comparative performance will also be judged on the basis of an encompassing test which attempts to ascertain whether one model is general enough to explain - encompass - other models. Or as Fair and Shiller (1990:375) put it: "Does the model have a strength of its own, so that each forecast represents useful information unique to it, or does one model dominate in the sense of incorporating all the information in the other models plus some."

The export-led model used here, discussed in detail in Chapter 16, while drawing heavily on previous work in the region, has been modified in three ways: (a) extension to include stochastic equations for government revenue, government expenditure, gross investment and depreciation; (b) disaggregation of the typical aggregated import equation; and (c) modification to make it a better representation of the features of the Guyanese economy. The justification for these changes centers around the idea that the ELM should be made comparable to the AKM so that noise not common to both models should be eliminated as far as possible. We refer to this idea as the principle of no unfair advantage.

Beyond building on existing models in the region in the sense discussed above, another reason for the modelling exercise undertaken in this study is to encourage the Guyanese authorities to employ macroeconometric models in the important tasks of policy-making and economic management. As we have noted in Chapter 9, Guyana is (to my knowledge) the only large MDC in the Caricom region that does not make use of such models. Several reasons contribute to this, but it would appear to me that the virtual non-existence of these models is a crucial constraint. How can the authorities be expected to use macroeconometric models when they are not yet convinced of the utility of these models in the Guyanese context? The only credible way of convincing the authorities is have an empirical consensus on basic issues produced by many models, but a body of such knowledge is yet to be accumulated. Indeed, to my knowledge only four known macroeconometric models of the Guyanese economy have ever been constructed, at least three of which were done as part of PhD studies. It is hoped that the modelling effort undertaken by this dissertation makes a small contribution this body of knowledge and brings the day closer when Guyana joins the other regional MDCs in enlisting the services of macroeconometric models.

Equation Estimation and Specification

The equations of the AKM are specified and estimated in chapters 11 through 16. The methodology underlying the specification of the model is based on that pioneered by the Cowles Commission: using economic theory as our guide, each final equation is arrived at via a process of experimentation that searches for the best specification. All equations are in the log-linear form; therefore, coefficients can be interpreted directly as elasticities. The complete specification of the model, including an alphabetical description of all endogenous and predetermined variables, their method of construction and appropriate equation number, are given in Annex 1, pages 356 to 369.

The model is a system of simultaneous equations[3] in that interdependencies exist among equations. In a system of simultaneous equations, one or more of the explanatory variables will be endogenous, and therefore correlated with the disturbance term. In other words, the assumption of nonautocorrelation of the disturbance term breaks down; that is, $E(\epsilon_i \epsilon_j) = 0$ for all i # j does not hold. In such cases, the variance-covariance matrix derived under OLS will be incorrect. The upshot is that the existence of correlation between the

[3] A model is said to constitute a system of simultaneous equations if all of the relationships involved are needed for determining the value of at least one of the endogenous variables included in the model. This implies that at least one of the relationships includes more than one endogenous variable.

explanatory variables and the disturbance terms in a simultaneous model leads to inconsistency of the OLS estimator of the regression coefficients. To deal with this problem, resort is usually made to the two-stage least squares technique, which aims at the elimination as far as possible of the simultaneous-equations bias. This technique produces consistent parameters estimates.

There are two major parts to the construction and estimation of each equation, with the exception of the equations for potential output and depreciation.[4] Empirical work on the relevant equation is first reviewed, with the emphasis being on the specification and results obtained; important modeling issues are also pointed out in the process. Next, the appropriate equation for the Augmented Keynesian Model is specified, estimated and discussed.

The following chapter begins with the equations for consumption and investment.

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[4] It does not appear that any empirical work on these two equations has been done in the region. This is why there is no review of previous work for these equations.

Figure 1. Major Linkages Among Endogenous Variables in the AKM

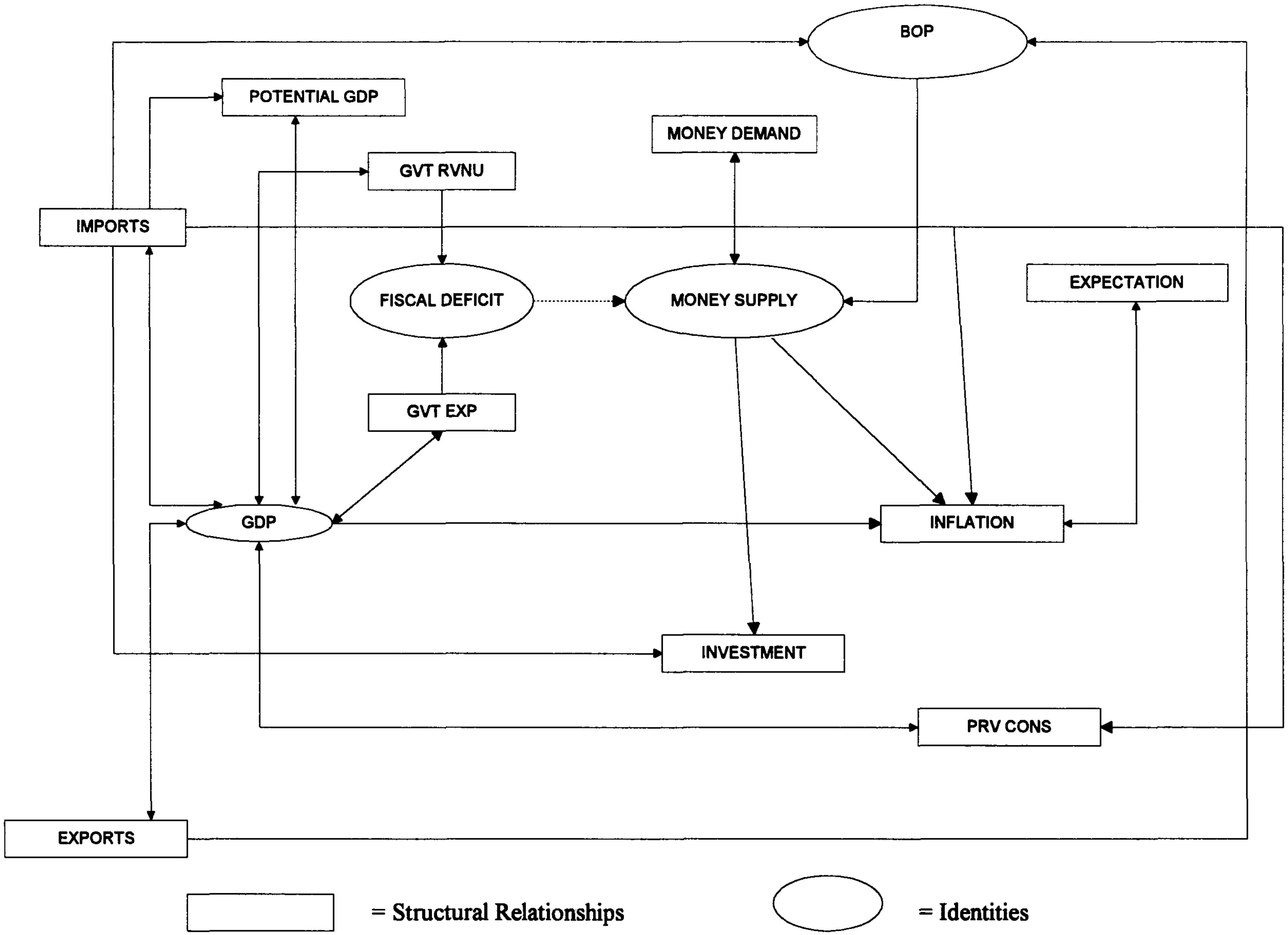

Table 15. Econometric Models of Guyana: A Comparative View

Equation	Jarvis	Ganga	Khayum	This Study
Period	Annual; 1957-76	Annual; 1966-85	Annual; 1960-84	Annual; 1960-88
Functional form	Linear	Log-linear	Linear	Log-linear
Objectives	To model behavior of economy; forecasting and policy simulation.	To model behavior of economy; to explain behavior of key macro-economic variables and the effect of various policies on these variables.	Policy analysis - the key focus is on output, price level and BOP; multiplier analysis; forecasting.	To model behavior of economy; historical simulation; ex-post forecasting.
Number of Equations	12 stochastic; 5 identities	7 stochastic; 6 identities	12 stochastic ; 1 definition; 2 constraints	12 main stochastic; 2 auxiliary stochastic equations; 43 identities
Output	Not modelled	Real output = f(real intermediate and capital goods; real domestic capital; labor supply; previous period real output; dummy for mandays lost)	Nominal output = f(labor employed; imports of intermediate goods; energy supply)	Potential output = f(labor supply; capital stock; imports capacity; linear time trend; quadratic time trend)
Depreciation	Not modelled	Not modelled	Not modelled	Depreciation = f(capital stock lagged on period; linear time trend)

Equation	Jarvis	Ganga	Khayum	This Study
Investment	Nominal total inv = f(ΔGNP; capital inflows)	Real total inv = f(real agg. demand; Δ credit;Δ real foreign exch. earnings; previous period real investment)	Nominal inv = f(inventory inv + private sector inv; domestic credit creation; imports of intermediate and capital goods; Δ in total domestic prod)	Real gross dom. inv = f(Δ real GDP; dom. credit per unit of investment; real import of int. and capital goods; relative prices; previous period capital stock)
Consumption (Private)	Private con = f(disposable income)	Real private con = f(real disposable income; real money supply; real cons of previous period)	Private con = f(total domestic production; wealth)	Real private con = f(real disposable income; trend real prv. cons; dev. from trend real prv . cons; Δ real wealth; dummy var. for lower level of cons. since 1977) .
Total Government Revenue	Not modelled	Not modelled	Not modelled	Real Gvt. Rev. = f(real GDP; real rev. lagged one period; dummy variable for rise in rev during sugar boom)
Direct tax	Personal tax = f(personal income)	Not modelled	Not modelled	Not modelled specifically but included in above equation for total revenue
Indirect Tax	Indirect business tax = f(GNP)	Not modelled	Not modelled	Ditto
	Tax on corporate profit = f(level of corporate profit)	Not modelled	Not modelled	Ditto

Equation	Jarvis	Ganga	Khayum	This Study
Treasury Financing Requirements	Not modelled	Treasury financing requirements = f(ΔCPI, previous period; implicit deficit; ΔGDP; dummy variable for abnormal gvt. transfer to public sector)	Not modelled Not modelled	Not modelled
Government Total Expenditure	Not modelled	Nor modelled	Not modelled	Real Gvt. Exp. = f(real GDP, real exp. lagged one period; real deficit; dummy variable for rise in exp during sugar boom)
Government Consumption	Central gvt. con = f(gvt. revenue)	Not modelled	Gvt. con = f(gvt. deficit)	Not modelled specifically but included in above equation for total govt exp
Export	Δ in export of food, beverage and tobacco = f(Δ in agri. output; Δ in export to CARIFTA[b]) Other exports = f(Δ agri. output; Δ export to CARIFTA)	Real total export = f(Δ real GDP; real prices of export; previous period export)	Nominal total export = f(export price index; productive capacity)	Real total export = f(real GDP; change export prices; dummy for sugar boom)

Equation	Jarvis	Ganga	Khayum	This Study
Import	Δ import of food, beverage and tobacco = f(Δ agri. output; Δ import to CARIFTA) Δ import of intermediate inputs = f(Δ GNP) Δ import of machinery and manufactured goods = f(Δ gross capital formation; Δ GNP)	Real imports of intermediate and capital goods = f(real investment; real prices of imports; Δ in foreign exchange earnings deflated by import price index; real import of intermediate and capital goods)	Nominal total imports = f(import price index; import capacity; total domestic production; nominal exchange rate; govt deficit; domestic price level)	Real import of con. good = f(real disp. income; relative prices; import capacity; lagged dep. vari; dummy var for policy restricting con. imports) Real imp. of raw mat. and int. gds. = f(cap. utilization; Δ rel. prices; real deficit; import capacity; lagged dep. var.; dummy var. for fuel) Real import of cap. goods. = f(Δ real investment; rel. prices lagged one period; import capacity; Δ real deficit; lagged dep. variable)
Money	Not modelled	Demand for money not modelled. Identity for money supply.	Real M = f(total domestic production, interest rate, expected inflation, expected exchange rate) Identity for money supply	Real M2 = (real wealth, interest rate, lagged dependent variable, money surprise) Stochastic equation for anticipated money given as an ARIMA(3,1,2)

Equation	Jarvis	Ganga	Khayum	This Study
Domestic Price Level	Index of urban retail prices = f(index of import prices)	Not modelled	Not modelled	Not modelled
Inflation	Not modelled	CPI = f(Δ money supply; Δ previous period money supply; Δ real agg demand; indirect taxes; Δ import price index times nominal exchange rate; previous period CPI)	Not modelled	Δ CPI = f(expected inflation; Δ markup rate; Δ excess money supply; Δ excess demand)

CHAPTER 11

Consumption and Investment

Private Consumption

Many early macroeconometric models in the region made consumption dependent upon disposable income or some other variant of national income. Recent models have, however, moved away from this simple Keynesian formulation.

Studies Based on the Simple Keynesian Consumption Function

One of the earliest modelling attempts in the region, that of Carter (1970), treats private consumption as a function of disposable income, obtaining an MPC of 0.80. The function also includes a dummy variable to represent the impact of the introduction of hire purchase - that is, purchasing on credit - on the Jamaican economy. Carter interprets the huge coefficient (16.53) on the dummy variable as evidence of a significant jump in the consumption function, possibly indicating a break in the function. One year later, Manhertz (1971), also modelling the Jamaican economy, employed a disaggregated function: nondurables (excluding food), durable goods, food (including beverages) and services, with the explanatory variable in each equation being disposable income and a dummy variable to capture a shift phenomenon resulting from the introduction of consumer installment credit (hire purchase). The dummy variable was subsequently dropped from the equation for food because it proved to be insignificant. The estimates are:

	Income	Dummy
Nondurables	0.10	1.80
Durables	0.19	4.60
Food	0.30	-----
Services	0.39	2.93

The sum of the coefficient on disposable income is 0.98, prompting Manhertz to observe that his estimate supports the presumption that the MPS in Jamaica is very low. The important point, however, is that both Carter and Manhertz found that the MPC was rather high in Jamaica.

A Keynesian consumption function was also employed by Persaud (1979), augmented by previous period consumption to take account of a "demonstration effect" which "... is very pronounced in the consumption patterns of Trinidadians" (p.394). In his preferred equation, Persaud obtained a coefficient of 0.62 for the "demonstration variable" and 0.30 on the (national) income variable, both variables being significant. The conclusion, therefore, is that "... consumption in Trinidad is significantly affected by past consumer behavior and by the level of income" (p.395). If the lagged consumption is dropped, the MPC out of income rises to 0.63. This would seem to indicate that the MPC in Trinidad and Tobago is rather low, which suggests a relatively high MPS for a developing country, although this may be due to the use of national instead of disposable income and the presence of multicollinearity between income and lagged consumption, with the latter dominating.

Unlike Persaud, Jarvis (1990) found that the Guyanese data did not support the "demonstration effect." This is also true of consumer installment credit, institutionalized in 1964, which was found to be an important factor in the explanation of consumption patterns in Jamaica. Thus the only explanatory variable in Jarvis' function was disposable income, which explained 0.99 percent of the variation in private consumption and which produced a coefficient of 0.89; this is comparable with the results obtained by Carter (1970) and Manhertz (1971) for Jamaica.

The Absolute Income Hypothesis was also used by Bourne and Nicholls (1990), who found that 89 per cent of the variation in private consumption in Trinidad and Tobago was explained by (national) income. The estimated MPC is 0.43 but the D.W. is relatively low (1.6). In the case of Barbados, the fit of the equation was even better (adjusted $R^2 = 0.96$) and the MPC was also higher (0.66). Again, the D.W. is rather low (1.4) even after an AR(1) term was added.

Studies Based on Other Explanations of Consumption Patterns

Essentially, these studies sought a "wider" explanation of consumption patterns, drawing on variables such as money supply and the rate of interest. One of these studies (Hilaire *et al*, 1990) moved completely out of the Keynesian framework and tested the permanent income hypothesis.

Ganga (1990) sought to explain private consumption in Guyana in terms of disposable income, changes in real money supply and the lagged dependent variable. The MPC obtained, 0.84, is not significantly different from that obtained by Jarvis, even though the time periods covered by the two researchers are very different. Commenting on the result of the monetary variable, Ganga observed that "[T]he coefficient of liquidity, whose elasticity is estimated to be 0.11 and insignificant, is contrary to the orthodox claim that consumption can be controlled through tight monetary policy" (p. 18). The relatively large (0.70) and significant coefficient on the lagged dependent variable is interpreted as evidence of slow adjustment, probably attributable to the widespread scarcity of consumer goods. In other words, as with Persaud's finding of the Trinidad-Tobago economy, Ganga found that the "demonstration effect" is a crucial explanatory factor of current consumption patterns in Guyana.

The closest attempt at gauging the propensity of different social classes to consume is that of St. Cyr and Charles (1992), who made consumption in Trinidad and Tobago dependent upon wage and salary income, and non-wage/salary income. The coefficients on both variables are correctly signed and highly significant and, as expected, the recipients of wage and salary income have a high propensity (0.82) to consume, while the MPC of the recipients of non-wage/salary income is only 0.24. Thus the sum of the coefficients on these two variables is 1.06, an MPC that exceeds unity. This contrasts sharply with the finding of Persaud who obtained an MPC of only 0.30.

Bourne (1989) posits that private consumption expenditure varies directly with GNP and the broad money stock, and inversely with the loan rate of interest. He found that for all four countries studied (table 16) broad money was a significant factor in the explanation of consumption behavior. In Guyana, for example, a 1 per cent increase in broad money supply results in an increase of consumption of 0.4 per cent. The rate of interest was significant in all countries except Barbados. In Jamaica, however, the impact was perverse: the rate of interest was directly related to consumption. Similarly, the hypothesized relation between GNP and consumption is supported in all countries except Barbados, although the estimate for this country is suspect, with a D.W. of 3.00.

Hilaire *et al* (1990) introduced a breath of fresh air into the private consumption function: studying Trinidad and Tobago, they utilize permanent disposable income instead of current disposable income. The estimate indicates a marginal propensity to consume of 82 per cent out of permanent disposable income, which seems reasonable compared to the findings of Persaud (1979) and St. Cyr and Charles (1992).

Table 16. Bourne's (1989) Estimates of the Private Consumption Function

Regressor	Barbados 1974-82	Guyana 1966-82	Jamaica 1964-82	Trinidad and Tobago 1966-82
Constant	1.33^{a}	1.94^{a}	0.15	5.06^{a}
GNP	-0.04	0.32^{a}	0.58^{a}	0.27
R	-0.01	-0.14^{a}	0.32^{c}	-2.07^{a}
M2	0.91^{c}	0.40^{c}	0.30^{c}	0.71^{b}
Adj. R^2	0.99	0.99	0.99	0.99
D.W.	3.00	2.20	1.90	2.20

Source: Bourne (1989), p. 276

Note: The consumption function is in log-linear form. R is the commercial bank loan rate of interest and M2 is broad money. a = significant at the 1 per cent level; b = significant at the 5 per cent level; and c = significant at the 10 per cent level.

In general, it would seem from the discussion above that the principal determinants of private consumption in the Caricom region are income, broad money supply and the rate of interest. The main result is that the marginal propensity to consume out of disposable income, while not showing much uniformity, can be considered to be very high, ranging from 0.80 to 0.98. In cases where consumption was made to depend on national income the coefficient ranged from 0.30 to 0.66.

Specification and Estimation of the Consumption Equation

Drawing on Gordon (1991), the model of private consumption developed here incorporates elements of Keynesian and structuralist theories, in addition to disequilibrium features and a "rainy days" corollary. Gordon, testing structuralist hypotheses about the role of distribution and finance, employed two central themes in his consumption function: (a) different propensities to consume by the recipients of wage and salary, and capital income; and

(b) a highly inertial quality to consumption, at least by a major portion of the recipients of wage-and-salary income.

A careful scrutiny of existing national accounts data will reveal both gaps and sporadic coverage of certain macro-economic aggregates. My research efforts indicate that the structure of the Guyana's national accounts has no provision for the collection and publication of data on factor shares, although the World Bank (1973) has published such data for 1960-72. It is difficult to update this (and other) series since other basic data, such as total employment, are not routinely covered in the nation's national accounts statistics. The absence of income data according to recipients eliminates any attempt at formulating a function based on the propensity to consume by different social classes. Given this lacuna, real private consumption, CONPR, will be made to depend on disposable income, YDR:

$$(11.1) \quad \ln CONPR = \lambda_{10} + \lambda_{11} \ln YDR, \qquad 0 < \lambda_{11} < 1$$

If liquidity constraints are binding for households, as would be for developing countries in particular, then current disposable income would be important, with $0 < \lambda_{11} < 1$. This means that aggregate private consumption would include a portion that is attributable to liquidity-constrained households whose consumption is constrained by current income.

To take account of the inertial quality to consumption, Gordon, drawing on Marglin (1984), introduced a "disequilibrium" mechanism, based on the proposition that most households will aim to achieve a target level of consumption. The disequilibrium feature implies that the consumers attempt to correct a short-run disequilibrium position by adjusting current consumption to the difference between recent and target consumption:

$$(11.2) \quad \ln CONPR = \lambda_{11} \ln CONPRT + \lambda_{12} \ln CONPRW \qquad 1 > \lambda_{11} > 0; \lambda_{12} < 0$$

where CONPRT is trend private consumption, a proxy for target consumption, and CONPRW is the deviation of consumption from target.

Accordingly, equation (11.2) is said to contain an error correction mechanism, represented by the term CONPRW. It can be seen from this equation that current consumption will be influenced by two dynamic adjustment effects. The first is that exercised by recent trends in consumption, given by the first term on the right-hand side of the equation. According to the second dynamic adjustment mechanism, current consumption will be "reduced below (above) warranted levels, other things equal, if circumstances had permitted consumption recently to grow more (less) rapidly than the target rate of growth of consumption" (Gordon, 1991:23).

Following Gordon, the disequilibrium hypothesis may be supplemented by two "rainy day corollaries". First, working households can reasonably be expected to reduce future consumption when the rate of unemployment increases. In the case of Guyana, however, an unemployment series does not exist and the estimate used here, although high, show only small year-to-year variations. In view of this, any impact of unemployment will be difficult to discern econometrically. Indeed, the estimates given in table 17 confirm this presumption. Second, as a natural consequence of the disequilibrium hypothesis, any temporary increase in net household assets - because of a temporary increase in saving - will lead to a positive adjustment in consumption. The incremental change in net household wealth (WLTHRD) will therefore be included as an argument in the consumption function. Finally, as noted in Chapter 2, Part 1, both per capita income and the growth rate of GDP have declined drastically since 1977, negatively impacting on consumption of the average Guyanese. The consumption function takes this into consideration by way of a dummy variable (DUCON), which takes on the value of zero for 1960-76 and one for 1977-88.

Combining equations (11.1) and (11.2), the second rainy-day corollary, the dummy variable and the best estimate in table 11.2, we arrive at the following equation for the consumption function:

$$(11.3) \quad \ln CONPR = \lambda_9 + \lambda_{10} \ln YDR + \lambda_{11} \ln CONPRT + \lambda_{12} \ln CONPRW + \lambda_{13} \ln WLTHRD + \lambda_{14} DUCON$$

Even a quick examination of the table below will indicate that regression number 5 - that is, (11.3) - is the best in terms of the estimated parameters and diagnostic statistics. At first brush it might be concluded that the marginal propensity to consume out of disposable income is rather low (0.47) for a developing country such as Guyana. This further suggests a rather high MPS which is not supported by the Guyanese data. This apparent anomaly is not supported by the work of both Jarvis (1990) and Ganga (1990), who obtained a coefficient of 0.89 and 0.84, respectively, on the disposable income term; Bourne (1989), it will be recalled, obtained a coefficient of 0.32.[1]

1 Among other regressions, Bourne (1989) estimated a private consumption function for Barbados, Guyana, Jamaica and Trinidad and Tobago. He postulated that private consumption varies directly with GNP and the broad money stock and inversely with the loan rate of interest. See table 16 in text for estimates.

Table 17. Estimates of Equation (11.3). Dependent Variable is Real Private Consumption.

VARIABLE	REGRESSION 1	REGRESSION 2	REGRESSION 3	REGRESSION 4	REGRESSION 5
CONSTANT	- 2.612 (1.976)	- 2.768 (1.958)	- 3.440 (3.015)	- 2.985 (2.656)	- 3.014 (2.822)
DISP. INCOME	0.447 (2.220)	0.484 (2.143)	0.553 (3.225)	0.466 (2.746)	0.471 (2.965)
TREND CONS	0.879 (6.020)	0.861 (5.368)	0.866 (6.668)	0.901 (7.339)	0.899 (7.570)
DEV CONS TREND	-0.635 (2.084)	-0.715 (2.043)	-0.502 (1.707)	- 0.515 (1.870)	- 0.528 (2.138)
CHN TRND WEALTH			0.897 (2.489)	0.881 (2.604)	0.874 (2.695)
CHN UNEMP RATE		0.004 (0.545)	- 0.001 (0.250)	- 0.001 (0.113)	
DUMMY VARIABLE					- 0.059 (1.733)
ADJ. R^2	0.797	0.776	0.873	0.888	0.893
S.E.R	0.107	0.113	0.086	0.081	0.079
D.W.	1.167	1.292	1.893	2.151	2.153
B-G statistic	$\chi^2(2)$ = 2.372	$\chi^2(2)$ = 2.729	$\chi^2(2)$ = 0.123	$\chi^2(2)$ = 2.601	$\chi^2(2)$ = 3.240
Engle's ARCH	$\chi^2(4)$ = 1.622	$\chi^2(4)$ = 0.622	$\chi^2(4)$ = 1.734	$\chi^2(4)$ = 2.826	$\chi^2(4)$ = 2.232

Notes: The G-B statistic is the result of the Breusch-Godfrey large sample test for autocorrelated disturbance. It is applicable whether the disturbances follow a AR(p) or an MA(p) process, where p can be specified as any order greater than or equal to unity. The χ^2-statistic produced by the test is the Breusch-Godfrey, Lagrange multiplier test statistic and is nR^2, where n is the sample size and R^2 is the square of the multiple correlation coefficient of the test regression. Throughout this study $\chi^2(2)$ is the Lagrange multiplier statistic for autocorrelation up to order 2, asymptotically distributed under the null of no serial correlation, as central chi-squared with two degrees of freedom. Critical value at 5 % significance level is 6.0.

Engle's ARCH is a test for heteroskedasticity in the disturbance. The $\chi^2(4)$ is the Lagrange multiplier statistic for heteroskedasticity up to order 4, asymptotically distributed under the null that the coefficients on the lagged residuals are all zeros (homoskedasticity), as central chi-squared with four degrees of freedom. Critical value at 5 % significance level is 9.5.

This reading of the estimate is perfectly acceptable if we were dealing with a purely Keynesian consumption function. Indeed, to confirm this, a consumption function specified exactly as in Ganga (1990) was estimated, using the two-stage least square technique. The result is given below.

$$(11.S1)\quad CONPR = \underset{(1.954)}{-3.769} + \underset{(4.105)}{0.904}\,YDR + \underset{(3.070)}{0.447}\,CONPR_{t-1} + \underset{(0.008)}{0.003}\,\Delta M2$$

$$+ \underset{(2.219)}{0.459}\,MA(1)$$

$$\text{Adjusted } R^2 = 0.718 \quad S.E.R. = 0.131 \quad D.W. = 1.918$$

The estimate on Ganga's own equation is:

$$(11.S2)\quad CPRIV = \underset{(1.56)}{-3.3769} + \underset{(2.63)}{0.839}\,YD + \underset{(5.18)}{0.701}\,CPRIV(-1) + \underset{(0.57)}{0.117}\,\Delta M2$$

$$\text{Adjusted } R^2 = 0.83$$

Note: CPRIV = real private consumption; YD = real disposable income; M2 = broad money supply, in real terms; estimation period: 1966 - 85. Aside from the adjusted R^2 Ganga did not supply other evaluation statistics.

In both estimates (11.S1) and (11.S2) the monetary term is insignificant as an explanatory factor of real private consumption.[2] In estimate (11.S1) the coefficient on the disposable income term is larger compared to (11.S2), but this is expected given the decline in per capita income during the 1980s. In Ganga's equation the coefficient on the previous period consumption term is about 1.6 times that of estimate (11.S1).

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2 Bourne (1989) found broad money to be significant at the 5 per cent level only for Trinidad and Tobago. In the case of Guyana, this variable, while producing a coefficient 0.40, is significant only at the 10 per cent level.

It seems likely, therefore, that the relatively low coefficient on the disposable income obtained from the estimate of (11.3), is due to the specification of the equation. Since consumption and income can be expected to display parallel movement in time (i.e, they are cointegrated), the inclusion of trended consumption as an explanatory variable in (11.3) can result in multicollinearity between it and disposable income. Indeed, the coefficient on trend consumption in regression 5 of table 11.2 is of the same magnitude as the coefficient obtained on the disposable income term in (11.S1).

The result, nevertheless, suggest that consumption patterns in Guyana are heavily influenced by trend consumption, implying that people strive to maintain the level of consumption to which they are accustomed. This notion of consumption finds some support from the coefficient (-0.528) on the deviation from trend-consumption term: even in the face of severe scarcity of consumption goods in Guyana, any deviation from trend consumption takes slightly under two years to be corrected, on an average. The inclusion of the wealth term turns out to be an important and significant determinant of consumption, as expected. Finally, the coefficient on the dummy variable has the expected negative sign and is significant, although the coefficient is not very large. There is, therefore, some support for the hypothesis that there was a transition to a lower level of consumption sometime in the late 1970s.

Gross Domestic Investment

Regardless of the theoretical perspective adopted, investment is seen as a crucial variable in the process of economic growth. In recognition of this fact, most econometric models contain behavioral equations for total investment or some component of it, although it is not difficult to find models, particularly in developing countries, in which total investment is assumed to be exogenous.

The approach adopted to modelling investment in developing countries, including the Caricom region, is influenced by two sets of issues: (a) exogenous/endogenous arguments, and (b) the need for disaggregation which, to a large extent, is dependent on data availability. The former may be best posed in terms of a question: what portion of investment is determined endogenously? A minority of researchers in the region take the view that a certain component of private investment is exogenously determined for it depends on the decisions of multinational corporations (Carter, 1970 and Khayum, 1991). On the other hand, these researchers regard public sector investment as an endogenously determined variable. Most studies in the region, however, take the view that total investment is endogenous (Manhertz, 1971; Persaud, 1979; Jarvis, 1990; Ganga, 1990; Bourne and Nicholls, 1990).

The data availability issue cuts across the exogenous/endogenous argument—the modelling of total investment is affected by the quality and the level of disaggregation of the data. Depending upon the data, the purpose of the model may require a disaggregated approach to investment, specifying separate equations for public and private investment (Carter, 1970; Manhertz, 1971). An alternative approach is to ignore the issue of disaggregation and to model total investment. This is the more common approach in the region (Ganga, 1990; Jarvis, 1990: Bourne and Nicholls, 1990).

As the discussion below shows, the level of investment, or components of it, in the region is explained by variables such as the level of confidence, credit, GNP, ΔGNP, aggregate demand, a linear time trend, the rate of interest, government revenues, capital inflows, the lagged dependent variable and the availability of foreign exchange.

Studies Assuming that Some Component of Investment is Exogenous

The ultimate justification for this approach derives from the Keynesian framework employed and the fact that during the period studied the government did not play a principal role in the economy.

Carter (1970) assumed that mining investment is exogenous since it depends on the decisions of multinational corporations (Khayum, 1991, takes a similar position as regards private investment). Non-mining investment comprises inventory and other fixed investment but the former is also taken to be exogenous because it "proved to be so near random that it was not possible to have a structural equation for it" (p.186). His investment equation refers, therefore, to other fixed investment. Having found that neither the change in income nor the previous level of investment constitutes a significant explanatory factor, Carter began a search for other variables which led to the level of confidence in the economy, proxied by the earnings from tourism, and the availability of credit. The coefficients on these variables were 0.64 and 1.08 respectively, while the overall fit was 0.86. The D.W. did not indicate the presence of serial correlation. Examining the plot of actual and fitted values for the estimate, Carter observed that the equation provided "... a reasonable explanation of the behavior of investment over the period 1959-1966" as it "... successfully picks up turning points, but does not reflect the full intensity of the swings in the investment cycle" (p. 186). (It known that the simulation performance of an equation (and a model) may be vastly different from the overall fit based on regression results. For a discussion of this issue, see, for example, Pindyck and Rubinfeld, 1991, chapter 12.)

Studies Assuming Total Investment to be Endogenously Determined

Manhertz (1971) takes gross domestic investment as the sum of fixed private investment, gross government capital formation and the physical change in (private) inventory, all of which have separate behavioral equations. Private fixed investment is explained by GNP which represents "a general indicator of the degree of economic prosperity" (p.209) and a linear time trend. Both variables were found to be very significant, with coefficients of 0.49 and -4.49 respectively. Judging from the size of the trend coefficient, Manhertz felt that "there are many exogenous factors for which a more satisfactory account has to be given" (p. 209).

There are two arguments in the inventory equation. The first is inventory in the previous period which, according to Manhertz, "provides a stock adjustment phenomenon and may also serve as an index of economic stability in the business cycle" (p. 210). The estimated coefficient on this variable, -0.56, is not, Manhertz believes, excessively high for the Jamaican economy. The second argument is the rate of interest on commercial bank loans, which is intended to capture the impact of changes in the monetary sector on inventory changes, given that firms in the Jamaican economy are heavily dependent on bank financing.[3] The estimate supports this hypothesis and suggests that rising of interest rates exert a considerable (-1.63) dampening impact on the accumulation of inventories.

Public sector capital formation is dependent on central government revenues and a time trend but the coefficient on both variables were higher than expected: 0.58 and -0.95 respectively. In the case of government revenues, a probable reason for this, Manhertz believes, is the very high levels of investment projects during the sample period, while the negative trend coefficient is justified by the sporadic nature of government capital expenditure.

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3 This is one of the earliest arguments in the region - if not in theory, then certainly in empirical terms - of the dependence of firms on banks for capital.

No distinction is drawn by Persaud (1972) between public and private investment. Further, even though he recognized that much of the investment in Trinidad and Tobago stems from the large petroleum sector, dominated as it is by multinational corporations, investment was taken as exogenously determined. Rather, the level of aggregate investment is made a function of capital inflows and an accelerator variable, ΔGNP, both of which were significant, with coefficients 0.65 and 1318.0, respectively. Persaud notes that "... the overall fit is surprisingly good," with an adjusted R^2 of 0.91 but notes that "capital inflows must be included as a control variable before evidence of an accelerator effect can be detected" (p. 399). The coefficient on the accelerator variable is huge, possibly because abnormal capital investment was being made in the petroleum sector during the time covered by the model..

Noting that the data did not permit disaggregation by business and government, Jarvis (1990) used gross investment in his model of the Guyanese economy. He experimented with GNP, ΔGNP, capital inflow and the change in capital inflow as the dependent variables in the equation. His best equation has ΔGNP and capital inflow as explanatory variables. The accelerator variable was insignificant and wrongly signed. Capital inflow, yielding a coefficient of 3.520, apparently exerts a heavy influence on domestic investment. The overall fit of the equation, as given by the adjusted R^2, is 0.79, although a D.W. of 1.61 is rather low. The high responsiveness of investment to capital inflow in the Jarvis equation is also a feature noted by Persaud (1979). Unlike the latter, however, Jarvis did not find any evidence of an accelerator effect in his investment equation.

There are four dependent variables in the (total) investment - gross fixed capital formation, that is - equation used by Ganga (1990): aggregate demand, total domestic credit, the dependent variable lagged one period and the availability of foreign exchange lagged one period. The latter variable is justified on the basis of the two-gap thesis as it places a constraint on the importation of capital and intermediate goods. The interest rate, according to Ganga, is omitted from the equation on the grounds of institutional rigidities and the relative immaturity of the domestic capital market.

The estimated equation yielded surprising results: only aggregate demand is significant in explaining investment, with a 1 per cent increase in this variable pushing investment up by 2.85 per cent. The insignificance of the foreign exchange variable is explained as follows: "The explanations for this probably lie in the fact that there has been excess capacity in Guyana and that in LDCs domestic investment for the most part is on infrastructure rather than industries" (p. 17). This is a rather weak argument as the bulk of capital investment is in infrastructure rather than direct productive capacity and such investments do require imports.

Bourne and Nicholls (1990) postulated that investment depends upon an accelerator type variable, represented by the first difference of GDP, and a credit. In the case of Barbados, the latter variable is represented by bank credit while for Trinidad and Tobago monetary sector credit to the private sector is used (p. 51).

For Trinidad and Tobago both variables are highly significant and correctly signed. The accelerator effect on investment is estimated at 0.62 but it seems that the availability of credit (coefficient: 0.72) is more important in explaining investment. The equation fits the data very well (adjusted R^2 of 0.92) and there is no indication of the presence of serial correlation. In the case of Barbados, the accelerator variable (coefficient: - 0.80) is not significant at the 5 per cent level, in addition to having the wrong sign. The credit variable, with a coefficient of 0.48, does exert an important impact on investment. Even though an AR(1) has been added to this equation, there is still a suggestion of the presence of serial correlation (D.W. = 1.55).

A quick summary of the coefficient range of the most common explanatory variables in the investment equation is given by table 18.

Table 18. Coefficient Range for Significant Variables in the Investment Equation

Variable	Estimate range
First difference of GDP	-1.43 - 0.62
Credit	0.48 - 1.02
Earnings from tourism	0.64 - 0.64
Capital inflow	0.65 - 3.52

Specification and Estimation of the Equation for Gross Domestic Investment

The approach adopted here is to specify an equation for total investment on the reasonable assumption that total domestic investment is endogenous, given the importance of the government in the economy and the drastic reduction of investment by multinational companies (this should be evident from Part 1). A review of the literature - for the region and other developing countries - indicates that the following variables can usually be found in the investment equation: income (GDP), an acceleration variable, usually ΔGDP or ΔGNP, the interest rate, imports of intermediate and capital goods, government expenditure, capital stock lagged one period and domestic credit.[4] Given the characteristics of the Guyanese economy, the arguments that would seem most important are ΔGDP, imports of intermediate and capital goods, domestic credit and the previous period's capital stock. In addition, I tried regressions in which the level of real GDP appeared but the results indicated that this variable was not significant. Although, as noted previously, the real rate of interest (nominal interest rate minus rate of inflation) has been negative for several years of the period studied, it was initially included in the investment function but the data failed to provide any support for it.

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4 In addition to the references given in footnote 1 of Chapter 9, see also Rashid (1984), Ahmad (1988), Sarkar and Panda (1988) and the various papers in Ichimura and Ezaki,(eds), 1985.

We therefore begin with an equation containing the following explanatory variables:

$$\text{(11.S3)} \quad \ln GDIR = \underset{(1.259)}{0.817} + \underset{(2.579)}{1.519 \ln GDPRD} + \underset{(4.108)}{0.519 \ln KR_{t-1}} + \underset{(3.770)}{0.589 \ln MIRKR} - \underset{(0.942)}{0.002 \ln DCR}$$

Adjusted R^2 = 0.834 S.E.R. = 0.157 D.W. = 1.742

where GDIR is gross domestic investment, GDPRD the change in GDP (accelerator variable), KR the stock of capital, MIRK the import of raw materials, intermediate and capital goods and DCR the level of domestic credit.

The coefficient on domestic credit is wrongly signed in addition to being insignificant. In other words, this estimate implies that domestic credit did not contribute anything to the explanatory power of the equation. As a test, domestic credit is dropped and the equation is re-estimated, yielding

$$\text{(11.S4)} \quad \ln GDIR = \underset{(2.239)}{1.166} + \underset{(2.679)}{1.542 \ln GDPRD} + \underset{(2.14)}{0.820 \ln KR_{t-1}} + \underset{(5.264)}{0.670 \ln MIRKR}$$

Adjusted R^2 = 0.845 S.E.R. = 0.153 D.W. = 1.723

This equation performed slightly better than estimate (11.S3). From a theoretical standpoint, this is a puzzling result—that domestic credit is not important to domestic investment. It will be recalled from Part 1 that during the 1980s the Guyanese economy found itself immersed in excess liquidity, which resulted from the widening fiscal deficit (which was being increasingly monetized) and the deliberate policy by the government to stifle the growth of the private sector. One direct result of the existence of excess liquidity is a worsening of the balance of payments deficits, via open economy macroeconomics, which feeds back to output and hence investment.[5] Given this situation, the amount of domestic credit per unit of investment (DCRGDI) seems to be a more appropriate variable. DCRGDI, created by dividing total domestic credit by gross domestic investment, can be expected to carry a negative sign since there was no motive force to drive investment toward expansion. The new credit variable is correctly signed and significant, and the equation as a whole performs better than (11.S4).

$$
\begin{array}{llllll}
(11.S5) & \ln GDIR = & 0.228 & + & 1.136 \ln GDPRD + & 0.517 \ln KR_{t-1} \\
 & & (0.393) & & (2.099) & (3.054) \\
 & + & 0.281 \ln MIRK - & & 0.280 \ln DCRGDI & \\
 & & (5.403) & & (2.755) &
\end{array}
$$

$$\text{Adjusted } R^2 = 0.873 \qquad S.E.R. = 0.139 \qquad D.W. = 1.700$$

Even though Guyana is heavily dependent upon imported investment inputs, as the various estimates above show, this cannot be taken *a priori* as evidence that investment is not responsive to prices. To test this, relative prices, defined as import price index\domestic price level ($RLTVP_{im}$),[6] is added to the equation and new estimates are obtained (table 19). Indeed, relative prices can be seen to exert a severe dampening effect on domestic investment with the latter contracting by 0.7 per cent when relative import prices increase by 1 per cent. But the biggest boost to current investment comes from an accelerator effect and the capital stock in the previous period. Jarvis (1990), it will be recalled, found no evidence of an accelerator effect, while Ganga (1990), on the other hand, found that only aggregate demand is of any significance to an explanation of investment.

5 It will be quickly recognized that the monetary model is at work here. For a good discussion of open economy macroeconomics, including the monetary model, see Copeland (1989) or Rivera-Batiz and Rivera-Batiz (1985).

6 Actually, this is a crude approximation of the real exchange rate, if the import price index is interpreted as foreign prices.

Table 19. Final Estimate for Gross Domestic Investment

Variable	Coefficient	t-statistics
CONSTANT	- 0.622	0.688
ACCELERATOR TERM (GDPRD)	0.896	2.051
LAGGED CAPITAL STOCK (KR_{t-1})	0.922	4.486
IMPORT OF INT. AND CAPITAL GOODS (MIRKR)	0.503	2.616
CREDIT PER UNIT OF INVESTMENT (DCRGDI)	- 0.476	4.109
RELATIVE PRICES ($RLTVP_{im}$)	- 0.687	3.326
AR(1)	0.377	2.288

Adjusted R^2 = 0.903 S.E.R. = 0.115 D.W. = 2.148

B-G $\chi^2(2)$ = 0.452 Engle's ARCH $\chi^2(4)$ = 4.124

The evaluation statistics show that there is no problem with the estimate. We can therefore state, in econometric terms, the investment equation as:

$$(11.4)\quad \ln GDIR = \lambda_{15} + \lambda_{16} \ln GDPRD + \lambda_{17} \ln MIRKR + \lambda_{18} \ln DCRGDI + \lambda_{19} \ln KR_{t-1} + \lambda_{20} \ln RLTVP_{im}$$

where λ_{16}, λ_{17} and $\lambda_{19} > 0$ and λ_{18} and $\lambda_{20} < 0$

Equation (11.4) deviates from the usual specification of the investment equation in the region in that it includes as arguments capital stock, relative prices and credit per unit of investment.

CHAPTER 12

The Government Sector

Approaches to Modelling the Government Sector

A study of the literature on developing countries, including the Caricom region, will indicate that no standard approach to modelling the government sector exists. The early history of macroeconometric modelling in these countries shows a tendency to treat the government sector in an exogenous manner with respect to the overall system, a direct result of the Keynesian framework. With the growing involvement of the government in the domestic economy, the preferred approach has been to develop structural equations for total government revenue, disaggregated according to source, and/or some component of its expenditure, usually capital.

Carter (1970) assumed that government consumption is exogenous, while "income from government enterprises" is explained by GDP, producing an estimated parameter of 0.0029. In other words, the level of economic activity, as gauged by GDP, is not an important source of revenue to public enterprises, at least in the short-run. Manhertz (1971), on the other hand, argued that it is essential to de-emphasize the short-run link between government revenues and expenditures in order to understand the long-run role of the government in the economy. This is particularly true in the Jamaican economy where the involvement of the government has been growing. Working on this insight, he developed separate equations for consumption expenditures by central government and local government; and central government capital formation and revenue according to source: indirect business taxes, taxes on corporate profits and personal income taxes. Each tax function has only one dependent variable.

In their model designed to analyze stabilization questions in small open economies, Worrell and Holder (1987) take total government expenditure as an exogenous policy variable. But there are two stochastic equations for the government sector. The first makes revenue dependent on income while the second models government borrowing requirements, or the deficit, defined as the difference between expenditure and revenue. Financing is obtained from banks as a function of the differential between banks' earning on credit to the private sector and to the government, and the size of the government borrowing requirements. The Central Bank always finances the difference between government credit needs and financing made available by the banks. The authors conclude from the estimate of this equation that in the case of Jamaica and Trinidad and Tobago governments were forced to depend on the monetary authority for an increasing share of funding as the need for financing arose but yet the "government was unable to crowd out the private sector in the competition for funds" (p. 243). However, the estimates do not provide strong support for this conclusion. In the case of Jamaica, both variables have the wrong a priori sign; for Trinidad and Tobago the variable for the size of government borrowing requirements is wrongly signed.

Jarvis (1990) reasoned that, in general terms, government spending is a function of its capacity to generate revenues (via taxation and domestic borrowing) and the balance of payments. In countries such as Guyana the BOP is important because it "... indirectly affects level of government spending by making more foreign exchange available to buy imports" (p. 19). Consequently, the inclusion of the BOP as an argument in the expenditure function is justified on the grounds of the heavy dependency of the economy on imports and exports: rising exports leads to rising revenues, permitting a higher level of imports. However, Jarvis points out that such increases do not constitute an increase in the internal capacity of the government to generate revenues; rather, they serve to soften the balance-of-payments constraint and thus allow the government to increase temporarily its imports. It is in this way - via shocks - that the balance-of-payments indirectly affects government spending on consumption.

Despite the foregoing argument, the BOP turned out to be an insignificant variable in the equation for central government consumption expenditure. Dropping this variable and re-estimating the equation yielded a coefficient of 0.53 on the revenue variable.

Following Manhertz (1971),[1] Jarvis developed separate revenue functions for personal tax payments, tax liability on corporate profits and indirect business tax; these equations are regressed, respectively, on personal income, the level of corporate profits and the level of GNP. All variables are significant but it is clear that changes in personal incomes and GNP produce relatively small changes to revenue (the coefficients on these variables are 0.11 and 0.13 respectively). In view of this, it is reasonable to infer form the equation that the major share of government's revenue was derived from taxes on company profits; i.e., the government sector can only expand at the expense of the private sector..

For Bourne (1989) government consumption expenditures are a positive function of government financial resources defined as the sum of fiscal revenues, domestic credit and foreign capital inflows to the government sector.[2] Table 20 shows the estimate of this function for Barbados, Guyana, Jamaica and Trinidad and Tobago.

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1 Manhertz (1971) was the first in the Caricom region to specify separate equations for the various components of government revenue.

2 As noted previously, Bourne (1989) is a comprehensive study that tested several hypotheses. The only category of government expenditure/revenue tested was consumption expenditure. As a result there was no need to make any specific assumption about other categories of government expenditure or about revenues.

Table 20. Bourne's (1989) Estimate of the Government Consumption Function

Regressors	Barbados 1967-82	Guyana 1966-82	Jamaica 1964-82	Trinidad and Tobago 1966-82
Constant	1.56	2.12[a]	4.30[a]	8.33[a]
RGR	0.61[b]	0.53[a]	0.33[c]	-0.09[c]
Adj. R^2	0.49	0.95	0.91	0.68
D.W.	1.90	1.83	2.00	1.90

Source: Bourne (1989), p. 276

Note: The consumption function is in log-linear form. RGR is real government financial resources; a = significant at the 1 per cent level; b = significant at the 5 per cent level; and c = significant at the 10 per cent level.

According to Bourne, "[T]he negative sign in the Trinidad and Tobago result is attributable to the massive windfall petroleum revenues which, although beyond the immediate absorptive capacity of the government, ultimately shifted expenditures to higher levels that were extremely slow to adjust downwards when real financial resources contracted" (p. 277). For the three other countries, it is clear that government financial resources are an important determinant of consumption.

Ganga (1990) departs from the traditional approach of developing separate equations for government expenditures and revenues. Rather, he develops an equation for the "fiscal sector" (p.9). To do this, government spending is set equal to treasury financing requirements plus total taxes, thus establishing an explicit government budget constraint. Next, treasury financing requirements are made to depend on inflation in the previous period, planned fiscal deficit, the discretionary stance of fiscal policy proxied by ΔGDP and a dummy variable to take account of abnormal government transfers to non-financial public corporations. All variables are significant in the estimated equation, except ΔGDP. Based on the results obtained, Ganga observes that (a) government revenues lagged behind expenditures in the face of rising prices, as can be seen from the coefficient on the inflation variable (5.50); (b) the coefficient (1.28) on planned deficit indicates that the government had control over the level of TFR, although the existence of a rapidly rising fiscal deficit does not support this conclusion (Chapter 5); and (c) the dummy variable (coefficient 0.54) suggests that government transfers is positively related to variations in TFR.

Assuming that government's capital expenditure is exogenously determined, Hilaire *et al* (1990) made current expenditure a function of current revenue, which is seen as a budget constraint on spending, and a one period lag of the dependent variable. Both variables are significant and the estimate shows that "about 70 per cent of current expenditure is carried forward as a commitment in the following year" (p.121); the revenue variable produces an impact of 0.30.

For the purposes of the model, revenues have been disaggregated by source. Revenue from oil is dependent on the value of oil exports, which has a coefficient greater than unity (1.04) because crude oil exports are used in the equation rather than oil production (p. 117). Import duties are explained by the value of total imports, producing a coefficient of 0.07, suggesting that the average rate of duty on imports is about 7 per cent. The authors note that the small size of the coefficient is due to (a) duty-free imports for a significant proportion of capital and intermediate goods; and (b) the fact that the independent variable includes import services which do not carry duties. Personal income taxes and other revenues are both functions of non-oil GDP. The estimate of this highly significant variable yields a coefficient of 0.11 in each equation.

