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Measuring the impacts of credit restrictions on the trade performance of debtor nations

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by

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I. INTRODUCTION

A. The Debt Crisis

International debt of the developing nations came increasingly under scrutiny[1], as concerns arose of possible consequences detrimental not only to the well being of the borrowers but to the lenders as well and to the world economy at large. As debt and thereby debt service obligations accumulated at a rapid rate in the late seventies and early eighties, it became apparent that the repayment capacities of these nations were getting increasingly strained. Not withstanding the sovereign guarantees embodied in a large share of these loans, lenders' confidence began to erode, accentuated by the rescheduling of debts and even threats of repudiations occurring at increasing frequency. Faced with the resulting credit restrictions coupled with mounting debt service obligations, many of the borrowers adopted both internal and external adjustment programs towards conserving

[1]Detailed literature reviews on the different aspects of debt can be found in Glick (1986), and McDonald (1982). McDonald describes the basic concepts of the different classes of models. Glick provides a comprehensive analytical review, highlighting the different aspects of debt dealt with by the different models.

foreign exchange. Belt-tightening domestic policies and currency devaluations to influence expansion of net exports were adopted. Expectations of further devaluations lead to capital flight adding to the liquidity problems. The lowered demand for the developed country exports and added supply from the borrowers started to make distinct changes in the international trade patterns. The frequency of rescheduling and possibilities of repudiations threatened the smooth functioning of the international financial system. The extent of interdependence between the developing and developed world became increasingly evident.

Such is the status of the international debt environment, a tangled mass of interwoven problems, both economic and political in nature. The situation, without reservation, qualifies as a crisis situation in most economic and financial literature. Why and how the theoretically justified capital transfer that, in contrast should have contributed to mutually beneficial results, resulted in this enigma is not clear. The decision to repudiate repayments may be political. Payer (1974) suggests the decision to lend itself may have political underpinnings and equates developed country lending to purchase of compliance. However, the consequences of the debt problems have economic manifestations, and require economic policies to alleviate the ills. Failure to address economic concerns may lead to political instability (Truman, 1986).

Perhaps even more importantly, economic theory has much to contribute to understanding lender and borrower behaviors in the decision making processes (Glick, 1986). To this extent, at least, the debt problem is thus an economic problem.

As Abbot (1979) points out, "*of the many problems the developing countries face, two can be singled out as potentially the most serious source of tension and disruption in the international economy. The first is the massive foreign debts which they have contracted (and continue to contract) and the acute service problems these cause. The second is the shortage of foreign funds on concessional terms for development purposes. The two are obviously related since the more debt they accumulate, the higher their debt service payments and the less resources there are for development purposes. This in turn reduces the rate of growth and provides less domestic savings for investment and debt service purposes. The process is cumulative and self-reinforcing...*". Further, the exposure of debt service component to inflationary changes also plays a significant role as two thirds of developing country debt is at floating interest rates tied to LIBOR (London Interbank Offer Rate). While it is true that the interest rates caused by high inflation amounts to merely accelerated amortization of debt in real terms (Sachs, 1981), there is a greater present cash flow burden in return for eroding the real value of the outstanding debt. Hence the monetary-fiscal policies of the developed countries will have a deciding influence on the capacity of developing countries to recover from the debt burden (Dornbush, 1984)[2].

The impeding influence of this burden, however, was not limited to the economic performance of the debtor countries. They reverberated across the rest of the world. Despite the large number of studies published in the past two decades highlighting the critical interdependence of the third world economic development and that of the developed world, never was this link as well appreciated as at present, subsequent to the World Debt Crisis. The rapid expansion of international financial markets as well as technological advancements in communication and transportation within the last decade prompted optimism about a rapid growth of global economic integration. A natural consequence of such an integration should have been an expansion of the world economy, and an even faster growth of world trade. Experience since 1980, however, has been the opposite. World income growth has slowed down; growth in world trade slowed even faster (Table 1). The coincident onset of the debt crisis has been popularly held responsible for this sluggish performance of world output and trade.

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[2]He argues that U.S., by its dominance in the world economy, could influence the world debt status substantially through its own monetary-fiscal policies as well as by its commercial policies.

Table 1. Rate of growth of output and trade (percent)[a]

	Period Average			Annual				
	71-75	76-80	81-85	1983	1984	1985	1986	1987[b]
Output								
World	4.2	3.9	2.7	2.9	4.7	3.3	3.5	3.7
Developing countries	6.1	4.9	1.4	0.8	2.0	2.4	3.0	3.5
Net energy importers	5.2	4.8	2.3	1.9	3.8	3.3	4.5	4.5
Net energy exporters	7.7	5.1	0.1	-0.8	-0.3	1.2	1.0	2.0
Developed market economies	3.1	3.5	2.3	2.6	4.8	2.7	3.1	3.3
North America	2.8	3.6	2.6	.7	6.6	2.4	3.3	3.6
Western Europe	2.9	3.9	1.3	1.5	2.2	2.4	2.9	2.8
Japan	4.6	5.1	4.0	3.3	5.1	4.2	3.0	3.7
Centrally planned economie	6.2	4.5	4.5	5.2	6.2	5.3	4.9	4.8
Eastern Europe and USS	6.3	4.1	3.0	4.1	3.8	3.1	4.0	4.0
China	5.5	6.0	9.8	9.1	14.6	12.3	7.5	7.0
Trade								
World trade volume	5.0	5.1	2.8	2.5	9.0	3.2	4.0	4.5
Implicit income elasticity of world trade(value)	1.2	1.3	1.1	0.7	1.8	1.0	1.1	1.2

[a]Department of International Economic and Social Affairs of the U.N. Secretariat, 1986.

[b]Estimates.

1. The debt crisis and the U.S. economy

Performance of the U.S. economy, especially that of the foreign sector is, perhaps, illustrative of this interdependence. Overall U.S. trade as a share of GNP has remained stable, at around 14 percent, since 1975, but this aggregate figure does not reveal why the U.S. trade balance continued to deteriorate over the period, reaching a record deficit of $148 billion in 1986 from a small surplus in 1975.

A change in import-export trade mix of the US has grown in favor of imports over this period and explains this disparity. Imports increased by about 13 percent between 1975 and 1985 compared to a mere 7 percent rise in exports. Consequently, imports' share in the GNP increased from 6.6 percent to 9.1 percent in the same period, while that of exports declined from 6.7 to 5.3 percent, resulting in the noted record deficit. Even more drastic is the deterioration in U.S. agricultural exports since its peak in 1980 following a rather rapid expansion in the 1970s.

Agricultural exports declined by 36.9 percent in nominal prices between 1980 and 1986, while agricultural trade balance plunged by 79.1 percent during the same period due to increased agricultural imports (Table 2). In real prices of 1967-dollar values, the declines were 52.7 percent and 84.5

Table 2. Agricultural exports of the United States (billion U.S. dollars)[a]

Year	Agricultural Exports		Agricultural Trade Balance		Quantity Indexes[b]	
	Nominal	Real(1967)	Nominal	Real(1967)	Exports	Imports
1970	7.3	6.3	1.5	1.3		
1971	7.7	6.3	1.9	1.6		
1972	9.4	7.5	2.9	2.3		
1973	17.7	13.3	9.3	7.0		
1974	21.9	14.8	11.7	7.9		
1975	21.9	13.6	12.6	7.8		
1976	23.0	13.5	12.0	7.0	98	112
1977	23.6	13.0	10.2	5.6	100	100
1978	29.4	15.0	14.6	7.5	121	109
1979	34.7	16.0	18.0	8.3	126	114
1980	41.2	16.7	23.9	9.7	140	106
1981	43.3	15.9	26.6	9.8	138	108
1982	36.6	12.7	21.2	7.3	135	105
1983	36.1	12.1	19.5	6.5	127	109
1984	37.8	12.1	18.5	5.9	126	117
1985	29.0	9.0	9.1	2.8	108	125
1986	26.0	7.9	5.0	1.5	105	125

[a]Economic Report of the President, 1985 and Foreign Agricultural Trade of the United States, 1986.

[b]Export quantity index is based on 46 major commodities that account for 92 percent of total U.S. agricultural exports in 1977. Import quantity index is based on 40 major commodities that account for 86 percent of U.S. agricultural imports in 1977.

percent, respectively.

2. Debt crisis and world economic performance linkage

The coincident onset of the debt crisis and the dampening of world economic growth in the 1982-83 period prompted hypothesizing direct linkage between the two. The fact that the 1970s, which experienced a rapid expansion of international trade also had increasing capital inflow into the developing nations added strength to this belief. Further confirming such possible linkages was the finding that the steepest drop in trade elasticities[3] with respect to output occurred mainly in the 10 major debtor countries (Table 3).

a. Direct links The loss in exports to these debt ridden countries are often attributed to three possible causes. Over and above reductions in imports by debtors as a direct result of sudden discontinuation of inward flow of foreign funds, these countries appear to have further restricted their economies to conserve foreign exchange needed for debt service payments. In addition, development strategies of several third world countries show evidence of a move towards "inward oriented" growth. Primary justification

[3]Trade elasticity is a measure of the response of trade to a one percent change in output.

Table 3. Elasticities of real imports with respect to output[a]

	1965-73	1971-79	1977-85
Developed market economies	1.97	1.45	1.29
Federal Republic of Germany	2.26	1.83	1.55
Japan	1.47	1.23	0.45
United States	2.77	1.68	1.76
European centrally planned economies	1.35	1.36	0.98
Energy-exporting developing countries	1.07	2.30	1.87
Energy-importing developing countries	1.23	1.06	0.53
Ten large debtors	1.27	1.21	-0.74

[a]Department of International Economic and Social Affairs of the U.N. Secretariat, 1986.

for adopting such a strategy is the fear that continued specialization in primary exports, often crops or minerals, only leaves these countries exposed to exploitation of their cheaply available labor and other resources by the developed world. Hence, many such countries are protecting their domestic industrialization through taxing imports and subsidizing domestic production for local consumption. The cost is high: economic development suffers, income is low, and imports are cutback.

Such supposition of direct linkages, however, is not universal. For instance, in a very recent paper, Johnson (1987) suggests that the observed facts are not in favor of such simple relationships. During the period 1980-86, the U.S. trade gap widened by $120 billion, only $12 billion of which is accounted for by the trade deficit with Latin

America, the major source of the debt crisis. Most of the remaining gap is the result of trade with Japan, Canada, and Western Europe, implying that the answer to the United States' trade deficit problems lies else where.

On the other hand, with respect to U.S. agricultural trade the connection seems stronger. The major share of growth of U.S. agricultural trade during the 1975-80 period is attributable to increases in imports by the third world, and by middle income countries such as Mexico, Korea and Nigeria. The recession in 1981-83 halted growth and countries with serious debt repayment problems curtailed purchases of U.S. exports.

World Bank data on 16 major purchasers of U.S. agricultural exports (excluding Taiwan and Iran) show their debt, on average, increased at a rapid rate of 13.8 percent per year during 1970-79 and dropped to 5.0 percent since then. Agricultural imports of these countries, which accounted for 22.9 percent of U.S. agricultural exports in the 1976-79 period, also showed similar growth between 1970 and 1983 and declined thereafter, suggesting possible links between debt of these countries and US agricultural exports. Major differences in the patterns of these two series have been pointed out, namely that the growth of debt peaked in 1979 while that of U.S. exports to these countries reached a maximum growth three years later.

b. Alternative sources of linkage A closer examination of U.S. trade data reveals that both agricultural exports and agricultural trade balance increased sharply in 1973 and again in 1978-80, both coinciding with oil price increases and dollar depreciation in real terms. Thus Dutton and Grennes (1985) suggest indirect correlations. On the one hand, the high prices for primary commodities that prevailed in the early 1970s were forecast to be permanent which strengthened the credit worthiness of the debtors and promoted capital inflow into these developing countries.

Contrary to expectations, the primary good prices declined initiating the necessary cut backs in imports and an added vigor to exports by these countries in their bid to repay earlier debt. Further, apart from this real market phenomenon, the prevailing asset market trends also contributed to the change. The linkage here is via exchange rates. According to the formulation of the transfer problem, capital out flow from the United States weakens the dollar, thus making U.S. agricultural exports more competitive in the international market. The increased lending of the 1970s and the net lender status of the United States up to 1982 provided such weakening of the dollar thus enabling increased exports of agricultural commodities. Switching to net debtor status thereafter accounts for the decline in exports through strengthening of its currency.

Hence the impact of debt on trade depends on the response of exchange rates to changes in capital flow and on the response of agricultural trade to exchange rate changes. It may be noted that the response of exchange rates to changes in capital flow depends not only on the magnitude of such changes, but also on their frequency, which affects the expected value of future exchange rate movements. Recent weakening of the U.S. dollar has thus renewed optimism about possible expansion of U.S. agricultural exports in the future (Edwards 1987; The Economist 1987). The question then is whether U.S. exchange rate management policies are effective tools to avoid similar collapses in the future.

c. Debtor growth and U.S. agricultural exports

Another popular view that has attracted much attention in this period of declining U.S. agricultural exports is the possibility that growth achieved by developing countries as a result of increased investments over the last decade and a half may have reduced their import requirements. In this sense, then, U.S. loans to these countries had a negative impact on the U.S. agricultural economy by reducing its export demand via substitution, contrary to the anticipation that income growth in those countries would promote such demand through income effect. Lee and Shane (1987) provide evidence to negate this suggestion. Malaysia and Brazil are excellent examples to repudiate such a claim. In spite of, or perhaps because of, rapid economic expansion and export growth, both these countries have become ever increasing markets for U.S. exports.

Table 4. U.S. agricultural exports by region (in million wheat equivalent metric tons)[a]

Year	World	Developing Countries	Planned Economies	Industrial Counties
1970	64.5	19.8	1.7	43.1
1971	61.8	19.9	3.0	38.9
1972	79.0	22.2	11.8	44.9
1973	105.7	28.9	23.5	53.4
1974	93.0	34.0	10.6	48.5
1975	99.0	34.0	11.8	53.1
1976	115.0	33.4	19.7	61.8
1977	110.2	37.0	12.9	60.3
1978	134.4	46.3	26.5	61.6
1979	144.8	45.3	39.5	60.1
1980	152.1	57.3	29.2	65.7
1981	149.9	56.3	28.6	65.0
1982	147.3	52.5	27.5	67.3
1983	142.6	66.7	16.6	59.3
1984	140.1	62.8	26.0	51.3
1985	111.3	48.6	19.0	43.0

[a]U.N. trade data from tape reported in Lee and Shane, 1987. Includes all food grains, coarse grains and oil seeds.

In general, the developing country share of U.S. exports continued to grow distinctly faster than that of the industrialized nations up until 1983 (Table 4). Only since then has the developing nations' share dropped faster, evidently constrained by the credit crunch and debt service requirements. The positive impact that successful farm development in the Less Developed Countries (LDC) can have on U.S. farm exports has also been emphasized by Paarlberg (1986). He contends that the "depressing macroeconomic environment in the early 1980s and harmful domestic policies of industrial and developing country governments are most responsible for the recent drop in U.S. agricultural exports".

3. Differences among the debtors

The macroeconomic performances of countries that received substantial inflow of foreign funds since late 1960s are by no means comparable. Some appear to have used these funds successfully, while others have suffered distinct deterioration. Obviously then, their demands for U.S. agricultural exports must have moved differently. Such differences are clear in the changing trade patterns of the United States illustrated by Rosensweig, Lium and Welch (1986). Asia's share in total U.S. trade has risen from $44.7 to $185.2 billion between 1975 to 1985, while that of Latin America increased from $34.3 billion to only $80.1 billion during the same period (Table 5). Trade deficit of U.S. with Asia, at $82 billion in 1985, accounts for 55 percent of the total U.S. trade deficit, compared to a mere 12 percent for

Table 5. U.S. foreign trade by region (billion U.S. dollars)[a]

Region	Total Trade			Exports			Imports			Deficit		
	1970	1980	1985	1975	1980	1985	1975	1980	1985	1975	1980	1985
Asia w/Japan	45	116	185	21	50	5	24	66	134	-4	-17	-82
Europe	50	112	136	28	65	5	22	48	82	7	17	-28
Canada	45	77	117	22	35	4	23	42	69	-1	-7	-22
Oil Exporters	30	74	34	10	17	1	20	57	22	-9	-40	-10
Latin America	34	78	80	17	39	3	17	39	49	-0	-0	-18
USSR & E.Europe	3	4	4	3	3		1	1	1	2	2	2
Total	207	461	555	101	208	19	106	253	357	-6	-45	-158
Developing Asia	23	62	90	11	29	2	12	33	61	-1	-4	-32
Japan	22	54	95	10	21	2	12	33	72	-3	-12	-50

[a]Directions of Trade Statistics, 1986 Yearbook.

the Latin American share.

The U.S. trade deficit, however, is not a result of reduced imports by Asian countries. In fact the United States' exports to Asia has grown the most, at 150 percent, for any of the United States' trading partners. Exports to Latin America in 1985 was only 81 percent of that in 1985, in nominal dollars. It is therefore necessary to understand what made the Asian debts work better than the Latin American debts, both for the debtors and the lenders, in order to better manage future capital flows. Sachs (1985) analyzes the possible reasons for the relative success of the East Asian debtors (except for the Philippines) compared to those of Latin America (except Colombia). The Latin American countries, in general, had poorer GDP growth, or higher inflation, or both, in the 1981-84 period than in the 1970s, while the East Asian countries have successfully curtailed their inflation without substantial loss of growth rate (Table 6). Many theories have been suggested to explain this disparate performance of these regions. One suggestion is that the external shocks faced by Latin America have been more severe. That is, these countries suffered a greater decline in their terms-of-trade. However, the data indicate that it is the Asian countries that faced a greater decline in the terms-of-trade, while that of Mexico and Venezuela appreciated in the same period. Another suggestion is that Latin America simply over borrowed. This, too, is not substantiated because the debt-GDP ratio of the two groups of countries are not so markedly different to have caused such a significant difference in their macroeconomic performances. The third argument attributes market oriented economic management of Asia for achieving this goal. However there is no evidence to show that the role of state in domestic enterprises or the tax structures were any different among these groups.

The main difference, it seems, is that Asian countries have used their foreign funds to develop the required resource

Table 6. Macroeconomic performance of the major debtors[a]

Country	GDP Growth(%) 1970-81	GDP Growth(%) 1981-84	Inflation(%) 1970-81	Inflation(%) 1981-84
Latin America				
Argentina	1.6	-0.1	130.8	340.4
Brazil	7.6	0.8	40.5	142.2
Chile	2.8	-3.2	42.7	18.8
Mexico	6.7	-0.9	17.5	74.4
Peru	3.4	-2.3	33.8	94.0
Venezuela	3.7	-2.2	9.1	9.3
Weighted Average	5.6	-0.4	46.3	137.9
Colombia	5.2	1.7	21.7	20.1
East Asia				
Indonesia	8.0	4.3	17.0	10.6
Korea	8.1	7.6	16.7	4.3
Malaysia	7.8	6.2	6.2	4.5
Thailand	7.1	5.3	10.0	3.3
Weighted Average	7.8	5.8	14.4	6.5
Philippines	5.9	-0.6	13.5	22.2

[a]GDP is from International Data Base, Data Resources Inc. Inflation is computed from CPI data, IFS of IMF.

base, namely the export industries, to meet future debt servicing obligations. This is evident from the divergent debt-export and debt service-export ratios (Table 7). Further, the share of exports in GDP has grown consistently faster for East Asia (Table 8). It thus appears that proper exchange rate management and trade regimes are the crucial determinants of success for developing countries as well.

Table 7. External-debt indicators of major debtor countries[a]

Country	Current Account Deficit 1970-80 (% of 1981 GDP)	Debt-GDP Ratio 1981	Debt-Export Ratio 1981	Debt service Ratio 1980-83
Latin America				
Argentina	2.3	31.6	334.7	214.9
Brazil	22.8	26.1	298.7	132.6
Chile	19.8	47.6	290.0	153.3
Mexico	13.9	30.9	258.8	161.8
Peru	19.3	44.7	223.5	122.2
Venezuela	-7.5	42.1	134.0	117.8
Weighted Average	13.6	31.3	271.5	153.8
Colombia	0.4	21.9	182.9	103.8
East Asia				
Indonesia	0.6	24.1	87.1	n.a
Korea	24.6	27.6	76.6	90.1
Malaysia	-2.0	27.8	51.8	16.9
Thailand	22.4	25.7	103.1	58.1
Weighted Average	11.9	25.9	82.1	61.7
Philippines	18.3	40.6	214.6	152.7

[a]Sachs, 1985.

Table 8. Exports' share in gross domestic product (GDP)[a]

Country	Share of Exports in GDP			Agricultural Exports in GDP		
	1965	1983	Change	1962	1980	Change
Latin America						
Argentina	8.0	13.0	5.0	11.3	3.0	-8.3
Brazil	8.0	8.0	0.0	4.4	3.0	-1.4
Chile	14.0	24.0	10.0	-0.5	0.9	1.4
Mexico	9.0	20.0	11.0	2.7	-0.7	-3.4
Peru	16.0	21.0	5.0	8.3	0.0	-8.3
Venezuela	31.0	26.0	-5.0	-0.8	-3.4	-2.6
Weighted Average	11.0	15.0	4.0	4.5	1.2	-3.3
Colombia	11.0	10.0	-1.0	6.3	7.2	0.9
East Asia						
Indonesia	5.0	25.0	20.0	n.a.	4.3	n.a.
Korea	9.0	37.0	28.0	-3.8	-4.2	-0.4
Malaysia	44.0	54.0	10.0	10.3	18.6	8.3
Thailand	18.0	22.0	4.0	11.3	8.6	-2.7
Weighted Average	13.0	32.0	19.0	3.1	3.5	0.4
Philippines	17.0	20.0	3.0	8.0	5.1	-2.9

[a]World Development Report, 1985 and various issues of FAO Trade Year Books.

4. Proposals for easing the debt problem

As presented at the outset, the current third world debt is not merely a problem concerning the directly involved parties - the debtor countries and the lenders, both public and private. It has all encompassing consequences for the world economy, especially through its impact on world trade. Several proposals have been presented in the last few years to ease the debt problem in order to mitigate the possible consequences of such a debt on the world economy.

Since 1982, the most commonly adopted practice, because of the serious threat of possible widespread repudiation, was rescheduling of debt: allowing a longer grace period as well as repayment period, but not without higher penalties for default. Although it can be claimed that a major political and economic calamity has been avoided, it is generally recognized that this is only a temporary measure and that if more permanent steps are not taken to resolve the problem now, an even more serious crisis cannot be avoided.

Yet another popular proposal is partial forgiving of the debt. Shane and Stallings (1987) suggest that such easing of the debt burden would remove many of the self-imposed constraints on foreign trade adopted by these countries to boost foreign exchange savings for debt repayments, and that trade benefits accrued would likely outweigh the direct losses incurred in forgiving such loans. Major opposition to such write-offs has been, understandably, by the banking community of the lender countries, who will be directly affected. On the other hand, the private sector lenders have been reducing their exposure to the debt ridden countries during the last four to five years, so the opposition is perhaps less intense now than it was at the height of the crisis.

Another option examined in an effort to reduce the debt burden was the swapping of debt for equities. Such transfer of investment risks to lenders was proposed under the contention that most failed investments of debtor nations were really loans pushed on them by over-eager lenders during the period of surplus oil money in the international market. The attempt by several countries to increase direct equity and portfolio investments through rather attractive concessions was not very successful due to the prevailing debt status of these countries. As such, it is doubtful if this method will be successful, until the existing debt problem is resolved and confidence in future investments is restored.

It has also been suggested that the only way debtor countries can improve their economic well being is by not depleting their current resource base by insisting on present debt liabilities, but rather by consolidating their resource base through rescheduling of old loans as well as further strengthening it through increased credits. It is argued that such augmentation of domestic resources will create the necessary impetus for rapid economic growth. Only such accelerated growth can improve their status so they can start repayments without having to resort to policy restrictions, which would retard both their domestic and the world economy.

Most noted of such activist proposals is the Baker Plan (Kuczynski, 1988) under which new credit to 15 major debtor countries is to expand by $16 billion per year, with the stipulation that they undertake market oriented structural adjustments in order to not retard world trade growth. Private sector cooperation is necessary to fund the plan, but is not readily available. Another similar proposal is the formation of a massive, umbrella organization to overlook financing of current major donors, including the World Bank and the International Monetary Fund. This institution is to act as the lender of last resort in the world financial market, on the assumption that such a massive scale operation should provide the necessary leverage to absorb shocks of the magnitude of the last crisis, far better than any available public or private financial institutions.

In summary, most proposals for resolving the debt problem, in an attempt to regain accelerated growth of world trade and the world economy, recognize that:

(a) The current debt service obligations of most, if not all, developing countries have led to world economic efficiency losses through excessive import restrictions and structural adjustments that reduce effective import demands of these countries. As such, there is a need to relax such debt obligations, and in fact, to increase funding to revitalize their economies, and consequently the world economy.

(b) The use of any new credits needs to be better supervised, if these credits are to contribute effectively to the economic growth of the debtors, so that their repayment capacities are strengthened and not worsened.

Conventional theory holds that if a wealth transfer is made from an exporting country to an importing one, and if such a transfer generates or promotes trade between the countries, then it will have offsetting consumer and producer surplus effects. This suggests that the true cost of such a transfer, from the exporting country's point of view, will be less than the nominal cost of the transfer: if the net surplus is positive then the true cost is lower than the nominal cost. Further, most studies in the past have assumed constant trade elasticities, with respect to income, in their projections of trade flows. Empirical evidence suggests that this elasticity changes differently among the different groups of countries and that debt status has significant impact on it. It is therefore intended to use the data on 24 debt affected countries to study in depth the debt service burden and its possible impact on the future growth of economies and international trade.

B. Problem Statement

Capital flow into the developing countries during the seventies coincided with rapid growth in world trade. The onset of the debt crisis in the eighties, on the other hand, was accompanied by stagnation and even reversal of this trend. The true cost of the debt crisis, to the borrower and to the lender, extends over many a dimensions, economic, social and political. The trade impact of the crisis, however, is probably the most crucial, being the common ground of concern for the lenders as well as the borrowers. And, thus may be the ground for a mutual reconciliation of the crisis. The borrower's inability to service debt could seriously hinder the lender's exports. Inability to import the necessary capital goods will be a major threat to the borrowers growth potentials. How and by how much does the capital flow affect borrowers' imports and exports is thus an area that has, and will receive much focusing as the debt crisis is scrutinized. The present study attempts to formulate the economic structure of this trade aspect. Generally, trade models constructed to measure the trade impacts of capital flow are based on the macro economic variables with little attention to the structural behavior at the micro level. There is a need to link the theoretical construct of the consumer theory with the application models of trade. In formulating the model in this study, thus, attention is drawn to construction of such linkage between the macroeconomic concerns and the underlying micro theory.

II. LITERATURE REVIEW

A. Debt Modelling

A wide range of economic literature on the debt problem has evolved, each focusing on different aspects of external financing and borrower/lender behavior. The initial attempts at modelling debt examined the macroeconomic conditions necessary for long run debt statuses by identifying feasible or sustainable dynamic debt paths. Sustainablity of debt paths were defined (Glick, 1986) as those along which debt, scaled by either output (Neher, 1970; Solomon, 1977) or exports (Avramovic, 1964; Riedel, 1983; Dornbush and Fisher, 1985) converges to a steady state. These models were formulated in line with Harrod-Domar conditions of fixed capital technology, on the assumption of limiting capital constraint, assumed likely in the developing countries. Such fixed technology restriction lead to monotonic paths ignoring investment efficiency (since no substitution between capital and labor was permitted), while the extension to neo-classical production approach (Onitsuka, 1974; Katz, 1982), with input substitutability between capital and labor, provided the insights for the existence of non-monotonic paths and consequently distinct balance of payment phases along the debt paths. The weaknesses of these models were in their concentration on the relationships among the macroeconomic variables, and disregard for the fundamental decision making behavior at the microeconomic level. Further, the models were non-optimizing in that attention was focused on sustainability of debt rather than on optimality. Another class of models (Hamada, 1966,1969; Pitchford, 1970; Bazdarich, 1978) focused on optimality of investment and debt, by modeling in an intertemporal setting. This was characteristically done by the policy planner maximizing the sum of utility of consumption flows over the planning horizon, discounted by the rate of time preference. Bardhan (1967) incorporated a social disutility associated with being a debtor and Obtsfeld (1981) incorporated real money balances as well as consumption into the utility function to drive the asset accumulation of money. Two-sector optimizing models were developed (Bruno, 1976; Dornbush, 1983; Razin, 1984; Glick and Kharas, 1986) distinguishing traded and non-traded goods to impose the restriction that repayment capacity of the debtors will be influenced only by the growth of the traded sector which alone generates the foreign exchange necessary for servicing debt. Further, this takes into account domestic production and consumption adjustments dependent on the relative movement of traded to non-traded good prices.

Based on economic considerations alone, the incidence of debt is not an undesirable phenomena nor is it necessary that the debt be desirable only as a temporary occurrence. International capital transfer has as much of economic justification as any resource transfer between two entities where one's marginal product of the resource exceeds that of the other. A unique price for the resource is established at which optimal transfer will take place. Although external borrowing for investment purposes will ensure equalization of cost of capital to its marginal productivity in investments, cognizance of other uses of foreign borrowing (Dornbush, 1984; Corden, 1985) such as for smoothing consumption and reducing adjustment costs during exogenous shocks, requires relaxing this criterion. The price of capital is the interest rate which will be expected to fall between the marginal product of capital of the borrowing country, as the upper limit, and that of the lending country, as the lower limit, adjusting for the cost of risks and uncertainties. This relationship between productivity and interest rate ensures that the added production of the borrower will be at least sufficient to meet the debt commitment without making the borrower any worse off than he originally was. This is necessarily a production oriented simplification, in that there is an implicit assumption that the marginal products and interest rate are measurable in a unit common to both countries. When, however, the borrowing motive is other than for direct investment, relative productivity of capital may not be so unambiguously established and hence the resulting interest rate may not have the same relationship to productivity of capital as noted above. For instance, in a consumption smoothing scenario, the country may borrow even at a rate higher than its marginal productivity, as measured from investment opportunities. Nevertheless, the benefit accruing to the borrower, in terms of overall welfare, must be higher than the cost incurred or else borrowing will not occur. Similarly, the lender benefits from lending if the interest is higher than his opportunity cost of the capital. Thus a state of debt indicates that a transfer of capital has taken place that benefits globally and debt, therefore, is in fact something to be desired rather than despised. The other main misconception is that debt is necessarily a transitory or temporary phenomena and cannot be desirable as a permanent feature. Subject only to the necessary restriction that all countries cannot be net debtors (or equivalently, be net creditors) at any one time, any one or more countries can be viable as net debtors continuously provided the debt is serviced uninterrupted.

While traditional approaches to debt modelling focused on the debt carrying capacities, and provided insights to the existence of dynamic debt paths, they abstracted from the microeconomic foundations underlying lender/borrower behavior in the decision making process. Frenkel and Razin (1987) provide a setup for incorporating such micro foundations and with this illustrate the intertemporal allocation decisions with respect to consumption and investment, using a simplified two period, single commodity case. While this simplified model provide the basic insights, other extensions and assumptions are required to formulate a model for estimation. A modified imperfect substitution model of trade was used by Khan and Knight (1988) to estimate the economic performance of the debtor countries. Debt service problems have contributed to restrictive imports by the debtors. But imported inputs form a vital component of many of the developing country exports. Khan and Knight model economic performance using this linkage between import restrictions and export performance. This model serves as the basic frame work of the model to be developed in the present study. The proposed enhancements come from incorporating the insights of the Frenkel and Razin's (F&R) model as well as its extensions to be discussed, and from appropriate revisions to Khan and Knight's (K&K) model. Therefore, in the rest of this chapter, first Frenkel and Razin's model is briefly described. The concept is graphically illustrated. Following this, a detailed discussion of desired extensions to the basic model is presented. Mathematical modelling and derivation of results in detail are postponed till Chapter IV. Finally, in the current Chapter, Khan and Knight's framework is critically discussed prior to developing, in the next chapter, the model for the present study.

B. Frenkel and Razin's Two Period Model

The model derives aggregate behavior from utility maximization of individuals. The basic model is of a small country case, in a two period setting, with free access to world capital market and a single commodity scenario. Initial sequence of exogenous endowments of the two periods are $\overline{Y}_0$ and $\overline{Y}_1$ respectively. Any investment made in the first period provide totally consumable output in the next. The second period total income will therefore include the returns from the first period's investment I_0, such that,

$$Y_1 = \overline{Y}_1 + F(I_0)$$

Firms maximize profits, Π, which is defined as,

$$\Pi = \max_{I_0} [\alpha F(I_0) - I_0]$$

with, $$\alpha = [\, 1/(1+r_0)\,]$$

where α is defined as a function of interest rate. Income plus net borrowing in the first period is allocated between consumption and investment in that period. The agent starts with a pre-existing debt service obligation that is brought forward in the first period (B_{-1}) and is paid back in that period. Net debt received in the first period is fully repaid by the second period. No investments are made in the second period, which is the final period. Resulting consumptions in the two periods can be thus represented by,

$$C_0 = \overline{Y}_0 + B_0 - I_0 - (1+r_{-1})B_{-1} \quad \text{and}$$

$$C_1 = \overline{Y}_1 + F(I_0) - (1+r_0)B_0$$

resulting in a life time budget constraint specified by equating the present value of expenditures to the present value of incomes.

$$C_0 + \alpha C_1 + I_0 + (1+r_{-1})B_{-1} = \overline{Y}_0 + \alpha\overline{Y}_1 + \alpha F(I_0) \equiv W_0$$

where, W_0 is defined as lifetime wealth. Thus the intertemporal utility maximizing problem can be stated as,

$$U = \max_{\{C_0, C_1, I_0\}} U(C_0, C_1) \quad \text{s.t.} \quad C_0 + \alpha C_1 + I_0 = W_0$$

Utility function is assumed separable for simplicity, such that,

$$U(C_0, C_1) = U(C_0) + \delta U(C_1)$$

The resulting first order conditions reduce to,

$$[U'(C_0)]/[U'(C_1)] = \delta/\alpha$$

$$F'(I_0) = 1/\alpha$$

and, the budget constraint.

Order conditions necessary for the maximizing problem are,

$$U'(C_0),\ U'(C_1),\ F(I_0) > 0$$

and $U''(C_0),\ U''(C_1),\ F''(I_0) \leq 0$

i.e., increasing functions, increasing at decreasing rates. The model is illustrated in Figure 1. Point **A** represents the exogenous sequence of incomes, $\bar{Y}_0$ and $\bar{Y}_1$. Pre-existing debt is assumed zero for simplicity. The curve **AI** is the investment-production possibility function(IPPF), reflecting the possible output in the second period for any investments made from the first period's income plus the second period's exogenous income. The slope of **rr** is $(1+r_0)$[4] or equivalently $1/\alpha$. The point of tangency of the IPPF to this slope (at point **J**) determines the optimal investment **BD** and the line **rr** is therefore the life time budget constraint. Life time utility is maximized by the tangency of the highest possible intertemporal indifference curve (**UU**) to the life time budget constraint, (**rr**) resulting in the two period consumption decisions represented by point **F**. Optimal borrowing in the first period is **DE** and consequently, the required repayment in the next period is $(1+r_0)$ times **DE**, which equals **HG** by construction. It may be noted that where a pre-existing debt, B_{-1}, is carried forward into the first period, the first period income will then be net of this obligation as well as

[4]The slope of **rr**, as drawn, appears to be less than unity, which would imply a negative interest rate. This is not intended. Drawing the slope steeper results in crowding of most of the crucial features in the diagrams that follow. Picture the vertical axis as drawn at a larger scale than the horrizontal axis to appropriately interpret the slope.

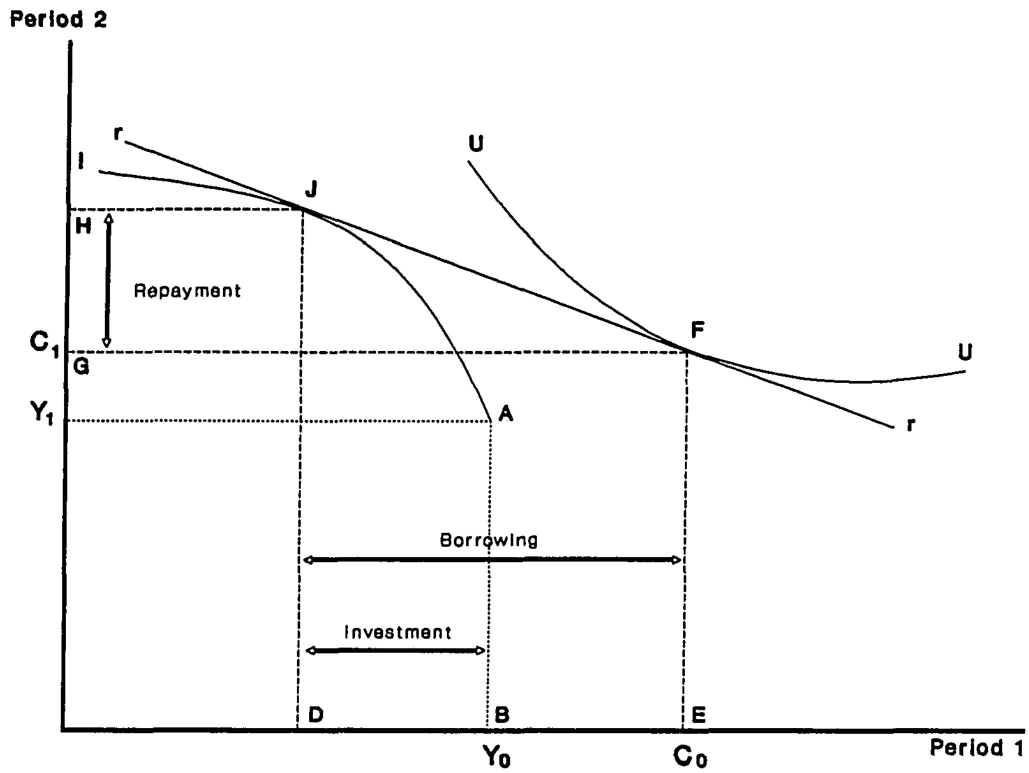

Figure 1. Frenkel and Razin's basic model

of the interest payable on that debt.

From these, implications with regard to three possible motives for borrowing, namely, consumption smoothing, consumption tilting and consumption augmenting motives are derived. An increase in $\bar{Y}_1$ shifts point **A** vertically up, and thereby shifts the curve **AI** and **rr** vertically up. Consumption in both periods increase as a result, instead of an increase in only the second period consumption. This is the consumption smoothing effect. Consumption tilting can be illustrated using different rates of time preferences. The rate of time preference determines the curvature of the indifference curves. A country with a higher rate of time preference will have indifference curves that will result in higher first period consumption. Finally, a proportionate increase in both period incomes shifts the budget constraint upwards and to the right proportionately, and is consumption augmenting in both periods.

Frenkel and Razin's multiple good model consists of traded and non-traded goods (imports and exports) and is formulated in a similar setup. The implications are that apart from the intertemporal terms of trade (interest rate in the one good model), there is also an intratemporal (also called temporal) terms of trade and thus there is both temporal and intertemporal allocation decisions.

C. Beyond the F&R Single Commodity Two-Period Model

1. Suitability of the two-period setting

The two-period setting provides the necessary frame work for substitution possibility between the two period consumptions. It is this feature that provides the crucial distinction to the F&R model in its ability to explain the three consumption motives referred to above. However, while aptly recognizing the substitution between consumptions in the two periods, the model overlooks the substitution possibilities within intertemporal investments, as investment is restricted to a single period. Allowing for substitution between intertemporal investments will necessitate use of a multiple period model. For instance, a three period model may be formulated, allowing investments in the first two periods. The investment criteria will then be based on the rate of returns averaged over the last two periods, instead of the restrictive assumption of equalizing the interest rate with the rate of returns in each of the two periods. Also, it is then possible to restrict the second period investment to be conditional on the first period investment (for example, first period investment will build the infrastructure, and the second period investment will put necessary plants and machinery in place). The returns in the third period will thus be conditional on meeting the second period investment requirements. This should allow for possible temporary liquidity problems in the intermediate period. Should the liquidity problem become binding, then the third period returns are reduced and may even lead to insolvency. Thus, such a model will enable examination of options available and decision making in the intermediate periods. A three period model however is substantially more complicated as the possible combinations of investments and consumptions become infinite (Bailey, 1959), requiring additional restrictions to obtain unique solutions. Consequently the resulting decisions depend on the particular assumptions made. Another option for modelling to examine the intermediate behavior, is to model in an infinite horizon setting. While this seems promising, this too complicates the model substantially, and further, requires imposing additional restrictions as in the three period case. Given these, the two period setting will be retained for this study.

