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External shocks and the real exchange rate: a simulation model for Egypt

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External shocks and the real exchange rate: A simulation model for Egypt

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ABSTRACT

In March 1990, the Government of Egypt (GOE) launched a comprehensive economic and social reform program (ERSAP) to strengthen Egypt's ongoing adjustment program. The reform program constituted a major break from the policies pursued in the past, and had the underlying objective of modernizing the country and improving living standards. While the program has scored many successes , many observers of the Egyptian economy believe that the real exchange rate (RE) is currently out of equilibrium.

The RE prevailing in a country at any point in time is determined by two main factors: structural (e.g., external capital flows, changes in terms of trade, and commercial policy), and short run factors (macroeconomic policy in general). This study suggests and focuses on three of the structural factors that can affect the RE in Egypt. The first is the increase in the flow of foreign capital both public and private. The second is the commercial policy which is characterized by a high degree of protection for industry and can be traced back to the import substitution policy regime. The final factor is changes in terms of trade, especially for food imports. This study suggests that each of these factors has significantly contributed to the RE overvaluation in Egypt.

The study uses a computable general equilibrium model (CGE) to study the impact of changes in structural factors on the RE trade flows, production and consumption in Egypt. The focus is on competitiveness and relative price effects. With their origin in microeconomic theory, CGE models are well prepared to study the impact of change in

relative prices. The model is static, and the data base is a social accounting matrix for 1991/92, originally prepared by Lofgren (1995).

The results of the simulations suggest that, in general, these structural factors, especially the increase in the flow of foreign capital and the commercial policy, could very well be responsible for the RE overvaluation in Egypt.

CHAPTER 1. INTRODUCTION

Stabilization and Structural Adjustment in Egypt

Stabilization becomes necessary when a country cannot meet its foreign payments' obligations, because of some internal or external shocks or other circumstances. Stabilization programs are launched when the crisis results from internal or external shocks. These programs usually involve expenditure reduction and demand management policies, e.g., fiscal and monetary policies. They operate over a short period to enable the economy to recover from the temporary difficulty.

Structural adjustment programs, on the other hand, are launched when the perception is that the economic crisis involves more permanent supply-side problems, namely distortions and other inefficiencies. The solution then usually entails expenditure switching policies, namely devaluation, liberalization of the trade and capital accounts, or liberalization of interventionist domestic policies, including institutional reforms such as privatization. The presumption is that such measures are needed to move the economy toward its production possibility frontier away from an inefficient position inside it and above it on a higher growth path.

Clearly, the appropriate prescription must follow from a diagnosis of what caused the crisis as well as how the economy might respond to the reforms. Some of the stylized sources of "crises", all of which have relevance in the Egyptian context are:

First, distortions in the domestic price mechanism such as tariffs, subsidies, wage policies and various labor laws are prime examples of such policies. Fixing domestic prices,

and/or quantities could not initially have been inconsistent with world prices. A change in the external terms of trade, however, in the face of rigid domestic prices and an inflexible labor market, could easily lead to excessive domestic absorption and a crisis. A combination of expenditure reducing and expenditure switching policies is required to correct periodic stabilization crises.

A second stylized source of a crisis could arise from private sector external windfalls such as remittances. The ensuing increase in high powered money through the increase in foreign assets results in a domestic monetary expansion if the government does not sterilize the inflow. The inflow will lead to an excess demand for non-traded goods, an appreciation of the real exchange rate, and an external deficit in a regime of fixed exchange rates or exchange controls. However, the loss of external reserves through the deficit will provide a self-correcting mechanism in the sense that it will reduce the domestic money supply and spending. However, if the trade deficit lags the reserve inflow and there is an accumulation of foreign exchange reserves, and if the government wrongly perceives the external inflow as augmenting aggregate domestic resources, then the government might be prompted or advised to run a bigger fiscal deficit. This, however, will lead to a still larger external deficit which will not be self-correcting in the sense that it will be larger than the inflow of remittances.

A third stylized source of a crisis occurs from windfall foreign exchange gains and losses accruing to the public sector. Consider a foreign exchange windfall that accrues to the public sector. This could be distributed to the general public through reduced taxation or other transfers, or they could be used to increase public expenditures. In either case, the

government incurs a fiscal deficit that is covered by sales of foreign exchange to the Central Bank. Hence domestic borrowing need not rise. Nevertheless, the increase in foreign assets, unless sterilized, leads to an increase in the domestic stock of high-powered money. The incipient monetary expansion will increase the domestic price level through increases of the price of non-traded goods (leading to an appreciation of the real exchange rate). The increased spending will spillover to the external sector through a deficit on the current account financed by the newly acquired external reserves. The foreign reserve outflow will in turn reduce the domestic stock of high powered money and the money supply. This will create an excess supply in the non-traded goods' sector and downward pressure on the non-traded goods price. If, however, there are price rigidities and the relative price of non-traded goods cannot adjust, then a crisis arises when foreign exchange inflows cease.

The above scenario illustrates that most crises are really crises of the public sector: misjudgments about the causes of crises can create unsustainable situations. The expansion of the public sector, which is almost always part of a crisis, creates problems that make subsequent adjustment quite difficult. Egypt, while being in a situation of external imbalance for a long time, has managed to postpone the really painful but necessary adjustment, basically by cashing in on its strategic importance.

Essentially, external economic difficulties in Egypt have been circumvented by securing additional external finances through significant debt relief, the centerpiece of which was U.S. dollars (USD) 10 billion in official Paris Club debit forgiveness in three phases. This was besides the aid by the U.S. that perceived Egypt as a key player in the overall Middle East political economic situation. The U.S. forgave a large part of Egypt's official

debt. It is not clear whether Egypt can keep cashing in on its strategic importance indefinitely.

Observers of the Egyptian economy believe that the *real* exchange rate[1] is currently out of equilibrium. The main causes of the disequilibrium are believed to be the cumulative domestic inflation[2] and too much capital inflow, both private and public, that the country is trying to absorb. Following are some viewpoints expressed in Fletcher (1996):

> Although it is too early to assess the full impact of these sweeping reforms, Khedr, Ehrich and Fletcher (1996) note that since the early 1980s the domestic market prices of the major crops wheat, maize, rice and cotton have all risen in nominal terms. They are now close to border prices at the prevailing (unified) exchange rate. But there is a potentially disquieting aspect to these price movements. After increasing from 1981 to about 1991, "real" farmgate prices, i.e., those prices adjusted by the GNP deflator, subsequently have fallen somewhat. (This could reflect a problem with exchange-rate overvaluation). (p. 12)
>
> Too much foreign capital can generate huge current-account deficits, exchange-rate overvaluation, a collapse in domestic saving, and a future debt crisis... Thus, at this stage in sequencing Egypt's liberalizing reforms, I would suggest that the authorities keep tight controls over private capital inflows, particularly at short term, as they move purposefully to restrict domestic demand. In addition, the authorities must be careful not to overabsorb official development assistance, which can also contribute to exchange-rate overvaluation. (p. 15)
>
> To avoid exchange-rate overvaluation, the main effort to disinflate the Egyptian economy should be an attempt to restrain domestic demand rather than relying on the exchange rate itself as the principal nominal anchor. Continued fiscal consolidation as well as restraints on central and commercial bank credits are in order. But a major potential problem here is that the economy may be trying to absorb too much foreign capital, either in the form of official grants in aid or as private capital inflows, which could undermine the efforts of the monetary authority to keep the lid on the expansion of domestic bank credit. (p. 15)

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[1] The real exchange rate is broadly defined as a relative price that summarizes the degree of competitiveness of the external sector of a country for exports and imports substitutes (Krumm, 1993).

[2] See Chapter 3, Exchange Rate Overvaluation, for elaboration.

> The cumulative real appreciation (using the CPI as a deflator) of the Egyptian pound against the US dollar may have been over 40 percent between the end of 1991 and the middle of 1995. Although the real exchange rate may have been overly depreciated in 1991, the current regime of an almost-fixed nominal exchange rate, coupled with ongoing moderate inflation of 8 to 10 percent, is neither sustainable nor desirable. Increasing exchange rate overvaluation, leading to a continuing fall in real farmgate prices, jeopardizes Egypt's agricultural reforms in numerous ways. (p. 16)

The nominal exchange rate in Egypt has remained almost constant since the unification of exchange rates in Egypt in 1991. This stability is attributed to the huge capital inflow from the remittances of Egyptians working abroad and the intervention by the central bank. Whether the nominal exchange rate is fixed or free is an area of disagreement between the government of Egypt, the IMF and the World Bank[3]. This study, however, focuses on the real exchange rate that is believed to be currently in a disequilibrium.

The (RE) prevailing in a country at any point in time is determined by two main factors. Structural (e.g. external capital flows, changes in terms of trade and commercial policy) and short run factors (macroeconomic policy in general). This study suggests and focuses on three of the structural factors that can be responsible for the real exchange rate overvaluation in Egypt: (1) the increase in the flow of foreign capital both public and private; (2) the commercial policy that is characterized by a high degree of protection for industry

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[3] While the announced exchange rate policy is of a market determined rate, the IMF relation with Egypt became strained in1994 and 1995 over the issue of the Egyptian pound's real appreciation vis-à-vis other currencies and a September 1993 IMF program was suspended. In October 1996 the two sides reached a consensus on a package of structural reform measures through 1998. (*Foreign economic trends and their implications for the United States: A report for the Arab Republic of Egypt, Cairo.* The United States Embassy, Cairo, 1996.)

and can be traced back to the import substitution policy regime; and (3) changes in terms of trade, especially for food imports.

The purpose of the present study is to investigate in a general equilibrium framework. the impact of commercial policy reform and external shocks on the real exchange rate, exports. imports, production, consumption and the overall level of economic activity of the Egyptian economy. The analysis is conducted in the context of a computable general equilibrium (CGE) model. The model belongs to the class of models that are described in details in Dervis (1982). The model framework is especially appropriate for analyzing the effects of changes in commercial policy and external shocks (increase in the flow of foreign capital and adverse terms of trade shocks) because of its ability to capture directly the important relative price effects of various shocks; both types of shocks undertaken in this research involve change in relative prices[4].

Organization of this Study

The remainder of this dissertation addresses the formulation and implementation of a model to study the impact of commercial policy reform and external shocks on Egypt's real exchange rate and trade flows. Chapter 2 will review the literature on exchange rate policy, emphasizing the role of the real exchange rate and its determinants. Chapter 3 contains background information on Egypt, a general overview of the SAM framework, and a SAM for

[4] As discussed in the methodology section, these types of models, unlike macroeconomic models, capture factors such as resource constraints, material balance constraint (i.e., market clearing conditions) and other elements grounded in the general equilibrium microeconomic theory.

Egypt. Chapter 4 discusses the methodology of CGE modeling and gives a brief review of the standard neoclassical trade focused CGE model. The remainder of Chapter 4 contains a lengthy discussion about the model, its principle features and its internal consistency. In Chapter 5 the model is presented in a complete form followed by a brief discussion about calibration and the selection of the functional forms. Chapter 6 presents the results of the simulations. Finally, Chapter 7 presents the conclusions and suggestions for further research.

CHAPTER 2. CHANGE RATE POLICY

This first part of this chapter addresses the role played by the real exchange rate in resource allocation. The second part discusses in detail the factors that affect the real exchange rate—being an endogenous variable—and how these factors in turn will affect the overall level of economic activity in an economy through their effects on the real exchange rate[5].

There is an increasing awareness that the exchange rate is one of the principal policy variables in the economies of least developed countries (LDCs). For many commentators, inappropriate exchange rate policies have been at the core of the poor performance of the agricultural sector, particularly in the African countries (see Bautista & Valdes, 1993; Krueger, Schiff, & Valdes, 1988) and in Egypt (see Dethier, 1989).

Overvalued real exchange rates undermine exports, harm agriculture, and generate capital outflows in LDCs. The real exchange rate plays a discernible role in the profitability of tradables—both exportables and importables—and provides a long-term signal for the allocation of resources among various sectors. Its through the real exchange rate in a way that trade policies affect the various sectors of the economy, the real exchange rate represents a key relative price in the economy.

Policies to change the real exchange rate are often the centerpiece of structural adjustment programs which are designed to improve international competitiveness and shift resources toward the production of tradable goods. Changes in the real exchange rate affect, not only trade flows and the balance of payments, but also the structure and level of production

[5] Alternative definitions of the real exchange rate are given at the end of this chapter.

and consumption, employment and the allocation of resources in an economy. While the nominal exchange rate in LDCs is typically a policy instrument, the real exchange rate is an endogenous variable that responds to both exogenous shocks and policy influences. Because it is such a crucial variable, it is important to understand how domestic and external disturbances (shocks) would affect the real exchange rate and, therefore, how exchange rate policies should be formulated.

Determinants of the Real Exchange Rate

The real exchange (RE) in Egypt, as in other economies, can alter when either the nominal exchange rate changes or the relative price of tradables with respect to non-tradables changes. Therefore, factors which affect the nominal exchange rate and the relative price of tradables are the determinants of the RE. The main explanatory variables of the RE identified in the literature comprise: terms of trade changes, commercial policies, differential productivity changes, fiscal policies, monetary policies, capital inflows, demand shifts (toward non-tradables), export booms, changes in real interest rates in international markets, and changes in economic activity in the industrial countries.

The objective of this section is to discuss some of factors which are of relevance for this study. The following discussion assumes the "dependent economy " models of Salter (1959) as a basic framework. This framework assumes small economy producing two goods, tradables and nontradables. Tradables goods are those with prices determined by world markets, they consist of exportable and importable goods. Nontraded goods are not traded under the prevailing exchange rate (e.g., Khan & Edwards, 1986; Montiel, 1987).

Exchange Rate Policy

The nominal exchange rate is often used as a policy instrument in many LDCs. To restore balance of payments equilibrium many governments rely on various methods of expenditure-switching policies, including devaluation of the nominal exchange rate. The presumption is that, by altering the relative price of importables relative to exportables, devaluation will expand the tradable goods sector and reduce domestic absorption (see Agenor & Montel [1996] for a comprehensive survey).

It is, however, widely recognized that nominal devaluation will only have a transitory impact on the RE. In the long term, the effects of devaluation can be eroded as domestic wages and prices can rise by the full amount of devaluation, and the RE can return to its original level. In other words, in the long run the RE is neutral with respect to the nominal devaluation. To sustain a change in the real exchange, therefore, devaluation of the nominal exchange has to be accompanied by expenditure-reducing policies. Such policies would restrain the increase in domestic factor cost caused by devaluation, there by inducing changes in the RE rate.

The impact of devaluation on the RE rate can be decomposed into short-term and long-term effects (Khan & Lizondo, 1987). In the short term, the effect depends on the share of tradable goods in total expenditure and on the relative price elasticities of the demand and supply of non-tradables. The RE rate would depreciate by the amount of nominal devaluation adjusted for the increase in domestic prices. If prices for non-tradables are constant in the short term, then the impact of devaluation can be estimated as the product of the nominal exchange rate change and the share of tradables to exportables. In the long term, the impact on the RE rate will depend on how prices of non-tradables respond to shifts in resources away from the

non-tradable sector. (assuming other things remain equal, the more flexible the prices of non-tradables, the faster the effects of devaluation on the RE).

It has been shown that the magnitude of the change in the RE depends not only on the size of the devaluation and the degree of fiscal adjustment but also on the means by which the fiscal deficit is reduced (Khan & Lizondo, 1987). The required depreciation of the domestic currency will be larger if the fiscal deficit is reduced by increasing taxes than it will be if the deficit is cut by lowering government expenditures. In addition, the depreciation will be smaller if the cuts in expenditures fall on tradable rather than non-tradable goods.

It should be pointed out, however, that the belief that the nominal exchange rate and the RE move in the same direction has not been unanimously accepted in the literature. It has been argued, for example, that a devaluation of the nominal exchange rate may lead to a RE appreciation rather than depreciation or it may have no effect. An appreciation of the RE caused by a devaluation of the nominal exchange rate might occur in a situation in which wages are kept constant and the tradable goods sector is labor intensive. The neutrality of the RE rate to nominal exchange rate changes might occur when the reduction in private real wealth arising from the "tax" on domestic money is fully compensated for by the increase in the interest-bearing reserves of the government.