Finally, Bourne and Nicholls (1990) have a single behavioral equation for government revenue, with total export receipts as the only argument. The justification is that much of the export receipts in Trinidad and Tobago accrue directly to the government because of its ownership of the petroleum and sugar facilities. The estimated coefficient (1.03), according to the authors, supports this formulation; the equation explains 77 per cent of the variation in government revenue, but the D.W., even after correcting for first order serial correlation, is low

(1.4). On the other hand, for Barbados the dependent variable is income, with an estimated parameter of 0.27; the adjusted R^2 is high (0.98) and serial correlation does not seem to be present.

Specification and Estimation of the Equations for the Government Sector

The strategy adopted here departs from those discussed above. Its basic premise is that the government has become too potent a force in the economy for any component of its activity to be ignored in any modelling effort: at least up to the end of the sample period, the government sector accounted for 80 per cent of the economy. My approach has two advantages:[3] (a) it employs a partial adjustment framework which quickly gives an idea of short-term and long-run impacts; and (b) it allows the direct testing of certain hypotheses about the long-run relationship between total government income and expenditure, which was not possible within the framework employed by previous researchers.

To reflect the overwhelming importance of the government in the Guyanese economy, behavioral equations will be developed for total expenditure and total revenue. The approach is based on that of Aghevli and Khan (1978), who argued that real government expenditure adjusts proportionally to the difference between the authorities' target spending and the actual level of expenditure in the previous period,

(12.1) $\ln[GCTXR_t - GCTXR_{t-1}] \quad = \quad \lambda_{24} [\ln CGTXR^*_t \ - \ \ln CGTXR_{t-1}]$

[3] This approach is certainly not new to the Caricom region. For an early application, see Sackey (1980) who attempted to establish relationships between "underdevelopment disequilibrium" and growth in government expenditures. However, my research efforts indicate that this is the only application of the approach in the region.

Outside of the Caricom region, this approach has been employed by several authors. See, for example, Aghevli and Khan (1978), Heller (1980), Khan and Knight (1982, 1991) and Otani and Sassanpour (1991).

where CGTXR and CGTXR* are the actual and desired levels of real government expenditure, respectively, and λ_{24} is the coefficient of adjustment, $0 \leq \lambda_{24} \leq 1$. The desired level of expenditure is simply related to the level of real income and the fiscal deficit (CGDFR),

$$(12.2) \quad \ln CGTXR^*_t = \lambda_{21} + \lambda_{22} \ln GDPR + \lambda_{23} \ln CGDFR$$

Substituting equation (12.2) into equation (12.1) and solving for the (logarithmic) level of government expenditure, one obtains

$$(12.3) \quad \ln CGTXR = \lambda_{24}\lambda_{21} + \lambda_{24}\lambda_{22} \ln GDPR + \lambda_{24}\lambda_{23} \ln CGDFR + (1 - \lambda_{24}) \ln GCTXR_{t-1}$$

To account for the expansionary impact of the sugar boom upon government expenditures during 1974-76, a dummy variable (DUGVTX) is added to (12.3), resulting in a final estimating equation of:

$$(12.4) \quad \ln CGTXR = \lambda_{24}\lambda_{21} + \lambda_{24}\lambda_{22} \ln GDPR + \lambda_{24}\lambda_{23} \ln CGDFR + (1 - \lambda_{24}) \ln GCTXR_{t-1} + \lambda_{26} DUGVTX$$

where $\lambda_{24}\lambda_{22} > 0$, $\lambda_{24}\lambda_{23} < 0$ and $\lambda_{26} > 0$.

It is perhaps reasonable to assume that in the long-run the government would like to increase its expenditure in line with the growth of nominal income. A priori, therefore, one would expect that the income elasticity, λ_{22}, would be equal to or close to unity. It is also easy to see from this equation that the mean or average lag in the adjustment of real government expenditures is defined as $(1 - \lambda_{24})/\lambda_{24}$.

As with expenditure, government revenues (CGTRR) adjust to the difference between planned revenues (CGTRR*) and the actual revenues obtained in the previous period,

$$(12.5) \quad \ln[GCTRR_t - GCTRR_{t-1}] = \lambda_{28} [\ln CGTRR^*_t - \ln CGTRR_{t-1}]$$

Desired revenues are specified as a function of income:

$$(12.6)\ \ln CGTRR^*_t = \lambda_{26} + \lambda_{27} \ln GDPR$$

Substituting from this equation for CGTRR* in equation (12.5) and adding a dummy variable (DUGVTR) for the 1974-76 expansion in expenditures as a result of the sugar boom gives:

$$(12.7)\ \ln CGTRR = \lambda_{28}\lambda_{26} + \lambda_{28}\lambda_{27} \ln GDPR + (1 - \lambda_{28}) \ln GCTRR_{t-1} + \lambda_{28}\, DUGVTR$$

If government expenditure and revenues both grow at the same rate as nominal income in the long-run, then this would imply that $\lambda_{24} = \lambda_{28} = 1$. Starting from an equilibrium position, this would ensure a balanced budget in the steady state. In the short run, however, even with the condition being satisfied that the income elasticities equal unity, one could observe a divergence between expenditures and revenues if the former adjusts faster. That is, the nominal deficit will be a function of the increase in the price level, provided that $\lambda_{28} < \lambda_{24}$, even though λ_{22} equals λ_{27}.

The fundamental hypothesis underlying equations (12.4) and (12.7), to be tested shortly, is that expenditure tends to adjusts to its desired level more rapidly than revenue, or that $\lambda_{24} > \lambda_{28}$. There are plausible reasons for expecting that government expenditures adjust faster than its revenues to income. In the case of Guyana, the principal reasons stem from the rapid growth of the public sector since the early 1970s and the paramountcy principle of the PNC. The paramountcy principle[4] to a large extent meant that the government found it extremely difficult to cut expenditures in real terms in the face of a growing deficit as employment was in actual fact a reward for party loyalty. Other reasons for the growing divergence include the eroding tax base as the informal sector rapidly expanded and became firmly entrenched in the early 1980s, low nominal income elasticities of the tax system and long lags in tax collection

[4] The "paramountcy principle" was based on "...the claim that the ruling party, the PNC, stood over all other parties and over the state itself" (Thomas, 1988: 253).

in the face of rising inflation.

The estimates of equations (12.4) and (12.7) are shown in table 21 with the value of the estimated coefficients in composite form (i.e., having applied the adjustment parameter to the coefficients) and the associated t-statistics. The coefficient of determination, the standard error of the estimated equation, the Breusch-Godfrey and Engle's ARCH statistics are also shown. Table 22, on the other hand, shows the values of the individual parameters, which include the value of the adjustment coefficients and the equilibrium, or long-run, values of the relevant elasticities.

Several interesting observations can be made from the estimates in these tables. First, does the result support the basic Aghevli-Khan hypothesis that expenditure tends to adjust to its desired level more rapidly than revenue, $\lambda_{24} > \lambda_{28}$? Before we examine this issue, it is necessary to note that both the CPI and the GDP deflators have been used in the literature and the result can be different depending upon which deflator was used. In fact, Heller (1980) found a larger adjustment coefficient, and hence a shorter adjustment period, *when the GDP deflator is used.* Intuitively, this may be explained by the fact the GDP deflator is a broader measure of inflation than the CPI. That this is not true in the case of Guyana has much to do with the quality of the data.

The Guyanese data support this hypothesis that $\lambda_{24} > \lambda_{28}$ if either the CPI or the GDP deflator is used. With the CPI as the deflator, the mean lag in the adjustment of government expenditures is 1.421 years, while it is 1.762 years in the case of the GDP deflator. In other words, it takes under two years for actual expenditure to adjust to desired expenditure. For revenue, the mean lag adjustment period is longer - 2.322 years. The relatively long period over which revenues adjust is apparently indicative of the difficulties in revenue collection as pointed out earlier. This established empirical fact, that expenditure adjusts faster than revenue ($\lambda_{24} > \lambda_{28}$), implies a widening fiscal deficit as a percentage of GDP and this is bourne out by the data as we have seen in Chapter 5.

Table 21. Government Finances: Short-run Estimates

Variable	Composite Coefficient	t-statistics
Equation (12.4) - Dependent Variable is Real Government Expenditure (CGTXR)		
(a) CPI deflator (preferred estimate)		
CONSTANT	- 1.428	-2.481
REAL INCOME	0.386	3.873
GOVT. DEFICIT	- 0.235	-4.775
DUMMY FOR SUDDEN INCREASE IN EXP	0.352	5.779
LAGGED DEP. VARIABLE	0.587	3.806

Adjusted R^2 = 0.9714 S.E.R. = 0.085 B-G $\chi(2)$ = 3.438
Engle's ARCH $\chi(4)$ = 7.069

(b) GDP deflator		
CONSTANT	- 1.131	-2.408
REAL INCOME	0.326	4.511
GOVT. DEFICIT	- 0.370	-6.601
DUMMY FOR SUDDEN INCREASE IN EXP	0.212	2.943
LAGGED DEP. VARIABLE	0.638	3.994

Adjusted R^2 = 0.974 S.E.R. = 0.104 B-G $\chi^2(2)$ = 4.053
Engle's ARCH $\chi^2(4)$ = 6.305

Equation(12.7) - Dependent Variable is Real Government Revenue (CGTRR)		
CONSTANT	- 0.829	1.530
NOMINAL INCOME	0.283	2.997
DUMMY FOR SUDDEN INCREASE IN REV	0.465	6.905
LAGGED DEP. VARIABLE	0.698	2.407
MA(1)	- 0.231	2.933

Adjusted R^2 = 0.938 S.E.R. = 0.083 B-G $\chi^2(2)$ = - 4.426
Engle's ARCH $\chi^2(4)$ = 5.830

Table 22. Government Finances: Long-run Estimates

Parameter	Value of Parameter
(a) Government expenditure - CPI deflator (preferred estimate)	
λ_{21} (constant)	- 3.458
λ_{22} (income)	0.935
λ_{23} (deficit)	- 0.568
λ_{24} (adjustment)	0.412
λ_{25} (dummy)	0.352
(b) Government expenditure - GDP deflator	
λ_{21} (constant)	- 3.123
λ_{22} (income)	0.900
λ_{23} (deficit)	- 1.022
λ_{24} (adjustment)	0.362
λ_{25} (dummy)	0.212
(b) Government revenue	
λ_{26} (constant)	- 2.744
λ_{27} (income)	0.940
λ_{28} (adjustment)	0.302
λ_{29} (dummy)	0.465
Ma(1)	- 0.764

Second, the value of the adjustment parameters, λ_{24} and λ_{28}, are below unity (table 21), as many previous studies have found. However, the value of these parameters in Guyana's case is much lower than the "norm". Heller (1980), studying 24 countries in South America, Central America, the Caribbean, Asia and Africa, found that "the median expenditure [adjustment] coefficient is approximately 0.8 in the estimations using the GDP deflator and slightly below 0.7 in the estimation using the CPI. The median revenue coefficient is slightly lower" (p.732). But this summary does not convey a full picture of Heller's table 3. In fact, eight (seven if the GDP deflator is used) of the 24 countries in this table have expenditure adjustment coefficients of less than 0.5, while 5 have revenue adjustment coefficients below this figure.

Aghevli and Khan (1978), working with data on Brazil, Colombia, Dominican Republic and Thailand and using the CPI as the deflator, found the expenditure adjustment for all countries to be greater than 0.9, while the revenue adjustment coefficient varied between 0.63 and 0.86. In his study of the growth of government expenditures in a number of Caribbean countries, Sackey (1980) obtained an expenditure and revenue adjustment coefficient of 0.395 and 0.521, respectively, for Guyana (sample period is 1955-77). This meant that the average adjustment time is 0.92 and 1.53 years for expenditure and revenue, respectively. Our estimates indicates a faster rate of adjustment for expenditure and slower rate of adjustment for revenues. Sackey's table 7 also shows that 42 per cent of the 12 countries studied have estimates of both adjustment coefficients of less than 0.5. The difference between Sackey's and the findings of this study may be due to the fact that inflation accelerated considerably in the 1980s. This thus lends support to the general notion that there is an increase in the rate of adjustment of expenditure and a corresponding decrease in adjustment for revenues as the rate of inflation stabilizes at a higher level.

From the foregoing discussion it is probably reasonable to observe that these adjustment coefficients have no universally predetermined value, a value that holds good for all countries. It would seem that the value taken on by these coefficients depends on several factors, which may or may not be country-specific. These include the structure of the taxation system, lags in tax collection, the evolution of the fiscal deficit, the ease with which governments can override established procedures as regards its revenue and expenditures, and the rate of inflation.

The effect of income on government expenditures and revenues is positive and significant. In the short-run (table 21) income has a greater impact on government expenditure than revenue: a one per cent increase in real income drives up government expenditure (real) and revenue by 0.4 and 0.3 per cent respectively. In both cases the long-run income elasticities are not significantly different from unity (table 22), implying that both expenditures and revenues would move proportionately with inflation. Given the size of the government and the growing fiscal deficit, it was expected that the demand coefficient for expenditure, λ_{22}, would be significantly greater than unity, reflecting the overall share of real government in the economy.

Does the fiscal deficit affect government expenditure? The estimate suggests (table 21) that in the short-run a one per cent increase in the deficit depresses expenditure by 0.2 per cent, *ceteris paribus*. However, in the long-term the deficit carries much more weight: it is more than twice the magnitude of the short-run impact (table 22).

Finally, the coefficients on the dummy variable for both equations have the expected sign and are significant. The fleeting sugar boom raised both government expenditures and revenues by an average of 0.36 (in the case of the CPI deflator) and 0.47 per cent respectively. In relative terms, therefore, the sugar boom had a larger impact on revenue, but this is not true in absolute terms as an examination of the data would indicate.

CHAPTER 13

The Monetary Sector

Empirical studies of the demand function for money in developing economies have frequently employed the same functional specification as those in developed economies (Coats and Khatkhate, 1980), with appropriate adjustments for peculiar institutional features or data limitations. This observation also holds true for the Caribbean (McIntyre, 1986), where the early work on money demand was focussed on studying the relative applicability of the Keynesian and the quantity theory formulations of the demand function for money. A review of the literature would indicate that macroeconometric modelling in the Caricom region either omitted any behavioral equation for the monetary sector; modelled components of the monetary sector; or modelled only the aggregate stock of money demand.[1] In what follows, the term "not modelled" means the absence of any behavioral equation.

Monetary Sector not Modelled

This approach is taken by researchers such as Carter (1970), Persaud (1979), St. Cyr (1981), Jarvis (1990), Bourne and Nicholls (1990) and Ganga (1990). Both Ganga (1990) and St Cyr (1981) took account of the monetary sector only in terms of a money supply identity,

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[1] The demand for money and inflation are the two most heavily researched areas in the Caricom region. This fact essentially accounts for the length of the review in this and Chapter 15.

defined as the balance of payments plus net domestic credit. It seems that the absence of a monetary sector, or components of it, in these models could be put down to a lack of data, their theoretical structure or their focus.[2]

Components of Monetary Sector Modelled

The second approach is exemplified by writers such as Manhertz (1971), Hilaire *et all* (1990) and Worrell and Holder (1987). Manhertz includes behavioral equations for demand deposits, time deposits and currency holdings, all of which contain income (nominal) or some variant of it as a prime explanatory factor, with estimates ranging from 0.06 to 0.58. His interest rate function for commercial bank loans contains the Central Bank discount rate and the reciprocal of income velocity index as arguments but there is certainly some problems with this equation as the D.W. statistic is 3.39. Manhertz, nevertheless, notes that the coefficient of -12.22 on the reciprocal of income velocity, while quite high, "... suggests that there is a significant interlocking relationship directly involving money supply, the level of economic activity, and the market rate of interest" (p. 214). He rightly concluded that further research on the monetary sector of the Jamaican economy was needed.

The monetary sector of the forecasting model of the Trinidad-Tobago economy by Hilaire *et al* (1990) comprises three equations and two definitions. In equations (11) and (12) the levels of net domestic assets and net foreign assets are explained by the government budget and current account balance, respectively, as well as by the lagged dependent variables themselves. The demand for money (it is not clear whether it is narrow or broad money) is simply a function of GDP. No assumption of money market equilibrium is made, nor does

2 Khayum (1991), while including a function for the demand for real money balance, did not estimate it since he reduced his basic system to three equations, an aggregate demand equation, an aggregate supply equation and a balance of payments equation.

money enter into any other equations in the model. According to the authors "[T]he model treats the monetary sector as capturing the influences of the various sectors but not affecting them, except for prices" (p. 112).

All variables in the equations came out with ".. coefficients corresponding to a priori expectations" (p.121). In the case of the net domestic assets equation, the government budget and the lagged dependent variable are both highly significant, with estimated parameters of -1.006 and 1.108, respectively. The basic message is that deficit financing is largely done through deposits withdrawals. For the net foreign asset equation, the results suggest that nearly all the current account surplus or deficit (coefficient: 1.095) is reflected in a change in the Central Bank's net foreign assets. The one period lag of the dependent variable has a coefficient of 1.058, suggesting a unitary relation between current net foreign assets and net foreign assets in the previous period. According to the money demand equation, GDP, with a coefficient of 0.356, explains 0.98 per cent of the variations in the dependent variable, suggesting the possible existence of a less than proportional relationship between money and income. However, the very low D.W. (0.82), even after allowing for an AR(1) term, makes the result of this equation suspect.

Perhaps the most comprehensive and systematic model of the monetary sector according to the second approach could be found in Worrell and Holder (1987), comprising 7 equations of which 2 are definitional (excess reserves and commercial bank reserves). The 5 behavioral equations are: the demand for credit by the private sector, the loan rate of interest, changes in bank deposits, the deposit rate of interest, and central bank advances to banks. The feed back loops in the monetary sector are quite complex, involving both endogenous and exogenous variables.

In general, this detailed modelling of the monetary sector did not find strong support from the data for the three countries studied. According to the estimates (Worrell and Holder, 1987:239-242) in all countries, but especially Trinidad and Tobago, the level of national income is an important determinant of credit to the private sector. In Barbados and Trinidad and Tobago rising interest rates choke off the demand for credit by the private sector, a typical Keynesian result. Paradoxically, however, there seems to be a direct relation between the interest rate and the demand for credit in Jamaica. Particularly in the case of Trinidad and Tobago, the estimate should be interpreted with caution as the D.W. statistic is very low (0.63) even after correction for first order serial correlation.

The foreign interest rate is postulated to affect directly the domestic loan rate but the data do not support a relationship in any of the three countries. Presumably this is because domestic firms are not able to tap alternative financial sources abroad, while banks have funded loans in the main, the authors note. The discount rate helped to determine the loan rate in Barbados; in Jamaica the relationship is very weak. In Trinidad and Tobago, there was no central bank advances to commercial banks in the sample period.

Bank deposits increase with rising incomes in all three countries and very rapidly in Jamaica and Trinidad and Tobago. Only in the case of the latter country is the differential between domestic and foreign interest rates significant, but the relation is an inverse one, the opposite of what is expected. In the main, therefore, it is the level of national income which seems to determine changes in bank deposits.

The foreign interest rate is an important factor in the determination of the deposit rate in Barbados and Trinidad and Tobago; it is insignificant in Jamaica. Only in Trinidad and Tobago do excess reserves have any influence on deposit interest rate. Even then the relationship is weak and its causal direction is contrary to what is expected on theoretical grounds.

The estimates for central bank advances to banks are unsatisfactory for Barbados and Jamaica. In Trinidad and Tobago there were no central bank advances in the sample period.

Modelling the Aggregate Demand for Money

The third approach to the study of the demand for money - i.e., modelling only the aggregate stock of money - has been mostly done outside the context of macroeconometric models. However, one recent model that did make provision for the aggregate stock of money is that by St. Cyr and Charles (1992). Basically, this model is a modification of the ILPES, a Keynesian demand-driven, model to take account of the structural features of the Trinidad and Tobago economy. The demand for nominal money (it is unclear whether the monetary measure is narrow/broad or nominal/real; presumably it is nominal since prices appear on the right-hand side of the equation) is a function of GDP and domestic prices (it is not known how prices were measured). In this model, money, through its impact on GDP and prices, influences supply, demand, the public sector, employment, wages and prices itself. Indeed, this is one of the first macroeconomic models in the region in which money is so closely woven into the fabric of the overall model.

The supply of money is specified in elaborate terms in the model: 5 equations, 3 of which are behavioral. First, as in the open economy model, the change in money supply is seen to depend on the change in international reserves and internal central bank credit. In turn, the change in reserves is the sum of the movements on the current and capital accounts of the balance of payments. The capital account is a function of the current account. Finally, real credit to the private sector is also dependent on the local currency value of the capital account in real terms. The money supply block works its way into the overall model through its impact on money demand and also directly on supply and demand through its influence on credit.

The estimated equation should be interpreted with some degree of caution, given a D.W. of 1.55 even after an AR(1) term has been added. The coefficient on GDP is 0.80 and highly significant, meaning that GDP is an important variable in the demand for money. The price variable, with a coefficient of 0.39, is not significant at the 5 per cent level. This means that the evidence on the price homogeneity postulate is inconclusive.

One of the earliest estimates of the demand for money (outside the context of a macroeconometric model) is that of Bourne (1974b) for the Jamaican economy.[3] Using quarterly data for the period 1962-71, Bourne estimated both narrow and broad demand for money functions. The regressors include the weighted average of the interest rate on time and saving deposits at commercial banks, the expected rate of inflation, and expected GNP as the transactions variable. He argues that his use of the linear specification is due to the fact that observations on the interest rate and inflation variable include negative values. In cases such as this it is not unusual to utilize semi-elasticities on variables with negative values.

Bourne employed adaptive expectations[4] to arrive at values for his two unobservable variables. Eventually, the equation tested (C.5) is rather complicated, comprising two or three lags on each explanatory variable, including three on the dependent variable. His equation is thus difficult to interpret and the estimates will not be discussed here. Like Coppin (1991) we merely note his conclusion:

> The application of the model is aggregated, single-equation form to quarterly data for Jamaica has yielded results suggestive of a relatively unimportant role for interest rates and price inflation, and an important role for incomes in the analysis of the demand for money in the Caribbean. Nonetheless, such findings are tentative, if only because of the demonstrated sensitivity of the regression results to the specification of the empirical model. (Bourne ,1974b: 442)

St. Cyr (1979) found that in Trinidad and Tobago the rate of interest exerted a negative, although small, influence on both narrow and broad money, while nominal income positively and significantly (but less that unity) impacted on the demand for money.

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[3] The discussion of Bourne's 1974 article draws upon the work of Coppin (1991).

[4] Coppin (1991) rightly observed that Bourne mistakenly refers to this as Muth's rational expectations hypothesis.

The only empirical study of the demand for money in Guyana that I am aware of is that of Michael Howard (1980), who estimated several regressions for the demand for narrow and broad money, currency in the hands of the public, demand deposits and saving deposits for the period 1960-77. Howard's study is premised on the assumption that "... the demand for money [in Guyana] is not homogeneous in the price level" (p. 70). This assumption was not subjected to any empirical test. Rather, it was justified on the grounds that the author found it to be true for Barbados and, according to Worrell (1982), on weak theoretical arguments. All variables are in nominal terms and the log-linear specification was employed for all equations. Very low D.W. statistics were obtained for all estimates, probably indicative of model misspecification, especially in those models based on market equilibrium, lower than those utilizing the partial adjustment framework - even with the application of the Cochrane-Orcutt iterative procedure to correct for first order serial correlation in the residuals.

With respect to the market equilibrium equations, Howard's best equations - equations (10) and (11) - produced an income elasticity of 1.339 for narrow money and 0.729 for broad money. A large coefficient on the income variable, according to Howard, is not to be unexpected in countries with underdeveloped money and capital markets, a feature of Caribbean economies. The interest rate variable is insignificant, which was traced to "... relatively few near-money substitutes" (p. 72). Actually, the rate of interest in Guyana was administered and remained unchanged for most of the study period (1960-77). In such cases it is difficult to discern any econometric impact (Khan and Knight, 1991). Howard's conclusion that "... income explains more of the variation in M_2 than in M_1" (p. 72) should be regarded as no more than very tentative, given the very low D.W. for both models (1.3 and 1.1 for equations (10) and (11) respectively), even after correcting for serial correlation .

Howard also estimated partial adjustment equations for narrow and broad money, the results of which are shown below. Clearly, a proportional relationship between nominal income and money is not supported by the partial adjustment models for either concept of money.

$$(13.S1)\quad \log M_{1t} = -2.158 + \underset{(4.830)}{0.748 \log Y_t} - \underset{(-1.080)}{0.142 \log r_t} + \underset{(3.338)}{0.477 \log M_{1(t-1)}}$$
$$R^2 = 0.96 \quad h = 0.005$$

$$(13.S2)\quad \log M_{2t} = -1.543 + \underset{(4.681)}{0.559 \log Y_t} + \underset{(6.299)}{0.626 \log M_{2(t-1)}}$$
$$R^2 = 0.99 \quad h = 0.149$$

On the basis of the significance of the adjustment terms for both M1 and M2, Howard concludes that "[T]his result tells us that habit and expectations play some role in demand for money in Guyana especially in the case of currency and saving deposits" (pg. 74-75). Indeed, the role accorded to "habit and expectations" must be important since in the case of (3.S1) actual money balances adjust to desired balances in little over one year. In the case of broad money, the adjustment is completed in 0.6 years.

Howard drew one principal policy implication from his study, which is that, given the insignificance of the interest rate variable in the demand function for money, interest rate policy may not be effective in mobilizing savings in Guyana.

Commenting on Howard (1980), Worrell (1982) was concerned about the rejection of the homogeneity postulate, noting that this postulate "... is almost sacrosanct in monetary economics." It "... simply enshrines the economist's assumption that transactors are rational" (p. 77). Worrell justifiably rejected Howard's argument that the homogeneity assumption does not hold for Guyana since it does not hold for Barbados. As to Howard's theoretical argument,[6] Worrell pointed out the former's interpretation differs considerably from those of other writers. More importantly, Worrell argues that, based on the established statistical relationship between the nominal money stock and income (Friedman and his followers hold that the causation is from money to income), Howard's demand for money function may be misspecified - it may be an inverse multiplier model or a money supply function.

[6] Based on White (1978)

Responding, Howard (1982) asserts that "... theory is not inviolable and in empirical work one can depart from accepted theoretical postulates" (p. 79). But not without good reasons, although Howard conceded that he should have tested for price level homogeneity in the Guyanese context. Howard took issue with the argument that the direction of causation is from money to income, arguing that this view is due to Worrell's "... immersion in conventional theory" (p. 80). The notion of causation from money to income, Howard argues, is based on the assumption that the nominal money stock is an exogenous variable. He contends that in an open economy both the nominal money stock and the monetary base are endogenous variables. Hence the causation is from nominal income to nominal money. Therefore, it is quite legitimate to use nominal money as the dependent variable in the demand for money function. McClean, as we shall see presently, is of the same view as Howard.

First, McClean (1981) argues that Bourne (1976) failed to address the theoretical issues relating to the money multiplier in small, open economies. Bourne commits the "cardinal error," McClean maintains, of imposing the logic of a closed economic system on a small, open economy. That is, Bourne erroneously assumed that the monetary base, and thus the money supply, is exogenous in a small, open economies such as Jamaica. This argument is also applicable to Bourne (1974).

Second, McClean (1982) argues that the practice of making the real stock of money the dependent variable rests on the twin assumptions that the (a) nominal stock of money is exogenous, and (b) nominal demand function is homogeneous of degree one in prices. McClean took issue with both of these assumptions, arguing that in a highly open economy such as Barbados the nominal stock of "money is an endogenous variable and can therefore be used legitimately as the dependent variable" (p.157). Further, he argues, the linear homogeneity postulate has not been rigorously established and that those models that restrict the price elasticity of the demand for money to unity are plagued by serial correlation. In the presence of a pronounced time trend, serial correlation could be explained by a price elasticity of the demand for money significantly different from unity, McClean notes. To support this argument, he points to the fact that conventional models have consistently overpredicted the money supply in the United States and in other countries during the mid and late 1970s. This suggests the possibility that the price elasticity of the demand for money is less than unity, observes McClean.

As a result of these considerations McClean constructs a function such as

$$(13.1) \qquad M^d = f(P, x, r)$$

in which the desired nominal stock of money (M^d) depends on the price level (P), a scale variable (x) and a vector of interest rates (r). This specification clearly allows the data to determine the price elasticity rather than constraining it to unity. The r vector expresses a direct functional relationship between the demand for money and the cost of liquidity. McClean argues that it is necessary to partition the interest rate vector into two: a vector of rates on liquid assets which can be held as an alternative to money, with an expected negative coefficient; and a vector of rates on non-monetary instruments used as medium of exchange, with the expected coefficient being positive.

With respect to the scale variable, McClean argues against the use of income (as measured by GDP) in a small open economy in which imports makes up a large share of total expenditure. He argued that "instability or secular drift in the ratio of imports to income could result in relatively low correlation between income and total money using transaction" (p.160). In view of this, McClean prefers to use an "augmented transaction proxy" (p. 160) comprising the sum of income and imports. As a check, regressions involving the income variable were also estimated.

Estimates (four) were implemented with both income and the "augmented transactions proxy." Equations employing the latter variable outperformed those employing income as an explanatory variable. For both specifications, very low price elasticities were obtained—less than 0.60 in all cases. Large coefficients for both transaction proxies, particularly in the case of income, and the interest rate variable were also obtained. Obvious questions arise, as noted by Coppin (1991): what is the significance of such low price elasticities and high transactions and interest rate elasticities? In particular, these results suggest a declining demand for real money balances even when prices are increasing. Moreover, with negative real interest rates, it is unreasonable to expect such high interest rate elasticities.

On the basis of his estimate, McClean's major conclusions are (a) a well-defined money demand function for Barbados exists; (b) the linear homogeneity postulate is not supported; and (c) confirmation of a second interest rate effect on the demand for money, namely the rate on illiquid assets. The first conclusion is highly questionable in light of the interpretation of the estimates. This is to say nothing of the fact that McClean did not perform any stability test. If anything, it can be said that McClean has not convincingly demonstrated the existence of a well-defined demand function for money for Barbados. Bourne (1974b), it will be recalled, also did not find any satisfactory evidence for such a function in the case of Jamaica.

In his "most extensive investigations" (p. 265) into the demand for money function in Jamaica, Worrell (1985) intended to do two things which he felt needed to be done: (a) to provide reasonable respectable estimates of the income and interest rate elasticities of the demand for money; and (b) to obtain "impressions of the stability of these estimates" during 1961-80. Worrell began by noting three things at the inception: the demand for money function should contain a scale variable such as wealth or permanent income and at least one opportunity cost variable; it should be a demand for real balances as there is little dispute that the demand for nominal money balances is homogeneous of degree one with respect to the general level of prices; and the empirical evidence suggests that the function should be log-linear.

In at least one respect, Worrell departs from previous studies of the demand for money in the region: he used permanent income as the scale variable. While the introduction of the lagged dependent variable into the equation is intended to capture the adjustment process, Worrell asks: does the adjustment refer to the desired stock of money or to the scale variable? Both adjustment processes cannot be captured by the lagged dependent variable. One of the variables must adjust instantaneously and the other dynamically. When annual data are used, as in the case of many developing economies, the estimates suggest that several years are required for the adjustment of actual to desired balances. Worrell felt that this was improbable. For these reasons, his study, using annual data, employs one lag and assumes instantaneous adjustment of the dependent variable but allows some degree of lag in the adjustment of income expectations. This, then, is the rationale for the use of permanent income in the demand for money equation.

For the opportunity cost variable, Worrell used the Treasury Bill rates. A number of other variables were experimented with, all of which turned in inferior performance. The result of the estimated equation "... appear to be reasonably comforting..." (p. 270) as all the coefficients have the expected signs and the magnitudes are reasonable; the adjusted R^2 is 0.93 and the D.W. is 2.21. The estimated coefficient on the permanent income term is 1.24 and highly significant. The conclusion, therefore, is that "... the demand for real balances elasticity with respect to real income over the first two decades of Jamaica's existence as a sovereign state was just over unity" (p.270). This is an empirical finding that policy makers can safely use, according to Worrell, as, in addition, it would appear adequate enough to explain events over the entire sample period (although he found that the estimated relationships are not stable).

Although the opportunity cost variable, with a coefficient of -0.049, has the sign expected on theoretical grounds, it is insignificant. The low interest elasticity suggests that real balances are only slightly sensitive to this variable, confirming the existence of a vertical LM curve, which is said to be a property of countries at Jamaica's stage of development. This implies, further, that Keynesian type policies are probably ineffective. These conclusions, it must be noted, have been drawn despite the fact that the interest rate variable is insignificant in the estimated equation.

A dummy variable to capture the effect of the monetary policy restrictions imposed on the economy was also included in the estimated equation. The significant coefficient on this variable (0.199) indicates that there has been as shift in the intercept of the real balance function. This, according to Worrell, is consistent with the argument that the introduction of IMF polices reduces the "flight from money" and thus improved the balance of payments.

The next logical step was to test the temporal stability of the estimated relationships. The Chow test reveals that the null hypothesis of stability cannot be accepted at the 5 per cent level. As Worrell puts it "[T]he evidence, therefore, suggests that the real balances function shifted over the years" (p.273). A closer examination indicates the function has become less income elastic.

Cognizant of the challenge to the linear homogeneity postulate posed by Howard (1980) and McClean (1982), McIntyre (1986) estimated both a nominal and a real demand function for money. Explicitly rejecting McLean's notion of an "augmented transactions proxy" as the scale variable, he argues that, since in the Caribbean economies a large portion of imports comprises intermediate and capital goods, correlation between GDP and imports is very likely. Moreover, since a large portion of imports is really meant for the production of export, then both imports and exports should be included in the "augmented transactions proxy", which boils down to GNP. Because of data limitations, McIntyre uses GDP as the scale variable.

McIntyre's estimate of the nominal money demand function, specified in log-linear form, supports the hypothesis that the demand for nominal money is proportional to the price level (the linear homogenous postulate), a result which is at variance with that of Howard and

McClean. The estimate of the demand for real balances produce results which "are not well established" (McIntyre, 1986, p.199)—very high D.W. (2.96) even after correcting for first and second order serial correlation and an incorrectly signed coefficient on the interest rate variable.

Another test of the homogeneity postulate was performed by Bourne (1989) who conducted a rather comprehensive econometric estimation of the nominal demand for money (both narrow and broad) for Barbados, Guyana, Jamaica, and Trinidad and Tobago. His results, shown by table 23 below, suggest that the homogeneity postulate is closely approximated for

Table 23. Demand for Nominal Narrow and Broad Money (M1 and M2)

	Barbados 1966-82		Guyana 1963-82		Jamaica 1961-82		Trinidad 1964-83	
Regressors	Log M1	Log M2	Log M1	Log M2	Log M1	Log M2	Log M1	Log M2
Constant	-4.44[a]	-4.57[a]	4.59[a]	-9.03[a]	-8.91[a]	-9.47[a]	-11.16[a]	-23.35[a]
log P	0.38[a]	0.94[a]	2.38[a]	2.45[a]	1.22[a]	1.25[a]	1.17[a]	0.66[b]
log (GDP/P)	1.13[a]	0.94[a]	0.04	0.71[b]	1.19[a]	1.34[a]	1.14[a]	3.00[a]
log WRST	-0.05[b]	-0.01	-0.25[c]	-0.02	-0.04[b]	0.02	-0.03	0.004
$\dot{P}$	0.13	-0.11	-0.90[a]	-0.43	0.22	-0.37	-0.73[a]	0.020
DUMMY	0.09	-0.18	-0.11	-0.49[a]	0.14	-0.23[b]	-0.19	-0.960
$\bar{R}^2$	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.990
D.W.	2.06	2.14	2.32	2.06	2.71	2.15	2.02	1.650

Source: Bourne (1989), p. 282

Note: P is the implicit price deflator for gross domestic product (GDP); $\dot{P}$ is its time rate of change; WRTSD is the weighted average rate of interest on time and savings deposits at commercial banks. Levels of statistical significance are: a = 1%; b = 5%; and c = 10%. The dummy variable was included to accommodate the oil price shock in 1973.

broad money in Barbados, and narrow money in Trinidad; in Guyana and Jamaica the postulate is true for either concept of money, while in all countries except Guyana money demand is strongly responsive to real GDP. In all four countries the rate of interest exerted a small negative effect on narrow money. Only in the case of Guyanese and Trinidadian narrow money were the inflation effects negative and significant. In general, therefore, Bourne found that the main influences on the demand for nominal money balances were real income and the price level.

Unsettled Issues

It is best to conclude by piecing together the crucial unsettled issues in empirical monetary research in the region. Firstly, the position on the linear homogeneity postulate seems still open, but the bulk of the evidence apparently supports it. Nevertheless, it seems clear that one position or the other in any research effort cannot be accepted without subjecting the postulate to empirical tests. This is a crucial input into the decision as to whether the left-hand variable in any money demand equation should be in nominal or real terms. If the data confirm the linear homogeneity postulate, as they have for other regions and countries, then we must employ a function for real money balances. Essentially, such a function argues that agents are interested in the purchasing power of their money holdings; that is, in the value of their cash balances in terms of the goods the cash will buy. Agents are not concerned with their nominal money holdings—that is, the number of bills they hold. In practical terms, this means that (a) real money demand is unchanged when the price level increases but all other variables, such as interest rate, real income and or real wealth, remained unchanged; and (b) nominal money demand increases in proportion to the increase in the price level, given the constancy of the specified real variables. A close scrutiny will indicate that both (a) and (b) say the same thing in slightly different ways: that behavior is not affected by changes in the price level itself, all other variables remaining unchanged. This means that agents are free from money illusion if a change in the level of prices, holding all real variables constant, leaves real behavior, including real money demand, unchanged. If, however, the data do not support the homogeneity postulate, then agents in the region suffer from money illusion, meaning that agents real behavior is affected by the price level.

Secondly, the literature is not unanimous as to whether the appropriate left-hand variable should be narrow or broad money. Some researchers, to avoid any uncertainty, have estimated both aggregates. But this uncertainty is likely to remain until the purpose of estimating the money demand equation for a particular monetary aggregate is settled. In many countries, developing as well as developed, research effort is concentrated on the broad aggregate in view of recent financial liberalization and innovation to which the regional economies have not been immune. Liberalization and innovation have severed the traditional predictable relationship between M1 and economic activity. Given these considerations, it is possible that M2 could emerge as the preferred variable in empirical studies.

Another unsettled issue for monetary research in the Caribbean relates to the scale variable in the money demand equation. Coppin (1991), among others, argued that it is necessary to test other variables, in addition to the usual measured income variable. Likely candidates include expenditure, wealth, imports, the sum of imports and exports, the ratio of transactions (proxied by the sum of imports and export) to income (Coppin (1991), all in real terms. Of course, the underlying need to test a range of scale variables is a crucial concern in an open economy.

A fourth issue concerns the appropriate opportunity cost variable—should it be the interest rate, static expectations (lagged inflation rate) or inflation modelled according to adaptive or rational expectations? Interest rates seem to be a particularly poor candidate given that they have been administered in the region, have remained unchanged for prolonged periods, have been negative in real terms in many cases and, more importantly, the paucity of alternative financial assets imply that less importance should be attached to interest rates. Moreover, if the view that developing economies are characterized by very strong liquid asset motives, then there is very little role for interest rates. Little experiment in the region has been done with inflation as the opportunity cost variable.

The issue as to whether the nominal money supply is endogenous or exogenous in small, open economies such as those of the Caricom region is still an unsettled one. This issue will be discussed further in Chapter 17. Despite the fact that several studies of money demand have been done in the region, none of them, to my knowledge, have attempted to interpret rigorously the coefficient estimates. Are they reasonable? Do they conform with theoretical expectations? More importantly, very few of these studies have tested for parameter stability and thus little information is available as to the stability of the money demand function in the Caricom area. This crucial shortcoming warrants attention in future research. The final issue is that of functional specification. While there has been almost a silent consensus for the log-linear form, most of the studies estimating money demand estimation have employed the equilibrium model or some version of the partial adjustment model. To my knowledge, other approaches such as the error correction models or the buffer stock have not been attempted.

Some of these issues will now be taken up in our search for an appropriate demand for money function in Guyana. We begin by testing the homogeneity postulate against the data for both narrow and broad money. This will determine whether (a) the appropriate monetary aggregate should be M1 or M2; and (b) the demand for money function should be specified in nominal or real terms.

Testing the Homogeneity Postulate

Cognizant of the challenge to the linear homogeneity postulate, we begin our search for a money demand function by testing, first of all, this assumption against the Guyanese data for both narrow and broad money. The functions to be tested are -

$$(13.2) \qquad M1 \quad = \quad M(P, X, L, e^{e})$$

(13.3) $M2 = M(P, X, L, e^e)$

According to the behavioral assumptions embodied in these equations, $M_P \geq 1$, $M_X > 0$, $M_L < 0$ *and* $M_{e^e} < 0$. M1 and M2 are, respectively, narrow and broad nominal money demand; P is the price level, proxied by the CPI, X is a scale variable (in real terms) and e^e is (nominal) exchange rate expectations. For the opportunity cost variable (L), tests will be done with the nominal rate of interest (R) and the current rate of inflation (Π). As pointed out above, some doubt exists as to the appropriate scale variable in developing countries. Here we experiment with real wealth, real GDP, real income, real exports, real imports and the ratio of transactions (imports + exports/income in real terms). This specification of the demand for money function, it will be observed, endeavors to take into account the fact that the Guyanese economy is very much open, providing the rationale for the inclusion of exchange rate expectations and for the experiments with exports, imports and a transactions proxy as scale variables.

Before proceeding further, two estimation issues must be dealt with. First, how does one arrive at values for exchange rate expectations, a variable that is not directly observable? An initial effort was made to proxy this variable by the lagged value of the nominal exchange rate on the premise that the formation of expectations is rather sluggish, given that Guyana was on a fixed exchange rate regime during the entire period studied, 1960-88. During this 29-year period, the nominal exchange rate was changed 15 times, 13 of which were only marginal adjustments. As an indication of the stability characterizing nominal exchange rates, the latter ranged between \$G1.74 and \$G3.00 per unit of US dollar during 1960-83 and \$G1.98 and \$G2.55 during 1967 and 1980. The assumption of sluggish expectations proved unsatisfactory, however, as the estimates obtained were rather poor: while the sign was correct, the expectations variable was always insignificant. It was then assumed that expectations were formed on the basis of an adaptive mechanism *à la* Nugent and Glezakos (1979)—see pages 370 to 372 of the present study for discussion of methodology) but, again, the estimates obtained were rather poor.

One common approach in the literature used to arrive at values for an expected variable is to take the fitted values of the best ARIMA model.[6] In the present case, the UROOT command of Micro TSP, ver. 7.0a, was used to determine whether the logarithm of the nominal exchange rate was stationary, a hypothesis which was rejected. In fact, this variable had to be differenced once before stationarity was achieved (Dickey-Fuller t-statistic of - 7.823 and MacKinnon critical values of -4.338 at the 1 per cent level). Next, the IDENT command was used to identify the appropriate specification for the model, which was found to be ARIMA(2,1,5). The estimated values of this model were:

$$(13.S3) \qquad (1 - 1.0449B - 0.3238B^2)\Delta e_t = 0.0296 + (1 - 0.1830B + 0.2920B^2 + 0.7560B^5)\epsilon_t$$

Adjusted R^2 = 0.8085 Breusch-Godfrey $\chi^2(1)$ = 0.05204 S.E.R. = 0.1437

where e_t is the nominal exchange rate, ϵ_t is the disturbance term and B is the backshift operator.

The ARIMA process is not a full rational expectations approach,[7] unless the cost of

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6 See, for example, Kallon (1992). In addition, ARIMA models have been used frequently in the literature to decompose money growth into anticipated and unanticipated components and to construct inflationary expectations. For an example of the latter, see Wasserfallen (1985).

7 The two key properties characterizing rational expectations or optimal forecasts are that (a) the forecast errors, conditional on the available information set, have zero means, and (b) the forecast errors are uncorrelated with the values of all variables and, therefore, with their own past values. The first characteristic is known as the orthogonality property of rational expectations, and the second is referred to as the lack of serial correlation. Strictly speaking, the use of rational expectations requires that expectations be related to the underlying macroeconomic structure. This requirement, however, is empirically quite untractable. Therefore, most researchers in this area follow Sargent (1973) and attempt to satisfy the key property of rationality: the orthogonality of expectational errors to the variables in the information set. From this point of view, the key assumption of rational expectations implies that -

$$(13.F1) \quad E(X_t) = E(X_t/\Omega) = X_t - \kappa$$

where $E(\kappa_t /\Omega)$ denotes the expectation of X_t conditional on the past values of the set of variables in the information set Ω and κ is a random term orthogonal to Ω_{t-1}; i..e, $E(\kappa/\Omega) = 0$.

obtaining and analyzing information contained in other variables is prohibitively high. The information set contained in the autoregressive series (nominal exchange rate) provides the economic agents only with the minimal information subset available to them. However, if agents act with exceptional rationality, they should exploit at least the information set contained in the time-series of the observed variable.

This approach, although widely used, is not without difficulties as it can result in inconsistent parameter estimates. This can happen if one of the explanatory variables Granger-cause any of the other explanatory variables in the structural equation. The Lucas critique may also be applicable when fixed coefficients AR and VAR models are used to generate values for expectational variables.[8] With these models forecasts made for the early part of the data set utilize information that was not available at the time the forecasts were made. This is because in obtaining the estimated parameters all of the data set was used. Clearly it may be more realistic to assume that agents update their views about the parameters of the expectations generating equations. This applies with stronger reason after major ('regime') changes in the

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Since, by design, the residual from ARIMA models are white noise, this approach satisfies the first characteristic of rational expectations. From a statistical point of view, there are two principal advantages to the use of the ARIMA approach: (a) parsimonious representation of the stochastic process, and (b) Zeller and Palm (1974) have shown that the final form of an econometric model possesses an ARIMA representation.

8 The *locus classicus* for the 'Lucas critique' is of course Lucas (1976). This critique, deriving from maximization principles (Laidler (1992), states that it is inappropriate to estimate econometric models of the economy, in which endogenous variables appear as unrestricted functions of predetermined variables, if one proposes to use such models for the purpose of evaluating alternative economic policy regimes. The reason is that the estimated parameters of such a model would be functions of more fundamental "structural" parameters in combination with other parameters that describe the characteristics of the policy rule itself. Any change in policy regime would change the characteristics of the reduced-form response - of endogenous to policy variables - by altering the expectations of agents whose behavior is summarized by the reduced-form model. In short, the parameters of the unrestricted econometric models are not invariant to changes in regime.

To allow parameters to vary directly with the policy variable, one can estimate a time-varying parameter (TVP) model so as to examine the timing of the change in the stochastic process underlying the policy regime. Not much work has been done in assessing the empirical relevance of the critique. Laidler (1992) notes that Hendry found no compelling evidence of the importance of forward-looking expectations in the French and British consumption function and in the British demand-for-money function.

economy (Cuthbertson, Hall and Taylor, 1992).

The second estimation issue relates to the potential endogenity of the rate of interest (R), when used an the opportunity cost variable, and the nominal exchange rate (e) in eqs. (13.2) and (13.3). The most satisfactory way to deal with this problem is to formulate a complete econometric model for the estimation of the demand for money function. A second-best solution is to employ the two-stage least-squares technique. However, in the present case endogenity of R and e is not likely to be a serious problem since (a) the interest rate was administered and remained unchanged for long periods of time, and (b) Guyana was on a fixed exchange rate regime during the period studied.

In summary, the approach used here to estimating the values of unobserved variables involves a two-step procedure: (a) the expected value of the variable is first estimated by means of an appropriate ARIMA model, and (b) the predicted values of the variable are then used in the equation of interest—the money equation in this instance.

With these preliminaries aside, we now present in table 24 below the results of the best estimate for each scale and opportunity cost variable. The conclusions are, however, tentative because some variables, GDP and inflation in particular, are underestimated, as discussed in the data appendix. A number of observations are now in order:

(a) Support for the proportionality postulate depends upon the scale variable. In the case of narrow money, the postulate is supported when GDP, exports and the transactions ratio are used as the scale variable; for broad money, the postulate holds when wealth and the transaction ratio are used as the scale variable. For these variables, it can be said that the demand for nominal money (both narrow and broad) is linearly

Table 24. The Demand for Nominal Balances:Best Estimates with Different Scale Variables

	Narrow Money (M1)						Broad Money (M2)					
	Regressions with different scale variable						Regressions with different scale variable					
Variables	Income	Wealth	GDP	Export	Import	Trans Rto	Income	Wealth	GDP	Export	Import	Trans Rto
Const	-6.868 (10.663)	-4.380 (4.692)	-1.806 (0.527)	-5.615 (0.183)	-1.859 (2.800)	-15.151 (0.066)	6.588 (9.644)	-3.911 (10.220)	7.740 (9.850)	-3.040 (3.658)	-3.652 (6.350)	2.446 (1.495)
Income	0.871 (12.174)						0.889 (12.665)					
Wealth		0.827 (5.548)						0.942 (15.341)				
GDP			0.480 (2.137)						1.018 (12.479)			
Export				0.160 (1.918)						0.546 (6.092)		
Import					0.334 (4.331)						0.614 (9.640)	
Trans Ratio						0.065 (1.047)						0.102 (2.119)
Price	1.674 (19.124)	1.311 (10.220)	1.192 (3.530)	0.909 (1.972)	1.550 (12.914)	0.962 (2.041)	1.878 (22.883)	1.128 (21.548)	1.880 (21.348)	1.611 (20.654)	1.624 (28.254)	1.175 (5.380)
Int Rate	-0.022 (1.228)	0.051 (1.910)	-0.049 (1.099)	-0.080 (2.538)	-0.036 (1.433)	-0.079 (2.041)		-0.022 (2.032)				
Curr Infl							-0.013 (3.049)		-0.012 (2.682)	-0.008 (1.115)	-0.010 (1.881)	-0.007 (2.017)

	Narrow Money (M1)						Broad Money (M2)					
	Regressions with different scale variable						Regressions with different scale variable					
Variables	Income	Wealth	GDP	Export	Import	Trans Rto	Income	Wealth	GDP	Export	Import	Trans Rto
AR(1)		0.764 (4.870)	0.949 (6.827)	1.012 (19.581)		1.005 (16.829)		0.730 (5.174)				0.927 (14.279)
Adj. R^2	0.992	0.995	0.992	0.992	0.984	0.992	0.995	0.999	0.995	0.989	0.993	0.997
D.W.	1.863	1.814	2.157	2.293	2.001	2.275	1.949	1.765	1.861	1.850	1.933	1.178
S.E.R.	0.105	0.082	0.104	0.102	0.146	0.106	0.085	0.034	0.088	0.130	0.111	0.072
Chow Test	$F_{5,27}$ = -2.498	$F_{5,26}$ = 5.906	$F_{6,26}$ = 5.091	$F_{5,25}$ = -4.087	$F_{5,26}$ = -1.774	$F_{5,26}$ = 3.950	$F_{5,26}$ = 2.664	$F_{5,26}$ = 7.199	$F_{6,26}$ = -2.021	$F_{5,26}$ = -2.391	$F_{5,27}$ = -2.811	$F_{5,26}$ = 1.212

homogeneous of degree one in prices, contrary to the challenge posed by Howard (1980). Put another way, when these scale variables are used economic agents in Guyana do not suffer from money illusion as changes in the price level apparently leave real income unchanged, other variables in the money demand function being held constant.