2. Ex-post changes

The model as described is based on perfect information on incomes and interest rate. Further, free access to international capital market at prevailing, constant interest rate is assumed. The following section discusses the suitability of these assumptions and modifications necessary to study the debt crisis situation.

An observed fact, and one of the main reasons for the inability of most delinquent debtors to meet repayment schedules, is lower-than-anticipated incomes. This may have resulted from poor performance of investments, or through exogenous shocks such as deterioration of terms of trade or a direct output shock. Such an unforseen income loss may lead

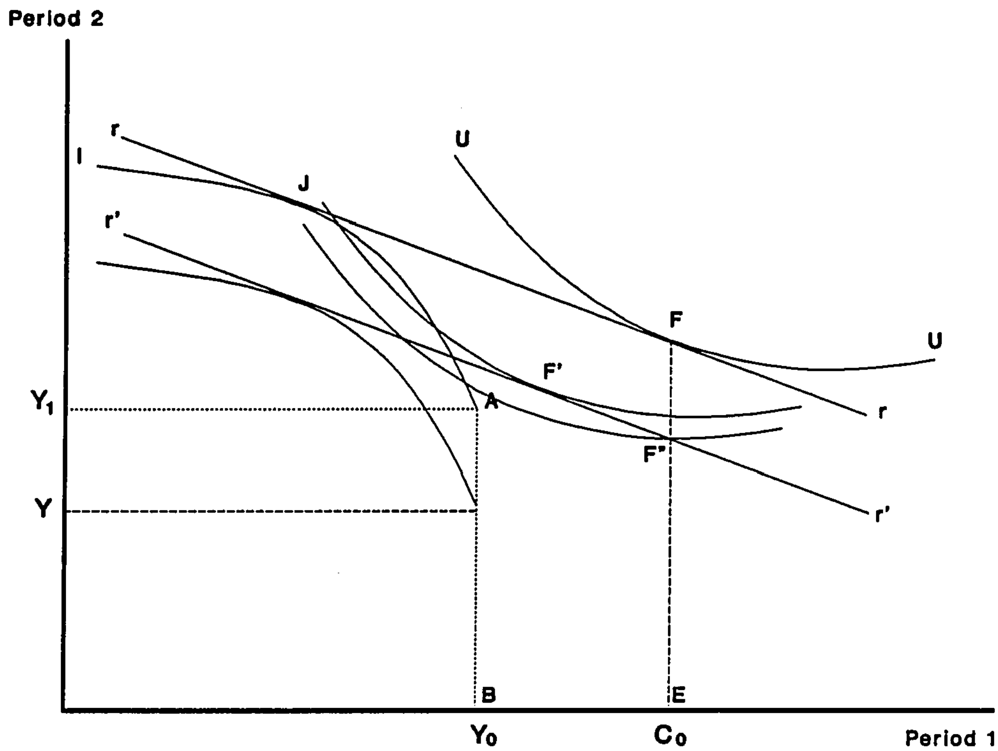

Figure 2. Ex-post change in income

to substantial welfare loss as can be shown using F&R model. Assume that the second period income is unknown, and Y_1 is the anticipated income (Figure 2). With this anticipation, consumption levels (F) for both periods are decided in the first period, and the first period level is consumed in that period. Say, in the second period, the realized income is at Y, a point lower than what was anticipated. Now, apart from the budget constraint shifting down, it is not possible to maximize over even this budget constraint at **F'**, as the first year consumption has already taken place. Rather the optimal consumption point moves to **F"** with further decreased utility. Poor performance of investment also can be modelled similarly by representing the actual IPPF as a curve rotated downwards with its axis at **A**.

The interest payable on a large portion of the third world debt is linked to LIBOR as was stated earlier. Consequently, the applicable interest rate on these loans have been growing since the seventies along with LIBOR. The impact of an ex-post change in interest rate can also be shown using the F&R model (Figure 3). In the first period, investment and consequently, consumption decisions are made in the first year, given the prevailing interest rate that results in the budget line **rr**. This leads to a borrowing of **DE** with the anticipated repayment of **HG** in the following period as was seen in Figure 1. In the second period, say the interest rate increases such that the slope of the budget line shifts to **r'r'**. Note that investment of **DB** has already been made in the first period, and therefore, the budget line merely rotates through point **J**. Not only is the investment not optimal for the effective interest rate, but has lead to an overly optimistic consumption in the first period. This results in reducing the intertemporal consumption point to **F"** with reduced life time utility as shown. Two points may be noted

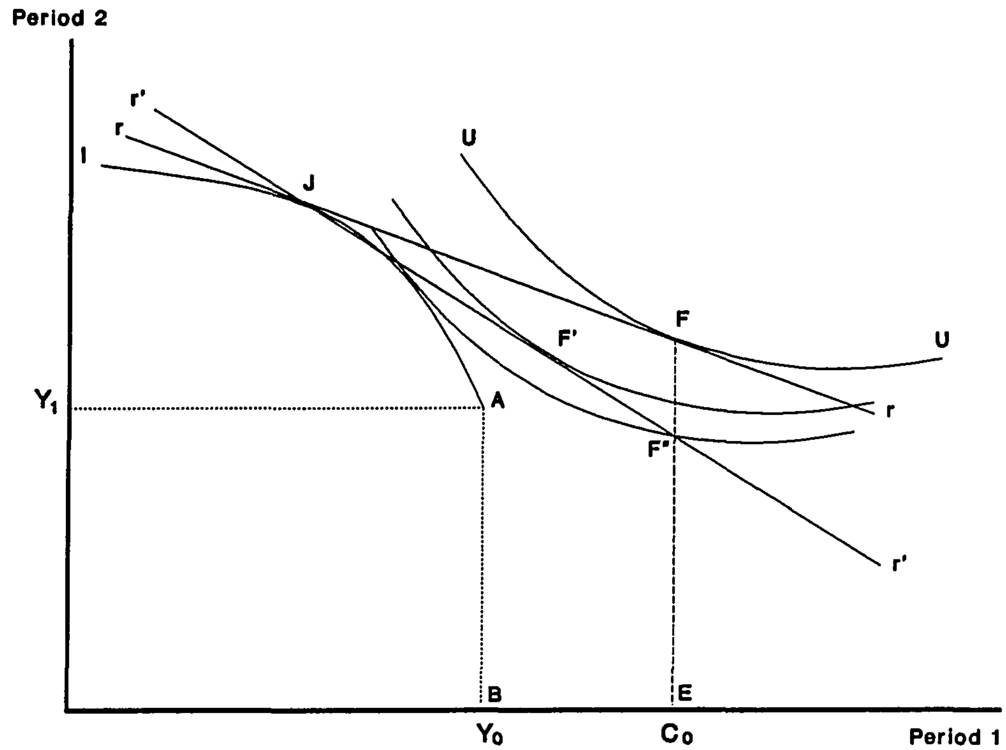

Figure 3. Ex-post change in interest rate

in this context. First, rational investment and borrowing decisions will therefore be made based not on the current interest rate, but on the anticipated future effective interest rate. A suitable proxy for such anticipated interest rate may include the current interest rate as well as the past trend of the rate. Use of current interest rate alone can be justified if interest rate is assumed to follow a random walk. Second, in as much as the ex-post increase in interest rate leads to a decreased utility to the borrower, this increase simultaneously offers the lender a consumption bundle with higher utility, even though the lending decision made is not optimal for the new interest rate. This suggests that under conditions of debt servicing problems caused by ex-post interest rate increase, a partial forgiving of debt may be more equitable, denying the lender of only unexpected or windfall gains.

3. Limited capital availability

It is widely recognized that the problem of debt is self-aggravating. When a country has debt servicing problem, it's credit worthiness starts to erode. This restricts the necessary capital flow and thereby further aggravates the debt servicing problem, which in turn, reduces the credit worthiness and the capital flow even more. It is possible to fall into an endless loop in this dilemma. The most commonly used proxy for restriction in supply of credit is the assumption of elastic supply function. As the need to borrow increases, the cost of borrowing increases. Credit worthiness (measured by various indices such as debt to GNP, debt to exports, debt service to exports) has also been used as proxy for the country specific risk, for justifying the observed differences in interest rate on loans to the different countries. A more serious concern, however, is not that the cost of borrowing is increasing, but that, often since the debt crisis, the affected countries are unable to attract capital inflow at whatever cost. Coupled with this, the lack of confidence on the part of investors in their own economies has lead to an accelerated rate of capital flight, further adding to the debt servicing problem.

F&R model assumes free access to the world capital market. The borrower, being a small country, is able to borrow all needed capital to optimize investment and consumption. The necessary modification to endogenize the borrowing rate as dependent on the quantity borrowed is straightforward, resulting in a budget constraint curved downwards to the right of point J, implying an increase in cost of borrowing only.

Quantity restrictions on capital availability has implications different from increasing capital cost. An increase in interest rate leads to reduction in investment as well as in consumptions in both periods, resulting in reduced borrowing. An interest rate reaction path (RR in Figure 4) may be obtained by tracing the optimal consumption points at different interest rates. As the interest rate increases the budget constraint rotates clockwise and shifts along the IPPF. The optimal solution with zero borrowing is obtained when the budget line is r"r", and leads to an investment corresponding to point KB. At higher interest rates, the country will

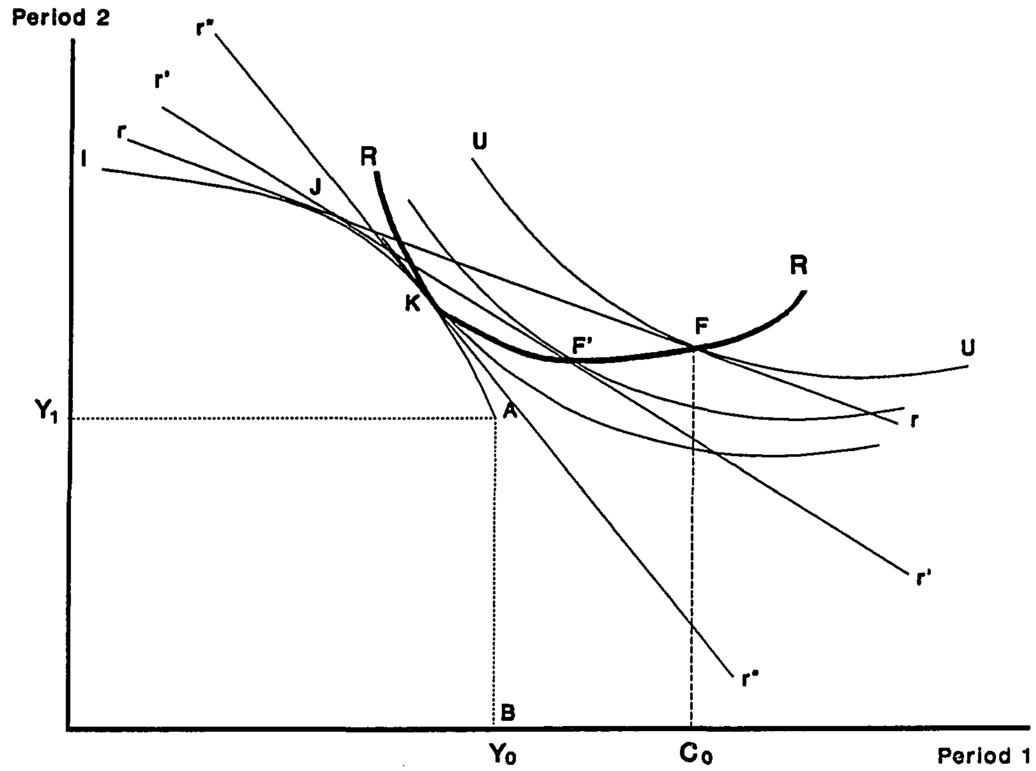

Figure 4. Interest rate reaction path

maximize intertemporal utility by lending.

A quantity limitation on borrowing also results in reduced investments and consumptions. However, the reaction path to quantity limits is different from that of the interest rate reaction path. This is illustrated in figure 5. Suppose the optimal level of borrowing is DE as in the original model. Say a limit on borrowing is set at less than DE. The country

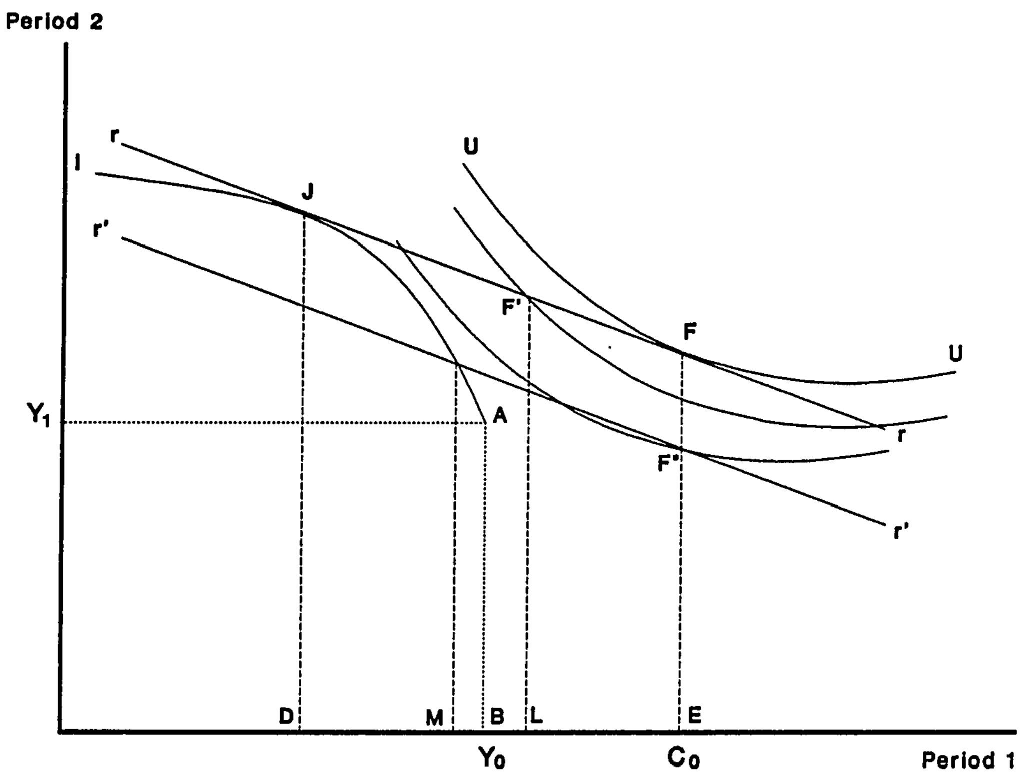

Figure 5. Borrowing limit imposed

could absorb this shortfall in capital by cutting down the first period consumption, say to point L (DL being the available credit) achieving the F' level of utility. Or else, investment can be reduced by the shortfall in borrowing to BM (ME = DL) leading to F" level of utility. Both F' and F" are clearly sub-optimal. The optimal adjustment is to suitably reduce both investment and consumption to obtain the maximum possible level of utility between F and F" in this construction. A reaction path of optimal consumption to credit restriction can thus be derived as shown in Figure 6. Note that this path is constructed with a constant interest rate represented by rr[5]. Also this path will not extend to the right of F for this given interest rate. When no borrowing is allowed, the optimal point of investment and consumption will coincide at K with that of the interest rate reaction path. However, to the right of K, the interest reaction path will always be below the reaction path to credit restriction path as shown. With credit restriction, the repayment obligation is always at the original interest rate while in the interest rate reaction path, the interest rate has been rising and thus service obligation rises. Hence,

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[5]Alternatively, the credit limit may be represented as follows. Say, the limit on borrowing is set at DE' instead of DE, where E' is a point to the left of E. If investments remain unchanged, then at the given interest rate with consumption at E', there is surplus demand for consumption borrowing leading to an upward pressure on effective interest rate. As interest rate rises, investment decreases shifting some of the borrowing to consumption. The equilibrium will be such that, for a common effective interest rate, the investment point D will have shifted right by the same amount E' shifts to the right, such that the limited borrowing is fully and optimally allocated. Thus, a credit restriction modeled as above leads to an endogenous effective interest rate change. The repayment obligations of the final users of borrowing are distinct from the obligations of the original borrower, and will necessitate addressing the distribution effects.

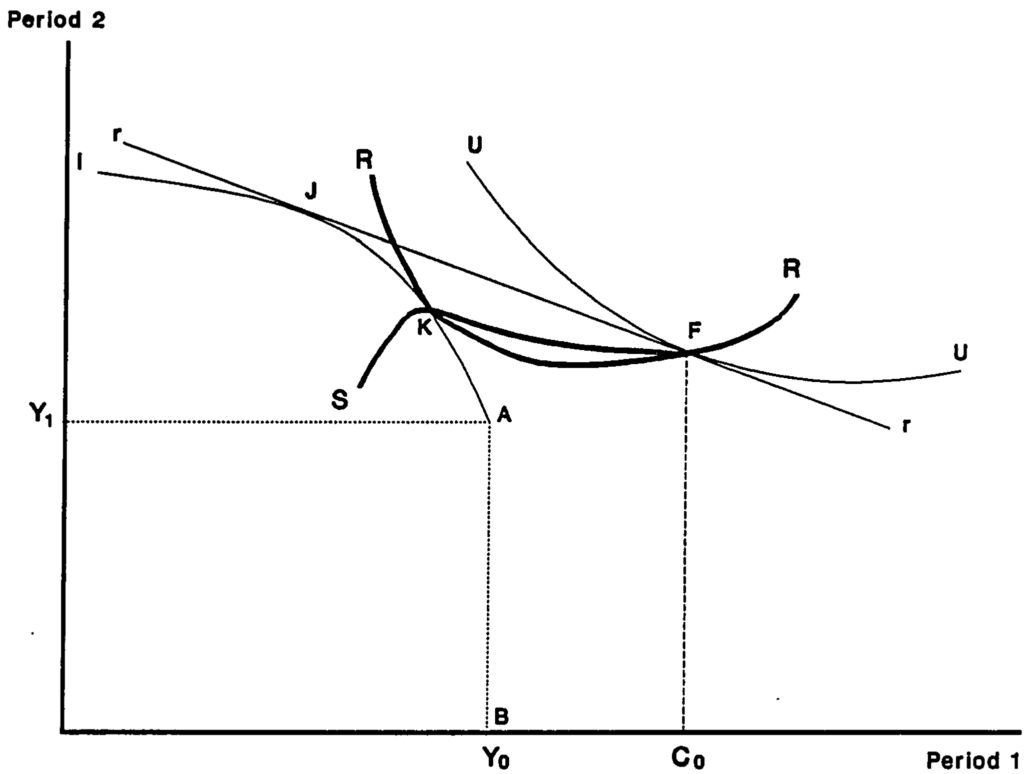

Figure 6. Interest rate and borrowing limit reaction paths

quantity restrictions allow lesser future service obligation and enables achieving higher utility for any given level of borrowing. To the left of point K the reaction paths are not comparable. The interest rate path shows lending behavior which has future benefits. The downward sloping reaction path to the left of point K illustrates a compulsory negative capital flow, such as in the case of pre-existing debt carried over into the first period, with zero borrowing allowed.

D. Imperfect Substitution Model of Trade

Trade models encountered in the related literature can be broadly classified into two groups, namely the perfect substitution models and the imperfect substitution models.

1. Perfect Substitution Models: where the export supply is the domestic excess supply curve and import demand is the domestic excess demand curve. Thus the import demand and export supply are not behavioral functions in themselves, but rather the "net" of the two behavioral functions, namely, the supply and demand functions of a single commodity. Obviously then, a country at any one time can have either an export demand or an import supply function, but can never have both simultaneously. This type of model may be suitable for analysis of a selected commodity or group that is traded unilaterally.
2. Imperfect Substitution Models: where export supply and import demand are two distinct behavioral functions, with their own, independent arguments. Thus the two functions can exist simultaneously. This type

of modelling is therefore more appropriate when dealing with aggregate commodity case, whether a single commodity or grouped as traded and non-traded goods.

The standard Imperfect substitution model is of the form,

$$X^S = X^S(P_x /P_d , K_x) \quad : \text{Export supply}$$
$$X^D = X^D(P_x /P_w , Y_w) \quad : \text{Export demand}$$
$$X^D = X^S \quad : \text{Equilibrium condition}$$
$$M^D = M^D(P_m /P_d , Y_d) \quad : \text{Import demand}$$

with X for exports, M for imports, P for price level, K for capital investment and Y for output. The subscripts x, m, d and w denote export, import, domestic and world respectively while the superscripts D and S identify the demand and supply functions. Commonly, import and export sectors are linked by specifying the domestic output, Y_d, as an increasing function of exports. Then, for instance, an exogenous decrease in export demand that leads to a decrease in exports reduces domestic income, which in turn will reduce import demand.

Trade balance at a given period, t, is,

$$TB_t = P_{x,t} X_t - P_{m,t} M_t$$

In the small country case, import supply function faced by the country is infinitely elastic and hence P_m is fixed. The reserves held at a given period is then,

$$R_t = R_{t-1} + TB_t + D_t$$

where D stands for new net debt incurred in that period. This specification merely looks at a particular time period, and is not complete in a dynamic setting, as the future consequences of the debt incurred in the current period is not taken into account. F&R's two period model provides a basis to suitably incorporate the debt component in this model because any first period debt is modelled as fully repayable in the second period.

Typically, developing countries import both consumption goods as well as inputs that are used for production of exportables. At times of debt servicing problems, it is conceivable that, while these countries may cut back on consumable imports, at the same time their import demand for inputs for export production may in fact rise as they attempt to boost exports. On the other hand, the policies may have tended to restrict manufacturing imports in favor of essential imports leading to a decrease in the share imported inputs. Therefore imports for consumption needs to be distinguished from inputs imported for manufacture of exports.

E. Khan and Knight's Model and Suggested Changes

Khan and Knight (1988) provide an extension to the standard imperfect substitution model to take this into consideration. The main revisions in their model are in the export supply and in the import demand functions. Export supply is modelled as dependent on imported inputs. The reserve position, a proxy for the debt service problem, enters as an argument in the import demand function and provides the only linkage between debt and the rest of the economy. The details of the model are discussed below in detail.

1. Export supply

Desired export supply, X_t^s, is modelled as having two distinct components, namely, imported input component (mx_t) and domestic value added component (vx_t).

$$\log X_t^s = \alpha_1 + \pi \log mx_t + (1-\pi)\log vx_t$$

However, since separate data on imports of inputs for export production is not available, they make a simplifying assumption that the share of imported inputs remains a constant proportion of total imports.

$$\log mx_t = \alpha_2 + \log m_t$$

As debt service problems increase, it is unlikely that the share of inputs will remain unchanged. Total imports will be expected to decline. If export promoting policies come in to play, then the input share in total imports are likely to rise. On the other hand, if the policies are partial to maintaining essential imports, which are generally consumables such as food and medical supplies, then the input share will be expected to fall. Thus, the direction of change in shares will be indicative of the policy directions in times of debt crisis.

This change in shares can be incorporated by re-specifying the share of imported inputs in the total imports to be an increasing function of the rate of change in reserves.

Next, domestic value added component is defined as a function of the relative price of exports, and capital in export sector, kx_t. Since data is not available on this capital component, it is also assumed to be a constant share of total output.

$$\log vx_t = \alpha_3 + \beta_1 \log(P_x/P)_t + \beta_2 \log kx_t$$

$$\log kx_t = \alpha_4 + \log Y_t$$

If declining reserve position leads to export boosting policies, capital in export sector must be a rising share of total capital and of total output. Therefore, it may be argued that the capital in export sector will be an increasing function of exports scaled by output. If, on the other hand, debt severity leads to policies which are inward oriented, such as self sufficiency as opposed to export promotion, then the share of capital in in export sector will be a decreasing function of such policies. Thus, again, the direction of change in shares will be indicative of the type of policies.

Finally, assumption of partial adjustment is used to provide dynamics to the system. Actual export supply is assumed to adjust by a constant factor γ_1 of the difference between desired supply and the actual supply in the previous period.

$$\Delta \log X_t = \gamma_1 [\log X_t^S - \log X_{t-1}] \quad \text{with} \quad 0 > \gamma_1 < 1$$

Substituting,

$$\begin{aligned} \log X_t^S = \gamma_1 & [\alpha_1 + \pi\alpha_2 + (1-\pi)\alpha_3 + \beta_2 \alpha_4)] + \gamma_1 (1-\pi) \log m_t \\ & + \gamma_1 (1-\pi)\beta_1 \log Px_t + \gamma_1 (1-\pi)\beta_1 \log P_t \\ & + \gamma_1 (1-\pi)\beta_2 \log Y_t + (1-\gamma_1) \log X_{t-1} \end{aligned}$$

from which model γ_1 , π, β_1 and β_2 can be identified.

Modifications proposed for export supply equation are:

(a) The ratio of $[mx_t / m_t]$ is likely to change with falling reserve position. The direction of change may be indicative of the policy directions in effect.

(b) Similarly, capital in export sector may be respecified as a function of income as well as change in reserve. The movement of the share of export capital will reflect either export promotional investments induced by falling reserves or inward growth directing policies.

2. Export demand

Export demand is specified as a function of world income and the relative price of exports as in the standard trade models.

$$X_t^d = \alpha_5 + \beta_3 \log Y_{w,t} - \beta_4 \log(P_x / P_w)_t$$

With assumption of lagged adjustment,

$$\Delta \log P_{x,t} = \gamma_2 [\log X_t^d - \log X_{t-1}] \quad \text{with} \quad 0 < \gamma_2 < 1.$$

Substituting,

$$\log P_{x,t} = \{\gamma_2 / (1+\gamma_2 \beta_4)\}[\alpha_3 + \beta_3 \log Y_{w,t} - \log X_{t-1}] + \{\gamma_2 / (1+\gamma_2 \beta_4)\} \log P_{x,t-1}$$

Especially given a small country assumption, lagged adjustment of world export price does not seem consistent.

Lagged adjustment in the export supply may be an alternative for obtaining the dynamics.

3. Import demand

Import demand is defined as a function of income, price of imports and the reserves, the last two scaled by suitable price levels. Debt linkage to the system is obtained via this function. Thus,

$$\log m_t^d = \alpha_6 + \beta_6 \log Y_t - \beta_7 \log(P_m / P_d)_t + \beta_8 \log(R/P_m)_t$$

A reduction in reserves leads to lowered demand for all imports. As a consequence, import of inputs for export production, being a constant share of imports by assumption, also decreases and results in export compression.

Again, with partial adjustment,

$$\Delta \log m_t = \gamma_3 [\log m_t^d - \log m_{t-1}]$$

Resulting function is,

$$\log m_t = \gamma_3 [\alpha_6 + \beta_6 \log Y_t - \beta_7 \log(P_m / P_d)_t + \beta_8 \log(R/P_m)_t] + (1-\gamma_3) \log m_{t-1}$$

4. Balance of trade identity

The model is closed by identities of trade balance, specified as,

$$TB_t = (X.P_x)_t + (M.P_m)_t$$

and balance of payments as,

$B_t = \Delta R_t = TB_t + DK_t$ where DK_t represents net capital transfers.

There is no mechanism to link changes in income with changes in exports. Changes in investments should have impacts on future income, and consumption-investment decisions need to be endogenized. Investment decision is affected by prevailing interest rates. Consumption decision depends on current income as well as expected future incomes. Another important aspect is, possible government policies affecting consumption-investment decisions during the debt crisis. With these observations, the standard model and Khan and Knight's model are re-examined below in a simplified form before the modifications adopted in the present study are discussed.

Standard Model:

$$X^S = \alpha_1 + \alpha_2 (P_x / P_d) + \alpha_3 K_x \quad : \text{Export supply}$$
$$X^D = \beta_1 + \beta_2 (P_x / P_w) + \beta_3 Y_w \quad : \text{Export demand}$$
$$X^D = X^S \quad : \text{Equilibrium}$$
$$M^D = \mu_1 + \mu_2 (P_m / P_d) + \mu_3 Y_d \quad : \text{import demand}$$
$$R = (X - M)$$

With K_x and Y_w exogenous, the first two equations determine P_x and X. With exogenous P_m and Y_d, M is determined. The resulting X and M determine R, the reserve accumulation. Most common modification is to have exports affecting domestic income and thereby imports, so that any exogenous impact on reserve accumulation is reduced through this feed back. In a similar fashion, Khan and Knight's model can be represented in a simplified form.

$$X^S = \alpha_1 + \alpha_2 (P_x / P_d) + \alpha_3 Y_d + \alpha_4 M_t \qquad : \text{Export supply}$$

Domestic income acts as a proxy for capital by the assumption that capital in exports is a constant share of total capital, and total capital is a fixed share of income (fixed marginal productivity). This component represents the domestic value added component of exports. The other component is the productivity of the imported inputs for which total imports act as a proxy (again $M_{x,t}$, the imported inputs for exports, is a fixed share of total imports, M_t, by assumption).

$$X^D = \beta_1 + \beta_2 (P_x / P_w) + \beta_3 Y_w \qquad : \text{Export demand}$$

$$X^D = X^S \qquad : \text{Equilibrium}$$

$$M^D = \mu_1 + \mu_2 (P_m / P_d) + \mu_3 Y_d + \mu_4 R \qquad : \text{Import demand}$$

$$R = (X - M)$$

"Dynamic" adjustments in the first three equations are introduced as follows:

$$X_t = \tau_1 [X_{D,t} - X_{t-1})$$
$$P_{x,t} = \tau_2 [P_{D,x,t} - P_{x,t-1})$$
$$M_t = \tau_3 [M_{D,t} - M_{t-1})$$

where the subscript $_{D,t}$ denotes the desired level at time t.

The model shows how reserve position affects import demand and how imports affect export performance. But, the assumptions of fixed capital productivity, fixed capital ratios in the export and non-export industries (irrespective of the reserve position) and fixed share of imported inputs to total imports, evidently must restrict the performance of the model. Further, the debt linkage is via the import demand function alone, the reserve position affecting imports directly. Debt impacts on consumption and investment, and the implications of restricted borrowing ability are not incorporated. Finally, possible governmental policy impacts on income, consumption and investments during periods of external financing difficulties are not considered. The model development in the following chapter address these concerns.

III. THEORETICAL MODEL DEVELOPMENT

A. Model Framework

A theoretical model of consumption and investment behavior under constrained borrowing, and the consequent import and export performances, is developed in this chapter. Empirical model used for the estimations in this study require functional form specifications as well as certain simplifying assumptions and modifications. These empirical details are discussed in Chapter IV in constructing the estimation model. The current chapter therefore abstracts from the empirical concerns, focusing on the theoretical aspects of the decision making behavior alone.

The model developed in this study is based on the frame work of Khan and Knight's modified imperfect substitution model of trade. Suitable modifications arising from the insights provided by the two-period model of Frenkel and Razin are incorporated. These modifications are primarily an attempt to appropriately take into account the micro economic considerations in developing the macroeconomic model. As a first step, therefore, F&R's model insights are formally presented, discussing the roles of inter-temporal income pattern, interest rate changes and borrowing constraints in the investment and consumption decisions. Anticipated fluctuations in income do not lead to similarly volatile consumption patterns, due to the consumption smoothening motive. A change in interest rate has both, a direct effect on consumption as well as an indirect effect by influencing investments. In order to differentiate the direct effect from the indirect effect, first a simplified model with no investments is developed and examined. This is followed by a model where investments are allowed. In both models the implications of constrained borrowing is investigated. The investment-consumption behavior thus derived, based on the micro economic foundations, is then incorporated into a modified version of K&K's model. The principal modification to K&K's model is the addition of the consumption-investment component. Thus, unlike in the K&K model where debt linkage to the system is limited to a single equation, namely the import demand function, the present model allows for linkage via consumption and investment functions.

Other modifications involve inclusion of policy variable dependent on the severity of debt, and flexibility in some of the critical ratios assumed constant in their original model. As these latter modifications are of empirical interest only, with little contribution to the theoretical features of the model, discussion and development of these modifications are also deferred to the next chapter.

B. Case I: Simple Economy With No Investments

Consider a two-period model, with separable utility function defined as follows.

$$U = U_0(C_0) + \delta U_1(C_1)$$

Note that the subjective discount factor, δ, is the marginal rate of substitution between consumption in the two consecutive periods evaluated at the point of a flat time profile of consumption ($C_0 = C_1$), and is assumed fixed as per F&R model. This discount factor is related to the subjective marginal rate of time preference, ρ, according to $\delta = 1/(1+\rho)$. Also, assume a small country case such that the interest rate for international transactions is exogenous, and that the incomes in the two periods ($\overline{Y}_0$ and $\overline{Y}_1$, respectively) are also exogenous as in Frenkel and Razin's case.

Presently, consider the case where no investments are allowed. This restriction is imposed temporarily to identify the direct impacts of the income and interest rate changes on consumption (as opposed to impacts via investment), and will be relaxed in the next section. Also for simplicity, let net trade (defined as exports less imports of goods and services) be zero.

The utility maximizing problem can then be expressed as,

$$\text{Max } U = U_0(C_0) + \delta U_1(C_1) + \lambda[\overline{Y}_0 + \alpha\overline{Y}_1 - C_0 - \alpha C_1]$$

The resulting order conditions for maximization are,

$$U_0' - \lambda = 0$$

$$\delta U_1' - \lambda\alpha = 0$$

$$\overline{Y}_0 + \alpha\overline{Y}_1 - C_0 - \alpha C_1 = 0$$

with $U_0', U_1' > 0$, and $U_0'', U_1'' < 0$ for this maximization problem. From the first two of the above conditions,

$$\frac{U_0'}{U_1'} = \frac{\delta}{\alpha}$$

Consider, for illustration, identical log linear utility functions for each period consumption, to derive explicit relationships.

$$U_t(C_t) = \beta(C_t)^{\gamma} \qquad \text{for } t = 1,2.$$

The first-order conditions with respect to consumptions in the two periods are,

$$U_t' = \gamma\beta(C_t)^{\gamma-1} \qquad \text{for } t = 1,2.$$

Substituting into the ratio of the first two first-order conditions,

$$\frac{C_0}{C_1} = \left[\frac{\delta}{\alpha}\right]^{\{1/(\gamma-1)\}}$$

Substituting for C_1 in the budget constraint,

$$\overline{Y}_0 + \alpha\overline{Y}_1 - C_0 - \alpha C_0(\alpha/\delta)^{\{1/(\gamma-1)\}} = 0$$

From which,

$$C_0 = \frac{\overline{Y}_0 + \alpha\overline{Y}_1}{1 + \alpha(\alpha/\delta)^{\{1/(\gamma-1)\}}}$$

Borrowing in the first period is thus,

$$B_0 = C_0 - \overline{Y}_0 = \left[\frac{\overline{Y}_0 + \alpha\overline{Y}_1}{1 + \alpha(\alpha/\delta)^{\{1/(\gamma-1)\}}}\right] - \overline{Y}_0$$

1. Effect of changes in income

To asses the consumption effect of changes in income, let the interest rate exactly compensate the subjective discount factor (i.e., $\delta = \alpha$). Define y as the difference in incomes,

$$y = \overline{Y}_1 - \overline{Y}_0$$

Then, since (δ/α) equals unity by assumption, consumption in the first period can be re-written as,

$$c_0 = \frac{\bar{Y}_0 + \alpha(\bar{Y}_0 + y)}{1 + \alpha}$$

That is,

$$c_0 = \bar{Y}_0 + \frac{\alpha y}{1 + \alpha}$$

Thus, consumption in the current period exceeds or falls short of current period income, depending on whether the next period income will be higher or lower than that of the current period, even when the interest rate effect is just compensated by the effect of the subjective discount factor. Further, the rate of adjustment to any income differences depends on the absolute level of interest rate.

2. Effect of interest rate changes

To isolate the effect of interest rate, assume that the incomes are equal in the two periods. Defining μ as the difference between the coefficients δ an α, such that,

$$\alpha = \delta + \mu$$

A positive μ implies that the rate of time preference at the point of flat time profile of consumption exceeds the interest rate, since,

$$\alpha = \frac{1}{1 + r} \quad \text{and} \quad \delta = \frac{1}{1 + \rho}$$

where, r and ρ are the interest rate and rate of time preference, respectively. Given the assumption of equal incomes,

$$c_0 = \left[\frac{1 + \alpha}{1 + \alpha(\alpha/\delta)^{\{1/(\gamma-1)\}}} \right] \overline{Y}_0$$

Substituting for α, the first period consumption can be expressed as,

$$c_0 = \left[\frac{1 + \delta + \mu}{1 + \delta[(\delta+\mu)/\delta]^{\{1/(\gamma-1)\}} + \mu[(\delta+\mu)/\delta]^{\{1/(\gamma-1)\}}} \right] \overline{Y}_0$$

That is, even when incomes in the two periods are equal and no investments are allowed, consumption is sensitive to the deviation of interest rate from the subjective discount factor. Thus, interest changes impact on consumption directly, apart from any indirect effects via investment which will be considered later.

3. Evaluating for general functional forms

Explicit derivation as above requires assuming specific form of utility functions. The general results regarding the effects of exogenous changes on the decision variables, however, can be established as follows, without having to specify the form of utility functions.

First, the maximizing problem is restated as,

$$\text{Max } U = U_0(C_0) + \delta U_1(C_1) + \lambda[\overline{Y}_0 + \alpha\overline{Y}_1 - C_0 - \alpha C_1]$$

The resulting first-order conditions are reduced to the two following equations by substituting for λ.

$$\begin{aligned} \alpha U_0' - \delta U_1' &= 0 \\ \overline{Y}_0 + \alpha\overline{Y}_1 - C_0 - \alpha C_1 &= 0 \end{aligned}$$

Taking total differentials and re-arranging,

$$\begin{aligned} \alpha U_0'' dC_0 - \delta U_1'' dC_1 &= -U_0' d\alpha \\ dC_0 + \alpha dC_1 &= d\overline{Y}_0 + \alpha d\overline{Y}_1 + (\overline{Y}_1 - C_1) d\alpha \end{aligned}$$

$$\begin{bmatrix} \alpha U_0'' & -\delta U_1'' \\ 1 & \alpha \end{bmatrix} \begin{bmatrix} dC_0 \\ dC_1 \end{bmatrix} = \begin{bmatrix} -U_0' d\alpha \\ d\overline{Y}_0 + \alpha d\overline{Y}_1 + (\overline{Y}_1 - C_1) d\alpha \end{bmatrix}$$

Defining the above 2 X 2 matrix of coefficients on the left as **A**, its determinant is,

$$|\mathbf{A}| = \alpha^2 U_0'' + \delta U_1'' < 0$$

because, from the second-order conditions for maximization, the second derivatives, U_0'' and U_1'', are negative.

To evaluate the consumption response to exogenous changes, by Cramer's rule,

$$dC_0 = \frac{1}{|\mathbf{A}|} \begin{vmatrix} -U_0' d\alpha & -\delta U_1'' \\ d\overline{Y}_0 + \alpha d\overline{Y}_1 + (\overline{Y}_1 - C_1) d\alpha & \alpha \end{vmatrix}$$

$$= \frac{1}{|\mathbf{A}|} \left[-\alpha U_0' d\alpha + \delta U_1'' [d\overline{Y}_0 + \alpha d\overline{Y}_1 + (\overline{Y}_1 - C_1) d\alpha] \right]$$

Consumption response to interest rate change is,

$$\left. \frac{dC_0}{d\alpha} \right|_{d\overline{Y}_0, d\overline{Y}_1} = \frac{-\alpha U_0' + \delta U_1'' (\overline{Y}_1 - C_1)}{\alpha^2 U_0'' + \delta U_1''} > 0 \text{ if } (\overline{Y}_1 - C_1) > 0$$

That is, if borrower in the first period, an increase in interest rate reduces first period consumption unambiguously. On the other hand, if lender in the first period, the impact of an increase in interest rate cannot be predetermined: at higher interest rates, and consequent higher returns from lending, the lender may in fact reduce lending so as to smoothen consumption over the two periods.