Capital Flows

International capital movements can influence substantially the RE. Capital inflow will lead to an appreciation of the RE and capital outflow to a depreciation. A capital inflow increases the supply of tradables (since the capital in real terms is an excess supply of goods)

and, as long as the income elasticity of demand for non-tradables is positive, the demand for non-tradables will increase and their price will rise (assuming that the goods are not inferior). The real exchange rate appreciates with the demand for tradables and non-tradables, which, in both cases, is higher than before.

On the production side, however, only the output of non-tradables rises, whereas that of tradables decreases. It should be emphasized that capital inflows affect the RE only to the extent that they are spent on non-tradable goods (i.e., their income elasticity of demand is positive). Only in this case would there be a monetary expansion (the central bank increases money supply in response to the capital inflow).

If the inflow of capital is spent solely on the outflow of capital caused by the current account deficit, then monetary expansion does not occur and foreign exchange flows determine the RE. Under a fixed-exchange rate regime, adjustments take place through devaluation and movements of the domestic price level. In the former case, additional capital inflows lead directly to a lower price for the RE, while in a fixed-exchange rate regime, the additional capital leads to an increase in the money supply so that prices will rise and the RE will fall (appreciate). Recent experience has shown that short-term capital movements can often be quite large and volatile. Because capital flows affect the RE, achieving targets for it can be very difficult, and short-term speculative capital flows can lead to overshooting or undershooting RE targets.

Fiscal Expansion

There are different ways in which government fiscal expansionary policies impinge on the RE. Let us first take the situation of increasing government expenditure under full employment, where the emerging budget deficit is being financed by borrowing from the private sector. In the absence of capital inflows, the real interest rate would rise and the effect on the real exchange rate would depend on the composition of different types of expenditures. If government expenditures encompass a high tradables component, the RE would tend to depreciate. Similarly, if it has a high non-tradable component, then the rate would tend to appreciate. This scenario assumes that private savings do not rise to pay future taxes to meet the interest payments on the borrowing. But, if the increase in the fiscal deficit is matched by a corresponding increase in private sector savings, total spending in the economy may remain unchanged and the RE would be unaffected.

Empirical evidence, generally, does not support the latter proposition either in developed or developing countries, and so fiscal deficits are usually associated with RE appreciations (Khan, 1986). When we allow for capital flows, savings to finance the additional fiscal deficit would be provided from abroad at a constant interest rate and crowding out of private sector expenditure does not occur. Capital flows would lead to an appreciation of the RE as explained earlier. Capital mobility substitutes a real appreciation of the exchange rate for an increase in the real interest rate.

Another issue worth mentioning is the fact that the composition of government expenditure(i.e., tradables non-tradables) may be quite different from that of private sector expenditures. In particular, it has been argued that the government's propensity to spend on

non-tradables is higher than that of the private sector (Harberger, 1986, Rodriguez, 1980). If this is so, then the relative price of non-tradables will increase as government expenditures rise and the RE will appreciate.

Another way that government spending influences the RE is through its effects on wages. If, for example, government spending drives up the general level of wages, either by raising the salaries paid to public servants or by increasing labor demand, then the RE will be affected. As long as nominal exchange rates and commercial policy are not adjusted, the increase in wages will squeeze profitability in the tradable sector since, in this sector, prices are exogenously determined and are constant. For the non-tradables, however, prices will rise with wages. The RE, therefore, would fall (appreciate). Thus, even with an unchanged fiscal deficit, variations in the level and composition of government spending would affect the RE and, as shown by Khan and Montiel (1987), such effects would be in force in the short as well as in the long term.

Trade Policies

Trade policies encompass policies directed toward imports or exports. The former might include changes in import tariffs and import quotas, while the latter reflects changes in export duties and subsidies. Import liberalization (i.e., a generalized reduction in tariffs and quotas) will increase the level of the RE, other things remaining equal. As domestic import prices go down with tariff reductions, imports increase. A deficit in the trade account is then generated which, if the Marshall-Lerner conditions hold, will require a higher RE to restore external balance. Similarly, import barriers would tend to appreciate the RE. If an import

tariff, for example, is imposed, the domestic price of the protected products will tend to rise relative to non-tradables and other tradables. The RE would therefore be expected to appreciate, encouraging imports and discouraging exports.

A point worth mentioning is that a contradiction may exist between trade liberalization and capital account liberalization. While trade liberalization is usually expected to produce real exchange rate depreciation, liberalization of capital movement is likely to bring about capital inflows which will tend to appreciate the real exchange rate. Thus, producers of importables can suffer a double blow, facing not only reduced protection but also an appreciated real exchange rate. For this reason some scholars have suggested that the liberalization of the capital account should occur after trade liberalization (for a detailed exposition of these points (see Edwards, 1986). Export promotion policies, on the other hand, make exports more attractive so that export supplies increase, thereby lowering the RE.

Terms of Trade

The effect on the RE of changes in the terms of trade is ambiguous and depends on such factors as the magnitude of the change, the share of exportables and importables in total production, and the nature of the price shocks impinging on the domestic economy. The ultimate effect is the outcome of substitution and income effects which are usually working in opposite directions. Suppose, for example, that there is a deterioration in the terms of trade. This adverse movement in the terms of trade has both supply and demand effects. On the supply side, the decline in the terms of trade would increase the production of non-tradable goods. In addition, on the demand side the fall in the terms of trade would have expenditure-

reducing effects since the real domestic income level falls. This, in turn, would tend to reduce spending on non-tradables. Thus, the net effect on the RE cannot be determined *a priori*.

Suppose that an adverse movement of the terms of trade is caused by a fall in the price of exportables. On the production side, such a movement implies that the exportable component of the tradable goods is exchanged in trade for fewer importables. Consequently, the overall quantity of tradable goods produced declines. The extent of the contraction of the production of tradables would depend, *inter alia*, on three factors: the magnitude of the adverse movement, the importance of the tradable sector in the economy, and the elasticity of production substitution between exportables and importables.

The larger the weight of tradables, the greater the contraction, and vice versa. On the other hand, the greater the elasticity of substitution between exportables and importables, the smaller would be the restraint on total production because resources would be reallocated among tradables away from exportables toward importables.

Similar considerations apply to consumers' demand. There would be a fall in demand. To restore simultaneous internal and external balance will require two actions. The first is a cut in expenditure equal to the national terms of trade effect and the second is a change in the relative price of tradables with respect to non-tradables. Obviously, the extent and direction of these adjustments will depend on demand and production substitution between importables and exportables.

Nevertheless, when the decline in the terms of trade is due to a fall in export prices, then the expectation is that the RE will depreciate. This is because there is a shift in demand toward tradables (since exportables are cheaper), while the production of tradables is expected

to fall. Furthermore, a fall in export price reduces the overall price of tradable goods relative to non-tradable goods and thus the RE tends to increase. This conclusion is reinforced when exportables comprise the main component of tradables and when they are not good substitutes for non-tradables.

Let us now consider the case of a deterioration in the terms of trade due to an increase in import prices. In this case, substitution among commodities would induce excess demand in the non-tradables market. As before, the ultimate effect on the RE is ambiguous since the relative price of non-tradables decreases with respect to importables and increases with respect to exportables. If substitution effects dominate income effects, and if the weight of importables in tradables is small, then it might be expected that the RE will appreciate (i.e., fall).

It should be noted that substitution effects may be significant when imports are competitive (i.e., when domestic substitutes for imports are available). If imports are not competitive, or if import price changes are large so that income effects dominate, then the likelihood of real currency depreciation in response to higher import prices is increased (Diakosavvas & Kirkpatrick, 1990).

Issues and Methods in Exchange Rate Analysis

What is the equilibrium exchange rate? Policy makers need answers to this question to determine how large the exchange-rate adjustment must be and how large a shock the domestic price system must sustain. In this section, alternative methods for calculating the

equilibrium exchange rate are compared, focusing on theoretical foundations and empirical tractability.

First, the real PPP exchange rate is defined as the nominal exchange rate multiplied by the ratio of an aggregate index of prices of trading partners, divided by an index of domestic prices. The PPP approach first finds a prior benchmark year when the current account was in equilibrium at some "sustainable" level (possibly, but not necessarily zero). The real exchange rate for that year is assumed to be the desired equilibrium real rate for the post-shock period. The equilibrium nominal rate is then calculated by computing the inflation differential between the country and its trading partners since the benchmark year.

The PPP approach has been criticized on both theoretical and empirical grounds. An obvious problem is that the external environment and structure of the economy have likely changed since the last time the current account was in equilibrium. Consequently, the real exchange rate for the benchmark year will not be an equilibrium value in the post-shock period.

Trade focused CGE models[6], on the other hand, unlike the PPP approach, can explicitly account for changes in the equilibrium real exchange rate due to changes in the balance of trade and in the international terms of trade. Second, the PPP approach uses a single index of world prices as the numerator in the definition of the real exchange rate. Typically, some index of the overall inflation rate in a country's trading partners is used.

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[6] Devarajan, Lewis, and Robinson (1991) use a much simplified structure, a version of the Salter Swan model, to show the exchange rate that results from changes in commercial policy.

Such an index will treat rises in export and import prices symmetrically. However a country is not indifferent between an increase in its export price (a favorable terms-of-trade shock) and an increase in its import price (an unfavorable shock).

In the same vein, in a trade focused CGE model, it is not the general level of prices in the trading partners that is relevant, but world prices of a country's exports and imports. This makes it possible to construct an exportable real exchange rate (the relative price of exportables to non-traded goods) and an importable real exchange rate (the relative price of importables to non-traded goods). Thus, the CGE model allows the different terms of trade shocks to affect the country differently.

Harberger (1989) and others argue that one should use some broad index of trading-partner prices on the grounds of data availability; for example, consumer price indices are available for the major industrial countries on a monthly basis. However, these indices include prices of non-tradables in the trading partners, as well as a different basket of imports, both of which are irrelevant for a country's own real exchange rate. Also, import and export price indices are generally available, so there is no need to look at data from trading partners.

A second approach to calculating the real exchange rate is based on the Salter-Swan model: compute a price index of tradables and divide by a price index of nontradables. While acknowledging the theoretical appeal of such an approach, both Harberger (1989) and Edwards (1989) recommend against it. Harberger claims that it "gives the wrong answer much of the time" and discusses a number of cases in which he argues it is a bad approach. For one, Harberger notes that, if all sectors with imports are labeled tradables, then an across-

the-board import tariff will lead to a depreciation of the real exchange rate (since the domestic price of imports will rise relative to nontradables), whereas an export tax will cause the real exchange rate to appreciate. Harberger argues, based on Lerner symmetry, that import and export taxes should have symmetric effects on the real exchange rate, and so favors a loose empirical approach using broad-based price indices.

The trade-focused model resolves this theoretical dilemma. An import tariff will cause the demand real exchange rate (PM/PD) to depreciate and the supply real exchange rate (PE/PD) to appreciate where PM, PE, PD refers to domestic prices of imports, domestic price of exports and the general domestic price level, respectively (see Devarajan, Lewis, & Robinson, 1991). An export tax will have exactly the same effect since, as shown above, changes in domestic relative prices are the same regardless of whether a price shock hits exports or imports.

There is a third approach to calculating the real exchange rate which has been termed the "elasticities" approach. Drawing on the analogy with the earlier elasticities approach to the balance of payments, it is argued that the real exchange rate should be related to the elasticities of demand for and supply of foreign exchange. In the trade-focused model, the elasticities are parameters in the underlying structural import-demand and export-supply functions. The elasticities approach is based on a reduced-form equation with no underlying structural model specified. Such a reduced-form model may be consistent with a variety of structural models.

Finally Mundlak, Cavallo, and Domenech (1990) employed a three-good model to look at the effect of macroeconomic policies on sectoral prices. They found it convenient

to specify different supply and demand real exchange rate, their results showed that the effect of a terms of trade shock will be different on the supply and demand real exchange rates.

The current study follows this approach for calculating the real exchange rate for simulations involving terms of trade change. Consequently, a real exchange rate for each of the importables and the exportables will be defined. With terms of trade shock, the relative price of the exportable to importable is not constant, so it is not possible to form a composite good called "traded good". For other simulations, the real exchange rate will be defined as a ratio of the index of the price of tradables over non-tradables.

CHAPTER 3. THE EGYPTIAN ECONOMY: PAST POLICIES AND RECENT TRENDS

In March 1990, the Government of Egypt (GOE) launched a new comprehensive economic and social reform program (ERSAP) to strengthen Egypt's ongoing adjustment and reform program. It constituted a major break from the policies pursued in the past, and has the underlying objective of modernizing the country and improving living standards. The program has three main objectives: (1) rapidly achieve a sustainable macroeconomic equilibrium; (2) lay the foundation for renewed economic growth in the medium and long term through a fundamental restructuring of the economy; and (3) minimize the negative short-term effects of economic reforms on the poor, through improvements in social policies.

Underlying the program measures is the Government's intention to make the transition from a highly interventionist centrally planned economy with significant price distortions to one that is decentralized, market based, and more outward oriented. With the reform process presently in progress, the Egyptian economy is going through a period of transition. The foundations for growth being put into place, supported by essential developments in the social sectors, would inevitably rely on agriculture, industry and tourism sectors.

Past Policies in Perspective

During the period between 1956 to 1984, Egypt pursued a public sector-led and inward-looking development strategy stressing social welfare objectives. As a result, state-owned enterprises played an important role in the economy, accounting for one of the largest shares of

gross national output and employment among the developing countries. Egypt's economy grew at an unusually high rates during 1974-85, averaging 8.5% a year.

The development strategy, however, remained one of import substitution financed by large inflows of foreign exchange from foreign assistance and borrowing, oil-related exports, workers remittances tourism, Suez canal revenue and foreign investment. Worsening credit-worthiness brought this growth strategy to a halt in the late 1980s, when imports and investments were further cut, and growth slowed down sharply to about 2.5 percent per annum. Public sector expenditures increased faster than revenues and the economy was not adjusting adequately to the negative external shocks.

The resulting massive fiscal and current account deficits were, in turn, financed through the large inflows of foreign assistance, foreign debt accumulation, surplus from the social insurance system, and domestic borrowing. Egypt became unable to service its debts, triggering a substantial reduction in gross capital inflows causing negative net transfers of capital and an accumulation of arrears resulting in a heavy external debt overhang.

Potential for Growth

In response to the deteriorating economic conditions, the GOE began implementing a new economic reform and structural adjustment program in the Spring of 1990. The first stage of the program aimed among other things at (a)curtailing inflation, the current account and budget deficits, and restoring creditworthiness; (b) liberalizing most prices in agriculture and manufacturing (while prices in transport and energy would be raised to long-term marginal cost or international levels); (c) phasing out most non-tariff barriers to imports and exports, and

reducing import tariffs dispersion, and (d) minimizing the effects of these reforms on the poor through implementing safety net mechanisms (World Bank, 1993).

Significant measures have been taken to initiate implementation of the reform program. The GOE, however, has proceeded more cautiously in key areas such as trade policy and privatization[7]. Exchange rates were unified in October 1991 as part of the reform program for the second standby agreement with the IMF.

Prior to the unification, a multiple exchange rate system existed. The official central bank exchange rate applied to export earnings from petroleum, cotton, rice, Suez Canal transit fees, and royalties from the summed pipeline; these proceeds were used to import essential row materials and foodstuffs. Between 1979and august 1989, the central bank rate was fixed at LE.7 a US dollar. It was adjusted to LE 1.1 per U.S. dollar in August 1989, and then to LE 2 per U.S. dollar in July, 1990.

There was also a transitory exchange rate between the central bank official rate and that of the commercial banks. The parallel foreign exchange market through the commercial banks applied to commercial banks foreign exchange receipts from workers remittances, tourism, and other export earnings. Finally, there was black market rate.