For the remaining seven estimates in table 24, the homogeneity assumption does not hold because a change in the price level evokes <u>more</u> than a proportional response in money demand. According to these estimates, economic agents super rational and do not suffer from money illusion.

(b) The opportunity cost variable in five (1, 2, 5, 10 and 11) of the seven estimates that did not pass the homogeneity test are not significant at the traditional 5 per cent level. The remaining two estimates (7 and 9), both of which employed a broad concept of money, seem to have a different problem: their estimates indicate that a 1 per cent rise in the general price level will occasion a 2 per cent increase in demand for nominal money balances, which is contrary to theoretical expectations. But it also raises a more practical problem: why would economic agents wish to hold such large incremental balances in a high-inflationary situation? This does not seem rational. As a consequence, these estimates do not merit further consideration.

(c) Which of the five estimates (regressions 3, 4, 6, 8 and 12) satisfying the homogeneity postulate is the best? It is difficult to decide this on the basis of the adjusted R^2 which differ only insignificantly for all five estimates. The best equation would appear to be estimate (8): broad money with wealth as the scale variable. This choice is based on two criteria: (i) lowest S.E.R. and (ii) most acceptable coefficient - a value close to unity - on the scale variable.

In addition to econometric performance, another development favors the use of the broad concept of money. This refers to financial innovations in recent years which have strengthened the substitutability between M1 and non-M1 financial assets, thereby weakening the link between the former variable and economic activity. In recognition of this fact, many studies now employ the broad concept of money, as pointed out earlier.

(d) For **narrow** money, the data suggest that the rate of interest is the appropriate opportunity cost, regardless of the scale variable used. There is no support for current inflation as the opportunity cost variable or for exchange rate expectations as an additional regressor. The latter variable, aside from being insignificant, always turned up with the wrong *a priori* sign. For **broad** money, current inflation emerged as the preferred opportunity cost variable for all scale variables except wealth, for which the preferred opportunity cost variable is the rate of interest. The data support exchange rate expectations when income and GDP are used as the scale variable.

(e) For both narrow and broad money, the estimates with the open-economy scale variables (exports, imports and the transactions proxy) did not turn in as good a performance as the traditional scale variables (income, wealth and GDP). Compared to the equations with the traditional scale variables, the "open economy" equations produce larger standard errors (and thus less reliable forecasts) and coefficient values for the scale variables, coefficients do not accord with theoretical priors.

(f) The results of the temporal stability of the estimates, using the Chow test, is also shown in table 24. (See page 225 to 226 for a more detailed discussion of the Chow test). As can be seen, the "best" equation selected in (c) above does not pass the Chow test. With an F-critical of 2.60 at the 5 per cent significance level, the F-observed is 7.199. But this is also true of all the other estimates that satisfy the homogeneity postulate except estimate 12.

Further scrutiny of the table reveals four of the seven estimates that did not satisfy the homogeneity postulate failed the Chow test; i.e., these equations apparently embody a stable relationship. It would thus seem that the nominal demand for money function, irrespective of the validity of the homogeneity postulate, does not embody a stable relationship.

In summary, we retain the "best" equation selected in (b) above, justifying our choice on the grounds of theory, validity of the homogeneity postulate, traditional statistical criteria and reasonability of the magnitude of the coefficient on the scale variable. The question of stability will be re-examined further in the context of a real demand for money function.

The Demand for Real Balances: Specification of Equations

We have now established that the demand for money function should be specified in real terms and that the appropriate monetary aggregate should be broad money (M2). Following common practice, the long-run demand for real money balances may be written as -

$$(13.4) \quad M2^{*}_{t}/P_{t} \quad = \quad f(X) + \mu$$

where $M2^{*}_{t}$ denotes the desired stock of nominal money (broad), P is the aggregate price level, X is a vector of factors determining the demand for real balances and μ is an error term which may or may not be white noise.[9] Some of the usual variables included in X are a scale variable (in real terms) and one or more opportunity cost variables. Additionally, a variable for exchange rate expectations will be included among the regressors given the openness of the Guyanese economy, even though the estimate of the nominal demand for money function - see table 24

[9] Partial adjustment models usually lead to an error term which is spherical, but a model which uses the adaptive expectations mechanism to generate permanent values of the regressors results in an error term which may be of the moving average variety. See Zeller and Geisel (1970).

above - did not indicate that this was an important variable. That is, the data will be allowed to determine the demand for real money balances. With this qualification, (13.4) can now be specified in econometric terms as:[10]

$$(13.5) \quad M2^{e}_{t}/P_{t} = \lambda_{30} + \lambda_{31} \ln S_{t} + \lambda_{32} \ln Q_{t} + \lambda_{33} \ln e^{e}_{t} + \mu$$

The expected signs of the coefficients in (13.5) are $\lambda_{31} > 0$, and $\lambda_{32}, \lambda_{33} < 0$, with S being the scale variable and Q the opportunity cost variable. As specified, (13.5) represents the individual desired level of real money balances in the long-run. It is quite possible that actual money holdings can deviate from this target from time to time for two reasons. First, the individual may be holding less money than desired, which means that he is deriving fewer benefits from his holdings of money. The opportunity cost of holding less than the optimal quantity of money represents the first reason why actual holdings may deviate from the desired level. The second reason, which derives from the first, is that the gap between the two levels creates incentives for adjusting actual to desired amounts. Both of these reasons impose portfolio adjustment costs on the individual.

The need to take adjustment costs[11] into consideration in the demand for money function provides a way of transforming $M2^{e}$ into an observable variable and thus arriving at

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[10] No consensus exists as to whether the money demand equation is semi-logarithmic or double logarithmic with respect to the opportunity cost variable. Aghevli and Khan (1978) pointed out that Frenkel (1977) has examined both forms for the German hyperinflation of the 1920s and concluded that there was no clear preference for one or the other. In some instances the data dictate the use of semi-logarithmic form as observations on the opportunity cost variable include negative values (the logarithm of a negative value is not defined).

[11] Another explanation for the lagged dependent variable appearing on the right-hand side of (13.6) is the existence of expectations lag, based upon sluggishness on the part of expectations to respond to experience. This argument would typically substitute real permanent income as the scale variable in (13.6). Then, to capture expectations, it is assumed that permanent income is generated according to a log-linear error learning formula, such as $Y^{*} - Y^{*}_{t-1} = Q[Y - Y^{*}_{t-1}]$. Laidler (1982) notes that the expectation-lag justification for the lagged dependent variable "does not consistently stand up to empirical testing" (p. 55). Indeed, lagged adjustment still appears to be present when permanent income is used as an income variable. For a recent work along this line, see Spienelli (1980).

the short-run demand for money function. Normally, a partial adjustment mechanism is specified, but should it be in real or nominal terms? The real adjustment mechanism is widely used in the literature but hardly any justification is given for this preference. This hypothesis may be written as:

$$(13.6)\quad \ln M2_t - \ln(M2_{t-1}/P_{t-1}) = \lambda_{34}\,[\ln(M2^*_t/P_t) - \ln(M2_{t-1}/P_{t-1})] + \epsilon_t$$

where $M2_t$ is actual broad money balances, λ_{34} is the speed of adjustment, $0 < \lambda_{34} \leq 1$, and ε_t is a random error term. The coefficient λ_{34} is generally found to be close to unity, especially for broader measures of money, implying a high level of persistence in the data. The basic presumption behind (13.6) is that individuals adjust their nominal money holdings instantaneously with respect to prices but with a lag with respect to the scale and opportunity cost variables.

Alternatively, if the nominal adjustment mechanism is specified, we have:

$$(13.7)\quad \ln (M2_t - \ln M2_{t-1}) = \lambda_{36}\,[\ln(M2^*_t) - \ln(M2_{t-1}] + \epsilon_t$$

where λ_{36} is the speed of adjustment, $0 < \lambda_{36} \leq 1$. Equation (13.7) allows individuals to adjust their nominal money holdings to price level changes with a lag.

Combining (13.5) with (13.6) and (13.7) and solving for the reduced-form short-run money demand function, one obtains

$$(13.8)\quad M2R_t = \lambda_{34}\lambda_{30} + \lambda_{34}\lambda_{31} \ln X_t + \lambda_{34}\lambda_{32} \ln L_t + \lambda_{34}\lambda_{33} \ln e^*_t + (1 - \lambda_{34}) \ln M2R_{t-1} + \xi \qquad \text{(Real Adj.)}$$

$$(13.9)\quad M2_t = \lambda_{34}\lambda_{30} + \lambda_{34}\lambda_{31} \ln X_t + \lambda_{34}\lambda_{32} \ln L_t + \lambda_{34}\lambda_{33} \ln e^*_t + (1 - \lambda_{34}) \ln M2N_{t-1} + \xi \qquad \text{(Noml. Adj.)}$$

where M2R is the demand for real money balances ($M2_t/P_t$), $M2R_{t-1}$ is a one-period lag of the stock of real money balances [$(M2/P)_{t-1}$] and $M2N_{t-1}$ is a one-period lag of the nominal money balances deflated by the current price level [$(M2_t/P_t)$]. Thus the only difference between (13.8) and (13.9) is embodied in the adjustment terms. On theoretical grounds, $\lambda_{34}\lambda_{31} > 0$, $\lambda_{34}\lambda_{32}\lambda < 0$, $\lambda_{34}\lambda_{33} < 0$, and $\lambda_{34} > 0$. The long-run elasticities of (13.5) can be derived easily: simply divide each of the composite coefficients in (13.8) and (13.9) by the appropriate adjustment parameter, λ_{34} or λ_{35}. For example, the long-run elasticity on the scale variable is $\lambda_{32}/\lambda_{34}$.

Equations (13.8) and (13.9) are usually referred to as the Chow model, after Chow (1966) who argued that a change in the determinants of the long-run demand for money would lead to a change in real money balances in the quarter which is a fraction of the difference between real long-run money demand and lagged real money balances, as given by (13.6) and (13.7). Partial adjustment models are widely used in empirical studies of money demand, both in developed and developing countries alike.

To return to the question raised above: which short-term hypothesis should be used—the nominal or real adjustment mechanism? To arrive at a decision, Fair (1987) recommended the inclusion of both lagged variables in (13.8) and (13.9) into a single equation and jointly estimating their coefficients. If a given specification is the correct one, then the coefficient on its lagged money term should be significant and the coefficient on the other lagged money variable should not. Of course, the test may be inconclusive, in which case both coefficients may be either significant or insignificant. The equation for the Fair test is as follows:

$$(13.10)\quad M2R_t = \theta_0 + \theta_1 \ln X_t + \theta_2 \ln L_t + \theta_3 \ln e^e_t + \theta_4 \ln M2N_{t-1} + \ln M2R_{t-1}$$

Because a lagged dependent variable is included in (13.10), OLS may yield inconsistent estimates as a result of possible serial correlation problems. There is also the possibility that the scale and opportunity cost variables might be endogenously determined. To get around these problems, the Two-Stage Least Squares technique will be used for estimation. Instruments used include the lagged dependent variable, lagged values of the explanatory variables, as well as other exogenous and endogenous variable that appear in the econometric models being constructed.

To my knowledge, none of the studies on money demand in the Caricom region have included among the regressors a variable representing price expectations. As Swamy and Tavlas (1989) point out, such a variable is particularly relevant if the historical data are essentially generated in a regulated financial environment. In such a situation the nominal interest rate, because it is administered, does not necessarily reflect market-clearing values and this is perhaps why the interest rate did not turn out to be a significant variable in most of the estimates presented in table 24. The partial adjustment model in either (13.8) or (13.9) can be readily amended to allow for the inclusion of price expectations

$$(13.11) \quad \ln M2R_t = \lambda_{34}\lambda_{30} + \lambda_{34}\lambda_{31}\ln X_t + \lambda_{34}\lambda_{32}\ln L_t + \lambda_{34}\lambda_{33}\ln e_t^e + (1 - \lambda_{34})\ln M2R_{t-1} + \lambda_{34}\lambda_{35}\ln\sum_{j=0}^{n}\zeta_j\Pi_{t-j} + \epsilon_t$$

assuming that (13.8) embodies the correct short-run hypothesis. In (13.11) $\sum_{j=0}^{n}\zeta_j\Pi_{t-j} = \Pi^e$ is a measure of inflationary expectations (Π^e), Π is the annualized consumer price inflation and ζ_j is the weight attached to inflation in period t - j in formulating price expectations. The $\lambda_{34}\lambda_{35}$ coefficient is expected to have a negative sign.

The popularity of the Koyck-lag mechanism used to estimate the demand for money function is due to its simplicity: the entire adjustment process is summarized by the mere inclusion of one-period lagged values of the dependent variable. And indeed, the addition of the lagged dependent variable proved important as far as increasing the explanatory power of

(13.8) and (13.9) is concerned. Nevertheless, aspects of the estimates based on the empirical implementation of these equations have raised certain criticisms, particularly by buffer stock monetarists.[12] First, particularly since 1975, empirical estimates of the coefficients of (13.8) have produced highly inaccurate estimates of $M2R_t$.[13] Critics interpret this as meaning that the money demand function has become unstable in the post-1975 years,[14] at least in developed countries. The poor forecasting performance of equations such as (13.8) have led many countries to move away from strict monetary targeting as the basis of monetary policy in recent years. In the United States, for example, much debate centered on the period of the "missing money" (a reference to the over-prediction of money supply) in the mid-1970s and the "great velocity decline" in the early 1980s.

There are several possible explanations of the instability of the econometric relations between real balances and its determinants. These include the breakdown of the Bretton Woods system of fixed exchange rates, financial liberalization and innovations, and the Lucas critique. According to the latter, the failure to obtain stable empirical relationships is the result of agents acting on forward-looking expectations based, among other things, on the expected future policy regime. A change in the policy will result in a change in the optimal choices, leading to "structural break" in the behavioral relationship estimated under the previous regime.[15] Another explanation for the parameter instability of the partial adjustment model,

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12 See Swamy and Tavlas (1989) for a discussion of the troublesome attributes associated with the partial adjustment specification.

13 All criticisms of the Chow model are based on the version that embodies the real adjustment hypothesis, since it is this version that is most widely used in the literature. However, these criticisms also hold for the version based on the nominal adjustment mechanism.

14 For a survey of the performance of the demand for money function, see Judd and Scadding (1982). This survey deals only with developed economies. Very little can be said about the stability of the money demand function in the Caribbean since, as far as I am aware, not much published work has been done in this area, as noted in the section on the review of empirical studies of the demand for money function.

15 The question has been raised, however, as to whether the instability of the demand for money is the result of poor theory or poor econometrics (see, for example, Melnick, undated). The argument is that the improper dynamic specification of the short-run demand for money could be the main source of

according to buffer stock monetarists, is the omission of a money shock variable as a regressor when the buffer stock specification is the "true" model of money demand.

A second dissatisfaction with the Chow model, particularly to the buffer stock monetarists, is that changes in money supply are accompanied by interest overshooting in the short-run. This argument can be readily seen from (13.8) where, it will be recalled, X and L (think of income and the interest rate) are exogenous relative to M_t and ϵ_t is white noise. Now the short-run (i.e., impact) interest elasticity of the demand for real money balance is $\lambda_{34}\lambda_{32}$, a negative number, while the long-run (after lagged adjustment has occurred) is $\lambda_{32}/\lambda_{34}$, where $\lambda_{34} = 1 - \lambda$. The values of these two elasticities satisfy the inequality

$$|\lambda_{32}| \leq |\lambda_{32}/\lambda_{34}|$$

with the equality holding only if $\lambda_{34} = 0$.[16] From this inequality it is clear that

$$\frac{1}{|\lambda_{32}|} \geq \left|\frac{1 - \lambda_{34}}{\lambda_{32}}\right|$$

In the literature this inequality is referred to as the overshooting effect (see, for example, Swamy and Tavlas, 1989). Thus, from the result that the demand for money function (13.8) is less interest elastic in the short-run than in the long-run (due, for example, to costs of adjusting portfolios), it is concluded that a given change in the money supply has to be accompanied by a larger interest rate response in the short-run (than in the long-run) in order to induce economic agents to absorb the given change in money supply. In other words, the inclusion of a lagged dependent variable as a regressor necessitates that the interest rate

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econometric malfunctioning of the estimated equation. The two most important and common errors are ignoring the (a) presence of a unit root in the real balances as well as inflation and income, and (b) basic cointegration relationship between real balances, expected inflation and income. As a result it is probable that the quantitative importance of the Lucas critique may be of minor consequence compared to the consequences of the dynamic misspecification of the equation.

[16] Model stability requires that λ_{34} be less than unity.

elasticity of money demand be less in the short-run than in the long-run. This implies that in the short-run interest rate has to overshoot its long-run equilibrium value in order to assure that changes in the money supply are willingly held. Buffer stock monetarists argue, however, that interest rate overshooting is not a feature of financial markets.

Boughton and Tavlas (1990) have also pointed out that the monetary transmission mechanics embedded in the partial adjustment model is apparently inconsistent with the commonly accepted view that the transmission of money supply to changes in spending involves long and variable lags. In fact, the addition of a lagged dependent variable to the money demand specification amounts to a challenge to the hypothesis of long and variable lags. The implication is that if the partial adjustment model is stable, then this would mean that there exists both a short-term and long-term predictable relationship among money, output and interest rate. In this context, Laidler (1982) has shown that in a multiequation macroeconomic model which includes a long-run equation for money demand and the postulate of price level stickiness, the coefficient of the lagged dependent variable is not a structural parameter. Rather, it is some unspecified reduced form of the parameter of the monetary transmission mechanism.

Finally, as an extension of the argument in the previous paragraph, buffer stock theorists maintain that by putting all of the monetary transmission mechanics on the coefficient of the lagged dependent variable, the Chow model is particularly vulnerable to the Lucas critique and can give rise to systematic errors that are inaccurately captured in the coefficient. This can happen if monetary innovations cause economic agents to move off their short-run money demand functions, possibly giving rise to long and variable transmission lags before equilibrium is restored.

These shortcomings of the partial adjustment model soon gave rise to the buffer stock or shock absorber model, pioneered by economists at the Reserve Bank of Australia in the context of the Reserve Bank's macroeconomic model. While other approaches have been used in the literature,[17] Boughton and Tavlas (1990) observe that the approach that comes closest to capturing the essence of the buffer stock notion is that of Carr and Darby (1981). The core of the buffer stock approach[18] is that when there is an exogenous increase in money supply, agents do not immediately attempt to unload the excess money but rather allow above-desired levels of cash balances to accumulate in a "buffer" and then attempt to work them off gradually. This approach therefore attempts to reconcile equations such as (13.8) with an exogenous money supply by adding a term representing the "money surprise" in each period. That is, the shock absorber equation augments the conventional demand for money equation by adding the monetary surprise term ($M^{s}U$):

$$\text{(13.12)} \qquad M2R_t = \lambda_{34}\lambda_{30} + \lambda_{34}\lambda_{31} \ln X_t + \lambda_{34}\lambda_{32} \ln L_t + \lambda_{34}\lambda_{33} \ln e^{e}_t + (1 - \lambda_{34}) \ln M2R_{t-1} + \lambda_{36} M^{s}U_t$$

where $M2R_t$, X and L are as defined before, and $M^{s}U = (M^{s}_t - M^{s}A_t)$ represents the unexpected addition to the nominal money stock and hence $M^{s}A_t$ is the anticipated nominal money supply. The coefficient (λ_{36}) on the monetary shock variable is expected to have a positive sign, according to the buffer stock hypothesis ($0 < \lambda_{36} < 1$), implying that a portion of unanticipated money accumulates as desired money holding. Clearly, then, unanticipated shocks lead to a rise in short-term real money holdings. Carr and Darby further argue that anticipated money is fully reflected in the current price level. In other words, if equation (13.12) included anticipated nominal money as an argument, its coefficient would be zero. Now

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[17] A review of the relevant literature will indicate that four approaches to modelling buffer stock money are considered: (a) money demand inversion, (b) complete disequilibrium models, (c) the shock absorber model, and (d) forward looking buffer stock models. A good review of these approaches is given by Cuthbertson (1991). See also Swamy and Tavlas (1989).

[18] See Laidler (1984) for an excellent review.

(13.13) $M^{s}A = g'Z_t$ and hence

(13.14) $M^{s} = g'Z_t + v_t$

Here Z is a set of variables that agents assume to have a systematic influence on money supply, g is a vector of coefficients to be estimated and v is a while noise error term. Unanticipated changes in money supply, denoted by $\hat{v}_t = (M_t^s - \hat{M}^sA_t)$ are the residuals from (13.14). The errors in (13.7) and (13.14) are assumed to be independent of each other. From (13.12) - (13.14) it is evident that the shock absorber specification thus approximates Laidler's theoretical derivation of the buffer shock model as a reduced-form equation of a complete macro model.

Equation (13.12) is supposed to avoid the problem of interest rate overshooting implied by the Chow model [13.8) or (13.9)] because the term (M^sU_t) produces a shift in the money demand in response to unexpected changes in money supply. Further, if (13.12) - (13.14) are in fact the "true" model of money demand, as shock absorber theorists assert, then the Chow model [(13.8) or (13.9)] is misspecified. And by omitting the term (M^sU_t), biased estimates on the included explanatory variables can be obtained. This specification bias, according to buffer stock theorists, is perhaps a contributory factor to parameter instability obtained by equations such as (13.8) (Swamy and Tavlas, 1989).

There are several difficulties with the buffer stock approach.[19] The first issue raises an important econometric problem: how to model M^sA_t, the anticipated money supply? What variables should be included in the Z vector? Two associated difficulties are: should the rational expectations hypotheses be used and what econometric techniques should be deployed? Differences exist with respect to the Z variables. Carr and Darby (1981) include transitory

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[19] See Milbourne (1987) for a critical survey of the empirical buffer stock literature.

income, while other researchers are critical of the use of such a variable. The issue of whether the rational expectations hypothesis should be used to model $M^{*}A_t$ is also an unsettled one. Swamy *et al* (1982) is critical of this, arguing that the rational expectations approach is inconsistent with the buffer stock approach unless the distribution of $M^{*}A_t$ has both frequency and subjective interpretations because it is a hypothesis about the formation of subjective expectations. Additionally, another problem arises when the model is being solved. In the process, the conditional means of the endogenous variables (given the exogenous variables) are made proportional to the means of the marginal distributions of exogenous variables. However, this violates the probability law connecting the joint conditional distributions of endogenous and exogenous variables, as shown by Swamy and Tavlas (1989).

Despite this criticism, the rational expectations hypothesis is still widely used to estimate $M^{*}A_t$. Generally, this approach employs a univariate ARIMA model, so that Z_t include only lagged values of $M^{*}A_t$ (Carr and Darby, 1981). Khan and Knight (1982) used a first order autoregressive model. Another approach uses a polynomial distributed lag of past values of the money supply; this is the approach taken by Swamy and Tavlas (1989b) and Boughton and Tavlas (1990). Both studies, using quarterly data, employ a second-degree, twelve-period (t - 1 through t -12) polynomial distributed lag of past values of the money supply.

Finally, Milbourne (1987) notes that if $M2_t$ is interpreted as an endogenous variable, then it will be correlated with ξ, and there will be positive correlation between $(M^{*}U_t)$ and ξ that must be dealt with during estimation. In the literature surveyed by Milbourne, attempts to produce unbiased estimates of λ_{36} have been unable to reject the hypothesis that $\lambda_{36} = 0$. If one instead interprets $M2_t$ as exogenous, then (13.12) should be renormalized prior to estimation, and various attempts to do so generally have not been supported by the data either. Milbourne concludes on the basis of his survey that the buffer stock notion cannot be tested in a single-equation framework, but rather should be tested in the context of a complete model.

The buffer stock adherents argue that the validity of the approach is an empirical matter. In their original test on US data, Carr and Darby claimed that the buffer stock formulation was successful, using the two-stage least squares technique. Mackinnon and Milbourne (1984) challenged this result, arguing that if the money stock is also endogenous, then ($M^{\bullet}U_t$) will be correlated with ξ_t- TSLS-estimating procedure or not - and propose an alternative estimating equation that solves for the reduced form (in $M2_t$) of equation (13.12). In comparison tests, the Carr-Darby test provides significant influence for unanticipated money, while the Mackinnon and Milbourne test does not.

Boughton and Tavlas (1990) attempted to throw further light on this question in a recent study in which they evaluated the empirical performance of the buffer stock and the more general error correction models for both narrow and broad monetary aggregates in five large industrial countries (United States, United Kingdom, Germany, France and Japan). They also compared these two approaches with the more conventional partial adjustment models. On the basis of their analysis, Boughton and Tavlas found that none of the three models (approaches) is unambiguously superior to the others. Thus the buffer stock approach is yet to establish itself as a superior way of modelling and estimating the demand for money.

Other researchers used a different technique to estimate the demand for money function instead of re-specifying the equation.[20] These researchers prefer to employ the Almon-lag technique whereby each independent variable is separately replaced by a distributed lag variable of its own current and past values. These values are then assumed to lie on a polynomial function of a certain degree chosen by the researcher. Using the Almon-lag technique, the money demand function in (13.5) takes the form:

$$(13.15) \qquad \ln M2R_t = \varphi_0 + \sum_{i=0}^{l_1} \beta_i \ln X_{t-i} + \sum_{i=0}^{l_2} \psi_i \ln L_{t-i} + \sum_{i=0}^{l_3} \varrho_i \ln e^{\bullet} + \epsilon_t$$

[20] See, for example, Darrat (1985).

where all variables are as defined before and l_j (j = 1,2, 3) are the lag lengths of the Almon lag on the three independent variables. A priori, money demand theory suggests that the summed coefficients be positive for the scale variable and negative for the opportunity cost and the exchange rate expectations variable.

Estimates of the Demand for Real Balances

Estimates of the demand for broad money will be made using (13.8), (13.9), (13.10), (13.11), (13.12) and (13.5). As will be recalled, table 24 suggests that real wealth and the rate of interest are, respectively, the appropriate scale and opportunity cost variables. The two-stage least square technique will be employed with the following as instruments: lagged dependent variables, one- and two-period lagged values of all explanatory variables and, in the case of equation (13.15), all the PDL variables created during estimation.

To begin, consider the Fair test of the demand for real balances (13.10)[21]

$$\text{(13.S4)} \quad \ln M2R_t = \underset{(0.449)}{-\ 0.224} + \underset{(2.136)}{0.292} \ln WLTHR_t - \underset{(2.584)}{0.036}\, R_t + \underset{(0.999)}{0.072}\, e^{*}$$
$$+ \underset{(2.263)}{0.510} \ln M2R_{t-1} + \underset{(1.360)}{0.302} \ln M2N_{t-1}$$

Adjusted R^2 = 0.972 D.W. = 2.185 S.E.R. = 0.072 G-B statistic $\chi^2(2)$ = 1.822

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21 When one or more lagged dependent variables are present in the estimated equation, the D.W. statistic will often be close to 2 even when errors are serially correlated. In such cases the Durbin h test should be used. However, this test is invalid when T Var $(\hat{\beta})$ in the formula for the h statistic is greater than 1, since the square root of a negative number is not defined (Pindyck and Rubinfeld, 1991). This is the case with the present estimate - hence the h statistic is not given.

The expected rate of exchange is clearly not significant in the demand for real balances, in addition to having the wrong sign. We have now found that for both the nominal and real demand for money functions the data do not support exchange rate expectations as an explanatory variable. The coefficient on the nominal-money term, while correctly signed, is not significant even at the 10 per cent level. On the other hand, the lagged dependent variable is significant at the traditional 5 per cent level and of the correct a priori sign. Dropping the exchange-rate variable and re-estimating the equation, one obtains:

$$\text{(13.S5)} \quad \ln M2R_t = -\underset{(0.816)}{0.387} + \underset{(2.632)}{0.340} \ln WLTHR_t - \underset{(2.603)}{0.037} R_t + \underset{(2.649)}{0.575} \ln M2R_{t-1} + \underset{(1.064)}{0.222} \ln M2N_{t-1}$$

Adjusted R^2 = 0.971 D.W. = 2.115 S.E.R. = 0.073 G-B statistic $\chi^2(2)$ = 1.608

Note: The h statistic for this estimate is invalid since the denominator in the formula is a negative number (see the previòus foot note for details).

Again the lagged nominal money variable term is not significant at the 10 per cent level. These estimates clearly show that the correct specification of the short-run demand function for money should be based on the real adjustment mechanism.

As a further test, estimates involving both the nominal and real adjustment terms in individual equations have been implemented. These are shown in table 25. Both adjustment terms are statistically significant - at the 5 per cent level - in their respective equations, although the significance level for the real adjustment term is much higher. While both estimates are free of autocorrelation and heteroskedasticity of the disturbance term, their adjusted R^2 and the S.E.R. both indicate a better performance for the real adjustment equation. Moreover, the estimated coefficient on the adjustment term, which is expected to be close to unity, is also more reasonable for this equation than for the equation based on nominal adjustment. Thus, in support of the result of the Fair equation, the estimates of the two short-run equations indicate that the correct short-run specification of the demand for money function should embody the real adjustment mechanism.

The addition of a term for price expectations[22] - now we are estimating equation (13.11) - actually led to a slight fall in the adjusted R^2 and an increase in the S.E.R. compared to the real partial adjustment model. Various concepts of price expectation were experimented with and all of them were insignificant. The price expectations term shown in table 25 is based on an ARMA (2,1) model; it is insignificant, in addition to having the wrong sign. The conclusion is that, in the Guyanese context, price expectations are not important to the demand for money function. This implies that, over the estimation period, the Fisher effect is fully captured by the opportunity cost variable (interest rate).

Two approaches were used to estimate the monetary shock variable (M^sU_t) in (13.12): ARIMA modelling and the polynomial distributed lag technique. Best results were obtained with an ARIMA(3,1,2) model.[23] In terms of the adjusted R^2 (0.990) and the S.E.R. (0.042), the buffer stock equation is unequalled in performance. It is also free of autocorrelation and heteroskedasticity of the

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22 Price expectations are proxied by expected inflation. Three measures of the latter were used: (a) lagged values of inflation; (b) expectations formed on the basis of an adaptive mechanism - see Annex 1 at the end of this chapter on the methodology used to arrive at values for adaptive expectations; and (c) weak rational expectations as gauged by an ARMA(2,1) model. The estimated values of the ARMA model were:

$(1 + 1.684B - 0.621B^2)\Pi_t = 0.013 + (1 - 0.948B)\epsilon_t$
Adjusted $R^2 = 0.800$ Breusch-Godfrey $\chi^2(4) = 6.625$ S.E.R. $= 0.059$.

The fitted values from this model were then used as the expected price (inflation) variable.

23 The fitted values of the ARIMA(3,1,2) model are:

$(1 + 0.3552B + 0.3472B^3)\Delta M^s_t = 0.2374 + (1 + 0.5418B^2)\epsilon_t$
Adjusted $R^2 = 0.3559$ Breusch-Godfrey $\chi^2(4) = 4.4393$ S.E.R. $= 0.0883$

The residuals from this equation was then used as the monetary shock variable.

Table 25. Estimates of the Demand for Real Money Balances (broad)

Variable	Nominal Adjustment	Real Adjustment.	Price Expectations	Buffer Stock	Pol. Dist. Lag
Constant	-1.137 (1.477)	-0.541 (1.232)	-0.527 (0.670)	-0.271 (1.043)	0.821 (1.369)
Wealth	0.549 (3.339)	0.349 (2.400)	0.474 (2.055)	0.283 (3.623)	1.172 (11.288)
Interest Rate	-0.055 (2.705)	-0.040 (2.591)	-0.061 (2.457)	-0.038 (4.493)	-0.070 (4.668)
Real Adj.		0.809 (9.023)	0.712 (5.496)	0.832 (15.126)	
Nominal Adj.	0.736 (5.963)				
Price Expect.			0.005 (0.699)		
Exchg Rate Expectations					-0.345 (3.278)
Monetary Shock				0.687 (6.430)	
Adj. R^2	0.959	0.968	0.960	0.990	0.974
S.E.R.	0.081	0.073	0.086	0.042	0.051
D.W./h	D.W.: 1.770	h: - 0.409	h: 0.026	h: 0.389	D.W.: 2.340
Engle's ARCH	$\chi^2(4)$ = 1.130	$\chi^2(4)$ = 0.861		$\chi^2(4)$ = 2.466	$\chi^2(4)$ = 3.577
G-B statistic	$\chi^2(2)$ = 4.171	$\chi^2(2)$ = -6.664	$\chi^2(2)$ = 3.375	$\chi^2(2)$ = 0.707	$\chi^2(2)$ = 2.757
Chow Test		F(5, 24) = 0.379		F(5, 24) = 1.361	
F-Statistic	136.971	173.703	147.064	613.546	93.506

disturbance term, judging from the statistics produced by the Breusch-Godfrey and Engle's ARCH tests. The estimated coefficients on the wealth and interest rate variables and the lagged dependent term are not very different in size from those produced by the real-adjustment equation. The monetary shock variable is highly significant, with a long-run estimated coefficient of 0.687. This large coefficient is indicative of the heavy monetary shock the economy experienced in the Post-Republic era, with broad money growing at an annual average of 19 per cent per year during 1970-78, 16 per cent during 1978-81 and 28 per cent during 1983-89. It may be concluded, therefore, that the Guyanese data strongly support the buffer stock hypothesis.

Generally, studies have found that the coefficient on the monetary shock variable is larger when the broader monetary aggregates are used as the dependent variable. Even so, there is hardly an accepted range within which the coefficient is expected to fall, depending as it is more on the particular circumstances of the economy being studied. Swamy and Tavlas(1989) obtained coefficients, when M3 is the dependent variable, in the range of 0.13 - 0.32 for Australia. Boughton and Tavlas (1990) obtained coefficients ranging from 0.48 to 1.35 in their study of comparative model performance in the United States, United Kingdom, Germany, France and Japan, using M2 and M3 as the dependent variable.

The PDL technique, as noted above, was also used to estimate the demand for money function. After much experimentation, the best-performing equation was found to be a second-degree polynomial on all variables. The lag structure was: wealth - five-periods, with no constraints imposed; interest rate - two-periods, with no constraints imposed; and price expectations - two-periods, constrained at the far end, which implies diminishing weights on the expectations variable as the time horizon is stretched out. The estimates obtained are quite good, with an adjusted R^2 of 0.974 and an S.E.R. of 0.051. Indeed, this is the second best performing equation, outperforming the real-adjustment and price expectations equations. The summed coefficient on the wealth variable is 1.172, which is not an unusually high for estimates obtained with this technique. For example, Darrat (1985) obtained a coefficient of

1.01 on the real income variable in his study of the demand for money in Brazil. The interest rate, with a coefficient of - 0.70, is highly significant. Importantly, this is the only equation in which the exchange rate expectations variable is significant and of the correct a priori sign; its coefficient is - 0.345 which means that a 10 per cent increase in nominal exchange rate expectations will lead, other things being equal, to a 3.5 per cent fall in real money balances.

Ever since Goldfeld (1973) found an unstable money demand relation for the United States, it has become standard to test whether the estimated coefficients are constant over time (temporal stability); that is, to test the stability and robustness of the estimated relationship. For this purpose, the most widely used test is the Chow test, which partitions the data set into two subsets, estimates the full sample and two sub-periods, and then uses the F-test to test the null hypothesis that the estimated coefficients for the two sub-periods are equal.

Prior to the Chow test, it is necessary to verify that the residuals are not heteroskedastic. The Engle's ARCH test, which test the hypothesis of homoskedasticity of the residuals, fails to reject the null hypothesis for all the equations (see table 25). The way is now clear for the Chow test.

How is the breakpoint in the sample chosen? Two significant events occurred during the sample period: the oil crisis of 1973 and the huge acceleration in the growth of broad money supply which began in 1975. The choice of 1973 as the breakpoint was disregarded for two reasons. First, the initial impact of the oil crisis was mitigated by the sugar boom of 1974-75, which meant that the economy did not experience a large shock in 1973. Second, and more practically, the choice of 1973 as the breakpoint is ruled out by data consideration; the number of observations is too small to permit this. Indeed, the temporal stability of the equation employing the PDL technique could not be ascertained for this very reason: with the estimation period of 1968-1988, the number of observations was too small to partition the data set. With these preliminaries aside, it is clear from the F-statistics presented in table 25 that the Chow test fails to reject the null hypothesis of structural stability for both the real-adjustment and the buffer stock equations.

We now have two "credible" estimates: the real-adjustment equation and the buffer stock equation. The issue now confronting us is: which of these equations should be chosen for inclusion in the econometric model being built? Although "goodness of fit" and "efficiency" are useful model-selection criteria, how well a model performs in ex post forecasts of the dependent variable is, in my opinion, one of the most exacting selection-criterion in this context. In other words, assuming that parameter estimates from competing equations have their correct a priori signs, the equation whose forecasts are the most accurate (the equation whose forecasts of the dependent variable track its actual value most closely) should be the preferred equation.

The results of the post forecasts, covering 1989-90, for the real-adjustment and the buffer stock equations are give in table 26 below. The evaluation statistics clearly point to the superiority of modelling money along the lines of the buffer stock theory. As the table shows, the buffer stock equation outperforms the traditional neoclassical money demand equation on all counts.

Table 26 Comparative Ex Post Forecasting Performance of the Real-adjustment and the Buffer Stock Equations

	Real-adjustment	Buffer Stock
RMSPERR	0.8600	0.7400
THEIL	0.0043	0.0037
UM	0.0483	0.0387
US	0.1394	0.1366
UC	0.8122	0.8247

The composite coefficients of the buffer stock equation - the estimated parameter times the adjustment - can now be given:

$$(13.S8) \quad \ln M2R_t = -0.225 + 0.235 \ln WLTHR_t - 0.032\, R_t$$
$$\qquad\qquad (1.043) \qquad (3.623) \qquad (4.493)$$
$$+ 0.168 \ln M2R_{t-1} + 0.572 \ln M^*U_t$$
$$(15.126) \qquad (6.430)$$

Adj. R^2 = 0.990 S.E.R. = 0.042 h = B-G$\chi^2(2)$ = 0.707

Engle's ARCH $\chi^2(4)$ = 2.466

CHAPTER 14

Imports and Exports

Imports

Considerable attention has been given to imports in regional macroeconometric modeling, probably because of the heavy dependence of the regional economies on outside inputs for both production and consumption. Earlier studies adopted a disaggregated approach, developing equations for each major category of imports. The tendency of more recent studies is to treat the aggregate level of imports but, of course, the level of aggregation depends upon the purpose of the study. Most studies in the region focussed on merchandise imports.

Studies Using the Disaggregated Approach

Carter (1970) disaggregated merchandise imports into food, other consumer goods, intermediate goods, capital goods, and fuel. The supply of fuel was assumed to be exogenous over the sample period since a refinery was established in Jamaica, which changed both the structure and rationale of fuel imports. Food and other consumer goods are both functions of one significant variable: personal consumption, yielding coefficients of 0.094 and 0.155 respectively. The sum of these estimates led Carter to observe that "... about 25 per cent of marginal personal consumption" (p. 182) is spent on imported consumer goods. With these estimates, the long-run elasticity of food imports is about 1.11, which, according to him, is much higher than in other countries. Part of the explanation for this, he believes, is the tourist industry: the import content of tourist food is almost 100 per cent.

Imports of capital goods are hypothesized to depend on fixed capital formation outside of mining and on mining investment. While the estimated equation explained 93 per cent of the variation in imported capital goods, a D.W. of 2.5 is too high for solid inference. The final equation, imports of intermediate goods, is related to manufacturing GDP instead of total GDP, which probably accounts for the rather low coefficient (0.42) on this variable.

Following Carter, Manhertz (1971) disaggregated merchandise imports along similar lines "... in order to facilitate the analysis of the sources of major leakages on the demand side of the foreign trade sector" (p. 211). The only argument in the equation for food imports, disposable income, produces a coefficient of 0.08, which Manhertz felt was too small but could possibly be explained by the seasonal nature of demand in the hotel industry. If this is true, then the formulation of the food-import equation in terms of levels might not be appropriate, a hunch which finds some support in the D.W. of 1.44.

There are two explanatory variables in the equation for other consumer goods: private consumption expenditure on nondurables (excluding food) and a linear time trend. The coefficient on the former variable, 1.54, is rather high but Manhertz points out that the propensity to import in Jamaica is also high. The highly negative coefficient (1.52) on the time variable might be due to the problem of aggregation or it might mean that some important explanatory variable(s) was omitted from the equation, according to Manhertz. But nothing further was done to track down possible source(s) of misspecification.

With a coefficient of 0.68, fixed private investment is the most important factor in the equation for imported capital goods. The size of this coefficient seems to be reasonable given that domestic production of investment goods "... is either negligible or nonexistent..." (p. 212). To proxy an accelerator effect, the previous period GNP was also used in this equation but a coefficient of 0.01 assigned it only marginal importance. It is interesting to note that the adjusted R^2 of the equation for imported capital goods is 0.93 but the D.W. is 2.94.

The expansion of the manufacturing sector in Jamaica resulted in increasing imports of intermediate goods, largely because of the limited domestic resource base. However, the only explanatory variable in the equation for this category of imports, GNP, fails to confirm the rising trend in imports: its coefficient, while significant, is only 0.19, much lower than Manhertz expected.

There are four import equations in Persaud (1979), all of which have the same two explanatory variables: an index of Trinidad-Tobago GNP (TG) and the ratio of the price index of imports into the country to the local wholesale price index (TMW). The first variable is expected to exert a positive impact while the price index is expected to be inversely related to imports.

The TG variable is insignificant and wrongly signed in the function for consumer imports as is the price variable is also insignificant at the 5 per cent level. Clearly, this equation is problematic and probably misspecified. This notwithstanding, Persaud remarked that "... imports of consumer goods (M_1) have been declining [referring to the negative coefficient on the TG variable] as a result of wide reaching campaigns by the government to encourage local industries" (p. 400). This might be an observable trend from the data but it is certainly an invalid inference from the estimated equation.

Only the TG variable (coefficient:1.4) is significant in the equation for intermediate goods and services, mainly comprising of crude petroleum. Both variables are insignificant in the equation for imports of capital goods and services. The poor performance of the equation, Persaud notes, is probably because "... capital goods are sometimes independent of market forces in developing countries" (p. 401). But the relatively large coefficients and a D.W. of 1.27 suggest that an alternative specification might have yielded better results.

For the purposes of their forecasting and policy evaluation model, Hilaire *et al* (1990) divides imports into (a) consumer imports; (b) intermediate and capital imports; and (c) imports of services. The imports of consumer goods and capital and intermediate goods are both functions of GDP, the lagged "import cover ratio" and prices (exchange rate times the foreign price of respective category of imports). Imported services are taken as a function of GDP and the lagged import cover ratio. All variables in these three equations have the expected signs, except the import cover ratio in the equation for services, and are significant at the 5 per cent level. The D.W. ranges between 1.5 and 1.7. The coefficients on the variables are as follows:

Table 27. Hilaire *et al* (1990): Estimates of the Imports Equations

Equation	GDP	Import cover Ratio	Price
Consumer goods	0.0005	0.182	-0.034
Intermediate and capital goods	0.0004	0.289	-0.019
Services	0.155	-22.776	

Source: Hilaire *et al* (1990:119-120).

According to computations by the authors, intermediate and capital goods are more price and income elastic than consumer imports. For the former the (average) price and income elasticities are (in absolute terms) 0.695 and 0.634 compared to 0.631 and 0.559 for consumer imports. The significance of the import cover ratio proves that exchange controls have a restrictive impact on imports according to the authors. The negative sign on the import cover ratio in the equation for services does not conform to a priori expectations.

Modelling the Guyanese economy, Jarvis (1990) notes that "the level of imports is mainly determined by the level of home demand"[1] (p. 16). This obvious statement in fact provides the starting point for much econometric work on import demand in developing countries and Jarvis himself made it the basis for his three import equations: import of food, beverages and tobacco; import of intermediate goods and raw materials; and import of machinery and manufactured goods. All three of equations employed differenced data, after regression runs indicate that the level of the variables did not yield acceptable results. Indeed, it was the low D.W. that prompted Jarvis to re-specify the equations. Jarvis is probably the only researcher in the region who regarded the problem of serial correlation strong enough to warrant a re-specification of his equations.

Food imports (first difference) are directly related to changes in imports from CARIFTA (Caribbean Free Trade Association) and inversely to changes in agricultural production, meaning that increasing agricultural production depresses food imports, a result which may or may not be true for many developing countries. It seems to me that in Guyana's case, since the major part of agricultural output - rice and sugar - is exported, the validity of this result hinges upon non-tradeable agricultural output, most of which are poor substitutes for imported food items. Both explanatory variables are significant at the traditional 5 per cent level and explain 64 per cent of the variation in the dependent variable. Their estimated parameters were: changes in agricultural production: -0.047; and changes in imports to CARIFTA: -0.43. The latter variable is, however, wrongly signed but the D.W., at a value of 2.2, falls in the acceptance region.

[1] Jarvis's quote is taken from Harvey (1977: 94).

After some experimentation, Jarvis found that intermediate goods (first difference) can be best represented as a function of changes in GNP which is a proxy for changes in the overall level of economic activity. The estimated coefficient on GNP, 0.239, is highly significant and Jarvis observed that it compares well with Manhertz's equation for Jamaica (0.19).

Noting that the production of machinery and manufactured goods (he did not define what is meant by "manufactured goods") is almost negligible in Guyana, Jarvis expected that this category of goods will be heavily dependent on gross investment and GNP. Indeed the coefficient on the first difference of gross investment is 1.19 and highly significant. However, there was no evidence of an accelerator effect (the coefficient on ΔGNP(-1) is -0.029).

Studies Using the Aggregated Approach

Studies using total merchandise imports as the dependent variable are just as common as those that specify a separate equation for each of the several categories of imports. Aggregated import equations have more or less conformed to the conventional specification: log-linear with income and relative prices as the explanatory variables.

Worrell (1981) estimated a conventional (real, log-linear) import function for Barbados and Jamaica. In the case of Barbados, relative prices (defined as cost of imported inputs/domestic price level) turned out to be an insignificant variable while a one per cent change in real income leads to a 0.62 rise in real imports. For Jamaica, both variables are significant, with increasing relative prices leading to a slight decline of imports (-0.03) while real income impacts more than proportionately (1.25.)

The export-led model of St. Cyr (1981) - probably the first empirical export-led model published in the region - explains the endogenous determination of total (merchandise) as a function of total expenditure and net capital inflows. The latter variable in this formulation, emphasizing demand effects, highlights the role of foreign capital in imports and thus exports through links among imports, exports and GDP. Using OLS, "... best ... results [were] obtained after extensive experimentation" (p. 122); still only the expenditure variable (coefficient: 1.09) is significant at the 5 per cent level, leaving this variable as the main determinant of imports. Both the explanatory power of the equation (R^2 = 0.41) and the D.W. statistics (1.69), given the degrees of freedom, are rather low.

A conventional demand function for (real) imports is used by Holder and Worrell (1985) in their study of price formation, with real income (output) and relative prices of tradables to non-tradables as the explanatory variables. Both variables have the expected signs and are highly significant for Barbados. In fact, a 1 per cent increase in real income produces a 2.57 per cent increase in real imports. Similarly, real imports are very responsive to relative prices (coefficient: -1.67), reacting sharply to rising prices. The results of this equation prompted Holder and Worrell to remark that this sharp response of imports augment or deplete financial resources through their effect on foreign exchange reserves. The equation has a good fit(adjusted R^2 = 0.97) but the D.W. is rather low (1.56) even after correction for first order serial correlation.

In the case of Trinidad and Tobago, the income elasticity is even greater—a 1 per cent rise in income induces a 3.16 response in real imports. Relative prices have a small (0.38) but perverse effect. On the other hand, the estimate for Jamaica produces poor results: both variables are insignificant while relative prices are incorrectly signed. Even so, the explanatory power of the equation is quite high (adjusted R^2 = 0.97).

The import equation or the "demand for foreign exchange" in Worrell and Holder (1987) is also dependent upon income and relative prices. As in the previous study, both variables are significant and of the correct sign in the estimate for Barbados. Imports are very elastic with respect to income (3.64); for relative price a situation of almost unitary elasticity exists (-1.19). For Trinidad and Tobago, the income coefficient is 0.83, which is much smaller than the 1985 estimate. Once again, however, relative prices have a perverse effect (0.79) but this could be dismissed as the variable turned to be insignificant. In the case of Jamaica, income has a unitary elasticity effect (1.078) while relative prices are insignificant and has the wrong sign.

Why are these two estimates so different, especially in the case of Jamaica and Trinidad and Tobago? While this is not a simple question, part of the explanation may be due to the different time periods—in Holder and Worrell (1985) the sample period is 1963-80 while it is 1960-82 in Worrell and Holder (1987). Measurement problems may also have a role but nothing can be said about this as we do not know how the variables were measured. Perhaps the variables may not be stationary which points to specification errors.

McIntyre (1986) hypothesized that total imports is a function of total domestic expenditure and relative prices (import price/domestic price level). The estimate shows that a 1 percent increase in the first explanatory variable calls forth a rise in imports of 0.490 per cent; the estimated parameter on relative prices is 433.364. McIntyre is justifiably "... reluctant to accept this result" (p. 199), arguing that this is most likely due to the short length of the data series.

Ganga (1990), studying the Guyanese economy, employs a single behavioral equation for the imports of intermediate and capital goods. Consumer imports have been omitted from the function on the grounds that such imports were subjected to an outright ban. This argument may be called into question for two reasons. First, not all consumer goods were subjected to complete restriction and, second, restrictions were imposed only towards the end of the 1970s while the Ganga model covers the period 1966-85.