Similarly, to asses the consumption response to incomes,

$$\left.\frac{dC_0}{d\overline{Y}_0}\right|_{d\overline{\alpha},d\overline{Y}_1} = \frac{\delta U_1''}{\alpha^2 U_0'' + \delta U_1''} \qquad \text{with 0,1 bounds.}$$

$$\left.\frac{dC_0}{d\overline{Y}_1}\right|_{d\overline{\alpha},d\overline{Y}_0} = \frac{\alpha\delta U_1''}{\alpha^2 U_0'' + \delta U_1''} \qquad \text{with 0,1 bounds.}$$

Income increase in either period will increase current consumption with a marginal propensity of less than unity, the rest being allocated to the next period consumption. Also note that the difference in consumption response to current and future income changes is by the factor α, i.e. in effect future change is discounted to present value in making the consumption decision. Given a positive interest rate, α is bounded by (0,1) and thus the consumption responses to current and future income changes can in fact be shown to be bounded as,

$$0 < \frac{dC_0}{d\overline{Y}_1} < \frac{dC_0}{d\overline{Y}_0} < 1$$

4. Borrowing constraint

As the main interest in this study is the impact of borrowing limits on economic performance, it may be appropriate to introduce this constraint into this simplified model, to see the effects on consumption decisions. The notation will be changed to reflect the difference between the optimal and the borrowing-limit constrained levels of the decision variables. Optimal level of consumption with unconstrained borrowing will henceforth be denoted as C^* while C will refer to optimal consumption with constrained level of borrowing. Given $\overline{B}$ as the upper limit of borrowing allowed and B^* as the desired or unconstrained optimal level of borrowing, it can be assumed that $\overline{B}$ will never exceed B^*. Re-specifying the maximizing problem with this added constraint,

$$\text{Max } U = U_0(C_0) + \delta U_1(C_1) + \lambda_1[\overline{Y}_0 + \alpha\overline{Y}_1 - C_0 - \alpha C_1] + \lambda_2[\overline{B} + \overline{Y}_0 - C_0]$$

The first-order conditions are,

$$U_0' - \lambda_1 - \lambda_2 = 0$$

$$\delta U_1' - \alpha\lambda_1 = 0$$

$$\bar{Y}_0 + \alpha\bar{Y}_1 - C_0 - \alpha C_1 = 0$$
$$\bar{B} + \bar{Y} - C_0 = 0$$

with $U_0', U_1' > 0$ and $U_0'', U_1'' < 0$.

Substituting for λ_1 in the first two equations,

$$U_0' - (\delta/\alpha)U_1' - \lambda_2 = 0$$

the system can be reduced to a three equation system. Taking the total differentials as earlier and rearranging,

$$U_0''dC_0 - (\delta/\alpha)U_1''dC_1 - d\lambda_2 = -(\delta/\alpha^2)U_1'd\alpha$$
$$dC_0 + \alpha dC_1 = d\bar{Y}_0 + \alpha d\bar{Y}_1 + (\bar{Y}_1 - C_1)d\alpha$$
$$dC_0 = d\bar{B} + d\bar{Y}$$

$$\begin{bmatrix} U_0'' & -(\delta/\alpha)U_1 & -1 \\ 1 & \alpha & 0 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} dC_0 \\ dC_1 \\ d\lambda_2 \end{bmatrix} = \begin{bmatrix} -(\delta/\alpha^2)U_1'd\alpha \\ d\bar{Y}_0+\alpha d\bar{Y}_1+(\bar{Y}_1-C_1)d\alpha \\ d\bar{B} + d\bar{Y} \end{bmatrix}$$

The determinant of the 3 X 3 matrix is α. Thus, evaluating the impact on consumption, if the constraint is binding (i.e. λ_2 is non-trivial) then,

$$dC_0 = d\bar{B} + d\bar{Y}$$

That is, when the last of the first-order conditions is binding, then C_0 is determined by,

$$C_0 = \overline{B} + \overline{Y}_0$$

unlike in the previous case of unconstrained borrowing, where,

$$C_0^* = \frac{\overline{Y}_0 + \alpha\overline{Y}_1}{1 + \alpha(\alpha/\delta)^{\{1/(\gamma-1)\}}}$$

Therefore, unlike consumption with borrowing unconstrained, consumption in the case of constrained borrowing is independent of the income differences (between periods) and interest rate deviations from the subjective discount rate, when investments are not allowed.

C. Case II: Incorporating Investments

First, the maximizing problem, with no limit on borrowing, is re-specified to include investments. Investment is made only in the first period, and the total returns from this investment is recovered and consumed in the second period as per F&R model.

$$\text{Max } U = U_0(C_0) + \delta U_1(C_1) + \lambda[\overline{Y}_0 + \alpha\overline{Y}_1 + \alpha F(I_0) - C_0 - I_0 - \alpha C_1]$$

This results in an additional first order condition and a modified budget constraint, as follows.

$$\alpha F'(I_0) - 1 = 0$$

$$C_0 + I_0 + \alpha C_1 - \overline{Y}_0 - \alpha\overline{Y}_1 - \alpha F(I_0) = 0$$

1. Income and interest rate effects

Solving for the first period consumption under unconstrained borrowing (C_0^*), and utility functions specified as in page 61,

$$C_0^* = \left[\frac{\overline{Y}_0 + \alpha\overline{Y}_1 + \alpha F(I_0) - I_0}{1 + \alpha(\alpha/\delta)^{\{1/(\gamma-1)\}}} \right]$$

From this, it is evident that when $\overline{Y}_1 = \overline{Y}_0$, and $\delta = \alpha$,

$$C_0^* = \overline{Y}_0 + \frac{\alpha F(I_0) - I_0}{1 + \alpha} \qquad (3.1)$$

and that I_0 itself is determined by $F'(I_0) = 1/\alpha$.

That is, investment is determined by interest rate, and the investment and interest rate together influence current period consumption. Investment in the current period, on the one hand, reduces available resources for consumption in that period, and on the other hand increases current period consumption by increasing the future income. Thus, in conclusion, C_0^* is affected by the level of $\overline{Y}_0$, the difference between $\overline{Y}_0$ and $\overline{Y}_1$, the level of α, and the deviation of α from δ. The level of α affects investments and thereby influences consumption. The deviation of α from δ, on the other hand, influences intertemporal substitution in consumption.

Again, to determine the comparative statics of the general functional forms in this unconstrained model with investments, the model is restated and the first-order conditions reduced to a system of three by substituting for λ.

$$\text{Max } U = U_0(C_0) + \delta U_1(C_1) + \lambda[\overline{Y}_0 + \alpha\overline{Y}_1 + \alpha F(I_0) - C_0 - I_0 - \alpha C_1]$$

$$\begin{aligned}
\alpha U_0' \quad &- \quad \delta U_1' &= 0\\
\alpha F' \quad &- \quad 1 &= 0\\
C_0 + I_0 + \alpha C_1 \quad &- \overline{Y}_0 - \alpha\overline{Y}_1 - \alpha F(I_0) &= 0
\end{aligned}$$

with U_0', U_1', $F' > 0$ and U_0'', U_1'', $F'' < 0$. Further, for positive interest rates (i.e. $0 < \alpha < 1$), investments will be made only if the marginal returns exceed the cost of investments. It follows then that $F' > 1$, at any profitable level of investment. This can also be seen directly from the first-order condition, $\alpha F' = 1$, from which $F' > 1$ since $\alpha < 1$.

Denoting the unconstrained optimal levels of choice variables as C_0^*, C_1^* and I_0^* respectively, the total differentials can be derived and rearranged as follows.

$$\begin{aligned} \alpha U_0'' dC_0^* \; - \; \delta U_1'' dC_1^* &= -U_0' d\alpha \\ \alpha F'' dI_0^* &= -F' d\alpha \\ dC_0^* + \alpha \, dC_1^* + (1-\alpha F') dI_0^* &= d\bar{Y}_0 + \alpha d\bar{Y}_1 + (\bar{Y}_1 + F - C_1^*) d\alpha \end{aligned}$$

$$\begin{bmatrix} \alpha U_0'' & -\delta U_1'' & 0 \\ 0 & 0 & \alpha F'' \\ 1 & \alpha & 1-\alpha F' \end{bmatrix} \begin{bmatrix} dC_0^* \\ dC_1^* \\ dI_0^* \end{bmatrix} = \begin{bmatrix} -U_0' d\alpha \\ -F' d\alpha \\ d\bar{Y}_0 + \alpha d\bar{Y}_1 + (\bar{Y}_1 + F - C_1^*) d\alpha \end{bmatrix}$$

The determinant of the above 3 X 3 matrix on the left is,

$$\begin{aligned} |A| &= -\delta U_1'' \alpha F'' - \alpha^3 U_0'' F'' \\ &= -\alpha F(\delta U_1'' + \alpha^2 U_0'') \quad < \quad 0 \end{aligned}$$

$$dC_0^* = \frac{1}{|A|}\begin{vmatrix} -U_0'd\alpha & -\delta U_1'' & 0 \\ -F'd\alpha & 0 & \alpha F'' \\ d\overline{Y}_0+\alpha d\overline{Y}_1+(\overline{Y}_1+F-C_1^*)d\alpha & \alpha & 1-\alpha F' \end{vmatrix}$$

$$= \frac{1}{|A|}\Big[-\delta U_1''\alpha F''[d\overline{Y}_0+\alpha d\overline{Y}_1+(\overline{Y}_1+F-C_1^*)d\alpha] + \alpha^2F''U_0'd\alpha - \delta U_1''(1-\alpha F')F'd\alpha\Big]$$

$$\frac{dC_0^*}{d\overline{Y}_0} = \frac{\delta U_1''\alpha F''}{\alpha F''[\delta U_1''+\alpha^2U_0'']} = \frac{\delta U_1''}{\delta U_1''+\alpha^2U_0''} > 0$$

Similarly,

$$\frac{dC_0^*}{d\overline{Y}_1} = \frac{\alpha\delta U_1''\alpha F''}{\alpha F''[\delta U_1''+\alpha^2U_0'']} = \frac{\alpha\delta U_1''}{\delta U_1''+\alpha^2U_0''} > 0 .$$

The consumption response to income changes can be shown to be bounded as follows.

$$0 < \frac{dC_0^*}{d\overline{Y}_1} < \frac{dC_0^*}{d\overline{Y}_0} < 1$$

Checking the consumption response to interest rate changes,

$$\frac{dC_0^*}{d\alpha} = \frac{-\delta U_1''\alpha F''(\overline{Y}_1+F-C_1^*)+\alpha^2 F''U_0'-\delta U_1''(1-\alpha F')F'}{-\alpha F''(\delta U_1'' + \alpha^2 U_0'')}$$

But, from the first-order condition, $\alpha F' = 1$. Hence,

$$\frac{dC_0^*}{d\alpha} = \frac{\delta U_1''(\overline{Y}_1+F-C_1^*) - \alpha U_0'}{\delta U_1'' + \alpha^2 U_0''}$$

If borrower in the first period, then $(\overline{Y}_1 + F - C_1) > 0$, and consequently, $(dC_0^*/d\alpha) > 0$, implying an increase in interest rate leads to reduced consumption in the first period. Therefore, borrowing-unconstrained consumption is a function of the two period incomes and of the interest rate and can be defined in terms of these exogenous variables alone as,

$$C_0^* = C_0^*(\overline{Y}_0, \overline{Y}_1, \alpha) \qquad (3.2)$$

The coefficients on $\overline{Y}_0$ and $\overline{Y}_1$ will be constants for utility functions that are just twice differentiable. On the other hand, consumption response to interest rate changes depend on the level of C_0^* because U_0' changes with level of consumption.

The investment response to exogenous changes can be established from,

$$dI_0^* = \frac{1}{|A|}\begin{vmatrix} \alpha U_0" & -\delta U_1" & -U_0'd\alpha \\ 0 & 0 & -F'd\alpha \\ 1 & \alpha & 1-\alpha F'd\overline{Y}_0+\alpha d\overline{Y}_1+(\overline{Y}_1+F-C_1^*)d\alpha \end{vmatrix}$$

$$= \frac{1}{|A|}\left[\delta U_1"F'd\alpha + \alpha^2 U_0"F'd\alpha\right]$$

$$\frac{dI_0^*}{d\alpha} = \frac{\delta U_1"F' + \alpha^2 U_0"F'}{-\alpha F"(\delta U_1" + \alpha^2 U_0")} = \frac{F'}{-\alpha F"} > 0$$

since F', $\alpha > 0$ and $F" < 0$. Also note that the above is independent of the derivatives of the utility functions implying investment decision is independent of consumption levels. Further, investment is also independent of incomes in this formulation because,

$$\frac{dI_0^*}{d\overline{Y}_0} = 0 \quad \text{and} \quad \frac{dI_0^*}{d\overline{Y}_1} = 0$$

The borrowing unconstrained investment function can therefore be represented as,

$$I_0^* = I_0^*(\alpha) \tag{3.3}$$

Note that F' changes with levels of investment and hence investment response to interest rate changes varies with level of investment.

Optimal investment is decided dependent on the interest rate alone, and independent of consumption levels. The consumption decision can be viewed as being sequentially determined dependent on the investment level (which is in turn determined by $F(I_0)$ and the interest rate), interest rate (as it deviates from the rate of time preference) and the income levels in the two periods.

2. Imposing limits on borrowing

When a country is faced with limits on borrowing, i.e. $B^* > \bar{B}$, then, as was discussed earlier, the reaction path of the two period consumption and investment behavior can be traced by changing $\bar{B}$ in the interval $0 \leq \bar{B} \leq B^*$. If the constraint is not binding, then actual borrowing will not exceed B^* and hence the upper limit of $\bar{B}$ is B^*. When $\bar{B}$ equals zero, investment and consumptions are optimized at the tangency between the inter-period indifference curve and investment-production curve, by choosing the highest indifference curve possible. This decision is independent of the absolute value of interest rate as well as the interest to time preference ratio. A negative $\bar{B}$ can be interpreted in a limited context of pre-existing debt. A pre-existing debt will be a mere liability on the first period, reducing the resources available in that period for consumption and investment. While a positive $\overline{B}$ will impose a negative repayment in the second period, the reverse is true only if the negative $\overline{B}$ implies a lending, rather than a pre-existing debt. The effect of pre-existing debt will be the same as a reduction in $\overline{Y}_0$ and will be treated as such. In this section, therefore, $\overline{B}$ is assumed to be in the interval $0 \leq \overline{B} \leq B^*$.

Under the assumption of limited borrowing, for $0 \leq \overline{B} \leq B^*$, the utility maximization problem can be re-specified as follows.

$$\text{Max } U = U_0(C_0) + \delta U_1(C_1) + \lambda_1[\overline{Y}_0 + \alpha\overline{Y}_1 + \alpha F(I_0) - C_0 - I_0 - \alpha C_1] + \lambda_2[\overline{B} + \overline{Y}_0 - C_0 - I_0]$$

From this, the first-order conditions derived are,

$$\begin{aligned}
U_0' - \lambda_1 - \lambda_2 &= 0 \\
\delta U_1' - \lambda_1\alpha &= 0 \\
\lambda_1\alpha F' - \lambda_1 - \lambda_2 &= 0 \\
\overline{Y}_0 + \alpha\overline{Y}_1 + \alpha F(I_0) - C_0 - I_0 - \alpha C_1 &= 0 \\
\overline{Y}_0 + \overline{B} - C_0 - I_0 &= 0
\end{aligned}$$

Again, the necessary conditions are U_0', U_1' $F' > 0$ and U_0'', U_1'', $F'' < 0$. Given a well behaved investment-production function, at investments below optimal level, the marginal returns will be such that $\alpha F'$ is strictly greater than unity (i.e. λ_2 is positive).

To determine the comparative statics of this model with respect to changes in exogenous variables, the system is reduced to a three equation system by substituting for λ_1 and λ_2, and the total differentials are derived assuming only the subjective discount rate to remain constant.

$$\lambda_1 = (\delta/\alpha)U_1'$$

$$\lambda_2 = \lambda_1(\alpha F' - 1) = (\alpha F' - 1)(\delta/\alpha)U_1'$$

Substituting for the above in the first equation,

$$U_0' - (\delta/\alpha)U_1' - (\alpha F' + 1)(\delta/\alpha)U_1' = 0$$

The resulting three first-order conditions are,

$$U_0' - \delta F'U_1' = 0$$

$$\overline{Y}_0 + \alpha\overline{Y}_1 + \alpha F(I_0) - C_0 - I_0 - \alpha C_1 = 0$$

$$\overline{Y}_0 + \overline{B} - C_0 - I_0 = 0$$

Taking the total differentials and re-arranging,

$$U_0''dC_0 - \delta F'U_1''dC_1 + \delta U_1'F''dI_0 = 0$$

$$d\overline{Y}_0 + \alpha d\overline{Y}_1 + \overline{Y}_1 d\alpha + \alpha F'dI_0 + Fd\alpha - dC_0 - dI_0 - \alpha dC_1 - C_1 d\alpha = 0$$

$$d\overline{Y}_0 + d\overline{B} - dC_0 - dI_0 = 0$$

$$\begin{bmatrix} U_0'' & -\delta F'U_1'' & -U_1'F'' \\ 1 & \alpha & 1-\alpha F' \\ 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} dC_0 \\ dC_1 \\ dI_0 \end{bmatrix} = \begin{bmatrix} 0 \\ d\overline{Y}_0 + \alpha d\overline{Y}_1 + (\overline{Y}_1+F-C_1)d\alpha \\ d\overline{Y}_0 + d\overline{B} \end{bmatrix}$$

The determinant of the matrix of coefficients is given by,

$$\begin{aligned} |A| &= \alpha U_0'' - \delta F'(1-\alpha F')U_1'' + \alpha U_1'F'' + \delta F'U_1'' \\ &= \alpha U_0'' + \alpha\delta F'F'U_1'' + \alpha U_1'F'' \quad < \quad 0 \end{aligned}$$

since F', δ, $\alpha > 0$ and U_0'', U_1'', $F'' < 0$ by assumption.

Evaluating the consumption responses by Cramer's rule as earlier,

$$dC_0 = \frac{1}{|A|} \begin{vmatrix} 0 & -\delta F'U_1'' & -U_1'F'' \\ d\overline{Y}_0+\alpha d\overline{Y}_1+(\overline{Y}_1+F-C_1)d\alpha & \alpha & 1-\alpha F' \\ d\overline{Y}_0+d\overline{B} & 0 & 1 \end{vmatrix}$$

$$= \frac{1}{|A|}\Big[-\delta F'(1-\alpha F')U_1''[d\overline{Y}_0+\overline{B}] + \alpha F''U_1'[d\overline{Y}_0+d\overline{B}] \\ \delta F'U_1''[d\overline{Y}_0+\alpha d\overline{Y}_1+(\overline{Y}_1+F-C_1)d\alpha]\Big]$$

$$\frac{dC_0}{d\bar{Y}_0} = \frac{1}{|A|}\left[-\delta F'(1-\alpha F')U_1'' + \alpha F''U_1' + \delta F'U_1''\right]$$

$$= \frac{\alpha\delta F'F'U_1'' + \alpha U_1'F''}{\alpha U_0'' + \alpha\delta F'F'U_1'' + \alpha U_1'F''} \quad \text{with 0,1 bounds.}$$

$$\frac{dC_0}{d\bar{Y}_1} = \frac{1}{|A|}\left[\delta\alpha F'U_1''\right] \quad > \quad 0.$$

But F' > (1+r) at investments below optimal level. Since the interest rate (r) is positive, F' is greater than unity. This result can be used to further re-assign the bounds as,

$$0 < \frac{dC_0}{d\bar{Y}_1} < \frac{dC_0}{d\bar{Y}_0} < 1$$

$$\frac{dC_0}{d\bar{B}} = \frac{1}{|A|}\left[-\delta F'U_1'' + \alpha\delta F'F'U_1'' + \alpha U_1'F''\right]$$

$$= \frac{-\delta F'U_1'' + \alpha\delta F'F'U_1'' + \alpha U_1'F''}{\alpha U_0'' + \alpha\delta F'F'U_1'' + \alpha U_1'F''} \quad > \quad 0$$

The bounds for marginal consumption due to changes in borrowing limit and current income can therefore be determined as,

$$0 < \frac{dC_0}{d\bar{B}} < \frac{dC_0}{d\bar{Y}_0} < 1$$

Consumption response to interest rate changes is,

$$\frac{dC_0}{d\alpha} = \frac{1}{|A|}\left[\delta F'U_1''(\bar{Y}_1+F-C_1)\right] > 0$$

if borrower in first period, implying an increase in interest rate decreases consumption. The sign is unambiguous for the case of lender too, and is of the opposite side: with a fixed lending level, an interest rate increase will lead to increased consumption and reduced investment.

Further, note that the marginal response of consumption with respect to all of the exogenous variables are dependent on the level of at least one of the endogenous variable. Therefore, the marginal rates will vary with varying levels of the endogenous variables.

The investment adjustments can be similarly analyzed as follows.

$$dI_0 = \frac{1}{|A|}\begin{vmatrix} U_0'' & -\delta F'U_1'' & 0 \\ 1 & \alpha & d\bar{Y}_0+\alpha d\bar{Y}_1+(\bar{Y}_1+F-C_1)d\alpha \\ 1 & 0 & d\bar{Y}_0+d\bar{B} \end{vmatrix}$$

$$= \frac{1}{|A|}\Big[\alpha U_0''(d\overline{Y}_0+d\overline{B}) - \delta F'U_1''[d\overline{Y}_0+\alpha d\overline{Y}_1+(\overline{Y}_1+F-C_1)]d\alpha$$

$$+ \delta F'U_1''[d\overline{Y}_0+d\overline{B}]\Big]$$

$$\frac{dI_0}{d\overline{Y}_0} = \frac{1}{|A|}\Big[\alpha U_0''\Big] > 0.$$

$$\frac{dI_0}{d\overline{Y}_1} = \frac{1}{|A|}\Big[- \delta\alpha F'U_1''\Big] < 0.$$

$$\frac{dI_0}{d\alpha} = \frac{1}{|A|}\Big[-\delta F'U_1''(\overline{Y}_1+F-C_1)\Big] < 0 \quad \text{if } \overline{Y}_1+F-C_1 > 0.$$

$$\frac{dI_0}{d\overline{B}} = \frac{1}{|A|}\Big[\alpha U_0'' + \delta F'U_1''\Big] > 0.$$

Also note the following identities.

$$\frac{dC_0}{d\overline{Y}_0} + \frac{dI_0}{d\overline{Y}_0} = 1$$

$$\frac{dC_0}{d\overline{Y}_1} + \frac{dI_0}{d\overline{Y}_1} = 0$$

$$\frac{dC_0}{d\alpha} + \frac{dI_0}{d\alpha} = 0$$

$$\frac{dC_0}{d\overline{B}} + \frac{dI_0}{d\overline{B}} = 1$$

Number of observations must be made with respect to the above results. First, note that marginal investment with respect to each of the exogenous variables vary with the level of investment because of the F' term. Thus, caution must be exercised in specifying the estimation model to ensure the coefficients are allowed the necessary flexibility. Next, investment increases rather than decreases with increase in interest rate under constrained borrowing. This is because an increase in interest rate decreases the life time budget for a borrower. Facing this lower budget, consumption smoothening behavior leads to reduced consumption in both periods. Given a fixed $\overline{Y}_0$ and $\overline{B}$, the savings from reduced consumption in the first period is channeled to investment. Third, how the response to a change in current income differs from that of a change in allowed borrowing is of interest. An increase in current income has a higher impact on consumption than a similar increase in borrowing limit as would be expected. The difference is because an exogenous income increase has no current or future costs, and the life-time budget increases by the full magnitude of income increase. In contrast, increase in borrowing entails added repayment in the next period, and thus the life-time budget does not increase by the same magnitude as the increase in borrowing. It can be seen that this difference is also in fact equal to the response to future income change, deflated to present value. In addition, the response in investment is exactly reversed, i.e. an increase in borrowing limit leads to higher investment than a similar increase in current income, and the magnitude of the difference is the same as the difference in consumption, because total absorption ($C_0 + I_0$) is unchanged under constrained borrowing. Finally, the sum of consumption plus investment changes due to a unit increase in either borrowing limit or current income is unity, while this sum is zero for a unit increase in interest rate or next period income. This is also to be expected because the total absorption in the current period is exactly equal to the current income plus the constrained borrowing. Thus any increase in either of these exogenous variables increases total absorption by the same amount. Increase in future income or interest rate, given fixed borrowing, has no effect on total current absorption: it only induces switching between investment and consumption in the current period.

The borrowing-constrained consumption and investment functions can be represented by,

$$C_0 = C_0(\overline{Y}_0, \overline{Y}_1, \alpha, \overline{B}) \quad (3.4)$$

$$I_0 = I_0(\overline{Y}_0, \overline{Y}_1, \alpha, \overline{B}) \quad (3.5)$$

The two equations are however not independent, being simultaneously determined subject to the national income identity that the total of goods and services produced and imported are either consumed, invested or exported. Further, it must be noted that the functions are such that the marginal responses with respect to each of the explanatory variable will not be constants. In contrast, the borrowing-unconstrained consumption and investment functions as derived previously and stated in (3.2) and (3.3) are, respectively,

$$C_0^* = C_0(\overline{Y}_0, \overline{Y}_1, \alpha)$$
$$I_0^* = I_0(\alpha).$$

In this case, the marginal response of consumption to income changes may be simplified to be constants by assuming just twice differentiable utility functions. Marginal responses to interest rate changes however cannot be similarly simplified as their values depend on the first derivatives of twice differentiable functions.

D. Trade Sector

The trade sector is represented by the same trade sector functions as in Khan and Knight's model. The general form of the trade sector equations[6] are presented here followed by specifying the total theoretical model, integrating the domestic sector and the trade sector via the national income and balance of payment identities. The detailed functional forms of these equations as used in the study along with the modifications are fully discussed in Chapter IV in developing the empirical model.

1. Export supply

This is specified as a function of total imports, relative price of exports and domestic income as in Khan and Knight model. Import volume is included to account for the share of export production dependent on imported inputs, while

[6]The terms "imports" and "exports", as used in this study, includes both goods and services unlike in the Balance of Payments Accounts where they refer to commodity trade alone. Consequently, the term "trade balance" in the discussions that follow is equivalent to the "Balance of Goods and Services" of the balance of Payments Accounts.

income accounts for the domestically value added share of exports.

$$X^s = X^s(M, P_x/P_d, Y_d) \quad (3.6)$$

2. Export demand

Export demand is determined by the price of exports relative to the world price level, and the world income, as is used in the standard trade models as well as in Khan and Knight's model.

$$X^d = X^d(P_x/P_w, Y_w) \quad (3.7)$$

Export sector equilibrium condition is imposed by,

$$X = X^s = X^d$$

3. Import demand

Import demand is generally defined as a function of the relative price of imports and income in the standard models. Khan and Knight include the changes in reserves as a proxy for debt related policies, and thereby obtain the critical and only linkage between debt and trade in their model. Under conditions of borrowing, imports are not necessarily limited by the income alone, since increased borrowing is likely to lead to increased imports. Thus, imports are more aptly a function of total absorption than income. Absorption consists of consumption and investment. Since, under conditions of constrained borrowing, consumption and investment are simultaneously determined, for a given set of income, borrowing and interest rate, each level of consumption has a unique level of investment. As such, import demand can be specified as a function of consumption and relative price of imports.

$$M^d = M^d(P_m/P_d, C)$$

With the small country assumption, import supply is defined as perfectly elastic as in Khan an Knight's model. Therefore, import sector equilibrium is,

$$M = M^d(P_m/P_d, C) \tag{3.8}$$

Setting equality of demand and supply in both the import and export sectors, the trade balance is the following identity.

$$TB = X - M$$

4. Borrowing and trade balance

Prior to formulating the model integrating the domestic consumption-investment sector with the trade sector, it is necessary to differentiate between trade balance and borrowing. Capital borrowed, or equivalently the accrued debt obligation of a country in any given period generally differs from the trade balance in that period. While part of the capital borrowed is for the purpose of increasing imports, there are other channels of disappearance of this capital, namely transfers, changes in reserves and capital flight. In the case of most debtor countries, net transfer is in general in their favor, and is a relatively small fraction of the capital flow. Such a positive net transfer in effect reduces the debt obligation from what the trade balance would indicate. During periods of debt service problems, the countries are likely to draw from the reserves to meet their imports, and as such again foreign borrowing is likely to be less than the trade balance observed. Capital flight, on the other hand is a major contributor to the intensity of debt problem, via buildup of gross debt, erosion of tax base and often reduction in domestic investment (Khan and Haque, 1985). Part of capital borrowed, and often guaranteed by the public sector, is leaked out of the country by private sources for various reasons (Cuddington, 1985). Estimates of capital flight from eight major debtors, for the period 1974-82 averaged around 35 percent of annual increase in indebtedness (Dooley and others, 1983: Cuddington, 1985), varying from zero to as much as 95 percent in some cases. The principal reason for such leakage is speculative investments and such leakage is accelerated as the confidence on domestic economic recovery erodes (Dornbush, 1984). This is another major source of the self-reinforcing nature of debt problem: as the debt problem becomes acute, domestic private sector confidence erodes. Consequently an even larger share of the limited borrowing leaks out of the country, leaving less for domestic investments and this in turn compounds the debt problem of the country as a whole. Although capital flight may be a mere transfer in asset holdings of the private sector (from domestic asset to foreign asset), thus not affecting the overall net status, the public sectors' foreign debt obligation is increased and domestic investible funds are drained.

Another reason for defining borrowing as distinct from trade balance is as follows. Khan and Knight's model estimates the export compression due to import restrictions as,

$$dX/dM = \beta$$

If borrowing is merely the trade balance itself, then the impacts of borrowing on imports and exports are defined by the above parameter alone. Since trade balance (TB) is defined as exports less imports (X - M),

$$dTB = dX - dM = \beta dM - dM$$

$$\frac{dM}{dTB} = \frac{1}{(\beta - 1)} \quad \text{and} \quad \frac{dX}{dTB} = \frac{\beta}{(\beta - 1)}$$

That is, once imports and exports are defined as behavioral functions then the trade balance is endogenous, and cannot be treated as an exogenous or control variable to analyze impacts of borrowing restrictions: to do so would require re-specifying either imports or exports by an identity rather than as a behavioral function.

In the present context it is sufficient to note that borrowing is different from trade balance, without having to specify what actually constitutes borrowing. Accordingly therefore, in the following section constrained borrowing ($\bar{B}$) is treated as a variable different from trade balance (TB = X - M). Construction of this variable, $\bar{B}$, for the current study is postponed until the next chapter (see page 115). In view of this distinction between trade balance and borrowing, the theoretical model developed thus far holds true if supplemented with the assumption that the borrowing is used for trading of goods and services alone such that $\bar{B} = - TB$. From the following section on-wards, however, the distinction is maintained, thus allowing for the possibility of capital exchanges not related to exchange of goods and services.

5. National income identity

From the national income accounts, by definition,

$$Y = C + I + (X - M) - F$$

where, Y is the gross domestic product,

C is total of private and public consumption,

I is total of private and public investment,

X is total exports,

and, M is total imports.

E. Integrating the Domestic and Trade Sectors

The following system of five equations illustrate how the domestic and trade sector national account identities are simultaneously imposed. The consumption function is as defined in (3.4), allowing for adjustments to constrained borrowing. The constrained investment is not independent of the consumption decision since both are simultaneously determined under conditions on constrained borrowing. Also, from the national income identity it can be seen that it is the trade balance rather than borrowing that determines this residual investment because, in terms of goods and services, total production plus imports are either consumed, exported or invested. The export and import functions are simplified for purposes of illustration below. Imports are defined as a function of consumption alone. Consumption in the import function (see page 89) provides the necessary link between the domestic and trade sectors in the model. Exports are defined by a single equation instead of by the supply and demand functions with price and quantity as variables. Imports and income constitute the arguments for this export function. Omission of essentially the price variables in these trade functions are for purposes of illustrating the working of this theoretical model. Expansion to their full form as in (3.6, 3.7 and 3.8) will not affect the observations made here.

$$C = C(\overline{Y}_0, \overline{Y}_1, \alpha, \overline{B})$$

$$I = \overline{Y}_0 - C - TB \quad : \text{ National income identity}$$

$$M = M(C)$$

$$X = X(M, \overline{Y}_0)$$

$$TB = X - M \quad : \text{ Balance of payments identity}$$

The above system of five equations can be reduced to a three-equation system by substituting for X and M in the trade balance equation as follows.

$$C = C(\overline{Y}_0, \overline{Y}_1, \alpha, \overline{B})$$
$$I = \overline{Y}_0 - C - TB$$
$$TB = X(M(C), \overline{Y}_0) - M(C)$$

Taking the total derivatives,

$$dC = C_1 d\overline{Y}_0 + C_2 d\overline{Y}_1 + C_3 d\alpha + C_4 d\overline{B}$$
$$dI = d\overline{Y}_0 - dC - dTB$$
$$dTB = X_1 M_1 dC + X_2 d\overline{Y}_0 - M_1 dC$$

Rearranging in matrix form,

$$\begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 1 \\ M_1(1-X_1) & 0 & 1 \end{bmatrix} \begin{bmatrix} dC \\ dI \\ dTB \end{bmatrix} = \begin{bmatrix} C_1 d\overline{Y}_0 + C_2 d\overline{Y}_1 + C_3 d\alpha + C_4 d\overline{B} \\ d\overline{Y}_0 \\ X_2 d\overline{Y}_0 \end{bmatrix}$$

Note that the 3 X 3 matrix has a determinant of unity. To investigate the impact of changes in the borrowing limit, $\overline{B}$, maintain $\overline{Y}_0$, $\overline{Y}_1$ and α as fixed.

$$dC = C_4 d\overline{B}$$

$$dI = [M_1(1-X_1) - 1]C_4 d\bar{B}$$
$$dTB = - M_1(1-X_1)C_4 d\bar{B}$$

An increase in borrowing limit is expected to increase consumption and thus a positive C_4 is presumed. Similarly, M_1 and X_1 are also assumed positive because an increase in consumption increases imports and increase in imports increases exports, as per the model. The necessary condition for a decrease in trade balance (increase in trade deficit) due to an increase in borrowing limit is,

$$dTB/d\bar{B} = - M_1(1-X_1)C_4 < 0 \quad \underline{\text{iff}} \quad 0 < X_1 < 1$$

The trade deficit increases only if an increase in import induces an increase in exports that is of a lesser magnitude.

Given $X_1 < 1$, therefore, M_1 needs to be greater than unity for an increase in borrowing to result in an increase in investment.

$$dI/d\bar{B} = [M_1(1-X_1) - 1]C_4 > 0 \quad \underline{\text{iff}} \quad M_1(1-X_1) > 1$$

Note that $M_1(1-X_1)$ reflects the net trade change, which is the change in imports less the import induced exports. If $M_1(1-X_1) > 1$, then $dTB/d\bar{B} > C_4$. That is, the trade deficit needs to increase faster than consumption for investment to increase.

$$\frac{dC}{d\bar{B}} = \frac{dC}{dTB} \cdot \frac{dTB}{d\bar{B}} = \frac{1}{M_1(1-X_1)} \cdot M_1(1-X_1)C_4 = C_4$$

$$\frac{dI}{d\bar{B}} = \frac{dI}{dTB} \cdot \frac{dTB}{d\bar{B}} = \frac{M_1(1-X_1) - 1}{-M_1(1-X_1)} \cdot [-M_1(1-X_1)C_4]$$

$$= [M_1(1-X_1) - 1]C_4$$

Also, it may be noted that net of consumption and investment change with respect to a unit change in borrowing is not necessarily unity: the net change is merely equivalent to the change in trade balance.

$$\frac{dC}{d\bar{B}} + \frac{dI}{d\bar{B}} = \frac{dTB}{d\bar{B}} = M_1(1-X_1)C_4$$

It can be shown that the net of consumption and investment changes due a unit change in trade balance on the other hand is unity, and this is the necessary condition ensuring consistent trade balance in both balance of payments and national income accounts (note that trade balance is the trade deficit with the opposite sign).

$$\frac{dC}{dTB} + \frac{dI}{dTB} = -1$$

F. Theoretical Model Summary

In summary, therefore, the theoretical model of constrained borrowing consists of the following system of equations. The system specification is followed by some general and specific observations discussed in this chapter that need to be considered in developing the empirical model.

$$C_0 = C_0(\bar{Y}_0, \bar{Y}_1, \alpha, \bar{B})$$
$$M = M(P_m/P_d, C)$$
$$X^s = X^s(M, P_x/P_d, Y)$$
$$X^d = X^d(P_x/P_w, Y_w)$$
$$X^s = X^d$$
$$TB = X^s - M$$
$$I = \bar{Y}_0 - C - TB$$

(a) Borrowing unconstrained investment function is,

$$I^* = I^*(\alpha).$$

The marginal investment is independent of the form of utility functions, but is dependent on F' which varies with the level of investment. Therefore, I^* is non-linear in α.

(b) The borrowing unconstrained consumption function can be simplified to be linear in $\overline{Y}_0$ and $\overline{Y}_1$ by the assumption of just twice differentiable utility functions. However, it is non-linear in α because the marginal consumption with respect to α is dependent on the level of F.

(c) The decision process can therefore be characterized as sequential, investment being decided dependent on the interest rate alone, and consumption being decided dependent on the level of investment made as well as the three exogenous variables.

(d) In contrast, consumption and investment decisions are made simultaneously in the case of constrained borrowing, and both C and I are non-linear in $\overline{Y}_0$, $\overline{Y}_1$, α and $\overline{B}$ because the respective marginal values are dependent on F'.

(e) Trade balance needs to be differentiated from foreign borrowing, as borrowed capital may be used up not only in imports of goods and services, but also in direct transfers including capital flight.

IV. ESTIMATION MODEL

A. Introduction

A theoretical model of decision making under constrained borrowing conditions was developed in the last chapter integrating the domestic sector with the trade sector, and ensuring its consistency with the national income identities. In the domestic sector, the consumption function remains a behavioral function while the investment function reduces to an identity to enable the necessary accounting equalities to hold. The link between the domestic sector and trade sector is achieved by specifying imports as a function of consumption rather than income. Exports are modeled as responding to imports since exportable products in most of debtor nations include imported inputs.

In developing the model, general forms of the functions were used so as not to unduly restrict the outcomes of the theoretical analysis. The next step is to modify the model for the empirical estimation, and this requires specification of the functional forms for use in the model. The discussion in the previous chapter provided some necessary conditions that must be met in simplifying and specifying the functional forms. The current chapter formulates the estimation model, discussing in detail the functional form specifications, simplifications and other modifications made from the theoretical framework.

The rest of the chapter is organized as follows. To ensure that the constrained consumption is non-linear as required (page 82) and not unnecessarily restricted by the functional form specifications, the mechanism of adjustment from unconstrained consumption to any limiting credit levels is re-specified as a partial adjustment process. This mechanism is first presented. To enable such a specification, it becomes necessary to specify the unconstrained consumption and investment functions. Detailed discussion of these function thus follows the discussion of the adjustment mechanism. Next, a suitable measure of borrowing, as distinct from trade balance (as per page 90) for use in the model is identified. Given this new measure of borrowing, the system specification is re-examined for consistency with the partial adjustment process. The model developed thus far neglects any possible impacts of the policy measures that may have been instituted at times of debt crisis. It seems appropriate to incorporate a policy variable in the model equations to take account of variability in performance due to changes in policy environment. A discussion of this is presented, constructing a suitable policy variable for this purpose. Finally, with the stage thus set for detailed specification of each of the functions, the integrated model of domestic and trade sector is developed, specifying each of the equations in the system in an estimatable form.

B. Adjustment to Credit Restrictions

The constrained consumption function from the theoretical model is,

$$C_0 = C_0(\overline{Y}_0, \overline{Y}_1, \alpha, \overline{B})$$

with the necessary condition that all of the four partials be dependent on the level of at least one exogenous variable (see pages 80-82). This requires that the function be non-linear in all of its arguments. On the other hand, it was observed that in the unconstrained borrowing case, consumption function could be linearized with respect to incomes (page 75) by the assumption of just twice differentiable utility functions. In view of these considerations, the method of consumption adjustment for credit restrictions is re-specified as is explained below.

In the constrained consumption function, the partial with respect to $\overline{B}$ ($\partial C_0/\partial \overline{B} = C_4$) is dependent on the levels of investment and incomes because of the first partials F' and U', and α in its formulation shown below.

$$\frac{dC_0}{d\bar{B}} = \frac{-\delta F'U_1'' + \alpha\delta F'F'U_1'' + \alpha U_1'F''}{\alpha U_0'' + \alpha\delta F'F'U_1'' + \alpha U_1'F''}$$

To enable this adjustment coefficient to be adequately flexible as necessary, the adjustment in consumption (and thereby investment) to changes in $\bar{B}$ within the interval $0 \leq \bar{B} \leq B^*$ is re-defined in a partial adjustment framework, with B^* defined as the optimal or unconstrained borrowing. The model assumes that actual consumption C_t adjusts from the desired consumption by an adjustment coefficient ϕ_t as follows.

$$C_t = C_t^* - \phi_t(B_t^* - \bar{B}_t) \qquad (4.1)$$

Thus, when B_t^* equals $\bar{B}_t$, actual consumption as well as actual investment will equal the desired or unconstrained optimal levels, as the borrowing limit constraint is not binding. It is assumed that the actual borrowing $\bar{B}$ never exceeds desired borrowing B^*, as it makes no sense to assume forced borrowing. In model estimation, when a negative $\bar{B}$ is encountered (total repayments exceeding new capital inflow), $\bar{B}$ will be set to zero and this will be compensated by a compensating reduction in income. In these cases, thus adjustment in consumption and investment, with respect to borrowing limit, takes the maximum value, as if actual borrowing is zero. Further, consumption and investment also adjust due to the shortfall in income, thus compensating for the negative $\bar{B}$ that was not incorporated.