In October 1991, a free market for foreign exchange was established as part of ERSAP. It abandoned the multiple exchange rate system and implemented a unified exchange rate. Approximately two years later, exporters were given free access to 100% of the foreign

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[7] *Egypt:Country report on economic policy and trade practices.* Washington, DC: Bureau of Economic and Business Affairs, U.S. State Department , 1994.

exchange they earned, and companies and individuals were allowed to open foreign exchange accounts[8].

The market was freed and subject to only central bank buying and selling intervention. Interest rates were completely freed in March 1993. As a result, interest rates have increased throughout the economy. The Central Bank of Egypt now has three main goals for monetary policy: (a) to control monetary expansion; (b) to stabilize the Egyptian pound exchange rate against the US dollar; and (c) to promote gradual decline in the interest rate on the Egyptian pound from today's higher levels in order to encourage investment and promote economic growth.

Exchange Rate Overvaluation

Some evidence of the overvaluation of the Egyptian pound vis-à-vis the US dollar can be seen from Table 3.1. Using the CPI as a deflator, Table 3.1 suggests that the commutative real appreciation of the Egyptian pound may have been over 40% between 1991 and the middle of 1995.

Although the real exchange rate may have been overly depreciated in 1991, the current regime of an almost fixed nominal exchange rate, coupled with ongoing moderate inflation of 8 to 10 percent, is neither sustainable nor desirable. Increasing exchange rate overvaluation, leading to a continuing fall in real farmgate prices, jeopardizes Egypt's agricultural reforms in numerous ways.

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[8] *Policies affecting agribusiness in Egypt: A comprehensive assessment using the agribusiness policy inventory method, Vol. I.* Bethesda, MD: USAID, 1995.

Table 3.1. Inflation and nominal exchange rate devaluation (1991-1994) (percent)

Year/Quarter	Annualized inflation	Exchange rate devaluation against the US$
1991.1	12.7	17.1
1991.2	17.3	20.3
1991.3	22.2	20.5
1991.4	25.4	17.3
1992.1	23.8	9.2
1992.2	14.8	3.1
1992.3	9.1	1.0
1992.4	9.1	0.3
1993.1	11.9	0.6
1993.2	13.9	0.7
1993.3	12.4	1.1
1993.4	10.3	1.3
1994.1	7.4	1.1
1994.2	6.5	1.3
1994.3	8.2	0.9

Source: McKinnon (1996) p. 17.

In addition, as mentioned previously, the evidence presented in Khedr et al. (1996) is that farmgate prices (in real terms) increased from about 1981 to 1991 and subsequently have fallen somewhat. However, despite the substantial cumulative inflation of about 12 percent per year since then, the nominal exchange rate has been stable at about 3.3 to 3.4 pounds to the dollar.

The other major potential problem is that the economy is absorbing too much foreign capital, either in the form of official grants in aid or as private capital inflows, which could undermine the efforts of the monetary authority to keep the lid on the expansion of domestic

bank credit. Too much foreign capital can generate huge current-account deficits, exchange-rate overvaluation, a collapse in domestic saving, and a future debt crisis.

The Social Accounting Framework

The following section describes the social accounting matrix (SAM). This is intended to show how the SAM framework organizes information about the economic structure of a country in a particular year. A second objective is to show how the SAM provides the basis for the creation of a plausible model, see Payatt and Round (1984, 1985). This is followed by a brief discussion about a SAM for Egypt, and includes some of the embodied features of the Egyptian economy in 1991/92, the base year for the model. The final part presents an

Table 3.2. A schematic Social Accounting Matrix (SAM)

	ACTIVITIES	COMMODITES	FACTORS	HH	GOV'T.	CAPITAL	ROW
ACTIVITIES		Domestic sales		Private Consumption	Gov't Consumption	Investment	Exports
COMMODITES	Intermediate Input						
FACTORS	Value added						
HH			Allocation Matrix		Gov't. Transfers		
GOV'T.	Indirect Taxes	Import Tariffs		Income Taxes			
CAPITAL				Private Savings	Gov't. Savings		Foreign Savings
ROW		Imports					

overview of the recent development in the Egyptian economy.

A SAM is the synthesis of two well-known ideas in economics. The first derives from the input-output table, which portrays the system of interindustry linkages in the economy. The purchase of an intermediate input by one sector represents the sale of that same input by another sector. While this transaction is entered in a single cell in the input-output table, it appears in the accounts of the two different sectors using traditional double-entry bookkeeping. The SAM generalizes the input-output idea that one sector's purchase is another sector's sale to include all transactions in the economy, not just inter-industry flows. Any flow of money from, for example, a household to a productive sector (representing the purchase of that sector's output by the household), or from a household to the government (representing tax payments), is recorded in the SAM as an expenditure by some actor (the column) of some other actor (the row).

The second idea embodied in the SAM, derived from national income accounting, is that income always equals expenditure. While true for the economy as a whole, the SAM requires a balance in the accounts of every factor in the economy. For example, the income from sales in the agriculture sector must equal its total expenditures on intermediate inputs, labor, imports, and capital services. Traditionally, this is captured in double-entry bookkeeping by the requirement that the two sides of the ledger must be equal. In the SAM, incomes appear along the rows, and expenditures down the columns; thus the budget constraints require that the row sum (income) must equal the column sum (expenditure).

The SAM also distinguishes between "activities" and "commodities", allowing for two different effects. First, it permits more than one type of activity to produce the same

commodity, thereby allowing for different production technologies. For example, small- and large-scale farmers may produce the same crop (a single "commodity"), but with different factor intensities (two or more "activities").

Second, this treatment addresses several difficult problems that arise from dealing with imports. If imports are at all competitive with domestically produced goods (which is usually the case), then domestic demand will consist of both types of goods. However, only domestic goods are exported. Separating activity accounts (or the domestic production of goods) from commodity accounts (the domestic demand for goods) enables us to portray this difference.

The commodity account can be thought of as a supermarket that carries both foreign and domestic goods. The commodity column shows purchases of domestic products from the activity account and purchases of imports from the rest of the world: it also pays import tariffs to the government (although the incidence is on consumers, since the market prices are higher by the amount of the tariffs). The commodity row shows how the total supply of commodities is demanded by domestic purchasers, including intermediate inputs, household and government consumption, and investment goods.

In the factors account, the value added received by factors of production is allocated to households (via the allocation matrix). The household account shows that households, in turn, divide this income, as well as any transfers from the government, between private consumption of goods, income taxes, and private savings. Similarly, in the government account, the government receives income from taxes (including tariffs, indirect taxes, and income taxes) and spends it on consumption, transfers to households, and savings.

The last two rows and columns contain familiar national accounts identities. The capital account reflects the equality between savings (the row, comprised of private, government, and foreign components), and investment (the column). The rest of the world account represents the equality between foreign exchange expenditures (imports) and foreign exchange earnings (exports plus foreign savings).

The different accounts in the SAM delineate the boundaries of an economy-wide model. Specification of a "complete" model requires that the market, behavioral, and system relationships embodied in each account in the SAM can be described in the model. The activity, commodity, and factor accounts all require the specification of market behavior (supply, demand, and clearing conditions). The household and government accounts embody the private household and public sector budget constraints (income equals expenditure). Finally, the capital and rest of world accounts represent the macroeconomic requirement for internal (saving equals investment) and external (exports plus capital inflows equals imports) balance, (see Taylor, 1990, for an alternative presentation).

A SAM for Egypt

The primary data source for this study, is a SAM for 1991/1992 developed using Lofgren (1994). Lofgren's SAM is built mainly around the input-output table for the same year prepared by the Ministry of Planning in addition to national income data, the governmental budget, and balance of payments data (see Appendix A). Lofgren's SAM is the most recent

SAM available for Egypt. The latest SAM prepared for Egypt by CAPMAS[9] is for the year 1989/90. The SAM for 1991/92 distinguishes nine production sectors: labor, capital and land are used as factors of production, the government, household, and the rest of the world as

Table 3.3. Selected data for Egypt, 1991/92

Sectoral Structure	% GDP	% of Employment
Agriculture	16.2	33.0
Oil	9.5	0.3
Electricity	1.6	0.7
Construction	5.0	6.6
Industry	16.8	3.7
Transportation	10.5	4.5
Services	40.4	41.3
GDP/per capita		757.0
Inflation		13.6
Current Account of Balance of Payment		
Revenues		
Non-Oil goods exports		10.2
Oil exports		14.7
Non factor service exports		40.9
Net factor service and transfers		34.1
Total ($18.1bn)		**100.0**
Expenditures		
Goods Imports		89.6
Non factor service imports		10.4
Total ($14.5bn)		**100.0**

Source: Lofgren (1995), p. 21.

institutions. Taxes net of subsidies and tariffs are distinguished as policy instruments. A saving and investment account represents the loanable funds market.

[9]CAPMAS is the Central Agency for Public Mobilization and Statistics. This agency is the main source of statistical data in Egypt.

Selected data for 1991/92, the base year for model, indicate that the GDP per capita position the country between the groups of low and middle income countries according to the world bank classification. Compared to the preceding year, 1990/91, the reform program led to a rapid cut in the budget deficit (from 15.2% of GDP to 4.4%) lower inflation (falling from 19.8% to 13.6%), smaller (goods) trade deficit (decline from 19.7% to 15.5% of GDP), a larger current surplus (increase from 3.1% of GDP to 8.7%) and rapid accumulation of foreign reserves from $ 5.3bn to $10.8bn). Investment, however, decreased, from 25% of GDP to 20.2%. Real GDP growth remained at low level (Lofgren, 1995).

Table 3.4 shows the structure of trade and output in the Egyptian economy in 1991/92, the base year for the model. The model distinguishes nine sectors, out of the nine sectors, seven are classified as tradables with varying degrees of tradability, two sectors are treated as completely non-tradable (i.e., electricity and construction). Among the highly tradable sectors food processing and industry are net importers with imports constituting about 40% and 38% of their domestic supply respectively. Oil and transportation (Suez canal dues) are the highest net exporters with exports constituting 55% and 48% of their output respectively. These ratios for the two agricultural sectors are relatively small. For the combined two sectors the exports share in output is 5.3% and the imports' share out of its domestic supply is 11%.

The equations of the model used in the current study capture all the linkages that are found in the 1991/92 Egyptian SAM. The complete model will be presented in Chapter 4 and 5.

Table 3.4. Structure of trade and output in the Egyptian economy in 1991/92

	XXD	M	E	X	XD	M/X	E/XD	XD/XD
AGR	21.248	1.894	0.890	23.142	22.138	0.0818	0.0402	0.9598
AGF	8.330	0.288	0.112	8.618	8.442	0.0334	0.0133	0.9867
FOD	17.073	13.446	0.456	30.519	17.529	0.4406	0.0260	0.9740
OIL	7.236	0.988	8.919	8.790	16.155	0.1124	0.5521	0.4479
IND	37.703	26.416	4.699	68.553	42.402	0.3853	0.1108	0.8892
TRN	9.241	0.759	8.571	10.000	17.812	0.0759	0.4812	0.5188
SER	45.737	4.273	16.088	50.010	61.825	0.0854	0.2602	0.7398
ELE	3.564			3.786	3.564	0.0000	0.0000	1.0000
CON	14.910			15.926	14.910	0.0000	0.0000	1.0000

Recent Trends in the Egyptian Economy: A General Overview

Fiscal policy

The government's commitment to fiscal stringency has been a major element in its successful stabilization program. From a high of 17 percent of GDP In FY 90/91, Egypt slashed its budget deficit to 1.3 percent in FY 95/96. The FY 1996/97 draft budget foresees a deficit of LE 6.3 billion (USD 1.9 billion), 15 percent higher than FY 95/96. The overall expenditure is anticipated to be LE 77.5 billion (USD 22 9 billion), an 8.1 percent increase over FY 95/96.

However, this expenditure may increase owing to the higher international wheat prices. Total revenues are expected to increase by 7.5 percent to LE 71 1 billion (USD 21 billion), 64.9 percent of which is expected to come from taxes. The government instituted the first phase of a general sales tax (GST) in May 1991, but it is currently applied to importers and manufacturers only. Full implementation of a Value Added Tax (VAT) is scheduled to be phased in over the next two years. In January 1995, the unified income tax came into effect. While it reduces

marginal rates, and simplifies the tax structure, it does not broaden the tax base and so may lead to a decrease of revenue collected.

Monetary policy

According to the Central Bank, broad money supply growth slowed to 10.5% in FY 1995/96-S, from 11% the previous year. Foreign currency deposits as a percentage of the overall money supply fell from 51% in 1991 to 23% in mid 1996, a sign of depositors' confidence in the Egyptian Pound (LE). Total bank deposits were LE 174 9 billion (USD 51.6 billion) in FY 95/96, showing growth of 11.8 percent. Total loans, however, grew more rapidly, at 0.8% to LE 128.8 billion (USD 38 billion), reflecting the increase in economic growth. The Egyptian Pound remained stable at LE 3.39 per USD during this period. By some measures, the LE's real exchange rate has appreciated substantially since February 1991 against the USD, leading to a decline in exports. Egypt will have to address this issue sooner rather than later as increased economic growth is expected to put increasing pressure on the current account. Many observers argue that the government's focus on exchange rate stability has contributed to an emphasis on keeping interest rates high and a reluctance to lower tariffs, both inhibiting growth.

Principal Growth Sectors

Agriculture

Agriculture remains one of the important sectors, contributing 22% of GDP in FY 1995/96, and 27% of employment. This is the sector where economic liberalization has been

earliest and strongest and it has seen continuous productivity gains since the mid-1980s. Sugar cane is the only crop that farmers are obliged to market with a public sector entity. Cotton liberalization during 1995 holds promise of increasing cultivation of Egypt's main cash crop, which has declined sharply in the last decade as farmers switched to more lucrative animal feed crops. Much of the growth in non-oil exports in FY 1994/95 was owing to increased agriculture exports, especially cotton, potatoes, and rice. However, Egypt remains one of the world's largest food importers, able to grow only 45 percent of its domestic wheat requirements.

Industry

The latest available official data show the industrial sector contributed about 17% of GDP and 13.7 percent of employment in FY 94/95. In recent years, growth in industry has been sluggish owing to heavy indebtedness by the public sector and a generally weak demand in the economy. Recent anecdotal reports of sharply increased profits in private sector industry indicates that it is benefiting from 1995's increase in economic growth. The government has targeted industry as a growth area and, in particular is seeking to promote industrial exports. In January 1996, a Higher Council for Exports was formed and many of the impediments to exports it will consider are those affecting the private industrial sector.

Services

Egypt's services sector is dominated by tourism and the Suez Canal. Egypt's tourism industry has been in prolonged boom since the mid-1980s, with pauses in 1990-1991 because of the Gulf War, and 1993-1994 owing to fears of violence. However, vigorous growth

resumed in 1995 when tourist nights increased by 33 percent over the previous year, while revenues shot up by 37%, reaching an estimated USD 206 billion in earnings.

This trend continues. September 1996 figures show a 17.9% increase in tourism numbers over September 1995. Booming tourism has spilled over into booming construction: cement sales increased 23% in the second half of 1995 over the same period in 1994. Similarly, steel bar sales increased by 29 percent in the same period. Suez Canal receipts have grown slowly in recent years. Suez Canal dues showed a drop of 8.4% in FY95/96 over the previous year reaching USD 1.9 billion.

Energy

The oil and gas sector accounted for about 9.9% of Egypt's GDP in FY 1994/95, the latest year for which statistics are available, while oil products made up more than 36.6% of total exports. Oil production has remained steady at about 890 thousand barrels per day. In the past five years, improved concession rates have attracted a wide variety of oil multinationals into exploration for oil and gas. Continued small finds in the Gulf of Suez have enabled Egypt to maintain oil reserves despite its mature oil fields.