The demand for the import of intermediate and capital goods is assumed to be positively related to investment, changes in foreign exchange and the lagged dependent variable; it is also inversely related to relative prices. All variables are correctly signed and are significant. In the short-run a 1 per cent increase in investment expenditure sends imports of capital and intermediate goods up by 0.49 per cent (long-run elasticity of this variable isis 1.02). Foreign exchange, with a coefficient of 0.422, is obviously important while rising relative prices constricts import (coefficient of - 0.33). But it is the lagged dependent variable that produces the biggest short-run effect (coefficient:0.534) on current imports of intermediate and capital goods. This seems reasonable given the heavy dependence of the economy on imported inputs (lagged adjustments).

A much simpler formulation of the import function can be found in Bourne and Nicholls (1990), where the only argument is gross domestic expenditure with no role assigned to relative prices. In the case of Trinidad-Tobago, gross domestic expenditure (coefficient of 0.296) is highly significant, the fit of the equation is good (adjusted $R^2 = 0.83$) but there is a hint of positive serial correlation, judging from a D.W. of 1.71. For Barbados, the equation performs rather poorly: although the estimated coefficient is 0.344, the D.W. is extremely low even with the presence of an AR(1) term. As is usually the case with such estimates, the fit is quite good.

Finally, both the demand-driven and export-led models of St. Cyr and Charles (1992) contain a behavioral equation for total imports, specified in exactly the same way. In the demand-driven model, increases in GDP, with a coefficient of 1.59, call forth a more than proportionate response in imports while relative prices (import price index/domestic price index) depress imports (-0.29). In the export-led model, GDP produces a larger impact (coefficient of 2.07) than in the demand-driven model. The relative price variable (0.27) is found to have a positive (and perverse) impact, contrary to what was found in the case of the demand-driven model. Clearly, in terms of theoretical expectations, the import function in the demand-driven model produces superior results.

Specification and Estimation of the Import Equations

As noted earlier, Carter (1970), Manhertz (1971), Persaud (1979), Jarvis (1982) and Hilaire *et al* (1990), all modelled imports according to broad components. The same approach is adopted here for the following reasons: (a) severe restrictions were not placed on consumer imports until about 1974 and even then not all consumer imports were restricted/banned; (b) raw materials and intermediate goods, a major portion of which comprises oil, is a fundamental bottleneck to production; and (c) capital goods imports are heavily dependent on domestic investment. Because of these reasons, an aggregate import function is not likely to be of much practical use.

The review of the literature in the region indicates that the principal explanatory variables in the import equations are: personal consumption expenditure, GDP, ΔGDP, GNP, ΔGNP, investment, total expenditure, capital inflow, relative prices (the ratio of the Import Price Index to the CPI or some variant), foreign exchange, national income, disposable income and the dependent variable lagged one period. Although the import equations specified below draw upon previous work in the region, they attempt to go beyond this literature in terms of the right-hand side variables used so as to more realistically proxy the Guyanese economy.

We begin by noting that merchandise imports (MMER) can be disaggregated into consumer goods (MCR), raw materials and intermediate goods (MRIR), and capital goods (MKR). That is,

(14.1) $MMER = MCR + MRIR + MKR$

The working assumption underlying the three import equations is that the supply of imports is perfectly elastic since Guyana accounts for an infinitesimally small share of the world trade market. The implication of this assumption is that the prices of imports are exogenously determined.

There are two common explanatory variables in these equations: relative prices and a measure of import capacity. The central government deficit is added as an explanatory variable to the equations for raw materials and intermediate goods, and capital goods but omitted from the equation for direct consumption imports which was drastically restricted, beginning in the early 1970s. Indeed, it proved to be insignificant when it was used as an argument in the several regression runs. Considerable importance is attached to government deficits since a major thesis of this dissertation is that deficits exercised a significant negative impact on imports and hence overall economic activity as measured by GDP or capacity utilization. We begin with the equation for consumer imports.

The import of consumer goods, which includes food and durables, is hypothesized to depend, initially, on disposable income (YDR), relative prices ($RLTVP_{im}$) and import capacity (MCAPR), with the latter variable defined as total exports deflated by the Import Price Index. The estimate of this equation yields:

$$
\begin{aligned}
(14.S1)\quad \ln MCR \; = & \; - \underset{(6.789)}{28.687} + \underset{(9.394)}{4.895 \ln YDR} - \underset{(6.834)}{1.399 \ln RLTVP_{im}} \\
& + \underset{(2.925)}{0.739 \ln MCAPR}
\end{aligned}
$$

Adjusted R^2 = 0.769 S.E.R. = 0.322 D.W. = 1.015

While all variables have the correct a priori signs and are significant, the coefficients on disposable income and relative prices are rather high. In the case of disposable income, the estimate implies that, other things being equal, a 1 per cent rise in the values of this variable will produce a 5 per cent increase in consumer goods imports. Studies in the region using total import as the dependent variable found that the coefficient on national income - which is not the same as disposable income - ranges between 0.63 and 3.64, implying a high marginal propensity to import of out national income. Even admitting that as a subset of national income, disposable income should carry a higher coefficient, it would appear that the estimate in (14.S1) is too high; particularly so since consumption imports were drastically restricted since the mid 1970s (more of this later).

Despite the fact of a high marginal propensity to import out of disposable income, rising relative prices induce a sizable contracting effect on consumer imports. This is rather odd and it might be an indication of the presence of collinearity in the data. It might be noted, however, that the review of the literature above shows that, as an explanatory variable in an equation for **total** imports, relative prices produce a coefficient that ranges from 0.79 to - 1.67. Finally, it is clear from the low D.W. statistic that the residuals of (14.S1) are not white noise.

Next, the dependent variable lagged one-period is added to the equation. Given that prior to the mid-1970s at least two (split peas and wheaten flour) imported consumer goods were staples, the addition of the lagged dependent variable will shed some light on past consumption patterns: how much does import of consumer goods in the previous period influence such imports in the current period? This device can also give us an idea as to the speed of adjustment of actual to desired imports of consumer goods. The estimates obtained on this equation is given below.

$$
\begin{array}{llllll}
(14.S2) & \ln MCR & = -\ 10.906 & +\ 1.549 \ln YDR & -\ 0.567 \ln RLTVP_{im} & \\
 & & \quad (2.8240 & \quad (2.843) & \quad (3.087) & \\
 & & +\ 0.542 \ln MCAPR & & +\ 0.747 \ln MCR_{t-1} & \\
 & & \quad (3.392) & & \quad (6.271) & \\
\end{array}
$$

$$\text{Adjusted } R^2 = 0.911 \quad \text{S.E.R.} = 0.2000 \quad h = 0.770$$

The lagged dependent variable seems to be an important factor to the explanation of consumer imports, judging form the size of its coefficient (0.747), indicating a high degree of persistence in the data. Stated slightly differently, (14.S1) indicates that it takes about 0.335 years for any adjustment between desired and actual consumer imports to be completed. Notice that the addition of the lagged dependent variable to (14.S2) caused the coefficients of both disposable income and relative prices to fall steeply, supporting a suspicion of collinearity in the data. From the h statistic, which is approximately normally distributed, we cannot reject the null hypothesis of no serial correlation (0.770 < 1.645).

As observed earlier, during the latter half of the 1970s, the Government of Guyana began to severely restrict the importation of a wide range of consumer goods, not only in response to the deteriorating domestic economy but, more importantly, because it argued that Guyanese should consume what they produce (its policy of self-reliance). This argument, the result of a policy directive, provided the rationale for the outright ban on two important imported staples: wheaten floor and split peas. A dummy variable can be used to proxy the negative impact of this policy directive on the level of consumption imports but an immediate problem arises: data on the years in which import controls were tightened are not available. One way around this problem is to assume that all years since 1976 in which consumer imports registered a decline represented years when import restrictions were enforced. For these years the dummy variable will take on a value of 1; otherwise it will take a value of zero.

As can be seen from the results (table 28), the policy of self-reliance depressed consumer imports, which is not an unexpected outcome. Moreover, the performance of the equation has improved, as judged by the adjusted R^2 and the diagnostic statistics. Notice also

Table 28. Final Estimates of the Equation for Consumer Imports

Variable	Coefficient	t-statistics
CONSTANT	- 6.400	-1.941
YDR	0.970	1.866
$RLVP_{im}$	- 0.305	1.866
MCAPR	0.321	2.290
MCR_{t-1}	0.757	7.977
DUMC	- 0.302	3.783

Adjusted R^2 = 0.944 S.E.R. = 0.159 h = 0.248 B-G. $\chi^2(2)$ = 1.294
Engle's ARCH $\chi^2(4)$ = 6.873

that the coefficients on disposable income, import capacity and relative prices declined substantially, as they have done through all the estimates with the addition of more explanatory variables to the equation. The fact remains, however, that disposable income and the lagged dependent variable exert the strongest impact on current consumer imports during the sample period.

We can therefore state the equation for consumer imports as follows:

$$\text{(14.2)} \quad \ln MCR = \lambda_{27} + \lambda_{28} \ln YDR + \lambda_{29} \ln RLTVP_{im} + \lambda_{30} \ln MCAPR + \lambda_{31} \ln MCR_{t-1} + \lambda_{32} \ln DUMC$$

where λ_{28} λ_{30} and λ_{31} > 0, and λ_{29} and λ_{32} < 0.

where MCR is the import of consumer goods, YDR is disposable income, $RLTVP_{im}$ is the ratio of the Import Price Index to the Consumer Price Index (relative prices), MCAPR is import capacity and DUMC is a dummy variable intended as a proxy for import restrictions.

Does the specification of this equation differ from previous work in the region? In terms of the explanatory variables included in the equation, it certainly does not conform to previous work. First, previous studies in region, with the exception Hilaire *et al* (1990), did not group the imports of food and consumer together—this, however, depends on the situation being analyzed and thus does not constitute any meaningful difference. Second, in terms of the range of variables and the variables themselves, the specification in (4.31) is different. For example, in similar functions most previous studies have GDP, GNP, personal consumption expenditure or expenditure as a right-hand side variable; none includes a measure of capacity to import; and only Hilaire *et al* (1990) made consumer imports dependent on a price variable.

The import of raw materials and intermediate goods (MRIR) - of which the import of oil comprises a very large portion - is postulated, initially, to depend on the level of economic activity as given by capacity utilization (CAPU), import capacity and the lagged dependent variable. The latter is expected to be a crucial variable in view of the dependence of the economy upon imported inputs for the production of the nation's output. In terms of a partial adjustment framework, this variable will indicate the speed with which the actual imports of raw materials and intermediate goods adjust to desired levels. Given the deep and prolonged economic crisis since 1977 - manifested in the dire shortage of foreign exchange and declining output, for example - adjustment of actual to desired level is expected to be rather sluggish. Indeed, here is a classic manifestation of the vicious cycle: shortage of foreign exchange --> compression of imports--->declining GDP--->falling foreign exchange earnings. The estimate of this experimental equation is:

$$
\begin{array}{llllll}
(14.S3) & \ln MRIR & = 0.733 & + \; 0.937 \ln CAPU & + \; 0.724 \ln MCAPR & \\
 & & \;\;(1.340) & \;\;(2.536) & \;\;(5.188) & \\
 & + \; 0.914 \ln MRIR_{t-1} & + \; 0.242\, AR(1) & & & \\
 & \;\;(11.702) & \;\;(1.053) & & & \\
 & \text{Adjusted } R^2 = 0.924 & \text{S.E.R.} = 0.153 & h = 0.510 & & \text{B-G } \chi^2(2) = 9.209
\end{array}
$$

All three explanatory variables have the expected theoretical signs and are significant at the 5 per cent level. The coefficient on the lagged dependent variable is very high as expected. The capacity utilization variable, as a measure of overall economic activity, shows that it is a critical factor in the determination of imported raw materials and intermediate goods. The size of the coefficient implies that there is almost a proportional relationship: a 1 per cent rise in capacity utilization will require, other things being equal, a 1 per cent rise in imported raw materials and intermediate goods. Autocorrelation does not appear to be a problem once an AR(1) term is added.

As pointed out above, oil comprises a critical component of this category of imports as Guyana imports all of her requirements; the supply of fuel thus constituted a serious supply bottleneck to the recovery of the Guyanese economy shortly after the first oil shock, which has been compounded by the second oil crisis in 1979. To capture the impact of rising oil prices on the economy, a dummy variable, DUFUEL, is used (1960-72 = 0; 1973-188 = 1), which is expected to take on a positive sign. Re-estimating the equation with this variable added, one obtains:

$$(14.S4) \quad \ln MRIR = \underset{(2.486)}{2.017} + \underset{(4.265)}{1.524} \ln CAPU + \underset{(4.805)}{0.649} \ln MCAPR + \underset{(5.669)}{0.706} \ln MRIR_{t-1} + \underset{(2.338)}{0.358} DUFUEL$$

Adjusted R^2 = 0.943 S.ER. = 0.136 h = 0.487 B-G $\chi^2(2)$ = 0.652

The new variable is correctly signed and is significant, adding about 2 per cent more to the explanatory power of the previous equation. (14.S4) also has a lower standard error of the regression; serial correlation is not a problem.

Does relative price matter to the import of raw materials and intermediate goods? Theory, despite the heavy import dependence of the economy, answers this question in the affirmative: there is an inverse relation between price and quantity. We test this hypothesis by adding relative prices to the equation that produces estimate (14.S4). However, the level of the price variable, while having the expected sign, turned out to be insignificant but when this variable is entered in first difference terms ($RLTVP_{im}D$), the results are:

$$(14.S5) \quad \ln MRIR = - \underset{(0.087)}{0.119} + \underset{(4.363)}{1.688} \ln CAPU + \underset{(3.613)}{0.486} \ln MCAPR$$

$$+ \underset{(2.004)}{0.509} \ln MRIR_{t-1} - \underset{(4.169)}{0.422} \ln RLTVP_{im}D + \underset{(4.145)}{0.626} DUFUEL$$

Adjusted R^2 = 0.932 S.E.R. = 0.149 h = - 0.0524 B-G $\chi^2(2)$ = 0.772

In terms of traditional statistical criteria, this equation performed slightly worse than the previous one. Nevertheless, it does provide support for the inverse relation between price and demand: it indicates that a 1 per cent rise in relative prices will lead to 0.42 per cent decline in the import of raw materials and intermediate goods. For this reason, the relative price variable will be retained.

As we observed in Part 1, the fiscal deficit not only widened during the downswing but it was also monetized. In the context of an open economy this course of action can be expected to depress the import of raw materials and intermediate goods. When added to the equation, the level form did not prove significant, but its first difference did (CGDFRD), as could be seen from the estimate below (table 29). A 1 per cent change the fiscal deficit will depress this category of imports by 0.26 per cent, according to the estimate. It might be noted that as variables are added to the basic equation, the coefficient on capacity utilization keeps on rising, moving from 0.937 in the first estimate to 1.945 in the final estimate. On the other hand, the coefficients of the lagged dependent variable and import capacity have declined throughout, suggestive of the presence of collinearity.

Table 29. Final Estimates of the Equation for Raw Materials and Intermediate Goods

Variable	Coefficient	t-statistics
CONSTANT	0.608	0.520
CAPU	1.945	5.810
MCAPR	0.478	4.191
$RLTVP_{im}$	-0.388	-2.178
$MRIR_{t-1}$	0.412	3.844
CGDFRD	-0.258	-1.718
DUFUEL	0.698	5.460

Adjusted R^2 = 0.948 S.E.R. = 0.126 h = 0.609

B-G $\chi^2(2)$ = 0.804 Engle's ARCH $\chi^2(4)$ = 2.156

The average adjustment period of 1.4 years over which desired imports of raw materials and intermediated move towards the actual quantities is indicative of the problems which confronted the economy. Heavy dependence on this category of imports and the dire shortage of foreign exchange meant that output was seriously compressed by supply constraints.

In terms of the adjusted R^2 and the standard error of the regression, this is the best-fitting equation; there is also no hint of autocorrelation and heteroskedasticity. And thus though a process of exploration, we have thus arrived at the best estimating equation for the imports of raw materials and intermediate goods -

$$(14.3) \quad \ln MRIR = \lambda_{33} + \lambda_{34} \ln CAPU + \lambda_{35} \ln RLTVP_{im}D + \lambda_{36} \ln CGDFRD + \lambda_{37} MCAPR + \lambda_{38} \ln MRIR_{t-1} + \lambda_{39} DUFUEL$$

where $\lambda_{34}, \lambda_{37}, \lambda_{38}, \lambda_{39} > 0$ and $\lambda_{35}, \lambda_{36} < 0$.

In terms of the specification and results obtained, (14.3) shows some difference from earlier studies in the region. Previous work employed a strictly conventional specification, with GDP/GNP and/or prices as the arguments in the function. The coefficient on the demand variable ranged between 0.01 and 1.40, which is smaller than the coefficient obtained on the capacity utilization variable in (14.3). The negative impact of prices obtained by (14.3) is greater than those obtained by previous studies in the Caricom area. In other words, the present study finds that demand and price variables exert a considerably greater influence on import of raw materials and intermediate goods despite the fact of the heavy dependence of the economy on this category of imports.

The final import equation is that of the demand for capital goods. Many previous studies contain an equation for the import of capital goods or capital and intermediate goods, which may be taken as an indication of the dependence of the region of such imports. More importantly, it is an admission of the incipient stage of the capital goods industry in the region. The explanatory variable most often used, as might be expected, is domestic investment or some variant of it. Relative prices also appear in several of the equations. But the most elaborate equation - intermediate and capital goods - is certainly that of Ganga (1990), who made this category of imports dependent on investment, foreign exchange, relative prices and the lagged dependent variable. The equation used in this study is heavily influenced by Ganga, as will be seen.

In Part 1 we noted that Guyana is characterized by an almost total lack of an indigenous capital goods sector, a serious structural weakness of the economy given that the productive apparatus is heavily capital-dependent. Intuitively, this would imply that capital goods must be a critical factor in domestic investment. We therefore hypothesize that a change in domestic investment would lead to a large increase in the import of capital goods. As in the other import equations, capital imports is also postulated to depend upon the country's capacity to import. The lagged dependent variable is deemed crucial to this equation, given the importance of capital import to investment: whatever investment is started cannot be completed if this category of imports is halted. In short, a commitment to invest is a commitment to continue importing capital goods. The magnitude of the coefficient on the lagged dependent variable is an open issue, depending on several factors, such as the expected time taken to complete projects, time overruns which seems to the exception rather than the rule, bureaucratic hindrances, and other local circumstances. The estimate of this tentative equation yields:

$$
\begin{array}{llllll}
(14.S6) & \ln MKR & = & -3.165 & + \; 0.926 \ln GDIRD \; + & 0.527 \ln MCAPR \\
 & & & (3.629) & \quad (6.780) & (4.419) \\
 & & + & 0.910 \ln MKR_{t-1} & \quad - & 0.779\ AR(1) \\
 & & & (17.563) & & (4.524) \\
 & \text{Adjusted } R^2 = 0.828 & & S.E.R. = 0.228 & & h = 0.034
\end{array}
$$

All variables have the signs expected on theoretical grounds. Evidently, a change in domestic investment plays a crucial role in the determination of the level of imported capital goods: there is almost a proportional relationship between these two variables. As with the other two equations in this section, the capacity to import is an important explanatory factor in (14.S6). The coefficient on the lagged dependent variable is in fact quite large: given that the duration of capital investment projects have been regularly exceeded, a smaller coefficient was expected.

Do relative prices have any impact on imported capital goods? From a theoretical standpoint, this question must be answered in the affirmative for all scarce commodities (i.e., for all commodities that are not free). Relative prices are therefore expected to depress imports of capital goods. The new estimate is:

$$\text{(14.S7)}\quad \ln MKR = \underset{(2.605)}{-2.445} + \underset{(6.590)}{0.878} \ln GDIRD + \underset{(4.462)}{0.511} \ln MCAPR$$

$$+ \underset{(15.539)}{0.944} \ln MKR_{t-1} - \underset{(1.700)}{0.131} \ln RLTVP_{im} - \underset{(4.733)}{0.791} AR(1)$$

Adjusted R^2 = 0.840 S.E.R. = 0.220 h = - 0.501

As could be seen form the estimate, rising relative prices depress capital imports. Judging from the size of the coefficient, relative prices have a much smaller impact on imported capital goods compared to the other categories of imported goods (consumer imports, and imports of raw materials and intermediate goods). This smaller elasticity of relative prices underscores the dependence of the country on such imports in the expansion\maintenance of her capital stock.

Finally, we wish to determine whether the fiscal deficit impacted on the import of capital goods. If it does, a negative relation is expected. Experiments, the results of which are not shown here, indicate that, while the sign is correct, both the current level and the first difference of the fiscal deficit are not significant variables. On the other hand, a one-period lag of the first difference of this variable proved to be significant, indicating that the fiscal deficit does compress capital imports, but with a lag. Tentatively, the delayed effect may be due to the fact that once a decision has been made to implement a capital investment project, there is very little that can be done to reverse in any significant way resources already committed. Support for the delayed impact of the fiscal deficit is also provided by the high coefficient (0.95) on the lagged dependent, which implies that actual import of capital goods adjusts rather quickly to desired levels, implying that high priority was accorded to this category of imports.

The estimate of the new equation is given below (table 30). In terms of the adjusted R^2, and the standard error of the regression, this is the best performing estimate. Judging from the other diagnostic statistic, there is no indication of the presence of autocorrelation or heteroskedasticity in the residuals. Finally, notice that the coefficients of the variables (GDIRD, MCAPR and MKR_{t-1}) in the original estimate - (14.S6) - have changed little in the experiments leading to the final estimates. Similarly, relative prices changed only marginally from estimate (14.S7) to the final estimate in the table above. It seems, therefore, that the specification of the equation for capital imports is fairly robust.

Table 30. Final Estimate of the Equation for Capital Imports

Variable	Coefficient	t-statistics
CONSTANT	-2.767	-2.969
GDIRD	0.975	6.879
MCAPR	0.570	4.918
MKR_{t-1}	0.946	17.971
$RLTVP_{im}$	-0.151	-1.949
$CGDFRD_{t-1}$	-0.542	-6.470
Adjusted R^2 = 0.850	S.E.R. = 0.213	h = - 0.834
B-G $\chi^2(2)$ = -8.442	Engle's ARCH $\chi^2(4)$ = 3.371	

Ganga (1990), in his model of the Guyanese economy, found that the long run elasticity of investment is about 1.02, which is not much different from that obtained by the estimate on this variable shown in table 30. Relative prices have a greater negative impact (0.33) in Ganga than we have found here. Both foreign exchange and import capacity try to capture the same thing: the ability of the country to import, although the latter is a broader measure. In the table above, the coefficient on this variable is 0.57 whereas in Ganga the estimated parameter on the foreign exchange variable is 0.42. To some extent, therefore, the present estimate seems to reproduce the results obtained by Ganga.

We can now write the estimating form of the equation for capital imports as follows:

$$\text{(14.4)} \quad \ln MKR = \lambda_{40} + \lambda_{41} \ln GDIRD + \lambda_{42} \ln RLTVP_{im} + \lambda_{43} MCAPR + \lambda_{44} \ln \ln MKR_{t-1} + \lambda_{46} \ln CGDFRD$$

where λ_{41}, λ_{43} and $\lambda_{44} > 0$, and λ_{42} and $\lambda_{46} < 0$.

Exports

Caribbean economists have done a great deal of research on the relation between exports and the notion of export-led growth, prompted, of course, by the high degree of openness of the Caribbean economies. Among others, Best and Levitt (1969), and Demas (1965)—indeed, the entire open economy school in the Caribbean context was about the relation between export and growth - have all attempted to examine the role of exports in the process of growth and to highlight its vital importance in economic transformation. While theoretical issues were the principal concern of these early studies, later research, done mainly in the context of modelling some aspect of the economy, sought the establish empirical relations.

Two sets of issues confront researchers in the region in their attempt to study exports. The first relates to the endogenous-exogenous dichotomy. Are total exports or a portion of them exogenous? The export-led model, of course, assumes that total exports are exogenously determined: this is, in fact, its *raison d'être*. Models in the Keynesian tradition are divided. Of the 11 studies in this tradition, three of them - Carter, 1970; Manhertz, 1971; and Hilaire *et al*, 1990 - assume that only a portion of exports is endogenously determined while the others endogenize total exports.

Once this issue is decided - that total exports or a portion of it is endogenous - a second issue arises: should the approach be an aggregated or disaggregated one? That is, should separate equations be specified for different categories of export? The general tendency has been to adopt an aggregated approach. For the eight studies which made exports or a portion of it as endogenous, only one (Jarvis, 1990), employs two behavioral equations. Whatever the approach, the export function(s) is (are) made dependent upon a number of variables, including an activity variable (GNP, GDP, agricultural share of GDP, world GNP), export prices, relative prices, wages, cost of finance, import of intermediate and capital goods and the dependent variable lagged one period. This variety will become evident from the review that follows.

Finally, the implicit assumption of all studies on exports is that of the "small country" assumption, which implies that the countries in the region are unable to alter the prices of export and that the demand for exports is infinitely elastic. It follows, therefore, that exports are determined by supply conditions.

Studies Assuming Part of Exports to be Endogenous

An early pioneer of macroeconometric modelling in the region, Carter (1970) treated all categories of exports except factor payments as exogenous, independent of government policies. He observed that exports of bauxite and aluminum were determined by the current needs of the mining companies; manufactured goods by quotas; tourism, in the period covered by his model, by confidence in Jamaica and the Caribbean area; and agricultural products by the vagaries of the weather. This means that factor payments are the only endogenous component of exports, which is explained by GNP and a dummy variable to capture the effect of a sharp decline of factor payments in 1966, due the curtailment of the migrant work program in the United States. Both variables, correctly signed, are highly significant, with coefficients of 0.044 and -3.86 on GNP and the dummy variable, respectively.

Similarly, Manhertz (1971) takes all Jamaican exports except tourism to be exogenously determined. The dependent variable, earnings from tourism, is made a function of the number of tour-days and the number of available beds (accommodation). The estimate indicates that accommodation constitutes the principal explanation of earnings from tourism. The equation is, however, troubled by an unacceptably high D.W. of 3.44.

Hilaire *et al* (1990) assume that only a subset of exports of goods and services is determined endogenously. This subset refers to manufactured goods; all other exports of goods (including oil) and services are exogenous. Manufactured goods depend on demand proxied by foreign (US$) prices of manufactured goods, the income of foreign importers of these goods and imported intermediate and capital goods. Only the first two variables are significant. According to the authors, the price elasticity of exports of manufactured goods is 0.61 in absolute terms, which suggests that lowering the foreign price of manufactured goods will not lead to increase in the value of manufactured goods measured in foreign prices.

Studies Assuming Total Export to be Endogenous

An early study that takes total exports as endogenously determined is that of Persaud (1979), who estimated both an aggregated and disaggregated (consumer and intermediate goods, and capital goods) export equations. The explanatory variables in all equations are an index of "world GNP" (p. 399), compiled from six countries representing major destinations for Trinidadian goods (WG), and the ratio of export price index of major exporting countries to the export price index of Trinidad and Tobago (WP).[2] In all equations the price variable enters linearly while the other variables are in logarithm. For the aggregated equation (total exports), a 1 per cent increase in "world GNP" produces a 2.6 per rise in exports from Trinidad and Tobago. The price variable, on the other hand, is insignificant. The large coefficients on both variables, a small t-ratio and a low D.W. (1.62), are probably indications of poor specification or serial correlation.

Jarvis (1990) uses exports to the Caribbean Free Trade Association (CARIFTA) and agricultural output as explanatory variables in his two export equations (food, beverages and tobacco, and other exports including sugar, rice and bauxite).[3] The use of exports to CARIFTA as an explanatory variable is questionable as it is a subset of the dependent variable, raising the issue of correlation between it and the dependent variable. Although Jarvis recognized the importance of prices, he opted not to use them as an argument in his export function. Both equations were initially estimated in levels form but were plagued by serial correlation. Respecifying the equations in difference form improved the D.W. to more acceptable levels.

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[2] Earlier Agarwala (1970), studying the Indian economy, argued that the level of economic activity in the rest of the world and relative prices are two of the most important influences in explaining the demand for exports. Many studies have actually adhered to this argument.

[3] Jarvis (1990) is an example that (a) assumes total exports to be exogenous, and (b) employs a disaggregated approach.

The first difference of the agricultural variable, with a coefficient of 0.171, proved to be insignificant in the equation for food, beverages and tobacco, while the estimated parameter on the ΔCARIFTA variable is 4.34. That the agricultural output is not a significant explanatory variable in this equation is not surprising for it is not clear how agricultural output can affect the export of food, beverages and tobacco: food is only a minuscule portion of agricultural output while "beverages and tobacco" are not. On the other hand, most of the export of "food, beverage and tobacco" were destined for the CARIFTA area.

Both variables are significant in the equation for other exports. A change in agricultural output results in an impact of 0.162 on the dependent variable, a relatively small coefficient given that the bulk of agricultural production is exported. The magnitude of the coefficient (1.44) on the CARIFTA variable is somewhat puzzling since the overwhelming portion of other export (indeed, total exports) does not go to this area.

The single-equation used by Ganga (1990) contains three explanatory factors: the change in output, lagged relative prices and the previous period's exports. According to the estimate, a 10 per increase in the first difference of output results in a 9.2 per increase in exports. This finding seems to suggest that productive capacity appears to be the main determinant of export performance, which lends credence to the thesis that exports are constrained from the supply side. The price variable, while having the correct sign, is insignificant, prompting Ganga to remark that this finding ".... is supportive of the structuralists' claim that export supply cannot be stimulated by changes in relative prices" (p. 19). The coefficient on the lagged dependent variable is 0.665 (no t-statistic is printed) which implies an adjustment coefficient of 0.34. On the basis of this, Ganga commented that "... [I]t would take 3 years to close 70 per cent of the gap between the desired level of exports and actual level of exports in the previous year" (p. 20).

In their paper on price formation in small, open economies, Holder and Worrell (1985) used a system of equations, one of which is the production of tradable goods. In the context of the model, all tradables are exported so that the equation for tradable output is in effect an equation for exports. Tradable output is determined by price (of tradables), wage index adjusted for productivity changes and the cost of bank finance. (Worrell and Holder, 1985:415, cite other Caribbean researchers for evidence that firms in the region turn to the commercial banks for their working capital needs). The cost of working capital, taken to be the loan rate of interest, is thus an important argument in the function.

The estimates for tradable output in Barbados, Jamaica, and Trinidad and Tobago are shown in table 31 below. The first important observation is the high coefficient of determination and the unacceptably low Durbin-Watson statistic which makes inference questionable. Moreover, for some countries at least one variable has the incorrect sign. It is clear that the cost of finance is not significant in the case of Barbados and Jamaica; for Trinidad and Tobago the cost of finance has a perverse effect as is wage and price in Jamaica. In fact, the estimate for Jamaica is remarkably poor. Perhaps correcting for serial correlation might have yielded different results.

Table 31. Holder and Worrell (1985): Estimate of the Equation for Tradable Goods

	Barbados	Jamaica	Trinidad and Tobago
Constant	0.834 (1.93)	4.13 (19.14)	2.84 (11.86)
Price	0.400 (5.96)	-0.94 (3.33)	0.29 (4.85)
Wage index	-0.240 (1.60)	0.87 (6.89)	-0.08 (2.55)
Interest rate	-0.035 (0.33)	0.39 (1.03)	0.22 (3.85)
Adj. R^2	0.85	0.86	0.87
D.W.	1.12	1.35	1.07

Source: Holder and Worrell (1985:421-22). Sample period is 1963-80.

Two years later Worrell and Holder (1987) tried again, this time with a model for economic forecasting in the Caribbean. Tradable goods is again made to depend on price and the cost of bank finance. However, the wage index variable used earlier is dropped and replaced by the cost of raw materials. Table 32 reproduces the estimate on this equation.

The authors note that the equations "seem to fit well" (p. 238)—at least the equations for tradable goods have high coefficients of determination and the problem of serial correlation is not as severe here as in the earlier study. Supporting the result of the earlier study, the cost of finance is not a significant variable in two of the three countries. These two studies have thus failed empirically to support the view that the cost of working capital is an important constraint to the production of tradables. The effect of price in this estimate is much lower than the earlier estimate (Holder and Worrell, 1985). As in the earlier study, the estimate for Jamaica produces perverse results: rising prices of tradables depresses output while rising cost of raw materials and interest rate provide a boost to output. For Trinidad and Tobago, the estimates are also poor: none of the variables is significant at the 5 per cent level.

Table 32. Worrell and Holder (1987): Estimate of the Equation for Tradable Goods

	Barbados	Jamaica	Trinidad and Tobago
Constant	3.900 (6.58)	3.133 (7.33)	3.990 (4.01)
Price	0.281 (1.97)	-0.474 (3.02)	0.030 (0.13)
Cost of raw materials	-0.257 (1.14)	0.339 (2.05)	0.462 (0.76)
Interest rate	-0.170 (0.52)	0.873 (2.54)	0.337 (1.19)
Adj. R^2	0.86	0.83	0.83
D.W.	1.74	2.11	1.60
Rho	0.69	0.39	0.743

Source: Worrell and Holder (1987:239- 242). Sample period is 1960-1982.

Instead of the traditional GDP variable, McIntyre (1986) used agricultural output as the activity variable, arguing that exports from the OCES countries are largely agricultural commodities. Exports are also made to depend on relative prices, defined as the price of exports divided by the domestic price level.

The activity variable, with a coefficient of 1.69, is significant but relative prices are not. McIntyre is reluctant to accept this result arguing that lags might be important since exports do not respond immediately to a price change. Moreover, he argues, in many cases changes in export prices are not passed on to the farmers, who base their decisions on farm gate prices. McIntyre thus recognizes that an alternative specification might have yielded more acceptable results but he did not pursue the idea any further.

Total exports in Bourne and Nicholls (1990), also explicitly premised on the "small country" assumption, are determined only by GDP. In the case of Barbados, this variable is significant, with an estimated parameter of 0.189. The fit is extremely good (adjusted R^2 = 0.96) but the D.W. is also very low (0.92) even after allowing for the inclusion of an AR(1) term. For Trinidad-Tobago, only non-petroleum exports is considered, which is explained by non-petroleum GDP. This variable, with a coefficient of 0.162, is highly significant but again the D.W. is low (1.26).

The export equation in the demand-driven model of St. Cyr and Charles (1992) is not vastly different from similar equations employed by other researchers who have done work on the Trinidad and Tobago economy (see, for example, Persaud, 1979). However, both variables, GDP in foreign countries and relative prices, are insignificant, even though their estimated coefficients carry the expected signs. There are certainly problems with the equation: very good overall fit, very low D.W., all variables insignificant, very large coefficient (224.5) on the constant term, and a big coefficient (5.29) on the foreign GDP term.

Specification and Estimation of the Export Equation

This study takes total exports as an endogenous variable. The "small country" assumption is also invoked. In heavily export-oriented economies, such as Guyana, it will be expected that a given increase in GDP will lead directly to a significant rise in exports. This means that a conventional specification of the equation for exports seems appropriate. With only GDP as the explanatory variable, we obtain the following estimate:

$$(14.S8)\quad \ln XTOTR = \underset{(4.262)}{-2.606} + \underset{(17.065)}{1.250} \ln GDPR$$

$$\text{Adjusted } R^2 = 0.917 \quad S.E.R. = 0.108 \quad D.W. = 1.957$$

Domestic output is highly significant and it explains 0.92 per cent of the variations in export. The estimate shows that a 1 per cent increase in GDP will lead to a more than proportionate response - 1.25 per cent - in exports. As judged by the D.W. statistic, the estimate does not indicate the presence of serial correlation.

Economic theory would suggest that a positive relationship is expected to hold between export demand and (export) price. Adding the export price index to the basic export equation, we obtain the estimate as show below:

$$(14.S9)\quad \ln XTOTR = \underset{(4.725)}{-2.980} + \underset{(17.696)}{1.269} \ln GDPR + \underset{(1.700)}{0.040} \ln EP_{ex}$$

$$\text{Adjusted } R^2 = 0.922 \quad S.E.R. = 0.104 \quad D.W. = 1.972$$

Exports, according to the results above, do respond positively to price but the response is rather weak. However, the question may be asked as to whether current export price is the appropriate variable. Given the type of exports produced by Guyana (mainly agricultural products), a response lag is expected, meaning that exports are expected to have a delayed response path. Lagging EP_{ex} one period does not improve the result—the variable is insignificant but of the correct a priori sign:

$$\text{(14.S10)} \quad \ln XTOTR = \underset{(4.303)}{-2.859} + \underset{(16.875)}{1.264 \ln GDPR} + \underset{(0.996)}{0.026 \ln [EP_{ex}]_{t-1}}$$

Adjusted R^2 = 0.915 S.E.R. = 0.108 D.W. = 2.040

The next experiment uses the change in the export price index rather than the level of this variable with the result:

$$\text{(14.S11)} \quad \ln XTOTR = \underset{(5.027)}{-2.499} + \underset{(20.682)}{1.233 \ln GDPR} + \underset{(3.698)}{0.294 \ln EP_{ex}D}$$

Adjusted R^2 = 0.945 S.E.R. = 0.088 D.W. = 1.542

The new variable is significant at the 5 per cent level and is correctly signed. The fit of the equation is better and the S.E.R. is lower but now serial correlation is present. Best results were obtained with an MA(1) term added to estimate (14.S11):

$$\text{(14.S12)} \quad \ln XTOTR = \underset{(5.144)}{-2.509} + \underset{(21.098)}{1.233 \ln GDPR} + \underset{(4.542)}{0.391 \ln EP_{ex}D}$$
$$+ \underset{(1.994)}{0.420\, MA(1)}$$

Adjusted R^2 = 0.947 S.E.R. = 0.086 D.W. = 2.043

B-G $\chi^2(2)$ = -1.512 Engle's ARCH $\chi^2(4)$ = 7.225

According to (14.S12), about 95 per cent of the variations in total exports are explained by GDP and the change in export prices, lagged one period. Notice that in arriving at the final equation the coefficient on GDP remained roughly constant.

During the sugar boom of 1974-76, export earnings increased considerably before tailing off to more normal levels. This unusual event would suggest the inclusion of a dummy variable into the export function, but the results were rather poor as could be seen from the estimate below:

$$\text{(14.S13)} \quad \ln XTOTR = \underset{(3.767)}{-2.321} + \underset{(16.305)}{1.210 \ln GDPR} + \underset{(3.960)}{0.362 \ln EP_{ex}D} + \underset{(0.767)}{0.052\ DISCI} + \underset{(1.521)}{0.349\ MA(1)}$$

Adjusted R^2 = 0.945 S.E.R. = 0.088 D.W. = 2.024

Further estimates, which are not shown, confirm that the domestic price level, proxied by either the CPI or the GDP deflator, is an not important argument in the export function.

The export function used in this study can is thus specified as:

$$\text{(14.5)} \quad \ln XTOTR = \lambda_{46} + \lambda_{47} \ln GDPR + \lambda_{48} \ln EP_{ex}D$$

where λ_{47} and $\lambda_{48} > 0$.

How do the results of this equation compare with those of previous studies? These studies found that the coefficient on GDP or some variant of it ranges from 0.189 to 1.69. Obviously, the estimate obtained on this variable in (14.S13) is within this range. Another common variable in the equation for export is that of price. Ganga (1990), using the first period lag of export prices, obtained a coefficient of 0.665, suggesting a strong, but delayed, response. In our case, exports respond to the change in price - the logarithmic first difference - rather than to the level of prices itself. In both cases, however, the response is delayed. Holder and Worrell (1985) and Worrell and Holder (1987) obtained estimates on the price variable ranging from 0.28 to 0.40 for Barbados; - 0.94 to - 0.47 for Jamaica; and 0.03 to 0.29 for Trinidad and Tobago.

CHAPTER 15

Inflation

In the world economy as whole, the rate of inflation since 1973 has been higher than during the preceding two decades.[1] In developing countries in particular, the many explanations of inflation have mostly emphasized the crucial importance of external factors, a line of thought that actually goes back to Latin America when ECLA argued in the late 1950s that structural factors were the principal cause of domestic inflation. Monetarists subsequently countered and thus ensued one of the more long-standing and famous controversies in development economics.[2] More specifically, monetarists argue that the prime cause of inflation is the rapid growth of the internal money supply which, in turn, derives from widening fiscal deficit; for the structuralist, distributional conflict and structural rigidities are the main casual factors.[3] Both positions were thus open to external influences.

In the course of time both sides have made theoretical concessions which led to the belief that inflation cannot be understood as a purely monetary or structural phenomenon. Indeed, theoretical debate took back seat with the publication of Harberger's (1963) classic

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1 For developing countries, the rates of inflation were: 1960-65: 8.03; 1966-69:8.50; 1970-73: 10.8; 1983-89: 39.47; and 1973-92: 18.90 (Maynard and Ryckeghem, 1975; IMF,1991)

2 Arndt (1985) and Little (1982) discuss the history of the monetarist-structuralist controversy. Both of them also provide good bibliographies. For an econometric comparison, see Watcher (1976).

3 Taylor (1991) notes that over the last 200 years three general approaches to inflation have been in use: monetarist, structuralist and wandering between them.

analysis of inflation in Chile, which shifted the focus of the controversy from economic theory to techniques of econometrics. As the controversy settled down (without any clear victory on either side) research began to focus more explicitly on the relative importance of internal and external factors in the inflationary process. The argument for external factors holds that the deeper a country is integrated into the world economy, the greater the effect of imported inflation. If this proposition is true, then external factors should play a prominent role in the generation and perpetuation of inflation in small, open economies such as those of the Caricom region.

Not very much published work on inflation in the Caribbean exists. Downes (1985), in his econometric study of inflation in Barbados during 1960-77, observed that "work on inflation is still embryonic" (p. 530), a remark specifically directed at small, open developing economies such as Barbados and other Caribbean countries. It is thus not surprising that Bourne (ed. 1977) still remains the most comprehensive reference source on inflation in the region. One of the major conclusions is that import prices are a prime cause of inflation in the region (St. Cyr 1974; Bourne and Persaud 1974; and Worrell 1981, among other Caribbean scholars). Francis (1986) puts this finding into perspective in her study on monetary policy in the Bahamas when she pointed out that "generally [it was] observed that the degree of imported inflation was directly related to the degree of 'openness' of these economies" (p. 114) which is contrary to what Iyoha (1973) found in his study of 33 developing countries.[4]

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[4] To ascertain whether a negative relationship between openness and inflation holds true in developing countries, Iyoha (1973) conducted a cross-country regression for 33 developing countries. The estimated equation, firmly in the neoclassical and monetarist tradition , yields "... results [which] were generally not bad, and there seems to be some evidence pointing to a negative relationship between openness and inflation", (p. 36). Aside from the inconclusiveness of Iyoha's results, there are other problems, including (a) no discussion of the problem of heteroskedasticity or of specification bias which are so typical of cross-country studies, (b) the variable "openness" is defined as the ratio of imports to income, with no explanation as to why this definition was chosen; perhaps other definitions, such as the ratio of export to income or the average of imports and exports to income, might have produced different results.

The rest of the discussion is organized as follows (a) review of empirical findings on inflation/prices in the Caricom region; and (b) a discussion of emerging issues.

Review of Empirical Findings

Manhertz (1971) explains prices, defined as the index of retail prices in the Kingston area,[5] as a linear function of the index of import prices. A highly significant variable, the latter yielded a coefficient of 0.90, the size of which is attributed to "... the high import content of locally produced commodities, as well as the relatively high level of imported consumer goods" (p. 220). The fit of the equation is quite good (0.92) but the D.W. is only 1.4. Following Manhertz, Jarvis (1990) regressed the index of retail prices, urban areas, solely on the index of import prices. This variable, yielding a coefficient of 0.72 and significant at the 5 per cent level, explained 60 per cent of the variation in retail prices, with a D.W. of 0.99. Jarvis recognized that such a low a D.W. is problematic, but decided to keep the equation "... as a matter of experimentation" (p. 21).

In his export-led model of the Trinidad and Tobago economy, St Cyr (1981) made inflation, defined as the percentage change of the index of retail prices, dependent on the money supply, import prices index (which excludes mineral fuels) and an expectation variable, with all variables measured as rates of change; no indication is given as to how price expectations are defined or measured. All variables except price expectations are significant at the 5 per cent level. Import prices exert the largest impact (0.39) on the rate of inflation, followed by changes in the money supply (0.32). This study suggests, therefore, that foreign prices and the money supply were the principal causal factors in the inflationary process in Trinidad and Tobago.

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5 Manhertz points out that the Kingston area price index cannot adequately serve as a "... surrogate for islandwide price changes" (p. 220).

Worrell (1981), in his article on external influences and domestic policies in the economies of Barbados and Jamaica, divides the economy into a traded and non-traded sectors. As is usual with this approach, prices in the traded sector are set on the world market. On the other hand, prices in the non-traded sector, which produces for the domestic market, are determined by internal demand and supply factors. The model is so constructed that foreign influence feeds to the non-traded sector via the traded sector, thus determining the overall rate of inflation.

The estimate of price changes is then made to depend on changes in excess demand, import prices, inflationary expectations (proxied by the lagged dependent variable) and the cost of credit. None of the variables was significant in the estimate for Barbados. In the case of Jamaica, the cost of credit is not a significant variable but import price and price expectations are crucial factors in the determination of the prices of non-tradables. The D.Ws. for both equation do not indicate the presence of serial correlation.

How does foreign prices affect domestic inflation in a small, open economy that has a fixed exchange rate with its main trading partners? According to Downes (1985), there are basically four ways in which foreign prices affect domestic inflation: cost-push, demand-pull, nonmarket or institutional and excess money supply stemming from the inability of the Central Bank to sterilize inflows of foreign exchange which lead to an increase in the money supply, creating disequilibrium in the money market and thus inflation. Downes believes that excess aggregate demand attributable to increase in the money supply (or credit creation) tends to affect the balance of payments rather than inflation in a small, open economy.[6] For Barbados, Downes argues that cost-push factors are of crucial importance in the inflationary process.

[6] Of course, the argument here derives from the monetary approach to the balance of payments. The essence of this approach is that the balance of payments is essentially a monetary phenomenon.

Within this framework, Downes examines the impact of changes in import prices, the interest rate and the wage rate on the rate of inflation, defined as the percentage change in the retail price index during 1960-77. To determine the "best fit" equation, he ran a series of regressions on a combination of the explanatory variables. With import prices as the sole argument, the equation accounts for 73 per cent of the inflation during the period. Adding the rate of interest pushed the coefficient of determination up to 84 per cent; both variables are significant at the 5 per cent level with coefficients of 0.72 and 0.35 for import price and the rate of interest respectively. The insignificance of the constant term is an indication that "... the mean effect of the omitted variables is insignificant" (p. 525). The addition of the current wage rate proved to be insignificant, aside from having the wrong sign. A one-period lag of this variable, while correctly signed, is still insignificant, prompting Downes to argue that "our result refutes the claim that wage rate increases have been a significant factor in the inflationary process. The direction of causation runs from inflation to wage rate increases" (p. 526).

The overall conclusion of the analysis is that increases in import prices and the prime lending interest rate are the principal determinants of inflation in the Barbadian economy, implying that inflation is attributable to both internal and external factors. From this perspective, the easiest way to take some pressure off the inflationary process is to manipulate the variable directly under the control of the authorities—the rate of interest. Control over imported inputs and thus the impact of import prices is more difficult because (a) the need for imported inputs is determined by the structural features of the Barbadian economy—-features that are deeply-rooted and go back to colonial times; and (b) more importantly, import prices cannot be controlled because they are exogenous (Barbados is a price-taker).

How important are **domestic** factors, such as fiscal and monetary expansion, wages, interest rate and exchange rate policies, in the inflationary process of small open economies? While recognizing the importance of foreign prices, Holder and Worrell (1985) shift the focus to internal factors and set out to answer this question through the construction and estimation of an elaborate model aimed at explaining price formation in Barbados, Jamaica and Trinidad-Tobago, using annual data for 1963 to 1980. There are 15 equations in the model, 8 of which are definitions/identities. The economy divides into a tradable and non-tradable sector, with a behavioral equation determining real output in each sector. The core of the model centers on the non-tradable sector for it is here that "... domestic influences interact with external factors to determine domestic prices" (p. 415) and output via the market. However, the market is not perfectly competitive and the price of non-tradables is set by market leadership:

$$(15.1) \qquad P_n = f(Q_n, S, r, P_t)$$

where the term on the left-hand side of the equation is the price index of non-tradables and the right-hand side terms are, respectively, the output of non-tradables, the wage index adjusted for productivity changes, the domestic interest rate and the price index for tradables which is taken to be the same as the price of raw materials "because of the level of aggregation at which this model operates ..." (p. 414). The prices of tradables are exogenous. Disturbances of the banking system are captured by three equations and are passed on to prices via the rate of interest. Wages are made a function of GDP deflator lagged one and two periods.

Given this system approach to the modelling of price formation, dependent as it is on feedback effects, it is impossible to do justice to the results of Holder and Worrell by just discussing the equation for non-tradables. It is for this reason that the econometric results for the non-tradeable sector, the core of the model, are given in table 33.

Looking at the price equation for non-tradables, in the case of Barbados only two of the four right-hand side variables are significant: the domestic interest rate and the price of imported inputs. The coefficient on the price of imported inputs suggests a more than proportionate response as a 1 per cent increase in this variable leads to a 1.6 rise in the price of non-tradable. It is clear that the rate of interest is the only channel through which domestic factors impact upon prices. It is also clear that the output of non-tradables is not important as far as the determination of the prices of tradables is concerned. These conclusions are not firmly based as the D.W. is unacceptably low (1.07), as the authors themselves note (pp. 420-422).

Table 33. Holder and Worrell (1985): Estimates for Output and Prices of Non-tradables

	Barbados	Jamaica	Trinidad-Tobago
(a) Real output of non-tradables			
Constant	-5.300	-2.070	-6.390*
Nominal income (+)	0.842	0.930	0.810*
Relative prices of non-tradables to tradables (-)	-0.119	0.080*	0.380
Domestic interest rate (-)	-0.052*	-0.060	1.490
Previous period output of non-tradables (+)	-0.139*	-0.080*	0.180
D.W	1.010	2.070	2.010
Adjusted R^2	0.820	0.980	0.990
(b) Price index for non-tradables			
Constant	-0.720*	3.200	-1.030
Real output of non-tradables (+)	-0.610*	-0.680	1.020
Price index for tradables (+)	1.550	0.290	0.310
Wage index, adj. for productivity changes (+)	-0.030*	0.660	-0.030
Domestic interest rate (+)	0.590	0.060*	-0.200
D.W.	1.070	1.250	2.030
Adjusted R^2	0.960	0.990	0.999

* Indicates coefficients with t-statistics of less than 1 in absolute value.

Note: Both equations employ the double logs specification and hence the coefficients can be interpreted as elasticities.