From the consumption adjustment equation above,

$$\frac{\partial C_t}{\partial \bar{B}_t} = \frac{\partial C_t^*}{\partial \bar{B}_t} - \phi_t \frac{\partial B_t^*}{\partial \bar{B}_t} + \phi_t = \phi_t$$

because both ∂C_t^* and ∂B_t^* with respect to $\partial \bar{B}_t$ equal zero as the desired levels are independent of actual borrowing. Hence, for the adjustment coefficient to be consistent with the earlier results with respect to consumption and investment adjustments, ϕ_t should enter the model as a function of the first derivatives of the consumption and investment-production functions, and of the interest rate. Therefore, the adjustment coefficient, ϕ_t, (which replaces the fourth partial, C_4, of the theoretical model without violating any of the theoretical basis) needs to be defined such that it is a function of the levels of consumption and investment and of the interest rate. It is thus evident that ϕ_t is not a constant over time, but a variable dependent on time t. While several alternative specifications may suit the construction of ϕ_t, it is convenient to construct this as a linear function of A_t,

$$\phi_t = \pi_0 + \pi_1 A_t \qquad (4.2)$$

where A_t is either a function of C, I and r, or is an appropriate proxy for the levels of these arguments.

Defining A_t in terms of C, I and r directly has two implications in the estimation procedure. First, the non-linear system of modelling for the two-stage least squares estimation of time series data requires that the endogenous function be specified explicitly in terms of other endogenous variables and instruments only. Use of C in the adjustment coefficient will lead to a consumption function that cannot be explicitly solved as required as will be seen in Chapter IV. F. Specification of Estimation Model. Next, use of either C or I in defining ϕ_t results in error terms with non-zero covariance matrix as is discussed in the Chapter V. D. Estimation Method. For simplicity therefore, ϕ_t may be defined in terms of the total absorption, $(Y+\overline{B})$, which is used as a proxy for the levels of the three variables C, I and r. The adjustment coefficient is still a function of consumption and investment because the total expenditure is divided between consumption and investment. While it may be more appropriate to add interest rate as a separate argument in this linear formulation, it is omitted so as to keep the final model not too large for estimation with the limited number of observations available. Since the variation in interest rate is relatively small compared to the variation in income and borrowing, it is assumed that this omission will not affect the estimation of ϕ_t substantially. The statistical considerations in the specification of A_t is further discussed in the Chapter V. D. Estimation Method.

Formulating the model as a partial adjustment process involves specifying the optimal (borrowing-unconstrained) consumption and investment behavioral functions and treating the observed consumption and investment as the constrained levels. As will be seen (page 127), the optimal behavioral functions can be substituted out so that observations on optimal behavior will not be necessary for the required estimations. Since the model requires specification of the optimal functions, first a more detailed discussion on investment and consumption under unconstrained borrowing conditions is presented.

1. Unconstrained investment-production function

The second period income in F&R model is the sum of two components, an exogenous component, $\overline{Y}_1$, and the output resulting from the first period's investment, $F(I_0)$. The investment function resulting from this specification, through the profit maximization process is, $I = f(r)$, the "classical form," where r is the interest rate. Graphically, with changes in $\overline{Y}_0$, the investment-production curve will face parallel shifts horizontally while retaining a constant shape, such that the level of investment is determined by the interest rate alone.

Specifying this investment demand function with interest rate as the single argument poses an identification problem. Further, such assumption of fixed investment-production possibilities at varying income levels is unrealistic and this rigidity is in fact unnecessary. The "Keynesian" form of investment function, $I = f(r,Y)$, relaxes this rigidity. Inclusion of Y in the investment function is defended in the investment literature on several grounds (Ackley, 1973). Higher income implies higher demand for final outputs, which translates to higher demand for inputs, including capital input.[7] For countries starting at well below capacity level of capital, the investment increases with income in the early

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7 Early investment literature however discounted this argument in favor of the "acceleration" hypothesis (Evans, 1969), relating investment to "change" in income rather than "level" of income. Subsequent support to the "level" arguments came from stock adjustment and capacity models (Goodwin, 1951 and Chenery, 1952), but requiring explicit incorporation of the level of capital stock. Koyock's (1954) lagged adjustment and the resulting transformation provided the basis for the "flexible accelerator" models. A more plausible argument for the level of income and investment link is via profitability (Anderson, 1964, and Meyer and Glauber, 1964, as referenced in Jorgenson, Hunter and Nadiri, 1970 use profits as an explanatory variable.) and the assumption that profits and hence investible fund availability increases with increase in income.

phase, and then declines, due to countering positive income effect and negative capital effect. In the present context, it is adequate to recognize that the investment potentials are different at different levels of income, such that the curvature of the investment-production function is allowed to change with changes in income. No assertion is made as to whether the investment will increase or decrease with increase in income: this is in keeping with the "flexible accelerator" model.

This form of investment demand can be derived by modifying the endogenous component of output to $F(I_0,Y_0)$, with the added condition that this function is non-linear in I_0 and Y_0. This modification does not affect the general structure or the conclusions of the F&R model. Derivation of investment demand from the F&R model and the modified model are compared below and is followed by the specification of unconstrained investment function for use in the study.

a. F&R's investment-production function From the first order conditions,

$$F'(I_0) \;=\; (1/\alpha)$$

Taking total partials,

$$F''(I_0).dI_0 \;=\; -(1/\alpha^2).d\alpha$$

$$(dI_0/d\alpha) \;>\; 0 \;\; \underline{iff} \;\; F''(I_0) < 0$$

The necessary condition is that, $F(I_0)$ is twice differentiable in I_0 such that $F'(I_0) > 0$, and $F''(I_0) < 0$. Thus, the "classical" form of investment function $I = f(r)$ is derived from F&R's specification as $F(I_0)$.

b. Modified investment-production function Since the only choice variable in the investment-production function is I_0, the first order condition is very similar.

$$F_1(I_0,Y_0) = (1/\alpha)$$

Taking total partials as earlier,

$$F_{11}.dI_0 + F_{12}.dY_0 = -(1/\alpha^2).d\alpha$$

Therefore, if F_{12} is non-zero, that is $F(I_0,Y_0)$ is non-linear in I_0 and Y_0, then $(dI_0/dY_0) \neq 0$. This leads to the "Keynesian" form of investment function, $I = f(r,Y)$.

c. Investment demand function If there are no constraints on borrowing, as was pointed out (page 77), investment decision is first made, based on the current and anticipated future interest rates, independent of consumption levels. Adoption of the modified investment-production function discussed above allows for inclusion of income level to ensure the identification of investment demand, but retains the independence from the utility functions and thus from consumption level. In this formulation, income may also be viewed as a proxy for capital stock, on the argument that investment-production possibilities are likely to vary with capital stock (both in cross-sectional and in time-series data), and a measure of capital stock for most of the countries are difficult to obtain.

For simplicity, the "random walk" hypothesis may be invoked with respect to the expectation of future interest rates, whereby the best, currently available estimate of the future interest rate can be assumed to be the current rate itself. Therefore, the unconstrained optimal or desired investment (such optimal or desired levels are, hereafter, identified by a superscripted asterisk) is defined as,

$$I_t^* = \eta_{10} + \eta_{11} r_t + \eta_{12} Y_t + \varepsilon_{i,t} \qquad (4.3)$$

with, $\eta_{11} < 0$

η_{12} of indeterminate sign.

The variables I_t^*, r_t and Y_t, are all used in their nominal[8] terms. All three can be converted to real terms by deflating with a single price index, such as the consumer price index. The a priori signs of η_{11} and η_{12} are unchanged whether the model is specified in real or nominal terms. The coefficient, η_{11} will be expected to be negative in this investment demand function. The sign on η_{12} is ambiguous as it depends on the productivity of capital, and Y_t is used only as a proxy for the capital productivity (which determines the shape of the investment-production possibility function). The error term is necessary to account for any excluded variables as well as measurement errors.

2. Unconstrained consumption

Desired level of consumption, under unconstrained borrowing conditions, was derived as a function of the two period incomes and interest rate (3.2). The decision making

[8]The variables used in the model are in current dollar terms. Converting them to real terms require use of different price indices: consumption and income needs to be deflated by consumer price index while exports and imports, by export and import price indices respectively. If so deflated, then the national income identity will not hold in real terms. This is in keeping with the Khan and Knight's model, where "*All nominal variables and prices are valued in units of foreign currency (dollars). Since the trade balance and balance of payments identities are in terms of foreign currency, there are no valuation effects on official foreign assets owing to exchange rate changes*". The relevance of using real vs nominal terms will be discussed separately for each of the functions used in the model.

process was characterized as sequential, with investment decision made independent of consumption, and then the consumption decision made dependent on investment.

Again, invoking the "random walk" hypothesis for income, the current income is the best estimate for the future income. The assumption of "random walk" in income needs to be clarified. Incomes in the two periods are defined as $Y_0 = \bar{Y}_0$ and $Y_1 = \bar{Y}_1 + F(I_0,Y_0)$, respectively. "Random walk" implies that the best estimate of the next period's income is the current period income. This "random walk" assumption is confined to the exogenous component only in this two-period scenario. That is, the expected income in the second period is the first period income plus the output dependent on the investment made in the first period.

$$E(Y_1) = E(\bar{Y}_1) + E[F(I_0,Y_0)]$$

But, from the "random walk" assumption,

$$E(\bar{Y}_1) = Y_0$$

such that,

$$E(Y_1) = Y_0 + E[F(I_0,Y_0)]$$

Observations are available only on Y_0 and Y_1, and not on $\overline{Y}_1$. Testing this "random walk" assumption will require information regarding either $\overline{Y}_1$ or $F(I_0,Y_0)$, neither of which can be obtained. It may be noted that, this formulation can be extended to the second period expectation for the third period income.

$$E(Y_2) = E(\overline{Y}_2) + E[F(I_1,Y_1)], \text{ and}$$
$$E(\overline{Y}_2) = Y_1, \text{ noting that } \; Y_1 = Y_0 + F(I_0,Y_0)$$

such that,

$$E(Y_2) = Y_1 + E[F(I_1,Y_1)]$$

The intuition for such "random walk" is that, the past resource endowments along with the past investments determine this periods income. In the absence of any investments in this period, the best guess for the next period income is the current period income itself. Therefore, any investments made in this period will add to the expectation of the next period income.

In conclusion, desired investment adds to the expected future income and thereby affects current desired consumption. Changes in interest rate affect consumption, by its deviation from the subjective discount rate, which is assumed to remain constant. Given these observations, the desired consumption could be defined in terms of the endogenous investment as well as the exogenous variables so as to appropriately take into account the expected future income changes due to current investments[9].

$$C_t^* = \eta_{20} + \eta_{21}Y_t + \eta_{22}I_t^* + \eta_{23}r_t + \varepsilon_{c,t} \tag{4.4}$$

This consumption function is also defined in nominal terms, and all the arguments and the dependent variable can be deflated using a single index. Thus, a priori signs of the marginal coefficients are unaffected. The marginal propensity to consume, η_{21} will be expected to be bound in the region $0 < \eta_{21} < 1$. The sign on η_{22} cannot be predetermined. An increase in investment, with Y_t and r_t unchanged can lead to higher or lower current consumption, depending on the

[9]This can be illustrated with simplified consumption and investment-production functions as follows. Assume a linear consumption function specified in terms of current income, expected future income and interest rate, and a linear investment function specified in terms of interest rate and current income.

$$
\begin{aligned}
& C^* = c_1 + c_2Y_0 + c_3E(Y_1) + c_4r \\
& F(I_0^*) = i_1 + i_2r + i_3Y_0 \\
\text{with,}\quad & Y_0 = \overline{Y}_0 \\
\text{and}\quad & E(Y_1) = Y_0 + F(I_0^*)
\end{aligned}
$$

By substitution, the resulting consumption function is,

$$C^* = (c_1+c_3i_1) + (c_2+c_3+c_3i_3)\overline{Y}_0 + c_3i_2I_0^* + c_4r$$

subjective rate of preference between C_t and I_t. An increase in interest rate will be expected to lower consumption implying a negative η_{23}.

C. Measuring Debt

In formulating the theoretical model, borrowing was viewed as the overspending in the first period in consumption and investment over and above that period's income. It was subsequently noted that this definition of borrowing was restricted to the real sector performance alone, and if so borrowing is equivalent to trade balance. The need for a different measure of debt was discussed (page 90) noting that actual borrowing may be used for financial exchanges in addition to exchanges of goods and services. Current Account Balance is the net of trade balance and direct transfers. Part of the trade balance may be "written off" as a gift thereby reducing the real obligation to be less than what the trade balance may indicate. Thus Current Account Balance measures the real obligations related to the exchange of goods and services. Hence this measure too does not address the possible financial transfers independent of the trade exchanges. The evidence of simultaneous borrowing and capital outflow is well documented (Dornbush, 1984; Cuddington, 1985;

Khan and Haque,1985), showing that while a developing country is accumulating debt obligations, there are several sources of leakage of these foreign funds out of the country thus depriving the country of domestically useable funds. Also, part of the overspending may in fact be met by drawing from domestic reserves without resorting to foreign borrowing thus accountable as overspending but involving no foreign debt.

Foreign exchange receipts come from either exports, counterpart adjustments and valuation changes[10] or through exceptional financing[11]. Part of such receipts are used for imports and any changes in reserves. The difference between the receipts and such usage (in imports and reserve accumulation) is the balance of financial transactions. This outflow of foreign exchange for purchase of non-monetary foreign assets consists of long-term and short-term investments as well as the residual classified as Errors and Omission. Given the identity that the total receipts are allocated within imports, reserve changes and capital outflow, it can be shown that the negative of Performance Balance is

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[10] Counterpart adjustments reflect changes in holdings of Special Drawing Rights, Reserves in IMF and gold holdings of central authorities, not including valuation changes due to change in price of gold (International Monetary Fund, 1988).

[11] Exceptional financing in Balance of Payments is defined as "... the deficit for which the central authorities have provided the financing, either by drawing on their reserves, by engaging in official borrowing, or by inducing other residents to borrow..." (International Monetary Fund, 1988).

the net foreign obligation, being the sum of the obligations arising from trade balance and non-trade balance[12]. Analogous to "trade deficit" being the negative of trade balance, this total obligation may be viewed as the "performance deficit", which will then be the sum of "trade deficit" and "non-trade deficit". Thus the negative of Performance Balance, which is the net of all excess foreign and reserve resources used within a period is selected to proxy the actual overspending in both real and financial resources in that period, defining borrowing as,

$$\bar{B} = NTD - TB \tag{4.5}$$

with the notations as used in footnote 12.

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[12]The computation of borrowing as the total foreign obligation is explained below. The concept is further clarified using the 1984 Balance of Payments Account of Brazil detailed in Appendix B.

Total receipts of foreign exchange comes from exports (X), counterpart adjustments and valuation changes (CPA&VC), exceptional financing (EF) and changes in reserves (R). Part of it is used for imports (M). Define the balance as the non-trade deficit (NTD), such that the following identity holds.

$$X + CPA\&VC + EF + R = M + NTD$$

Rearranging,

$$NTD + (M - X) = CPA\&VC + EF + R$$

That is, given that trade balance (TB) is (X - M) and hence trade deficit (TD) is (M - X),

$$NTD + TD = CPA\&VC + EF + R$$

or, $$NTD - TB = CPA\&VC + EF + R$$

The negative of this is precisely the definition for Performance Balance as per the BOP Accounts. Since this reflects the total of trade and non-trade deficit, it is used to proxy net borrowing.

While the choice of Performance Balance as an appropriate proxy to measure borrowing is discussed above, further empirical and accounting justifications along with a look at the actual cross-sectional and time-series data on this variable are presented in Chapter V. C. Debt and Debt Severity.

D. Re-examining the System Model

Since borrowing is now specified to be different from trade balance, a re-examination of the system of equations as specified in page 98 is in order.

(a) First, from the borrowing unconstrained model,

$$C^* = \alpha_{11} + \alpha_{12}\overline{Y} + \alpha_{13}I^* + \alpha_{14}r$$

$$I^* = \alpha_{21} + \alpha_{22}r + \alpha_{23}\overline{Y}$$

$$TD_n{}^* = C^* + I^* - \overline{Y} \quad ; \text{ national income identity}$$

where, $TD_n{}^*$ is the borrowing unconstrained trade deficit from the national income identity. Thus, given the two behavioral functions, the system is closed and trade deficit is endogenously determined.

From the trade sector,

$$M^* = \alpha_{31} + \alpha_{32}C^*$$
$$X^* = \alpha_{41} + \alpha_{42}M^* + \alpha_{43}\bar{Y}$$
$$TD_f^* = M^* - X^*$$

where, TD_f^* is the trade deficit from the foreign sector accounts. This system is also closed, and thus if the trade deficits from the two accounts are to be equalized, then either $\bar{Y}$ or r will have to be endogenized. Note that imports and exports are defined as optimal (by the superscripted asterisk) because they are determined by the optimal consumption level.

Instead, if the whole system is specified including the partial adjustment process as,

$$C^* = \alpha_{11} + \alpha_{12}\bar{Y} + \alpha_{13}I^* + \alpha_{14}r$$
$$I^* = \alpha_{21} + \alpha_{22}r + \alpha_{23}\bar{Y}$$
$$TD^* = C^* + I^* - \bar{Y}$$
$$C = C^* - \phi[TD^* - TD]$$
$$I = \bar{Y} - TD - C$$
$$M = \alpha_{31} + \alpha_{32}C$$
$$X = \alpha_{41} + \alpha_{42}M + \alpha_{43}\bar{Y}$$
$$TD = M - X$$

In the above system of eight equations and eight unknowns (C^*, I^*, TD^*, C, I, TD, M and X), TD and TD^* are endogenously determined and the national income and trade sector identities are simultaneously met without having to endogenize either income or interest rate.

Two observations need to be made with regard to TD in the above system. First, since TD is determined endogenously in the system, it cannot be used as a control variable to assess the consumption, investment and trade impacts of exogenous changes in TD. Next, in the consumption function, it is the difference between TD^* and TD rather than the levels of these that determine the adjustment in consumption.

Now, incorporating the non-trade deficit as per (4.5),

$$\bar{B} = NTD + TD$$

But from the national income identity of real sector,

$$TD = (C + I - Y - F)$$

where, Y stands for Gross National Product(GNF) and F, for Net-Factor Payments, noting that,

$$GNP = GDP - F$$

Therefore,

$$\overline{B} = (C + I - Y - F) + NTD \tag{4.6}$$

Now define an "optimal borrowing" B^* as,

$$B^* = (C^* + I^* - Y - F) + NTD \tag{4.7}$$

and replace the $(TD^* - TD)$ in the constrained consumption equation with $(B^* - \overline{B})$,

$$C = C^* - \phi[B^* - \overline{B}]$$

Note that $(B^* - \overline{B}) = (TD^* - TD) = (C^* + I^* - C - I)$ and it can be checked that,

$$C = C^* - \phi[C^* + I^* - C - I]$$

$$(C - C^*)(1-\phi) = \phi(I - I^*)$$

and thus, if $C = C^*$ then $I = I^*$. Similarly, then it can also be verified $M = M^*$ and $X = X^*$, consistent with the condition that if there was no constraint on borrowing, the optimal levels are obtained. The main advantage and the reason for formulating as above is that $\overline{B}$ is now exogenous and can be used as a control variable to assess the consumption, investment and trade impacts of changing the limits on borrowing.

E. Policy Responses to Debt Problems

When faced with debt servicing difficulties, the debtor nations may adopt general or selective policy interventions. These may take the form of generalized consumption reducing or investment augmenting policies. On the other hand, they may be more specific towards restricting imports for conservation of foreign exchange required to either service debt or to maintain essential imports at the cost of non-essential imports. A policy variable may thus be included in the behavioral functions to account for variability arising from the changes in policy environment. Such a variable must measure the debt severity, or analogously the policy intensity in effect at various time periods.

Annual net debt receipts per se is not a proper measure because the debt carrying capacity varies between countries as well as between periods within each country. This flow of debt, scaled by an appropriate variable (such as exports) to adjust for such variability, is typical of the type of indexes used to measure the seriousness of debt in the early literature, and in fact as a practical evaluation tool of credit worthiness by the major lending institutions in the seventies. Even such measures are, however, inappropriate to proxy the debt severity and thus the policy intensity. In the early seventies, the period when the countries were borrowing heavily, with low levels of output, such debt to export ratios would have been high while the debt service obligations and consequently debt severity were low: no external or internal adjustments would have been necessary.

Alternatively, therefore either the debt service obligation or actual debt repayments scaled similarly by an appropriate variable may be considered. However, these will not differentiate the countries that had prudently managed the borrowing through early investments and thereby avoided debt service difficulties from the countries which failed to do so. That is, say, of two countries with similar borrowing and consequently comparable debt service obligations, one may be able to successfully meet the obligations without much self-adjustments in its trade, while the other may need to restrict its spending severely. The concern in using the actual repayments is that, a country by merely postponing its repayments will be measured as having little problem, where as in fact the severity is only being intensified.

Finally, the cumulative debt outstanding, scaled properly, may appear to be a suitable measure. This cumulative debt outstanding has been increasing from relatively insignificant levels for most of the countries during the last two decades. If this is used to measure debt severity, the measure would be a continuously increasing function from the sixties, implying debt severity, albeit at a low level, in the early periods too. A "critical" level may be specified to overcome this difficulty, such that when the ratio is below this "tolerance" level, the index can be forced to be zero, to reflect no debt severity. Above this level, the index could increase appropriately with the relative debt level. However, in practice, construction of such an index will necessitate identifying an appropriate basis for setting the tolerance level, preferably, different for the different countries. It is difficult to justify, without facing much ambiguity, any valid basis for determining such "tolerance" levels.

"Import compression occurs when governments impose direct controls on imports through tariffs, quotas, and licensing schemes; engage in deflationary policies; or depreciate the currency for the purpose of servicing external debt or rebuilding foreign exchange reserves..."(Khan and Knight, 1988). Hemphill (1974) and Zaidi (1984) show evidence that many developing countries' capacity to import is constrained by the stock of real international reserves. To account for the role of quantitative restrictions in estimating import demand, many studies (for example, Dutta 1964, Islam 1961, Turnovsky 1968) have included measures such as the level of international reserves, of export receipts, and of overseas assets in the import equation (Khan, 1974).

With these considerations, change in reserves were used to proxy the policy intensity, and a policy variable, Z_t, constructed such that when reserves are increasing the policy variable takes the value of zero, but increases with falling reserves. The specification of Z_t, the policy variable is,

$$Z_t = \begin{cases} 0 & \text{for } R_t > 0, \text{ and} \\ 1-e^{-G_t} & \text{for } R \leq 0. \end{cases} \tag{4.8}$$

where, $$G_t = [R_t/X_t]^2 \tag{4.9}$$

and R_t stands for the annual change in international reserves. This specification makes the policy variable effective only when the reserves are falling. Also, this variable is bounded between zero and one, with smooth partials throughout (see Appendix C). Z_t increases with falling reserves, but is zero when reserves are increasing. The assumption is that when the reserves are declining government implements policies to reduce consumption. Reserves are scaled by exports to scale the magnitude of G_t. Apart from such belt tightening policies, it has been argued that under debt service problems governments undertake policies to boost exports. Thus, this policy variable Z_t is included in the investment function too. In the current model, the unconstrained optimal consumption and investment functions are re-specified with the inclusion of this policy variable. This formulation would then take into account the effects of declining reserves on consumption directly as well as via its impact on investments.

F. Specification of the Estimation Model

1. Consumption and investment functions

Let $\overline{B}_t$ be the observed or actual borrowing. When desired borrowing deviates from the actual borrowing, consumption adjusts by an adjustment coefficient, which itself is a function of the levels of consumption, investment and interest rate (4.1 and 4.2).

$$C_t = C_t^* - \phi_t(B_t^* - \overline{B}_t)$$

But, from (4.8),

$$\overline{B}^* = (C^* + I^* - Y - F) + NTD$$

Therefore, substituting for B_t^*,

$$\begin{aligned} C_t &= C_t^* - \phi_t[C_t^* + I_t^* + NTD_t - F_t - Y_t - \bar{B}_t] \\ &= (1-\phi_t)C_t^* - \phi_t I_t^* - \phi_t[NTD_t - F_t - Y_t - \bar{B}_t] \end{aligned}$$

Substituting B_t^* for $\bar{B}_t$ in the above, it can be verified that as actual borrowing approaches desired borrowing, the actual consumption and investment approaches desired levels. The following substitutions for C_t^* and I_t^* results in an estimatable consumption function, non-linear in its parameters due to the adjustment function.

$$\begin{aligned} C_t = (1-\phi_t)[\eta_{20} + \eta_{21}Y_t + \eta_{22}I_t^* + \eta_{23}r_t] - \phi_t I_t^* \\ - \phi_t[NTD_t - F_t - Y_t - \bar{B}_t] + (1-\phi_t)\varepsilon_{c,t} \end{aligned}$$

Substituting for I_t^*,

$$\begin{aligned} C_t = (1-\phi_t)[\eta_{20} + \eta_{21}Y_t + \eta_{23}r_t] \\ + \{(1-\phi_t)\eta_{22} - \phi_t\}\{\eta_{10} + \eta_{11}r_t + \eta_{12}Y_t\} \\ - \phi_t[NTD_t - F_t - Y_t - \bar{B}_t] \\ + (1-\phi_t)\varepsilon_{c,t} + \{(1-\phi_t)\eta_{22}-\phi_t\}\varepsilon_{i,t} \end{aligned}$$

The error terms are correlated to the right hand side variable ϕ_t. The consequences of this in selecting the arguments for ϕ_t in the estimation procedure is discussed in the Chapter V. D. Estimation Method. In the discussion in the rest of this section, the error term is excluded for simplicity.

Expanding the above,

$$\begin{aligned} C_t = {} & \eta_{20}(1-\phi_t) + \eta_{21}(1-\phi_t)Y_t + \eta_{23}(1-\phi_t)r_t \\ & + \eta_{10}\eta_{22}(1-\phi_t) - \eta_{10}\phi_t + \eta_{11}\eta_{22}(1-\phi_t)r_t \\ & - \eta_{11}\phi_t r_t + \eta_{12}\eta_{22}(1-\phi_t)Y_t - \eta_{12}\phi Y_t \\ & - \phi_t[NTD_t - F_t - Y_t - \bar{B}_t] \end{aligned}$$

Collecting the common terms,

$$\begin{aligned} C_t = {} & \eta_{20} + \eta_{10}\eta_{22} - (\eta_{20} + \eta_{10}\eta_{22} + \eta_{10})\phi_t \\ & + (\eta_{21} + \eta_{12}\eta_{22})Y_t - (\eta_{21} + \eta_{12}\eta_{22} + \eta_{12})\phi_t Y_t \\ & + (\eta_{23} + \eta_{11}\eta_{22})r_t - (\eta_{23} + \eta_{11}\eta_{22} + \eta_{11})\phi_t r_t \\ & - \phi_t[NTD_t - F_t - Y_t - \bar{B}_t] \end{aligned}$$

The model can thus be represented in a linear form, substituting for the composite parameters of the above as,

$$\begin{aligned} C_t = {} & \eta_0 - \eta_1\phi_t + \eta_2 Y_t - \eta_3\phi_t Y_t + \eta_4 r_t - \eta_5\phi_t r_t \\ & - \phi_t[NTD_t - F_t - Y_t - \bar{B}_t] \end{aligned}$$

There are seven unknown parameters (η_{10} to η_{12} and η_{20} to η_{23}) in the original form, but only six of their linear combinations (η_0 to η_5) can be estimated, provided the form of ϕ_t is known. The adjustment factor, as discussed earlier (4.2), is specified as,

$$\phi_t = \pi_0 + \pi_1 A_t$$

Substituting,

$$\begin{aligned} C_t = {} & \eta_0 - \eta_1\pi_0 - \eta_1\pi_1 A_t + \eta_2 Y_t - \eta_3\pi_0 Y_t - \eta_3\pi_1 A_t Y_t \\ & + \eta_4 r_t - \eta_5\pi_0 r_t - \eta_5\pi_1 A_t r_t + \pi_0 Y_t + \pi_1 A_t Y_t \\ & - \pi_0[NTD_t - F_t - \overline{B}_t] - \pi_1 A_t[NTD_t - F_t - \overline{B}_t] \end{aligned}$$

$$\begin{aligned} C_t = {} & (\eta_0 - \eta_1\pi_0) - \eta_1\pi_1 A_t + (\eta_2 - \eta_3\pi_0 + \pi_0) Y_t \\ & - (\eta_3\pi_1 - \pi_1) A_t Y_t + (\eta_4 - \eta_5\pi_0) r_t - \eta_5\pi_1 A_t r_t \\ & - \pi_0[NTD_t - F_t - \overline{B}_t] \\ & - \pi_1 A_t[NTD_t - F_t - \overline{B}_t] \end{aligned}$$

Again, substituting for the composite parameters, the estimation model can be written in a linear form as,

$$\begin{aligned} C_t = {} & \alpha_{10} - \alpha_{11} A_t + \alpha_{12} Y_t - \alpha_{13} A_t Y_t + \alpha_{14} r_t - \alpha_{15} A_t r_t \\ & - \pi_0[NTD_t - F_t - \overline{B}_t] \\ & - \pi_1 A_t[NTD_t - F_t - \overline{B}_t] \end{aligned} \qquad (4.10)$$

from which π_0 and π_1, the parameters of the adjustment factor can be estimated. The other parameters estimated can be decomposed into their original structural parameters as follows.

$$\alpha_{10} = \eta_0 - \eta_1\pi_0 = \eta_{20} + \eta_{10}\eta_{22} - \pi_0(\eta_{20} + \eta_{10}\eta_{22} + \eta_{10})$$
$$\alpha_{11} = \eta_1\pi_1 = (\eta_{20} + \eta_{10}\eta_{22} + \eta_{10})\pi_1$$
$$\alpha_{12} = \eta_2 - \eta_3\pi_0 + \pi_0 = \eta_{21} + \eta_{12}\eta_{22} - (\eta_{21}+\eta_{12}\eta_{22}+\eta_{12})\pi_0 + \pi_0$$
$$\alpha_{13} = \eta_3\pi_1 - \pi_1 = (\eta_{21} + \eta_{12}\eta_{22} + \eta_{12})\pi_1 - \pi_1$$
$$\alpha_{14} = \eta_4 - \eta_5\pi_0 = \eta_{23} + \eta_{11}\eta_{22} - (\eta_{23} + \eta_{11}\eta_{22} + \eta_{11})\pi_0$$
$$\alpha_{15} = \eta_5\pi_1 = (\eta_{23} + \eta_{11}\eta_{22} + \eta_{11})\pi_1$$

Only the structural parameters, π_0 and π_1 are estimated directly. From the structural equations, C^* and I^*, the expected signs of the original parameters, as discussed earlier under each of these functions, are,

$$\eta_{21} > 0$$
$$\eta_{11}, \eta_{23} < 0$$

Since, a priori signs cannot be assigned to π_0 and π_1, none of the α variables can be pre-assigned any definitive signs.

An interesting feature of this estimation function is that all the parameters of the original (optimal) investment function can be computed even though there are no observations on I^*_t. The computations are shown below.

$$(\alpha_{15}/\pi_1) = (\eta_{23} + \eta_{11}\eta_{22} + \eta_{11})$$

$$\alpha_{14} = (\eta_{23} + \eta_{11}\eta_{22}) - \pi_0(\alpha_{15}/\pi_1)$$

$$\alpha_{14} + \pi_0(\alpha_{15}/\pi_1) = (\eta_{23} + \eta_{11}\eta_{22})$$

But,

$$\eta_{11} = (\eta_{23}+\eta_{11}\eta_{22}+\eta_{11}) - (\eta_{23}+\eta_{11}\eta_{22})$$

$$= (\alpha_{15}/\pi_1) - [\alpha_{14} + \pi_0(\alpha_{15}/\pi_1)]$$

Similarly, the parameters η_{10} and η_{12} can be computed as,

$$\eta_{12} = \pi_0 - \alpha_{12} + (1-\pi_0)[(\alpha_{13}+\pi_1)/\pi_1]$$

$$\eta_{10} = (\alpha_{11}/\pi_1) - [\alpha_{10} + (\pi_0/\pi_1)\alpha_{11}]$$

Such decomposition of the parameters of the consumption function is not possible because of linear dependence among them (four parameters and only three independent equations).

Note that actual investment will enter the system specified as the residual from the national income identity,

$$I_t = Y_t - (X_t - M_t) - C_t + F_t$$

Next, incorporating the policy variable, Z_t, discussed in pages 122 to 126, into the unconstrained consumption and investment functions,

$$C_t^* = \eta_{20} + \eta_{21}Y_t + \eta_{22}I_t^* + \eta_{23}r_t + \eta_{24}Z_t$$
$$I_t^* = \eta_{10} + \eta_{11}r_t + \eta_{12}Y_t + \eta_{13}Z_t$$

If in fact effective government policies are implemented during debt service problems, and the change in reserves is an appropriate indicator of debt severity, then an increase in Z_t (i.e., a decrease in reserves) will be expected to decrease consumption. Then the a priori expectation of η_{24} is negative. Similarly, if the policies induce investments, then the sign of η_{13} will be positive. However, if on the face of falling reserves investments are curtailed by policy initiatives, in a bid, say, to meet basic consumption or repayment obligations, then η_{13} will be negative instead. Resulting consumption function is,

$$\begin{aligned} C_t = {} & (1-\phi_t)[\eta_{20} + \eta_{21}Y_t + \eta_{23}r_t + \eta_{24}Z_t] \\ & + \{(1-\phi_t)\eta_{22} - \phi_t\}\{\eta_{10} + \eta_{11}r_t + \eta_{12}Y_t + \eta_{13}Z_t\} \\ & - \phi_t[NTD_t - F_t - Y_t - \overline{B}_t] \end{aligned}$$

Expanding, and collecting terms as earlier,

$$
\begin{aligned}
C_t = \; & \eta_{20} + \eta_{10}\eta_{22} - (\eta_{20} + \eta_{10}\eta_{22} + \eta_{10})\phi_t \\
& + (\eta_{21} + \eta_{12}\eta_{22})Y_t - (\eta_{21} + \eta_{12}\eta_{22} + \eta_{12})\phi_t Y_t \\
& + (\eta_{23} + \eta_{11}\eta_{22})r_t - (\eta_{23} + \eta_{11}\eta_{22} + \eta_{11})\phi_t r_t \\
& + (\eta_{24} + \eta_{13}\eta_{22})Z_t - (\eta_{24} + \eta_{13}\eta_{22} + \eta_{13})\phi_t Z_t \\
& - \phi_t[NTD_t - F_t - Y_t - \overline{B}_t]
\end{aligned}
$$

Replacing the composite parameters,

$$
\begin{aligned}
C_t = \; & \eta_0 - \eta_1\phi_t + \eta_2 Y_t - \eta_3\phi_t Y_t + \eta_4 r_t - \eta_5\phi_t r_t \\
& + \eta_6 Z_t - \eta_7\phi_t Z_t - \phi_t[NTD_t - F_t - Y_t - \overline{B}_t]
\end{aligned}
$$

Substituting for the adjustment factor, the above consumption function is rewritten as an estimatable linear form.

$$
\begin{aligned}
C_t = \; & \alpha_{10} - \alpha_{11}A_t + \alpha_{12}Y_t - \alpha_{13}A_t Y_t + \alpha_{14}r_t - \alpha_{15}A_t r_t \\
& + \alpha_{16}Z_t - \alpha_{17}A_t Z_t - \pi_0[NTD_t - F_t - \overline{B}_t] \\
& - \pi_1 A_t[NTD_t - F_t - \overline{B}_t] + \varepsilon_{1,t} \qquad (4.10a)
\end{aligned}
$$

The additional parameters α_{16} and α_{17} can be decomposed as follows.

$$
\alpha_{16} = \eta_6 - \eta_7\pi_0 = \eta_{24} + \eta_{13}\eta_{22} - (\eta_{24} + \eta_{13}\eta_{22} + \eta_{13})\pi_0
$$

$$\alpha_{17} = \eta_7\pi_1 = (\eta_{24} + \eta_{13}\eta_{22} + \eta_{13})\pi_1$$

With decreasing reserves, the policy variable increases. The signs of η_{24} and η_{13} are policy dependent, and cannot be predetermined. Given that the signs of π_0 and π_1 are also indeterminate, the signs of α_{16} and α_{17} cannot be predetermined. However, the structural parameter, η_{13} can be computed similar to the other parameters of the investment function.

$$\eta_{13} = (\alpha_{17}/\pi_1) - [\alpha_{16} + (\pi_0/\pi_1)\alpha_{17}]$$

2. Export supply

The export supply function is derived with the two components introduced by Khan and Knight, with modifications as suggested in the previous chapter.

$$\log X_t^s = \log\eta_{31} + \kappa\log M_{x,t} + (1-\kappa)\log V_{x,t}$$

Share of imported inputs in the total import increases or decreases dependent on the policies effected as reserves fall. If the policies are export promoting, then the input share is likely to increase, while if the policies favor essential imports the opposite will be expected.

Since the change in reserves can be negative, the function needs to be specified ensuring that no log transformation of such negative values are required. Thus,

$$\log(M_{x,t} / M_t) = \eta_{32} + \eta_{33}R_t$$
$$\log M_{x,t} = \eta_{32} + \eta_{33}R_t + \log M_t$$

Both $M_{x,t}$ and M_t can be deflated by the import price index, while R_t may need to be deflated by either a general price index or a composite of the export and import price indices. Clearly, the share of $(M_{x,t} / M_t)$ is not affected whether it is in real or nominal terms. The a priori sign of η_{33} is also independent of whether R_t is used in nominal or real terms, being dependent on the policy orientation. Because, use in nominal terms allows direct use in the balance of payments identity, this function is also specified in nominal terms.

Value added component in exports, in addition to being a function of relative export price, is defined such that the net of consumption and investment affecting policies contribute to changes in export share. Hence the domestically value added component of Khan and Knight's model is re-specified to allow for relative change in exports in total income due to changes in policies when reserves are falling. Since, Z_t is defined to fall within the zero-one range, log transformation of this is avoided by specifying the share of value added component as,

$$\log(Vx/Y) = \log\eta_{34} + \eta_{35}Z_t + \eta_{36}\log(P_x/P_d)_t$$

Here too, the use of nominal values for the variables can be justified as in the case of import share above. The dependent variable is a ratio that is not affected by deflation. Z_t is dependent on R_t and thus the same argument holds as in the case of import share equation. If indeed debt severity leads to export promotion policies, η_{35} will be positive, while inward policies will be reflected by a negative sign. The expected sign of η_{36} in this supply function is positive.