The greatest progress has been made in natural gas, with extremely promising finds in 1995 in the Western Desert (Shell, Repsol) and in the offshore Nile Delta region (Amoco, AGIP). These companies are making large investments in developing these fields, encouraged by attractive Egyptian purchase prices indexed to Gulf of Suez crude. At the same time, Egypt has built a gas distribution network reaching most major electrical plants and stretching some 3000 kilometers. Egypt expects its gas consumption will rise from the current 1.3 billion cubic

feet of gas per day to 2.0 billion by the year 20009 although this rise will depend heavily on increased economic growth. Owing to the strong new discoveries, by 1999 Egypt will have an exportable surplus of gas.

Employment and the labor market

As for employment by sector, the service sector is the largest employer accounting for more than 41% of employment; agriculture follows with 33% of employment, then construction, transport and industry (this is based on data for 91/92 which is clearly different from the figures given for 95/96). The sectors accounting for the smallest share of employment are oil and electricity accounting both for only 1% of employment.

Egypt's total domestic work force is expected to reach 16.9 million during FY 1995/96. Official government figures place the unemployment rate at 9.4 percent in FY 1995/96. International observers, however estimated that in 1993 the figure was about 21 percent. Egypt's job creation, estimated in 1995 at 250 to 300 thousand (including the informal sector), continues to fall short of the estimated 500 thousand annual expansion of the work force. Notably, the two largest employers, agriculture and the government, offer very limited prospects for job expansion. Underemployment probably affects one-third to one-half of all workers. Approximately 2.5 million Egyptians work overseas.

Balance of payments

Assisted by generous Gulf aid, exceptional debt relief, and strong inflows from remittances, tourism, and Suez receipts, Egypt's balance of payments moved into surplus in FY 91. By September 1993, Central Bank reserves were approximately $15 billion

(equivalent to almost 17 month of imports). Such capital inflows have contributed to the appreciation of the effective exchange rate of the Egyptian pound. While this may be expected to help slow inflation, it could have detrimental effects on the process of diversification and expansion in the industrial sector and on export performance.

According to the Central Bank. the current account balance registered a USD 128 million deficit in FY 1995/96, down from the previous year's (revised) surplus of USD 387 million. Egypt has strong surpluses in transfers and the services account. Remittances from workers in the Gulf countries, the largest single source of foreign earnings, totaled USD 2.8 billion, a drop of 14.6 percent from the previous year. Government transfers rose by 1.4 percent to 932 million dollars. Egypt's services account jumped 33 percent to USD 5.4 billion in FY 95/96, led by large surges in tourism. Egypt's merchandise trade deficit increased 17.6 percent to USD 9.23 X billion in FY 1995/96. Non-petroleum exports declined by 14.9 percent, led by a decline in agricultural exports while petroleum exports increased by 203 percent.

The overall export decreased by 7.9 percent, to USD 4.5 billion dollars. Imports, on the other hand grew 7.9 percent reaching USD 13.8 billion dollars. The artificially high Egyptian pound is a major reason behind the poor export performance. This again suggests a problem with the real exchange rate overvaluation.

CHAPTER 4. FORMULATION OF THE MODEL

This chapter is divided into two parts. The first part is intended to show the appropriateness of the methodology for studying the problem at hand and briefly discuss the major features of the "standard" neoclassical, trade-focused CGE model. The following part contains a lengthy discussion about the formulation of the model and its principal features. This is intended to give a clear and through understanding of the working of the model. The final section of this chapter explores the internal consistency and appropriateness of the model for this study.

Methodology

CGE models have been used for a wider range of issues, from medium- to long-term macro economic policy analysis to the more traditional microeconomic issues analyzed in developed countries as well. Three reasons account for this wider range of applications: (1) reliable time series for sufficiently long periods are usually not readily available; (2) if available the data are often not appropriate for standard econometric analysis without considerable further preparation to remove inconsistencies; and (3) significant changes in policy regimes often take place, calling for different structural models , there by reducing the time span available for hypothesis testing.

Policy applications have ranged from long running issues such as the impact of alternative development strategies on growth and resource allocation, or on policy concerning exhaustible resources, to medium run issues such rural-urban migration, labor market and employment, the functional and size distribution of income, and tax reform. Because foreign

exchange is scarce in most developing countries, the issue of foreign trade policy has occupied center place in the majority of applications.

Even in the applications that do not have a foreign trade focus, the way foreign trade is modeled has a decisive influence on the outcome of policy simulations. For example, in a model focusing on income distribution, change in the equilibrium value of agricultural trade in response to a change in policy will depend on assumption about the behavior of exports and imports.

The issue of foreign trade policy and the interaction between the domestic economy and foreign sector is well suited for general equilibrium rather than partial equilibrium policy analysis because of the sensitivity of domestic resource allocation to developments in the external sector. The extent to which the scarcity value of foreign exchange is affected by change in policy cannot be easily estimated in partial equilibrium analysis because of the difficulty of estimating excess demand functions for tradables and non-tradables without specifying the appropriate economy wide budget constraint (de Melo, 1988).

Neoclassical Trade Focused CGE Models

Virtually all trade-focused CGE models[10] developed over the past decade, whether applied to developing or developed countries, share a common core theoretical specification that represents an extension of the neoclassical trade model incorporating tradable and non-tradables. The theoretical framework starts from the Salter-Swan model, which classifies sectors as either purely tradable or non-tradable, and the real exchange rate is defined as the

[10] See Robinson (1988) and Bergman (1990).

relative price of tradable and non-tradables. With only a few exceptions, trade-focused CGE models have extended the Salter-Swan model, incorporating the Armington (1969) specification and treating imports and domestic goods with the same sectoral classification as distinct goods with a specified elasticity of substitution in demand.

Most models have also extended this specification to the export side, specifying that there is an elasticity of transformation in each sector between goods supplied to the domestic market and those supplied to the export market. By differentiating exports, imports, and domestically produced goods sold on the domestic market, the CGE model effectively increases the scope of the non-tradable sector.

All domestically produced goods sold on the domestic market are defined as "semi-tradable" relative to both exports and imports and serve the role of nontradables in the Salter-Swan model. The assumption of product differentiation on both the import and export sides is very appealing for applied models, especially at the levels of aggregation typically used. The specification is a theoretically clean extension of the Salter-Swan model and gives rise to normally shaped offer curves. The effect is to endow the domestic price system in the model with a realistic degree of autonomy, partially insulating it from changes in the world prices of exports and imports and from changes in the exchange rate or protectionist policies (tariffs, subsidies, or quotas).

Many single-country CGE models make the small country assumption, fixing the world prices of exports and imports. It is straightforward, however, to add downward-sloping world demand curves for exports. The effect is to specify both upward-sloping and downward-sloping demand curves for exports in each sector.

In various studies[11], the import aggregation and export transformation functions have been typically specified as constant elasticity of substitution (CES) and constant elasticity of transformation, (CET) functions, respectively. In these studies the model has seven prices associated with each sector: the world prices of exports and imports; their domestic prices which are linked to world prices through the exchange rate, tariffs, and subsidies; and the prices of the domestic substitute, sectoral output (the CET aggregate), and the composite goods (the CES aggregate).

In effect, changes in the prices of imports and exports are not completely "transmitted" to the prices of domestic goods in the same sector categories. For a single country model, the CES and CET functions capture the reasonable notion that it is not easy to shift trade shares in either export or import markets. In single-country models, the CES formulation for the import-aggregation function has been criticized on econometrics grounds. Its constraint is, for example, the income elasticity of demand for imports to be one in every sector. The distinction between exports, imports, and semi-tradable is important because it determines the role of the real exchange rate in achieving equilibrium.

In the CGE model, the real exchange rate is a well-defined relative price. The model specifies a functional relationship between the balance of trade and the real exchange rate (the relative price of tradables and semitradables). This relationship is one of the crucial driving mechanisms determining how external shocks and stabilization policies will affect the real side of the economy (Robinson, 1991).

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[11] See Mercenier and Srinivasan (1994), Srinivasan and Whalley (1986), and Mitra (1994).

Factor markets, product markets, and households

Neoclassical CGE models assume profit-maximizing behavior by producers, utility maximization by consumers, and markets which clear through flexible adjustments in wages and prices. Given the focus on income distribution, models disaggregate the household sector and differentiate the factor market, especially the labor market. Given that adjustment will occur through market mechanisms, the model will capture distributional effects largely by specifying a detailed mapping from the functional distribution to the household distribution. Adelman and Robinson (1989) describe this mapping as the "extended functional" distribution. specifying in detail the factors of production owned by households. It is obviously crucial to specify as much detail as possible in order to capture the chain of causation that moves from shocks and policy responses, which largely hit product markets, through changes in wages. profits, and employment, and finally to the distribution of income. While it is important to disaggregate households and factor markets, the more critical assumptions concern the working of the factor and product markets. Assuming profit maximization, flexible prices, and functioning markets implies that the economy will always operate at full employment (Robinson 1991) .

Macro closure and the neoclassical model

The neoclassical CGE model contains three basic macro balances: balance of trade. savings-investment, and government deficit. In this model, all after tax income accrues to the single household, which then splits it between savings and consumption. Government savings is determined residually, equaling government revenue minus government expenditure.

Foreign savings (the balance of trade) is specified exogenously. The result is a savings-driven macro specification, or "neoclassical closure".

The model has no independent investment equation ; aggregate investment is set equal to aggregate savings. In addition, the neoclassical model assumes full employment, so aggregate real income is fixed. While a neoclassical CGE model may contain macro aggregates, as must any economy wide model, it is best seen as a neoclassical general equilibrium model of production and exchange. The addition of government, savings investment, and the balance of trade are done in ways that retain the notion of flow equilibria and do not strain the Walrasian paradigm (Robinson, 1991).

Macro closure and the balance of trade

The balance of trade provides another source of savings, or injection, into the loanable funds market. Since all trade-focused CGE models embody a functional relationship between the balance of trade and the real exchange rate, variations in the real exchange rate will have a strong effect on the loanable funds market. It is possible to specify a macro closure which works entirely through changes in the balance of trade. Devarajan and de Melo (1987) specify such a model for franc-zone African countries. In these countries, the local currency is tied to the French franc, so they have no independent monetary authority.

In addition, it is reasonable to assume that real government expenditure and aggregate real investment are fixed exogenously. Given fixed tax rates, government revenue and private savings may not suffice to finance government expenditure and real investment. For these

countries, it is assumed that any shortfall is financed by foreign borrowing. In effect, the French central bank finances the sum of the twin deficits.

The neoclassical CGE model can be extended to capture these assumptions. Since real investment and government expenditure are fixed, the model is "investment driven" rather than savings driven. The demand for funds in the loanable funds market is essentially set exogenously. The balance of trade is now an endogenous variable, providing the necessary injection into the loanable funds market to achieve savings-investment equilibrium.

The nominal exchange rate is chosen as numeraire, reflecting the fact that the exchange rate in these countries is tied to the French franc. The domestic price level will then vary to achieve a real exchange rate that generates a balance of trade that achieves macro balance. The CGE model will thus solve for a flow equilibrium that is consistent with the assumed macro behavior.

The CGE model reflects the macro rigidities, in particular the government revenue constraint. Given the macro assumptions, this model indicates that these countries might well react in a counterintuitive way to some standard policy packages. Consider, for example, the imposition of an export subsidy. The direct effect is to encourage exports, which should improve the balance of trade. The subsidy, however, represents expenditure by the government and, without any increase in taxes, will increase the government deficit. The increased deficit is financed by foreign borrowing, which will lead to a revaluation of the real exchange rate, and so counteract the effect of the subsidy. The net effect will certainly worsen the balance of trade and may actually reduce exports. The adverse revenue effect of the subsidy can easily

overwhelm the beneficial relative-price effect. Factors are fully employed, product and factor markets clear, and changes in macro aggregates will have little or no affect on aggregate GDP.

In addition, the model is homogeneous (solves only for relative prices). The equilibrating variable is the real exchange rate; it does not matter whether the nominal exchange rate or the aggregate price level is chosen as numeraire. This model demonstrates the importance of macro effects which work through changes in the real exchange rate and the balance of trade, even with a neoclassical model of the domestic economy (Devarajan & de Melo 1987).

Overview of the Model

The model developed for this analysis follows the standard CGE methodology as described in details in Dervis et al. (1982). Both neoclassical and structuralist features are included in the model for example sector specific production factors, The neo-classical part of the model concerns the assumptions of homogeneous commodities, perfect competition and market clearing at home, whereas foreign commodities are treated as differentiated products and price differentials between domestic and foreign goods are possible.

Overall, the model assumes a fairly flexible Egyptian economy. The government has pervasive control over the Egyptian economy, both by direct ownership of industrial production units and by rules and regulations. Nevertheless, it is part of the ongoing SAP to reduce the government's interference with the markets. For example, public enterprises in principle now have been converted into independent profit maximizing units, and the

government has revoked the employment guarantee. This research, therefore, analyzes the effects of particular shocks in a market based economy.

Figure 4.1 shows the structure of the Model schematically. Production of each of the commodities specified in the SAM is modeled by Cobb Douglas production functions. Each commodity corresponds to one sector of the economy. First order conditions determine the demand for labor, capital, and agricultural land. Production factors are owned by households except for some government owned capital and supply is exogenously fixed. Firms pay value-added to factors of production and the perfect competition, constant-returns-to-scale technology ensures that the distribution is exhaustive.

Domestically produced goods are either used at home or exported. Intermediate good demands are determined by linear Leontief input-output equations. No difference exists in the production of goods used for consumption, as intermediates, or investment goods. Households derive income from given quantities of production factors, as well as transfers from abroad and the government which are largely exogenous. They pay income tax on factor income and transfers, and also save a given part of their incomes. Households maximize utility given disposable income and derived commodity demand is modeled as linear expenditure system (LES) which means no substitution occurs.

The modeling of foreign trade regards intentionally traded goods as differentiated by country of origin, using the Armington specification. Domestically available tradables are composites of imported and domestically produced goods and imports are imperfect substitutes for domestic goods. A constant elasticity of substitution function specifies users' demand tradeoff. Egyptian exports are imperfect substitutes for other countries goods.

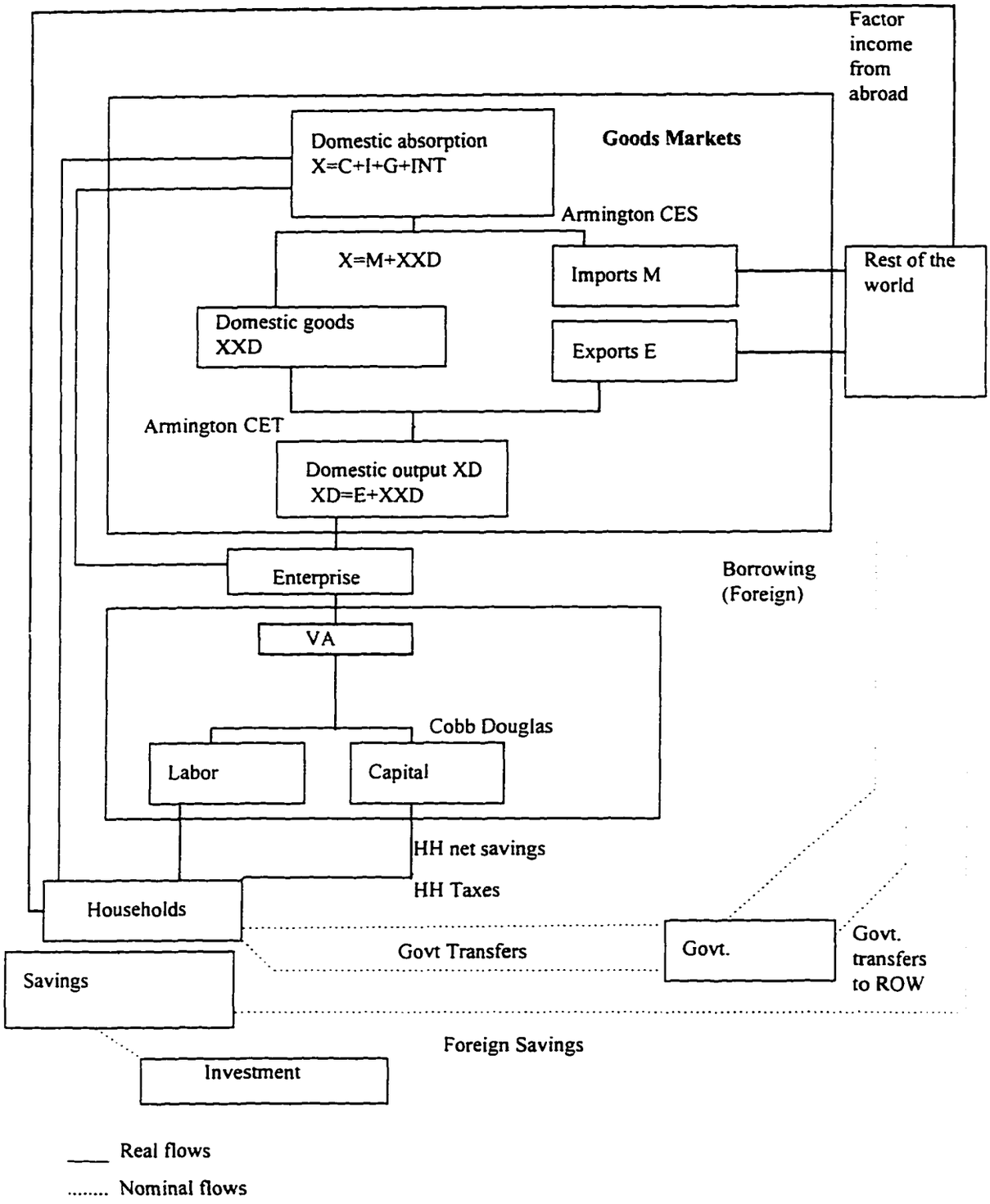

Figure 4.1. Flow chart of the model

Exported goods are not the same as domestically sold goods and a constant elasticity of transformation (CET) function specifies producers' supply tradeoff. Exports, imports, and foreign savings, as well as transfers to and from the rest of the world determine the current account balance. The exchange rate adjusts to ensure equilibrium on the market for foreign exchange.