Source: Holder and Worrell (1985:421-422).

In Jamaica, it would appear that the price of non-tradables receives a serious wage-push effect. Indeed, the authors note that "wage increases in Jamaica are inflationary and the economy suffers from a dynamic wage-price spiral. However, the spiral is not explosive; wages do not increase by the full amount of the previous year's price increase, and the overall effect on current year prices will be less than the amount of wage increase, since only non-tradable will be affected" (p. 424). The claim that wages increase affect only the prices of non-tradables is rather fuzzy as the tradable sector is not completely isolated. The price of tradables (foreign prices) is clearly important to price formation in the non-tradables sector. Unlike Barbados, the output of non-tradables in Jamaica exerts a big but perverse impact on price: a 1 per cent increase in the output of non-tradables **decrease** the price level by 0.68 per cent. The interest rate variable is insignificant. Again, these results should be interpreted with caution in view of the low D.W. (table 33).

All variables in the price equation for Trinidad-Tobago are significant at the 5 per cent level except the rate of interest. Supply-side influences as gauged by the output of non-tradables are very strong, underscoring the importance of feedback effects of the variables in the equation for the determination of the output of non-tradables. The price of tradables is also an important factor in the formation of the price of non-tradables. Rising wages induce a small response but, contrary to received theory, the effect is to depress prices. Interest rates, with a coefficient of 0.2 and a t-statistics of 1.2, have a weak and perverse linkage to rising prices.

Continuing their modelling work on the same three countries, the study by Worrell and Holder (1987) also contains an output block, where the volumes and price of non-tradables are determined. Like their model of 1985, numerous feedback effects have been introduced in an effort to depict the complexities of a modern economy, particularly as it relates to price formation. The equation for the price of non-tradables in this study is exactly the same as in earlier model (Holder and Worrell, 1985) except that the wage index variable of the latter is now replaced by the cost of factor supplies. No indication is given as to what this includes.

As with the earlier study, foreign prices have an inflationary impact in all three countries, (this variable is significant at the 5 per cent level in all three countries), although the effect is much more restrained in Trinidad-Tobago, while for Barbados it is the only significant variable. Once again, wages are of considerable importance in Jamaica. For Trinidad and Tobago, demand pressures exert a strong upward pull on prices, while the cost-of-factor-price link is weak. In all three countries the cost of credit is not a significant variable in the formation of prices in the non-tradable sector, contrary to the findings of the authors' 1985 study.

We have seen so far that foreign prices are a principal determinant of the inflationary process in the Caricom region. McIntyre (1986) starts off from this presumption as well, but in addition to cost-push factors he felt that excess demand, taken as the difference between money supply (M2) and the demand for money balances, is also an important consideration. With little manipulation, he arrived at an equation in which the level of domestic prices (McIntyre did not indicate how this is measured) is explained by the level of import prices, real income, money supply, and the weighted average of interest on time, saving and demand deposits (WRSTD). All variables in the equation are significant at the traditional level, except import prices, which seems to imply that the inflationary process in OECS states have little to do with foreign prices. The interest rate variable in this linear equation has a huge negative coefficient (-4.739) which is counter to a priori reasoning, while the impact of money supply on the domestic price level is estimated at 0.138. McIntyre argued that the negative sign (-0.068) on the"... income proxy is a counter-intuitive result" (p.199) because an increase in income will result in an increase in expenditure, which should therefore lift, rather than depress, the level of prices. Finally, with an adjusted R^2 of 0.97 and a D.W. of 3.04, it is fair to say that the results of this equation are too poor to draw any reasonable conclusions.

According to Francis (1986), in a small, open economy such as the Bahamas, the maintenance of internal stability "... is very limited since inflation is primarily imported" (p. 113). This observation is based on Harberger (1980) who argued that the exchange rate determined the domestic price level in a small, open economy with a fixed exchange rates, given the tax structure and other influences. In effect, for a small economy in a fixed exchange rate regime, there is only one kind of inflation: imported inflation. Given the strong trade and financial ties between Bahamas and her major trading partner, the USA, Francis postulated that consumer prices in the Bahamas will closely approximate those in the United States.

To support her case, Francis draws upon an econometric analysis of the relationship between the price indexes in the two countries by the International Monetary Fund (1980). The dependent variable, the percentage change in the CPI (for New Providence, Bahamas), is made a function of the percentage change in the weighted finished consumer goods components of the US producer price index. Using monthly data from August 1973 to December 1979 and employing an Almon distributed lag (unconstrained), a coefficient of 0.918 was obtained on the independent variable. The results, in the words of Francis, "... suggest that the effects of changes in U. S. prices last up to 15 months, with one-half of the effects occurring in the first five to six months" (p. 115). Francis further notes that other factors such as wage increases and money supply are not significant factors in the inflationary process in the Bahamas. Similarly, the impact of deficit financing is limited because the Central Bank is limited by law to the amount of advances it can make to the government and by the amount of government securities it can hold in its portfolio. The conclusion, therefore, is that inflation in the Bahamas is "... almost solely imported" (p. 116).

Perhaps the most extensive recent study of a number of macroeconomic phenomena, including inflation, in the Caricom region is that of Bourne (1989). Both the level and changes in price are made to vary inversely with real income (RGDP) and directly with the nominal money stock (M2), the world price level (FP), the exchange rate (e), the nominal rate of interest (LR) and the wage rate (w).

The results, shown in table 34, indicate that for all four countries changes in the broad money stock (M2) contributed to inflation; this is one of the very few studies to establish such a relationship in the region. The exchange rate exerted a push influence in Jamaica, and Trinidad and Tobago and a depressing influence in Barbados and Guyana. The finding on Guyana is perhaps tenable since the Guyanese dollar has been considerably undervalued until the latter half of the 1980s. The other 'monetary' variable, the loan rate of interest, is also a determinant of the price level and inflation in all countries except Jamaica. Foreign prices exerted a push effect on the inflationary process only in Barbados and Jamaica while the wage rate is important only in Trinidad and Tobago, a finding that does not square up with the research of other writers. In general, Bourne's findings point to a central role of monetary variables (money supply, foreign exchange rates, and interest rates) in the determination of the aggregate domestic price level and the inflationary process.

Table 34. Double Logarithmic Domestic Price Level and Inflation Equations

Regressors	Barbados		Guyana		Jamaica		Trinidad	
	1970	1982	1966	1982	1966	1982	1966	1982
	P	$\dot{P}$	P	$\dot{P}$	P	$\dot{P}$	P	$\dot{P}$
CONSTANT	2.18^{a}	-	2.06	-	2.31^{b}	-	4.26^{c}	-
RDGP	0.39^{b}	-0.29	-0.19	1.10	-0.48^{a}	-0.20	-0.53^{c}	-0.20
M2	0.43^{c}	0.41^{c}	0.30^{a}	0.28^{b}	0.31^{a}	0.31^{a}	0.21^{b}	0.18^{c}
e	-1.11^{a}	-0.84^{b}	-0.68^{c}	-0.26	0.34^{a}	0.38^{a}	0.50^{b}	0.32^{c}
FP	0.49^{b}	0.42^{c}	0.21	0.24	0.95^{a}	0.74^{a}	0.30^{b}	0.12
w	0.17	0.24	-	-	-	-	0.29^{a}	0.34^{a}
LR	0.31^{b}	0.31^{b}	0.65^{a}	0.43^{c}	-0.20	0.01	0.09	0.29^{b}
$\bar{R}^2$	0.99	0.60	0.99	0.15	0.99	0.85	0.99	0.70
D.W.	2.45	1.95	2.12	2.30	2.19	2.00	2.12	1.83

Source: Bourne, (1989:280).

Notes: RGDP is real gross domestic product; FP is foreign prices (i.e., import-weighted average of foreign currency export prices of major trading partners); LR is the loan rate of interest; w is the wage rate; and e is the exchange rate (i.e., import-weighted local currency price of foreign exchange). Explanatory variables are expressed in log differences, i.e., percentage changes.

Levels of statistical significance are: a = 1 %; b = 5 %; and c = 10 %.

The determination of the price level (no indication as to how this variable is defined) in Hilaire *et al* (1990) rests on a hybrid formulation, "... reflecting monetary, demand-pull and cost-push influences on prices" (p. 112). On the assumption that an increase in the money supply is produced by an excess supply of money, this variable is expected to positively impact upon prices. Wages and import prices, two other explanatory variables, constitute cost-push factors which producers pass on to consumers. The final dependent variable in the equation, GDP, negatively influences prices, since an increase in supply squeezes the excess demand gap, relieving pressure on prices. Rising GDP also increases the transaction demand for money, sapping up any excess supply in the money market.

All variables in the estimated equation are significant, except the wage rate. Hilaire *et al* observed that this result suggests a lack of a contemporaneous wage-price relationship. The insignificance of the wage-rate together with the size of its coefficient, 3.360, suggests that something is wrong—perhaps with the definition of the wage rate or its measurement. Both money supply (0.060) and GDP (-0.021) exerted on a small effect on price formation in Trinidad-Tobago. The most import factor influencing domestic price formation is the import price level (0.818): *ceteris paribus*, "... a 10 per cent change in the level of import prices would lead to an 8 per cent change in the domestic price level" (p. 121).

Ganga's (1992) (log-linear) equation for inflation, defined as the log percentage change in the consumer price index, contains as explanatory variables changes in the nominal money supply, current and lagged one period (he did not specify whether it was broad or narrow money), real output, the import price index, indirect taxes and inflationary expectations, proxied by the lagged dependent variable. With an adjusted R^2 of 0.92, the most important result is that the current rate of inflation is heavily dependent on past rates (0.901), thus pointing to the influential role of (static) inflationary expectations. Like Jarvis (1990) and Bourne (1989), Ganga also found that imported prices play an important role in the inflationary process in Guyana: a 1 per cent rise in import price lead, other things being equal, to 0.35 per cent increase in inflation. On the other hand, the current money supply variable depresses inflation (coefficient: -0.327), contrary to the prediction of the theory. The lagged money supply term, with a coefficient of 0.165, is not significant at the traditional 5 per cent level. Increases in real output negatively impacts (-0.409) on the rate of inflation as expected. The tax variable is insignificant. In short, the inflationary process in Guyana is apparently fueled by expectations and foreign prices while rising real GDP takes some pressure off the process.

St. Cyr and Charles (1992), in their modeling effort of the economy of Trinidad and Tobago, built two models: a demand-driven model and an export-led model. Both models contain an equation for the index of domestic prices, but it is not clear whether the CPI, the GDP deflator or some other measure is used. Prices in the former model are explained by an index of capacity utilization, defined as GDP divided by aggregate capacity supply, which may be seen as a summary variable in the sense that it is directly related to imports and it reflects pressure in the labor market. There is no way, however, of gauging the impact of either of the two variables implied in this measure of aggregate capacity utilization; there are two other undefined right-hand side variables in this equation that appear to be non-traditional variables. This attempt at explaining the process of price formation thus marks the first attempt in the region to move away from the traditional equation, which contains variables such as money supply, the wage rate, interest rate, the rate of exchange, import prices and real GDP. The OLS estimate of this log-linear equation produces t-values for all three variables greater than 1 in absolute value. However, only the variable FPTT is significant at the 5 per cent level. The index of capacity utilization has a unitary elasticity impact (1.02), but the t-value on this variable is only 1.19, suggesting only a weak link to prices.

The price equation in the export-led model is more typical in the sense that the explanatory variables are the import price index and real average wage. According to the OLS estimate, wages are highly important in the formation of domestic prices: a 1 per cent increase in real wage induces a 0.56 per cent rise in the price level. The import-price variable, with a relatively small coefficient of 0.15, is not significant at the 5 per cent level (t-statistic is 1.88).

Emerging Issues

From the foregoing review a number of issues becomes evident. First, there is the definition of the price level/inflation itself. It would seem that, in the Caribbean region, the consumer price index is the preferred variable. While no justification for the choice of this variable is given in any of the studies reviewed, it is probable that it is based on expediency. Indeed, in many countries of the region measures of inflation besides the CPI are either not available or have insufficient data points. In using the CPI-based measure, interpretation of the results of price/inflation equations should note the following: (a) in some cases the CPI is not for the country as a whole but for specific areas; (b) the scope of the CPI varies from country to country since certain services, such as health and education, receive different amounts of public versus household financing; (c) different weights are assigned to the goods and services comprising the CPI basket; and (d) the CPI may be considerably underestimated for several reasons. These issues make comparisons across countries in the difficult.

It is also clear from the foregoing discussion that it is difficult to obtain empirical estimates of the price/inflation equation in the Caricom region. Variables which are widely recognized, both in theory and practice, as being important turned up either insignificant or else suggest only a weak link. The empirical work so far has almost unanimously identified import prices and the rate of interest (cost of finance) as crucial factors in the inflationary process in the region. There is also some support for the money supply and the wage rate. Other variables such as exchange rate, excess demand, real GDP, capacity utilization and indirect taxes have not been generally supported.

Do inflationary expectations fuel the upward spiralling of prices? Not much consideration has been devoted to this question in the region, probably because the rates of inflation have not been particularly high compared to other regions in the developing world. In the Caricom region as a whole, for example, the average rate of inflation during 1979-88 was only 10.3 per cent.[7] Since expectations are only important in an environment of rapidly rising inflation, this apparent 'oversight' by researchers in the region is probably justifiable.

However, three studies have included static expectations (the one period lag of the dependent variable) as an explanatory variable in the equation for inflation (St. Cyr, 1981; Worrell, 1981; and Ganga, 1990). Expectations were of no importance in the study by St. Cyr while both Worrell and Ganga found them to be important. Thus the question of the significance of expectations in the inflationary process in the region is an unsettled issue which demands further research. Other ways of modeling the formation of expectations should also be experimented with.

The most widely used specification of the price/inflation equation combines monetarist and structuralist variables—money supply, lagged money supply, income, exchange rate, wage rate, the rate of interest. I am not aware of any study in the region that specifically sets out to test the monetarist model *à la* Harberger. To my knowledge, there is no study of inflation in the region which is strictly based on structuralist theory.

The relatively poor results obtained on the inflation equation are also evidenced by the fact that, in general, the fit is not as good as that for other macro aggregates. Areas for exploration include variable search, functional specification, stationarity and the underlying theory. This observation is reinforced by the fact that in several of the estimates discussed above the D.W. statistic is, generally, unacceptable.

The unavoidable conclusion is that, although import prices appear to be a prime cause of inflation in the Caricom region, there is certainly scope for further, more systematic and rigorous, research.

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7 Computed from World Bank (1990b), table 2.11. Of course, there are considerable variations across countries and through time.

Inadequacies of the CPI

It is perhaps best to begin this section by pointing out some of the crucial shortcomings of the data for Guyana. The CPI, introduced in 1952, has not been published officially since about 1985 even though it continues to be computed (World Bank, 1986). Apparently the Government itself lost faith in its reliability. The first problem with the CPI concerns the basket of goods which is no longer representative of current consumption patterns. Second, several items in the basket are no longer available or are available at vastly exorbitant prices. A third issue with the CPI is that many items in the basket have their prices officially controlled but effective control is never exercised. Fourth, the weights attached to different components - food, clothing, housing and other - in both rural and urban areas are unrealistic, biasing the CPI downwards. Not only is the weighing unrealistic, but the weights themselves have been in existence for a long time. Against this background, the substitution bias becomes more pronounced.[8]

Finally, account must be taken of the "expanding parallel market" (World Bank, 1986), which is not captured by the official statistics. Particularly since the early 1980s, the fledgling underground economy has added much more importance to the price of imports as an explanatory factor of the inflationary process. One distinctive feature of the informal economy is that the bulk of its goods come from abroad, which is an indication of the dependence of both consumption and production on imported items. Mark-ups in the informal economy are unusually high. First, there is a provision, an insurance provision in effect, against the official net once the goods are offered for sale on the informal market. Second, there is a bribery element which the hucksters (as those who procure the goods are called) have to pay to clear customs. Finally, there is a provision for risk which must be seen as a reward for unusual courage and as an insurance against loss of capital. These risks notwithstanding, the informal

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[8] The substitution bias refers to the fact that those goods whose prices increase the most are purchased in smaller quantities, and those that rise the least are purchased in larger quantities. A fixed-weight index such as the CPI does not regularly take this fact into account.

market is a lucrative business for the last decade has seen more new millionaires than any other time in the country's history.

These inadequacies of the CPI mean, in short, that the rate of inflation is considerably underestimated, particularly since the 1980s. The upshot is that the results of any empirical study of inflation must be interpreted and used with great caution.

The GDP deflator could be used as an alternative measure of inflation, but a series covering the entire sample period does not exists. Aside from this several other factors militate against the GDP deflator as a measure of inflation. First, in the present case, the GDP deflator does not capture very well the impact of import prices on inflation because of the huge informal sector. Second, it is a broader measure covering, in Guyana's case, agriculture, forestry and fishery; mining and quarrying; manufacturing and processing; construction; and services, including government services. As a consequence, the GDP deflator does not particularly focus on private consumption. Finally, the GDP deflator was specifically designed as a price index because it reflects changes in the composition of GDP, as well as prices. The differences between the GDP deflator and a fixed-weight index such as the CPI can be significant over either short or long periods, if there are large changes in the composition of GDP - which is in fact the case as discussed in Part 1.

Specification and Estimation: A Naive Monetarist Model

Our search for an appropriate explanation of inflation in Guyana begins with the basic monetarist specification first used by Harberger (1963).[9] Next, we incorporate "structuralist" variables into this model. Given the poor performance of these models, we then formulate a model based on the theory of markup pricing. An added advantage of this method is that it

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9 Extensive testing of the monetarist specification has been done in Latin America. For a good review of the literature, see Watcher (1976), who also tests and compares an alternative structuralist specification.

furnishes a natural way for benchmarking the best model against the two other alternatives.

The Harberger model can be specified as -

$$(15.2) \quad \Pi_t = \phi_0 + \phi_1 M2D_t + \phi_2 M2D_{t-1} + \phi_3 Y_t + \phi_4 A_t$$

where all variables are in the logarithmic first difference. For example, Π, representing inflation, is the first difference in the log of the price level. Similarly, M2D is the nominal stock of broad money supply; Y is a scale variable; and A is a proxy for the cost of holding money.[10]

Several studies of inflation (for example, Harberger, 1963; Sheehey, 1979; Saini, 1982; and Morrison, 1987) introduce lags of various length in the monetary variable, defined here as broad money (M2).[11] The lagged adjustment pattern is intended to capture the delayed effects of an increase in the money stock on prices and is especially appropriate to less developed countries with relatively underdeveloped financial institutions and insufficient monetization of economic activities (Saini, 1982). It also offers the opportunity to test the monetarist proposition that, in the long run, changes in the supply of money will be followed by proportionate changes in prices. That is, the sum of the coefficients of the money variable, current and lagged, should not differ significantly from plus 1, if changes in the money stock lead to direct and proportionate changes in prices (Harberger, 1963).

Studies of inflation (and the demand for money) differ widely with respect to the specification of the scale variable. While there is general agreement that real income should be used, the issue is how to measure this variable. Harberger (1963), in his classic study of Chilean inflation, used measured income. Vogel (1974) used real permanent income, approximating the latter by lagging real measured income one or more periods. In this study,

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10 Rates of change rather than levels are used as explanatory variables in (15.2) because they are of more interest to policy makers and promise better behaved residuals (Harberger, 1963 and Vogel, 1974).

11 These studies adopt a narrow definition (M1) of the money stock.

following other Caribbean economists, real measure income (GDPRD) is used as the scale variable. The rate of inflation is expected to vary inversely with changes in real income, that is, to show a negative relation with respect to the rate of change of real income. In fact, a strong monetarist argument would be that the coefficient of the scale variable will not differ significantly from minus 1. If the coefficient of the scale variable is greater than unity, this means that there is a tendency for the public to increase its holdings by a greater than proportional amount, given an increase in income. Values of less than unity is consistent with the Baumol-Tobin proposition of economies of scale in holding cash.

There are also problems with finding an appropriate variable to proxy the cost of holding money, especially in developing countries. In many of these countries the rate of interest is not only administered but has changed too infrequently and is therefore not suitable for estimation purposes. As a consequence, many studies of inflation in developing countries have employed past changes in the rate of inflation as a proxy for the cost of holding money. Harberger (1963), for example, employed $\Pi_{t-1} - \Pi_{t-2}$ as the cost of holding money. More recently, Nugent and Glezakos (1979) have used changes in expected inflation, modelled according to adaptive expectations, as the proxy. In this study experiments will be conduced with changes in (a) the nominal rate of interest (R); (b) the actual rate of inflation (ΠD), and (c) the expected rate of inflation (Π^eD). The expected rate of inflation is generated by an ARMA(2,1).[12]

As specified, equation (15.2) claims that changes in money supply cause changes in prices, given the rate of growth of output. Some authors - Wachter (1976), Harberger (1963) - simply add variables such as relative prices of food, import price and/or wages to the equation to test for the importance of these "structuralist" variables in the inflation process. If the

12 More precisely, the fitted values of the ARMA(2,1) model are used for the (unobservable) expected rate of inflation. The estimate of this model is:

$$(1 + 1.684B - 0.621B^2)\Pi = 0.013 + (1 - 0.948B)\epsilon_t$$

where Π is the actual rate of inflation and ϵ_t is the error term of the ARMA equation.

coefficients on these variables are significant and correctly signed, they are interpreted as evidence of the validity of structuralist models of inflation. However, the mere inclusion of these cost-push variables in the monetarist equation does not do justice to the structuralist arguments concerning the origin and control of inflationary dynamics. The estimate of (15.2) with the three different variables for the cost of holding money are shown on the following page (table 35). Clearly, regression 1 in this table is the preferred equation.

The results indicate that the only opportunity cost variable supported by the data is the rate of interest—regression 1. This variable is significant at the 5 per cent level, indicating that a 1 per cent rise in the rate of interest will lead, *ceteris paribus*, to an increase in inflation of about 0.5 per cent. It will be recalled from the review of the literature that in the case of Barbados Downes (1985) found an estimated parameter of 0.35 on the interest rate variable, while Holder and Worrell (1985) found a much larger coefficient (0.59). Bourne (1989), on the other hand, found that the coefficient on the interest rate variable ranged from 0.29 to 0.43.

While the magnitude of the coefficient on the rate of interest is within acceptable empirical range, it does raise an important question: is it reasonable for this variable to have such a relatively large effect given that the rate of interest remained unchanged for long periods of time? More importantly, the real interest rate was negative for some periods. These questions cast some doubt on the validity of the estimate.

Table 35. Estimates of Monetarist Equation (15.2) for Inflation

Variable	Regression 1	Regression 2	Regression 3
Constant	-0.073 (2.348)	-0.028 (0.841)	-0.028 (0.892)
Money	0.577 (4.355)	0.468 (2.929)	0.465 (2.994)
Money(-1)	0.370 (2.698)	0.329 (1.843)	0.326 (2.081)
Real GDP	-0.175 (1.728)	-0.174 (1.416)	-0.171 (1.433)
Interest Rate	0.463 (2.704)		
Actual Infl.		0.067 (0.277)	
Exp. Infl			0.114 (0.338)
Adj. R^2	0.599	0.454	0.468
S.E.R	0.055	0.064	0.063
D.W.	1.756	1.377	1.538
Comment	Smpl = 1962-88; no. of obs = 28. Adding an AR(1) term results in: the sum of the money terms declining to 0.86; real GDP term not significant at the 5 per cent level; absence of serial correlation. The interest rate term remained significant.	Smpl = 1962-88; no. of obs. = 26. Adding an AR(1) term results in: real GDP becoming insignificant; the coefficients of the 2 money terms summing to 0.64; and removal of serial correlation. The proxy term for cost of holding money remained insignificant.	Smpl. = 1962-88; no. of obs. = 27. Adding an AR(1) term results in: real GDP becoming insignificant; the coefficients of the 2 money terms declined considerably, summing to 0.0.5; and removal of serial correlation. The proxy term for cost of holding money remained insignificant.

The coefficient on both the current and one-period lagged money supply terms are significant and correctly signed. As expected, the impact of money supply on inflation is distributed over more than one period, beginning with the largest impact in the current period, implying that changes in money supply are not fully reflected in prices within one year. To test whether the effects are delayed further in time, a two-period lag of the money supply was added to (15.2). The result, not reproduced here, shows that this term, while having the correct sign, is insignificant (coefficient = 0.045; t-statistic = 0.258), confirming the finding that changes in money supply are fully reflected in price changes within one year.

The sum of the coefficients on the two money terms amounts to 0.947, which is not significantly different from 1 as predicted by the theory, implying that changes in money supply do seem to lead direct and proportionate changes in prices. In his macroeconometric model of the Guyanese economy, Ganga (1990), it will be recalled, did not find much support for money supply as a significant source of inflation. In fact,he found that the change in **current** money supply impacted **negatively** on inflation while the change in the previous period money supply exerted a small positive influence. Other studies in the region include only the current money term as an explanatory variable, with the coefficient ranging from 0.18 to 0.41.

The length of the lag on the monetary terms is an unsettled issue and is usually allowed to be determined by the data set. The importance of this issue stems from its relation to monetary stabilization policies. If long lag lengths exist in the effect of money supply on prices, then monetary stabilization policies will be harder to implement due to the length of time required for them to have full effect. Long lag lengths, defined as lags of up to M_{t-3}, have been found by Vogel (1974), Morrison (1987), Saini (1982) and others. On the other hand, if monetary policy has a faster impact - that is, if the lag length is not long -, then changes in the money supply will have a rapid effect on prices and monetary stabilization policies should be very effective in the short run. This is what the studies in the region suggest, including the estimates in table 35. This finding is, however, tentative, given the inchoate state of financial markets in the countries of the region.

Perhaps the most serious problem with the best results (Regression 1, table 35), of equation 15.2 is that the coefficient of the income term is significantly different from -1, which is not in accordance with the monetarist theory. In fact, the coefficient on this term (-0.2) supports the Baumol-Tobin proposition of economies of scale in holding cash. The two other studies on Guyana found conflicting results. Ganga (1990) obtained a coefficient of - 0.4 on real income while Bourne (198) obtained a perverse result - a positive coefficient of 1.0 on this term. Bourne's results for the three other countries, Barbados, Jamaica, and Trinidad and Tobago, ranged between - 0.20 to 0.29. In general, therefore, the present study as well as those of other researchers do not support the monetarist proposition as far as the coefficient on the real income term is concerned. Indeed, the results on the real income term point to fundamental weaknesses in the financial infrastructure of the economy, a further reason why the applicability of the monetarist models to developing countries such as Guyana should be viewed with skepticism.

What, then. can we conclude from the explanatory power of the (naive) monetarist equation? At best, the performance is mixed. While the proportionality assumption is apparently supported, there are problems surrounding the rate of interest and real income. Additionally, the best equation in table 35, regression 1, has an adjusted R^2 of only 0.60 and apparently suffers from positive serial correlation. Correcting for this by adding an AR(1) term results in a decline of the sum on the money terms, while real income becomes insignificant. It seems, likely, therefore, that the data do not provide very strong support for the monetarist explanation of inflation in Guyana.

Specification and Estimation: An Extended Monetarist (Hybrid) Model

Structural variables are frequently introduced into (15.2) to improve its performance and to demonstrate that inflation is much more than the monetarist theory claims. Following Morrison (1987), Saini (1982) and Sheehey (1979), among others, we add two cost-push terms to equation (15.2). These are the logarithmic changes in the import price index ($P_{im}D$) and wages (WD). The equation may thus be re-stated as:

$$(15.3) \quad \Pi_t = \phi_0 + \phi_1 M2D_t + \phi_2 M2D_{t-1} + \phi_3 Y_t + \phi_4 A_t + \phi_5 P_{im}D + \phi_6 WD$$

The results of the estimate of this equation are given below (table 36).

A number of observations are now in order. First, both estimates clearly show that import prices are a significant source of domestic inflation. The magnitude of the coefficients on this variable for both estimates are about the same as in Bourne's (1989) estimate for Guyana. They are much smaller, however, than that obtained by Ganga (1990) and Jarvis (1990): 0.35 and 0.72, respectively.

Second, wages do not appear to be a source of domestic inflation as this term proved to be insignificant, aside from having the wrong sign. It will be recalled that both Downes (1985) and Bourne (1989) in the case of Barbados and Hilaire *et al* (1990) in the case of Trinidad and Tobago found no support for the argument that wages are an explanatory factor in the inflationary process in these countries. On the other hand, St. Cyr and Charles (1992) and Holder and Worrell (1985) found that wages are a contributory factor to the upward spiralling of prices in Jamaica, and Trinidad and Tobago, respectively.

Third, the re-estimated equation (15.3) resulted in real income becoming in significant. Fourth, the addition of these variables improved the adjusted R^2s considerably. Finally, for both estimates the sum of the coefficients on the money supply terms declined considerably, falling to about 0.55. This observation also holds true for the rate of interest. The changes in the coefficients brought about by the addition of the two "structuralist" variables may be point to collinearity in the data set, interdependence between money supply and the structural variables or more fundamental problems, such as misspecification.

In summary, it is reasonable to say that, given the estimates produced by equations (15.2) and (15.3), the monetarist explanation of inflation in Guyana is not strongly supported by the data.

Table 36. Testing the Significance of Structuralist Variables in the Inflation Equation

Variable	Regression 1	Regression 2
Constant	-0.312 (4.514)	-0.314 (4.368)
Money Supply	0.329 (2.635)	0.330 (2.575)
Money supply(-1)	0.224 (1.928)	0.229 (1.816)
Real GDP	-0.063 (0.726)	-0.061 (0.675)
Interest Rate	0.254 (1.722)	0.263 (1.574)
Import Price Index	0.237 (3.708)	0.238 (3.606)
Wages	----	-0.016 (0.127)
Adj. R^2	0.746	0.734
S.E.R.	0.043	0.044
D.W.	2.034	2.068

Specification and Estimation: A Model Based on the Theory of Markup Pricing

As should be evident from the discussion above, studies of inflation in the Caricom region have employed exclusively theories based on neoclassical and monetarist schools of thought. Indeed, I have been unable to identify any published work in the region coherently based on structuralist, or any other alternative, theory of inflation. Empirical research has apparently lagged behind theoretical development as the region has played an important role in the evolution of both the dependency and structuralist schools of economic thought.

This effort at modelling inflation draws heavily upon the Post-Keynesian theory of markup pricing, but it also incorporates elements of neoclassical and monetarist theories. The theory of mark-up pricing, as is well-known, is an important element in the structuralist theory of inflation.

Cost of production comprises purchases of inputs (both imported and domestically produced), the wage bill, profits and paid-out earnings, and interest charges. Assuming a one-sector economy, the costs of home-produced intermediate inputs can in principle be reduced to primary and imported inputs through the input-output system. Pricing behavior is assumed to follow the theory of markup pricing, along the lines of Kalecki (1971) and Sylos-Labini (1984). The markup is defined over prime costs of labor and imported intermediate inputs. Prime costs per unit of output are defined as:

$$(15.4) \quad PRMCST = W*LOCOF + EXRT*P_{im}*IOCOF$$

where PRMCST is prime cost, W the money wage rate, LOCOF the labor-output ratio, EXRT the nominal rate of exchange, P_{im} the Import Price Index used as a proxy for the price of imported intermediates, and IOCOF the input-output coefficient of intermediates. Let ω be the period over which prime inputs must be financed as working capital, assumed to be one year in the context of the annual model being formulated. Let R be the nominal rate of interest on loans borrowed by productive units, IDRATE the rate of indirect taxation on final goods, taken as (agriculture + mining and quarrying + manufacturing + construction)[13] and MKUP the rate of markup over interest-inclusive prime cost. Direct cost, DRCST, per unit of output is then

$$(15.5)\quad DRCST = [[1+(MKUP/100)]*[1+(IDRATE/100]*[1+(R/100)\omega]]*PRMCST$$

where $R\omega$ represents interest on working capital, with ω the period over which working capital is to be financed. Equation (15.5) could be re-written more compactly as:

$$(15.6)\quad DRCST = MDW*PRMCST$$

where

$$(15.7)\quad MDW = [[1+(MKUP/100)]*[1+(IDRATE/100]*[1+(R/100)\omega]].$$

MDW is thus the product of direct tax, the markup and the cost of working capital. Henceforth, this variable will be referred to as the "rate of imposition" since it represents the total "taxes" imposed on direct costs.

The cost of credit, measured by the nominal rate of interest, is particularly important in developing, capital-constrained countries. The assumption here is that entrepreneurs must have money on hand to pay in advance for the services of current inputs in the production process. In a poor, inflationary economy, suppliers of inputs are too financially constrained to allow their payments to wait.[14] This specification reflects the fact that with poor articulation

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13 In the national accounts of Guyana, GDP is disaggregated into (a) agriculture, forestry and fishing, (b) mining and quarrying, (c) manufacturing and processing, (d) construction and (e) services. With the exception of (d) all other categories are further subdivided into narrower groupings.

14 Taylor (1983) noted that the emphasis on working capital goes back a long way in the structuralist tradition. In this regard, a good empirical study is Morely (1971) for Brazil.

of both the transport and financial systems in developing countries, entrepreneurs typically have to make large advances for working capital; interest on these advances thus becomes a critical consideration. The positive impact of interest on prices is variously referred to as the "Wright Patman effect" after the late easy-money Congressman from Texas by Americans and in Latin America it is attributed to Cavallo, while references to it date back to a generation ago (Streeten and Balough, 1957 and Galbraith, 1957). In the Caribbean setting Worrell and Holder (1987) note that the behavior of firms in the region suggests that the cost of labor and finance are crucial to firms in the short-run.

Although a minimum wage policy has been in effect for sometime now, the state-regulated minimum wage rate has not been used in this exercise because it sets the absolute minimum below which workers would not take on employment. Rather, the wage rate used here represents the arithmetic average of hourly wages paid to workers in sugar fields, sugar milling, rice milling, bauxite mining, metal works, manufacturing, government (public works), commercial undertakings, motor transport and construction. Estimates for the 1960s and 1970s are fairly accurate (since they are taken from World Bank, 1973 and various issues of Social and Economic Studies) but those for the 1980s are subject to an unknown downward margin of error; that is, the estimates are presumably higher, but by an unknown amount according to discussions with various sources in Guyana. The estimates for 1980-88 have been obtained from interviews with the private sector, government officials and unofficial data during a data-collecting mission to Guyana in July 1992.

As formulated here, indirect taxes on final goods are defined over interest-inclusive prime costs. The price level is thus dependent on the rate of indirect taxes, the markup rate, the interest rate, the exchange rate, the price of imported intermediate inputs and the period over which prime costs must be financed, assumed to be one-year.[15] In short, changes in output prices will depend on unit factor cost and the markup.

[15] The assumption of a one-year production cycle is made for convenience and is perhaps questionable.

To the extent that the markup relates to some normal level of output (Coutts, Godley and Nordhaus, 1978), it is postulated that prices will also be positively associated with the existence of excess demand. That is, we can now write the price equation as

(15.8) P_t = COSTLW + COSTII + GDPXS

where COSTLW is the cost of labor, including the rate of imposition as given by (15.7); COSTII is cost of imported raw materials, including the rate of imposition; and GDPXS, excess demand for output, is the deviation of actual GDP from trend (GDP3XSD).

To model the rate of inflation, two modifications are made to the price equation (15.8). The first is to include some measure of expected inflation (Π^e_t) for which three different notions are employed. Method 1 follows established practice and simply takes the previous period inflation rate as the expected rate of inflation. The second method uses the Nugent-Glezakos approach (Nugent and Glezakos, 1979) which assumes that people predict the value of a variable from its past observations by using the adaptive expectation mechanism and a quadratic loss function. For a brief discussion of the Nugent-Glezakos see the annex to this section. The third method (weak rational expectations) of modelling expectations employs an ARMA (2,1) process. See footnote 22, page 222, for greater details on this method.

The second modification to the price equation is to accommodate the widespread presence of goods shortage and high liquidity ratios that have characterized the Guyanese economy since at least the late 1970s to the end of the period modelled. Demand pressures in the goods market are captured by the deviation of broad money from a perceived normal level, the latter being defined as the trend value of M2 (M23XSD). This variable is intended as a proxy for excess purchasing power and hence demand-side pressure in the economy. The inclusion of both an explicit purchasing power variable and an output gap (GDPXS) in the inflation equation is an attempt to pin down the particular excess demand features in an economy characterized by widespread shortages. The estimating equation for price inflation can now be written as:

$$(15.9)\quad \Pi_t = \lambda_{49} + \lambda_{60}\,\Pi^e_t + \lambda_{61}\,\text{COSTLWD} + \lambda_{62}\,\text{COSTIID} + \lambda_{63}\,\text{M}^*\text{3XSD}_{t-1} + \lambda_{64}\,\text{GDP3XSD}_{t-1}$$

where λ_{60}, λ_{61}, λ_{62}, λ_{63}, and $\lambda_{64} > 0$.

The three best estimates - each corresponding to a different notion of expected inflation - are shown in table 37 below.

Table 37. Estimates Based on the Theory of Markup Pricing

VARIABLE	REGRESSION 1 STATIC EXPT.	REGRESSION 2 ADAPTIVE EXPT.	REGRESSION 3 RATIONAL EXPT.
CONSTANT	-0.013 (0.936)	0.003 (0019)	0.003 (0.179)
LAGGED DEP. VAR.	0.975 (12.468)		
ADPT. EXPT.		0.009 (6.643)	
"RATIONAL EXPT."			0.771 (7.925)
COST OF LABOR	0.068 (1.412)	0.110 (1.949)	0.113 (2.269)
COST OF IMP. INPUTS	0.114 (3.442)	0.278 (1.938)	0.279 (2.198)
EXCESS DEMAND	0.142 (1.587)	0.301 (2.410)	0.228 (2.032)
EXCESS MONEY SUPPLY	0.507 (3.099)	0.701 (3.590)	0.638 (3.632)
ADJ. R^2	0.907	0.776	0.824
S.E.R.	0.040	0.041	0.0361
D.W.	2.127	1.863	2.002
B-G STATISTIC	$\chi^2(2)$: 0.598	$\chi^2(2)$: 0.444	$\chi^2(2)$:1.071
ENGLE'S ARCH	$\chi^2(4)$: 6.225	$\chi^2(4)$: 2.024	$\chi^2(4)$: 7.529

All estimates find the cost of labor and imported raw materials to be important factors in the inflationary process. Regressions 2 and 3 produced coefficients of a similar magnitude on these two variables, although their significance level is higher in regression 3.

Excess demand, taken as the deviation from trend output, is significant at the 5 per cent level in the estimates using adaptive and near-rational expectations but not in the equation employing static expectations. Of the three estimates, regression 2 produced the biggest coefficient on the excess demand variable: a 1 per cent rise in excess demand will drive prices up by 0.3 per cent. The only study in the region that includes excess demand as an explanatory variable (Worrell, 1981) obtained a coefficient of 0.26, which is not very different from that obtained by regression 3 in the table 37 above.

All estimates find evidence of a positive impact of excess money supply (measured as the deviation of broad money from trend) on rising prices. The coefficients on this variable range from 0.51 to 0.70. The magnitudes of these coefficients are probably a result of the rapid growth of money supply, fueled by a burgeoning deficit, and the existence of excess of liquidity in the banking system, particularly during the 1980s (Part 1).

Do expectations exert a large impact on the inflationary process during a period of mild inflation? The issue here is not that agents do not build expectations during periods of mild inflation; rather, it is about the magnitude of the impact. In theory, high inflationary expectations are expected to prevail in periods of rapidly rising prices, but less so when prices are not going up as rapidly.

What does the evidence show in the case of Guyana, a country that experienced only moderate inflation - according to official data - during the sample period? Regressions involving both static and weak rational (modelled according to an ARIMA process) expectations provide strong support for the existence of high inflationary expectations (table 37). According to regression 1, a 1 per cent rise in (static) expectations leads to a proportional increase in inflation. Ganga (1990), also using static expectations, obtained a coefficient of 0.91. Regression 3 (weak rational expectations) produces a smaller coefficient (0.77) on the expectational term. On the other hand, the estimate using adaptive expectations - regression 2 - yielded an implausibly small (0.009) but highly significant coefficient on this variable.

In terms of the "goodness of fit," regression 1 has the highest adjusted R^2, followed by regression 3 and 2 respectively; the lowest S.E.R. is produced by regression 3. All three estimates performed well in terms of the D.W., the B-G statistic and the Engle's ARCH. The issue before us now is: which of the three estimates is the best? If only the adjusted R^2 were the decision criterion, the clear winner would have been regression 1 which employs static expectations. Unfortunately, the problem is not as simple as this, as is evident from the foregoing discussion. If other criteria are used, such as the standard error of the regression and the reasonability of the estimated parameters, the issue boils down to a choice between regressions 2 and 3. To convincingly settle the issue, an *ex post* forecast, an exacting decision criterion, of all three regressions in table 35 will be done. All three equations were estimated over 1960-88 while the forecast period is 1989-90. The results, given in table 38 below, clearly show that, *ex post* forecast 3, which is based on weak rational expectations (modelled by an ARMA process) outperformed the other two forecasts, which are based on static and adaptive expectations.

Table 38. Comparative Ex Post Forecasting Performance of Regressions 1, 2 and 3

CRITERIA	FORECAST 1 (STATIC EXP)	FORECAST 2 (ADAPTIVE EXP)	FORECAST 3 (RATIONAL EXP)
RMSPERR	20.4	0.23	0.17
THEIL	0.11	0.13	0.09
UM	0.39	0.59	0.27
US	0.23	0.14	0.23
UC	0.39	0.28	0.50

How does the performance of regression 3 of table 37 compare to the best monetarist and best extended monetarist equation? To answer this question, we need to consider regression 1 of table 35 (monetarist), regression 1 of table 36 (extended monetarist) and regression 3 of table 37 (structuralist). We have already seen that the monetarist model is not supported by the data. We noted that the extended monetarist equation provides only a crude framework for testing structuralist theories of inflation. Moreover, regression 3 of table 37 outperformed the extended monetarist equation (table 36) in terms of adjusted R^2, and the standard error of the regression.

We conclude, therefore, that during the sample period inflation in Guyana is best modelled according to the theory of markup pricing. The single most important factor in the inflationary process appear to be expectations: they are crucially important despite the fact that Guyana experienced mild rates of inflation during the sample period. This could be taken as further evidence (in addition to incorrect estimates as pointed out earlier) that the mild rates of inflation shown by official figures are misleading—mild rates of inflation and high inflationary expectations do not go together. Excess money supply, according to the estimate of the best equation, is also an important cause of inflation: a 1 per cent rise will call forth a 0.6 increase in domestic inflation, pointing to the need for a much more disciplined monetary policy than has actually been the case (Chapter 6). The output gap - i.e, excess demand pressures -, while important, does not exert an overwhelming impact on inflation, which is contrary to the standard Bretton Woods institutions assumption of a considerably overheated economy. Finally, the markup, the rate of indirect taxes and the rate of interest, and thus the Cavallo effect, are also of importance in the inflationary process through their impact on imports and wages.

CHAPTER 16

Potential Output and Depreciation

Potential Output

Many models of developing economies do not have a behavioral equation for either actual or potential output. Rather, these models express output as an identity, being the sum of consumption, investment, government, export and imports. Potential output is normally not modelled for many reasons, including the fact that it is not an observable variable. In the present exercise, the need for this variable arises from the fact that capacity utilization, defined as the ratio of actual to potential output, appear as an explanatory variable in the equation for the import of raw materials and intermediate goods. The idea is that capacity utilization, and hence potential output, acts as a supply-side constraint on this category of imports.

Potential output is taken as an endogenous variable since it is not postulated to depend on engineering capacity. Rather its level is explained within the model, being dependent on economic conditions, using a two-step modelling strategy. The first involves obtaining values for potential output, which was estimated by SORITEC, using the method of peak-to-peak interpolation.[1] The second step involves the specification of a behavioral equation for the endogenous determination of potential output (GDPTR) according to a Cobb-Douglas production

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[1] SORITEC is an Integrated Econometric and Statistical Analysis package produced by Sorties Group, Inc.

function relating labor and capital to output:

$$(16.1) \qquad GDPTR = \lambda_{66} KR^{\lambda_1} L^{\lambda_2}$$

where KR and L are measures of the aggregate capital stock and potential labor supply, respectively, and λ_i's (i = 0, 1, 2) are coefficients to be estimated. Because of the absence of data on the capital stock (no time series on this variable exists for Guyana), this variable is proxied by summing gross fixed investment during 1950-1988. That is,

$$(16.2) \qquad KR_t = \sum GDIR_t$$

where t = 1950...1988, KR_t is the capital stock in year t and $GDIR_t$ gross domestic investment in year t. Potential labor supply, for which no data exist, is obtained by deflating the labor force, defined as males and females between the ages of 15 and 55, by the unemployment rate. Unemployment data, which are not published by the Government of Guyana, were obtained from various World Bank reports, discussions with business men, senior government officials and from personal knowledge of the Guyanese economy. The estimates are, however, on the conservative side. The estimate of (16.1), with labor and capital as the explanatory variables, is:

$$(16.S1) \qquad \ln GDPTR = \underset{(23.356)}{8.427} + \underset{(5.400)}{0.196} \ln L + \underset{(25.065)}{0.245} \ln KR$$

Adjusted R^2 = 0.952 S.E.R. = 0.014 D.W. = 0.874

The coefficients on labor and capital, as far as the Guyanese economy is concerned, seem reasonable, but this equation is misspecified, judging from the very low Durbin-Watson statistics. Indeed, assuming the presence of positive serial correlation and adding an AR(1) term to the equation results in lower coefficient estimates, higher adjusted R^2 and a slightly improved D.W. statistic.

Production in Guyana is heavily dependent upon imported inputs, comprising raw materials and fuels. In the case of fuels, not only is the economy totally dependent upon imports but all imports are purchased by the government. Imported inputs thus exercise a stranglehold on the economy. In other words, even with adequate labor and capital, output would grind almost to a halt if imports, fuel in particular, were no longer available. In view of this, it is necessary to include an explanatory variable in the potential output equation for import bottlenecks.[2] The variable used is the capacity to import, defined as export earnings deflated by the import price index. In way the impact of foreign exchange, and thus one gap of the now famous two-gap thesis, is factored into the equation for potential output.

The foreign exchange rate, also a proxy for import bottlenecks, was not used in view of the fact that (a) all fuel imports are purchased by the government at the fixed, non-market-determined official rate of exchange, (b) the Guyana dollar was considerably overvalued during the sample period; hence the "black market" premium paid for US dollars (Thomas, 1989), and (c) all imports by firms have to pass through the Bank of Guyana, again at the official rate of exchange.

With a variable for import bottleneck, defined as real import capacity (MCAPR), added to the equation, the following result was obtained :

$$
\begin{aligned}
(16.S2)\qquad \ln GDPTR &= \underset{(20.227)}{8.653} + \underset{(4.850)}{0.208 \ln L} + \underset{(16.902)}{0.223 \ln KR} \\
&\quad + \underset{(3.030)}{0.212 \ln MCAPR_{t-1}}
\end{aligned}
$$

$$\text{Adjusted } R^2 = 0.970 \quad \text{S.E.R.} = 0.014 \quad \text{D.W.} = 1.831$$

2 Many models of developing countries with an equation for potential output include an import variable as an argument in the function. This variable is intended to underscore the impact of foreign exchange shortages, and thus imports, on production. For a further discussion, see Rashid (1984), who used import of raw materials, intermediate goods and capital goods. See also Winston (1971).

A higher adjusted R^2 has been obtained and the estimates are more acceptable on the grounds of conventional statistical criteria.

To take account of the impact of technical progress, a linear time-trend, t, is added to the equation. But the constant rate of technical progress implied by the linear time trend is not a very tenable assumption, given the technological dependency of the Guyanese economy and the nature of its productive apparatus. This prompts the addition of a quadratic time trend as well, which allows for the possibility of an accelerating or decelerating trend rate of growth. The estimating equation for potential output can now be stated as:

$$(16.3)\quad \ln GDPTR = \lambda_{65} + \lambda_{66} \ln KR + \lambda_{67} \ln L + \lambda_{68} \ln MCAPR_{t-1} + \lambda 5_{69}\, t - \lambda_{60}\, t^2$$

where λ_{66}, λ_{67}, λ_{68}, and $\lambda_{69} > 0$ and $\lambda_{60} < 0$

The estimate, given by table 39, indicates that this - equation (16.3) - is the best-performing equation as judged by the adjusted R^2, the D.W. statistic and the standard error of the regression. The ARCH test also indicates that the disturbance term does not suffer from heteroskedasticity. The relatively small coefficient on (potential) employment indicates that labor productivity is rather low: a 10 per cent increase in employment will call forth, other things being equal, a 1 per cent rise in potential output. Ganga (1990), it may be recalled, obtained a small negative but insignificant labor coefficient (-0.092) in his equation for actual output. To an extent, these results are not conflicting as they both point to under-employment and low labor productivity.

Table 39. Final Estimate for Potential Output

Variable	Coefficient	T-stat
CONSTANT	1.167	4.734
ln POTENTIAL EMPLOYMENT (L)	0.101	2.221
ln CAPITAL STOCK (KR)	0.205	3.380
ln IMPORT BOTTLENECK VARIABLE (MCAPR)	0.304	4.356
LINEAR TIME TREND (t)	0.094	7.385
QUADRATIC TIME TREND (t^2)	- 0.002	- 7.983

Adj. R^2 = 0.997 D.W. = 2.005 S.E.R = 0.007
F = 1815.743 G-B statistic $\chi^2(2)$ = 0.983
Engle's ARCH $\chi^2(4)$ = 2.909

The coefficient on the capital stock, 0.205, lends empirical support to belief that production of all commodities in Guyana is heavily dependent on capital, in terms of capital infrastructure and mechanization. Rice, in particular, is heavily mechanized, a trend that began since World War II. Given the high import dependency of the economy, a relatively large coefficient on the import bottleneck variable is expected and the estimate of (16.3) does provide some support for this hypothesis: every one percent increase in import capacity induces a 0.3 per cent rise in potential output. Indeed, as could be seen from table 39, the import bottleneck variable exerts the biggest quantitative impact on the level of potential output.

Technical progress does boost output as shown by the semi-elasticity on the linear trend variable. Its cumulative impact over the sample period of 30 years adds up considerably, which is rather unsurprising, given the bulk of domestic investment goes into infrastructure, such as dams, sea defence, irrigation schemes—investments that embody high technology in the Guyanese setting. The presumption that the impact of technical progress is not linearly distributed over time is also supported by the estimate. Indeed, the results show that, beyond a point, the fruits of technical progress begin to decline, albeit by a modest factor. The implication is that new technology needs to be constantly added to boost productivity.