Consequently,

$$\log Vx_t = \log\eta_{34} + \eta_{35}Z_t + \eta_{36}\log(P_x/P_d)_t + \log Y_t$$

Substituting these,

$$\log X_t{}^s = \log\eta_{31} + \kappa[\log\eta_{32} + \eta_{33}R_t + \log M_t] + (1-\kappa)[\log\eta_{34} + \eta_{35}Z_t + \eta_{36}\log(P_x/P_d)_t + \log Y_t]$$

$$\log X_t{}^s = [\log\eta_{31} + \kappa\log\eta_{32} + (1-\kappa)\log\eta_{34}] + \kappa\eta_{33}R_t + \kappa\log M_t + (1-\kappa)\eta_{35}Z_t + (1-\kappa)\eta_{36}\log(P_x/P_d)_t + (1-\kappa)\log Y_t$$

Partial adjustment is incorporated as in Khan and Knight's model with a partial adjustment coefficient of γ_{xs}.

$$\Delta \log X_t = \gamma_{xs}[\log X_t^{s} - \log X_{t-1}]$$

$$\begin{aligned}\log X_t = {} & \gamma_{xs}\{[\log\eta_{31} + \kappa\log\eta_{32} + (1-\kappa)\log\eta_{34}] \\ & + \kappa\eta_{33}R_t + \kappa\log M_t + (1-\kappa)\eta_{35}Z_t \\ & + (1-\kappa)\eta_{36}\log(P_x/P_d)_t + (1-\kappa)\log Y_t\} \\ & + (1-\gamma_{xs})\log X_{t-1}\end{aligned}$$

$$\begin{aligned}\log X_t = {} & [\gamma_{xs}\log\eta_{31} + \gamma_{xs}\kappa\log\eta_{32} + \gamma_{xs}(1-\kappa)\log\eta_{34}] \\ & + \gamma_{xs}\kappa\eta_{33}R_t + \gamma_{xs}\kappa\log M_t \\ & + \gamma_{xs}(1-\kappa)\eta_{35}Z_t + \gamma_{xs}(1-\kappa)\eta_{36}\log(P_x/P_d)_t \\ & + \gamma_{xs}(1-\kappa)\log Y_t + (1-\gamma_x)\log X_{t-1}\end{aligned}$$

Noting the linear dependence between the three coefficients of $\log M_t$, $\log Y_t$ and $\log X_{t-1}$, the model is constrained as,

$$\begin{aligned}\log X_t = {} & [\gamma_{xs}\log\eta_{31} + \gamma_{xs}\kappa\log\eta_{32} + \gamma_{xs}(1-\kappa)\log\eta_{34}] \\ & + \gamma_{xs}\kappa\eta_{33}R_t + \gamma_{xs}(1-\kappa)\eta_{35}Z_t \\ & + \gamma_{xs}(1-\kappa)\eta_{36}\log(P_x/P_d)_t \\ & + \gamma_{xs}\kappa(\log M_t - \log Y_t) + \gamma_{xs}(\log Y_t - \log X_{t-1}) \\ & + \log X_{t-1}\end{aligned}$$

This function will be represented by the following equation in the model.

$$\begin{aligned} \log X_t = \; & \alpha_{20} + \alpha_{21}R_t + \alpha_{22}Z_t \\ & + \alpha_{23}\log(P_x/P_d)_t + \alpha_{24}(\log M_t - \log Y_t) \\ & + \alpha_{25}(\log Y_t - \log X_{t-1}) + \log X_{t-1} + \varepsilon_{2,t} \end{aligned} \quad (4.11)$$

Evaluating the a priori expectations of these parameters,

$\alpha_{20} = \gamma_{xs}\log\eta_{31} + \gamma_{xs}\kappa\log\eta_{32} + \gamma_{xs}(1-\kappa)\log\eta_{34}$

$\alpha_{21} = \gamma_{xs}\kappa\eta_{33}$

$\alpha_{22} = \gamma_{xs}(1-\kappa)\eta_{35}$

$\alpha_{23} = \gamma_{xs}(1-\kappa)\eta_{36}$

$\alpha_{24} = \gamma_{xs}\kappa$

$\alpha_{25} = \gamma_{xs}$

$0 < \alpha_{25} < 1$, because $0 < \gamma_{xs} < 1$

$0 < \alpha_{24} < 1$, because $0 < \gamma_{xs}, \kappa < 1$

$\alpha_{23} > 0$, because $0 < \gamma_{xs}, \kappa < 1$ and $\eta_{36} > 0$

α_{22}, ambiguous, because η_{35} is policy dependent

α_{21}, ambiguous, because η_{33} is policy dependent

Note that, only six parameters are estimated in the above form, while the there are eight structural parameters of the model and all but η_{31}, η_{32} and η_{34} can be uniquely determined.

3. Export demand

Export demand is defined, as in Khan and Knight's model, as function of the relative price of exports to world price level and of the world output level. However, the world price of the small country exports are unlikely to be sticky to any significant degree. As such partial adjustment of export price used in K&K's model is not used. Instead, partial adjustment of total value of exports by a coefficient of γ_{xd} is assumed. The demand function is specified as,

$$\log X_t^d = \log\eta_{40} + \eta_{41}\log(P_x/P_w)_t + \eta_{42}\log Y_{w,t}$$

$$\Delta\log X_t = \gamma_{xd}[\log X_t^d - \log X_{t-1}]$$

$$\log X_t = \gamma_{xd}\log\eta_{40} + \gamma_{xd}\eta_{41}\log(P_{x,t}/P_{w,t}) + \gamma_{xd}\eta_{42}\log Y_{w,t} + (1-\gamma_{xd})\log X_{t-1}$$

Unlike in the earlier functions, the use of nominal vs real variables here has implications with respect to the a priori signs of the coefficients. If export demand is defined in real terms, the coefficient of the real price will be expected to be negative. However, when specified as above, in nominal terms, the coefficient η_{41} is ambiguous[13]. Specifying

[13] An increase in price increases the value of exports, while reducing the quantity exported. Thus, the total value (continued...)

the function in real terms will complicate the final representation of this particular function as well as the National Income and Balance of Payments identities. Thus, the nominal term representation will be retained and the coefficient η_{41} will be appropriately interpreted. η_{42} will be expected to be positive as export demand is likely to rise with world income.

The function is rearranged with $P_{x,t}$ on the left hand side.

$$\log P_{x,t} = -(\log\eta_{40}/\eta_{41}) + (1/\gamma_{xd}\eta_{41})\log X_t + \log P_{w,t} - (\eta_{42}/\eta_{41})\log Y_{wt} - [(1-\gamma_{xd})/(\gamma_{xd}\eta_{41})]\log X_{t-1}$$

---

[13](...continued) of exports will increase or decrease dependent on the price elasticity of export demand. To show this, say, q, x, p, y and k denote quantity demanded, value of exports, price, income and general price level respectively. Then, by definition,

$$q = [x/p]$$

The demand function in real terms is,

$$[x/p] = \alpha + \beta[p/k] + \gamma y/k,$$

where the expected signs are $\beta < 0$, and $\gamma > 0$.

Therefore, $$x = \alpha p + \beta[p/k]p + \gamma yp/k.$$

Keeping k unchanged,

$$(\partial x/\partial p) = \alpha + 2\beta(p/k) + \gamma y/k = q + \beta(p/k).$$

Therefore, given, $\beta < 0$, and $q,p,k > 0$, the sign of $(\partial x/\partial p)$ is indeterminate.

Imposing the linear dependence between the parameters of X_t and X_{t-1},

$$\log P_{x,t} = -(\log\eta_{40}/\eta_{41}) + \log P_{wt} - (\eta_{42}/\eta_{41})\log Y_{wt} + [1/(\gamma_{xd}\eta_{41})](\log X_t - \log X_{t-1}) + (1/\eta_{41})\log X_{t-1}$$

Therefore, the export demand function enters the estimation model specified as follows.

$$\log P_{x,t} = \alpha_{30} + \log P_{w,t} - \alpha_{31}\log Y_{w,t} + \alpha_{32}(\log X_t - \log X_{t-1}) + \alpha_{33}\log X_{t-1} + \varepsilon_{3,t} \qquad (4.12)$$

The a priori signs of none of the estimated parameters can be pre-determined because of their dependence on the η_{41} parameter as shown below.

$$\alpha_{30} = -\log\eta_{40}/\eta_{41}$$
$$\alpha_{31} = \eta_{42}/\eta_{41}$$
$$\alpha_{32} = 1/(\gamma_{xd}\eta_{41})$$
$$\alpha_{33} = 1/\eta_{41}$$

There are four unknown parameters (γ_{xd}, and η_{40}-η_{42}) and four parameter estimates of their linear combinations. Thus the export demand function is fully identified.

4. Import demand

Import demand will depend on the price of imports and level of consumption, instead of on income directly. Thus changes in reserves impacts import demand via its impact on consumption. Import demand is specified with an adjustment coefficient of γ_{md}. Therefore,

$$\log M_t{}^d = \log\eta_{50} + \eta_{51}\log(P_m/P_d)_t + \eta_{52}\log C_t$$

$$\Delta\log M_t = \gamma_{md}[\log M_t{}^d - \log M_{t-1}]$$

$$\log M_t = \gamma_{md}\log\eta_{50} + \gamma_{md}\eta_{51}\log(P_m/P_d)_t + \gamma_{md}\eta_{52}\log C_t + (1-\gamma_{md})\log M_{t-1}$$

The use of nominal variables has the same implications as in the case of the export demand function. Thus the nominal form will be retained and the coefficient η_{51} with an indeterminate sign will be appropriately interpreted.

The functional representation of the demand function is,

$$\log M_t = \alpha_{40} + \alpha_{41}\log(P_m/P_d)_t + \alpha_{42}\log C_t + \alpha_{43}\log M_{t-1} + \varepsilon_{4,t} \quad (4.13)$$

where, the expected signs can be evaluated from,

$\alpha_{40} \;=\; \gamma_{md}\log\eta_{50}$

$\alpha_{41} \;=\; \gamma_{md}\eta_{51}$ indeterminate

$\alpha_{42} \;=\; \gamma_{md}\eta_{52}$ > 0

$\alpha_{43} \;=\; (1-\gamma_{md})$ > 0

The import demand function with four unknown parameters is also fully identified.

Finally, the model will be closed by the two identities, the national income identity and an identity of performance deficit as the sum of trade and non-trade deficit.

$$I_t = Y_t - C_t - (X_t - M_t) \tag{4.14}$$

$$NTD_t = \bar{B} - (M_t - X_t) \tag{4.15}$$

The estimation model is therefore a simultaneous system of the following equations and identities.

1. $$C_t = \alpha_{10} - \alpha_{11}A_t + \alpha_{12}Y_t - \alpha_{13}A_tY_t + \alpha_{14}r_t - \alpha_{15}A_tr_t + \alpha_{16}Z_t - \alpha_{17}A_tZ_t - \pi_0[NTD_t - F_t - Y_t - \bar{B}_t] - \pi_1A_t[NTD_t - F_t - Y_t - \bar{B}_t] + \varepsilon_{1,t}$$

$$2.\ \log X_t = \alpha_{20} + \alpha_{21}R_t + \alpha_{22}Z_t + \alpha_{23}\log(P_x/P_d)_t + \alpha_{24}(\log M_t - \log Y_t) + \alpha_{25}(\log Y_t - \log X_{t-1}) + \log X_{t-1} + \varepsilon_{2,t}$$

$$3.\ \log X_t = \alpha_{30} + \log P_{w,t} - \alpha_{31}\log Y_{w,t} + \alpha_{32}(\log X_t - \log X_{t-1}) + \alpha_{33}X_{t-1} + \varepsilon_{3,t}$$

$$4.\ \log M_t = \alpha_{40} + \alpha_{41}\log(P_m/P_d)_t + \alpha_{42}\log C_t + \alpha_{43}\log M_{t-1} + \varepsilon_{4,t}$$

$$5.\ I_t = Y_t - C_t + (X_t - M_t)$$

$$6.\ NTD_t = \overline{B} - (M_t - X_t)$$

Also, predefined in the system is,

$$Z_t = \begin{cases} 0 & \text{for } R_t > 0, \text{ and} \\ 1-e^{-G_t} & \text{for } R \leq 0. \end{cases}$$

where $G_t = (R_t/X_t)^2$

The adjustment coefficient ϕ_t is defined as,

$$\phi_t = \pi_0 + \pi_1 A_t$$

where A_t is a proxy for the levels of C_t, I_t and r_t. The form of A_t is discussed in Chapter V. B. Model Estimation.

Exogenous variables are, Y_t, Y_w, $\bar{B}_t$, P_m, P_d, P_w, R_t, Z_t and r.

Endogenous variables are, C_t, I_t, X_t, M_t, NTD_t and P_x.

The estimatable parameters, their decomposition in terms of the structural parameters and the a priori expectations are summarized in Table 9. The structural parameters which are uniquely determined, along with their computations and a priori expectations are identified in Table 10.

Table 9. Estimatable parameters

Estimation parameter	Variable	Structural composition	a priori sign or bounds[a]
Consumption: C			
α_{10}	Int[b].	$\eta_{20}+\eta_{10}\eta_{22}-\pi_0(\eta_{20}+\eta_{10}\eta_{22}+\eta_{10})$	
α_{11}	-A	$(\eta_{20}+\eta_{10}\eta_{22}+\eta_{10})\pi_1$	
α_{12}	Y	$\eta_{21}+\eta_{12}\eta_{22}-(\eta_{21}+\eta_{12}\eta_{22}+\eta_{12})\pi_0+\pi_0$	
α_{13}	-A.Y	$(\eta_{21}+\eta_{12}\eta_{22}+\eta_{12})\pi_1-\pi_1$	
α_{14}	r	$\eta_{23}+\eta_{11}\eta_{22}-(\eta_{23}+\eta_{11}\eta_{22}+\eta_{11})\pi_0$	
α_{15}	-A.r	$(\eta_{23}+\eta_{11}\eta_{22}+\eta_{11})\pi_1$	
α_{16}	Z	$\eta_{24}+\eta_{13}\eta_{22}-(\eta_{24}+\eta_{13}\eta_{22}+\eta_{13})\pi_0$	
α_{17}	-A.Z	$(\eta_{24}+\eta_{13}\eta_{22}+\eta_{13})\pi_1$	
π_0	-[.][c]	π_0	
π_1	-A.[.]	π_1	
Export supply: X			
α_{20}	Int.	$\gamma_{xs}\log\eta_{31}+\gamma_{xs}\kappa\log\eta_{32}+\gamma_{xs}(1-\kappa)\log\eta_{34}$	
α_{21}	R	$\gamma_{xs}\kappa\eta_{33}$	?
α_{22}	Z	$\gamma_{xs}(1-\kappa)\eta_{35}$	?
α_{23}	(Px/Pd)'[d]	$\gamma_{xs}(1-\kappa)\eta_{36}$	> 0
α_{24}	M'-Y'	$\gamma_{xs}\kappa$	$0 < \alpha_{24} < 1$
α_{25}	Y'-X_{-1}'	γ_{xs}	$0 < \alpha_{25} < 1$
1	X_{-1}'	1	
Export demand: log(Px)			
α_{30}	Int.	$-\log\eta_{40}/\eta_{41}$	
1	Pw	1	
α_{31}	-Yw'	η_{42}/η_{41}	
α_{32}	X'-X_{-1}'	$1/(\gamma_{xd}\eta_{41})$	
α_{33}	X_{-1}'	$1/\eta_{41}$	
Import demand: log(M)			
α_{40}	Int.	$\gamma_{md}\log\eta_{50}$	
α_{41}	(Pm/Pd)'	$\gamma_{md}\eta_{51}$	
α_{42}	C'	$\gamma_{md}\eta_{52}$	> 0
α_{43}	M_{-1}'	$(1-\gamma_{md})$	> 0

[a]Blank represents indeterminate form, and "?" denotes policy dependent. [b]Intercept. [c][.] = [NTD-F-$\bar{B}$]. [d]Prime indicates use in log terms.

Table 10. Structural parameters

Structural parameter	Variable	Computation (when uniquely identified)	a priori sign or bounds[a]
Investment:	I^*		
η_{10}	Int[b].	$(\alpha_{11}/\pi_1)-[\alpha_{10}+(\pi_0/\pi_1)\alpha_{11}]$	
η_{11}	r	$(\alpha_{15}/\pi_1)-[\alpha_{14}+\pi_0(\alpha_{15}/\pi_1)]$	< 0
η_{12}	Y	$\pi_0 - \alpha_{12} + (1-\pi_0)[(\alpha_{13} + \pi_1)/\pi_1]$	?
η_{13}	Z	$(\alpha_{17}/\pi_1)-[\alpha_{16}+(\pi_0/\pi_1)\alpha_{17}]$	?
Consumption:	C^*		
η_{20}	Int.		
η_{21}	Y		$1 < \eta_{21} < 1$
η_{22}	I^*		
η_{23}	r		< 0
η_{24}	Z		?
Adjustment:	ϕ		
π_0	Int.	π_0	
π_1	A	π_1	
Export supply:	log(X)		
η_{31}	Int.		
κ	Mx'	α_{24}/α_{25}	$0 < \kappa < 1$
Imported inputs:	log(Mx/M)		
η_{32}	Int.		
η_{33}	R	α_{21}/α_{24}	?
Domestic value added:	log(Vx/Y)		
η_{34}	Int.		
η_{35}	Z	$(\alpha_{23}/\alpha_{25})\{1-(\alpha_{24}/\alpha_{25})\}$	?
η_{36}	(Px/Pd)'[c]	$(\alpha_{22}/\alpha_{25})\{1-(\alpha_{24}/\alpha_{25})\}$	> 1
Export supply adjustment:	log(X)		
γ_{xs}	$X'-X_{-1}'$	α_{25}	$0 < \gamma_{xs} < 1$
Export demand:	log(X)		
η_{40}	Int.	$\exp(-\alpha_{30}/\alpha_{33})$	
η_{41}	(Px/Pw)'	$1/\alpha_{33}$	
η_{42}	Yw'	α_{31}/α_{32}	> 0
Export demand adjustment:	Δlog(X)		
γ_{xd}	$X'-X_{-1}'$	α_{33}/α_{32}	$0 < \gamma_{xd} < 1$
Import demand:	log(M)		
η_{50}	Int.	$\exp[\alpha_{40}/(1-\alpha_{43})]$	
η_{51}	(Pm/Pd)'	$\alpha_{41}/(1-\alpha_{43})$	
η_{52}	C'	$\alpha_{42}/(1-\alpha_{43})$	> 0
Import demand adjustment:	Δlog(M)		
γ_{md}	$M'-M_{-1}'$	$1-\alpha_{43}$	$0 < \gamma_{md} < 1$

[a]Blank represents indeterminate form, and "?" denotes policy dependent. [b]Intercept. [c]Prime indicates use in log terms.

V. DATA AND ESTIMATION METHODS

A. Data

1. Country selection and data source

The World Debt Tables (WDT) provide detailed debt related data of 109 countries who are members of the Debt Reporting System (DRS) of the World Bank (1987). Twelve of the countries are categorized as Major Borrowers (MB), defined as those with disbursed and outstanding long-term debt at more than US $ 17 billion at the end of 1985. A total of seventeen countries, including five of the above are classified as Highly Indebted (HI) countries, dependent on the loan to asset ratio at the same period. These HI countries accounted for nearly half of all developing countries' debt in 1986-87 period. Thus, a total of twenty four countries (see Appendix A) are identified as either having substantial debt, or a potential debt service problem or both. These countries can be considered representative of the continents of the third world, namely, South America, Asia and Africa. The five countries identified as both Major Debtors and Highly Indebted are Argentina, Brazil, Chile, Mexico and Venezuela. For the purposes of the analysis in this study, all these twenty four countries were initially selected on the basis of their debt status. Their geographical distribution makes the selection opportune for representative regional analysis.

Proposals for debt resolution have often taken the stand that any policies or concessions should be on a country-to-country basis, as the problem faced by each country is unique. Of recent however, there have been opposing thoughts because the underlying problem in most, if not all, cases is the eroded confidence of the lenders. Individualized concessions may not be adequate to set the market forces of the financial sector in motion and to revitalize the eroded confidence. Thus regional or even perhaps global policies may need to complement country specific resolutions. Selection of the above specified countries allows analysis on a regional basis as well as on the basis of established debt categories (MB, HI and MB&HI) of the World Bank, enabling identification of any common features in their debt structure and economic performance. In this study, focus will be on the basis of debt groups and on individual country performance. Regional analysis will not be attempted.

While the World Debt Tables may be the most comprehensive on the stocks and flows of both public and private debt, these are compiled from debt as reported periodically by the member nations, on a preset format. It is not clear if there is adequate provision to reconcile the debt as reported here with the foreign resource flows in the Balance of Payments accounting. Analysis in this study requires data on foreign resource receipts and disappearance, that needs to be reconciled with the National Income Accounts as well as the Balance of Payments Accounts. The International Financial Statistics (IFS) of the International Monetary Fund (IMF) provide detailed data on the components of both National Income and Balance of Payments Accounts. The country-wise data used in this analysis is thus obtained from the IMF data tapes, and covers up to the year 1988. Annual data are used for the period 1970 to 1987, covering the periods of substantial capital flow as well as the period since the onset of the debt crisis in the early eighties. Data prior to 1970 are scanty, especially for the Latin American countries who have experienced extremely high rates of inflation and exchange rate changes in the eighties. While the Balance of Payments Accounts were generally complete for all the countries, National Income data for Bolivia, Israel, Ivory Coast and Yugoslavia were deficient for use in the model and these countries were thus dropped from this study. Due to the rapid rates of inflation in Argentina and Chile during the eighties, relatively very insignificant or zero exchange rates are reported for the early seventies which make the conversion between domestic currency values of the National Accounts and the US dollar values of the Balance of Payments Accounts impossible. Therefore, although these countries were used in the early stages of investigation, with respect to general performance of national economy, trade and foreign resource use, they were excluded in model estimation.

In addition to country specific data, the model also requires global data, specifically, data on world output and price levels. Further, some of the price data, namely, import and export price indexes were not available for each country in the IFS data. In such cases, regional price data and world price and growth data were obtained from the publication of Wharton Economic Forecasting Associates (WEFA, 1988). The countries selected fell into one of the four regions, namely, Africa, Asia and Middle east, Latin America and Pacific Basin as per the regional classification in WEFA.

2. Reconciling national accounts

National Income Accounts provide consumption, investment, import, export, net factor payments, gross domestic product and gross national product figures in domestic currency. In general there was a discrepancy varying from five to ten percent between the sum of the components of GNP and the reported GNP. The model requires national income identity to hold. The computed discrepancy was added to the net factor payments to obtain this identity. It may also be noted that the investment used includes the change in stock at the end of period. Data of foreign fund flows and use of reserves comes from the Balance of Payments Accounts. Balance of Payments are reported in million US dollars for all the countries and the account fully reconciled internally in all cases. However, the two components common to the National Accounts and Balance of Payments Accounts, namely export and import figures did not tally for reconciliation between the two accounts. The reported exchange rate was the annual average for both imports and exports. The export figures in the Balance of Payments Accounts are sums of the quarterly export figures in domestic currency converted at the exchange rate of that quarter. Import figures, on the other hand, has been computed on an annual basis. Thus the effective exchange rate obtained as a ratio of exports in domestic currency to exports in US dollars differed from that of the corresponding import figures. It was necessary to reconcile the export and import figures of both accounts, and at the same time retain the identities of the National Income as well as the Balance of Payments Accounts. Thus, an average exchange rate was computed as the average of the import and export exchange rates, and all the national income figures including imports and exports were converted to US dollar values using this rate. As a result, the original import and export figures of the Balance of Payment Account in US dollar may vary somewhat from the figures used in the model. This discrepancy, which in general was not larger than five percent, was offset in the Balance of Payments Accounts by including it into the Errors and Omissions category, such that the Basic Balance and Performance Balance remain unaffected.

3. Units of measure

All economic variables were converted to per capita basis at the preliminary investigation of trends and the same basis was retained in the model estimation. Such conversion removes the country size effect in the observed trends. Also, the heterogeneity in model estimation between country blocks due to the varying country size is reduced by this conversion. Further, it may be noted that all of the variables are used in their nominal US dollar terms, and the reason and consequences of such use are discussed in detail in Chapter VI. Estimation Model.

B. Economic Performance of Debtor Nations

1. Income, consumption and investment

The economic performance, in general, showed steady growth during the 70's, and a distinct stagnation or deterioration in the early 80's (Figure 7), seemingly

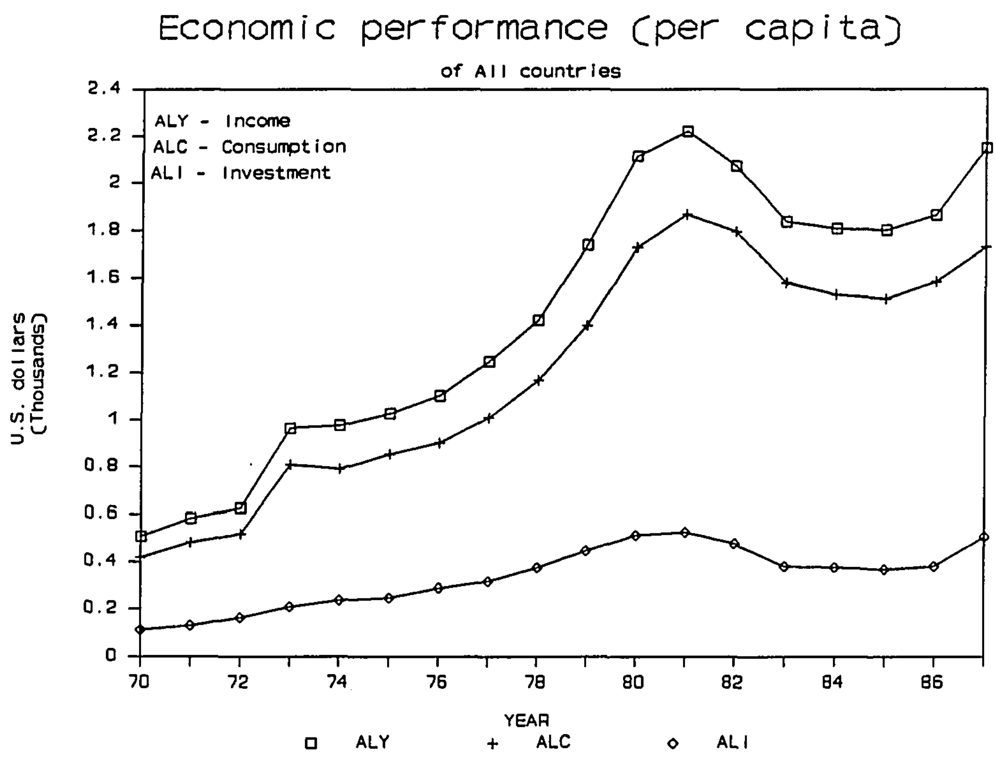

Figure 7. Income, consumption and investment

supportive of the "debt crisis induced sluggishness" argument, as the onset of the debt crisis was in the early 80's. Consumption accounted for nearly 80 to 90 percent of the income. Investment accounted for about 22 to 25 percent of income throughout the period. The surplus in absorption over income evidently was either borrowed from abroad or withdrawn from reserves.

Figures 8, 9 and 10 show the general performance of these countries grouped by their debt status, as Major Borrowers, Highly Indebted or those in both categories (MB&HI). In general it is evident that the countries which fell into both categories showed relatively better performance in income, consumption and investment in the 70's, and also had steeper declines in these during the 80's. Income trends of the five countries which were categorized as both MB and HI are shown in Figure 11. The same pattern in the income can be seen, with steady increase in the 70's and sharp decline in the 80's. It may be noted here that Brazil's 1973 consumption and investment figures also appeared to be 'outliers' as is the figure for income. Therefore the 1973 observation for Brazil was deleted in the final data set used for estimation.

2. Trade performance

The trade performance, on an average for all countries, also showed a trend similar to those observed for the general

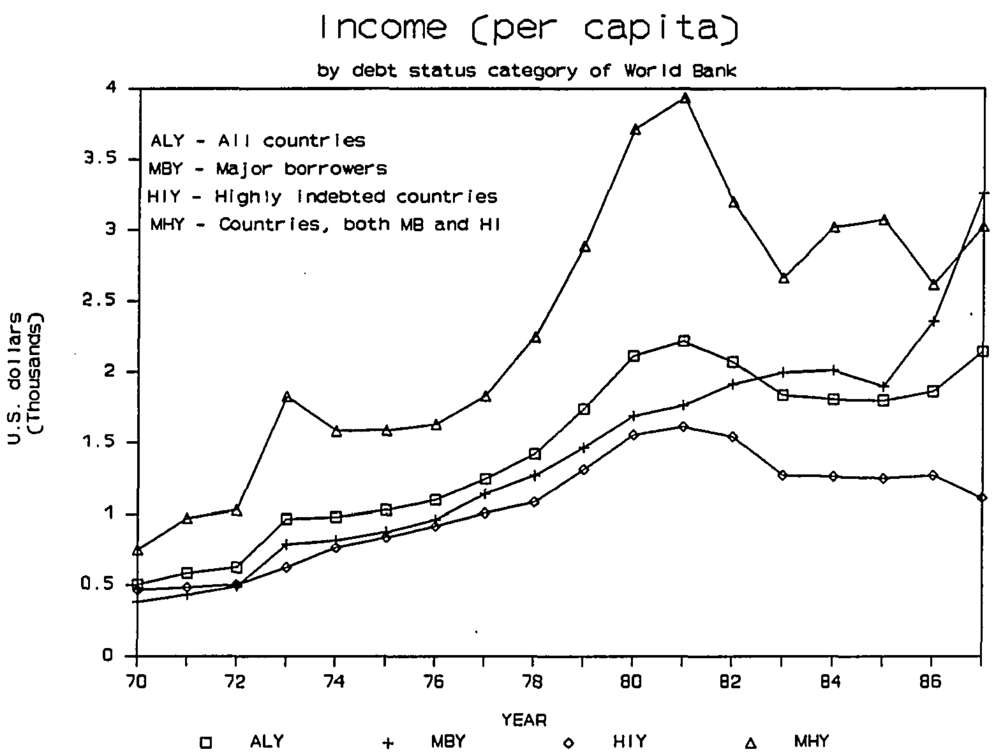

Figure 8. Income, by debt group

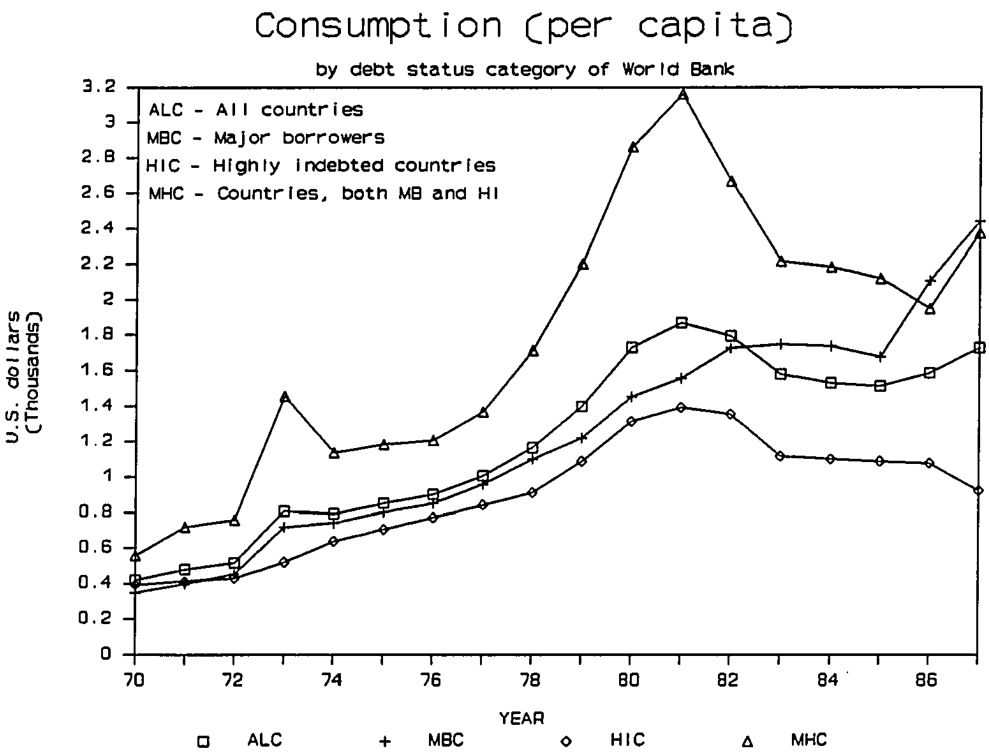

Figure 9. Consumption, by debt group

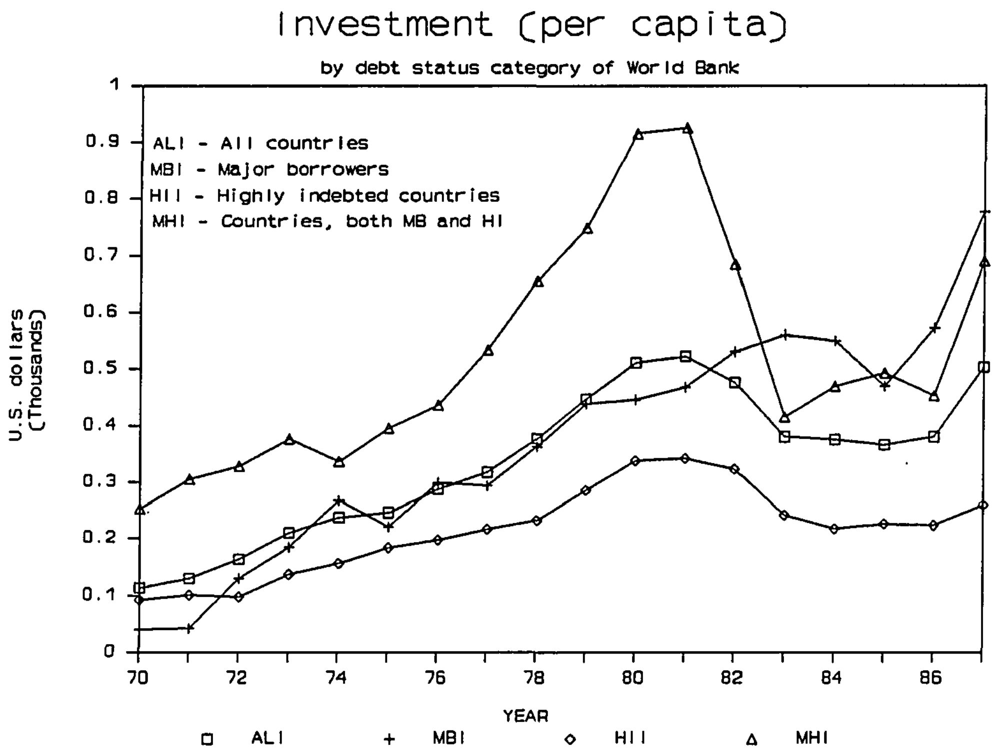

Figure 10. Investment, by debt group

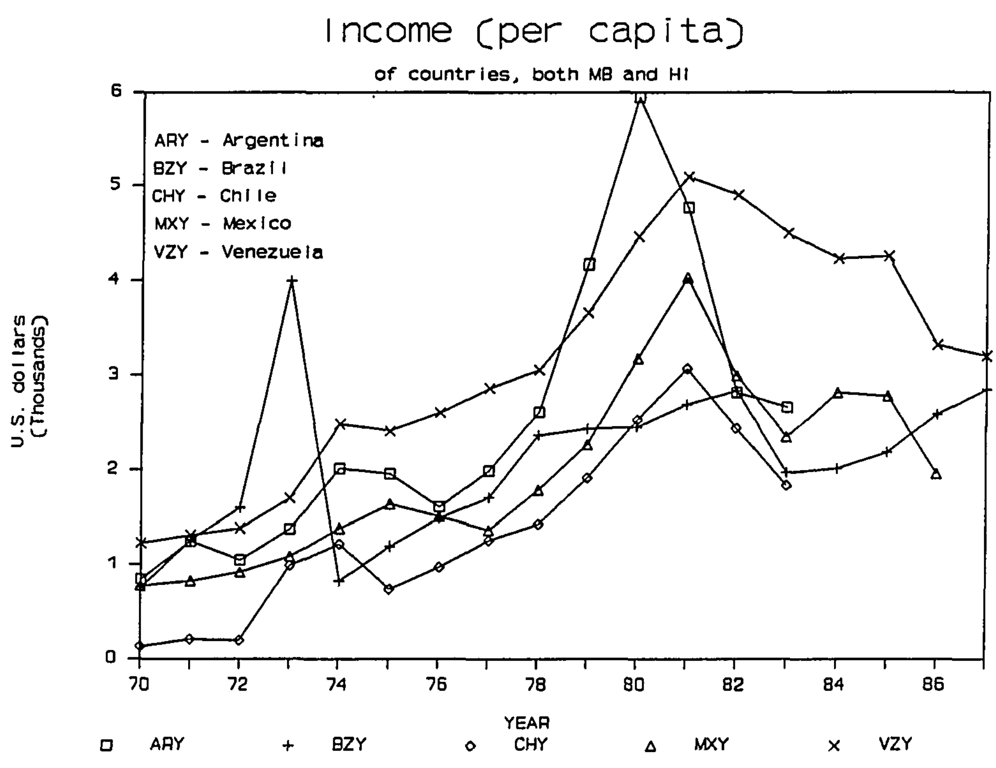

Figure 11. Incomes of the MB&HI countries

economic performance, with a steady increase in the 70's and stagnation thereafter (Figures 12 and 13). Major borrowers had increasing imports and exports during the early 80's, while those for the HI countries started to decline from 1980. The countries which were both MB and HI again had sharply declining trade from 1980, perhaps supportive of the argument that the countries facing greater debt service problems curtailed their imports to a greater degree and experienced stronger export compressions since the onset of the debt crisis. Figure 14 compares the imports and exports of all countries with those of MB&HI group. For all countries, imports exceeded exports throughout the 70's, but the trade gap became narrower after 1982. The MB&HI group showed a trend similar to the rest during the 70's, but in the 80's both imports and exports of this group declined faster than in the other countries. Also, in the 80's exports of this group exceeded imports reversing the trend observed in the 70's. Figure 15 illustrates the import trend for each of the MB&HI countries. Each country in this group individually too show the observed steady increase in imports in the 70's followed by the sharp decline in the 80's.