Household savings, government, and foreign savings determine the availability of loanable funds. A "closure rule" has to be chosen which specifies which variables adjust to ensure macro-economic equilibrium. The main policy simulations are performed using a neo-classical closure: the level of investment adjusts to ensure macro-economic equilibrium. Investment goods are demanded using fixed commodity shares.

Composite goods and the treatment of imports

Pure trade theory views domestic goods as perfect substitutes for imports. Such treatment rules out cross hauling: a country may be either an exporter or importer but not both. Most importantly, for a small country the domestic prices of tradables are determined internationally. Under conditions of constant returns to scale and perfect competition, if the number of factors is less than the number of traded goods such perfect substitute assumption leads to over-specialization, that is, either the domestic or foreign good swallowing up the whole domestic market (Samuelson, 1953).

To prevent the problem of over-specialization, allow for cross hauling, and confer some sort of market power on a small open economy, the Armington assumption is adopted. Thus, domestic goods are assumed imperfect substitutes for comparable goods produced in

other countries. Domestic goods and comparable imports, as well as goods produced for domestic markets and comparable exports, can be different—both in the physical characteristics and in the package of services involved in their marketing. Prices reflect these differences. In the model, domestic purchases, including consumers', are assumed to purchase only composite goods. The share of the domestic component in the composite goods versus the imported component is determined by the price of domestic goods relative to their import price. This is derived by minimizing the cost of obtaining one unit of domestic good i and one unit of import good subject to a constant elasticity of substitution (CES) constraint:

$$\text{Minimize: } P_i X_i = PM_i . M_i + PD_i . XXD_i \qquad (1)$$

$$M_i, XXD_i$$

$$ST \quad X=CES(M_i, XXD_i)$$

The corresponding first order condition gives the intermediate-import demand as:

$$M_i/XXD_i = f_1 (PM_i / PD_i) \qquad (2)$$

Where PM = Imports price and PD = Domestic intermediate price.

The familiar first order condition equates the marginal rate of substitution in the composition of X to the price ratio of domestic to imported commodity. Figure 4.2 shows how relative prices determine the optimal allocation of demand between domestic and imported goods given the assumption of product differentiation. The iso-absorption curve represents an indifference curve derived from the import aggregation function, where the combination of domestic use and imports is consistent with the supply of the composite

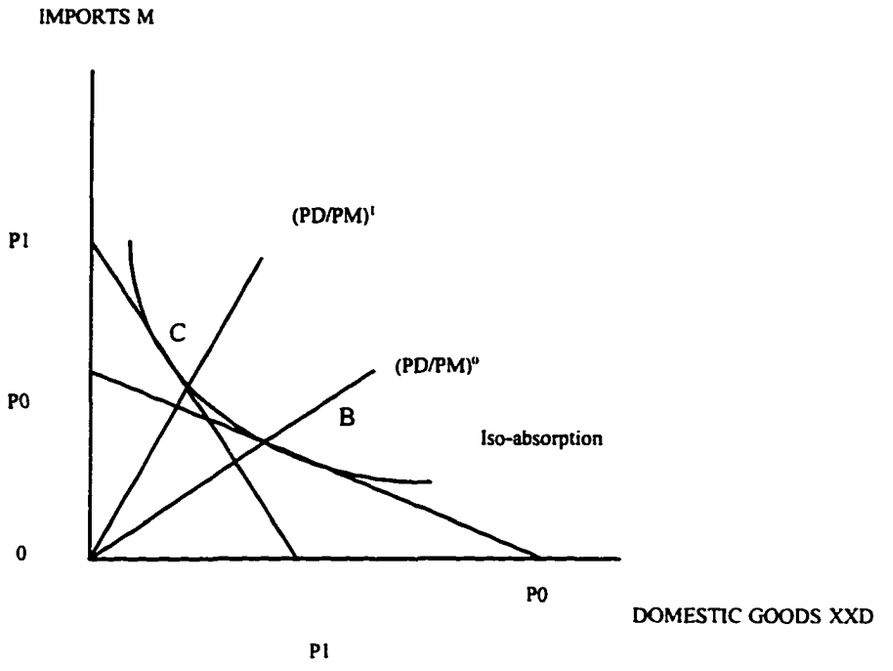

Figure 4.2. Minimization of expenditures on domestic and imported goods

commodity. The model calibrates the import aggregation function on the base-year data for a given trade substitution elasticity. That elasticity establishes the shape of the curve around the initial point, B, which represents a tangency between the composite commodity's indifference curve and the price line:

$$PM_i.M_i + PD_i.\ XD_i \qquad (3)$$

If , for example, the price of the imported good is lowered by removing the tariff, the initial price ratio will change from $(PD_i/PM_i)^0$ to $(PD_i/PM_i)^1$. Demanders will minimize the cost of the composite good by shifting to point C, which represent a higher imports to domestic use ratio. The aggregation function is linearly homogeneous function, hence, the composite commodity price can be represented as a weighted average (linear combination) of

the respective prices of its domestic and imported components. Consequently, the change in the price ratio will also be reflected as a change in the price of the composite commodity:

$$P_i = (PD_i .XXD_i + PM_i .M_i)/X_i \quad (4)$$

Product differentiation in import markets assumes both two-stage budgeting and a weakly separable aggregation function. It also implies that the price of domestic goods, PD_i and their corresponding domestic prices for imports, PM_i need not be directly linked through trade policies and the exchange rate, such that:

$$PM_i = pmw_i(1 + tm_i)ER \quad (5)$$

Under the Armington assumption, PD_i and PM_i need not be equal; yet, Equation 5 still holds true. While PD_i is now endogenous, the price-taking assumption (small country assumption) in the import market link PM_i to pmw, the exogenously specified world price of Egyptian imports; tm_i , the tariff rates in sector i; and ER, the exchange rate between U.S. and Egyptian prices.

How responsive domestic prices are to changes in the world prices depends on the elasticity of substitution between domestic goods and their imported counterpart. As the elasticity of substitution approaches infinity, the composite commodity's indifference curve becomes increasingly linear, indicating that XXD_i and M_i are becoming perfect substitutes in use. In turn, as they become more linear, cost minimization can only accommodate limited divergences between domestic and world prices.

When the elasticity of substitution approaches zero, the composite commodity's indifference curve becomes increasingly Leontief, indicating that XXD_i and M_i are approaching perfect complements in consumption. Again, as the indifference curve becomes

more curvilinear, cost minimization can accommodate greater divergence between domestic and world prices.

Export supply

The model also extends the Armington specification to the export side, specifying that there is an elasticity of transformation in each sector between goods supplied to the domestic market and those supplied to the export market. The export transformation function is specified as constant elasticity of transformation, (CET) function, a specification which has typically been adapted in CGE models. Producers are assumed to allocate their output between domestic and export markets in the following manner:

$$\text{Maximize: } PX_i = PE_i.E_i .+ PD_i.XXD_i \qquad (6)$$

E_i, XXD_i

$$XD_i = CET(E_i, XXD_i)$$

The corresponding first order condition then determine the optimal mix of domestic and export supplies, or:

$$E_i/XXD_i = f(PE_i/PD_i) \qquad (7)$$

where PD_i is the commodity i's endogenous domestic price, and PE_i, is its corresponding export price (in Egyptian pounds) which is determined as:

$$PE_i = pwe_i (1 + te_i).ER \qquad (8)$$

where te_i, is the export subsidy rate, and pwe_i is the world price of Egyptian exports.

Analogous to the import demand situation, the small-country assumption implies that pwe_i is exogenously specified. Figure 4.3 shows how the allocation of total output supplies

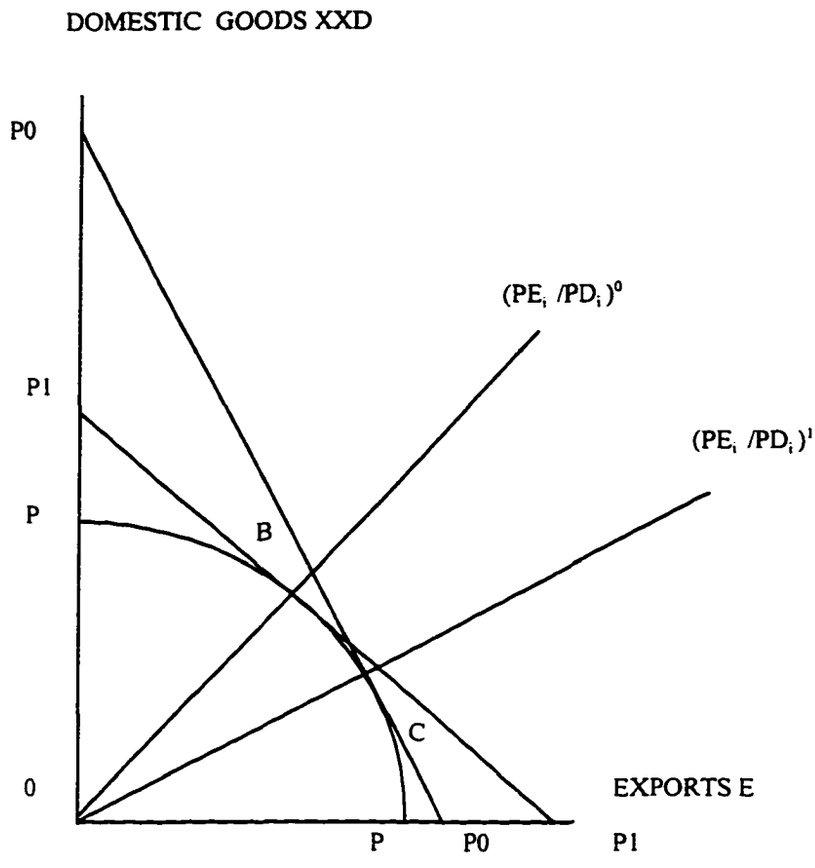

Figure 4.3. Allocation of output between domestic and export goods

between domestic and export markets is determined through changes in relative prices given the assumption of product differentiation. The PP production possibility frontier curve represents the CET output aggregation function:

$$XD_i = CET\ (E_i\ ,\ XXD_i) \qquad (9)$$

The CET function shows the combinations of domestic and export supply which are consistent with the level of total output. The shape of the frontier around the initial

equilibrium point, B is determined by the elasticity of transformation. Point B represents a point of tangency between the production possibility frontier and the revenue line,

$$PE_i . E_i + PD_i . XXD_i \qquad (10)$$

with initial equilibrium price ratio, $(PE_i/PD_i)^0$.

If, for example, the world price of a commodity increase its export price increases, the initial equilibrium price ratio at point B $(PE_i/PD_i)^0$ will change, say to $(PE_i/PD_i)^1$. To maximize sales revenues from domestic and export markets, suppliers will shift to the new equilibrium point which represents a higher export to domestic use ratio point C. This switches supply from the domestic market to the export market, which in turn puts upward pressure on the domestic market price.

The change in the price ratio is also reflected as a change in the price of the composite output supply. Similar to the CES function the CET aggregation function is linearly homogeneous, hence the composite price can be represented as a weighted average (linear combination) of the respective prices of its domestic and the exported components.

$$PX_i = (PE_i.E_i + PD_i.XXD_i)/X_i \qquad (11)$$

As with the case of imports, the direct link between the domestic prices of export and domestic sales need not hold; the divergence between the two prices depends on the elasticity of transformation[12]. For example, if the elasticity of transformation were to assume a relatively high (elastic) value of, say sixth, then it would only require a 1.06 change (divergence) in the relative price of exported to domestic goods to induce a 6.0% change in

[12] Note the relation between the CES function exponent ρ and the elasticity of substitution σ can easily be derived as $\sigma = 1/(1+\rho)$ and $\rho = (1-\sigma)/\sigma$ (Henderson & Quandt, 1980, 111-112).

the ratio of exported goods to domestic goods supplied by the producers of the composite output. The elasticity values used in the model follow a literature review (Lofgren, 1994b) because econometric estimates are not available.

Household consumption

There is a single representative household in the model. The household utility function consists of two levels. At the upper level, households maximize utility given disposable income (which is the sum of different factors in income plus transfers from the government and less tax abroad) and the derived commodity demand is modeled as a linear expenditure system (LES). Given the consumption expenditure, household spends a fixed share on each of the consumption commodities.

At the lower level of nesting, consumer aggregates composites goods of imports and domestic goods according to a CES utility function. Households are assumed to maximize utility by consuming a basket of composite consumer commodities X^{c}_{d}, subject to a post-tax post-savings household budget constraint. This creates demand functions for consumer goods and services that are responsive to variations in relative prices and incomes. The price response is derived from the substitution possibilities between consumer imports and consumer domestic output associated with the Armington aggregation assumption.

By comparison, the income response comes from variations in labor incomes, which are established in factor markets and by exogenous income, transfers from other economic agents within the system. Mathematically, the representative household's optimizing problem can be stipulated as:

$$\text{Maximize: } U(X^i_d)$$

$$X^i_d$$

$$\text{S.T. } \sum P^i X^i_d = YH(1-T^H).(1 - mpsh) \quad (12)$$

The resulting first order conditions generate household demands for goods and services that are homogeneous of degree zero in prices and income:

$$X^i_d = X(YH^*, P) \quad (13)$$

where:

P^i = Price of Composite Consumer-Commodity i.

X_d^i = Quantity of Composite Consumer-Commodity i.

YH^* = Household Income

P = N x 1 Vector of Composite Consumer-Commodity Prices.

Government demand

Government spending consists of transfers and expenditures. Government is treated as a separate consuming agent procuring private goods and services. The government is assumed to exercises discretionary fiscal policy by taxing a variety of incomes and transactions; the proceeds are then spent on goods and services, or disbursed as transfer payments. The government receives income mainly from taxes and tariffs, but also from transfers from domestic and foreign accounts. It pays for goods and services and transfers resources to domestic and foreign accounts. Tax and tariff rates are most usually seen as determined exogenously, as well as transfers from abroad and domestic households.

$$GR = TARIFF + INDTAX + HHTAX + CAP_{govt} + ROW_{govt} \quad (14)$$

Output supply and factor demands

Each sector in the economy is treated as if it were made up of many similar firms maximizing profits and competing for the scarce factors, that is, each productive sector consists of a representative firm. Profit maximization by firms thereby gives rise to factor demands and commodity supply.