Depreciation

It will be recalled that investment enters into the formula for the capital stock in gross amounts, which means that depreciation charges (DPRR) must be determined within the system of equations. This is intuitively clear: the amount used up for current depreciation charges must be related to the wear and tear suffered by the capital stock in producing the previous period output. A time trend has been added to the equation to chart the course of depreciation charges through time. A simple equation for depreciation is used:

$$(16.4)\quad \ln DPRR = \lambda_{61} + \lambda_{62} \ln KR_{t-1} + \lambda_{63}\, t$$

where $\lambda_{62} > 0$ and $\lambda_{63} > 0$ or < 0.

The estimate of equation (16.4) yields:

$$(16.S3)\quad \ln DPRR = \underset{(4.175)}{-12.808} + \underset{(6.285)}{2.417} \ln KR_{t-1} - \underset{(7.697)}{0.244}\, t + \underset{(6.971)}{0.604}\, AR(1)$$

Adjusted $R^2 = 0.940$ S.E.R. $= 0.072$ D.W. $= 1.544$

B-G $= \chi^2(2) = 11.358$ Engle's ARCH $= \chi^2(4) = 3.277$

The very high coefficient on K_{t-1} is not unexpected given the peculiar Guyanese situation where a large portion of the capital stock is infrastructure. The capital stock has been subjected to heavy wear and tear resulting from usage, the elements, and poor maintenance since the late 1970s. In view of this, the negative sign on the time trend is puzzling. A graph of real depreciation charges show a rising tendency during 1960-1979 but between 1980-88 the graph turns steeply downward. However, it is difficult to tell from this plot whether the rising or falling trend predominates. It is also possible that depreciation charges have been considerably underestimated.

While the ARCH test does not indicate the presence of heteroskedasticity, the equation suffers from the problem of positive serial correlation, as could be seen from the D.W. and B-G statistics, even after adding an AR(1) term; nor was the problem solved by the inclusion of an AR(2) term. No further attempt was made to correct the equation - by respecification or otherwise - because it is peripheral to the model in that it is not intended to test any hypothesis of major importance.[3]

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[3] Some studies have found that the equation for depreciation suffers from serial correlation. See, for example, Chiu (1985) and Kobayashi *et al* (1985).

CHAPTER 17

The Export-led Model

Preliminaries

How does another model of the Guyanese economy perform with the same data set used by the Augmented Keynesian Model? This is a legitimate question which any model-building effort should seek to answer: not only to ascertain which model more accurately approximates the data-generating process, but also to discover properties of the respective models. The purpose of this chapter is to set out the econometric specification of a model against which the AKM will be benchmarked.

It is usual to construct a somewhat stripped-down version of the main model as the standard for comparison as this permits a good insight into the properties of the main model. Here we departs from this approach and will use instead an export-led model (ELM) for the purposes of comparison. It is believed that this approach to model comparison accomplishes two things: (a) provision of the usual benchmark; and (b) allowing a direct comparison between two models based on the two main approaches to econometric modelling in the region. The idea as regards point (b) is to shed some light on the relative merit of the two approaches, an issue raised recently by St. Cyr and Charles (1992). Their conclusion is that in "... comparison with the larger ILPES [Keynesian] model the export driven model performs at least as well" (p. 202).

The ultimate rationale for the export-led model, on which considerable theoretical work has been done in the region, rests upon the proposition that in open economies overall activity is driven by exports. Table 40 does support the argument that the four large regional economies are indeed very open, using the three traditional definitions of openness (exports, imports, and exports plus imports as a percentage of GDP). The openness of these four MDCs economies - as is the economies of the other member countries of Caricom - is in fact an inherited feature that goes back to their colonial origin, as we try to show in Part 1 in the case of Guyana. The World Bank (1990b:6) notes in this context that "all countries [i.e., Caricom countries] have extremely open economies, as measured by the ratio of exports to GDP, which averages 60 %. This compares to a ratio of 18% for middle-income developing countries."

Table 40. Indicators of Openness, 1980-1988

Country	Exports as % of GDP[a]	Imports as % of GDP[a]	Exports and Imports as % of GDP[a]
Barbados	68.3	72.4	140.7
Guyana	58.4	70.2	128.6
Jamaica	59.6[b]	76.7[b]	136.3
Trinidad and Tobago	38.6	41.6	80.2

Source: Computed from the country tables of World Bank (1991)

a/ GDP at current factor cost

b/ Denotes 1980-87

The export-led model constructed here is based on the works of St. Cyr (1981) and St. Cyr and Charles (1992), with four modifications. First, previous models have been extended to include behavioral equations for government revenue, government expenditure and gross investment. Second, the normal aggregated import equation has been disaggregated into consumption goods; raw materials and intermediate goods; and capital goods so as to make it comparable to the main model built by this study. The third modification attempted to make equations of the present export-led model more representative of the Guyanese economy.

Finally, the construction of the present ELM was guided by the principle of comparison on equal grounds. In practical terms, this means that all sources of error which are **not** common to both models - the Export-led Model and the Augmented Keynesian Model - will be eliminated as far as possible. The usual export-led models have behavioral equations for the wage rate and labor supply which open it to the accumulation of errors over time introduced by these variables, thus giving it an unfair disadvantage compared to the AKM set out earlier. To eliminate this potential source of error, these two equations have been deleted. Next, a behavioral equation for the determination of depreciation was added to the ELM, bringing it on even grounds with the AKM. Export-led models, unlike the AKM, have always omitted a behavioral equation for money demand. To make the two models comparable - as far as possible -, a money supply identity was added to the export-driven model, on the assumption that money supply - i.e., broad money - equals money demand in equilibrium. That is,

$$(17.1) \qquad M^s = M^d$$

One crucial assumption of the ELM is the endogenity of money supply. The endogenity-of-money-supply argument has a long history as early pioneers of monetary theory in the Caribbean apparently maintained this presumption, albeit not in a fully developed framework. This position is evident from a quote in Jones-Hendrickson (1985), who succinctly reviews the exogenous-endogenous argument in the Caribbean context, to the effect "... that the U.K. money market acted as a financial intermediary in the transmission of funds from the

Caribbean up to the early 1970s...[1]

In the post 1970s period, the influence of the British pound was replaced by that of the American dollar, which became the anchor currency in the region. Even after the former Caribbean colonies acquired independence and established their own central banks, the latter were no more than "keepers of nonreserve currencies" (Jones-Hendrickson, 1985:117). Moreover, during this time it is natural to assume that the international reserve position of many Caricom countries changed frequently as several of these countries maintained a regime of fixed exchange rates. Obviously, this impacts upon the monetary base and thus money supply. Given this background, and the high degree of openness of the regional economies, Howard (1982:80) argues that "... the nominal money stock as well as the monetary base are endogenous variables." McClean (1981, 1982) echoes Howards' argument, while Bourne(1974) and Worrell (1982) expressed dissenting views. A definitive position on the exogenous-endogenous argument in the Caribbean remains to be established, although both theory the evidence amassed thus far weigh in favor of the endogenity argument.

The precise way in which the money supply is linked to the balance of payments can be easily demonstrated. For any developing country on a fixed exchange rate, the money supply is definitionally the sum of two components: the amount of domestic credit of the banking system that is outstanding (NDC), and the stock on international reserves of that country (IR), measured in terms of domestic currency. There is, therefore, a domestic and an international component of the money supply, viz.:

$$M^{s} = NDC + IR \tag{17.2}$$

Changes in the domestic money stock ($M^{s}D$) can occur either through an expansion/contraction of domestic credit (NDCD) or by monetary movements that lead to changes in international

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[1] This quote is from Jones-Hendrickson (9185:118) who takes it from Joseph-Napier (1980:48).

reserves (IRD). That is,

$$(17.3) \qquad M^{*}D \quad = \quad NDCD + IRD$$

where 'D' at the end of a variable name indicates the difference operator. Changes in international reserves, IRD, are brought about by movements in the balance of payments:

$$(17.4) \qquad IRD \quad = \quad BOPR - CARR$$

$$(17.5) \qquad BOPR \quad = \quad CABALR + TKINR$$

where CABALR is the balance on the current account, TKINR is net capital flow (i.e., the balance on the capital account) and BOPR is defined as the overall balance on the current and capital accounts. Once allowances are made for changes in commercial arrears (CARR) on the BOPR, the resulting balance is known as changes in net reserves, in Guyana dollars (IRD). The equations for the complete Export-led Model are given in Annex 3, pages 373 to 381.

Estimates of the Equations for the Export-led Model

Government Revenue and Expenditure

The estimate of the revenue function indicates a heavy dependence upon output, with the coefficient on this variable two times as large as that of the Augmented Keynesian Model (Chapter 12). In fact, the results (17.S1) show that, other things being equal, a 1 per cent increase in GDP calls forth a 1.9 rise in revenue. Income (GDP) and a first order autoregressive term account for 0.86 per cent of the variation in government revenue. After correcting for serial correlation, both the D.W. and the B-G statistics are in the acceptable range. Also there is no sign of heteroskedasticity, as is evidenced from the result of the ARCH test. Nevertheless, while the equation performed well as judged by standard statistical criteria, the large coefficient on the intercept term for a double logarithmic function is somewhat troublesome. It seem likely that the equation is under-specified.

$$(17.S1) \qquad CGTRR = -\underset{(2.050)}{8.027} + \underset{(3.879)}{1.855}\,GDPR + \underset{(2.452)}{0.517}\,AR(1)$$

Adj. R^2 = 0.856 S.E.R. = 0.135 D.W. = 1.894

B-G $\chi(2)$ = -0.845 Engle's ARCH $\chi(4)$ = 4.992

As with the revenue function, it was necessary to add an AR(1) term to the expenditure equation in order to correct for serial correlation. The estimate produces:

$$(17.S2) \qquad \ln CGTXR = -\underset{(1.778)}{8.479} + \underset{(3.322)}{1.930}\ln GDPR - \underset{(4.931)}{0.722}\ln CGDFR + \underset{(3.667)}{0.636}\,AR(1)$$

Adj. R^2 = 0.938 S.E.R. = 0.129 D.W. = 1.828

B-G $\chi(2)$ = 6.577 Engle's ARCH $\chi(4)$ = 2.276

All variables are correctly signed and significant at the 5 per cent level. Output impact heavily upon expenditure: a 1 per cent increase in output induces a 1.9 rise in expenditure, highlighting the dependency of the a huge government sector (about 80 per cent of the economy) on total output. A large share of this expenditure goes to the upkeep of the nation's infrastructure upon which production is so dependent. The fiscal deficit, as expected, exerted a restraining impact on expenditure and while the response is not proportional, the magnitude of the coefficient in this model indicates a greater response of expenditure to the deficit compared to the AKM, discussed in Chapter 12. The equation explains about 0.94 per cent of the variation in the expenditure data, but it is possible that the problem of serial correlation is still present as the statistic on the B-G test is greater than the critical value of 5.99 at the 5 per cent significant level.

Imports

As pointed out previously, the specification of the import function in this model departs from traditional export-led models in that it is disaggregated according to components. The idea is to facilitate comparison with the AKM. The equation for consumer imports has output, relative prices and a linear time trend as arguments. The estimate is -

$$
\begin{array}{llllll}
(17.S3) & \ln MCR = & - \; 6.121 & + \; 1.956 \ln GDPR & - \; 0.567 \ln RLTVP_{im} \\
 & & (4.479) & (8.008) & (2.244) \\
 & & - \; 0.027\, t & + \; 0.201\, AR(1) & \\
 & & (2.108) & (0.933) & \\
\end{array}
$$

$$\text{Adj. } R^2 = 0.940 \quad \text{S.E.R.} = 0.169 \qquad \text{D.W.} = 1.820$$

$$\text{B-G } \chi(2) = 6.833 \qquad \text{Engle's ARCH } \chi(4) = 3.393$$

All variables are significant and carry the signs expected on theoretical grounds. Income, as proxied by GDP, has a large coefficient, impacting more than proportionately on consumer imports. This is somewhat troublesome as consumer imports were drastically restricted since the late 1970s. The AKM, which uses disposable income, produces a coefficient of 0.97 on this variable.

Relative prices - that is, the ratio of import to domestic prices ($RLTVP_{im}$) - indicate a relatively large negative response, much larger than obtained by the AKM. In other words, consumer imports are very sensitive to changes in relative prices as consumer are apparently willing to withhold consumption or to substitute locally produced goods. The latter is somewhat disturbing as it is a known fact that domestic goods are a poor substitute for imported goods. Perhaps after more than a decade of harsh import restrictions, consumption patterns might have shifted more to internally produced commodities.

The time variable, t, shows that consumer imports experienced a falling trend during 1960-88, which is in fact confirmed by the data and is probably expected given government's policies towards consumer imports. This finding is supported by the estimates of the AKM, which approximates the impact of restrictive policies towards consumption imports by means of a dummy variable.

A good fit has been obtained, although there is probably some residual serial correlation as indicated by the B-G test, the result of which is above the critical value of 5.99. The S.E.R. of 0.169 on this estimate compares acceptably with the same equation of the AKM, which has an S.E.R. of 0.159. In terms of predictive ability, then, the two equations are not expected to differ widely. Estimate (17.S3) is free from the problem of heteroskedasticity.

The equations for raw materials and intermediate goods, and capital goods have the same set of explanatory variables: output, relative prices, capital inflow and a linear time trend. The capital-inflow variable (TKRMMER) enters both equations in "rate" form. The estimate of the equation for capital imports (MKR) yields:

$$(17.S4) \qquad \ln MKR = \underset{(2.243)}{-4.664} + \underset{(5.973)}{1.808} \ln GDPR - \underset{(2.202)}{0.785} \ln [RLTVP_{im}]_{t-1} + \underset{(2.970)}{2.020}\, TKRMMER + \underset{(2.155)}{0.044}\, t$$

$$\text{Adj. } R^2 = 0.770 \quad S.E.R. = 0.262 \quad D.W. = 2.413$$
$$\text{B-G } \chi(2) = -4.049 \quad \text{Engle's ARCH } \chi(4) = 0.748$$

The results of this estimate are not particularly impressive and compare rather poorly with the corresponding equation of the AKM, both in terms of the traditional statistical criteria and the reasonability of the magnitude of the coefficients. According to (17.S4), output is a principal determinant of capital imports but since output is driven by exports in this model, it is fair to assume that capital imports are geared to serve the requirement of exports. This offers one probable explanation for the magnitude of the coefficient on the real GDP variable.

The single most important determinant of capital imports is the inflow of capital, according to (17.S4). This comes as no surprise in light of the discussion in Part 1: the heavy dependence of investment on foreign capital and the virtual absence of a capital-goods industry—for it is true that any major investment in the country would die still-born if it were not for the inflow of foreign capital. Relative prices put a break on capital imports but again the magnitude of the coefficient on this variable is rather high: in the AKM the coefficient on this variable is - 0.151. The estimate also reveal that capital imports have been rising over time, albeit very slowly.

After several experiments with various combinations of variables, the best estimate for the import of raw materials and intermediate goods (MRIR) is shown by (17.S5) below. The basic message of this estimate is that the import of raw materials and intermediate goods depend upon what is happening to the domestic economy, as proxied by the level of output. The results show that a 1 per cent increase in output calls forth a 1.7 per cent rise in this category of imports. That is, rising output, presumably stimulated by exports, requires a more than proportionate rise in this category of imports if the momentum is not to be lost. The AKM found similar evidence: a 1 per cent increase in capacity utilization drives up this category of imports at twice that rate. Both models thus provide evidence in support of the observation that production is very import-dependent (Part 1). Further, capital inflow

$$\text{(17.S5)} \qquad \begin{aligned} \ln MRIR = &\underset{(3.119)}{-9.048} + \underset{(5.571)}{1.742 \ln GDPR} + \underset{(2.836)}{0.666\, TKRMMER_{t-1}} \\ &- \underset{(1.720)}{0.197 \ln [RLTVP_{im}D]_{t-1}} + \underset{(4.097)}{0.081\, t} \end{aligned}$$

$$\text{Adj. } R^2 = 0.938 \quad \text{S.E.R.} = 0.133 \quad \text{D.W.} = 1.804$$
$$\text{B-G } \chi(2) = 0.177 \quad \text{Engle's ARCH } \chi(4) = 1.809$$

acts as a stimulant to the import of raw materials and intermediate goods. This is not entirely unexpected since some of this inflow has been used as balance-of-payments support and to purchase fuel without which the productive mechanism of the economy would have grounded to a halt. The rising level of this category of imports over time, as shown by the trend variable, is alarming as it implies that the economy is becoming even more import-dependent on productive inputs.

The level of relative prices, though correctly signed, was not significant in the equation. However, the change in the relative price level in the previous period, $[RLTVP_{im}D]_{t-1}$, is significant at the 10 per cent level; the relatively small coefficient could be construed as further evidence of the dependency of the economy on imported inputs.

Output

Output in the export-led model is a function of exports (XTPTR) and taxes (TAXR). Given the basic presumptions of the model (that overall economic activity is driven by exports), the coefficient on the export variable is expected to be positive and relatively large. Taxes, on the other hand, are a disincentive to production and an inverse relation between the two variables is posited. The estimate of the equation provides support for this theoretical reasoning:

$$(17.S6) \qquad \ln GDPR = \underset{(4.222)}{2.230} - \underset{(7.354)}{0.009} \ln TAXR + \underset{(15.627)}{0.789} \ln XTOTR$$

$$\text{Adj. } R^2 = 0.909 \quad \text{S.E.R.} = 0.089 \quad \text{D.W.} = 1.870$$

$$\text{B-G } \chi(2) = 0.926 \quad \text{Engle's ARCH } \chi(4) = 5.717$$

Both explanatory variables have the expected signs and are significant at the traditional 5 per cent level. The marginal negative impact of rising taxes on output seems to imply that taxes in Guyana are not a major deterrent to production. As predicted by the export-led model, domestic output is highly dependent on exports: a 1 per cent increase in exports calls forth a 0.79 per cent increase in output. It would seem, therefore, that (17.S6) supports one of the crucial implications of the export-led model: that the internal dynamic of the economy is derived from exports. Similar results were obtained when GDP and exports enter the equation in terms of growth rates (the results of which are not shown here). These results, it must be observed, do not provide evidence on causation—that is, it cannot be said from the estimate that exports cause output as this can only be determined from a causation test (such as the Granger test).

Gross Domestic Investment

Investment (GDIR) has been made to depend on an accelerator effect ($GDPD_{t-1}$), the current capital stock (KR), and the inflow of capital per unit of gross domestic investment (TKRGDR). All three variables are expected to impact positively upon investment. The estimate obtained on this equation is shown in (17.S7).

$$\text{(17.S7)} \quad \ln GDIR = \underset{(3.520)}{2.237} + \underset{(2.410)}{1.476 \ln GDPD_{t-1}} + \underset{(7.341)}{0.469 \ln KR} + \underset{(3.572)}{0.691\, TKRGDR} + \underset{(6.185)}{0.880\, MA(1)}$$

Adj. R^2 = 0.785 S.E.R. = 0.172 D.W. = 1.833
B-G $\chi(2)$ = 0.000 Engle's ARCH $\chi(4)$ = 7.546

The accelerator effect on domestic investment is quite large but delayed by one period, with a 1 per cent increase in the variable leading to a 1.5 per cent rise in investment. The magnitude of the coefficient on this variable offers some support for another assumption of the export-led model: that investment, and hence productive capacity, grows to satisfy export demand. Much of this increase in investment is financed by capital inflow as it evident from the coefficient on the capital-inflow variable. This means that even after most of the economy was nationalized by the late 1970s, the country continues to rely heavily on external financing of her investment needs, as pointed out in Chapter 4.

Inflation

Any explanation of inflation in Guyana, regardless of the theory, must confront the problem of very poor data. As noted in Chapter 15, the most widely (probably the only) used measure of inflation in Guyana, the Consumer Price Index, considerably underestimates this malady and, as a consequence, results from the estimate of the inflation equation will have to interpreted with this shortcoming in mind.

Inflation (Π) in the export-led model is explained by a combination of monetarist and structuralist variables. The function is neither a traditional monetarist equation nor a structuralist equation, but rather a curious combination, with explanatory variables appended almost in an *ad hoc* manner. Our first estimate of this equation produces:

$$\text{(17.S8)} \quad \Pi = \underset{(1.854)}{-0.046} + \underset{(3.464)}{0.726}\,\Pi_{t-1} + \underset{(0.125)}{} \underset{(2.205)}{0.032\ M^{\bullet}D} + 0.277M^{\bullet}D_{t-1} + \underset{(0.304)}{0.003\ WD} + \underset{(2.023)}{0.219\ P_{im}D}$$

$$\text{Adj. } R^2 = 0.788 \qquad \text{S.E.R.} = 0.040 \qquad \text{B-G } \chi(2) = -0.316$$

All variables have the expected signs, but the first money term (MD) and the wage variable (WD) are not significant. After some experimenting, the best estimate of the inflation equation was found to be:

$$\text{(17.S9)} \quad \Pi = \underset{(2.481)}{-0.044} + \underset{(4.900)}{0.637\ \Pi_{t-1}} + \underset{(2.700)}{0.277M^{\bullet}D_{t-1}} + \underset{(1.865)}{0.012\ WD_{t-1}} + \underset{(5.526)}{0.245\ P_{im}D}$$

$$\text{Adj. } R^2 = 0.826 \quad \text{S.E.R.} = 0.036 \quad \text{B-G } \chi(2) = 0.088$$
$$\text{Engle's ARCH } \chi(4) = 2.513$$

All variables are now significant. The estimate shows that the single most important explanatory factor of the inflationary process is expected inflation (Π_{t-1}), modelled as a static process: a 1 per cent rise in expected inflation will push prices up by about 0.73 per cent. The impact of money supply on price comes not from changes in the current period but from change in the previous period, which is perfectly consistent with the theory. In the case of import prices ($P_{im}D$), it is the current values of this variable which are important to the inflationary process, exerting about the same magnitude of impact on prices as the lagged money term. Wages affect prices with a delay of one period, which may reflect money illusion, but the relationship is rather weak.

Depreciation is explained in terms of convention - capital stock in the previous period and a linear time trend. The specification of this equation is the same for both the ELM and the AKM.

PART 3 - PERFORMANCE OF THE MODELS

The final part of this dissertation assesses the performance of the Augmented Keynesian Model against an alternative Export-led Model. The justification for benchmarking the main model against a full-blown competing model derives from the fact that the Export-led Model is the second most popular approach to econometric modelling in the region. In the final analysis, this comparison is expected to throw some light on the most appropriate modelling strategy for the small, open economies of the Caricom region.

The following performance tests will be done: historical simulation, turning point accuracy, long-swing accuracy, ex post, out-of-sample, forecasting and a recently developed encompassing-like test. In the case of the traditional tests, the Augmented Keynesian Model outperformed the Export-led Model by a wide margin. The encompassing-related test clearly establishes the dominance of the Augmented Keynesian Model in "quasi ex ante" forecasting, but it also shows that the Export-led Model carries some information for forecasting investment and government revenue not contained in the former model.

CHAPTER 18

Simulation and Ex Post Forecasting Performance

Evaluation Criteria

While it is customary to evaluate the properties of an econometric model to ascertain its "goodness of fit," it is necessary to point out that the overall usefulness of the model depends critically upon the purpose for which it was built. In a single equation model, for example, one would expect that a model intended for forecasting purposes should have as small a standard error of forecast as possible. On the other hand, a model designed to test a specific hypothesis or measure some elasticity would rely much more on t ratios.

The same considerations apply to a multi-equation model, except that the evaluation criteria become more complicated. Because of the richer and dynamic structure of a multi-equation model, it is not necessarily true that the statistical fit of the individual equations will offer a solid guide as to the tractability of the model. Pindyck and Rubinfeld (1991:337) note that "... even if all the individual equations fit the data well and are statistically significant, the model as a whole, when simulated, may not track those data closely." Aside from the ability of the model to replicate the actual data within the sample period (historical simulation), including turning points, the usefulness of an econometric model can also be assessed in terms of its forecasting performance (*ex post* and *ex ante*) and policy simulation runs, which examines the effect of "shocks" arising from one or more of the exogenous variables. The effect of the policy change is then measured by the difference between the shocked and control solutions. More recent and exacting performance test include several encompassing test. Generally, it is said that model A encompasses model B if it has the ability to account for the behavior of B or, in other words, if it can explain the behavior of relevant characteristics of model B.[1]

In the final analysis, the several model performance tests - all of which aim to throw some light on the "goodness of fit" of the model - are captured by summary statistics, but the following will be employed here: (a) root-mean-square error (RMSE); (b) root-mean-square percent error (RMSPE); (c) Theil inequality coefficient and its decompositions UM/UV/UC);[2] and (d) two tests developed by Gordon; these will be discussed later.

The RMSE and RMSPE are the most widely used criteria of the "goodness of fit" of a model (Watson, 1987). One important feature of these measures is that they attach greater weight to large errors than, for example, the mean absolute error criteria. The RMSE and the RMSPE are particularly appropriate when lagged endogenous variables appear among the predetermined variable; for then the dynamic behavior of the system at time t depends on its position at time t-1. It is quite possible, therefore, that some variables which had very nicely fit equations may show large RMSE simulation error.

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1 For a good, introductory, discussion of non-nested models and encompassing tests, see Charemza and Deadman (1992).

2 For a discussion of these criteria, see, for example, Pindyck and Rubinfeld (1991), Chapter 12.

The Theil inequality coefficient lies between 0 and ∞. The smaller the value of the inequality coefficient, the better is the simulation and forecasting performance of the model. If $Y_t^s = Y_t^a$, then Theil = 0 and the model has attained perfect forecast and historical simulation. If $Y_t^s = 0$, then Theil = 1 and the simulation and forecast performance of the model are no better that a 'naive' zero-change scenario. If Theil > 1, the simulation and predictive of the model is worse than the zero-change. Thus if Theil > 1 it is preferable to accept the zero-change extrapolation that $Y_{t+1} = Y_t$—that is, to assume that there will be no change in the value of the dependent variable between the periods t and t+1.[3]

Further insights into the sources of the forecast and simulation errors may be obtained by decomposing the inequality coefficient into its three proportions (Pindyck and Rubinfeld, 1991), known as the partial inequality coefficient. The first proportion is an indication of systematic error, since it shows the discrepancy between mean simulation values (predictions) and mean actual values of the variable concerned; it is referred to as the bias component of the inequality coefficient, denoted by UM. It is desirable to have UM as close to zero as possible and large value of UM (above 0.1 or 0.2) would be an indication of the presence of systematic bias, pointing to the need to revise the model. The second component, UV, is the variance portion of the inequality coefficient and is an indication of the ability of the model to replicate the degree of variability in the variable of interest. A large value of UV implies that the actual series fluctuated considerably while the simulated series did not, or vice versa. Finally, the covariance portion, UC, of the inequality coefficient measures the presence of unsystematic error since it represents the remaining error after deviations from average values and average variabilities have been accounted for. All the proportions have positive values are constrained by UM + UV + UC = 1. For any value of Theil > 0, the ideal distribution of inequality over the three sources is UM = UV = 0, and UC = 1.

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[3] Note that in the formula for the Theil inequality coefficient, the numerator is in fact the RMSE. The denominator, on the other hand, is simply a way for achieving the independence of Theil from the units of measurement of the variables.

Aside from the foregoing two analytic measure of the "goodness fit" of a model, two other measures will be used: turning point accuracy and "long-swing" accuracy. The former gauges the accuracy of the model in replicating turning points or rapid changes in the actual data series. A model which predicts turning points in the historical data series is obviously better than one that does not. Two measures of turning point accuracy are employed here. The first, a visual measure, simply counts the number of peaks and troughs which have been missed and generated as extra turning points in the simulated series.

The second measure, devised by David Gordon, is called "root-mean-squared years error".[4] It measures the average (root-squared) years by which the model misses the peaks and troughs of the business cycle within the period of estimation. Perfect turning point accuracy results in an index value of 0.0; an average (root-squared) error of one year results in an index value of 1.0, and so on. The index is computed as $\sum(t^{a} - t^{s})^2/n$, where t_i indicates the year of the turning point for the actual and simulated series. An arbitrary value of one- or two-years' error is assigned for the business cycles in which the peak or troughs are missed altogether, depending upon how far in time the cycles are spaced. Undoubtedly, this measure borders on subjectivity as there is no objective way of assigning errors to missed turning points.

The "long-swing" accuracy criterion attempts to gauge the relative performance of the model in the up-swing (expansion phase) and down-swing (stagnation or contraction phase) of the economic cycle. As pointed out in Part 1, the long up-swing of the Guyanese economy ended in 1975, ushering the down-swing which continued to the end of the sample period. Two measures of long-swing accuracy are employed.[5] The first, labelled stagnation/boom, compares the relative bias of the average performance for the boom and stagnation periods by measuring the ratio of $GDIR^{s}$ / $GDIR^{a}$ for 1977-88 to $GDIR^{s}$ /$GDIR^{a}$ for 1965-76, where GDIR

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4 See Handout for GE213 (Alternative Macroeconomic Models), Course Exercise, January 1989.

5 Again these are due to David Gordon. *Ibid.*

is real gross domestic investment. A value of 1.00 implies that the model performed equally well on average for the two periods, while a value of less (greater) than one means that the model has a relative downward (upward) drift in the stagnation years. The second index, "rstag-rboom", compares the correlation coefficient between simulated and actual values for the two periods, subtracting the correlation coefficient for the boom years from the correlation coefficient for the stagnation years. That is, the index is given by $r_{s(77-88)} - r_{b(66-76)}$, where s is the stagnation period and b the boom period. A value of 0.00 shows that the relative accuracy (correlation) of the model's performance was comparable for the two periods, while a negative (positive) values shows that it performed less (more) accurately in the stagnation period.

Ideally, the stagnation/boom and rstag-rboom measures should used in conjunction with a measure of capacity utilization, since the aim is to gauge the accuracy of the model in duplicating the overall level of economic activity. In this study, the Augmented Keynesian Model has a behavioral equation for potential output and an identity for GDP; on the other hand, the Export-led Model has a behavioral equation for GDP. In consonance with our principle of no unfair advantage, none of these variables can be used. However, since both models have behavioral equations for investment, this variable will be used instead.

Finally, an encompassing-like test recently developed by Fair and Shiller (1990) of the two models will be done in the following chapter. No attempt is made to gauge the overall sensitivity of the models to certain factors, including (a) alteration of the initial simulation period (b) minor changes in the estimated coefficients (at least within one-half of the estimated standard error for the coefficient) and (c) small changes in the time path of the exogenous variable. None of these modification should produce significant changes in a well-specified model.

Evaluation of Simulation Results[6]

Root-mean-square Percent Error (RMSPE)

In general, the Augmented Keynesian Model (AKM) outperformed the export-led model (ELM) in the historical simulation exercise, turning in a superior performance for all variables except inflation (Tables 41 and 42). If the magnitudes of the RMSPE in the historical simulation are examined, for the AKM all variables have values of less than 2.9, except inflation which turned in an RMSPE of 8.97. For the ELM, 5 out of the 8 common variables - investment, depreciation, import of consumption goods, import of raw materials and intermediate goods, and inflation - have RMSPE which exceed 2.9. In fact, the ELM produced RMSPEs for investment, depreciation, government revenue and government expenditure which are more than twice the corresponding values for these same variables in the AKM.

Charts 23 to 43, which plot the actual and simulated values of the variables, also offer some insight into the comparative performance of the models. These charts are presented at the end of this chapter.

The Theil inequality coefficient, which is zero if perfect simulation is achieved, provides additional support for the superior performance of the AKM. As may be seen from table 42, the coefficient is much smaller for all variables in the AKM except inflation. Both models, according to the UM coefficient, have relatively little bias which implies that there is no need to revise their specification. In terms of the ability to replicate variability in the data set, measured by UV, both models performed well, with the AKM better at replicating variability in gross domestic investment, government expenditure and government revenue. For the other five variables (depreciation, consumption imports, capital goods imports, raw materials and

[6] Both models were estimated, simulated, forecasted and evaluated with Micro TSP.

Table 41. Historical Simulation: Comparative Performance of the Models

Common Variables	AKM	ELM
Gross domestic investment	S	--
Depreciation	S	--
Import of consumption goods	S	--
Import of raw mat. & Int. goods	S	--
Import of capital goods	S	--
Government revenue	S	--
Government expenditure	S	--
Inflation	--	S

Note: S = superior performance. The root-mean-square percent error (RMSPE) was used for the evaluation of the models.

Table 42. Historical Simulation: Evaluation Statistics for the AKM and the ELM

	AKM	ELM	AKM	ELM	AKM	ELM	AKM	ELM	AKM	ELM
Variable	RMSPE		Theil	Theil	UM	UM	UV	UV	UC	UC
Potential output	0.073		0.000		0.002		0.014		0.984	
Gross domestic output		1.027		0.005		0.004		0.009		0.987
Private consumption	0.883		0.004		0.000		0.059		0.941	
Gross dom. investment	1.398	2.870	0.007	0.015	0.000	0.004	0.044	0.222	0.956	0.774
Depreciation	1.330	6.367	0.006	0.030	0.002	0.853	0.077	0.022	0.921	0.126
Import of consumption goods	2.429	3.730	0.012	0.019	0.000	0.000	0.019	0.000	0.981	0.999
Import of raw mat. & int. goods	1.639	2.613	0.008	0.013	0.010	0.003	0.125	0.010	0.864	0.988
Import of capital goods	2.892	4.443	0.014	0.022	0.013	0.000	0.003	0.000	0.984	0.999
Exports	0.000		0.000		0.010		0.125		0.864	
Broad money demand	0.689		0.003		0.026		0.094		0.881	
Govt. revenue	1 .131	1.960	0.006	0.010	0.001	0.001	0.000	0.405	0.999	0.594
Govt. expenditure	0.940	1.907	0.005	0.010	0.001	0.000	0.000	0.360	0.999	0.640
Inflation	8.973	5.179	0.147	0.113	0.000	0.002	0.037	0.000	0.963	0.998

intermediate goods imports and inflation), the ELM does a slightly better job at duplicating changes in the data. From the table, it is clear that the remaining errors, measured by UC, in the AKM are essentially due to unsystematic factors. This is not true for the ELM, particularly for investment, depreciation, government revenue and government expenditure.

How does AKM compare with other models of the Guyanese economy in terms of their simulation accuracy? Before we attempt to answer this question, it is necessary to observe that in comparing the performance of models it is critically important to compare identical periods. The importance of this lies in the fact that different time periods are characterized by different exogenous shocks, if not in nature then at least in severity, which impacts differently on the performance of a given model. Thus, for example, the performance of models in the 1970s was poorer than in the 1980s.[7] The 1970s, it will be recalled, was a more tumultuous decade, with two oil shocks that suddenly sent the world economy spiralling downwards. The point, in short, is that a model's accuracy varies over time and neither logic nor econometrics can provide any assurance that the future will resemble the present. More fundamentally, the fact that accuracy of models varies over time poses a challenge to the constancy assumption needed to make inferences about future periods.

The model by Jarvis and Ganga were tested, respectively, over periods 1957-76 and 1966-85, while the model constructed here (the AKM) has as its sample period 1960-88. While these models do have a common sub-period, 1966-76, their entire samples are quite different. Nevertheless, the AKM completely "encompasses" the Ganga model in terms of time, while the model by Jarvis has a sample that began 3 years earlier. One other point should be mentioned—the phase(s) of the economic cycle covered by these models. From the discussion in Part I of this dissertation, it can be seen that the Jarvis model is a model of upswing of the economy only; the Ganga model partially embraces both phases of the cycle.

[7] McNees (1992), discussing the accuracy of economic forecasts, notes that "The best forecaster's errors in the 1970s would be far larger, in absolute terms, than an inferior forecaster's errors in the 1980s" (p. 28), pointing to the crucial importance of the forecast period in determining the size of the forecast errors.

The AKM spans the entire downswing and a large portion of the upswing; in other words, it can be said that of the three models, the AKM most comprehensively embraces both phases of the economic cycle. Given this background, if the AKM produces a lower RMSE/RMSPE for the same variable, this may be tentatively interpreted as indicative of a superior performance.

Table 43 below shows the RMSPE for those variables for the Ganga model that are common to the AKM. A comparison of this table with table 42 reveals that the AKM easily outperforms the Ganga model in historical simulation: the RMSPE for all 4 variables are much lower than those in table 43. Indeed, the RMSPEs obtained by Ganga for investment, exports and inflation are more than twice the values for these same variables in the AKM. The inflation equation in the Ganga model performed particularly poorly, producing an RMSPE of 43 per cent, which is more than 4 times as large as that of the AKM (9.0 per cent).

The AKM can also be compared with Jarvis (1990). The RMSE - Jarvis did not compute the RMSPEs - for those variables Jarvis model that are common to the AKM are given in table 44. Once again, it is evident that the Jarvis model does not measure up to the AKM in terms of their historical simulation of the data.

Table 43. Evaluation Statistics of Simulation Results for the Ganga Model

Variable	RMSPE	Theil	UM	US	UC
Investment	3.912	0.038	0.006	0.068	0.926
Consumption	1.455	0.014	0.000	0.105	0.895
Exports	1.247	0.012	0.000	0.008	0.992
Inflation	43.118	0.229	0.001	0.044	0.955

Source: Ganga (1990:21).

Table 44. RMSE for the Jarvis Model and the AKM

	Jarvis' Model		AKM	
Variable	RMSE	Theil	RMSE	Theil
Investment	48.0	0.12	0.10	0.01
Consumption	12.9	0.02	0.01	0.00
Import of food, beverages and tobacco	4.4	0.25	0.23	0.02
Import of intermediate goods	10.6	0.22	0.19	0.01
Import of machinery and manufactured goods	14.1	0.14	0.28	0.00

Source: Jarvis (1990:40) for results on the Jarvis model.

Turning Point Accuracy

To get an idea of the ability of the two models to simulate turning points in the historical data, a peak-trough analysis was done for the investment equation. Gross domestic investment was selected for demonstration since it is the closest behaviorally-determined variable of overall economic activity common to both models. (Ideally, this exercise should be done with output or capacity utilization). The data series on investment is characterized by 5 peaks - 1967, 1970, 1976, 1979 and 1986 - and 5 troughs - 1969, 1971, 1978, 1983 and 1988.

The most widely used measure of the ability of models to duplicate turning points is to simply to visually inspect a plot of actual and simulated values for the variables of interest, which is, of course, a subjective exercise. A more formal approach is to count the number of peaks and thoughs missed and generated as extras in the simulated series. These 'extras' are generated by a patch written for Micro TSP by Prof. Gordon. The patch program first determines the peaks and troughs in the actual series, comparing with the simulated values. 'Hits' and extras are then computed as is the 'root-mean-squared years error; see page 317 for a discussion of the formula of the latter.

Table 45. Turning Point Accuracy of the Models

(a) The Augmented Keynesian Model

Turning Point	Criteria	Value of Criteria
Peaks	Missed/Extras	2
	Root Years Error	0.2
Troughs	Missed/Extras	0
	Root Years Error	0.0

(b) The Export-led Model

Turning Point	Criteria	Value of Criteria
Peaks	Missed/Extras	6
	Root Years Error	0.8
Troughs	Missed/Extras	8
	Root Years Error	1.0

Table 45 above contains the results of the turning point accuracy of the two models. As could be see, the AKM missed the peak in 1979 and it also generated an additional peak in the simulated series (1981), giving in all 2 peaks that have been missed or generated as extras, while the a root-year-error is 0.2. All troughs in the historical series were accurately duplicated. By contrast, for the ELM the root-year-errors for peaks and troughs are 0.8 and 1.0 respectively. This model was only able to duplicate 2 of the 5 peaks (40.0 per cent) in the actual data series for gross domestic investment. Three peaks have thus been missed and three additional ones were generated. With regards to the troughs, only 1 of the 5 (10 per cent) was replicated, while 4 additional ones were generated. That is, a total of 8 troughs were missed or generated as extras.

The ability of the ELM to replicate turning points in the data series for investment was particularly poor during 1976-1988. During this period, the down swing of the economic cycle, the economy performed dismally as a result of a combination of factors. These include the two oil shocks, the sugar boom (revenues were misallocated and an expenditure spree was initiated), poor management and the dramatic involvement of the government in the economy. These features of the economy were not built into the ELM.[8]

In the final analysis, based on the two criteria in table 45, it must be concluded that the AKM does a superior job than the ELM at duplicating turning point in the actual data series.

Long-swing Accuracy

Measures of long-swing accuracy, it will be recalled, attempt to gauge relative performance over the up-swing and down-swing of the economic cycle. The results of the two measures, stagnation/boom and"rstag-rboom", are given below (table 46). With a value of 0.99 - which indicates an insignificant drift during the down cycle -, it could be said that the AKM performed equally well during the stagnation and boom periods (down-swing and up-swing). This performance is confirmed from the result for "rstag-rboom": a value of 0.002 is, for all practical purposes, no different from a value of 0.0, indicating perfect performance accuracy in both phases of the economic cycle.

How does the ELM perform by these criteria? For all practical purposes, as measured by stagnation/boom, the ELM achieved a performance comparable to the AKM during the two phases of the cycle, although the drift during the down cycle was greater than that of the

[8] While models of developed market economies are normally evaluated for their turning point accuracy, I have been unable to locate anywhere in the literature a similar exercise for models of developing countries. In fact, at least in the Caricom region, this is the first study to evaluate formally an econometric model on its ability to duplicate turning points in the historical data series.

AKM. The finding on this measure is not fully supported by the "rstag-rboom" criterion: at -0.50, it indicates that the performance of this model was much poorer in the downswing of the cycle.

Table 46. Long-swing Accuracy of the Two Models

	Stagnation/Boom	"rstag-rboom"
Augmented Keynesian Model	0.990743	0.001587
Export-led Model	0.989689	-0.504821

In summary it can be said that (a) both criteria indicate that the AKM performed insignificantly poorer in the contractionary phase of the cycle; (b) point (a) is also true for the ELM with the exception that the criterion based on correlation coefficients ("rstag-rboom") indicates a considerable deterioration of the performance of this model in the down-swing. The long-swing accuracy of the models thus lends support to the analysis based on turning point accuracy—that the AKM outperforms the ELM.

Ex Post Forecasting Performance

Many models are constructed and estimated with forecasting in mind, either ex post and ex ante. Both predict values of the dependent variables beyond the time period in which the model is estimated, but the similarity ends there. An ex ante forecast predicts values of the dependent variables beyond the estimation period conditional on the estimated model and predictions of the exogenous variables and disturbances (since these are not available). The errors of an *ex ante* forecasts may be due to the fact that the estimated model is wrong, because the predictions of the disturbances or exogenous variables are wrong, or because of some combination of the two. An *ex post* forecast , on the other hand, predicts the values of the dependent variables in a situation where the exogenous variables are known with certainty during the forecast period. *Ex post* forecasts can be checked, therefore, against existing data and provide a means of evaluating a forecasting model, but this is not usually true for *ex ante* forecasts since the forecaster normally makes subjective adjustments to his/her results. It is for this reason *ex post* forecasts are usually taken as scientific hypotheses.

Evaluating the works of previous authors, Carl F. Christ (1993) found that the root-mean square error (RMSE) of an econometric model's ex post forecast roughly quadruples as the horizon increases from one to eight quarters in the case of dynamic models; that is, models that contain lagged endogenous variables as explanatory variables. If an n periods ahead forecasts is made with dynamic models, errors in any period will involve disturbances from all the previous periods. For example, the error in the n-1 period is a function of the errors in all the n-2 periods. Thus, for a dynamic model, the variance of a forecast n periods ahead will depend on the variances and covariances of disturbances in all n periods of the horizon, and except in very special circumstances, it will increase as the horizon increases.

On the other hand, the performance of a static model is not expected to be degraded so significantly since the error for each forecast would involve disturbances only for the period being forecasted and not for periods in the earlier part of the horizon. There is, therefore, no reason to expect significant changes in the size of the forecasting error for a static model as the horizon increases. Of course, small increases in the errors will occur because of errors in the estimates of the model's parameters if the values of the independent variables move further away from their estimation-period means as the horizon lengthens.

The present exercise compares the *ex post*, out-of-sample, one-year ahead forecasting performance of the two models. As annual data are used, the observations by Christ (1993) regarding the speed with which the forecasts is degraded as the forecast horizon is extended may or may not be true. Did the *ex post* forecast of the models deteriorate as the forecast horizon was extended from one to two periods (years)? Before this question can be answered, it is necessary to observe that both models contain lagged endogenous variables, deriving from structural equations and/or identities. However, this feature is more pronounced in the AKM as it is present in 11 of the 14 behavioral equations. Lagged endogenous variables appear in 3 of the 9 behavioral equations comprising the ELM. Clearly, the scope for errors in the forecast of the AKM is much greater as the forecast period is lengthened.

Table 47. Ex Post Forecasting : The RMSE for the AKM and the ELM

Variable	RMSE -AKM			RMSE - ELM		
	1989	1990		1989	1990	
Potential Output	0.013	0.065	(5.00)			
Gross Domestic Output				0.005	0.004	(0.20*)
Private Consumption	0.002	0.010	(0.40)			
Gross Domestic Investment	0.663	0.523	(0.21*)	0.612	1.627	(1.66)
Depreciation	0.472	0.658	(0.38)	0.590	0.573	(0.03*)
Import of Consumption Goods	0.014	0.020	(0.43)	0.307	0.445	(0.45)
Import of Raw Materials and Intermediate Goods	1.001	1.189	(0.18)	0.844	1.220	(0.45)
Import of Capital Goods	0.122	0.425	(2.46)	2.178	2.648	(0.22)
Exports	0.100	0.210	(1.10)			
Broad Money Demand	0.796	1.019	(0.28)			
Government Revenue	0.027	0.046	(0.70)	0.434	0.353	(0.19*)
Government Expenditure	0.285	0.211	(0.26*)	0.537	0.420	(0.22*)
Inflation	0.014	0.118	(7.43)	0.101	0.184	(0.29)

Note: Numbers in parenthesis indicate the order of deterioration of the RMSE; starred numbers indicate order of improvement of the RMSE. Numbers in parenthesis are calculated as (RMSE 1990/RMSE 1989)*100

Now consider table 47 above. In general, the performance of the AKM deteriorated as the forecast horizon is lengthened from one to two years, except for investment and government expenditure. For the latter variable, a 26 per cent improvement in the RMSE was recorded, slightly more than in the case of investment (21 per cent). The reliability of the forecasts for the capital goods imports and inflation declined considerably as the horizon is increased from 1989 to 1990. For capital goods imports the RMSE in 1990 was 2.5 time greater than the RMSE for 1989; for inflation the increase was even more pronounced: the RMSE in 1990 was 7.5 times greater than the RMSE in 1989. For the rest of the variables, the deterioration was in the range of 0.18 to 1.10 times.

The ELM produced better results as judged by the deterioration of the RMSE as the forecast period is lengthened from one to two years. The RMSEs for depreciation, government revenue and government expenditure registered improvements: 3, 19 and 22 per cent respectively. For the rest of the variables, the deterioration was in the range of 0.22 to 1.66.

So, on the basis of the speed of deterioration of the RMSEs, it would seem that the ELM outperformed the AKM as the forecast horizon is lengthened from one to two years. This not an unexpected result, given that the AKM incorporates a more dynamic structure than the ELM (more on this later). Performance cannot be judged, however, only on the basis of the speed at which forecast errors increase. The absolute magnitude of the errors are of paramount importance and it is in this area that the strength of the AKM lies as a close examination of table 47 will confirm. For example, the AKM for 1989 recorded smaller RMSE for all variables except investment (marginal) and imported raw materials and intermediate goods. This observation holds with more force for the 1990 forecast: the ELM produces larger RMSEs for all variable except depreciation. In other words, the AKM can be said to yield superior short-term (up to 2 years at least) results.

We have now established that (a) the ELM suffers a slower rate of deterioration as the forecast horizon is extended; (b) in general, the absolute magnitude of the RMSE of the ELM for one-period ahead forecasts are much higher than those for the AKM. Because of point (b), it must be concluded that the forecasts produced by the AKM are more reliable since its errors, as measured by the RMSE and the RMSPE, are smaller[9] than those of the benchmark model. Clearly, the verdict as to which is the better model as far as ex post forecasting is concerned must go to the AKM.

[9] A similar conclusion is reached if the RMSPE is used as the evaluation criterion. By this yardstick, the ELM has the edge only for the imports of raw materials and intermediate goods (both years), investment in 1989 and depreciation in 1990.

In general, therefore, based on the evaluation of the results of the historical simulation, turning point accuracy, long-swing accuracy and ex post, out-of-sample forecasting, it is concluded that the AKM outperformed the alternative, competing benchmark export-led model. The results of this exercise thus lends support to a modelling strategy in Guyana - and possibly in the region as well - that seeks to take account of all major macroeconomic aggregates, specifying both domestic and foreign channels of influence and endogenizing exports. We also found that the AKM turned in a better performance record than the Jarvis and Ganga models.

Comparative Performance of the Models: Towards an Explanation

What accounts for the superior performance of the Augmented Keynesian Model compared to the Export-led Model? The answer, in short, has to do with the theory underlying the models and hence their specifications, as the following discussion attempts to show.

Briefly, while both approaches share Keynesian modelling principles, the three major differences are:

(a) the AKM, as the term implies, is a more detailed and richly specified model, in terms of the characterization of the economy, the level of disaggregation, the parameterization of the equations and the specification of channels of influence;

(b) the core difference between the two models centers around the determination of exports: the AKM assumes that exports are determined endogenously, while the raison d'être of the ELM is the exogenization of exports; and

(c) supply-side factors—the ELM is structured in such a way that there is an explicit supply-side response to demand stimuli, implying that demand pressures have to be played out in a framework where supply factors kick in. The AKM also takes supply-side argument into consideration but in a more limited way. Both models are, however, unable to deal in any meaningful way with supply shocks—sudden massive supply influences, such as an oil shock, which are not necessarily initiated by demand pressures. In this sense, both models are susceptible to the criticism of over determination from the demand-side.

The AKM has 14 behavioral equations and 47 identities. Two of the behavioral equations determine expectational variables. The ELM has 9 behavioral equations and 17 identities. Clearly, in terms of the picture drawn of the economy, the AKM is more comprehensive, but the purposes of these two models must always be kept in mind. The export-led model is principally intended to illustrate the dependence of the economy on exports. Because of this feedback loops are limited to the depiction of the impact of exports, and thus external factors, on the economy. On the other hand, the AKM aims, at the aggregate level, to illustrate channels of interaction in the economy, regardless of whether the stimuli originate domestically or abroad.