3. Balance of payments

Current Account Balance, as reported in the IFS data equals the trade balance plus the balance on other goods and

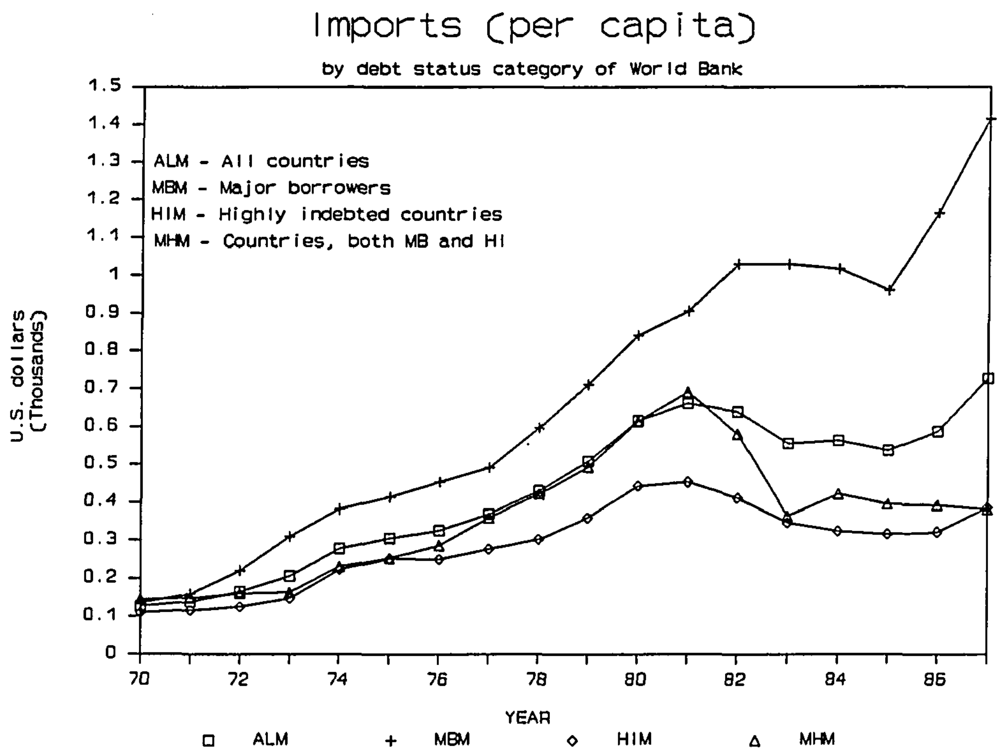

Figure 12. Imports, by debt group

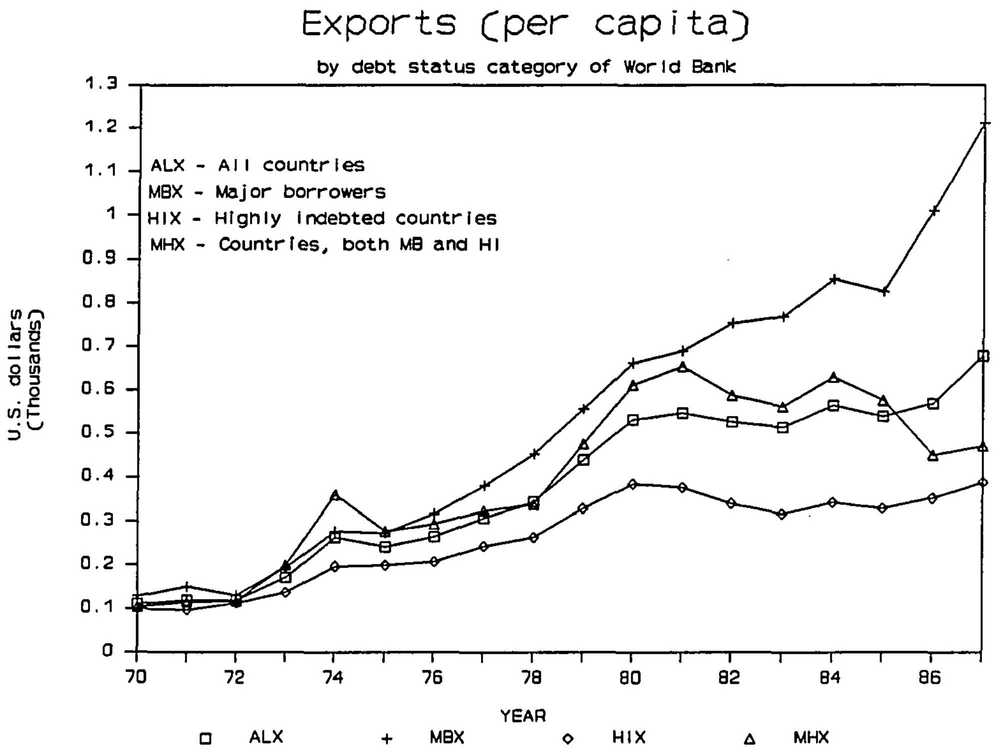

Figure 13. Exports, by debt group

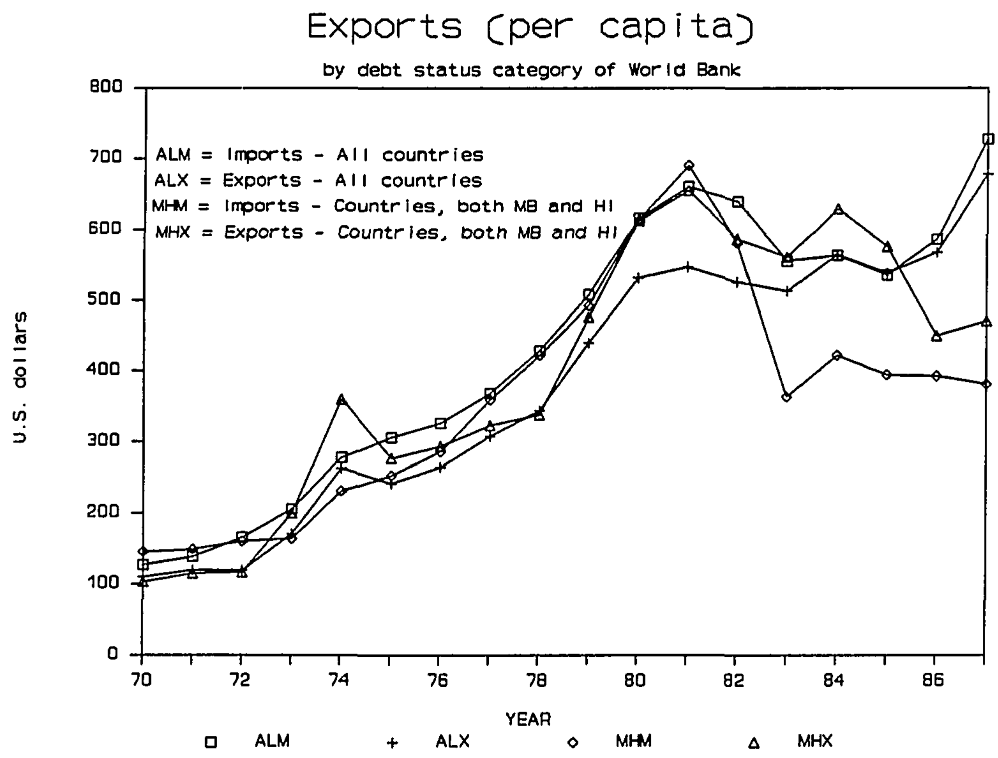

Figure 14. Trade of MB&HI countries compared with all debtors

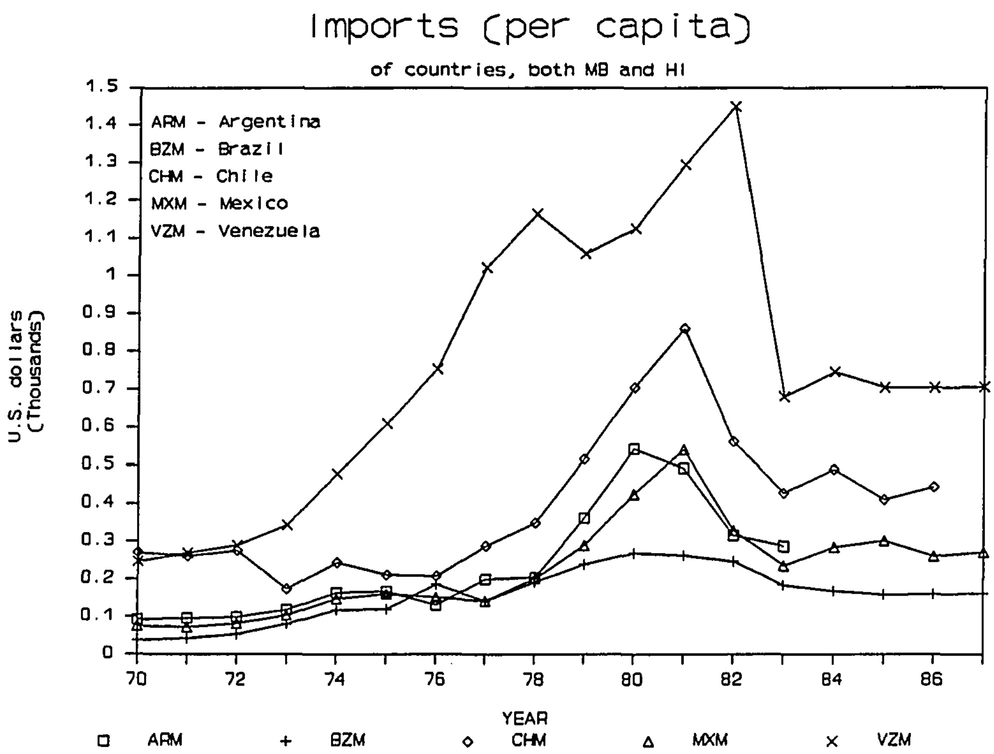

Figure 15. Imports of MB&HI countries

services and income (where income is the private and public unrequited transfers n.i.e[14]). A negative current account balance implies a liability on the part of the domestic economy vis-a-vis the rest of the world. The average current account balance of the selected debtor countries declined rapidly over the period from 1970 to 1982 (Figure 16). The same trend was generally true for each of the debtor groups, except that in the mid 70's, the MB&HI group had positive balance on an average due to the large positive balance of Venezuela (Figure 17). Since 1982, the current account balances improved and in fact for MB and MB&HI group turned positive.

Overspending during a year may be financed by either borrowing from abroad or by withdrawals from the country's own reserves, or both. Conversely, a larger current account balance need not necessarily imply higher overspending, since some may have gone to increase the reserves. The change in reserves by debt groups are presented in Figure 18. A negative value for changes in reserves (an off-setting entry) in the IFS data implies a debit entry to the reserve account, which means the reserve account has received that amount. In this study, however, the opposite sign is used, such that the meaning of a change in reserve is more direct: a positive

[14]Abbreviation used in IFS publications for "not included elsewhere".

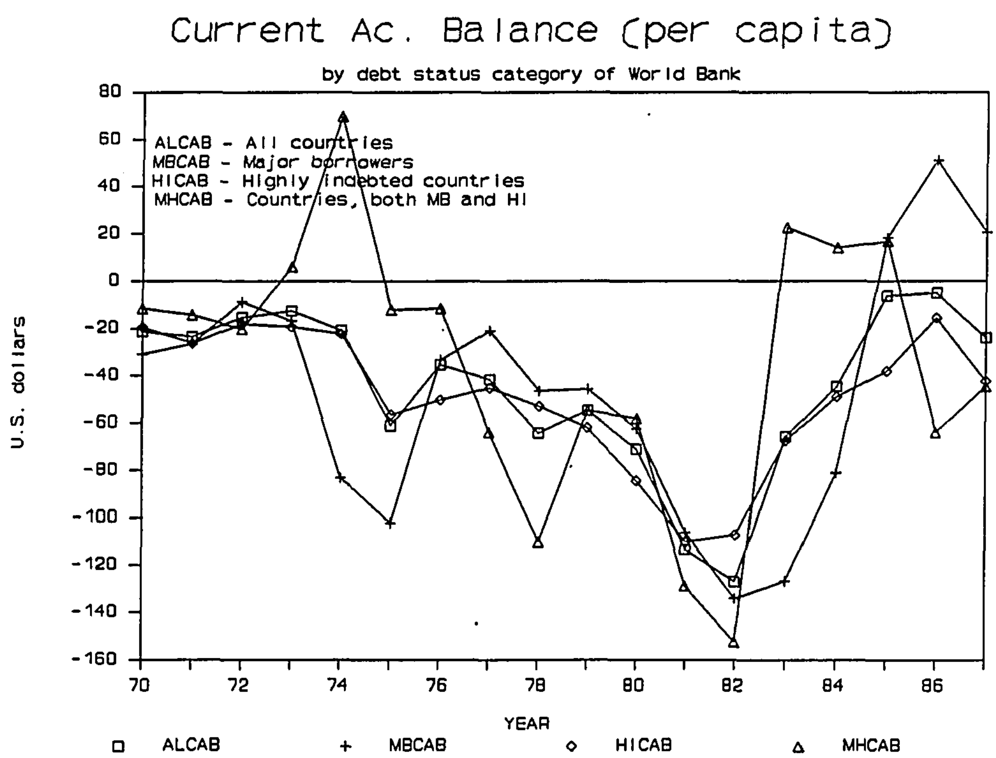

Figure 16. Current account balance, by debt group

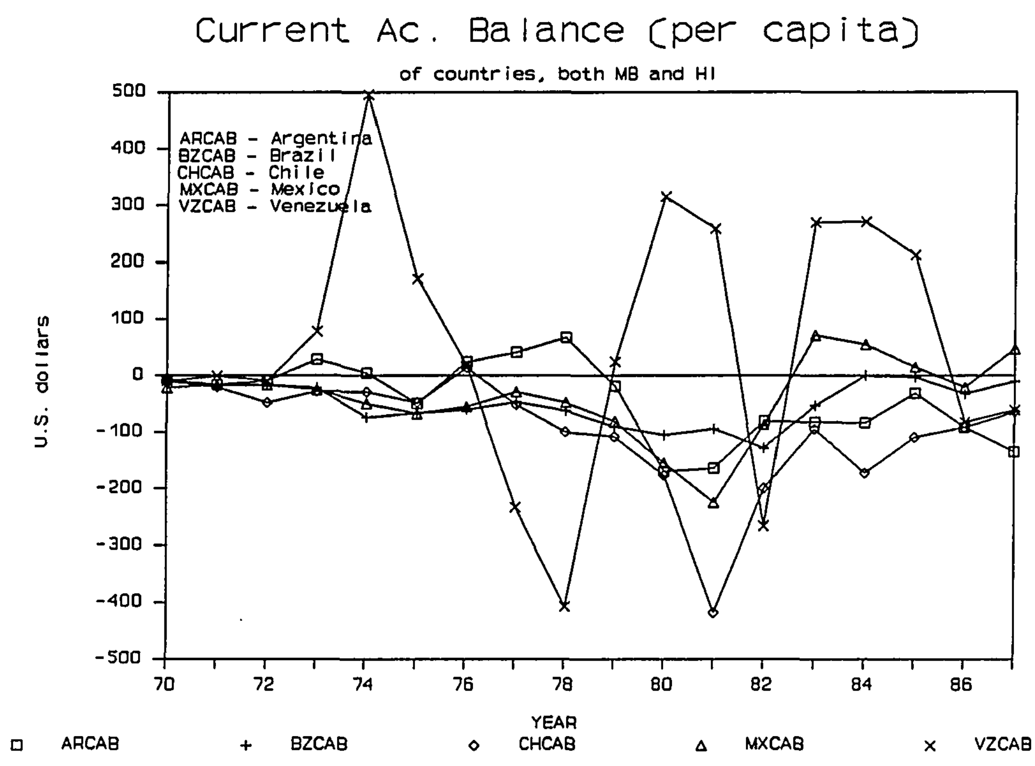

Figure 17. Current account balance of MB&HI countries

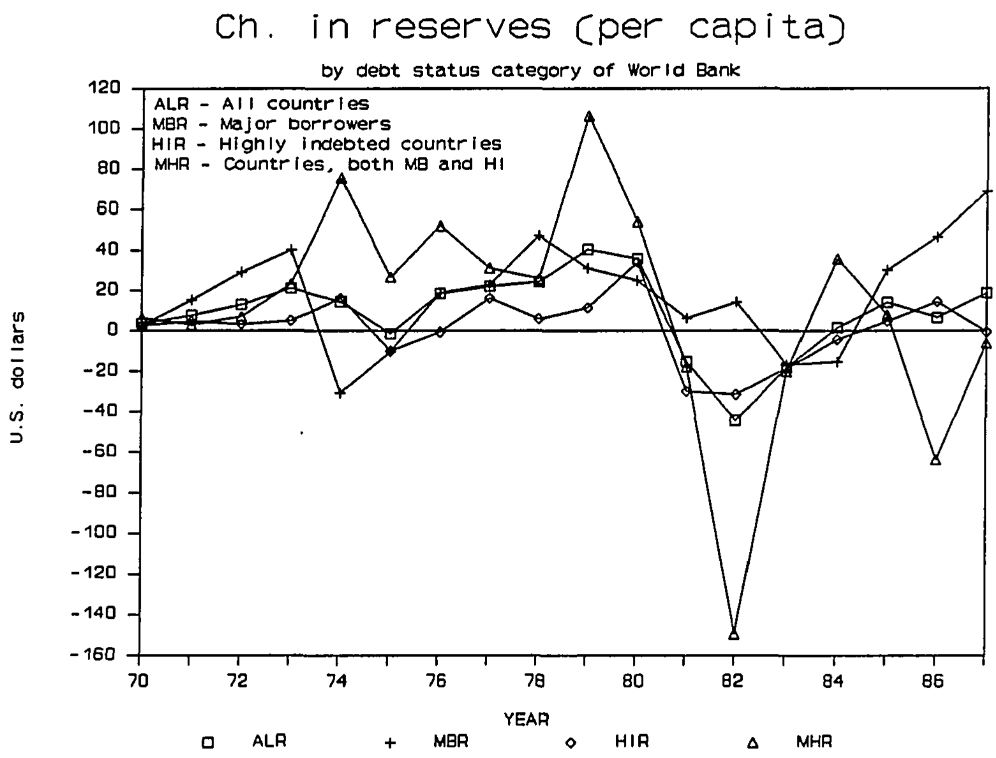

Figure 18. Change in reserves, by debt group

change in reserve to indicate an increase in reserves. Thus the IFS figures on change in reserves are multiplied by negative unity. In general all groups show reserve accumulation during the 70's, with the MB&HI group distinctly at higher levels. During 1980-83, the reserve accumulations of all groups declined, with very sharp decline for the MB&HI group. While the other groups recovered to some positive reserve changes thereafter, the MB&HI group evidenced sharp declines

4. Price indices and interest rates

The average consumer price, import price and export price indices of all selected countries and the general world price level, all indexed to 1985 (= 100) are presented in Figure 19. All consumer price indices are from the IFS data tape. Import and export price indices were reported only for a few of the countries, and thus the WEFA data on regional indices were substituted for the other countries. World price index is from the WEFA data set. The domestic price level of the debtor nations, on average, increased rapidly over the whole period. The steep increase of domestic price level in the 80's is explained by the super inflation of the Latin American countries included. The trade price indices show a trend favorable to the debtors in the 70's, with export prices rising faster than the import prices. In the 80's the trend

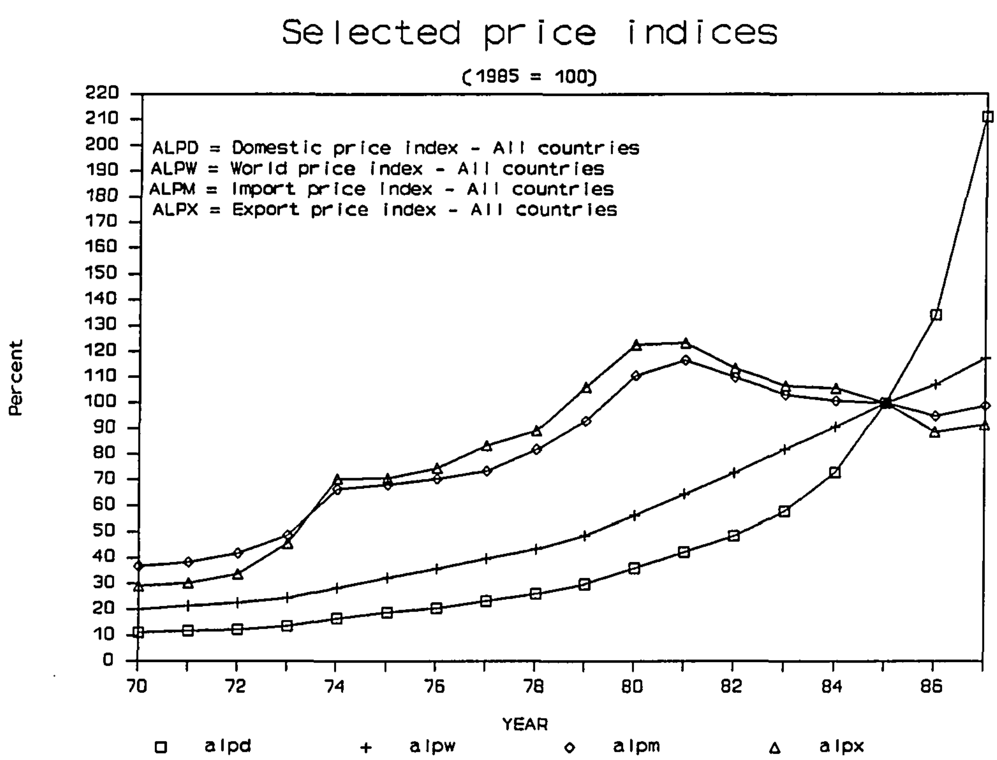

Figure 19. Selected price indices

was reversed. The import and export price indices, by debt group, are shown in Figures 20 and 21, respectively.

The interest rate movements of the debt groups are presented in Figure 22. The MB and MB&HI groups experienced rapid increases in the late 70's and 80's, increasing the overall average interest rate. The extremely high rates of Argentina, Brazil, Costa Rica and Israel were the main reason for such increases. Also, as seen in Figure 23, Argentina and Chile had no interest rates reported for the 1970-76 period and these two countries, along with Israel were not included in the final data set used for model estimation.

C. Debt and Debt Severity

1. Debt and borrowing

In the context of the current model, borrowing is the excess resources used for consumption, investment and debt repayments in a given period, over and above the income generated in that period. The World Debt Tables provide data on public and private long term and short term debts. A substantial portion of short term debts are often supplier credits to cover the time lag in shipping contract and final shipment. Further, WDT debt data is not necessarily complete in respect of transfers. Thus, the annual debt flow as

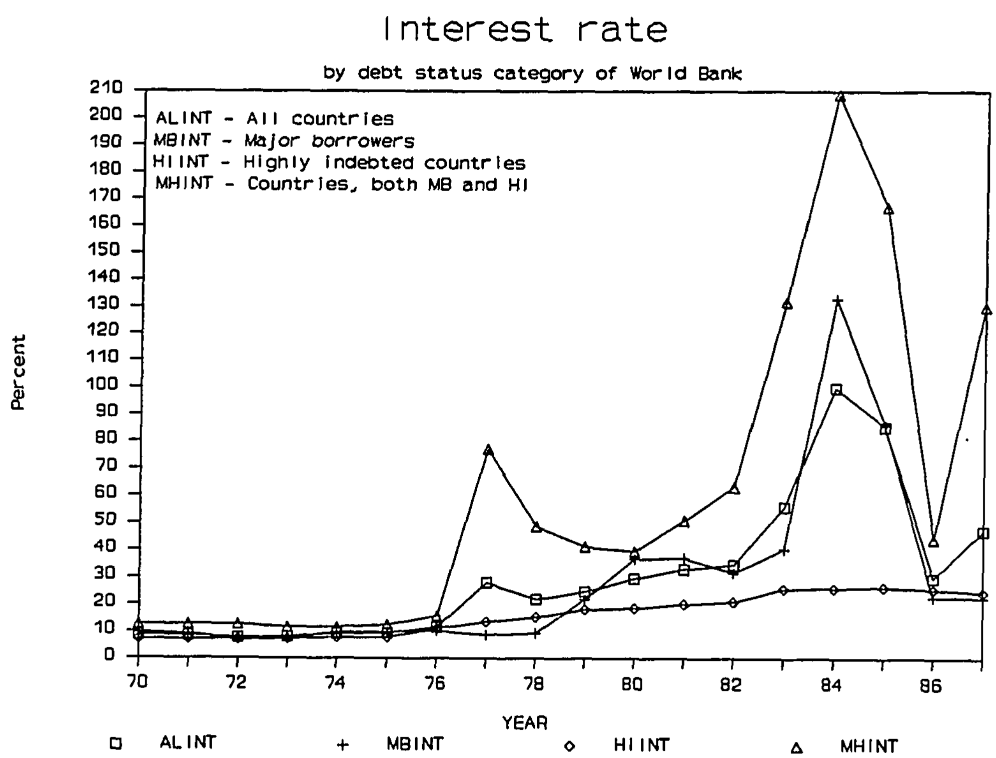

Figure 20. Interest rate, by debt group

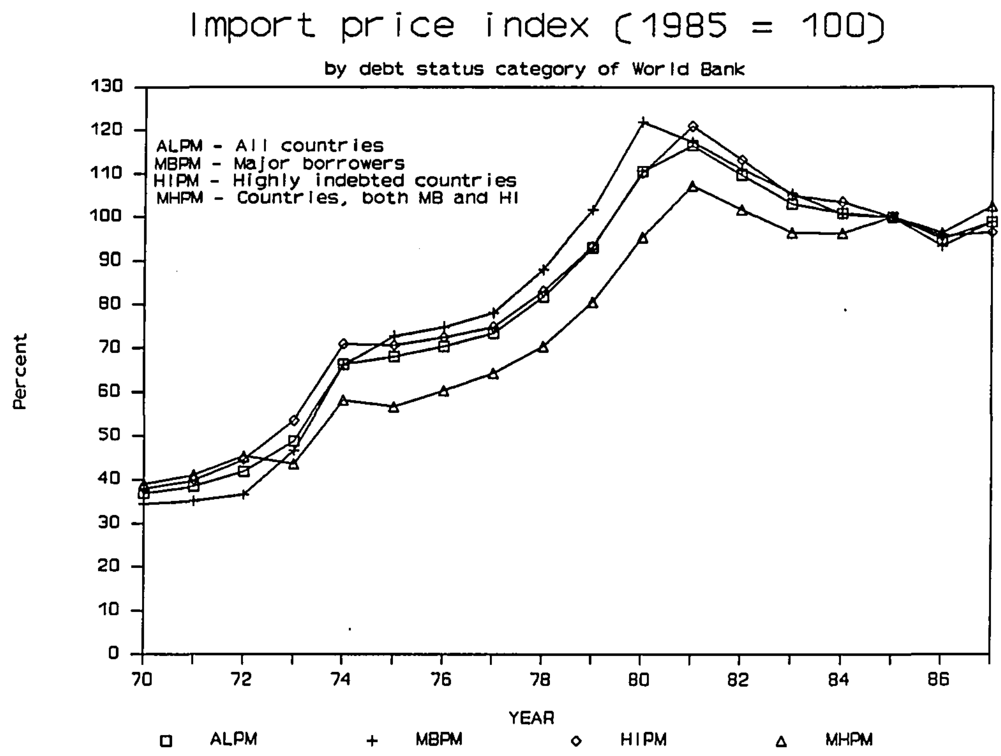

Figure 21. Import price index, by debt group

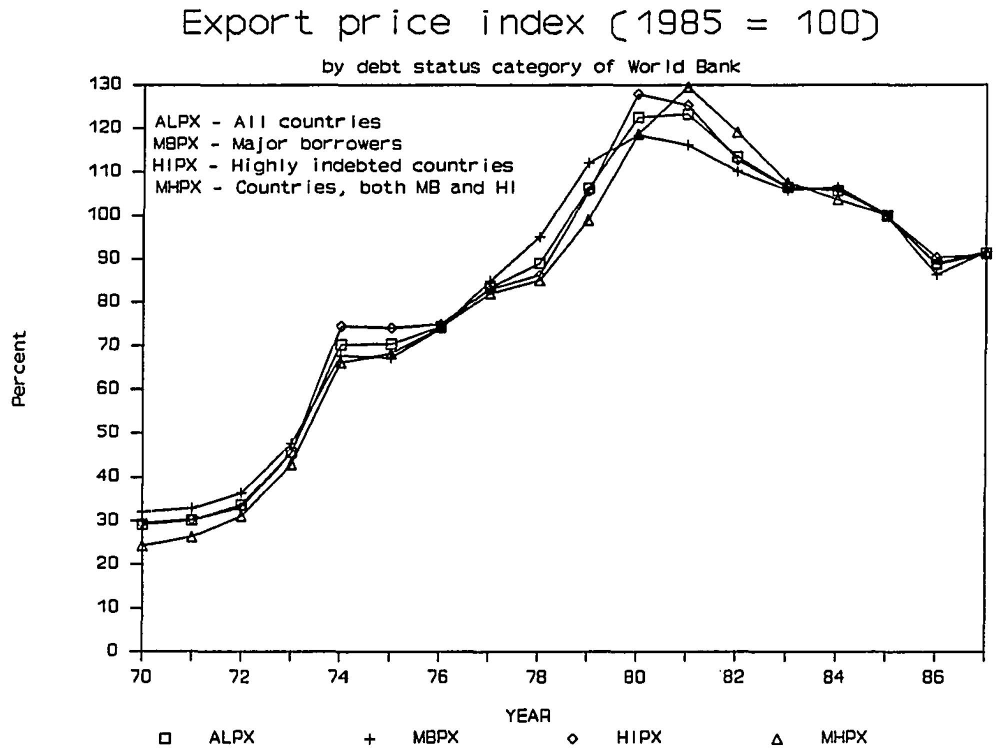

Figure 22. Export price index, by debt group

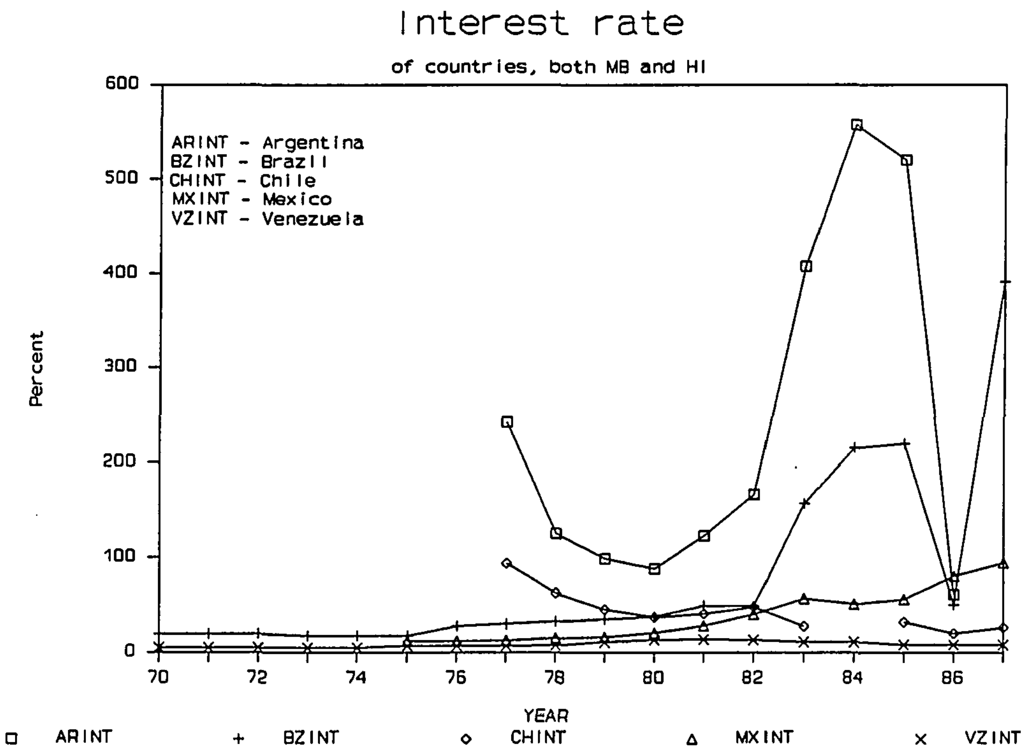

Figure 23. Interest rates of MB&HI countries

reported by the WDT is not adequate to represent the borrowing defined above.

Apart from any possible incomplete reporting, the changes in reserves are not included in the WDT measure of debt. Also, the changes in reserves may be due to withdrawals or savings, or due to valuation changes. Conventionally, valuation changes in gold and other reserves do not enter the National Income Accounts. Use of these reserve resources, including SDR's are also external to the income generated and should thus be considered borrowing. A measure of this over spending can be obtained from the Balance of Payments Accounts. Current Account Balance measures the value of the net foreign resources received during that year. While it provides the net transfer of the country vis-a-vis the rest of the world, the reserve changes are not included. Balance of Payments Account is presented in a typical book keeping setup. There is a credit and a debit side, and the two sides balance. The accounts can therefore be split into receipts vs use of foreign resources, with items of reserves, such as gold and SDRs, also accounted for as foreign resources, as per this accounting convention (see Appendix B). Exceptional finance is the total grants and loans received. Along with this, counterpart adjustments and valuation changes of these reserves add to the total receipts. From the resulting total, the change in reserves is deducted to obtain the net value of foreign assets used up in current period consumption, investment or factor payments abroad, and this is referred to as the Performance Balance. Looking at the same balance from the other side of the accounts, transfer of funds include the unrequited transfers, direct and portfolio investments, long and short terms capitals and errors and omissions.

Performance Balance is obtained when the net trade balance is removed from this total. Hence the negative of the Performance Balance is the over spending incurred in that period, or is the sum of trade and non-trade deficit. This measure is therefore used as borrowing in the current study, to be consistent with the model developed.

Borrowing, defined as the negative of Performance Balance, for the debt groups are presented in Figure 24. The negative borrowings in the 70's are indicative of positive reserve changes, due both to valuation changes and reseve accumulation. The debt crisis period show decumulation of reserves, more so for the highly indebted countries than for the others, in per capita terms. The average borrowing of all countries and the MB&HI group are compared with the Current Account Balance of these in Figure 25.

2. Debt severity

The model is formulated to take into account possible government policies that may affect consumption, investment,

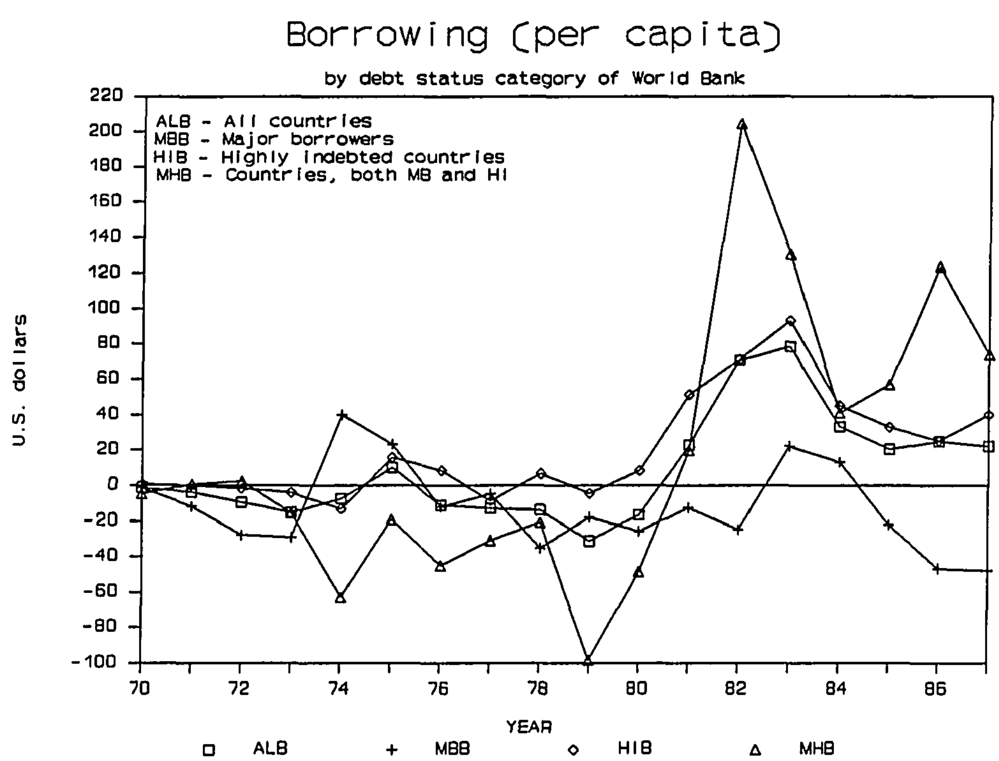

Figure 24. Borrowing, by debt group

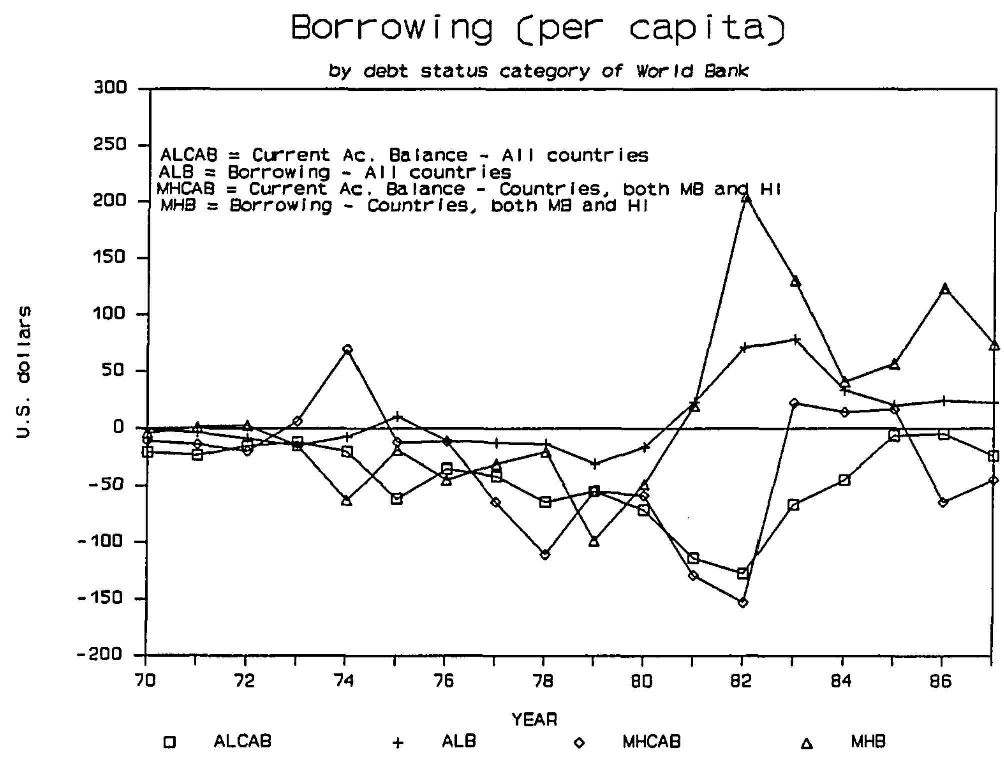

Figure 25. Borrowing and Current Account Balance

imports and exports at times of increasing debt service problems. The total borrowing or even the accumulated debt by themselves are not appropriate measures of debt service problems. The capacity of a country to service debt depends not on the absolute value of the debt, but on the magnitude of debt relative to other economic factors such as exports, GNP and reserves. Several different indices have been used to measure this debt servicing capacity. It is likely that during periods of debt service difficulties, the countries would tend to draw from their reserves. Conversely, when the economic performance is satisfactory, and when required borrowing from external resources is not constraining, the reserves are likely to remain unchanged or even increase. Therefore, the change in reserves are used as a measure of debt severity. The policy variable is constructed such that at times of falling reserves the policy impacts come into play, where as when the reserves are not falling, the belt tightening and investment promotion policies are relaxed.

D. Estimation Method

1. Model specification and estimation technique

The data set contains information on the selected 18 countries for a period of 18 years starting in 1970. Of the resulting 324 observations, 20 had one or more missing values and these observations were thus deleted. A pooled cross-sectional and time-series estimation method is used. The model was run on per capita basis for all the variables to remove the effect of the varying size of countries. Further, for each of the semi-reduced form equations of the model, scale or intercept dummies were used for each country to account for the heterogeneity among the country blocks.

The model consists of four equations, one for each of the endogenous variables namely, consumption, exports and imports and an identity for the fifth endogenous variable, investment, in a simultaneous system setup. Therefore it was estimated by the two-stage least squares method, with all the exogenous variables defined as instruments. The model contained a combination of linear and log-linear structures, and thus the non-linear simultaneous estimation procedure in SAS (Statistical Analytical System) was used to estimate the model.

2. Construction of ϕ_t, the adjustment factor

The adjustment factor, ϕ_t, enters the error term in the estimated consumption function as was shown in Chapter IV. Estimation Model. The error term of the estimation equation is a function of the error terms $\varepsilon_{c,t}$ and $\varepsilon_{i,t}$ (of the two behavioral functions C^*_t and I^*_t, respectively) and of ϕ_t. For least squares estimate, the error term needs to satisfy certain conditions. It follows that a variable A_t should be selected in the construction of ϕ_t such that the resulting error term satisfies these necessary conditions.

The semi-reduced form of the consumption function, inclusive of the error term (Chapter IV. F. Specification of the Estimation Model) is,

$$
\begin{aligned}
C_t = (1-\phi_t)[&\eta_{20} + \eta_{21}Y_t + \eta_{23}r_t \\
&+ \{(1-\phi_t)\eta_{22} - \phi_t\}\{\eta_{10} + \eta_{11}r_t + \eta_{12}Y_t\} \\
&- \phi_t[NTD_t - F_t - Y_t - \overline{B}_t] \\
&+ (1-\phi_t)\varepsilon_{c,t} + \{(1-\phi_t)\eta_{22}-\phi_t\}\varepsilon_{i,t}
\end{aligned}
$$

where, $\phi_t = \pi_0 + \pi_1 A_t.$

For illustration, consider a similar, but simpler form of the error term,

$$C_t = \phi_t C^*_t$$

with $$C^*_t = \beta_0 + \beta_1 Y_t + \varepsilon_t$$

and $$\phi_t = \pi_0 + \pi_1 A_t$$

Assumptions:

(i) $\varepsilon_t \sim \text{iid}\ (0, \sigma^2)$

(ii) Y_t uncorrelated with ε_t

The resulting estimation function then is,

$$C_t = \beta_0\pi 0 + \beta_0\pi_1 A_t + \beta_1\pi_0 Y_t + \beta_1\pi_1 A_t Y_t + \pi_0\varepsilon_t + \pi_1 A_t\varepsilon_t$$
$$= \rho_0 + \rho_1 A_t + \rho_2 Y_t + \rho_3 A_t Y_t + \varepsilon^*_t$$

where $$\varepsilon^*_t = \pi_0\varepsilon_t + \pi_1 A_t\varepsilon_t$$

That is, $$C_t = f(\rho_0, \rho_1, \rho_2, \rho_3, Y_t, A_t, A_t Y_t) + \varepsilon^*_t$$

For BLUE estimates of the ρ coefficients, the necessary conditions are,

(i) $E(\varepsilon^*_t) = 0$

(ii) ε^*_t is uncorrelated with A_t, Y_t, and $A_t Y_t$

(iii) ε^*_t is homoscedastic

Choosing a variable for A_t, such that A_t is uncorrelated to ε_t satisfies the above conditions as is shown below.

(a) $E(\varepsilon^*_t) = E(\pi_0\varepsilon_t + \pi_1 A_t\varepsilon_t)$

$= 0$ if A_t and ε_t are uncorrelated.