In most CGE models, the structure of intermediate demand (INT_i) follow a Leontief specification (see Chowdhury & Kirkpatrick [1994] for a similar exposition):

$$INT_{ij}^{d} = \sum_i a_{ij} XD_j^{s} \tag{15}$$

The a_{ij}s represents input-output coefficients, output of industry i is used as inputs in industry j, and the XD_j^{s} represents gross sectoral outputs. Rewriting Equation 15, a_{ij} can be interpreted as

$$a_{ij} = INT_{ij}^{d} / \sum_i XD_j^{s}$$

the amount of intermediate inputs used to produce one unit of output in industry j. From Equation 15, it is evident that there is no substitution possibilities between the various sectoral components of intermediate demand. However, within a given intermediate-sector, the aggregate level of domestic and foreign intermediate goods are imperfect substitutes in accordance with the Armington assumption, where a CES function is employed in the aggregation of the respective domestic and imported components.

Output supply is derived following a two-stage optimization process. Producers first minimize the total cost (TC_i) of producing output (XD_i^{s}) using capital labor (and land in the case of agriculture) only as factors of production. Value-added is assumed to be produced using a constant-returns-to-scale, Cobb Douglas function:

$$XD_i^s = CD(FDSC_l, FDSC_k, FDSC_d) \quad (16)$$

where l, k, and d stand for labor, capital, and land, respectively.

Total cost of production as a function of factor prices can be written as:

$$TC_i = \sum_i WF_i FDSC_i \quad (17)$$

where, again, i stands for labor, capital and land, respectively. Producers are then assumed to solve the following cost minimization problem:

$$\text{Minimize: } TC_i = \sum_i WF_i FDSC_i \quad (18)$$

$FDSC_i$

$$\text{S.T. } XD_i^s = CD(FDSC_l, FDSC_k, FDSC_d) \quad (19)$$

This minimization problem then solves for conditional demand which are homogenous of degree zero in prices:

$$FDSC_i = F(XD_i^s, WF_l, WF_k, WF_d) \quad (20)$$

The resultant optimal cost function can be written as:

$$TC_i^* = \sum_i WF_i FDSC_i^*$$

$$= TC_i^*(XD_i^s, WF_l, WF_k, WF_d) \quad (21)$$

Given constant returns to scale technology, Equations 20 and 21 can be written as a function of factor prices multiplied by the level of output, specifically:

$$FDSC_i^* = F_i^*(WF_l, WF_k, WF_d)\, XD_i^s \quad (22)$$

$$TC^* = TC(WF_l, WF_k, WF_d).XD_i^s \quad (23)$$

Note that with constant returns to scale, Equation 23 be easily manipulated to show the coincidence of marginal and average costs associated with constant-returns-to-scale cost functions.

Producers in the second stage choose the output level that maximize profit (Π). Let the output price be PX , then producers:

$$\text{Maximize: } \Pi_i = PX_i XD_i^s - TC_i^*(WF_l\ WF_k\ WF_d).XD_i^s \qquad (24)$$

XD_i^s

In the presence of constant-returns-to-scale technology, the rate of change of profit with respect to changes in output supply is not a function of the level of output, but rather a function of only factor prices and the output price. This means that supply functions are perfectly elastic-they do not relate levels of output to the price of the product. There is an indeterminate number of profit maximizing output levels compatible with a given set of relative prices. That is to say, any profit making firm with a constant return to scale technology would be in a state of unending expansion.

Conversely, at a given set of prices, if production is not profitable at the existing level of output, then it will not be profitable at any other level of output. Only with zero profits can a firm with a constant-returns-to-scale technology be in equilibrium, and this equilibrium is compatible with any of the set of possible output levels. The firm's zero profit condition can be incorporated as:

$$\Pi_i = PX_i.XD_i^s - \sum WF_i.\ FDSC_i - \sum_i a_{ij} XD_j^s P_i - tax_i \qquad (25)$$

where tax_i represents indirect taxes, net of subsidies. The zero-profit condition implies that:

$$PX_i.XD_i^s = \sum WF_i.\ FDSC_i\ +. \sum_i a_{ij} XD_j^s P_i + tax_i \qquad (26)$$

It is convenient to define indirect taxes as per unit commodity taxes, such that:

$$taxi = tx_i.XD_i^s \qquad (27)$$

Substituting Equation 27 into Equation 26 and dividing through by XD gives the price (cost) per unit of output:

$$PX_i = (\sum WF_i . FDSC_i) / XD_i^s + . \sum_i a_{ij} P_i + tx_i \quad (28)$$

The term:

$$(\sum WF_i . FDSC_i)/XD_s^i \quad (29)$$

represents value-added per unit of output, often referred to in the literature as the value-added or net price (PN). Making the appropriate substitutions Equation 28 becomes:

$$PX (1 - tx_i) = PN_i + \sum ia_{ij} . P_i \quad (30)$$

Equation 30 shows that the zero profit condition implies that the unit cost of output is solely determined by both primary and intermediate factor costs. Equation 28 is usually rewritten in terms of (PN_i) to give:

$$PN_i = PX_i(1 - tx_i) - \sum_i a_{ij} P_i \quad (31)$$

In the model, productive capital is assumed to be sector-specific (immobile across economic sectors); therefore, in a perfectly competitive environment, any excess of revenues over labor and intermediate-costs is treated as a return to the sector-specific factor. That is to say, whenever the stock of capital is fixed and output prices function as the equilibrating variable, as in a Walrasian adjustment mechanism, profits are decided residually after payments for labor services and intermediate-inputs.

With the stock of capital fixed, immobile, and fully employed, labor inputs determine the level of output. Using the definition of value-added price, the aggregate economic activity of each sector can be thought of as a single firm whose short-run profit maximizing problem are represented as follows:

$$\text{Maximize: } PN_i \cdot CD(FDSC_l, FDSC_k, FDSC_d) - {}_i\Sigma\, WF_i \cdot FDSC_i \qquad (32)$$

$FDSC_l$

The reduced form solution gives the derived demand for labor expressed in terms of the value-added price, and factor prices:

$$FDSC_l = F_i(PN_i, WF_l, WF_k, WF_d) \qquad (33)$$

Finally, substituting Equation 33 into the value-added function, gives the level of output supply.

Savings-investment balance

Aggregate savings consist of household, government, and foreign savings:

$$SAVINGS = HHSAV + GOVSAV + FSAV.ER \qquad (34)$$

Foreign savings are denominated in foreign currency and change in domestic value with changes in the exchange rate. Changes in the current account, therefore, have an impact on the savings-investment balance via the change in the domestic value of foreign savings.

Another feedback from the current account on the savings-investment balance is the effect of changes in the domestic currency value of foreign transfers to domestic households. Transfers to and from the rest of the world are usually regarded as exogenously determined and are therefore denominated in foreign currency in the model: receipts by families of migrant workers depend more on their incomes abroad than on economic conditions in Egypt. Domestic households save a given fraction of disposable income which includes the domestic value of foreign transfers. An increase in exports because of (e.g., a decrease in export taxes) leads to an appreciation of the exchange rate to balance the current account with

fixed foreign savings. This depresses the domestic value of foreign savings and transfers to households leading to a decrease in aggregate savings.

With savings determined by disposable incomes and the current account balance requirement, the way macro-economic equilibrium is achieved depends on how investments are determined. There are two possibilities:

1. aggregate investment fixed and savings adjust; or
2. aggregate investment adjusts to a given level of aggregate savings.

Given the neo-classical specification of the model it seems natural to choose macro 'closure', the second posibility, i.e., investments adjust to a given level of savings. It is also possible to have investment fixed and savings adjust. The former could be achieved through some form of loanable funds market: a given amount of savings meets a flexible investment demand with an interest rate as the equilibrating variable. Because the model does not contain money or other financial assets this market has been omitted as well as the investment demand function.

Investment

Since the model is a static specification, investment does not add to the existing stock of productive capital. Within the single period, the model does generate savings, investment, and the demand for capital goods. However, by assumption, these capital goods are not installed during the period, so that investment simply represents a demand category with no effect on supply in the model.

A Two-Sector Three-Good Model

The purpose of this section is to show the internal consistency of the model. This is done by using a simplified two sectors three goods analytical version of the model. A major advantage of small models is their simplicity. They make transparent the mechanism by which external shock affects the economy. In addition the model presented here require relatively simple and transparent specifications which facilitate tractable algebraic or graphical solutions.

The basic model (Figure 4.4) can be illustrated using two producing sectors and three goods. It follows the work of de Melo and Robinson (1989), Devarajan, Lewis, and Robinson (1990), and deMelo and Tarr (1992).

The two commodities that the country produces are: (1) an export good, E, which is sold to foreigners and is not demanded domestically; and (2) a domestic good, D, which is only sold domestically. The third good is an import, M, which is not produced domestically. There is one consumer who receives all income. The country is small in world markets, facing fixed world prices for exports and imports. The model has three actors: a producer, a household, and the rest of the world. The production possibility frontier, which gives the maximum achievable combinations of E and D that the economy can supply is assumed to be concave and will be specified as a constant elasticity of transformation (CET) function with transformation elasticity Ω.

The constant, X, defines aggregate production and is fixed. Since there are no intermediate inputs, X also corresponds to real GDP. The assumption that X is fixed is equivalent to assuming full employment of all primary factor inputs. Equation 4 gives the

Flows

1) $X = G(E, D^S; \Omega)$
2) $Q_S = F(M, D^D; \sigma)$
3) $Q^D = Y/PQ$
4) $E/D^S = g_2(PE, PD)$
5) $M/D^D = f(PM, PD)$
6) $Y = PX.X + R.B$

Prices

7) $PM = R.pwm$
8) $PE = Rpwe$
9) $PX = g_1(PE, PD)$
10) $PQ = f_1(PM, PD)$
11) $R \equiv 1$

Equilibrium Conditions

12) $D^D - D^S = 0$
13) $Q^D - Q^S = 0$
14) $pwmM - pweE = B$

Identities

I. $PX.X = PE.E + PD.D^S$
II. $PQ.Q^S = PM.M + PD.D^D$
III. $Y = PQ.Q^D$

Endogenous Variables

E Export good
M Import good
D^S Supply of domestic good
D^D Demand for domestic good
Q^S Supply of composite good
Q^D Demand for composite good
Y Total income
PE Domestic price of export good
PM Domestic price of import good
PD Domestic price of domestic good
PX Price of aggregate output
PQ Price of composite good
R Exchange rate

Exogenous Variables

pwe World price of export goods
pwm World price of import goods
B Balance of trade
X Aggregate output
σ Import substitution elasticity
Ω Export transformation elasticity

Figure 4.4. Two-Sector Three-Good Model

corresponding ratio of exports to domestic output (E/D) as a function of relative prices. Equation 9 defines the price of the composite commodity and its the cost-function dual to the first-order condition, Equation 4. The composite good price PQ corresponds to the GDP deflator. Equation 2 defines a composite commodity made up of D and M which is consumed by the single consumer.

In multisector models, we extend this treatment to many sectors, assuming that imports and domestic goods in the same sector are imperfect substitutes. This is the Armington assumption. Following this treatment, we assume the composite commodity is given by a constant elasticity of substitution (CES) aggregation function of M and D, with substitution elasticity σ. Consumers maximize utility, which is equivalent to maximizing Q in this model, and Equation 5 gives the desired ratio of M to D as a function of relative prices. Equation 10 defines the price of the composite commodity. It is the cost-function dual to the first-order conditions underlying Equation 5. The price, PQ, corresponds to an aggregate consumer price or cost-of-living index. Equation 6 determines household income. Equation 3 defines household demand for the composite good. Note that all income is spent on the single composite good. Equation 3 stands in for the more complex system of expenditure equations found in multisector models and reflects an important property of all complete expenditure systems: the value of the goods demanded must equal aggregate expenditure.

The price equations define relationships among seven prices. There are fixed world prices for E and M; domestic prices for E and M; the price of the domestic good D; and prices for the two composite commodities, X and Q. Equations 1 and 2 are linearly homogeneous, as are the corresponding dual price Equations 9 and 10. Equations 3 to 5 are homogeneous of

degree zero in prices thus doubling all prices. For example, it leaves real demand and the desired export and import ratios unchanged.

Since only relative prices matter, it is necessary to define a numeraire price; in Equation 11, this is specified to be the exchange rate, R. Equations 12, 13, and 14 define the market-clearing equilibrium conditions. Supply must equal demand for D and Q, and the balance of trade constraint must be satisfied. The complete model has 14 equations and 13 endogenous variables. The three equilibrium conditions, however, are not all independent. Any one of them can be dropped and the resulting model is fully determined. To prove that the three equilibrium conditions are not independent, it suffices to show that the model satisfies Walras' Law. Such a model is closed" in that there are no leakages of funds into or out of the economy. First note the three identities (i, ii, and iii) that the model satisfies. The first two arise from the homogeneity assumptions and the third from the fact that, in any system of expenditure equations, the value of purchases must equal total expenditure. Multiplying Equations 12 and 13 by their respective prices, the sum of Equations 12, 13, and 14 equals zero as an identity (moving B in Equation 14 to the left side). Given these identities, simple substitution will show that if Equations 12 and 13 hold, then so must 14.

De Melo and Robinson (1989) analyze the properties of this model in some detail and argue that it is a good stylization of most recent single-country, trade-focused, CGE models. Product differentiation on both the import and export sides is very appealing for applied models, especially at the levels of aggregation typically used. The exchange rate is a well-defined relative price. If the domestic good is chosen as the numeraire commodity, setting PD

equal to one, then the exchange rate variable, R, corresponds to the real exchange rate of neoclassical trade theory: the relative price of tradables (E and M) to non-tradables (D).

Trade theory models often set R to one, with PD then defining the real exchange rate. For other choices of numeraire, R is a monotonic function of the real exchange rate. We will use the graphical apparatus to analyze the impact of two shocks: an increase in foreign capital inflow and a change in the terms of trade. The transformation function can be depicted in the fourth (southeast) quadrant of the four-quadrant diagram in Figure 4.5. For any given price ratio PD/PE, the point of tangency with the transformation frontier determines the amounts of the domestic and exported good that are produced. Assume, for the moment, that foreign capital inflow B is zero. Then the balance-of-trade constraint, is a straight line through the origin, as depicted in the first quadrant of Figure 4.5, if we assume for convenience that all world prices are equal to one, then the slope of the line is one. For a given level of E produced, the balance-of-trade constraint determines how much of the imported good the country can buy. Intuitively, with no capital inflows (B = 0) , the only source of foreign exchange is exports.

The second quadrant shows the "consumption possibility frontier," which represents the combinations of the domestic and imported good that the consumer can buy, given the production technology as reflected in the transformation frontier and the balance of trade constraint. When world prices are equal and trade is balanced, the consumption possibility frontier is the mirror image of the transformation frontier. The tangency between the "iso-absorption" (or indifference) curves and the consumption possibility frontier will determine the amount of D and M the consumer will demand, at price ratio PD/PM. The economy produces at point P and consumes at point C.