The ELM, as might be expected, makes no use of dummy variables, while the AKM employs 5 such variables. A description of these variables and their associated absolute t-statistics is given below (table 48). These variables are significant in the sense that they contribute to the explanation of the behavior of the economy. Three of the dummy variables [DUCON, DUMC and DUFUEL] are to some extent subjective in the sense that different researchers may locate their starting and ending points in different years. Nevertheless, they are intended to capture the impact of certain events for which no time series exist.

The differences in performance between the two models must be located within this overall framework, assuming that data inadequacies are common to both models since they use the same data set.

Table 48. Dummy Variables Used in the AKM

Variables	Description	Equation	t-statistics
DUCON	Dummy variable for depressed consumption level during 1977-88	Consumption	1.73
DUGVTR	Dummy variable for surge in government revenue during the sugar boom of 1974-76	Govt. Revenue	6.91
DUGVTX	Dummy variable for surge in government expenditure during the sugar boom, 1974-76 and during the period 1981-84	Govt. Expenditure	5.78
DUMC	Dummy variable for years of rising import restrictions on consumer goods	Import of Cons. Goods	3.78
DUFUEL	Dummy variable for depressed fuel imports	Import of Raw Mat. and Cap. Goods	5.46

The equation for depreciation is a good starting point for the examination of the coherence of the models. The equation is specified in same manner for both models, with the previous period's capital stock and a linear time trend as the only arguments in the function. A brief examination of the ELM shows that the depreciation equation contains only exogenous variables—this equation is thus a "stand alone" equation in the sense that it does not interact with the rest of the model. On the other hand, the capital stock appearing in the depreciation equation of the AKM is an exogenous variable. But what is the importance of this distinction? It is that in the simulation/forecasting exercises simulated values of the capital stock will be used in the AKM while actual values of this variable will be used in the ELM. Since the depreciation equation in both models have the same coefficients, it will be impossible for the depreciation equation in the AKM to perform better than in the ELM. This can be verified from tables 42 and 47.

Despite the high and similar adjusted R^2 obtained on the three import equations for both models, the AKM clearly demonstrates superior performance in this area, especially in the *ex post* forecasting exercise, scoring lower RMSPEs. The explanation for this lies in the structure, including linkages and specification, of the models. As far as the import equations of the AKM are concerned, there are two kinds of linkages: between right-hand side (endogenous) variables and the rest of the model and between left-hand side (explanatory) variables and rest of the model. Thus, in one way or the other, the three import equations directly impacts upon all other equations in this model. These linkages not only clarify the import-dependent feature of the economy; they also indicate internal feedback loops, which establish a mechanism for the magnification of dynamic behavior. For example, growing fiscal deficits constrain imports which, in turn, impacts upon exports, GDP, investment, money demand and government finance itself. In short, the dampening effect of an import constraint, for example a foreign-exchange constraint, is fed back to the economy as a whole.

In the ELM, on the other hand, imports are tied to GDP and the capital-flow variable, but the model still fails to capture the rich interaction among 'domestic' variables as a result of the primacy of the export-dependence hypothesis. For example, output is not directly dependent upon imports despite the high import-dependence of the economy; nor is it clear how the government sector and investment, itself highly dependent upon imported capital goods, impact upon imports.

The AKM also demonstrates superior performance for government finance, though the difference here is not pronounced. On closer examination, this model is superior because it takes into account the 1974-75 sugar boom on government finances, in addition to embodying a short-term specification which makes it possible for this sector to affect the rest of the economy in a shorter time period. Importantly, too, is the fact that the equations for government finances in the AKM are more tightly integrated in this model, compared to the ELM.

In modelling inflation, the ELM draws heavily upon neoclassical and monetarist ideas as could be seen from the use of variables such as import prices, money supply, wage rate and lagged inflation. The logic of the equation can be readily traced. Given the assumptions of the model, BOP determines the money supply. An increase in the money supply translates into higher prices as demand pressures for real goods and services build up. Output rises to accommodate demand pressures but even as this happens wages begin to go up, reflecting pressures in the labor market. Additional pressure on prices, in the face of rising output, is generated by imports, given the high dependency of the economy on imports. This chain of reasoning is perhaps questionable for two reasons: (a) high rates of unemployment in Guyana (and many other Caricom countries), in excess of 20 percent throughout the last decade; and (b) as noted in Chapter 15, the empirical evidence does not provide strong support for the monetarist explanation of inflation in Guyana.

The AKM employs a different approach to modelling inflation. While drawing heavily upon the theory of mark-up prices, it also allows for the presence of widespread goods shortages, high liquidity ratios and expected inflation. The impact of the former is captured by deviations of actual from trend output; high liquidity ratios are proxied by the deviations of actual M2 from trend M2. Expectations about inflation are assumed to be formed according to near rational expectations. The feedback loops between inflation and the rest of the model are quite strong and well specified in the model, which makes the inflation sensitive to perturbations, both domestic and external in origin.

The different specification of the equation for inflation in the two models notwithstanding, when tested against the data, the adjusted R^2 and the standard error of the regression are practically the same for both models. In the simulation exercise, the ELM outperformed the AKM while the latter holds the edge in the *ex post* forecast exercise. In short, despite the different theory underlying the equation for inflation and the degree to which the equation is integrated into the respective model, relatively poor performance was obtained, as judged by the RMSPE. This, in my view, would seem to provide some confirmation of our suspicion about the poor quality of the data.

Investment in both models is assumed to depend on an accelerator variable and capital stock but this is where the similarity ends. Capital-inflow (defined as the balance on the capital account) is of central importance to the investment equation of the ELM. It will be recalled that part of the rationale for the exogenity of exports in this model is the assumption that the major portion of the tradable sector is foreign-controlled and dominated, if not owned. In this situation, decisions on production and investment are removed from the hands of domestic agents; investment thus presumes an inflow of capital. Indeed, the estimate of the investment equation supports the hypothesis of the dependence of investment on foreign capital inflow: a 1 per cent increase on this variable results in a 0.7 per cent rise in the level of domestic investment.

While capital inflow is not an argument in the AKM, other factors are crucial to investment. Two of these include imports of capital and intermediate goods, and relative prices, thus taking into account both foreign supply and demand influences. Credit per unit of investment also constitutes an explanatory factor in the equation and it is intended to account for the impact of excess liquidity for much of the 1980s. In short, this model seeks to incorporate a richer explanation which is comprehensive enough to account for both foreign and domestic influences. This modelling strategy is supported by the estimates as this equation outperformed its counterpart in the ELM in both historical simulation and ex post forecasting:

	RMSPE - AKM	RMSPE - ELM
Simulation	1.4	2.9
Ex post forecast	7.2	21.7

The relatively poor performance of the investment equation in the ELM in *ex post* forecasting exercise calls attention to its crucial shortcomings, namely its inability to account for the changes to the economy since the early 1970s.

Finally, we close with the observation that the underlying rationale, that export growth causes output growth, of the Export-led Model, has not been formally evaluated here. Other researchers, studying a number of countries, found that export growth did not cause output growth in the case of Guyana.[10] If this presumption is in fact invalid, then it casts further doubts on the validity of the export-led approach as an important modelling strategy of the regional economies, including Guyana.

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[10] In the case of Guyana and several other countries, see Jung and Marshall (1985), Bahmani-Oskooee, Mohtadi and Shabsigh (1991) and Dodaro (1993) for a discussion of the hypotheses that export growth causes output and vice versa.

Chart 23 – Actual and Simulated Values: Private Consumption, 1965–1988

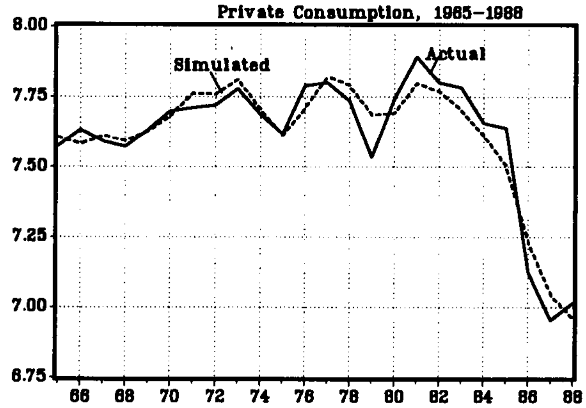


Chart 24 – Actual and Simulated Values: Gross Domestic Investment, 1965–1988

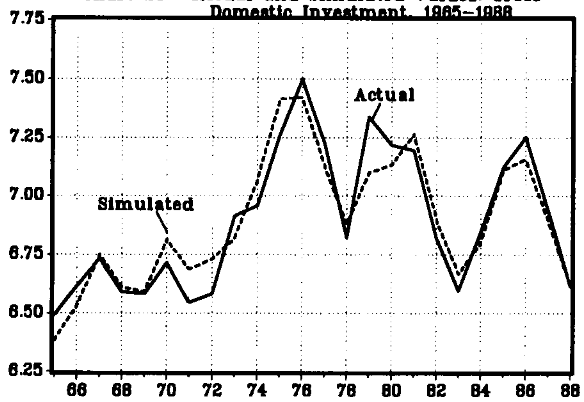


Chart 25 – Actual and Simulated Values: Broad Money Demand, 1965–1988

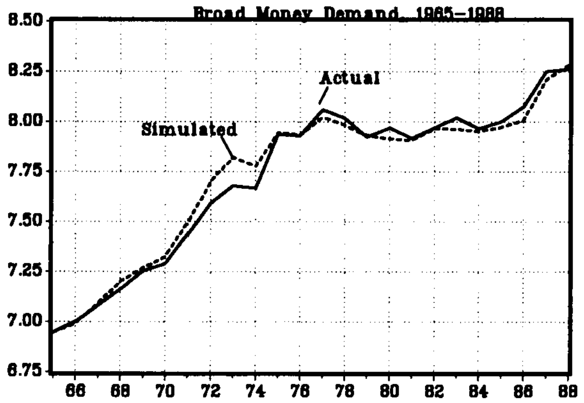


Chart 26 – Actual and Simulated Values: Inflation, 1965–1988

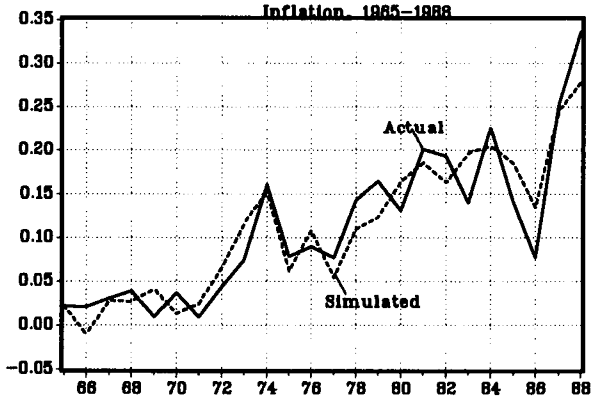


Chart 27 – Actual and Simulated Values: Government Revenues, 1965–1988

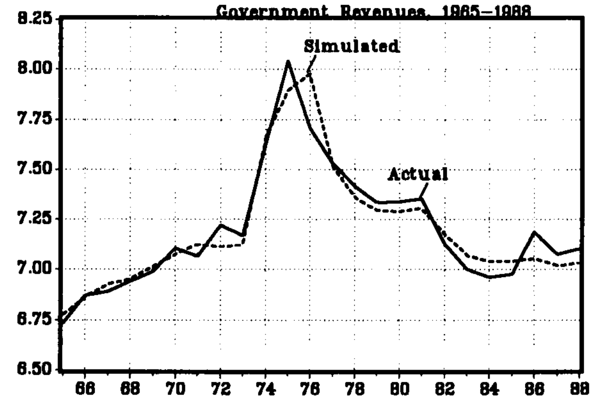


Chart 28 – Actual and Simulated Values: Government Expenditures, 1965–1988

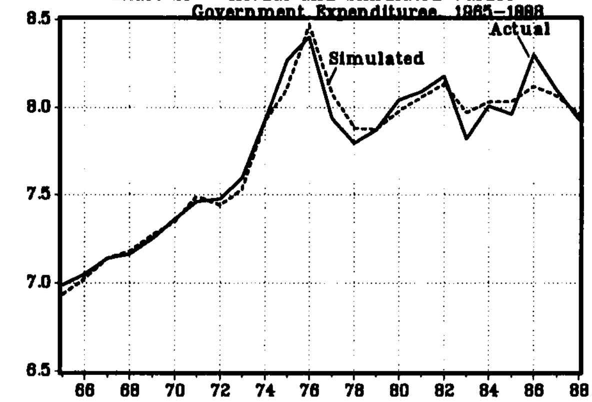


Chart 29 – Actual and Simulated Values: Imports of Consumption Goods, 1965–1988

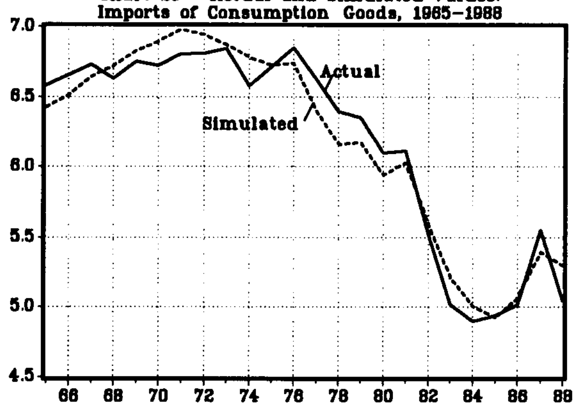


Chart 30 – Actual and Simulated Values: Imports Raw Materials and Intermediate Goods, 1965–1988

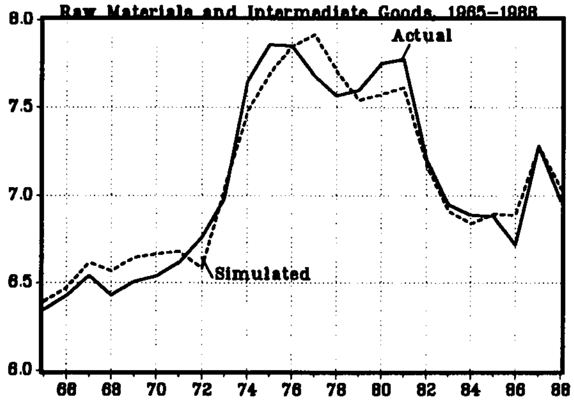


Chart 31 – Actual and Simulated Values: Imports of Capital Goods, 1965–1988

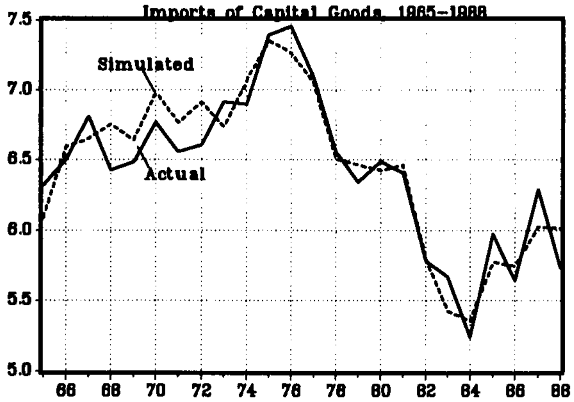


Chart 32 – Actual and Simulated Values: Exports, 1965–1988

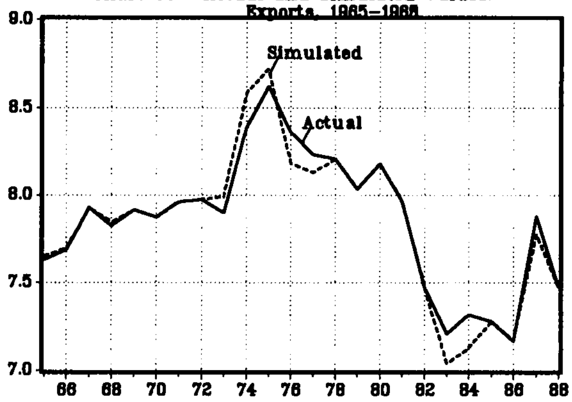


Chart 33 – Actual and Simulated Values: Potential Output, 1965–1988

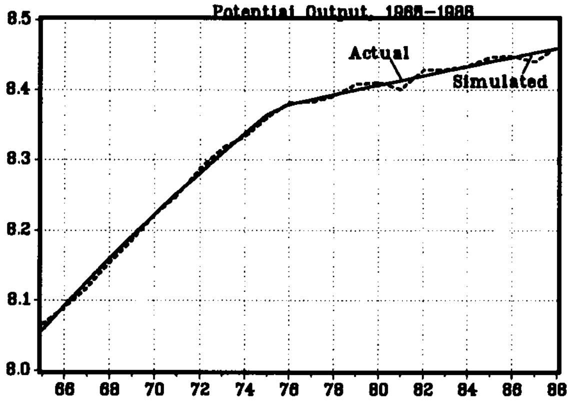
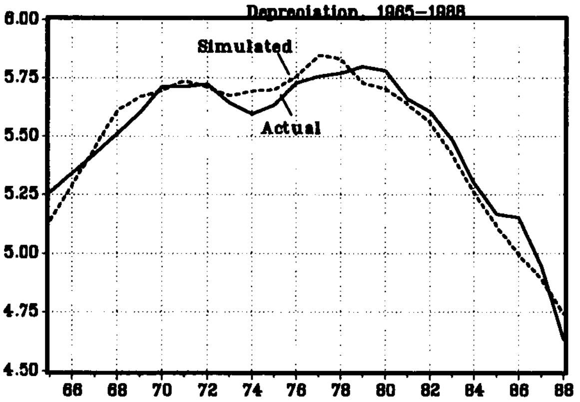


Chart 34 – Actual and Simulated Values: Depreciation, 1965–1988



The Export-led Model

Chart 35 – Actual and Simulated Values: Gross Domestic Investment, 1965–1988

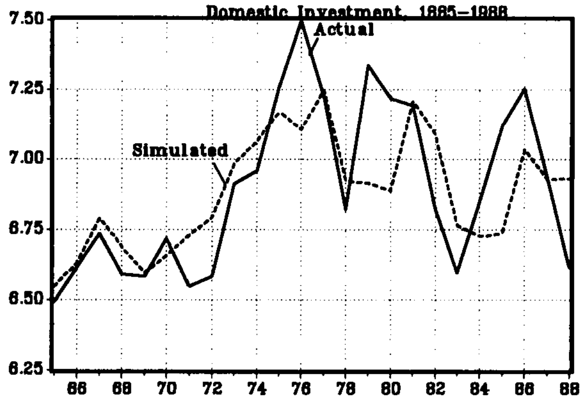


Chart 36 – Actual and Simulated Values: Government Revenues, 1965–1988

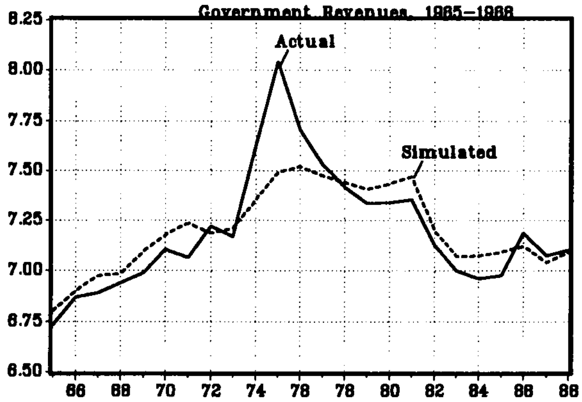


Chart 37 – Actual and Simulated Values: Government Expenditures, 1965–1988

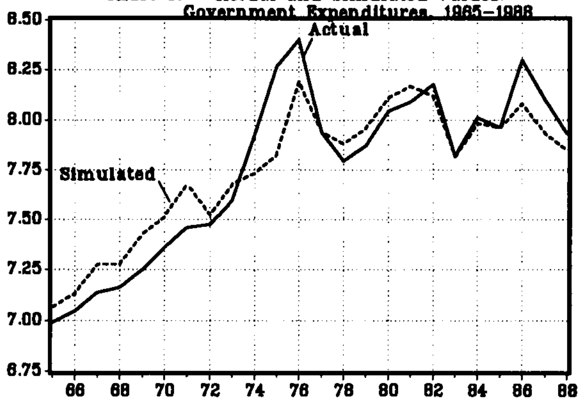


Chart 38 – Actual and Simulated Values: Imports of Consumption Goods, 1965–1988

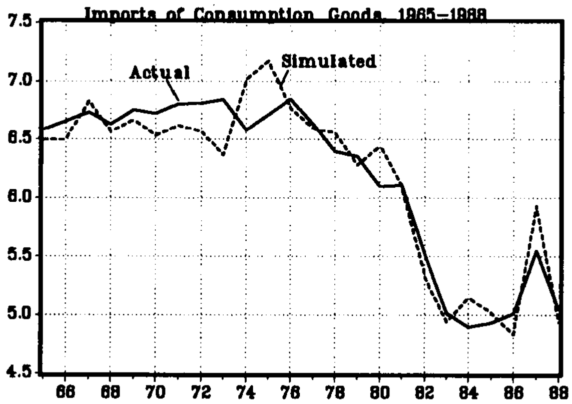


Chart 39 – Actual and Simulated Values: Imports of Raw Materials and Intermediate Goods, 1965–1988

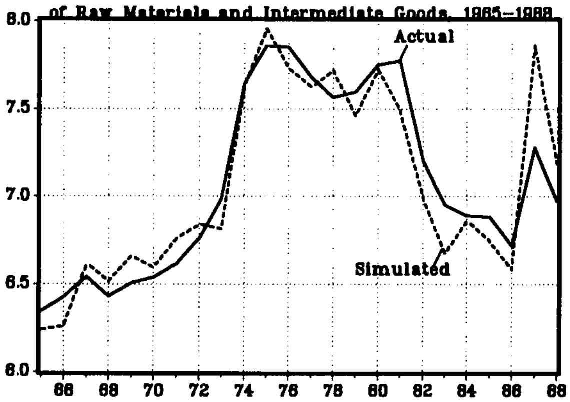
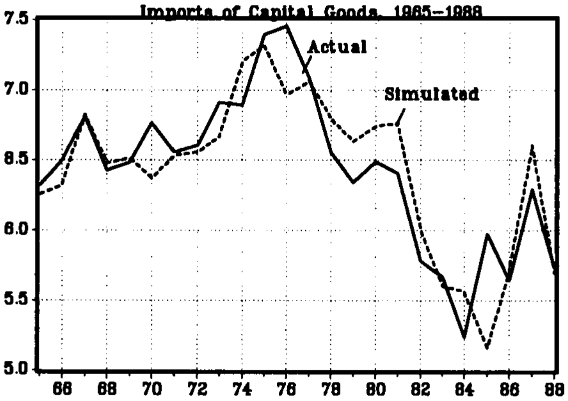


Chart 40 – Actual and Simulated Values: Imports of Capital Goods, 1965–1988



The Export–led Model

Chart 41 – Actual and Simulated Values: Inflation, 1965–1988

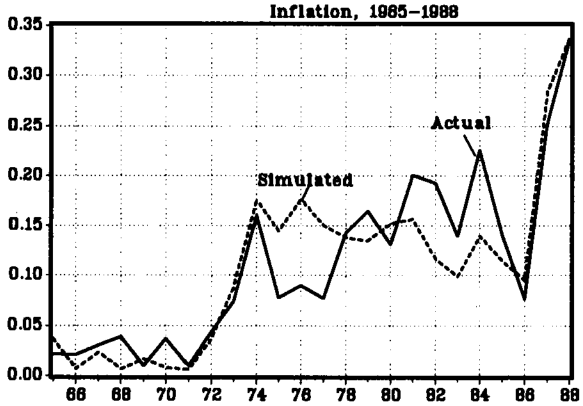


Chart 42 – Actual and Simulated Values: Output, 1965–1988

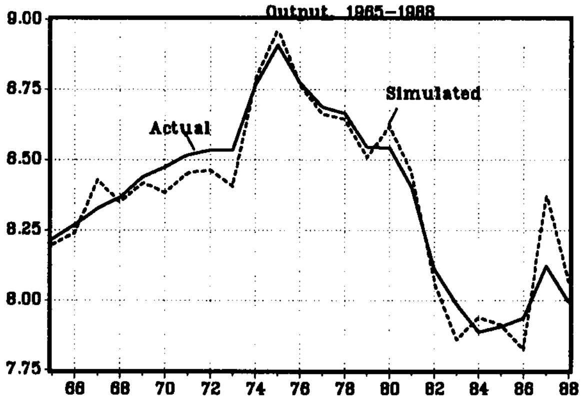
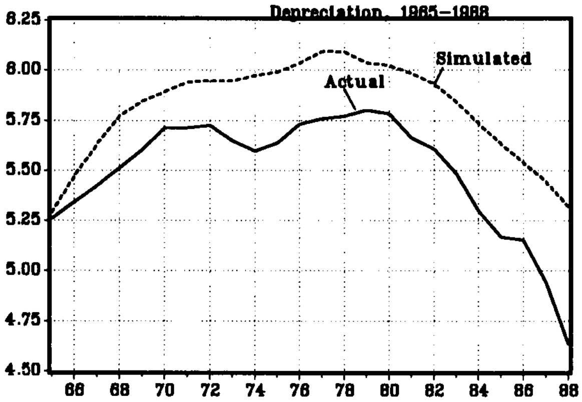


Chart 43 – Actual and Simulated Values: Depreciation, 1965–1988



CHAPTER 19

An Encompassing Test of the Models

Since this chapter relies on a new test developed by Fair and Shiller (1990), the test procedure and related issues are discussed in some detail. These two parts of the chapter draw heavily on the original source - Fair and Shiller (1990) - as well as on Fair (1993). The results of the test and a brief discussion are presented in the final section of the chapter.

The test focuses on three endogenous variables common to the Augmented Keynesian Model (AKM) and the Export-led Model (ELM): investment, government revenue and government expenditure which are, in my view, three of the most crucial equations in the models, especially the AKM. Investment can be used as a proxy of the overall level of economic activity while the overwhelming size of the government sector argues for its inclusion in any such test.

The Test Procedure

In the previous Chapter we saw that the AKM outperformed the ELM in both historical simulation and ex post forecasting, judging on the basis of the basis of the root mean squared error and the root mean squared percentage error. This chapter implements a final test of comparative performance which focuses on the information contained in each model's forecasts. It is an encompassing-related test[1] proposed by Fair and Shiller (1990), who were interested in knowing how to interpret the differences in forecasts produced by models which are different in structure and in the data used, thus producing forecasts which are not perfectly correlated with each other. In other words, Fair and Shiller were interested in finding an answer to the question: "Does each model have a strength of its own, so that each forecast represent useful information unique to it, or does one model dominate in the sense of incorporating all the information in the other models plus some" (p. 375)?

Whatever differences characterize the models, the testing procedure essentially involves regressing the actual value of an endogenous variable, say the log of real investment, on a constant and forecasts of the variable from two or more models. More formally, the procedure is given as:

$$(19.1) \qquad Y_t - Y_{t-s} + \alpha + \beta({}_{t-s}\hat{Y}_{1t} - Y_{t-s}) + \gamma({}_{t-s}\hat{Y}_{2t} - Y_{t-s}) + \mu_t$$

where, following Fair and Shiller, ${}_{t-s}\hat{Y}_{1s}$ denotes a forecast of Y_t made from model 1 using information available at t-s and using the model's estimation procedure and forecasting method each period. Similarly, ${}_{t-s}\hat{Y}_{2s}$ denotes the same thing for model 2. The estimate of (19.1) yields four possibilities:

1. If the estimates of both β and γ in (19.1) are zero, this means that neither model 1 nor model 2 contains any information useful for s-period ahead forecasting of Y_t.

2. If both models contain independent information for s-period ahead forecasting then β and γ should both be nonzero.

[1] The test is also related to the literature on the optimal combination of forecasts.

3. If both models contain information, but information in, say, model 2 is completely contained in model 1 and model 1 contains further relevant information, then β and not γ should be nonzero.

4. If both models contain the same information, then the forecasts are perfectly correlated, and β and γ are not separately identified.

The procedure is to estimate (19.1) for forecasts for different models and then test the hypothesis H_1 that $\beta = 0$ and the hypothesis H_2 that $\gamma = 0$. H_1 is the hypothesis that model 1's forecasts contain no information relevant to forecasting s period ahead not in the constant term and in model 2. H_2 is the hypothesis that model 2's forecasts contain no information not in the constant term and in model 1.

The usual assumption that μ_t is identically distributed does not make much sense with this procedure as it is quite likely that this term is heteroskedastic. If, for example, $\alpha = 0$, $\beta = 1$, and $\gamma = 0$, μ_t is simply the forecast errors from model 1, and in general forecast errors are heteroskedastic. In the current case of one-period ahead forecasts, heteroskedasticity is corrected using White's procedure, which produces a heteroskedasticity-consistent covariance matrix.[2]

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[2] Whenever $s > 1$, an s -1 moving average process is introduced into the error term in equation 19.1 This means that a correction must be made for both heteroskedasticity and the moving average process. See Fair and Shiller (1990) for further details on this.

Some Issues with the Fair-Shiller Test

The Fair-Shiller forecast-information test requires that forecasts be based only on information available prior to the forecast period. For this reason, they call forecasts that reach this requirement "quasi ex ante" forecasts. Obviously, these are not true ex-ante forecasts if they were not issued at the appropriate time, but they are forecasts that could in principle have been issued had one been making forecasts at the time since, as will be discussed in more detail below, (a) both the AKM and the ELM are assumed to exist as of 1975 and 1980, depending upon the forecasting period; (b) there are no exogenous variables in either model; and (c) forecasts are produced by rolling estimation - i.e., by extending the forecast horizon one year at a time.

It is necessary to point out that quasi ex ante forecasts may have different properties from forecasts made with a model estimated with future data. If the model is misspecified (for example, if parameters change through time), then the rolling estimation forecasts (where estimated parameters vary through time) may carry rather different information from forecasts estimated over the entire sample period.

Assume that the beginning of the forecast period is t, so that only information through t-s should be used for forecasts, then, according to Fair and Shiller, there are four ways in which future information can creep into a current forecast. These are (a) the use of actual values of the exogenous variables for periods after t-s in the forecast; (b) estimating the coefficients of the model over a sample period that includes observations beyond t-s; (c) inclusion of information beyond period t-s in the specification of the model even though for purposes of the test the model is only estimated through period t-s; and (d) the use of information beyond period t-s to revise the data for period t-s and back, such as revised seasonal factors and revised benchmarks figures.

How does one deal with these problems? Fair and Shiller handled the exogenous-variable problem by estimating an autoregressive equation for each exogenous variable in the model and adding these equations to the model. In effect, the expanded model has no exogenous variables in it. The present exercise also employs this method of dealing with the exogenous-variable problem.

For each exogenous variable in the AKM and the ELM a third-order autoregressive equation, including a constant term and a time trend, has been postulated.[3] As a result of this, the AKM now contains 78 equations, 31 of which are stochastic. The expanded ELM now has 37 equations of which 21 are stochastic.

Forecasts generated by both models cover three periods: 1976-90, 1981-90 and 1981-2000. For forecasts in the former period, both models are assumed to exist as of 1975, which, given the sample size, means that each model is estimated over 1960-75; from this point in time one-year ahead forecasts are made until 1990. Each model is, therefore, estimated 15 times. Forecasts during 1981-90 and 1981-2000 assume that both model exist as of 1980, which implies that the estimation period is 1960-1980. The one-year ahead forecast allows the models to be estimated, through rolling estimation, 10 times for 1981-90 and 20 times for 1981-2000. Clearly, in all cases, both the estimation and the forecast periods are rather small. Very little can be done about the size of the sample periods since pre-1960 data are either non-existent or very unreliable. Precisely for this reason, it was decided to extend the sample period to the year 2000, which meant that values had to be generated for endogenous variables as the test implemented by equation 19.1 uses the forecast error which requires actual and forecasted values for the endogenous variables considered. Autoregressive equations were employed for this purpose. There are, therefore, two situations:

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[3] Working with quarterly data, Fair and Shiller (1990) used an eight-order autoregressive equation, including a constant term and a time trend, for each exogenous variable. Annual data are used in the present exercise.

(a) forecasts for the periods 1976-89 and 1981-90 where autoregressive equations were used to obtain values of exogenous variables only; and

(b) forecasts for 1981-2000 where autoregressive equations were used to obtain values for all exogenous variables and the three endogenous variables (investment, government revenue and government expenditure) for the period 1991-2000.

The foregoing notwithstanding it hardly needs emphasizing that the results of this exercise, whatever the technical appeal of the procedure, can only be indicative.

The coefficient-estimate problem - the second way in which future information can creep into the forecasts - is handled by doing rolling estimations for each model. That is, holding the beginning observation fixed for all regression, the sample period is extended by s > 1 each time a time period elapses. In the present case, s = 1, since we are working with annual data. For example, for the forecast period, the model - that is, the expanded model which includes all exogenous-variable equations - is estimated through period t-1; for the forecast period t+1, the model is estimated through period t; and so on.

The third problem - the possibility of using information beyond period t-1 in the specification of the model—is usually difficult to handle because models are normally changed through time. In the present case, this problem is circumvented by assuming that both models existed as of the end of 1975 for forecasts covering 1976-90 and as at 1980 for forecasts covering 1981-90 and 1981-2000. All forecasts are for periods beyond these cut-off dates.

The data-revision problem is hard to deal with as it is very difficult to purge the data of the possible use of future information. It is not enough simply to use data that existed at any point in time, say period t-1, because data for period t are needed to compare predicted values to actual values. In the case of Guyana, moreover, it is not known what changes, if any, have been made to the data and, if so, how the changes have been made. For the purposes of the work in this chapter nothing has been done about the data-revision problem.

Aside from the ways in which future information can enter the forecasts, two other points should be noted. First, the procedure for comparing information in forecasts developed by Fair and Shiller has two advantages over the standard procedure of computing root mean squared errors (RMSEs) to compare forecasts, as the authors point out. Little can be said about the relative merits of two models when the RMSEs for their forecasts are close; the current procedure enables one to discriminate more. But, even if one RMSE is much smaller than the other, it may still be that the forecast with the higher RMSE contains information not in the other forecast. There is no way to test this using the RMSE framework.

Second, the procedure developed by Fair and Shiller does not allow one to discover whether all the variables in a model contribute useful information for forecasting. If, say, the regression results reveal that a large model contains all the information in smaller models plus some, it may be that the good results for the large model are due to a small subset of the information. It can only be said that the large model contains all the information in the smaller models that it has been tested against, not that it contains no extraneous variables.

The Results

As we have indicated, the one-year ahead forecast of the model are for the periods 1976-90, 1981-90 and 1981-2000. In discussing the results it is necessary to remember that (a) each observation for a model's forecast is based on a different set of coefficient estimates - the rolling estimation; (b) the values of all exogenous variables in both models have been generated by autoregressive equations—neither model has any exogenous variable; and (c) the estimated standard errors of the coefficient estimates in table 49 are corrected for heteroskedasticity.

Table 49. Bias and RMSE for Each Model's Forecast

Model	Const	SE	DW	RMSE
Equation: Investment				
AKM, 1976-1990	-0.063035 (1.15)	0.67359	2.08	0.20589
ELM, 1976-1990	-0.139261 (0.46)	1.17393	1.63	1.13412
AKM, 1981-1990	-0.055247 (0.81)	0.21500	1.22	0.20249
ELM, 1981-1990	-0.117869 (0.26)	1.44488	1.62	1.37073
AKM, 1981-2000	-0.097188 (2.47)	0.17613	1.81	0.17167
ELM, 1981-2000	-0.125185 (0.56)	1.00655	1.82	0.98116
Equation: Government Revenue				
AKM, 1976-1990	-0.053237 (1.50)	0.13740	1.43	0.13274
ELM, 1976-1990	0.060691 (1.22)	0.19207	2.11	0.18556
AKM, 1981-1990	-0.031598 (0.64)	0.15561	1.48	0.14762
ELM, 1981-1990	0.048485 (0.73)	0.21037	2.21	0.19957
AKM, 1981-2000	0.014477 (0.53)	0.12299	1.16	0.11988
ELM, 1981-2000	0.027531 (0.84)	0.14687	2.16	0.14315
Equation: Government Expenditure				
AKM, 1976-1990	-0.000003 (0.00)	0.13407	1.67	0.12952
ELM, 1976-1990	0.058911 (0.87)	0.26157	2.66	0.25270
AKM, 1981-1990	-0.000105 (0.00)	0.10594	1.72	0.10051
ELM, 1981-1990	0.057062 (0.56)	0.31986	2.71	0.30344
AKM, 1981-2000	0.019693 (1.15)	0.07675	1.76	0.07481
ELM, 1981-2000	0.056024 (1.13)	0.22258	2.71	0.21694

Note: The absolute values of the t-statistics are given in parenthesis.

The bias and RMSE for each model's forecasts over three different periods are also presented in table 49 above. The bias is estimated by regressing the forecast error (predicted minus actual values of the appropriate variable under consideration) on a constant. A negative or a positive sign on the constant shows a systematic tendency to underestimate or overestimate the actual outcome. Also, if the constant term is zero in this regression, then the standard error (SE) of the regression is the same as the RMSE; otherwise the RMSE is larger.

The errors are roughly in percentage points (0.01 is a 1 per cent error) because real investment, government revenue and government expenditure are in logs.

Both models show a systematic tendency to underpredict the actual value of investment in all three periods. The bias of the ELM is twice that of the AKM for the periods 1976-90 and 1981-90 but over a longer period of time, 1981-2000, it is reduced to only about 75 per cent that of the AKM. In terms of a single number, as the table shows, the bias of the AKM did not exceed 10 per cent, which is 4 per cent less than that of the ELM. The bias of the AKM increases as the number of observations in the forecast period increases.

For both government revenue and expenditure, the AKM underpredicts the actual outcome for the first two periods while the ELM overpredicts for all periods. The biases for these variables for both models are considerably smaller that the biases for investment. In other words, in terms of the bias produced, both models are better at forecasting (quasi ex ante) government revenue and expenditure than domestic investment. It is also evident from the table that the AKM recorded substantially smaller biases for all periods than the ELM.

In addition to having the smallest biases for all three forecast periods and all three variables (investment, government revenue and expenditure), the AKM also has the smallest RMSE. Using this criteria, both models turned in superior forecasting performance during the period 1981-2000. In fact, in general, both models are associated with declining RMSE as the number of observations in the forecast period increases. Importantly, however, the RMSEs of the AKM are many orders smaller than those of the ELM, particularly for investment and government expenditure. On this criterion, therefore, the AKM must be deemed as outperforming the ELM.

Consider now table 50 which shows estimates of equation (19.1). The coefficient estimates of the AKM are always significant at the traditional 5 per cent level for all three forecasting periods and for all three variables forecasted. Moreover, as can be seen from the table, unlike the forecasts produced by the ELM, the various regressions give heavy weights (larger coefficients) to the AKM forecasts.

The coefficient estimates of the ELM forecasts for investment are also significant at the 5 per cent level even though the coefficients are not particularly large. Nevertheless, it is clear that the ELM carries some useful information for forecasting investment not contained in the AKM.

As regards the forecasts of government revenues during 1976-90 and 1981-90, the results provide strong support for the hypothesis that the AKM carries useful information not in the ELM. However, for the period 1981-2000, both models carry useful forecasting information, although the AKM dominates.

Table 50. The AKM Versus the ELM:Estimates of Equation 19.1

Period	Const	AKM ${}_{t-s}\hat{Y}_{1s} - Y_{t-1}$	ELM ${}_{t-s}\hat{Y}_{2s} - Y_{t-1}$	SE	DW
Equation:Investment					
1976-1990	0.0960 (1.35)	1.0518 (3.65)	0.0912 (1.92)	0.2222	2.62
1981-1990	0.0872 (0.88)	0.8404 (1.97)	0.0955 (1.95)	0.2631	2.57
1981-2000	0.0963 (1.62)	0.6694 (2.17)	0.1034 (2.55)	0.1746	2.86
Equation: Government Revenue					
1976-1990	-0.0106 (0.36)	0.6493 (2.39)	-0.1078 (0.35)	0.1251	0.85
1981-1990	0.0036 (0.12)	0.5663 (2.12)	0.1400 (0.92)	0.0759	1.71
1981-2000	-0.0193 (1.61)	0.3807 (2.37)	0.2423 (2.50)	0.0545	1.79
Equation: Government Expenditure					
1976-1990	-0.0251 (0.55)	1.1441 (2.34)	0.0951 (0.66)	0.1798	1.56
1981-1990	-0.0077 (0.16)	1.7491 (4.70)	0.1742 (0.12)	0.1573	2.06
1981-2000	-0.0046 (0.22)	1.7398 (6.12)	0.0131 (0.09)	0.1058	2.10

Note: The absolute values of the t-statistics are given in parenthesis.

It is with respect to the forecasting of government expenditure that the AKM completely dominates as is readily seen from the table: large and significant coefficient estimates compared to small and insignificant coefficient estimates for the ELM. In other words, the AKM encompasses all information in the ELM.

A comparison of tables 49 and 50 gives some indication of the advantages of the procedure developed by Fair and Shiller over the RMSE procedure. The former table show that the AKM dominates the ELM by a large amount in terms of the RMSE. One might conclude from this that there is no additional information in the ELM for forecasting investment, government revenue or government expenditure not already contained in the AKM. However, it is clear from table 50 that the ELM contains information for the forecast of investment and revenue not contained in the forecast of the AKM. One would not have known this from table 49 alone.

ANNEXES

ANNEX 1

Equations for the Augmented Keynesian Model

(All variables in sections A and B are in logarithm except the dummy varaibles DUCON, DUGVTR, DUGVTX, DUMC and DUFUEL)

A. Behavioral Equations

$$\text{(A1.1)} \quad \text{CONPR} = \lambda_1 + \lambda_2\,\text{YDR} + \lambda_3\,\text{CONPRT} + \lambda_4\,\text{CONPRW} + \lambda_5\,\text{WLTHRD} + \lambda_6\,\text{DUCON} \qquad \text{[Prv. Cons.]}$$

$$\text{(A1.2)} \quad \text{GDIR} = \lambda_7 + \lambda_8\,\text{GDPRD} + \lambda_9\,\text{DCRGDI} + \lambda_{10}\,\text{MIRKR} + \lambda_{11}\,\text{RLTVP}_{im} + \lambda_{12}\,\text{KR}_{t-1} \qquad \text{[Gross Inv.]}$$

$$\text{(A1.3)} \quad \text{CGTXR} = \lambda_{16}\lambda_{13} + \lambda_{16}\lambda_{14}\,\text{GDPR} + \lambda_{16}\lambda_{15}\,\text{CGDFR} + (1 - \lambda_{16})\,\text{CGTXR}_{t-1} + \lambda_{17}\,\text{DUGVTX} \qquad \text{[Gvt. Exp.]}$$

$$\text{(A1.4)} \quad \text{CGTRR} = \lambda_{20}\lambda_{18} + \lambda_{20}\lambda_{19}\,\text{GDPR} + (1 - \lambda_{20})\,\text{CGTRR}_{t-1} + \lambda_{21}\,\text{DUGVTR} \qquad \text{[Gvt. Rev.]}$$

(A1.5)	M2R	=	$\lambda_{25}\lambda_{22} + \lambda_{25}\lambda_{23}\,\mathrm{WLTHR} + \lambda_{25}\lambda_{24}\,\mathrm{R} + (1 - \lambda_{25})\,\mathrm{M2R}_{t-1} + \lambda_{26}\,\mathrm{M2U}_t + \mathrm{M^SU}$	[Money Dem.]
(A1.6)	MCR	=	$\lambda_{27} + \lambda_{28}\,\mathrm{YDR} + \lambda_{29}\,\mathrm{RLTVP}_{im} + \lambda_{30}\,\mathrm{MCAPR} + \lambda_{31}\,\mathrm{MCR}_{t-1} + \lambda_{32}\,\mathrm{DUMC}$	[Cons. Imp.]
(A1..7)	MRIR	=	$\lambda_{33} + \lambda_{34}\,\mathrm{CAPU} + \lambda_{35}\,\mathrm{RLTVP}_{im}\mathrm{D} + \lambda_{36}\,\mathrm{CGDFRD} + \lambda_{37}\,\mathrm{MCAPR} + \lambda_{38}\,\mathrm{MRIR}_{t-1} + \lambda_{39}\,\mathrm{DUFUEL}$	[R. Mt & Int Imp]
(A1.8)	MKR	=	$\lambda_{40} + \lambda_{41}\,\mathrm{GDIRD} + \lambda_{42}\,[\mathrm{RLTVP}_{im}]_{t-1} + \lambda_{43}\,\mathrm{MCAPR} + \lambda_{44}\,\mathrm{MKR}_{t-1} + \lambda_{45}\,\mathrm{CGDFRD}$	[Cap. Imp.]
(A1.9)	XTOTR	=	$\lambda_{46} + \lambda_{47}\,\mathrm{GDPR} + \lambda_{48}\,\mathrm{EP}_{ex}\mathrm{D}$	[Exports]
(A1.10)	Π_t	=	$\lambda_{49} + \lambda_{50}\,\Pi^e_t + \lambda_{51}\,\mathrm{COSTLWD} + \lambda_{52}\,\mathrm{COSTIID} + \lambda_{53}\,\mathrm{M^e3XSD}_{t-1} + \lambda_{54}\,\mathrm{GDP3XSD}_{t-1}$	[Inflation]
(A1.11)	GDPTR	=	$\lambda_{55} + \lambda_{56}\,\mathrm{KR} + \lambda_{57}\,\mathrm{L} + \lambda_{58}\,\mathrm{MCAPR}_{t-1} + \lambda_{59}\,t + \lambda_{60}\,t^2$	[Pot. Output]
(A1.12)	DPRR	=	$\lambda_{61} + \lambda_{62}\,\mathrm{KR}_{t-1} + \lambda_{63}\,t$	[Depreciation]

B. Auxillary Equations

(A1.13)	Π^e	=	$\Pi + 0.013 - 0.948\,\mathrm{MA}(1) + 1.684\,\mathrm{AR}(1) - 0.621\,\mathrm{AR}(2)$	[Exp. Inflation]
(A1.14)	$\mathrm{M^eA}$	=	$\mathrm{M^eD} + 0.237 + 0.542\,\mathrm{MA}(2) + 0.355\,\mathrm{AR}(1) + 0.347\,\mathrm{AR}(2)$	[Antp. Mny Sup]

C. Identities

Private consumption

(A1.15)	YDR	=	GDPR - TAXR	[Disp. Income]
(A1.16)	CDNPRT	=	(1/3)*(CONPR(-2) + CONPR(-1) + CONPR)	[Trn Prv. Con]
(A1.17)	CONPRW	=	CONPR(-1) - CONPRT	[Dv Trn Prv Con]
(A1.18)	WLTHRD	=	D(WLTHRT)	[Dv. Trn Wlth]

Gross domestic investment

(A1.19)	GDPRD	=	D(GDPR)	[Frst Diff GDP]
(A1.20)	DCRGDI	=	DC/GDI	[Cr. per Unit Inv]
(A1.21)	GDI	=	(GDPR*P)/100	[Noml Gross Inv]
(A1.22)	MIRKR	=	MRIR + MKR	[Intrd & Cap Imp]
(A1.23)	$RLTVP_{im}$	=	$((EXRT*P_{im})/P)*100$	[Rltv Imp Prices]

Government revenue and expenditure

(A1.24)	CGDFR	=	CGTRR / CGTXR	[Fiscal Deficit]

Money demand

(A1.25)	M^*U	=	M^* - M^*A	[Unantp Mny Sply]
(A1.26)	M2	=	(M2R*P)/100	[Nml Mny Suply]
(A1.27)	M^*D	=	$D(M^*)$	[Ch Nml Mny Sply]
(A1.28)	M^*	=	DCR + IR	[Nml Money Supply]
(A1.29)	M^*	=	M2	[Mny Mkt Equil]

Three import equations

(A1.30)	$RLTVP_{im}D$	=	$D(RLTVP_{im})$	[Frst diff Rltv Prcs]
(A1.31)	CAPU	=	GDPR /GDPTR	[Cap Utilization]
(A1.32)	CGDFRD	=	D(CGDFR)	[Frst Diff Fcl Defct]
(A1.33)	GDIRD	=	D(GDIR)	[Frst Diff Grs Inv]

Export

(A1.34)	$EP_{ex}D$	=	$D(EP_{ex})$	[Frst Diff Exp Prcs]

Inflation

(A1.35)	MKUP	=	(COPROF/MFCN)*100	[Markup Rate]
(A1.36)	MFCN	=	GDP - (AGRI + MQ + SERV)	[Manufct GDP]
(A1.37)	IOCOF	=	MRI/GDP	[I-O Cof Imp Intd]
(A1.38)	LOCOF	=	L/GDP	[L-O Cof]
(A1.39)	IDRATE	=	IDTX/GDPFT	[Id Tx Rt Fnl Gds]
(A1.40)	GDPFT	=	GDP - SERV	[Final goods]
(A1.41)	MDW	=	(1 + (MKUP/100))*(1 + (R/100))*(1 + (IDRATE/100))	[Rte of Imposition]
(A1.42)	COSTLW	=	MDW*LOCOF*W	[C of lab & MDW]
(A1.43)	COSTLWD	=	D(COSTLW)	[Fst Diff COSTLW]
(A1.44)	COSTII	=	$MDW*(P_{im}*EXRT)*IOCOF$	[C Im Mt & MDW]
(A1.45)	COSTIID	=	D(COSTII)	[Frst diff COSII]
(A1.46)	M^*3	=	$(1/3)*(M^*(-2) + M^*(-1) + M^*)$	[Trnd Brd Money]
(A1.47)	M^*3XS	=	M^* - M^*3	[Dv M frm Trnd]
(A1.48)	M^*3XSD	=	$D(M^*3XS)$	[Frst Diff M3XS]
(A1.49)	GDP3	=	(1/3)*(GDP(-2) + (GDP(-1) + GDP)	[Trnd GDP]
(A1.50)	GDP3XS	=	GDP - GDP3	[Dv GDP frm Trnd]
(A1.51)	GDP3XSD	=	D(GDP3XS)	[Frst diff GDP3XS]

Potential output and depreciation

(A1.52)	KR_t	=	KR_{t-1} + $GDIR_t$	[Cap. Stock]
(A1.53)	MCAPR	=	$((XTOTU/P_{im})*100)*EXRT$	[Imp. Capciity]

<u>Others</u>

(A1.54)	P	=	(EXP(Π)*P(-1))	[Dom Price lvl]
(A1.55)	GDP	=	(GDPR*P)/100	[Nml GDP]
(A1.56)	XTOTU	=	(XTOT/EXRT)	[Tot Export, US$]
(A1.57)	XTOT	=	(XTOTR*P)/100	[Nml Tot Export]
(A1.58)	MRI	=	(MRIR*P)/100	[Nml R. Mt& Int Imp]
(A1.59)	BOPR	=	XTOTR - (MCR+MRIR+MKR) + CAOTHR + TKINR	[B. of Payments]
(A1.60)	IR	=	BOPR - CARR	[Intl. Reseres]
(A1.61)	GDPR	=	CONPR + GDIR + XTOTR - (MCR+MRIR+MKR+MNFSR) - (CGTXR - CGIR)	[Gross Dm Product]