(b) ε^*_t is a function of A_t and ε_t, and is clearly uncorrelated with Y_t.

$$\begin{aligned}
Cov(\varepsilon^*_t, A_t) &= E(\varepsilon^*_t A_t) - E(\varepsilon^*_t).E(A_t) \\
&= E(\pi_0\varepsilon_t + \pi_1 A_t\varepsilon_t)A_t \quad \text{since} \quad E(\varepsilon^*_t) = 0 \\
&= \pi_0 E(A_t\varepsilon_t) + \pi_1 E(A^2_t\varepsilon_t) \\
&= 0 \quad \text{if } A_t \text{ is uncorrelated with } \varepsilon_t
\end{aligned}$$

$$\begin{aligned}
Cov(\varepsilon^*_t, A_tY_t) &= E(\varepsilon^*_t A_tY_t) - E(\varepsilon^*_t).E(A_tY_t) \\
&= E(\varepsilon^*_t A_tY_t) \quad \text{since} \quad E(\varepsilon^*_t) = 0 \\
&= E[(\pi_0\varepsilon_t + \pi_1\varepsilon_t A_t)A_tY_t] \\
&= \pi_0 E(\varepsilon_t A_tY_t) + \pi_1 E(\varepsilon_t A^2_t Y_t) \\
&= 0 \text{ since } \varepsilon_t \text{ and } Y_t \text{ are uncorrelated}
\end{aligned}$$

(c) Homoscedasticity:

$$\begin{aligned}
V(\varepsilon^*_t) &= V\{(\pi_o + \pi_1 A_t)\varepsilon_t\} \\
&= E[V\{(\pi_o + \pi_1 A_t)\varepsilon_t\}|A_t] \\
&\qquad + V[E\{(\pi_o + \pi_1 A_t)\varepsilon_t\}|A_t]
\end{aligned}$$

$$= E[(\pi_0 + \pi_1 A_t)^2 \sigma^2_\varepsilon] \quad \text{if} \quad \varepsilon_t, A_t \quad \text{uncorrelated}$$
$$= \sigma^2_\varepsilon . E(\pi_0 + \pi_1 A_t)^2$$
$$= \sigma^2_\varepsilon . E(\pi^2_0 + 2\pi_0\pi_1 A_t + \pi^2_1 A^2_t)$$

If $A_t \sim iid(\mu_A, \sigma^2_A)$, then

$$V(\varepsilon^*_t) = \sigma^2_\varepsilon(\pi^2_0 + 2\pi_0\pi_1\mu_A + \pi^2_1\sigma^2_A)$$
and is independent of t

Thus, if the variable A_t is uncorrelated to and ε_t the resulting error term satisfies the necessary conditions for BLUE estimate of the parameters. The error terms of the functions C^*_t and I^*_t are components of the error term of the estimation function. Hence, C_t and I_t (at least, when the borrowing constraint is not binding) are likely to be correlated to ε^*_t and had to be avoided in the construction of A_t. Hence, the variable, A_t, constructed as (Y+B) satisfies the necessary conditions for BLUE estimate.

VI. RESULTS AND DISCUSSION

A. Structure of Models

The estimation model, as developed in Chapter IV, is a simultaneous system of four estimatable equations and two identities, namely the performance balance and investment identities. Model parameters of the system were estimated using the two-stage least squares method. The system contained linear and non-linear equations and therefore PROC SYSNLIN, the non-linear system estimation method in SAS (Statistical Analytical System) was used.

Model estimations were run at different levels of aggregation. Four models were constructed with time series data, pooled across groups of countries as illustrated in Figure 26. In the first model, the all-country model (referred to as "ALL" model in the following discussions), all the 18 countries identified as either Major Borrower (MB) or as Highly Indebted (HI) by the World Bank (1987) were pooled together. In each of the four estimation equations of the system, an intercept dummy for 17 countries (except Venezuela, to avoid singularity) were included to allow for country specific intercept shifts as was done in Khan and Knight model. This resulted in 68 dummy variables

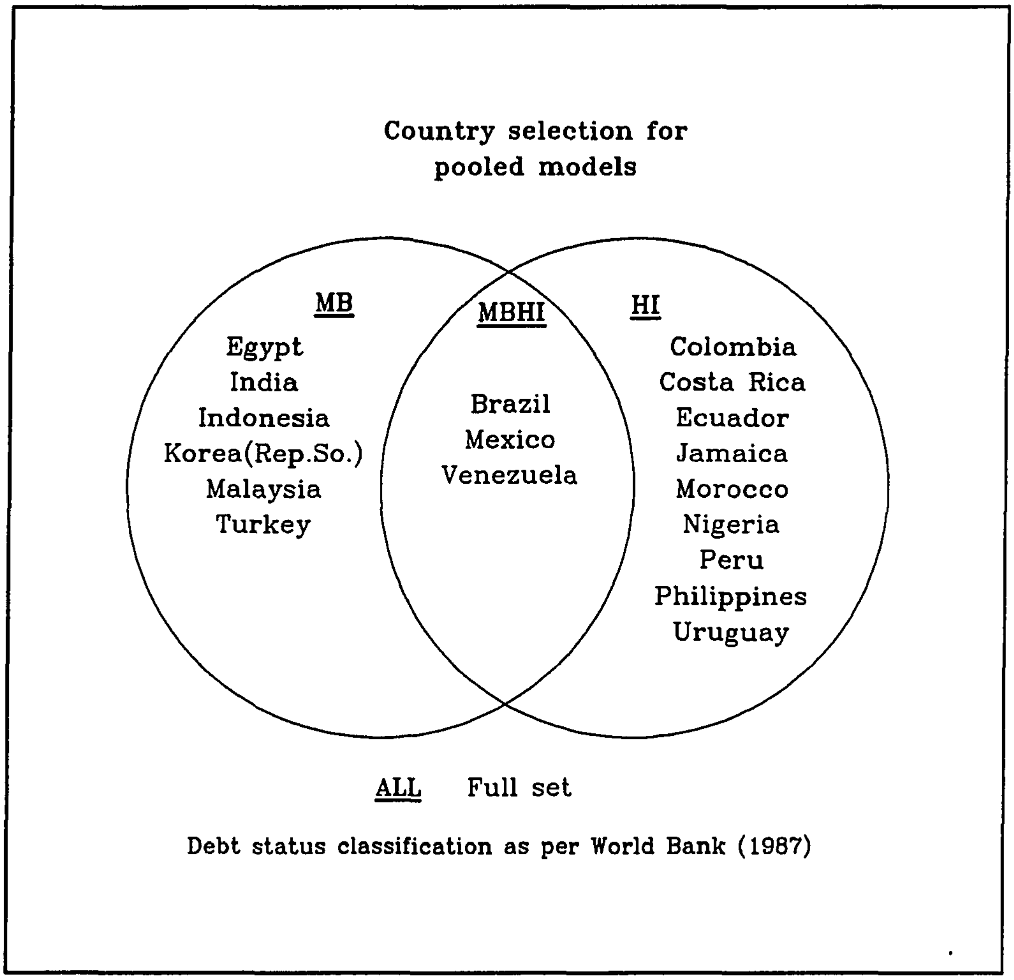

Figure 26. Country groups in the four pooled models

in the system. Slope parameters across countries were not differentiated by dummy variables. The assumption of common slope parameter may be justified by the use of per capita variables because the effect of country size is thereby removed. It may be noted that Khan and Knight estimate the model assuming common slope parameters even with the variables specified in total terms, rather than in per capita terms, in which case the intercept shifters alone account for all differences between countries including the difference in size. From an application point of view, if a single slope parameter in each of the four equations were to be specified with country dummies, this will reduce the degrees of freedom by 68 in the all-country model.

The second and third models, namely MB and HI models, were similar constructs as above with only the non-intersecting sub-sets of the Major Borrower and the Highly Indebted countries respectively. The last pooled model is the MBHI model, which includes only the countries that qualified under both debt categories. Thus the last three models are distinct sub-sets with no intersection, and the union of these three is the full set used in the first (ALL) model. Finally, in addition to the above pooled models, 18 more single country models were estimated, one for each of the debtor country selected.

The form of the functions in the model are detailed in Chapter VI, Section F. Specification of the Estimation Model. In brief, the consumption function was specified in a semi-reduced form, implicitly substituting for the two unknown behavioral functions, C^* and I^*. In addition, an adjustment variable (response to credit restrictions) and a policy variable effective during times of falling reserves form arguments of this reduced form, estimatable consumption function. Export supply function was also defined in a semi-reduced form, specified in terms of domestic income, imports, relative export price, lagged supply and changes in reserves. Further, export supply consists of two distinct components, namely, imported input share and domestically value added share in total exports. Export demand was specified with export price as the dependent variable. Value of total exports, world income and lagged exports were the explanatory variables of the export demand function. Total consumption, along with import price index and lagged imports, entered the import demand function. The last three functions were specified in log form and incorporated one-period lagged dynamic adjustment.

The above system of four estimatable equations were restricted by two identities. First, to reflect the balance in goods and services (real sector), the national income identity was imposed specifying investment as the residual of income plus imports less consumption and exports. Next, foreign sector balance was imposed through specifying the total deficit as the sum of trade and non-trade deficits, where trade deficit is defined from the real sector as the net of imports and exports of goods and services.

B. Model and Parameter Estimates

1. Performance of models

The results of the four pooled models estimated are presented in Tables 11 through 14. The explanatory power of consumption, export supply and import demand functions were consistently high across all models, at over 90 percent as measured by R^2, the coefficient of determination (SAS program reports only the unadjusted R^2 values for PROC SYSNLIN. SAS/ETS User's Guide, P. 532., SAS, 1987). These tables present the estimated parameters of the reduced form equations along with the computed values of the identifiable structural parameters based on the estimations. The computations and the expected sign/value of the structural parameters are noted at the bottom of the tables. The relationship between the structural parameters and the estimated parameters are discussed in Chapter VI and summarized in Tables 9 and 10. Export demand function had lower R^2 values, ranging from 0.57 to 0.70 in the pooled models, indicative of possible exclusion of some important variables. The R^2 values of these functions in the single country models were also, in general, similar to those of the pooled models.

Table 11. Estimated reduced-form consumption function

Model[a]	ALL	HI	MB	MBHI
Estimated parameters:				
α10	-29.05	11.24	49.15	-276.52
α11	0.119	-0.295	5.174	0.063
	(0.43)	(1.22)	(1.29)	(0.07)
α12	0.940	0.441	5.916	1.080
	(2.93)	(1.21)	(1.46)	(1.18)
α13	0.000010	0.000086	0.000051	0.000052
	(0.61)	(0.92)	(0.79)	(1.44)
α14	1.753	0.296	-20.858	0.831
	(1.45)	(0.06)	(0.93)	(0.42)
α15	0.000484	0.000107	-0.014	0.00022
	(1.07)	(0.03)	(0.73)	(0.32)
α16	-2528.47	-164.20	-3973.80	-1119.19
	(2.03)	(0.07)	(0.11)	(0.13)
α17	-1.904	0.047	-5.387	-1.667
	(2.88)	(0.03)	(0.12)	(0.71)
π0	1.005	1.799	10.036	0.890
	(1.41)	(1.57)	(1.37)	(0.91)
π1	-0.00046	-0.0013	-0.00456	-0.00046
	(1.90)	(1.61)	(1.29)	(1.35)
Deg.Freedom:	276	136	81	39
R^2	0.9872	0.9888	0.9417	0.9839
Computed structural parameters:				
η10	30.343	-192.778	10203.53	261.455
η11 (r)	-1.748	-0.230	-6.870	-0.886
η12 (Y)	0.059	0.506	-4.815	-0.093
η13 (Z)	2560	192	-6703	1525

Structural parameter computations and expected signs:

η10:	(α11/π1)-[α10+(π0/π1)α11]	Not pre-defined.
η11:	(α15/π1)-[α14+π0(α15/π1)]	η11 < 0
η12:	π0 - α12 + (1-π0)[(α13 + π1)/π1]	η12 = ?
η13:	(α17/π1) - [α16 + (π0/π1)α17]	η13 = ?

[a]Model ALL : Pooled data of all 18 countries
HI : HI but not MB, 6 countries
MB : MB but not HI, 9 countries
MBHI: Both MB and HI, 3 countries
where, MB: Major Borrowers, HI: Highly Indebted. Values in parentheses are 't' values.

Table 12. Estimated export supply function

Model[a]	ALL	HI	MB	MBHI
Estimated parameters:				
$\alpha20$	0.032	0.151	-0.351	0.215
$\alpha21$	0.00078	0.00141	0.00411	0.00114
	(3.01)	(2.12)	(4.77)	(2.42)
$\alpha22$	-2.355	-2.900	-3.156	1.758
	(2.74)	(2.28)	(2.38)	(0.73)
$\alpha23$	-0.096	-0.042	-0.032	0.060
	(6.29)	(1.86)	(0.55)	(1.96)
$\alpha24$	0.906	0.929	0.915	0.582
	(10.54)	(7.45)	(9.67)	(3.71)
$\alpha25$	0.916	0.813	1.016	0.554
	(16.22)	(9.67)	(11.08)	(3.32)
Deg. Freedom:	280	140	85	43
R^2	0.9752	0.9417	0.9926	0.9520
Computed structural parameters:				
κ	0.989	1.143	0.900	1.050
$\eta33$ (R)	0.000861	0.00152	0.00449	0.00196
$\eta35$ (Z)	-0.00119	0.00736	-0.00316	0.00543
$\eta36$ (Px)	-0.0291	0.508	-0.310	-0.160
γxs	0.916	0.813	1.016	0.554

Structural parameter computations and expected signs:

κ :	$\alpha24/\alpha25$	$0 < \kappa < 1$
$\eta33$:	$\alpha21/\alpha24$	$\eta33 = ?$
$\eta35$:	$(\alpha22/\alpha25)/\{1-(\alpha24/\alpha25)\}$	$\eta35 = ?$
$\eta36$:	$(\alpha23/\alpha25)/\{1-(\alpha24/\alpha25)\}$	$\eta36 > 1$
γxs:	$\alpha25$	$0 < \gamma xs < 1$

[a]Model ALL : Pooled data of all 18 countries
HI : HI but not MB, 6 countries
MB : MB but not HI, 9 countries
MBHI: Both MB and HI, 3 countries
where, MB: Major Borrowers, HI: Highly Indebted. Values in parentheses are 't' values.

Table 13. Estimated export demand function

Model[a]	ALL	HI	MB	MBHI
Estimated parameters:				
α30	38.685	33.216	40.296	22.90
α31	4.793	4.223	4.735	2.915
	(12.65)	(11.66)	(6.03)	(3.19)
α32	1.397	1.384	1.112	1.134
	(13.24)	(11.14)	(6.30)	(4.16)
α33	0.871	0.901	0.622	0.607
	(9.24)	(8.39)	(4.19)	(2.78)
Deg.Freedom:	282	142	87	45
R^2	0.5726	0.7640	0.5947	0.6858
Computed structural parameters:				
η40	0.0	0.0	0.0	0.0
η41 (Px/Pw)	1.148	1.110	1.609	1.647
η42 (Yw)	3.430	3.052	4.259	2.571
γxd	0.623	0.651	0.559	0.535

Structural parameter computations and expected signs:

η40: exp(-α30/α33)	Not pre-defined.
η41: 1/α33	η41 < 1
η42: α31/α32	η42 > 0
γxd: α33/α32	0 < γxd < 1

[a]Model ALL : Pooled data of all 18 countries
HI : HI but not MB, 6 countries
MB : MB but not HI, 9 countries
MBHI: Both MB and HI, 3 countries

where, MB: Major Borrowers, HI: Highly Indebted. Values in parentheses are 't' values.

Table 14. Estimated import demand function

Model[a]	ALL	HI	MB	MBHI
Estimated parameters:				
α40	-3.024	-1.633	-4.980	-0.853
α41	0.0643	0.014	0.292	0.0536
	(3.31)	(0.48)	(3.76)	(2.20)
α42	1.232	0.888	1.239	0.302
	(15.10)	(7.98)	(11.37)	(1.44)
α43	0.011	0.206	0.142	0.740
	(0.14)	(1.67)	(1.58)	(4.36)
Deg.Freedom:	282	142	87	45
R^2	0.9553	0.9234	0.9874	0.9303
Computed structural parameters:				
η50	0.061	0.137	-	0.018
η51 (Pm/Pd)	0.065	0.017	0.340	0.206
η52 (C)	1.245	1.118	1.444	1.163
γmd	0.989	0.794	0.858	0.260

Structural parameter computations and expected signs:

η50: exp[α40/(1−α43)]	Not pre-defined.
η51: α41/(1−α43)	η51 < 1
η52: α42/(1−α43)	η52 > 0
γmd: 1−α43	0 < γmd < 1

[a]Model ALL : Pooled data of all 18 countries
HI : HI but not MB, 6 countries
MB : MB but not HI, 9 countries
MBHI: Both MB and HI, 3 countries
where, MB: Major Borrowers, HI: Highly Indebted. Values in parentheses are 't' values.

2. Country-specific intercept shifters

In Tables 11 through 14, the coefficients of the 68 country-specific dummy variables are omitted as of little interest in the present context. However, a note regarding these variables is in order. The estimated intercept measures the intercept of the country that was not represented by a dummy variable (Venezuela), and thus the coefficients of the included dummies measure the deviation from this intercept. The reported intercept is the computed mean intercept of all the countries in the group, rather than the estimated intercept (of Venezuela). The parameter estimates of the dummy variables of all the four equations, in almost all countries were statistically highly significant. For instance, in the all-country model, of the 68 shift parameters estimated, only eight were not statistically significant at 10 percent probability level, while 48 of them were significant at 0.001 level.

3. Consumption function

The fit of the consumption function was very high across the pooled models. Since all parameters estimated, except the adjustment parameters (π_0 and π_1) were in reduced-form (composite, as functions of two or more of the structural parameters), it is not possible to identify the structural variables individually that performed well as explanatory variables, and those which did not. In any case, even if some of the composite variables were found to have little explanatory value, it would not be appropriate to drop those without violating the theoretical basis of constructing the consumption function.

Of the nine reduced-form slope parameters estimated, namely, α_{11} to α_{17}, π_1 and π_0, six were significant at 15 percent level in the all-country model. Of the four parameters of direct interest in the current study namely, α_{16}, α_{17}, π_0, π_1 , all but π_0 were significant at 0.5 percent.

The coefficients α_{16} and α_{17} correspond to the policy influence on consumption and investment respectively, as constructed. While these were estimated with high level of significance in the ALL model, the significance levels in the other three pooled models were low indicating little consistency among the countries within the debt groups in their responses to the proxy for debt severity constructed in the study.

The π_0 and π_1 parameters, along with the level of absorption (Y+B) define the adjustment factor, ϕ, which is the adjustment in consumption from an unobserved optimum (unconstrained consumption) due to a restriction in borrowing below an unobserved optimal (or unconstrained) level of borrowing. The estimates of these two parameters were of 10 to 20 percent level of significance across all four pooled models. Further, in all four models, π_1 was consistently negative. That is, the rate of adjustment in consumption due to borrowing restrictions decreased with increase in income. The computed adjustment coefficient, its variability among the debt groups and its significance in trade impact measures will be further discussed in section D. Assessing Trade Impacts.

As was seen in Table 10, from the estimated parameters of the reduced-form consumption function, only η_{10} to η_{13}, the structural parameters of the optimal investment function can be uniquely determined. The computed values are given at the bottom of Table 11. In all four pooled models, the signs were consistent with the priors. Unconstrained investment demand response to interest rate was negative. Income increase in the different pooled models showed mixed impact on investment. The MB and MBHI models evidence falling investment with increase in income while the other two models showed the reverse. However, the component parameter estimates of these structural parameters were in general of very low significance across all models.

The sign and value of η_{13} is of special interest. This is computed using only the last four parameters, all of which are significant (no attempt is made to construct the 't' values for the structural parameters which will require computing the covariance matrix of the estimated parameters. Instead, the significance levels of the component parameter estimates are checked to infer if the computed ones are likely to be significant or not). A positive sign, as in the case of three of the pooled models, implies that the constructed policy variable has a boosting effect on optimal investment demand, implying that during periods of falling reserves, the policies in general have tended to favor investments. The negative η_{13} in the case of MB model implies that during debt crisis, policy environments have been discouraging investments in favor of sustaining consumption levels. It must be noted that, when the optimal investments were computed using these behavioral parameters for each country, such investment levels were widely different from the observed and simulated constrained investments. Often, the optimal levels fell far short of the actuals. This, along with the low significance levels of the component parameters, does not allow much confidence to be placed on the investment function thus identified.

As was noted earlier, although the consumption function in the other three pooled models had good fit, most of the estimated parameters were not significant. The exception was the adjustment parameters which were consistently significant at least at fifteen percent level. No consistent pattern was observed in the parameter estimates in the country-wise models. However, in dynamic simulation at the country level, consumption function performed extremely well (the RMS error was about 2 percent on average, Table 15). The low level of significance for the individual parameters in the single country models are possibly due to sampling error, the number of observations being small. Given the low significance level of parameter estimates in the single country models as well as the pooled sub-set models, only the all-country pooled model was selected for further investigation in section E. Conutry-by-Country Analysis. Following the presentation of estimated export supply, export demand and import demand functions in the rest of this section, a note on optimal and predicted values and a discussion of impact assessments in the pooled model precede the single country results.

4. Export supply

The fit of the export supply function was good, with R^2 between 94 to 99 percent across the pooled models. In general, all parameters were highly significant across the models (except α_{22} in MBHI and α_{23} in MB). The parameter κ represents the share of imported inputs in exports and was close to unity in all the models, and both its component parameters, α_{24} and α_{25} were highly significant in all the

Table 15. Regression Mean Square error (percent) in dynamic simulation of single-country models

Country	C	I	Log(X)	Log(Px)	Log(M)
Brazil	1.69	12.88	3.63	5.03	4.19
Colombia	1.25	10.16	2.25	5.65	1.36
Costa Rica	2.52	11.42	1.17	4.02	1.02
Ecuador	0.60	18.99	3.93	5.43	3.32
Egypt	1.17	11.32	2.59	6.09	2.26
India	2.60	20.59	5.40	5.12	3.45
Indonesia	1.65	6.73	5.39	4.93	3.63
Jamaica	3.31	30.90	1.82	6.05	1.82
Korea	2.91	9.25	1.80	2.29	1.30
Malaysia	2.23	10.96	0.91	2.94	1.23
Morocco	2.01	28.13	3.25	4.66	2.80
Mexico	0.71	7.01	2.12	4.78	1.50
Nigeria	2.63	53.12	4.17	3.10	4.88
Philippines	2.10	14.17	1.27	3.42	2.63
Peru	1.19	15.88	2.14	5.78	1.85
Uruguay	1.11	14.68	1.91	5.79	2.78
Venezuela	4.98	28.49	1.20	3.44	3.11

pooled models. This implies a predominance of imported inputs in the export sector in all of the debtor nations selected.

Next, the positive η_{33}, with highly significant component parameters in all the four models, demonstrate the changing share of imported inputs in total imports during periods of falling reserves. As was expected, during times of falling reserves, the composition of imports tend to favor inputs for export supply. The parameter η_{35} is a measure of the direct export enhancing/reducing effects of policy environment during debt severity. The component parameters of η_{35} are in general significant across the models. The HI and MBHI group evidence export enhancing policies while the MB and ALL models show the opposite.

The sign of η_{36}, computed from α_{23}, α_{24} and α_{25} (all of which were highly significant in the models), was negative in three of the models and less than unity in the other, contrary to expectation. Such a downward slope is evidently not characterizing a supply function. Recall that the domestically value added component V_x was defined as a function of income, price and the policy variable. Income was included as a proxy for the capital stock. It is thus possible that the resulting function, instead, generated the domestic demand function of exports, due to the inclusion of domestic income.

The lag adjustment, γ_{xs}, is measured by α_{25}, which was highly significant in all the models. Also, the magnitude was almost unity in the all-country and MB models, implying no stickiness in export supply. The MBHI group evidenced substantial degree of stickiness ($\gamma_{xs} = 0.55$) in export supply, while it was sticky to a lesser extent in the HI model. The structural parameter κ denotes the importance of the imported inputs in total exports.

5. Export demand

Export demand function had R^2 values ranging from 57 to 70 percent among the pooled models. All the coefficients were very highly significant in all of the pooled models. The estimated parameters were generally consistent with the priors. In all models, the computed η_{41} was greater than unity contrary to expectation. In the formulation of the demand function, it will be observed that the value of exports are in US dollar terms. The export price index is discounted by the world price index. The difference in the movements of the world price index and the nominal US dollar is probably the reason for the η_{41} estimates being higher than unity. The MB and MBHI groups show higher gains in total value of exports due to export price increases than the other groups. World income increase, on the other hand, lead to a greater demand for the MB exports ($\eta_{42} = 4.26$)

than the exports of the others. Further, the world demand for exports of the debtor countries appear sticky in lagged adjustment, with exports of countries in the MB and MBHI groups facing slightly higher degree of stickiness.

6. Import demand

The R^2 values for this function ranged from 92 to 99 percent, indicating good model fit. Significance levels of the parameter estimates were also generally high, except for α_{43} in ALL model and α_{41} in HI model. The coefficients computed were in conformity with the priors across the models. Since the value of imports were regressed on price in the import demand function, the price effect on quantity will be expected to be $(\eta_{51}-1)$. On this basis, the import demand of the HI group appear more responsive to price changes than that of the MB countries. Further, in all countries a unit increase in consumption leads to a greater than proportionate increase in imports, with MB countries evidencing a marginal increase of 1.44 units in imports. In the MB and HI models, lagged adjustment showed relatively small degree of stickiness (γ_{md} of 0.86 and 0.79, respectively) when compared to the MBHI model (γ_{md} of 0.26). Of noteworthy is that the significance level of α_{43}, the single component parameter of γ_{md}, was very high for the

MBHI group confirming the stickiness in adjustment, while that of the other groups were of low significance levels.

C. Optimal and Predicted Performance

It was shown in the theoretical construction of the model that quantity restrictions in credit leads to simultaneous adjustments in consumption and investment, which in turn changes import and export performances. In constructing the estimation model, adjustment in consumption was specified as a partial adjustment process dependent on the deviation between desired (or unconstrained) and actual levels of borrowing. Actual consumption adjusts from the unconstrained level of consumption by a factor, ϕ, of the deviation in borrowing. A change in consumption induces a change in imports, which in turn affects exports. The adjustment in investment follows, maintaining the national income identity of appearance and disappearance of goods and services.

In formulating the model for the evaluation of the trade impacts of marginal changes in borrowing, the constrained consumption and investment were specified as adjusting from unobservable optimal levels. While the evaluation of such marginal changes do not require the estimation of optimal levels, it will be of interest to find if the model could identify the optimal levels and if so, how well those levels compare with any priors. If, for instance, the optimal levels of consumption and investment of a country are known, then it will be possible to assess how much more a country would have borrowed in total, and by how much the total imports and exports would have changed. The distinction between the above concern and the purpose for which the model was constructed must, however, be emphasized. The current study is an attempt to evaluate what the impact of a marginal change is, rather than to measure the total change. That is, the question addressed is, by how much will consumption, investment, imports and exports change in response to a marginal change in borrowing. This is different from measuring the total change in consumption, investment, imports and exports (and consequently, borrowing) under unconstrained conditions. Not withstanding this distinction, an attempt was made to estimate the optimal levels within the framework of the estimated model as is discussed below.

Unconstrained borrowing implies optimal or unconstrained levels in consumption, investment, imports and exports. The relationships, in a simplified form, omitting the lagged adjustments and policy variables can be represented as follows, with the asterisks denoting unconstrained levels.

1. Consumption: $C^* = \eta_{20} + \eta_{21}Y + \eta_{22}I^* + \eta_{23}r$
2. Adjustment: $C^* = C + \phi[B^* - \bar{B}]$
3. Borrowing: $B^* = \bar{B} + C^* + I^* - C - I$

   from equations 4.6 an 4.7 of Chapter IV.
4. Import demand: $M^{*'} = \eta_{50} + \eta_{51}(P_m/P_d)' + \eta_{52}C'$

   where the prime denotes log term.
5. Export supply: $X^{*'} = \eta_{31} + \kappa M^{*'} + (1-\kappa)\eta_{36}(P_x^*/P_d)' + (1-\kappa)Y'$
6. Export demand: $X^{*'} = \eta_{40} + \eta_{41}(P_x^*/P_d)' + \eta_{42}Y_w'$
7. Investment: $I^* = \eta_{10} + \eta_{11}r + \eta_{12}Y$
8. N.I. identity: $I^* = Y + M^* - C^* - X^*$

There are six unknown variables, namely C^*, B^*, X^*, M^*, I^* and P_x^* and eight equations. If both consumption and investment equations (1 and 7, above) are dropped, then the system is exactly identified. However, η_{31} of the export supply function is not computable from the estimated coefficients (as was shown in Table 10) and therefore the export supply cannot be determined, and consequently the model cannot be solved for the unknowns. Also, if optimal export and import functions are to be used as above, then the lagged adjustment factors specified in the original model will have to be included. Apart from making the model more complex, it is also arguable whether, for instance, the current period optimal import should be specified as adjusting from last period's optimal level or from the last period's actual level. In addition, the computed coefficients of the investment function will not be used in solving the system.

In view of these, and for simplicity, an alternative approximation was attempted. Optimal investment was computed for each country on the basis of the four pooled model estimates. Adjustment in investment was specified as,

$$(I - I^*) = (1-\phi)[B^* - \bar{B}]$$

from which, for given I and $\bar{B}$, the corresponding B^* was computed. Following this, C^* was computed as $C + \phi(B^* - \bar{B})$. The optimal values thus computed were compared with both the actual and simulated (given the level of $\bar{B}$) levels of investment, consumption and borrowing. While the simulated values generally followed close to the actuals, the computed optimal values were substantially different. In many cases, the optimal investment thus computed fell far below the actuals and simulated values, contrary to expectation that the unconstrained borrowing should lead to increased investments. The low significance levels of the estimated component parameters (page 197 as well as Table 11) suggests such estimates to be suspect and this may have caused the unexpected low computed levels of optimal investments. Further, as a result of the poor identification of investment, estimates of optimal consumption and borrowing were also poor.

Fortunately, however, the impact assessment of trade restrictions on consumption, investment or trade do not depend on the successful estimation (or computation) of the optimal levels of any of these macro variables. The identifiability of the investment function is, in fact, due to the simplified formulation of the behavioral investment function (as dependent only on interest rate and income) and because investment does not enter either the import demand or export supply functions. The computability of the optimal investment function is only of casual importance, because the concern here is to evaluate the impacts of marginal changes in credit restrictions. The inability to compute the unconstrained levels of the macro variables (I^*, B^*, C^*, M^* and X^*) do not interfere with the marginal impact assessments, although successful estimates of these would strengthen the confidence that could be placed on the evaluations of marginal impacts.

On the other hand, the simulations, which implicitly assume the current level of borrowing as the constrained levels, are of significance in demonstrating the model performance. The regression mean square errors (RMS) in simulations in the country-wise simulations of consumption, investment, imports and exports (Table 15) show that the predicted values in all cases were within 5 percent of the actuals, except in investment where the range was particularly high in few cases.

D. Assessing Trade Impacts

The adjustment coefficients estimated above can be used to evaluate the possible impacts of credit restrictions on the import and export performances of the economies. First, the linkages between borrowing, consumption, imports and exports in the model structure need to be identified. A credit constraint is reflected by a reduction in $\bar{B}$. Such a reduction leads to simultaneous adjustment in both investment and consumption, and as per the model, the adjustment in consumption is measured by $(\pi_0 + \pi_1 A)$, where A is a proxy for the total absorption. Elasticity of consumption with respect to this credit constraint can be thus defined as,

$$\xi_{c,b} = (\pi_0 + \pi_1 A).[B/C]$$

The subscripts c and b in the elasticities refer to consumption and borrowing respectively. Elasticities of imports with respect to consumption and exports with respect to imports are similarly defined from the import demand and export supply functions respectively (assuming exogenous P_x, for simplicity. Also, reserves are assumed to remain unchanged in the following computations, such that there is no change in the debt severity based policies). The respective parameters from the log linear models can be directly used. To compute the long-run elasticities, in the import demand function, setting $M_t = M_{t-1}$, and holding (Pm/Pd) constant,

$$(1-\alpha_{43})\log M_t = \alpha_{42}\log C_t$$

Therefore, it follows that,

$$\xi_{m,c} = [\alpha_{42}/(1-\alpha_{43})]$$

where the subscript m represent imports.

Similarly, from the export supply function, holding R, Z, (Px/Pd) and Y constant and setting $X_t = X_{t-1}$,

$$\alpha_{25}\log X_t = \alpha_{24}\log M_t,$$

from which, with subscript x denoting exports,

$$\xi_{x,m} = \alpha_{24}/\alpha_{25}$$

The ratio of the two estimated coefficients, α_{24} and α_{25}, therefore, gives a direct measure of the export compression resulting from import restrictions.

From these, the cross elasticities of trade with respect to borrowing constraint can be computed as,

import elasticity	$\xi_{m,b} = \xi_{m,c}\cdot\xi_{c,b}$
export elasticity	$\xi_{x,b} = \xi_{x,m}\cdot\xi_{m,c}\cdot\xi_{c,b}$

Point estimates of the elasticities can be obtained at the overall mean values of adjustment factor, borrowing and consumption. The post-1981 average figures were used in the construction of elasticities and in computing the trade impacts of credit restrictions of the debtor groups on the above basis (Table 16). The reduced form coefficients α_{24}, α_{25}, α_{42} and α_{43} are employed directly in computing the elasticities, and thus the 't' values of the coefficients provide a measure of confidence on the elasticities. All but α_{43} in the ALL model are significant at 15 percent or

Table 16. Trade impacts evaluated at 1982-87 mean values

Model[a]	ALL	HI	MB	MBHI
Average for 1982-87 (in U.S.$ per capita):				
GNP(Y)	1560	1289	1180	3008
Consumption(C)	1272	1123	870	2388
Borrowing(B)	47	60	2	84
Imports(M)	400	343	485	431
Exports(X)	423	335	483	584
A(=Y+B)	1607	1349	1182	3092
Estimates:				
$\pi 0$	1.005	1.799	10.036	0.890
	(1.41)	(1.57)	(1.37)	(0.91)
$\pi 1$	-0.00046	-0.00130	-0.00456	-0.00046
	(1.90)	(1.61)	(1.29)	(1.35)
$\alpha 24$	0.906	0.929	0.915	0.582
	(10.54)	(7.45)	(9.67)	(3.71)
$\alpha 25$	0.916	0.813	1.016	0.554
	(16.22)	(9.67)	(11.08)	(3.32)
$\alpha 42$	1.232	0.888	1.239	0.302
	(15.10)	(7.98)	(11.37)	(1.44)
$\alpha 43$	0.011	0.206	0.142	0.740
	(0.14)	(1.67)	(1.58)	(4.36)
Adjustment factor:				
$\phi(= \pi 0 + \pi 1 * A)$	0.2658	0.0453	4.6461	-0.5323
Elasticities with respect to Borrowing:				
Consumption	0.0098	0.0024	0.0107	-0.0187
Import	0.0122	0.0027	0.0154	-0.0218
Export	0.0121	0.0031	0.0139	-0.0229
Increase due to a dollar increase in Borrowing($):				
Consumption	0.2658	0.0453	4.6461	-0.5323
Import	0.1041	0.0155	3.7401	-0.1116
Export	0.1089	0.0173	3.3545	-0.1589

[a]Model ALL : Pooled data of all 18 countries
HI : HI but not MB, 6 countries
MB : MB but not HI, 9 countries
MBHI: Both MB and HI, 3 countries
where, MB: Major Borrowers, HI: Highly Indebted. Values in parentheses are 't' values.

higher. Using the 1982-87 average trade figures, the absolute change in imports and exports due to a dollar increase in borrowing are also computed.

The adjustment factor (ϕ), which is the same as the change in consumption due to a unit change in $\overline{B}$, ranges from -0.53 in MBHI model to 4.65 in MB model. The elasticities and dollar value changes in consumption, imports and exports, consequently, show similar disparity between the models.

The low significance levels of both π_0 and π_1 of these models and the dependence of ϕ on these two parameters question the confidence that can be placed on these point estimates. A substantial variability in ϕ across the countries may be the reason for the low significance levels. This possibility is therefore further examined in the following section on country-by-country analysis.

In the ALL model, a dollar increase in borrowing leads to only a $0.27 increase in consumption. Also, both imports and exports increase by nearly the same magnitudes, thus leaving the trade deficit more or less unchanged. This would imply that almost all of the additional borrowing is diverted for non-trade purposes (basically, either into reserve changes or lost as capital flight). These observation also will be discussed further in the country-by-country analysis.

E. Country-by-Country Analysis

Wide variability was observed among the parameter estimates of the four pooled models. On the other hand, in the single country models, the significance levels of estimates were, in general, low. The low significance levels probably resulted due to sampling error, the number of observations being only eighteen, at most, per country. The system estimated had four estimatable equations and the longest of these equations had ten estimatable parameters. Consequently, the degrees of freedom for the consumption function was, at most, seven in the single country models. Of the pooled models estimated, the all-country model (ALL) estimates were the most statistically significant and best complied with most of the priors as was discussed in Section B. Model and Parameter Estimates. In view of this, the ALL model estimates are used in this section to investigate country-by-country performance in consumption and trade. Also, the assumption of common slopes in the import demand and export supply functions specified in log form leads to constant import to consumption and export to import elasticities across countries. Such constant elasticities may be too restrictive and resulting mean trade evaluations may be misleading. Therefore, the single country estimates of these slope parameters and the resulting elasticities are also examined.

The 1982-1987 average figures of the main macro variables used in the computations, namely income, consumption, borrowing, imports and exports for each of the country selected are presented in Table 17. The averages, by debt group, of these macro variables are presented at the bottom. The annual figures for Turkey for post-1983 were not available and therefore this country was not included in the analysis in this section. The range of income and consumption in the MI and HI groups are quite similar, while the MBHI group shows distinctly higher levels. Further, the figures for Venezuela is well above average, thus pushing the MBHI group average substantially above the all-country average. The adjustment factor, ϕ, is dependent on the two π parameters as well as on total absorption (Y+B): ϕ decreases with increase in Y since π_1 was consistently negative. This accounts for the negative point estimates of the adjustment factor for the high per capita income countries in the MBHI group, especially Venezuela. The values of the computed adjustment coefficients for each country is plotted in Figure 27, grouped by their debt status. The group average is identified by the corresponding label within the plots. The adjustment in

Table 17. 1982-87 mean values of selected macro variables

Country	Group	Y	C	B	M	X
Egypt	MB	818	686	2.9	237.0	156.3
India	MB	294	237	0.8	25.4	19.0
Indonesia	MB	540	395	3.0	128.5	136.8
Korea,(Rep.So.)	MB	2301	1639	1.0	877.5	932.5
Malaysia	MB	1947	1392	3.2	1157.3	1171.6
Colombia	HI	1600	1318	18.7	215.6	225.0
Costa Rica	HI	1519	1258	168.2	582.6	570.4
Ecuador	HI	1311	1110	146.4	318.3	339.7
Jamaica	HI	1194	1137	45.0	734.9	644.2
Morocco	HI	750	642	6.8	234.7	148.8
Nigeria	HI	942	838	27.6	103.2	138.9
Peru	HI	1071	897	77.2	221.4	238.1
Philippines	HI	770	639	15.8	172.5	164.3
Uruguay	HI	2442	2269	31.9	505.1	548.5
Brazil	MBHI	2407	1992	74.4	180.5	250.0
Mexico	MBHI	2581	1990	45.6	280.8	452.8
Venezuela	MBHI	4037	3181	131.5	831.9	1048.1
<u>Averages</u>:						
All countries		1560	1272	47.1	400.4	422.6
Major borrowers		1180	870	2.2	485.1	483.2
Highly Indebted		1289	1123	59.7	343.1	335.3
MB & HI countries		3008	2388	83.8	431.1	583.6

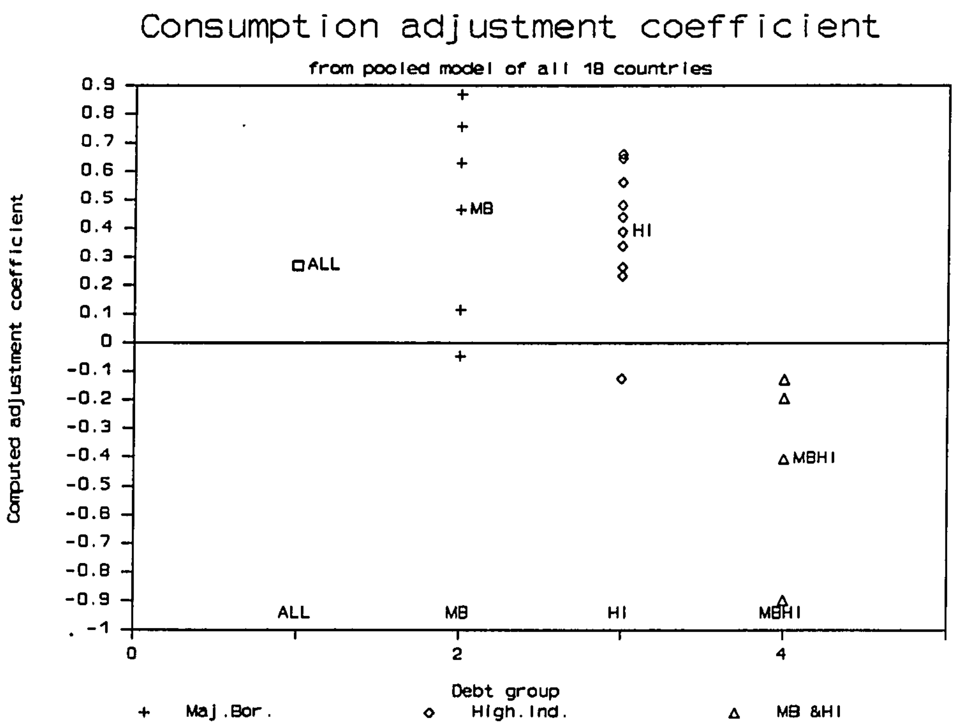

Figure 27. Adjustment factor computed from ALL model estimates

consumption falls well within the expected range for most countries. The very high income level of Venezuela appear to be an outlier causing significant shifts in the MBHI and ALL group averages. The mean estimate of all countries is thus not a fair representation of the adjustment factor of the countries selected. It must be noted that in the above plot as well as in the following analysis in this section, the reference to MB, HI and MBHI do not refer to the three different pooled models. Rather, all computations are made at country level based on the ALL model estimates, and the reference to MB, HI and MBHI only refers to the respective group means of such country-wise estimates.