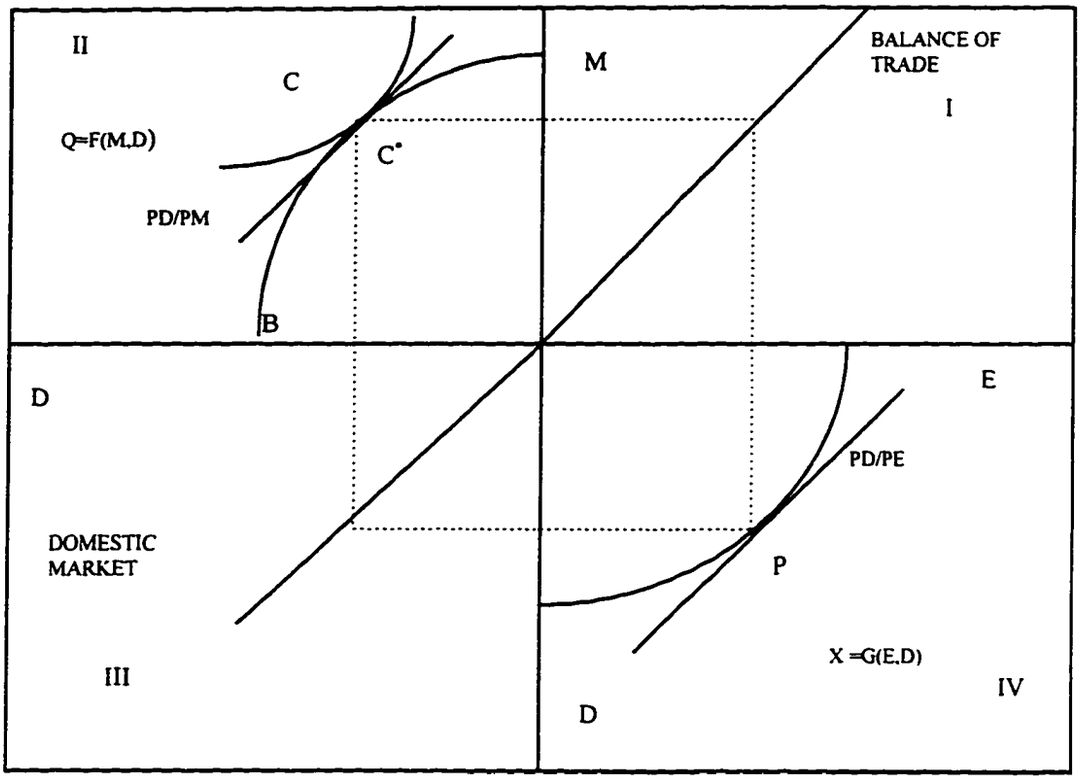

Figure 4.5. Two-Sector Model

Now, consider what would happen if foreign capital inflow increased from its initial level of zero, some value B > 0). For example, the country gains additional access to world capital markets or receives some foreign aid. Alternatively, there is a primary resource boom in a country where the resource is effectively an enclave, so that the only direct effect is the repatriation of export earnings. In all of these cases, we would expect domestic prices to rise relative to world prices and the tradable sector to contract relative to the nontradable sector. In short, the country would contract "Dutch disease". That this is indeed the case can be seen by examining Figure 4.6. The direct effect is to shift the balance of trade line up by B. This shift, in turn, will shift the consumption possibility frontier up vertically by the same B. The new

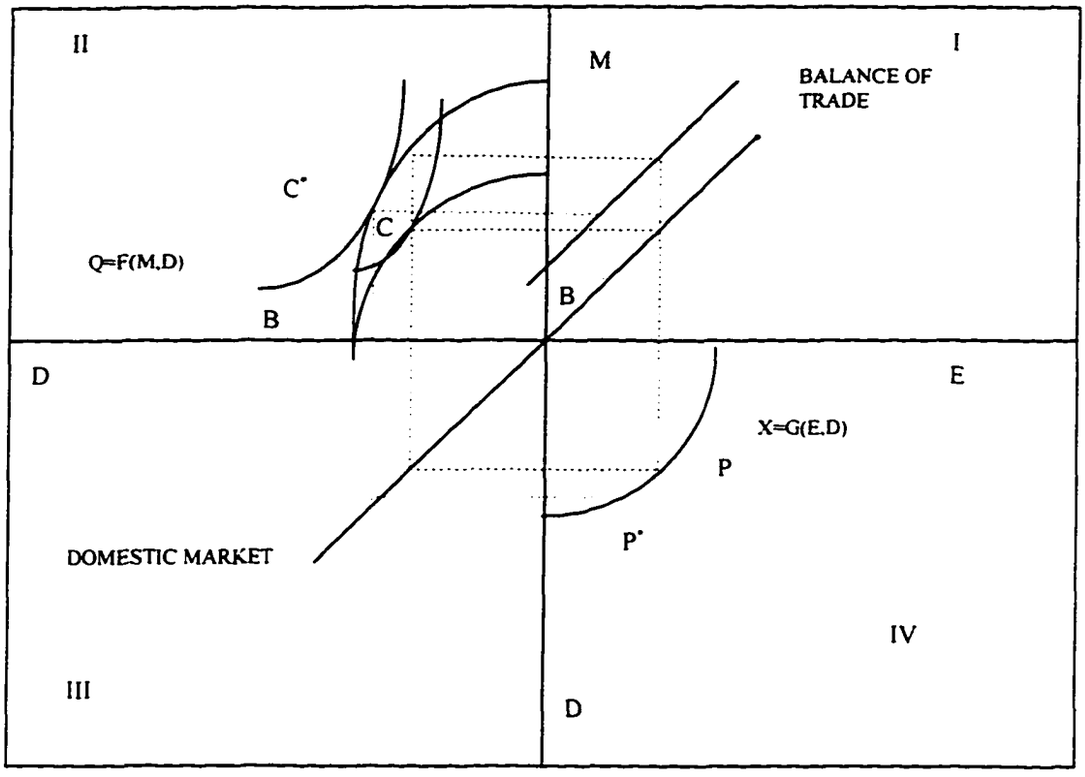

Figure 4.6. Increasing foreign capital inflow

equilibrium point will depend on the nature of the import aggregation function (the consumer's utility function). In Figure 4.6, the consumption point moves from C to C*. with increased demand for both D and M and an increase in the price of the domestic good, pd. On the production side, the relative price has shifted in favor of the domestic good and against the export an appreciation of the real exchange rate. Will the real exchange rate always appreciate?

Consider two extremes, which bracket the range of possible equilibria. Suppose the elasticity of substitution between imports and domestic goods is nearly infinite, so that the indifference curves are almost flat. In this case, the new equilibrium will lie directly above the initial one (point C) , since the two consumption possibility curves are vertically parallel. The

amount of D consumed will not change and all the extra foreign exchange will go towards purchasing imports. By contrast, suppose the elasticity of substitution between M and D is zero, so the indifference curves are L-shaped. In this case (assuming homotheticity of the utility function), the new equilibrium will lie on a ray radiating from the origin and going through the initial equilibrium. In this new equilibrium, there is more of both D and M consumed, and the price ratio has risen. Since P^m is fixed by hypothesis, P^d must have increased—a real appreciation. The two cases bound the range of possible outcomes. The real exchange rate will appreciate or, in the extreme case, stay unchanged. Production of D will either remain constant or rise and production of E, the tradable good in this economy, will either stay constant or decline. The range of intermediate possibilities describes the standard view of the Dutch disease.

Consider now an adverse terms of trade shock represented by an increase in the world price of the imported good. The results are shown in Figure 4.7. The direct effect is to move the balance of trade line, although this time it is a clockwise rotation rather than a translation (we assume that initially B = 0). For the same amount of exports, the country can now buy fewer imports. The consumption possibility frontier is also rotated inward. The new consumption point is shown at C*, with less consumption of both imports and domestic goods. On the production side, the new equilibrium is P*. Exports have increased in order to generate foreign exchange to pay for more expensive imports, and PE/PD has also increased to attract resources away for D and into E. There has been a real depreciation of the exchange rate. Will there always be a real depreciation when there is an adverse shock in the international terms of trade? Not necessarily. The characteristics of the new equilibrium depend crucially on the

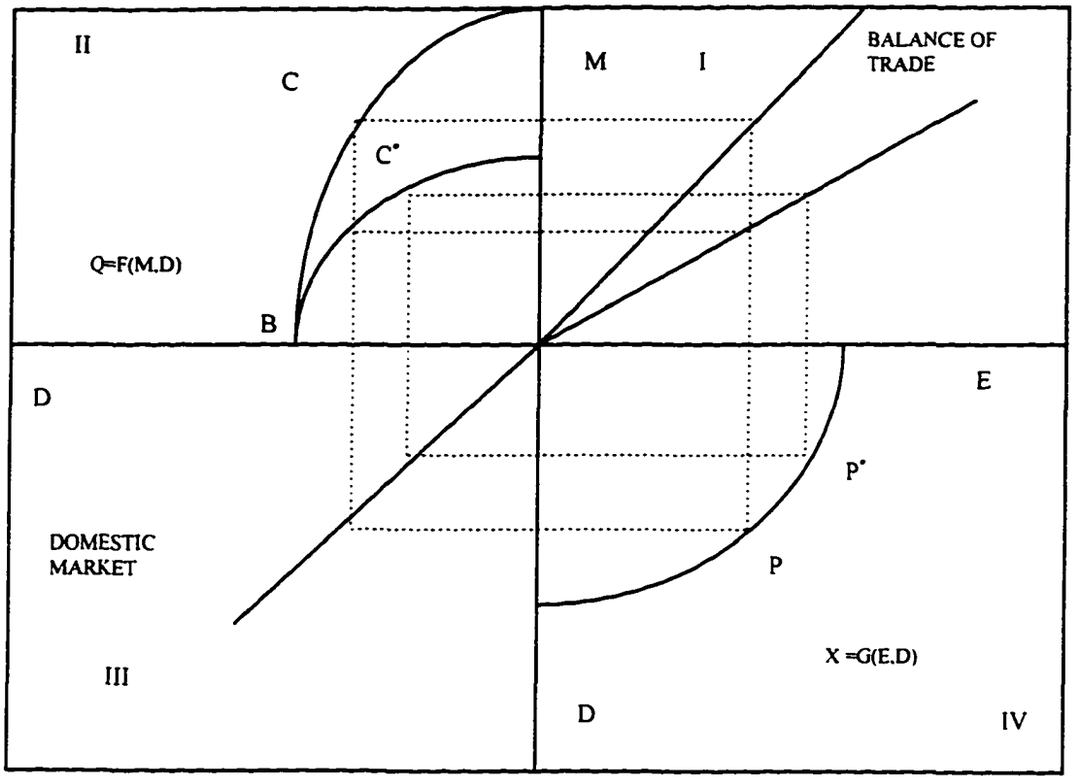

Figure 4.7. Change in terms of trade

value of σ, the elasticity of substitution between imports and domestic goods in the import aggregation function.

Consider the extremes of $\sigma = 0$ and $\sigma = \infty$. In the first case, as in Figure 4.7, there will be a reduction in the amount of domestic good produced (and consumed) and a depreciation of the real exchange rate. In the second case, however, flat indifference curves will have to be tangent to the new consumption possibility frontier to the left of the old consumption point C , since the rotation flattened the curve. At the new point, output of D rises and the real exchange rate appreciates. When $\sigma = 1$, there is no change in either the real exchange rate or the production structure of the economy. The intuition behind this somewhat unusual result is as

follows. When the price of imports rises in an economy, there are two effects: an income effect (as the consumer's real income is now lower) and a substitution effect (as domestic goods now become more attractive). The resulting equilibrium will depend on which effect dominates. When $\sigma < 1$, the income effect dominates. The economy contracts output of the domestic good and expands that of the export commodity. In order to pay for the needed, non-substitutable import, the real exchange rate depreciates. However, when $\sigma > 1$, the substitution effect dominates. The response of the economy is to contract exports (and hence also imports) and produce more of the domestic substitute. For most developing countries, it is likely that $\sigma < 1$, so that the standard policy advice to depreciate the real exchange rate in the wake of an adverse terms of trade shock is correct. The analysis with this simple model has yielded several lessons.

First, the bare bones of multisector general equilibrium models are contained in this small model. Second, and perhaps more surprisingly, this two-sector model is able to shed light on some issues of direct concern to this study. For example, the appreciation of the real exchange rate from a foreign capital inflow, widely-understood intuitively and derived from more complex models, can be portrayed in this simple model. In addition, results from this small model analyze a standard policy dictum: always depreciate the real exchange rate when there is an adverse terms-of-trade shock. The model shows the conditions under which the policy of real exchange rate depreciation (in the wake of adverse terms of trade shock) should be followed.

This analytical model represents the starting point in the application of empirical models to policy analysis. The multisector CGE model provides a versatile empirical simulation laboratory for analyzing quantitatively the effects of economic policies an external

shocks on the domestic economy. While analytical and stylized model s may tell us the direction of change in response to a policy or external shocks, they do not tell us the magnitude of the change nor does they tell about the sectoral impacts or how a sector specific policy will affect the whole economy. Finally, this simple model does not capture the institutional arrangements in Egypt. Chapter 5 gives complete presentation of the model, and Chapter 6 presents the simulations results from the multisectoral model.

CHAPTER 5. COMPLETE PRESENTATION OF THE MODEL

This chapter is intended to give a complete presentation of the model. This is done by bringing together all of the assumptions of the model into a unified system of equations grouped under five blocks: (I) Prices; (II) Quantities; (III) Income Equations; (IV) Expenditure equations; and (V) Market Clearing Conditions. The chapter also contains a section on calibration and the choice of functional forms.

The Structure of the Simulation Model

The purpose of a modeling exercise is to build a model that links detailed microeconomics modeling of the production structure, prices and incomes with a macroeconomic framework (government budget, current account, and the saving investment balance), that is capable of analyzing the impact of policy induced and external shocks on the real exchange rate, production, consumption and trade flows. This study's model has four institutions through which funds flow, namely: (1) Household; (2) Firms; (3) Government; and (4) The Rest of the World.

Disaggregation of the Production Sectors

Production will be disaggregated into nine sectors, namely: (1) Crop Agriculture; (2) Animal Agriculture; (3) Industry; (4) Food Processing; (5) Transportation; (6) Oil; (7) Services; (8) Construction; and (9) Electricity.

Price Equations

The model incorporates the "small country" assumption on both the import and the export sides, so that world prices of imports (pwm) and of exports (pwe) are exogenous. In Equations 1 and 2, the domestic price of imports (PM) and of exports (PE) is the tariff or subsidy-inclusive world price times the exchange rate (ER). Equations 3 and 4 describe the prices for the composite commodities X_i and XD_i. X_i represents the CES aggregation of sectoral imports (M_i) and domestic goods supplied to the domestic market (D_i). XD_i is total sectoral output, which is a CET aggregation of goods supplied to the export market (E_i) and goods sold on the domestic market (XXD_i). Equation 5 defines the sectoral price of value added, or "net" price (PV), which is the output price minus unit indirect taxes (tx_i) and the unit cost of intermediate inputs (based on the fixed input-output coefficients, a_{ij}). Finally, Equation 7 defines an aggregate price index (PINDEX) which for this study is taken to be the whole sale price index.

This index provides the numeraire price level against which all relative prices in the model will be measured. the choice of a numeraire is necessary because the core CGE model can determine relative prices only. The selection of this index makes it possible to interpret the nominal exchange rate as the real exchange rate. If there were assets in the model, the nominal exchange rate could be defined as the relative price of two assets.

In the absence of assets, the real exchange rate is the relative price tradables to nontradables. In a multi-sector setting the real exchange rate is defined as the ratio of an index of the value of all tradables to an index of the value of all nontradables:

$$RER = \frac{\sum \Psi^e(1+te_i)pwe\ ER + \sum \Psi^m(1+tm_i)pwmER}{\sum \omega PD_i}$$

where RER represents the real exchange rate, Ψ^e, Ψ^m, and ω are the weights in the export, imports and domestic goods indexes, respectively.