D. List of Endogenous Variables

Name	Description	Eq. No.	Construction	STO. EQ/ID
BOPR	Balance of Payments	A1.60	(XTOTR - (MCR + MRIR + MKR) + CAOTHR + TKINR)	ID
CAPU	Capacity utilization	A1.31,A1.7	GDPR/GDPT	ID
CGDFR	Real fiscal deficit	A1.24,A1.3, A1.32	CGTRR /CGTXR	ID
CGDFRD	First difference of real fiscal deficit	A1.32,A1.7, A1.8	D(CGDFR)	ID
CGTRR	Real government revenue	A1.4,A1.24	(CGTR/P)*100	STO
CGTXR	Real government expenditures, including capital expenditures (CGIR)	A1.3,A1.24	(CGTX/P)*100	STO
CONPR	Real private consumption	A1.1,A1.16, A1.17, A1.61	(CONP/P)*100	STO
CONPRT	Trend real private consumption, defined as three-period moving average	A1.16,A1.1	(1/3)*(CONPR(-2) + CONPR(-1) + CONPR)	ID
CONPRW	Deviation of private consumption from trend	A1.17,A1.1	CONPR(-1) - CONPRT	ID
COSTII	Cost of imported raw materials, including markup, indirecct taxes and cost of working capital	A1.44, A1.45	MDW*(P_{im}*EXRT)* IOCOF	ID

Name	Description	Eq. No.	Construction	STO. EQ/ID
COSTIID	First difference of COSTII	A1.45, A1.10	D(COSTII)	ID
COSTLW	Cost of labor, including markup, indirect taxes and cost of working capital	A1.42, A1.43	MDW*LCCOF* W	ID
COSTLWD	First difference of COSTLW	A1.43, A1.10	D(COSTLW)	ID
DCRGDI	Domestic credit per unit of gross investment	A1.20,A1.2	DC/GDI	ID
DPRR	Real depreciation of capital stock	A1.12	(DPR\P)*100	STO
GDI	Gross Domestic Investment	A1.21, A1.20	(GDIR*P)/100	ID
GDIR	Real gross domestic innvestment	A1.2,A1.33,A1.52, A1.61	(GDI/P)*100	STO
GDIRD	First difference of real gross domestic investment	A1.33, A1.8	D(GDIR)	ID
GDP	Nominal GDP, current market prices	A1.55, A1.36, A1.37, A1.38, A1.40, A1.49, A1.50	(GDPR*P)/100	ID
$EP_{ex}D$	Change in export prices	A1.34, A1.9	$D(EP_{ex})$	ID

Name	Description	Eq. No.	Construction	STO. EQ/ID
GDPFT	GDP of final goods. Also equals agriculture, mining and quarrying, manufacturing and construction share of GDP	A1.40, A1.39	GDP - SERV	ID
GDP3	Trend GDP, three-period moving average	A1.49,A1.50	(1/3)*(GDP(-2)+GDP(-1) +GDP)	ID
GDP3XS	Excess demand	A1.50,A1.51	GDP - GDP3	ID
GDP3XSD	First difference of GDP3XS	A1.51,A1.10	D(GDP3XS)	ID
GDPR	Real GDP	A1.61,A1.3, A1.4,A1.9,A1.15, A1.19,A1.21, A1.31,A1.55	CONPR+GDIR+(CGTXR-CGIIR)+XTOTR-(MCR+MRIR+MKR+MNFSR)	ID
GDPRD	Fist diference of real GDP	A1.19,A1.2	D(GDPR)	ID
GDPTR	Real potential output (i.e., potential GDPR)	A1.11,A1.31	Potential GDP, estimated with SORITEC. Command: GDPTR GDPR	STO
IDRATE	Rate of indirect taxes on final goods	A1.39,A1.41	(IDTX/GDPFT)*100	ID
IOCOF	Input-output coefficient of imported intermediates	A1.37,A1.44	MRI/GDP	ID

Name	Description	Eq. No.	Construction	STO. EQ/ID
KR	Real capital stock, defined as the sum of GDIR from 1950 to 1988	A1.52,A1.2,A1.11, A1.12	KR_{t-1} + $GDIR_t$	ID
LOCOF	Labr-output coefficient	A1.38,A1.42	L/GDP	ID
M2	Nominal broad money supply	A1.26,A1.29	(M2R*P)/100	ID
M*	Nominal broad money supply, defined as the sum of net domestic credit and the stock of international reserves	A1.28,A1.25, A1.29,A1.46, A1.47	NDC + IR	ID
M*A	Anticipated broad money supply	A1.14,A1.25	ARIMA(3,1,2) on M*	STO
M*D	First difference of broad money supply	A1.27,A1.14	D(M*)	ID
M2R	Demand for real money (broad) balances	A1.5,A1.26	(M2/P)*100	STO
M*U	Unanticipated broad money supply	A1.25,A1.5	M* - M*A	ID
MCAPR	Real import capacity, defined as total export earnings deflated by the import price index	A1.53,A1.6, A1.7,A1.8, A1.11	$((XTOTU/P_{im})*100)*EXRT$	ID
MCR	Real import of consumer goods	A1.6,A1.59, A1.61	(MC/P)*100	STO

Name	Description	Eq. No.	Construction	STO. EQ/ID
MDW	The rate of imposition, comprising the product of direct tax, markup and the cost of working capital	A1.41,A1.42, A1.44	(1 + (MKUP/100)) * (1 + (IDRATE/100)) * (1 + (R/100) ω))	ID
MFCN	Manufacturing share of GDP	A1.36,A1.35	GDP - (ARGI + MQ + SERV)	ID
MKUP	Markup over interest-inclusive prime cost	A1.35,A1.41	(COPF/MFCN)*100	ID
MRI	Import of raw materials and intermediate goods in nominal terms	A1.58,A1.37	(MRIR*P/100	ID
MIRKR	Imports of raw mateiral, intermediate and capital goods	A1.22,A1.2	MRIR + MKR	ID
MRIR	Real import of raw materials and intermediate goods	A1.7,A1.22,A1.58 A1.59,A1.61	(MRI/P)*100	STO
MKR	Real import of capital goods	A1.8, A1.22, A1.59,A1.61	(MK/P)*100	STO
M*3	Trend of broad money, defined as three-period moving average	A1.46.A1.47	(1/3)*(M*(-2) + M*(-1) + M*)	ID
M*3XS	Deviation from trend, broad money (excess money supply)	A1.47,A1.48	M* - M*3	ID
M*3XSD	First difference of M23XS	A1.48,A1.10	D(M*3XS)	ID

Name	Description	Eq. No.	Construction	STO. EQ/ID
P	Domestic price level, proxied by the Consumer Price Index, base 1987 (CPI87)	A1.54,A1.21,A1.23, A1.26,A1.55, A1.57,A1.58	$(EXP(\Pi)*P(-1))$	ID
$RLTVP_{im}$	Relative import prices/ real exchange rate	A1.23,A1.2,A1.30, A1.6,A1.8	$((P_{im}*EXRT)/P))*100$	ID
$RLTVP_{im}D$	Change in relative import prices	A1.30,A1.7	$D(RLTVP_{ex})$	ID
WLTHRD	First diffewrence of trend wealth	A1.18,A1.1	D(WLTHRT)	ID
XTOTR	Real total exports, inluding nonfator services	A1.9,A1.59,A1.61	(XTOT/CPI87)*100	STO
XTOT	ominal value of total exports	A1.57,A1.56	(XTOTR*P)/100	ID
XTOTU	Nominal value of total exports in US dollars	A1.56,A1.53	XTOT/EXRT	ID
YDR	Real disposable inncome	A1.15, A1.1, A1.6	GDPR - TAXR	ID
Π^{e}	Expected Inflation	A1.13,A1.10	Prediction from an ARMA(2,1) on Π	STO
Π	Consumer inflation	A1.10,A1.54	D(LOG(P))	STO

E. List of Exogenous Varaibles

Name	Description	Comment	Eq. No.
AGRI	Agriculture share of GDP		A1.36
CAOTH	Other items on the current account of the BOP: namely, net factor services and net current transfers	BOP, World Bank's format, table 3.1	A1.59
COPROF	Company profits		A1.35
DC	Total domestic credit in nominal terms	Exogenous, policy variable	A1.20
DUFUEL	Dummy variable for depressed fuel imports	1960-1972 =0; 1973-1988 = 1.	A1.7
DUGVTR	Dummy variable for sudden surge in government revenue during the short-lived sugar boom	1974-76 =1; zero for all other years.	A1..3
DUGVTX	Dummy variable for sudden surge in government expenditure during the short-lived sugar boom and during the period 1981-84	1973-76 = 1; 1981-81 = 1; zero for all other years.	A1.4
DUCON	Dummy variable forlower level of consumption	1960-76 = 0; 1977-88 = 1.	A1.1
DUMC	Dummy variable for policy restricting consumer imports	1963, 1977,1978 = 1; 1982-85 = 1; 1988 = 1; zero for all other years.	A1.6

Name	Description	Comment	Eq. No.
EP_{ex}	Export Price Index in local currency	Defined as Export Pice Index times the nominal rate of exchange	A1.34
EXRT	Nominal rate of echange	Exogenous because Guyana was on a fixed exchange rate regime during the model period. Indeed, EXRT remained unchanged for long periods.	A1.23, A1,44, A1.53, A1.56
IDTX	Indirect taxes in nominal terms		A1.39
L	Potential labor supply, proxied by the labor force, defined as males and females between the ags of 15 and 55, deflated by the rate of unemployment		A1.11, A1.38
MNFSR	Nonfactor services, import (real terms)	BOP, World Bank's format, table 3.1	A1.61
MQ	Mining and quarrying share of GDP		A1.36
P_{im}	Import Price Index, base 1987 (IPI87)	Guyana has no control over import price - her total imports are too negligible toexert any effect on either price or quantity.	A1.23, A1.44, A1.53
R	Nominal commercial bank lending rate of interest	Administered rather than determined by the market.	A1.5,A1.41
SERV	Service share of GDP	DEFINITION: GDP-(agriculture+mining and quarrying+manufacturing+construction sahre of GDP)	A1.36

Name	Description	Comment	Eq. No.
t	Linear time trend	1960 = 1 and 1988 = 29	A1.11, A1.12
t^2	Quadratic time trend	1960= 1 and 1988 = 841	A1.11
TAXR	Total taxes, real	Defined as the sum of direct and indirect taxes	A1.15
TKINR	Real net capital inflow, defined as the balance on the capital account of the BOP	Includes net public capital inflow as a residual. The latter comprises direct investment, private capital, short-term capital, errors and omissions, SDR allocation, debt refinancing.deferment and others, according to World Bank (1990c). TKINR is exogenously determined because Guyana has little, if any, control over capitla inflow of this nature.	A1.59
W	"Average" wage rate	Set by tade unions in major sectors of the economy. Data for 1973-88 estimated, based on discussions with government officials, private enterprise and personal knowledge of the Guyanese economy	A1.42
WLTHR	Real wealth defined as the sum of time and saving deposits		A1.5
WLTHRT	Trend real household wealth	Trend wealth is taken as the three-period moving average of wealth.	A1.18

ANNEX 2

The Nugent-Glezakos Method of Arriving at Expected inflation

The discussion here is based on the Nugent and Glezakos (1979). Expected inflation, Π^{*}_{t}, is assumed to follow an adaptive mechanism:

$$\text{(A2.1)} \qquad \Pi^{*}_{t} = \Pi^{*}_{t-1} + \beta(\Pi_{t-1} - \Pi^{*}_{t-1})$$

where the term on the left-hand side represents the rate (annual) of inflation expected to take place during year t and formed during the preceding year and β is the adjustment coefficient.

As Nugent and Glezakos show, (A2.1) can be converted readily into a distributed lag model by successive substitution:

$$\begin{aligned} \Pi^{*}_{t} &= \beta\Pi_{t-1} + \beta(1-\beta)\Pi_{t-2} + \beta(1-\beta)^{2}\Pi_{t-3} + \ldots \\ \text{(A2.2)} \qquad &= \beta\sum_{i=1}^{\infty}(1-\beta)^{i-1}\Pi_{t-1} \end{aligned}$$

In effect, expected inflation has now been expressed as a function of its past values, ad infinitum. In practical applications it is necessary to have a finite period wherein the adaptive mechanism is supposed to operate. Experiments with various lag lengths suggest that three is optimal: higher order lags did not contribute significantly to the explanatory power of the model. Equation (A2.2) can now be rewritten as:

$$(A2.3) \qquad \Pi_t^e = \beta \sum_{i=1}^{3} (1-\beta)^{i-1} \Pi_{t-1}$$

How does one estimate β? Following Nugent and Hlezakos, it is assumed that people choose β in such a way as to minimize expected losses (LS) in quadratic form,

$$(A2.4) \qquad LS = \sum_{i=1}^{T} (\Pi_t - \Pi_t^e)^2$$

Substituting (A2.3) into (A2.4) and varying β by increments of 0.1, starting from $\beta = 0$ to $\beta = 1$, one can derive the β that gives the lowest LS. That is, we need to minimize the expression

$$(A2.5) \qquad LS = \sum_{i=1}^{T} \left[\Pi_t - \beta \sum_{i=1}^{3} (1-\beta)^{i-1} \Pi_{t-1} \right]^2$$

Support for the adaptive expectation mechanism can be readily found in the literature. Lim (1987), for example, noted that rational expectations and "near-rational expectations" approaches yield poor results, perhaps because of the strong assumption that economic agents have full information at their disposal and are thus able to employ the "correct" model. In an underdeveloped country, such as Guyana, this assumption breaks down for more than one reason. Sophisticated communication and information systems are lacking or are located only in well-developed areas such as the few cities. Moreover, detailed and accurate economic data simply do not exist or become available only with a long lag and are not widely circulated. Economic agents therefore have less than full information on which to base their decisions.

Using (A2.4), the numerical value of LS are:

β	LS
0.1	3084.422
0.2	2091.167
0.3	1503.868
0.4	1171.878
0.5	994.145
0.6	906.216
0.7	869.331
0.8	861.618
0.9	871.338
1.0	892.262

It is clear from the above that the loss function is minimized when $\beta = 0.8$. With the value of β, the expected inflation can be easily computed from (A2.2).

ANNEX 3

Equations for the Export-led Model

A. Behavioral Equations[1]

(All variables in (A3.1) to (A3.9) are in logarithm, except TKRMMER and TKRGDIR)

(A3.1) $CGTRR = \beta_0 + \beta_1 \, GDPR$ [Gvt. Rev.]

(A3.2) $CGTXR = \beta_2 + \beta_3 \, GDPR + \beta_4 \, CGDFR$ [Gvt. Exp.]

(A3.3) $MCR = \beta_5 + \beta_6 \, GDPR + \beta_7 \, RLTVP_{im} + \beta_8 t$ [Cons. Imp.]

(A3.4) $MRIR = \beta_9 + \beta_{10} \, GDPR + \beta_{11} \, RLTVP_{im}D + \beta_{12} \, TKRMMER + \beta_{13} t$ [R. Mt. & Int Imp]

(A3.5) $MKR = \beta_{14} + \beta_{15} \, GDPR + \beta_{16} \, RLTVP_{im} + \beta_{17} \, TKRMMER + \beta_{18} t$ [Cap. Imp.]

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1 As pointed out in Chapter 17, behavioral equations for the determination of wage and labor supply have been omitted from this model so as to permit comparison on equal grounds with the Augmented Keynesian Model. Usually, equations for these variables are as follows:

(F3.1) $W = \alpha_1 + \alpha_2 \, XTOTR + \alpha_3 \, P$

(F3.2) $L = \alpha_4 + \alpha_6 \, GDPR$

(A3.6) GDPR	=	β_{19}	+	β_{20} XTOTR	+	β_{21} TAXR			[Gr. Dm Product]
(A3.7) GDIR	=	β_{22}	+	β_{23} $GDPRD_{t-1}$	+	β_{24} TKRGDIR	+	β_{25} KR	[Gross Inv.]
(A3.8) Π_t	=	β_{26}	+	β_{27} $P_{im}EXD$	+	β_{28} M^*D_{t-1}	+	$\beta_{29}WD_{t-1}$	
	+	β_{30} Π_{t-1}							[Inflation]
(A3.9) DPRR	=	β_{31}	+	β_{32} KR_{t-1}	+	β_{33} t			[Depreciation]

B. Identities

(A3.10) CGDFR	=	CGTRR - CGTXR	[Fiscal Deficit]
(A3.11) $RLTVP_{im}$	=	$((EXRT*P_{im}/P)*100$	[Rltv Imp Prices]
(A3.12) $RLTVP_{im}D$	=	$D(RLTVP_{im})$	[Ch Rltv Imp Prcs]
(A3.13) TKRMMER	=	(TKINR/MMER]	[Cap Infl/Me Imp]
(A3.14) GDPRD	=	D(GDPR)	[Frst Diff GDP]
(A3.15) TKRGDIR	=	TINKR/GDIR	[Cap Inflow/Inv]
(A3.16) KR_t	=	KR_{t-1} + $GDIR_t$	[Cap. Stock]
(A3.17) $P_{im}EXD$	=	$D(P_{im}*EXRT)$	[Frst Diff Imp Prcs]
(A3.18) P	=	$(EXP(\Pi)*P(-1))$	[Dom Prcs Level]
(A3.19) WD	=	D(WAGE)	[Frst Diff of Wage]

(A3.20)	MMER	=	MCR + MRIR + MKR	[Merchand.ise Imp]
(A3.21)	M^s	=	NDC + IR	[Money Supply]
(A3.22)	M^s D	=	NDCD + IRD	[Chgn. Money Supply]
(A3.23	IRD	=	BOPR - CARR	[Intl. Reserves]
(A3.24)	NDCD	=	D(NDC)	[Chng Net Dom Crdt]
(A3.25)	BOPR	=	CABALR + TKINR	[Bal. of Payments]
(A3.26)	CABALR	=	MTOTR - XTOTR + FSR + CUTRNSR	[Current Ac. of BOP]

It is necessary to point out that the entire model is in the double-logarithmic form except for the capital flow variables, TKRMMER and TKRGDIR, in equations (A3.4, A3.5 and A3.7). For the during 1984, 1985, 1987 and 1988 Guyana experienced negative net capital inflows—that is, more capital flowed out of than into the country. Since the logarithm of a negative value is not defined, the use of the log form of the capital-inflow variable is ruled out. To get around this problem, equations (A3.4) and (A3.5) employ the ratio of capital inflow to total merchandise imports. Similarly, equation (A3.7) uses the ratio of capital inflow to gross domestic investment. Studies have shown that "rates" variables entered directly or in log form produces the same result (see, for example, Frenkel, 1977).

C. List of Endogenous Variables

Name	Description	Eq. No.	Construction	STO. EQ/ID
BOPR	Balance of payments, defined as the overall balance; i.e., the sum of the current and capital accounts	A3.23	CABALR+TKINR	ID
CABALR	Current account balance on the balance of payments, in real terms	A3.26,A3.25	MTOTR-XTOTR+ FSR + CUTRNSR	ID
CGDFR	Government fiscal deficit	A3.10,A3.2	CGTRR-CGTXR	ID
CGTRR	Real government revenue	A3.1,A3.10	(CGTR/P)*100	STO
CGTXR	Real government expenditure	A3.2,A3.10	(CGTX/P)*100	STO
DPRR	Real Depreciation of capital stock	A3.9	(DPR/P)*100	STO
GDPR	Real GDP	A3.6,A3.1,A3.2, A3.3,A3.4, A3.5	(GDP/P)*100	STO
GDPRD	First difference of real GDP	A3.14,A3.7	D(GDPR)	ID
GDIR	Real gross domestic investment	A3.7,A3.16	(GDI/P)*100	STO
IRD	Changes in international reserves	A3.23,A3.22	BOPR-CARR)	ID

Name	Description	Eq. No.	Construction	STO. EQ/ID
KR	Real capital stock, defined as the sum of GDIR from 1950 to 1988	A3.16, A3.7	KR_{t-1} + $GDIR_t$	ID
MCR	Real import of consumer goods	A3.3,A3.20	(MC/P)*100	STO
MKR	Real import of capital goods	A3.5,A3.20	(MK/P)*100	STO
MMER	Real merchandise imports	A3.20,A3.13	MCR+MRIR+MKR	ID
MRIR	Real import of raw materials and intermediate goods	A3.4,A3.20	(MRI/P)*100	STO
M*	Broad money supply, nominal terms	A3.21	NDC + IR	ID
M*D	Change in broad money supply, nominal terms	A3.22,A3.8	NDCD+IRD	ID
MTOTR	Real total imports, defined as merchandise imports plus net non-factor services on the import side of the current account	A3.26	MMER+NFSR*	ID
NDCD	first difference of net domestic currency	A3.24, A3.22	D(NDC)	ID
P	Domestic price level, proxied by the CPI, base 1987	A3.18,A3.11	EXP(PD)*P(-1)	ID

Name	Description	Eq. No.	Construction	STO. EQ/ID
$P_{im}EXD$	First difference of the Import Price Index (IPI87)	A3.17,A3.8	$D(P_{im}*EXRT)$	ID
$RLTVP_{im}$	Relative import prices	A3.11,A3.3,A3.5, A3.12	$((P_{im}*EXRT)/P))*100$	ID
$RLTVP_{im}D$	Change in relative import prices	A3.12,A3.4	$D(RLTVP_{im})$	ID
TKRMMER	Capital inflow per unit of merchandise import	A3.13,A3.4, A3.5	TKINR - MMER	ID
TKRGDIR	Capital inflow per unit of gross domestic investment	A3.15,A3.7	TRNR - GDIR	ID
WD	First difference of wages	A3.19,A3.8	D(W)	ID
Π	Consumer inflation	A3.8,A3.18	D(P)	STO

D. List of Exogenous Variables

Name	Description	Comments	Eq. No.
CARR	Change in commercial arrears, real terms	Item on BOP, World Bank's format. All references to World Bank's format refer to table 3.1, Statistical Appendix, of World Bank's report titled "Guyana: From Economic Recovery to Sustainable Growth", April 10, 1992 (Report No. 10307-GUY).	A3.21
CUTRNSR	Net current transfers on the current account of the balance of payments, in real terms	Penultimate line of the current account, World Bank's format.	A3.28
EXRT	Nominal rate of exchange	Exogenous because Guyana was on a fixed exchange rate regime during the model period. Indeed, EXRT remained unchanged for long periods. Difficult in such circumstances to determine impact econometrically.	A3.11, A3.22
FSR	Net factor services, in real terms	Current account , part of.	A3.28
IR	Stock of international reserves		A3.22

Name	Description	Comments	Eq. No.
KR_{t-1}	Capital stock in the previous period	Lagged endogenous variable.	A3.9,A3.16
TKINR	Real capital inflow, defined as the balance on the capital account	Includes net public capital flow and a residual. The latter comprises direct investment, private capital, short-term capital, errors and omissions, SDR allocation, debt refinancing/deferment and other, according to various World Bank reports on Guyana (see bibliography). TKINR is exogenously determined because Guyana has little, if any, control over capital flow of this nature.	A3.13, A3.16
NDC	Net domestic credit	Includes net credit to all domestic sources. An argument could be made to endogenize this variable, but it is taken as exogenous within the context of the export-led model.	A3.23,A3.26
P_{im}	Import Price Index, base 1987 (IPI87)	Exogenous - Guyana's imports too small to exert any perceptible influence on the world market.	A3.11
t	Linear time trend	1960 = 1 and 1988 = 29	A3.3, A3.4, A3,5, A3.9
TAXR	Total taxes, real	Defined as the sum of direct and indirect taxes.	A3.6

Name	Description	Comments	Eq. No.
W	"Average" wage rate	Set by trade unions in the major sectors of the economy. Data for 173-88 estimated, based on discussions with government officials, private enterprise and personal knowledge of the Guyanese economy.	A3.8
XTOTR	Total export earnings	Exogenous - the core assumption of the export-led model	A3.6,A3.28

ANNEX 4

Data used by the Models

This annex contains some of the data (original series only) used in the estimation, simulation and forecasting of the Augmented Keynesian and Export-led models All data series are for the period 1960-90, the sample period of both models. Unless otherwise indicated, all variables are in nominal terms; hence the exclusion of the "R" as the terminal character of each variable. Constructed variables are not included in the annex. These include real variables and combinations of one or more series to form a single series such as relative prices.

The quality of the data leaves much to be desired, particularly since 1980. The World Bank (1986:73) notes:

> Since 1981, the quality of the national accounts, consumer price index and population estimates has deteriorated considerably. The overall data situation has also deteriorated because of internal inconsistences in the accounts and editing problems.

One of the principal reasons for the apparently inaccurate official data is the growth of the undeground economy since the early 1980s. As far as I am aware, with the exception of Thomas (1989) no other formal attempt has been to estiamte the size of the "balck market" phenomenon. Through a study of monetary and income behavior, Thomas estimated that the size of the underground economy ranged from about 26 to 99 per cent of GDP over the period

1982-86. Thomas emphasised that the "estiamtes are very crude, but if income velocity is a useful guide then the ones used here are the most conservative of the dozen or more possible permutations which the data suggest" (p. 159).

Given the magnitude of the "balck market" it is likely that all data series with the exception of the official rate of exchange are affected. The result is that all data series are underestimated.

The sources for the data given below are World Bank (1973, 1981, 1982, 1984, 1985, 1986, 1990c, 1990d, 1991, 1991) International Monetary Fund (1990, 1992) and Bank of Guyana (1990).

Table 51. Data Set Used by the Models - 1
(millions of Guyana dollars)

Year	GDP	GDPT	DPR	CONP	GDI	M2
1960	291.70	2583.70	12.20	200.70	82.40	62.20
1961	318.60	2700.00	17.90	207.20	76.40	60.80
1962	334.20	2723.72	19.50	200.70	55.60	71.88
1963	301.30	2387.48	16.20	162.70	50.90	84.10
1964	333.90	2664.80	17.20	221.70	53.60	95.60
1965	362.20	2959.15	18.80	237.70	80.60	101.66
1966	388.80	3120.39	20.80	256.70	92.80	109.20
1967	425.30	3246.56	23.30	259.20	109.80	122.30
1968	459.50	3261.18	26.40	273.50	102.30	137.80
1969	498.60	3462.50	29.20	297.00	103.80	152.20
1970	535.60	3618.92	33.80	325.70	121.90	164.00
1971	564.10	3735.76	34.10	336.30	105.10	190.90
1972	599.30	3632.12	36.00	371.10	118.90	233.40
1973	644.80	3684.57	35.90	417.50	175.50	273.80
1974	954.70	3977.92	40.00	522.00	252.10	317.20
1975	1187.50	4287.00	45.00	562.30	392.60	447.70
1976	1136.20	4353.26	54.00	629.50	469.40	487.10
1977	1124.60	4243.77	60.00	645.90	363.30	598.90
1978	1267.60	4169.74	70.00	693.90	278.00	662.50
1979	1326.00	4092.59	85.00	606.00	497.00	709.60
1980	1508.00	4154.27	95.00	835.30	494.00	846.20
1981	1597.00	4236.07	103.00	1005.50	501.00	982.40
1982	1446.00	3660.76	118.00	962.20	361.00	1253.90
1983	1468.00	3413.95	120.00	1030.50	314.00	1518.10
1984	1663.00	3421.81	125.00	1025.70	456.00	1794.90
1985	1950.00	3457.45	126.00	1169.00	698.00	2139.50
1986	2170.00	3511.33	134.00	765.90	871.00	2488.50
1987	3359.00	3359.00	140.00	1044.00	1025.00	3820.20
1988	4138.00	3456.98	144.00	1330.00	890.10	5407.00
1989	10330.00	4745.06	325.00	2557.70	3536.00	8030.00
1990	15665.00	4323.77	140.00	4225.30	6624.00	12292.00

GDP	Gross Domnestic Produt	GDPT	Potential GDP
DPR	Depreciation charges	CONP	Private consumption
GDI	Gross domestic investment	M2	Broad money supply

Table 52. Data Set Used by the Models - 2

(millions of Guyana dollars)

Year	CGTR	CGTX	MC	MRI	MK	XTOT	Π
1960	56.80	66.60	56.09	38.99	52.50	143.13	NA
1961	59.50	78.70	56.09	43.60	46.85	165.53	1.12
1962	59.40	81.80	50.62	40.87	34.88	188.78	4.35
1963	65.90	73.40	46.68	43.26	28.22	189.13	1.06
1964	71.00	79.60	55.92	49.76	44.80	190.15	1.05
1965	82.10	106.10	70.45	55.75	54.21	201.61	2.06
1966	96.10	114.70	77.43	61.60	66.47	216.98	2.02
1967	101.00	129.20	86.00	71.20	93.00	285.00	2.96
1968	110.30	137.90	80.80	66.20	65.80	267.60	3.81
1969	116.90	151.80	92.00	72.00	70.40	295.40	0.93
1970	135.80	175.83	92.60	77.20	97.00	293.20	3.64
1971	131.90	195.80	101.57	83.95	79.20	323.14	0.89
1972	160.90	207.40	106.59	101.57	86.73	342.34	4.33
1973	164.20	252.00	118.37	136.51	127.22	341.71	7.35
1974	304.90	411.90	106.82	310.64	146.51	652.72	15.98
1975	497.70	626.70	131.92	414.89	261.02	891.14	7.75
1976	389.70	782.50	165.24	450.07	302.94	750.72	8.91
1977	352.40	530.90	143.05	410.55	226.44	710.94	7.65
1978	363.60	529.60	130.82	421.01	153.51	799.68	14.20
1979	394.90	674.20	147.39	511.78	145.86	793.05	16.39
1980	451.30	914.10	130.05	680.34	192.52	1041.93	13.06
1981	559.90	1165.80	160.73	850.31	216.93	1030.99	19.97
1982	539.40	1545.80	108.00	584.70	140.70	763.20	19.20
1983	548.00	1239.80	75.00	519.90	144.00	673.50	13.93
1984	659.50	1880.10	83.11	611.65	117.20	937.58	22.47
1985	768.40	2061.00	99.45	698.70	280.92	1039.97	13.99
1986	1024.20	3117.00	116.14	641.35	218.20	1004.30	7.62
1987	1178.80	3278.40	255.71	1448.38	536.80	2627.39	25.23
1988	1694.20	3882.90	216.00	1487.00	431.00	2456.00	33.58
1989	3174.10	4959.90	578.51	3066.36	2056.01	6347.29	47.87
1990	5357.60	10925.70	1288.68	4502.47	4850.33	9321.17	51.07

CGTR Central Government total revenue
CGTX Central Government total expenditure
MC Imports of consumption goods
MRI Imports of raw materials and intermediate goods
MK Imports of capital goods
XTOT Total exports Π Rate of inflation

Table 53. Data Set Used by the Models - 3

Year	P	P_{im}	P_{ex}	EXRT	R	WAGE
1960	8.90	16.90	30.90	1.71	4.00	3.35
1961	9.00	16.80	33.70	1.71	4.50	3.49
1962	9.40	17.40	34.50	1.71	4.80	3.79
1963	9.50	18.20	41.40	1.71	5.00	3.89
1964	9.60	17.20	39.70	1.71	5.30	4.24
1965	9.80	19.80	35.10	1.71	5.60	4.41
1966	10.00	20.10	36.70	1.74	6.00	4.56
1967	10.30	20.70	39.80	2.00	6.50	4.64
1968	10.70	21.00	43.20	2.00	6.50	4.83
1969	10.80	22.90	45.70	2.00	6.50	5.04
1970	11.20	24.00	43.70	2.00	6.50	5.23
1971	11.30	26.50	44.60	1.98	6.50	5.38
1972	11.80	28.80	51.50	2.09	6.50	5.60
1973	12.70	34.40	59.60	2.16	6.50	6.01
1974	14.90	53.30	119.90	2.23	7.50	6.83
1975	16.10	56.10	126.50	2.36	7.50	7.90
1976	17.60	57.00	94.60	2.55	7.50	10.79
1977	19.00	63.00	95.20	2.55	7.50	10.98
1978	21.90	70.50	103.00	2.55	9.50	12.66
1979	25.80	84.20	114.90	2.55	11.50	17.45
1980	29.40	97.30	146.40	2.55	13.50	19.72
1981	35.90	99.40	141.00	2.81	13.50	20.74
1982	43.50	96.10	122.10	3.00	14.40	21.45
1983	50.00	93.60	116.50	3.00	15.00	22.57
1984	62.60	92.20	105.40	3.83	15.00	22.73
1985	72.00	90.60	99.00	4.25	15.00	23.58
1986	77.70	93.20	103.50	4.27	15.00	24.06
1987	100.00	100.00	100.00	9.76	15.00	30.00
1988	139.90	104.50	116.00	10.00	15.10	34.00
1989	225.80	115.20	130.94	27.16	37.50	52.30
1990	376.30	121.40	138.04	39.53	31.00	69.12

P	The level of domesticc prices
P_{im}	Import Price Index
P_{ex}	Export Price Index
EXRT	The official nominal exchange rate, G$ per unit of US$
R	The rate (nominal) of interest
WAGE	Wage rate per day

Table 54. Data Set Used by the Models - 4

Year	K	L	MCAP	TAX	WLTH	DC
1960	729.85	137487.50	846.91	47.30	24.40	35.20
1961	1377.31	140853.05	985.29	49.70	24.50	32.60
1962	1830.44	144684.09	1084.97	49.00	30.10	33.50
1963	2233.77	147444.30	1039.15	50.90	40.80	31.90
1964	2661.55	152476.80	1105.53	56.10	48.30	35.60
1965	3320.04	158491.00	1018.23	62.10	56.40	53.60
1966	4064.83	161723.25	1079.49	71.70	62.50	70.70
1967	4902.99	164982.41	1376.81	79.40	71.60	70.10
1968	5629.04	166898.16	1274.29	90.60	81.50	91.50
1969	6349.87	168614.55	1289.96	96.60	91.60	116.60
1970	7173.52	170514.70	1221.67	118.10	102.60	137.20
1971	7869.55	176494.00	1219.38	111.50	121.50	157.90
1972	8590.16	172304.00	1188.69	140.50	145.90	181.90
1973	9593.01	179611.61	993.35	135.90	173.20	276.00
1974	10643.43	186850.80	1224.62	261.20	184.00	254.60
1975	12060.76	192081.05	1588.48	430.80	240.40	320.60
1976	13859.23	199160.00	1317.05	336.40	265.70	583.50
1977	15230.17	206913.42	1128.48	300.70	313.90	758.40
1978	16144.64	214355.84	1134.30	310.00	362.10	844.60
1979	17678.59	222304.12	941.86	333.20	421.40	1070.60
1980	19039.47	229933.44	1070.84	384.00	518.20	1450.40
1981	20368.39	293445.47	1037.21	479.50	631.60	1790.10
1982	21282.31	242999.77	794.17	453.80	817.90	2467.10
1983	22012.54	249774.56	719.55	477.20	1009.20	3168.50
1984	22950.81	256175.81	1016.90	572.50	1176.30	4006.90
1985	24188.40	263195.41	1147.88	675.20	1399.90	5350.50
1986	25597.79	268930.56	1077.58	918.60	1607.80	6181.80
1987	26622.79	274948.37	2627.39	1025.80	2487.60	8168.00
1988	27366.40	279087.31	2350.24	1559.20	3312.00	13125.00
1989	28990.65	284202.00	5509.80	2835.40	5107.00	29742.20
1990	30818.97	289225.41	7678.07	5040.70	8030.00	40456.30

K	Value of capital stock, millions of Guyana dollars
DC	Total comestic credit, millions of Guyana dollars
L	Potential labor supply
MCAP	Import capacity, millions of Guyana dollars
TAX	Total taxes, millions of Guyana dollars
WLTH	Private (financial) wealth, millions of Guyana dollars

Table 55. <u>Data Set Used by the Models - 5</u>

Year	MDW	M^sU	Π^e
1960	1.67	NA	NA
1961	1.68	-0.26	1.00
1962	1.75	-0.07	1.00
1963	1.72	-0.08	5.00
1964	1.62	-0.01	2.00
1965	1.63	-0.08	2.00
1966	1.65	-0.07	3.00
1967	1.64	0.02	3.00
1968	1.60	0.03	4.00
1969	1.57	-0.05	4.00
1970	1.75	-0.08	2.00
1971	1.61	0.04	4.00
1972	1.89	0.09	2.00
1973	1.82	-0.03	5.00
1974	1.63	-0.08	7.00
1975	1.58	0.17	14.00
1976	1.73	-0.12	9.00
1977	1.90	-0.04	10.00
1978	1.91	-0.10	10.00
1979	1.97	-0.05	15.00
1980	2.05	0.06	17.00
1981	2.21	0.01	16.00
1982	2.26	0.06	21.00
1983	2.45	-0.03	22.00
1984	2.53	-0.06	19.00
1985	2.48	-0.02	26.00
1986	2.78	-0.02	21.00
1987	2.27	0.26	16.00
1988	2.42	0.07	29.00
1989	2.54	0.01	37.00
1990	2.77	0.03	49.00

MDW	The "rate of imposition," including the mark-up
M^sU	Unanticipated money supply, millions of Guyana dollars
Π^e	Expected inflation

ANNEX 4

Data used by the Models

This annex contains some of the data (original series only) used in the estimation, simulation and forecasting of the Augmented Keynesian and Export-led models All data series are for the period 1960-90, the sample period of both models. Unless otherwise indicated, all variables are in nominal terms; hence the exclusion of the "R" as the terminal character of each variable. Constructed variables are not included in the annex. These include real variables and combinations of one or more series to form a single series such as relative prices.

The quality of the data leaves much to be desired, particularly since 1980. The World Bank (1986:73) notes:

> Since 1981, the quality of the national accounts, consumer price index and population estimates has deteriorated considerably. The overall data situation has also deteriorated because of internal inconsistences in the accounts and editing problems.

One of the principal reasons for the apparently inaccurate official data is the growth of the undeground economy since the early 1980s. As far as I am aware, with the exception of Thomas (1989) no other formal attempt has been to estiamte the size of the "balck market" phenomenon. Through a study of monetary and income behavior, Thomas estimated that the size of the underground economy ranged from about 26 to 99 per cent of GDP over the period

1982-86. Thomas emphasised that the "estiamtes are very crude, but if income velocity is a useful guide then the ones used here are the most conservative of the dozen or more possible permutations which the data suggest" (p. 159).

Given the magnitude of the "balck market" it is likely that all data series with the exception of the official rate of exchange are affected. The result is that all data series are underestimated.

The sources for the data given below are World Bank (1973, 1981, 1982, 1984, 1985, 1986, 1990c, 1990d, 1991, 1991) International Monetary Fund (1990, 1992) and Bank of Guyana (1990).

Table 51. Data Set Used by the Models - 1
(millions of Guyana dollars)

Year	GDP	GDPT	DPR	CONP	GDI	M2
1960	291.70	2583.70	12.20	200.70	82.40	62.20
1961	318.60	2700.00	17.90	207.20	76.40	60.80
1962	334.20	2723.72	19.50	200.70	55.60	71.88
1963	301.30	2387.48	16.20	162.70	50.90	84.10
1964	333.90	2664.80	17.20	221.70	53.60	95.60
1965	362.20	2959.15	18.80	237.70	80.60	101.66
1966	388.80	3120.39	20.80	256.70	92.80	109.20
1967	425.30	3246.56	23.30	259.20	109.80	122.30
1968	459.50	3261.18	26.40	273.50	102.30	137.80
1969	498.60	3462.50	29.20	297.00	103.80	152.20
1970	535.60	3618.92	33.80	325.70	121.90	164.00
1971	564.10	3735.76	34.10	336.30	105.10	190.90
1972	599.30	3632.12	36.00	371.10	118.90	233.40
1973	644.80	3684.57	35.90	417.50	175.50	273.80
1974	954.70	3977.92	40.00	522.00	252.10	317.20
1975	1187.50	4287.00	45.00	562.30	392.60	447.70
1976	1136.20	4353.26	54.00	629.50	469.40	487.10
1977	1124.60	4243.77	60.00	645.90	363.30	598.90
1978	1267.60	4169.74	70.00	693.90	278.00	662.50
1979	1326.00	4092.59	85.00	606.00	497.00	709.60
1980	1508.00	4154.27	95.00	835.30	494.00	846.20
1981	1597.00	4236.07	103.00	1005.50	501.00	982.40
1982	1446.00	3660.76	118.00	962.20	361.00	1253.90
1983	1468.00	3413.95	120.00	1030.50	314.00	1518.10
1984	1663.00	3421.81	125.00	1025.70	456.00	1794.90
1985	1950.00	3457.45	126.00	1169.00	698.00	2139.50
1986	2170.00	3511.33	134.00	765.90	871.00	2488.50
1987	3359.00	3359.00	140.00	1044.00	1025.00	3820.20
1988	4138.00	3456.98	144.00	1330.00	890.10	5407.00
1989	10330.00	4745.06	325.00	2557.70	3536.00	8030.00
1990	15665.00	4323.77	140.00	4225.30	6624.00	12292.00

GDP	Gross Domnestic Produt	GDPT	Potential GDP
DPR	Depreciation charges	CONP	Private consumption
GDI	Gross domestic investment	M2	Broad money supply

Table 52. Data Set Used by the Models - 2

(millions of Guyana dollars)

Year	CGTR	CGTX	MC	MRI	MK	XTOT	Π
1960	56.80	66.60	56.09	38.99	52.50	143.13	NA
1961	59.50	78.70	56.09	43.60	46.85	165.53	1.12
1962	59.40	81.80	50.62	40.87	34.88	188.78	4.35
1963	65.90	73.40	46.68	43.26	28.22	189.13	1.06
1964	71.00	79.60	55.92	49.76	44.80	190.15	1.05
1965	82.10	106.10	70.45	55.75	54.21	201.61	2.06
1966	96.10	114.70	77.43	61.60	66.47	216.98	2.02
1967	101.00	129.20	86.00	71.20	93.00	285.00	2.96
1968	110.30	137.90	80.80	66.20	65.80	267.60	3.81
1969	116.90	151.80	92.00	72.00	70.40	295.40	0.93
1970	135.80	175.83	92.60	77.20	97.00	293.20	3.64
1971	131.90	195.80	101.57	83.95	79.20	323.14	0.89
1972	160.90	207.40	106.59	101.57	86.73	342.34	4.33
1973	164.20	252.00	118.37	136.51	127.22	341.71	7.35
1974	304.90	411.90	106.82	310.64	146.51	652.72	15.98
1975	497.70	626.70	131.92	414.89	261.02	891.14	7.75
1976	389.70	782.50	165.24	450.07	302.94	750.72	8.91
1977	352.40	530.90	143.05	410.55	226.44	710.94	7.65
1978	363.60	529.60	130.82	421.01	153.51	799.68	14.20
1979	394.90	674.20	147.39	511.78	145.86	793.05	16.39
1980	451.30	914.10	130.05	680.34	192.52	1041.93	13.06
1981	559.90	1165.80	160.73	850.31	216.93	1030.99	19.97
1982	539.40	1545.80	108.00	584.70	140.70	763.20	19.20
1983	548.00	1239.80	75.00	519.90	144.00	673.50	13.93
1984	659.50	1880.10	83.11	611.65	117.20	937.58	22.47
1985	768.40	2061.00	99.45	698.70	280.92	1039.97	13.99
1986	1024.20	3117.00	116.14	641.35	218.20	1004.30	7.62
1987	1178.80	3278.40	255.71	1448.38	536.80	2627.39	25.23
1988	1694.20	3882.90	216.00	1487.00	431.00	2456.00	33.58
1989	3174.10	4959.90	578.51	3066.36	2056.01	6347.29	47.87
1990	5357.60	10925.70	1288.68	4502.47	4850.33	9321.17	51.07

CGTR Central Government total revenue

CGTX Central Government total expenditure

MC Imports of consumption goods

MRI Imports of raw materials and intermediate goods

MK Imports of capital goods

XTOT Total exports Π Rate of inflation

Table 53. Data Set Used by the Models - 3

Year	P	P_{im}	P_{ex}	EXRT	R	WAGE
1960	8.90	16.90	30.90	1.71	4.00	3.35
1961	9.00	16.80	33.70	1.71	4.50	3.49
1962	9.40	17.40	34.50	1.71	4.80	3.79
1963	9.50	18.20	41.40	1.71	5.00	3.89
1964	9.60	17.20	39.70	1.71	5.30	4.24
1965	9.80	19.80	35.10	1.71	5.60	4.41
1966	10.00	20.10	36.70	1.74	6.00	4.56
1967	10.30	20.70	39.80	2.00	6.50	4.64
1968	10.70	21.00	43.20	2.00	6.50	4.83
1969	10.80	22.90	45.70	2.00	6.50	5.04
1970	11.20	24.00	43.70	2.00	6.50	5.23
1971	11.30	26.50	44.60	1.98	6.50	5.38
1972	11.80	28.80	51.50	2.09	6.50	5.60
1973	12.70	34.40	59.60	2.16	6.50	6.01
1974	14.90	53.30	119.90	2.23	7.50	6.83
1975	16.10	56.10	126.50	2.36	7.50	7.90
1976	17.60	57.00	94.60	2.55	7.50	10.79
1977	19.00	63.00	95.20	2.55	7.50	10.98
1978	21.90	70.50	103.00	2.55	9.50	12.66
1979	25.80	84.20	114.90	2.55	11.50	17.45
1980	29.40	97.30	146.40	2.55	13.50	19.72
1981	35.90	99.40	141.00	2.81	13.50	20.74
1982	43.50	96.10	122.10	3.00	14.40	21.45
1983	50.00	93.60	116.50	3.00	15.00	22.57
1984	62.60	92.20	105.40	3.83	15.00	22.73
1985	72.00	90.60	99.00	4.25	15.00	23.58
1986	77.70	93.20	103.50	4.27	15.00	24.06
1987	100.00	100.00	100.00	9.76	15.00	30.00
1988	139.90	104.50	116.00	10.00	15.10	34.00
1989	225.80	115.20	130.94	27.16	37.50	52.30
1990	376.30	121.40	138.04	39.53	31.00	69.12

P	The level of domesticc prices
P_{im}	Import Price Index
P_{ex}	Export Price Index
EXRT	The official nominal exchange rate, G$ per unit of US$
R	The rate (nominal) of interest
WAGE	Wage rate per day

Table 54. Data Set Used by the Models - 4

Year	K	L	MCAP	TAX	WLTH	DC
1960	729.85	137487.50	846.91	47.30	24.40	35.20
1961	1377.31	140853.05	985.29	49.70	24.50	32.60
1962	1830.44	144684.09	1084.97	49.00	30.10	33.50
1963	2233.77	147444.30	1039.15	50.90	40.80	31.90
1964	2661.55	152476.80	1105.53	56.10	48.30	35.60
1965	3320.04	158491.00	1018.23	62.10	56.40	53.60
1966	4064.83	161723.25	1079.49	71.70	62.50	70.70
1967	4902.99	164982.41	1376.81	79.40	71.60	70.10
1968	5629.04	166898.16	1274.29	90.60	81.50	91.50
1969	6349.87	168614.55	1289.96	96.60	91.60	116.60
1970	7173.52	170514.70	1221.67	118.10	102.60	137.20
1971	7869.55	176494.00	1219.38	111.50	121.50	157.90
1972	8590.16	172304.00	1188.69	140.50	145.90	181.90
1973	9593.01	179611.61	993.35	135.90	173.20	276.00
1974	10643.43	186850.80	1224.62	261.20	184.00	254.60
1975	12060.76	192081.05	1588.48	430.80	240.40	320.60
1976	13859.23	199160.00	1317.05	336.40	265.70	583.50
1977	15230.17	206913.42	1128.48	300.70	313.90	758.40
1978	16144.64	214355.84	1134.30	310.00	362.10	844.60
1979	17678.59	222304.12	941.86	333.20	421.40	1070.60
1980	19039.47	229933.44	1070.84	384.00	518.20	1450.40
1981	20368.39	293445.47	1037.21	479.50	631.60	1790.10
1982	21282.31	242999.77	794.17	453.80	817.90	2467.10
1983	22012.54	249774.56	719.55	477.20	1009.20	3168.50
1984	22950.81	256175.81	1016.90	572.50	1176.30	4006.90
1985	24188.40	263195.41	1147.88	675.20	1399.90	5350.50
1986	25597.79	268930.56	1077.58	918.60	1607.80	6181.80
1987	26622.79	274948.37	2627.39	1025.80	2487.60	8168.00
1988	27366.40	279087.31	2350.24	1559.20	3312.00	13125.00
1989	28990.65	284202.00	5509.80	2835.40	5107.00	29742.20
1990	30818.97	289225.41	7678.07	5040.70	8030.00	40456.30

K	Value of capital stock, millions of Guyana dollars
DC	Total comestic credit, millions of Guyana dollars
L	Potential labor supply
MCAP	Import capacity, millions of Guyana dollars
TAX	Total taxes, millions of Guyana dollars
WLTH	Private (financial) wealth, millions of Guyana dollars

Table 55. Data Set Used by the Models - 5

Year	MDW	$M^{s}U$	Π^{e}
1960	1.67	NA	NA
1961	1.68	-0.26	1.00
1962	1.75	-0.07	1.00
1963	1.72	-0.08	5.00
1964	1.62	-0.01	2.00
1965	1.63	-0.08	2.00
1966	1.65	-0.07	3.00
1967	1.64	0.02	3.00
1968	1.60	0.03	4.00
1969	1.57	-0.05	4.00
1970	1.75	-0.08	2.00
1971	1.61	0.04	4.00
1972	1.89	0.09	2.00
1973	1.82	-0.03	5.00
1974	1.63	-0.08	7.00
1975	1.58	0.17	14.00
1976	1.73	-0.12	9.00
1977	1.90	-0.04	10.00
1978	1.91	-0.10	10.00
1979	1.97	-0.05	15.00
1980	2.05	0.06	17.00
1981	2.21	0.01	16.00
1982	2.26	0.06	21.00
1983	2.45	-0.03	22.00
1984	2.53	-0.06	19.00
1985	2.48	-0.02	26.00
1986	2.78	-0.02	21.00
1987	2.27	0.26	16.00
1988	2.42	0.07	29.00
1989	2.54	0.01	37.00
1990	2.77	0.03	49.00

MDW	The "rate of imposition," including the mark-up
$M^{s}U$	Unanticipated money supply, millions of Guyana dollars
Π^{e}	Expected inflation

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