It will also be observed that the MB countries had low borrowing in the post-1981 period. In general, these are countries with larger population and thus while the total borrowing is large, their per capita borrowing is small especially in the post-1981 period where repayments have been common in number of these countries.

Consumption and trade elasticities computed using the ALL model estimates of the parameters π_0, π_1, α_{24} and α_{25} and the post-1981 mean values of the relevant macro variables are presented in Table 18. The MB countries consistently had low elasticity of consumption with respect to borrowing. This can also be seen in Figure 28, where the computed consumption elasticities are plotted by debt

Table 18. Consumption and trade impact computations[a]

Country	Group	$\varepsilon_{c,b}$,	$\varepsilon_{m,b}$	$\varepsilon_{x,b}$
Egypt	MB	0.00266	0.00331	0.00327
India	MB	0.00286	0.00357	0.00353
Indonesia	MB	0.00579	0.00720	0.00712
Korea,(Rep.So.)	MB	-0.00003	-0.00003	-0.00003
Malaysia	MB	0.00026	0.00033	0.00033
Colombia	HI	0.00378	0.00471	0.00466
Costa Rica	HI	0.03147	0.03919	0.03875
Ecuador	HI	0.04485	0.05586	0.05523
Jamaica	HI	0.01740	0.02166	0.02142
Morocco	HI	0.00693	0.00863	0.00854
Nigeria	HI	0.01851	0.02305	0.02279
Peru	HI	0.04143	0.05160	0.05101
Philippines	HI	0.01602	0.01995	0.01973
Uruguay	HI	-0.00174	-0.00216	-0.00214
Brazil	MBHI	-0.00474	-0.00591	-0.00584
Mexico	MBHI	-0.00443	-0.00551	-0.00545
Venezuela	MBHI	-0.03704	-0.04613	-0.04561
Averages:				
All countries		0.00847	0.01055	0.01043
Major Borrowers		0.00231	0.00287	0.00284
Highly Indebted		0.01985	0.02472	0.02444
MB & HI countries		-0.01540	-0.01918	-0.01897

Marginal changes computed with 1982-87 average figures:

Country	Group	ΔC/ΔB	ΔM/ΔB	ΔX/ΔB
Egypt	MB	0.630	0.271	0.177
India	MB	0.870	0.116	0.086
Indonesia	MB	0.757	0.307	0.323
Korea,(Rep.So.)	MB	-0.045	-0.030	-0.032
Malaysia	MB	0.116	0.120	0.120
Colombia	HI	0.266	0.054	0.056
Costa Rica	HI	0.235	0.136	0.131
Ecuador	HI	0.340	0.121	0.128
Jamaica	HI	0.440	0.354	0.307
Morocco	HI	0.660	0.300	0.188
Nigeria	HI	0.562	0.086	0.115
Peru	HI	0.481	0.148	0.157
Philippines	HI	0.646	0.217	0.205
Uruguay	HI	-0.124	-0.034	-0.037
Brazil	MBHI	-0.127	-0.014	-0.020
Mexico	MBHI	-0.193	-0.034	-0.054
Venezuela	MBHI	-0.896	-0.292	-0.363
Averages:				
All countries		0.272	0.107	0.087
Major Borrowers		0.465	0.157	0.135
Highly Indebted		0.390	0.154	0.139
MB & HI countries		-0.405	-0.113	-0.146

[a]Computations are based on the ALL model estimates and the 1982-87 average figures of consumption, borrowing, imports and exports.

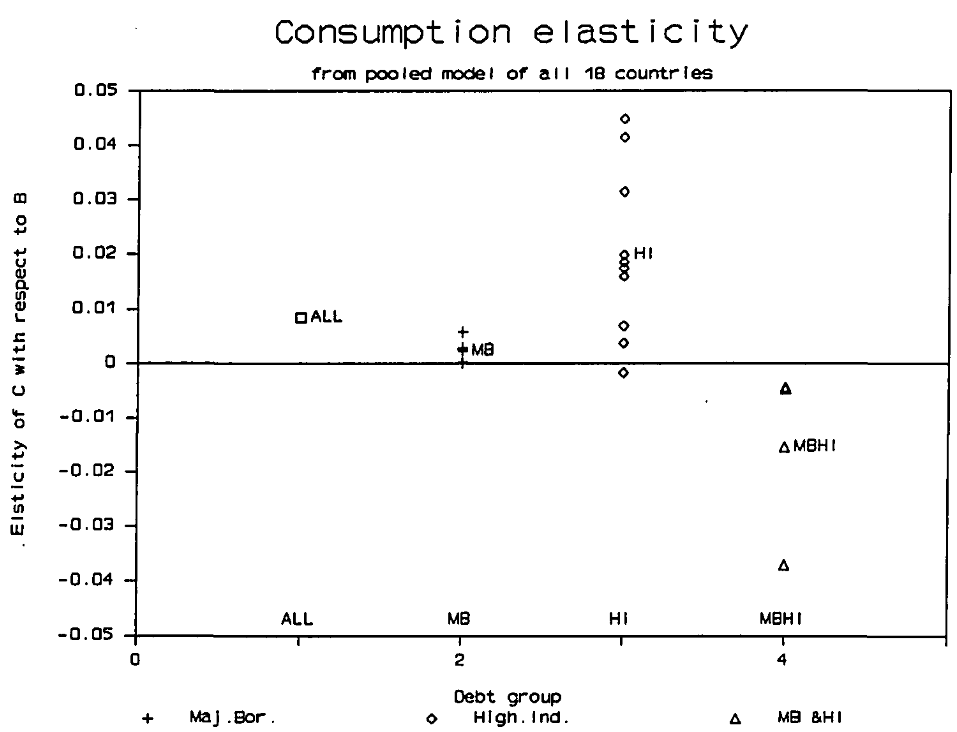

Figure 28. Consumption elasticity with respect to borrowing, by debt group

group, and the group means are identified by a corresponding label. The values for MB countries are clustered in the region of zero to 0.01, while those of the HI countries span a much wider range. The large negative elasticity of Venezuela is possibly an outlier as explained above, while the values for Brazil and Mexico are close enough to zero that, not much significance can be attached to their negative signs. In Figure 29, the computed consumption elasticity with respect to borrowing is plotted against the computed adjustment coefficient. Countries of the different debt groups are identified with different symbols in the plot and the group averages are labelled as appropriate. It will be observed that while adjustment coefficient spanned a similar, if not wider, range in the MB group compared to the HI group, elasticity of consumption remained close to zero for the major borrowers irrespective of the magnitude of the adjustment coefficient.

The other four parameters used in computing the import and export elasticities from the consumption adjustment factor are α_{24}, α_{25}, α_{42} and α_{43}. All of these are slope parameters, and in the model construction, it will be recalled, the slope parameters were assumed fixed across countries as was done in Khan and Knight model. Consequently, the elasticities, $\xi_{m,c}$ and $\xi_{x,m}$ are constant across countries and the import and export elasticities with

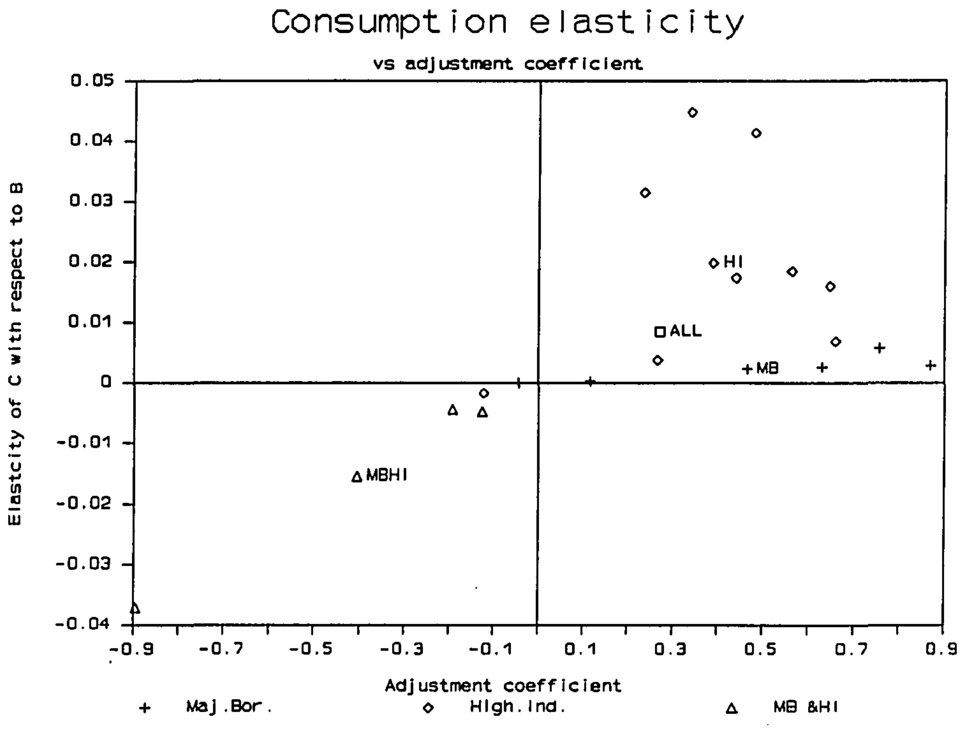

Figure 29. Consumption elasticity vs adjustment coefficient

respect to borrowing ($\xi_{m,b}$ and $\xi_{x,b}$) retain the same ordering among countries as the consumption elasticity. However, the level of imports and borrowing also enter the computation of the dollar value change in imports in response to changes in borrowing. Since these levels vary between countries, the distribution of computed change in imports differ among countries. The country plots of the change in imports, by group, is shown in Figure 30. While the change in consumption per unit change in borrowing of MB countries spanned a wider range than those of HI (Figure 27), changes in imports for the MB group appear relatively more concentrated. Since, the elasticity, $\xi_{x,m}$ is constant across countries, the dollar value of changes in exports due to a unit change in borrowing follows the same distribution as changes in imports. The computed change in imports was plotted against computed adjustment coefficients in Figure 31. The scatter does not evidence any distinction between the MB and HI groups. Two countries of MBHI group, namely Brazil and Mexico show relatively little response in consumption or trade to changes in borrowing, while the values for Venezuela appear to be a distinct outlier in all cases.

While the overall mean value of import response to relaxation of credit restriction was low, close to 0.1, the country plots show evidence of higher responses in many of

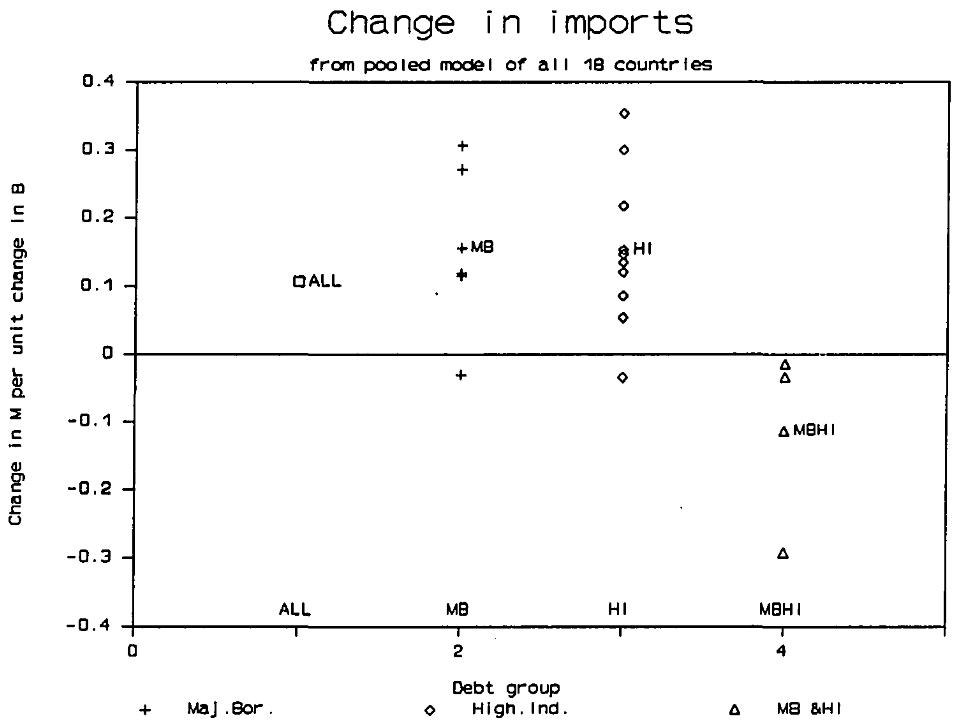

Figure 30. Change in imports, by debt group

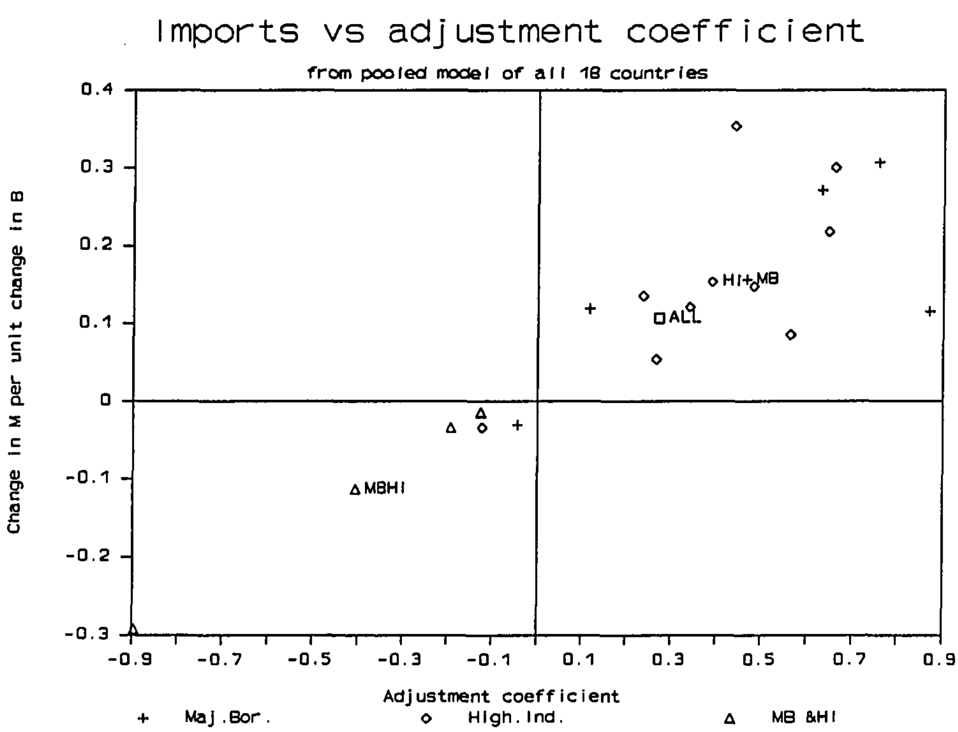

Figure 31. Change in imports vs adjustment coefficient

the countries ranging from close to zero to 0.4, ignoring the case of Venezuela with a very large negative response and four other countries with negative, but close to zero, values.

While the import response seen on a country-by-country case may appear reasonable, it was also observed (Table 18) that the magnitudes of import and export changes were closely similar, suggesting that a dollar increase in borrowing does not lead to any conspicuous increase in trade deficit. The ratio of the estimated parameters α_{24} and α_{25} determines the elasticity of exports with respect to imports. These are two (slope) parameters which were constrained to be constant across countries in the model. Also, in most of the countries there was little disparity between the values of exports and imports, especially in the post-1981 period. These lead to the computed change in exports to remain close to the change in imports.

In an attempt to examine how well this assumption of constant elasticity of exports ($\xi_{x,m}$) holds across the selected countries, and to get an indication of what the trade changes would be if the slopes were not held constant, the single country results were reviewed. The relevant parameter estimates of the seventeen single country models (the Turkey model was not estimatable because of inadequate number of observations) are presented in Table 19. The mean

Table 19. Single country model estimates of selected parameters[a]

Country(code)	Group	π_0	π_1	α_{24}	α_{25}	α_{42}	α_{43}
Egypt(EG)	MB	-0.365	0.00263	0.2358	0.3320	0.6711	0.5804
		(0.37)	(1.44)	(1.05)	(1.79)	(1.94)	(3.14)
India(ID)	MB	2.313	-0.00421	0.3130	0.6398	0.5109	0.6444
		(0.52)	(0.46)	(0.98)	(4.37)	(1.53)	(2.29)
Indonesia(IN)	MB	13.763	-0.10551	0.2868	0.3127	1.0627	0.3487
		(0.87)	(0.88)	(0.90)	(0.58)	(3.88)	(2.20)
Korea(KO)	MB	1.011	-0.00006	0.6712	0.9983	1.1170	0.1851
		(0.42)	(0.04)	(1.54)	(2.73)	(5.25)	(1.14)
Malaysia(MA)	MB	1.353	-0.00021	0.4943	0.9142	1.0389	0.1885
		(1.19)	(0.32)	(3.35)	(9.26)	(4.28)	(1.24)
Colombia(CO)	HI	1.545	-0.00041	-1.1297	0.4029	1.1244	-0.0326
		(1.02)	(0.43)	(2.88)	(1.52)	(6.05)	(0.18)
Costa Rica(CR)	HI	-15.320	0.00798	0.5036	0.4478	0.5260	0.4524
		(0.29)	(0.34)	(1.49)	(2.19)	(5.01)	(4.63)
Ecuador(EU)	HI	0.440	-0.00003	0.2150	0.5846	0.5819	0.3852
		(0.52)	(0.05)	(0.60)	(2.45)	(1.58)	(1.20)
Jamaica(JM)	HI	2.914	-0.00168	0.1044	-0.0100	0.4651	0.3014
		(1.49)	(1.11)	(0.28)	(0.03)	(1.45)	(0.83)
Morocco(MO)	HI	0.220	0.00008	-0.2489	0.3118	0.2891	0.7281
		(0.24)	(0.05)	(1.21)	(1.52)	(1.04)	(4.02)
Nigeria(NG)	HI	-0.321	0.00058	0.8048	1.2996	0.0585	0.8462
		(0.46)	(0.73)	(2.73)	(3.77)	(0.28)	(4.89)
Peru(PU)	HI	0.927	-0.00023	0.2805	0.4286	1.4699	0.0828
		(1.05)	(0.26)	(1.22)	(2.09)	(5.57)	(0.48)
Philippines(PH)	HI	0.117	-0.00202	0.1354	0.3960	0.4871	0.5784
		(0.01)	(0.15)	(0.78)	(2.12)	(2.73)	(4.49)
Uruguay(UR)	HI	7.569	-0.00295	0.2632	0.3695	0.7466	0.3148
		(0.61)	(0.60)	(1.65)	(2.72)	(3.49)	(1.60)
Brazil(BZ)	MBHI	4.297	-0.00174	0.5982	0.6548	0.0413	0.7962
		(2.85)	(2.10)	(1.98)	(1.91)	(0.12)	(4.57)
Mexico(MX)	MBHI	1.199	-0.00030	0.4074	0.0640	1.3750	-0.0722
		(0.72)	(0.77)	(2.06)	(0.31)	(8.48)	(0.57)
Venezuela(VZ)	MBHI	0.276	-0.00029	-0.0520	1.1449	-0.0649	0.9278
		(0.24)	(0.73)	(0.40)	(6.73)	(0.14)	(2.47)
Averages:							
All countries		1.290	-0.00637	0.2284	0.5466	0.6765	0.4268
Major borrowers		3.615	-0.02147	0.4002	0.6394	0.8801	0.3894
Highly indebted		-0.212	0.00015	0.1031	0.4701	0.6387	0.4063
MB & HI countries		1.924	-0.00078	0.3179	0.6212	0.4505	0.5506

[a]Values in parentheses are 't' values, with those over 1.42 (over 0.9 probability, at 7 degrees of freedom) underscored.

values of the different debt groups are presented at the bottom of the table. The 't' values are given in parentheses, with the values of over 1.42 (ten percent probability level with 18 of freedom) underlined for ease of recognition. As was noted earlier, it is apparent that the significance levels of most of the parameters, especially the π parameters, are low perhaps as a result of sampling error. A fair number of (44 out of 68) the other four slope parameters are estimated at better than ten percent significance level. The ratio of α_{24} to α_{25} ($\xi_{x,m}$), in general, indicates a larger discrepancy in the import and export responses. The average of all countries show a ratio of 0.42 (0.2284/0.5466) while MB, HI and MBHI group averages are 0.63, 0.22 and 0.51, respectively. It will be recalled that in the pooled ALL model estimate where the slope parameters were held constant across countries, the corresponding ratio was close to unity, thus resulting in insignificant changes in trade deficit due to increase in borrowing. The consumption, import and export responses in terms of elasticity as well as in dollar values were computed from the single country estimates and are presented in Table 20. The results can be studied closely to infer about each country response to change in levels of the borrowing constraint. For instance, most coefficients for Egypt had fair significance levels (except π_0). The change

Table 20. Consumption and trade impact computations from single country model estimates

Country	Group	$\xi_{c,b}$	$\xi_{m,b}$	$\xi_{x,b}$
Egypt	MB	0.0076	0.0121	0.0086
India	MB	0.0036	0.0052	0.0025
Indonesia	MB	-0.3306	-0.5394	-0.4948
Korea,(Rep.So.)	MB	0.0005	0.0007	0.0005
Malaysia	MB	0.0022	0.0028	0.0015
Colombia	HI	0.0125	0.0136	-0.0382
Costa Rica	HI	-0.2482	-0.2384	-0.2681
Ecuador	HI	0.0523	0.0495	0.0182
Jamaica	HI	0.0329	0.0219	-0.2281
Morocco	HI	0.0030	0.0032	-0.0025
Nigeria	HI	0.0079	0.0030	0.0019
Peru	HI	0.0571	0.0914	0.0598
Philippines	HI	-0.0364	-0.0420	-0.0144
Uruguay	HI	0.0038	0.0042	0.0030
Brazil	MBHI	-0.0008	-0.0002	-0.0001
Mexico	MBHI	0.0094	0.0121	0.0769
Venezuela	MBHI	-0.0386	0.0346	-0.0016
Averages:				
All countries		-0.0272	-0.0333	-0.0515
Major Borrowers		-0.0633	-0.1037	-0.0963
Highly Indebted		-0.0128	-0.0104	-0.0520
MB & HI countries		-0.0100	0.0155	0.0251

Marginal changes computed with 1982-87 average figures:

Country	Group	ΔC/ΔB	ΔM/ΔB	ΔX/ΔB	Δ(M-X)/ΔB
Egypt	MB	1.794	0.991	0.464	0.5270
India	MB	1.072	0.165	0.060	0.1046
Indonesia	MB	-43.529	-23.105	-22.561	-0.5442
Korea,(Rep.So.)	MB	0.873	0.641	0.458	0.1829
Malaysia	MB	0.943	1.004	0.550	0.4545
Colombia	HI	0.881	0.157	-0.459	0.6163
Costa Rica	HI	-1.856	-0.826	-0.909	0.0835
Ecuador	HI	0.396	0.108	0.042	0.0653
Jamaica	HI	0.832	0.358	-3.265	3.6230
Morocco	HI	0.281	0.109	-0.055	0.1642
Nigeria	HI	0.241	0.011	0.009	0.0019
Peru	HI	0.663	0.262	0.185	0.0776
Philippines	HI	-1.470	-0.458	-0.149	-0.3092
Uruguay	HI	0.271	0.066	0.051	0.0149
Brazil	MBHI	-0.021	-0.000	-0.000	0.0001
Mexico	MBHI	0.411	0.074	0.763	-0.6890
Venezuela	MBHI	-0.933	0.219	-0.013	0.2317
Averages:					
All countries		-2.3029	-1.1896	-1.4605	0.2709
Major Borrowers		-7.7693	-4.0608	-4.2057	0.1450
Highly Indebted		0.0266	-0.0237	-0.5057	0.4820
MB & HI countries		-0.1808	0.0977	0.2501	-0.1524

in consumption is likely an over estimate, and consequently the import and export changes too are possibly exaggerated. However, the imports and exports increase by substantially different magnitudes, thus causing a conspicuous change in trade deficit in response to an increase in borrowing. India, on the other hand, shows little response in imports (about 17 cents per dollar borrowing). This added imports boosts exports by 6 cents, resulting in a trade deficit of 11 cents. The balance of 89 cents is the non-trade deficit, being either added to reserves or lost as capital flight. The values for Indonesia are perverse of the large and negative $\xi_{c,b}$ (-0.3306) which is unexplainable. Note that the occurrence of negative values in the elasticity estimates, which was not infrequent, is difficult to explain except perhaps as possible problems in data. The computed change in trade deficit, using the single country estimates of the relevant parameters and the post-1981 mean of the macro data are plotted by debt group in Figure 32. The country codes as used in Table 19 and the group labels are noted along side the observations. Jamaica, with an outlier value of 3.62 was dropped in the plot to show the distribution of other countries within the 1 to -1 scale. In general, Korea, Malaysia, Colombia and Venezuela appear to show significant changes in trade deficit due to changes in borrowing. Brazil and Nigeria, on the other hand, appear

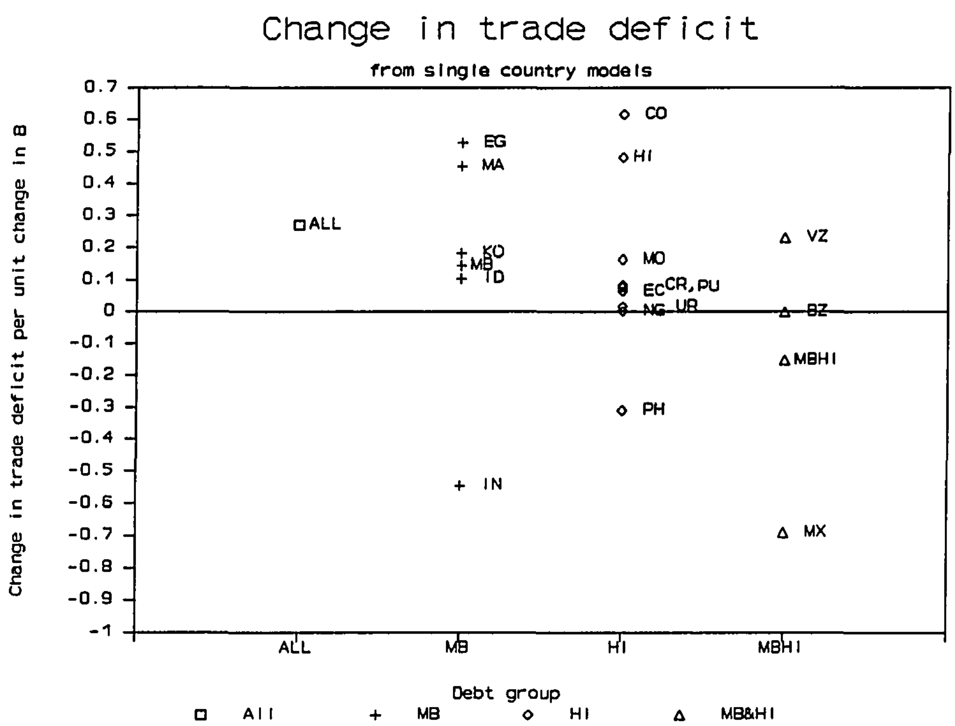

Figure 32. Trade deficit computed from single country model estimates and post-1981 mean values of macro data

to channel all extra borrowing into the non-trade deficit, with little or no change in trade deficit. It must be emphasized here that the confidence that can be placed on the present evaluations on the basis of country model estimates suffer due to the small number of observations. As such, the inferences made here are principally to obtain an indication of how well the common slope assumptions of the pooled model hold across the countries rather than to assert the validity of the computed values. The pooled model of all countries indicated an elasticity of exports to imports ($\xi_{x,m}$) close to unity, thus resulting in little response in trade deficit to any changes in borrowing. The single country estimates, on the contrary, demonstrate the variability in the response across countries which seem to negate the suggestion of common elasticities adopted in the pooled models.

F. Summary and Conclusions

Trade models formulated to assess the local and global impacts of the debt crisis generally tend to focus directly on the trade aspects, ignoring the underlying microeconomic causal effects (Frenkel and Razin, 1986). The inability to borrow (or conversely, an obligatory repayment) affects trade through the resulting adjustments in consumption and investments, and there is inter-temporal substitutability between consumption and investments. The current study is an attempt to incorporate such micro foundations of consumer theory in a typical macroeconomic setting of trade model, to investigate its applicability in evaluating the trade impacts of a credit restriction.

The first step was the development of a theoretical model of a country borrowing at exogenous interest rate, but with limit on quantity of borrowing. The comparative statics were derived with general form of utility and investment-production functions. Changes in borrowing limit causes simultaneous adjustments in consumption and investment, and the rate of adjustment along the reaction path is itself a function of the levels of consumption and investment. A change in interest rate has a positive, rather than negative, effect on investment under credit restrictions. Life time budget declines as interest rate rises, leading to a fall in consumption, and consequently frees available resources for investments. Finally, to integrate the microeconomic features into the trade model, both national income and balance of payment identities need to be simultaneously imposed. This necessitates differentiating trade deficit from foreign borrowing, allowing for a non-trade deficit.

Next step was construction of the empirical model. Khan and Knight's (1987) trade model was used, incorporating the results of the theoretical, inter-temporal model of consumption and investment behavior. Constrained consumption was modelled as a partial adjustment from unconstrained (desired) consumption dependent on the deviation of allowed borrowing from desired (unconstrained) borrowing. The partial adjustment coefficient was specified as a variable dependent on the level of absorption (income plus borrowing). While maintaining the general structure of Khan and Knight's model, modifications were adopted to make the model less restrictive. The variable, Performance Deficit, defined as the sum of trade deficit and non-trade deficit was used as a proxy for borrowing. Also, a policy variable was constructed from the observed change in reserve levels to proxy debt severity, and this variable was incorporated to assess possible impacts of policy environment on the endogenous variables.

The model constructed as above, was estimated using data of eighteen countries identified by the World Bank (1985) as either major borrowers or highly indebted. Number of model were run at various levels of aggregation of the time series data for the 1971-87 period. The largest aggregate model (of all eighteen countries) proved best, as measured by the coefficient of correlation for the model equations and regression mean square error in simulations. The parameters of the hypothesized adjustment in consumption were measured with at least 90 percent probability in all the pooled models. The rate of adjustment in consumption was negatively related to income in all models. The measure of policy impact had high significance levels only in the largest pooled model. In general, the parameter estimates of the consumption function in all but the largest model had low significance levels. The other three functions estimated in the model, namely, export supply, export demand and import demand had high explanatory power, and the coefficients were estimated with high confidence levels. They also, in general, complied with the priors with few exceptions.

Trade impacts, both in terms of elasticity as well as in dollar terms per dollar increase in borrowing, were computed for each country based on the pooled estimates. Computed mean values of groups appeared lower than would be expected. However, when the distribution among the countries were examined, wide variability among countries were observed. It was possible to identify countries where consumption was highly responsive to borrowing from those that were not responsive. The countries classified as major borrowers evidenced distinctly lower elasticity of consumption with respect to borrowing.

Response of trade deficit to change in borrowing was insignificant in the pooled models. The model structure restricted the export elasticity with respect to import to be constant across the countries in these models. Thus, the single country model estimates (despite the lower levels of significance, probably resulting from small degrees of freedom) were examined and the elasticity was found to vary considerably among countries. The resulting change in trade deficit proved to be much more significant than what the pooled models had indicated.

Construction of a theoretical basis for the assessment of trade impacts of credit restriction, incorporating the micro foundations, is the main focus of the present study, and the empirical application, only a test of the performance of the construct. The empirical results depend on both the suitability of the model as well as the consistency of data across time and countries. It would be best to test on a long time series of single countries, but such data are unavailable. Thus pooled cross sectional and time series data were selected. The estimates of interest were statistically acceptable, albeit only at minimum levels. The variability among countries appear too vital to be ignored.

Aside from the data considerations, the application is also weakened by its treatment of income. Although investment and consumption are endogenized, the investment impact on future income and the consequent effect on consumption is not endogenized. Instead, income is assumed exogenous, and the random walk theory of income is invoked to forecast future income. Endogenizing income, as a function of investment is thus an area of interest for further development. This aspect was not merely over looked in conducting this study. Various ways of formulating this into the model were considered, but it was evident that any such attempt will have to consider multiple period models spanning at least a three period setting. A three period setting necessitates restrictive assumptions for constructing the model in an estimatable form. It may in fact be more plausible to construct an infinite horizon model to endogenize income.

While within country variability is to be recognized for appropriate action to ease debt severity, there are important features common to sets of countries, in total and in the major categories of debt status that may be of use in examining the options. For instance, the countries categorized as highly indebted show greater response in their consumption adjustment to changes in borrowing. This is in no way understating the individual variations that needs to be addressed on country-by-country basis. Rather it only points to the possibility of common starting ground for assessment of the impacts in a global setting which needs to be followed by characterizing on the individual country basis.

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VIII. APPENDIX A

COUNTRIES SELECTED, BY DEBT GROUP

No.	Country	Major Borrower	Highly Indebted	
1.	Argentina	X	X	dropped
2.	Bolivia		X	dropped
3.	Brazil	X	X	
4.	Chile	X	X	dropped
5.	Colombia		X	
6.	Costa Rica		X	
7.	Ecuador		X	
8.	Egypt	X		
9.	India	X		
10.	Indonesia	X		
11.	Israel	X		dropped
12.	Ivory Coast		X	dropped
13.	Jamaica		X	
14.	Korea (South)	X		
15.	Malaysia	X		
16.	Morocco		X	
17.	Mexico	X	X	
18.	Nigeria		X	
19.	Phillipines		X	
20.	Peru		X	
21.	Turkey	X		
22.	Uruguay		X	
23.	Venezuela	X	X	
24.	Yugoslavia		X	dropped

IX. APPENDIX B

BALANCE OF PAYMENTS ACCOUNT OF BRAZIL, 1984[1]

	Cr.	Dr.[2]
Merchandise Exports	27,002	
Merchandise Imports		13,916
TRADE BALANCE	**13,086**	
Other Goods and Services Cr.	3,203	
Other Goods and Services Dr.		16,418
BALANCE OF GOODS AND SERV	**(129)**	
Private Unreq. Transfers. Net	161	
Official Unreq. Transfers. Net	10	
CURRENT ACCOUNT BALANCE	**42**	
Direct Investments	1,556	
Portfolio Investments		272
Long Term Capital		4,086
BASIC BALANCE	**(2,760)**	
Short Term Capital		3,195
Errors and Omissions	398	
PERFORMANCE BALANCE	**(5,557)**	
C'part to Monet/Demone. of Gold	336	
C'part to Monet/Demone. of SDR alloc.	229	
OVERALL BALANCE	**(4,992)**	
Exceptional Finance	10,434	
Valuation Changes	491	
Change in Reserves (offsetting entry)	(5,933)	

The Two sides of the International account:

Exceptional finance		10,434	Balance of G & S.		(129)
Changes in reserves		(5,933)	Non-trade Balance		
		4,501	Unreq. Tr.	171	
Total C'part adj.			Dir. Inv.	1,556	
Gold	336		P/F. Inv.	(272)	
SDR	229		L/T Cap.	(4,086)	
Val.Ch.	491	1,056	S/T Cap.	(3,195)	
			E & O.	398	(5,428)
- PERFORMANCE BALANCE		5,557	PERFORMANCE BALANCE		(5,557)

[1]Balance of Payments Accounts, 1988.
[2]These debit entries are negative in IFS accounts.

X. APPENDIX C
CONSTRUCTION OF Z_t, THE POLICY VARIABLE

Government policies are implemented at times when the reserves (R_t) are falling. A variable Z_t is constructed such that it takes a value between zero and one when reserves are falling and stays at zero when reserves are increasing. When reserves are falling , the value of Z_t depends on the rate of fall of reserves: when the rate is low, Z_t is close to zero, and as the rate of fall increases, Z_t increases towards its maximum value of unity.

Desired conditions are that, Z_t be defined as as function f(x), such that,

$$\begin{array}{lll} \text{for} & x > 0 & f(x) = 0 \\ \text{for} & x < 0 & 0 < f(x) < 1 \\ & & f(0) = 0 \\ \text{and} & & f'(0) = 0 \end{array}$$

The last condition makes sure that the function is not disjointed at x = 0, but rather has smooth first derivatives throughout.

With these considerations, Z_t is defined as,

$$Z_t = \begin{cases} 0 & \text{for } G_t > 0, \text{ and} \\ 1-e^{-G_t} & \text{for } G \leq 0. \end{cases}$$

where, $G_t = [(R_t - R_{t-1})/X_t]^2$, X_t = Exports. Thus, when (R_t-R_{t-1}) is zero, Z_t is zero, and Z_t' is also = 0.

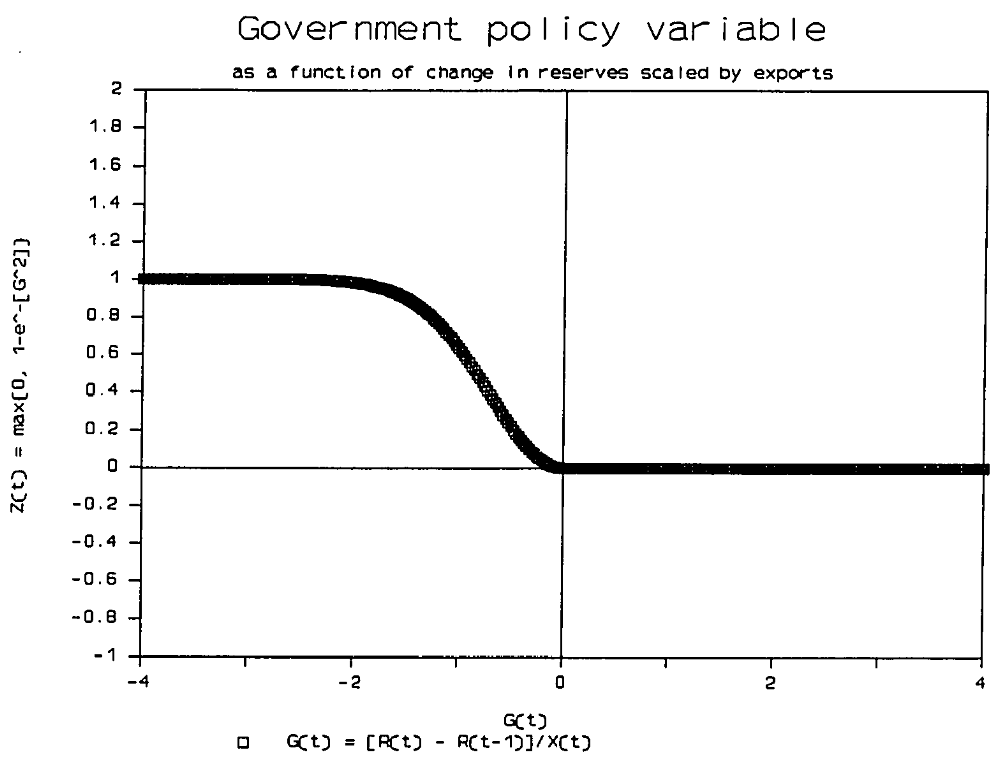

Figure 33. Construction of Z_t, the policy variable