Given the small country assumption, the percentage change in the real exchange rate reduces to the difference between the percentage change in ER and the percentage change in the index of domestic prices. That is

$$\Delta RER = \Delta ER - \sum \omega \Delta PD_i$$

If we choose as numeraire $\sum \omega \Delta PD_i$ Equation 6 and fix its value at unity, the percentage change in ER is the percentage change in the real exchange rate (see De Melo & Tarr, 1992). Other common numeraire choices include the exchange rate or a wage rate. For simulations involving change in the terms of trade, following the discussion of Chapter 2, an exportables and an importables, real exchange rates are defined.:

Price Equations

(1) $PM_i = pwm_i(1 + tm_i)\ ER$

(2) $PE_i = pwe_i(1 + te_i)\ ER$

(3) $P_i = (PD_i.XXD_i + PM_i.M_i) / X_i$

(4) $PX_i = (PD_i.XXD_i + PE_i.E_i) / XD_i$

(5) $PV_i = PX_i(1-tx_i) - \sum_j aa_{ji}P_j$

(6) $PINDEX = \sum_i \omega_i\ PD_i$

Endogenous Variables

ER exchange rate

Pm_i domestic price of imports

PE_i domestic price of exports

P_i composite good price

PX_i average sales price of domestic output

PV_i value added (or net) price

PD_i domestic price of domestic output

X_i sectoral composite supply

XD_i sectoral domestic output

XXD_i domestic demand for production

M_i imports

E_i exports

Exogenous Variables

PINDEX price index

te export subsidy rate

pwm_i world price of imports

pwe_i world price of exports

tm_i import tariff rate

tx_i indirect tax rate

aa_{ij} input-output coefficients

ω_i weights in the price index

Quantity Equations

For the quantity equations, which describe the supply side of the model, the functional forms chosen must satisfy certain restrictions of the general equilibrium theory. Equations 7 to 10 define the production technology and demand for factors. Equation 11

contains the CET transformation functions combining exports and domestic sales, and Equation 13 shows the corresponding export supply functions, which depend on relative prices (PE/PD). Equations 12 and 14 give the CES aggregation functions describing how imports and domestic products are demanded, and the corresponding import demand functions, which depend on relative prices (PD/PM).

The production function is nested. At the top level, output is a fixed coefficients function of real value added and intermediate inputs. Real value added is a Cobb-Douglas function of capital, labor and land in the case of agriculture. Intermediate inputs are required according to fixed input-output coefficients with no substitution among its additive components Equation 10, each intermediate input is a CES aggregation of imported and domestic goods.

The specification of production technology and factor demands in these equations embodies a useful simplification often used in CGE models. To be complete, the production function Equation 7 should include all inputs as arguments: capital, labor, and intermediate inputs. Instead, in Equation 7, we specify the production function only as a function of primary factors, defined as capital and labor. Intermediate input demands are given in Equation 10, while Equations 8 and 9 show the demand for primary factors. FDSC now refers only to primary factors, and PV is the value added price Equation 5, which is defined net of both indirect taxes and intermediate input costs. This treatment is equivalent to writing out the full set of nested functions and their corresponding derivatives. The approach used here is simpler and has become traditional in many CGE models.

In Equation 11, total domestic production (XD_i) is supplied to domestic (XXD_i) or foreign (E_i) markets. These three "goods" (XD_i, XXD_i, and E_i) are all distinct, with separate prices, even though they have the same sectoral classification. Imports (M_i) and domestic goods (XXD_i) are also distinct from their composite (X_i), with separate sectoral prices. The model allows two-way trade (that is, simultaneous exports and imports) at the sectoral level, again reflecting empirical realities in developing economies.

Production, Employment, and Final Demand

7) $XD_i = \alpha_i^D CD\ (\ FDSC_{mi}.\ FDSC_{si}\ )$

8) $WF_s\ FDSC_{is} = \omega_s.PV.XD_i$

9) $WF_m\ FDSC_{im} = \omega_s.PV.XD_i$

10) $INT_i = \sum a_{ij}.XD_i$

11) $XD_i = \alpha^t\ [\beta^t_i.E^{\rho ti}_i + (1-\beta^t_i).XXD^{\rho ti}_i\ ]^{1/\rho ti}$

12) $X_i = \alpha^q\ [\beta^q_i.M^{-\rho qi}_i + (1-\beta^q_i).XXD^{-\rho qi}_i\ ]^{-1/\rho ti}$

13) $E_i = XXD_i[\ (PE_i.(1-\beta^t_i)/PD_i.\beta^t_i\ ]^{1/\rho ti}$

14) $M_i = XXD_i[\ (PD_i.\ \beta^q_i/PM_i.\ (1-\beta^q_i\ )\ ]^{1/(\rho qi+1)}$

Endogenous Variables

$FDSC_{im}$ factor demand for sectorally mobile factor

$FDSC_{is}$ factor demand for sector specific factor

WF_s factor price for sector specific factor

WF_m factor price for sectorally mobile factor

INT_i intermediate demand

Exogenous Variables

$\omega_s\ \omega_m$ factor share in value added

α_i^t , α_i^q shift parameters for CES composite goods, and CET export supply functions

$\beta,\ \beta^q{}_i$ share parameters in CES and CET

ρ^t, ρ^i trade functions elasticities in CES and CET trade functions

α_i^D production function shift parameter

Income Equations

The income equations map the flow of income from value added to institutions and ultimately to the household. These equations fill out the inter-institutional entries in the SAM. The distinction between parameters and variables also becomes important—while conceivably variable, many of these items will be set exogenously or determined by simple share or multiplier relationships, rather than through complex behavioral representations. Equations 15 and 16 define factor incomes, capital received income from both the domestic market and the rest of the world. Factors income are in turn distributed to household. Equation 18 defines household income which consists of factors income, transfers from the government and transfers from the rest of the world. Equation 20 determines total government revenue (GR).

Government revenue is obtained as the sum of income tax revenue (HHTAX), government tariff (TARIFF), and indirect tax (INDTAX) plus government capital income. Equation 17 captures the transfers from factors to households while Equation 19 captures the transfers between institutions(e.g., government and households)

Income and Flow of Funds

15) $YF_s = \sum WF_s^i \, FDSC_{is} + CAP_{ROW}.ER$

16) $YF_m = WF_m(FDSC_{im} + FDSC_{mg})$

17) $T_i^f = psif.\ YF_f$ (transfer from factor to institution i)

(f, factors, sector specific s and sectorally mobile m)

18) $YH = \sum_f T_i^f + RMIT.ER + piig_i$

19) $piig_i = psii.YI$ transfer between institutions (This term captures the share of govt. revenue from all sources of taxes e.g household, sales tax been transferred to HH)

20) $GR = TARIFF + INDTAX + HHTAX + CAP_{govt} + ROW_{govt}$

Endogenous Variables

YFs income to sector specific factor

YFm income to sectorally mobile factor

T_i^f transfers from factor to institutions

YH income to households

HHTAX household income tax revenue

GR government revenue

TARIFF import tariff revenue

INDTAX indirect tax revenue

CAP_{govt} government capital income

Exogenous Variables

$piig_i$ transfers from institution to institution

CAP.ER remittance income from abroad to capital

RMIT.ER remittance income from abroad to HH

$ER..CAP_{ROW}$ transfer from ROW to capital (dollars)

psif share of factor f income transferred to institution i

psii share of the income of institution id transferred to i

$ROW_{gov}t$ transfers from ROW to institution i

$FDSC_{mg}$ government labor demand

Expenditures Equations

Expenditures equations complete the circular flow in the economy, determining the demand for goods by the various actors. Households maximize utility given disposable income and derived commodity demand is modeled as linear expenditure system (LES) which means no substitution occurs. Not all domestically produced goods are consumed by households, construction product is not bought by private households. Private consumption is determined by simple linear share Equation 23. In Equation 24, government expenditures (G_i) is composed of expenditure on labor, households transfers, good s and services subsidies net of taxes and transfers to ROW.

Expenditures Equations

22) $EH = psiye.YH$

23) $P_i X_h^i = psie_i.EH$

24) $G_i = .WF_m.FDSC_{mg} + piig_{id} + \sum P_i X_g^i + TaugYG + GOVT_{ROW}$

Endogenous Variables

EH consumption expenditure for HH

X_h^i consumption demand for good i from HH

Exogenous Variables

psiye income share for consumption spending of HH i

psie spending share for HH on good i

$\sum P_i X_g^i$ government sectral consumption

$GOVT_{ROW}$ government transfer to ROW

G_i government expenditures

$piig_{id}$ transfer from the government to institution id

TaugYG government net spending on subsidy less tax revenue

Market Clearing Conditions and Macroeconomic Closure

The model is a general equilibrium system, with all endogenous variables jointly determined. In a competitive market economy, the equilibrium conditions correspond to market-clearing conditions, with prices adjusting to clear each market. Equation 27 states that the sectoral supply of composite commodities must equal demand, and thus defines market-clearing equilibrium in the product markets. Equation 28 defines equilibrium in the production and use of nontradables. Equation 29 defines equilibrium in the supply and use of nontradables.

There is no separate market-clearing condition for domestic output (X), since this involves adding exports to both sides of the above market -clearing condition Equation 29. For the import and export markets the small country assumption imply that they can be modeled in a partial equilibrium fashion, so there is no need to specify market clearing condition for imported or exported commodities. The model is homogenous of degree zero in prices an d solves only for relative prices.

As explained before the whole sale price index is chosen as a numeraire against which all relative prices will be measured. Equation 25 and 26 define equilibrium in factor markets. The supplies of primary factors are fixed exogenously. Market clearing requires that total factor demand equal supply, and the equilibrating variables are the factor prices for labor which

is intersectorally mobile. Sectoral capital stocks are fixed exogenously. Fixing capital stocks means that the factor demands are fixed, so that aggregate supply and demand for capital are automatically equal, and the market clearing condition for capital is redundant and can be dropped.

Without factor mobility, however, sectoral rental rates will not be the same across sectors. The remaining two equations describe macroeconomic equilibrium conditions for the balance of payments and savings-investment balance. Satisfying each of these requires the selection of the variables that will adjust freely to achieve equilibrium and constrain other variables by fixing them exogenously. Equation 31, represents the balance of payments: the rest of the world receive capital income, transfers from households and government as well as payments from Egypt's imports.

Egypt's receipts from row belongs to the same categories with exports substituted for imports. Foreign savings (FSAV) is the difference between Egypt's payments and receipts. Positive foreign savings are capital inflow to Egypt, negative savings are capital outflow or a decrease in Egypt's debts abroad. Except for most exports and all imports, payment to and from the rest of the world are exogenous in foreign currency. This means that all non trade current-account transactions are exogenous, consequently there is one to one positive relationship between changes in the current account surplus and the trade surplus.

For this equation, given certain level of foreign savings, equilibrium will be achieved through movements in ER that affect export and import prices (PE and PM) relative to domestic good prices PD, in other words, by changing the relative price of tradables to nontradables. For example, an increase in the exchange rate leads to a real depreciation, so that tradable prices

(PM and PE) rise relative to PD. Given the export supply and import demand functions, the result will be higher exports and lower imports. Thus, from an initial equilibrium, any fall in foreign savings will lead to a new equilibrium with a higher (depreciated) exchange rate.

The final macro closure condition in Equation 30 requires that aggregate savings equal aggregate investment. This model specification, as explained in the extended discussion about the model, corresponds to a "savings driven" model, in which aggregate investment is the endogenous sum of the separate savings components. This is often called "neoclassical" closure in the CGE literature. As with the balance of payments equation, there are alternative ways to achieve savings-investment equilibrium in CGE models. Investment driven" closures can be used in which aggregate investment (INVEST) is fixed and some savings component or parameter (such as FSAV) becomes endogenous.

Market Clearing Conditions

25) $FDSC_s^i = f_s^i$

26) $FDSC_m^i + FDSC_{mg} = f_m$

27) $X_i = INT_i + \sum PX_i + G_i + Z_i$

28) $XD_N = XXD_N$ $_N$: nontraded

29) $X_N = XXD_N$

30) INVEST = HHSAV + (YG-EG) +FSAV.ER

31) $FSAV = \sum pwm,M_i + ROW_{CAP} + ROW_{HH} + ROW_{Govt} - \sum pwe_iE - RMIT - GOVT_{ROW} - CAP_{ROW}$

Endogenous Variables

HHSAV household savings

Exogenous Variables

ROW_{CAP} capital transfers to rest of the world

ROW_{HH}	household transfers to rest of the world
ROW_{Govt}	government transfers to the rest of the world
RMIT	remittances (From Egyptians working abroad)
$GOVT_{ROW}$	rest of the world transfers to the Government
CAP_{ROW}	capital transfers to Egypt from rest of the world
f_s	factor supply for the sector specific factor
f_m	factor supply for the sectorally mobile factor

Functional Forms and Calibration

CGE models are not estimated, only "calibrated". This calibration is based first and foremost on the exact replication of the base year data compiled in the SAM[13]. The SAM gives consistent and complete record of nominal values of transactions in the base year. A measurement unit for labor is chosen so that all wages are initially equal to one. Similarly, measurement units for quantities of domestic commodities, imports and exports are chosen so that the consumer prices of domestic goods and imports, the world price exports, and exchange rate are all equal to one in the base year. With this normalization rule, all initial prices and quantities can be computed and parameters that are directly computed from shares can be easily derived. Share parameters of the CES and CET are also directly derived from observed values in the SAM.

The major constraints on the specification of demand and production function in applied models is that they must satisfy restrictions such as Walras's law for demand functions and be analytically tractable. They also must be such that demand and supply responses form

[13] The CAMS modeling software used to implement the model (Brooke et al., 1988).

the economy be easy to evaluate for any price vector considered as a candidate equilibrium solution for the economy (Shoven & Whalley, 1992). This largely explains why the functional form used are often restricted to the family of convenient forms (Cobb Douglas: constant elasticity of substitution (CES); linear expenditure system (LES); and others).

Experience has shown that the empirical results obtained from simulations with CGEs are quite insensitive to the specific values chosen for all the elasticites (Sadoulet, 1995, p 354; Lofgren, 1994, p. 2). The only exception to this is the elasticity of substitution between domestic goods and imports[14]. The possible range for of substitutability is relatively well represented by four values: 0.3 for very low substitutability, 0.8 for medium-low, 1.2 for medium high and 3.0 for very high (Sadoulet, 1995). Based on the survey by Lofgren (1994) in which he reported the result of a survey for 18 CGE models including seven for Egypt. All the elasticity values reported for substitution between primary factors in the survey are borrowed elasticites (guess estimates). For the group of agriculture, the range is 1 to 1.3, industry .4 to 1 and for services .2 to 1.6. This study uses the convenient Cobb Douglas function for production of value added.

[14] See the section on model consistency for elaboration.

CHAPTER 6. ANALYSIS OF THE SIMULATION RESULTS

This chapter is composed of two parts. The first part gives a brief review of the assumption used to specify the behavioral equations of the model. The second part describes the specific experiments performed and presents the results.

Production of each of the commodities is modeled by Cobb Douglas production functions. First order conditions determine the demand for labor, capital, and agricultural land. Production factors are owned by households except for some government owned capital and supply is exogenously fixed. Firms pay value-added to factors of production and the perfect-competition, constant-returns-to-scale technology ensures that the distribution is exhaustive. Domestically produced goods are either used at home or exported. Intermediate goods demand is determined by linear Leontief input-output equations. No difference exists in the production of goods used for consumption, as intermediates, or investment goods.

Households derive income from given quantities of production factors, as well as transfers from abroad and the government which are largely exogenous. They further pay income tax on factor income and transfers, and also save a given part of their incomes. Households maximize utility given disposable income and derived commodity demand is modeled as linear expenditure system (LES) which means no substitution occurs. The modeling of foreign trade regards internationally traded goods as differentiated by country of origin, using the Armington specification. Domestically available tradables are composites of imported and domestically produced goods and imports are imperfect substitutes for

domestic goods. A constant elasticity of substitution function specifies users' demand tradeoff.

Egyptian exports are imperfect substitutes for other countries goods. Exported goods are not the same as domestically sold goods and a constant elasticity of transformation (CET) function specifies producers' supply tradeoff. Exports, imports, and foreign savings, as well as transfers to and from the rest of the world determine the current account balance. The exchange rate adjusts to ensure equilibrium on the market for foreign exchange. Household savings, government and foreign savings determine the availability of loanable funds. The policy simulations are performed on GAMS using the SAM for 1991/92 as abase period for the analysis.

The simulation results are comparative static in nature. The time path of the adjustment is not traced. After a particular policy change the economy converges to a new equilibrium. The time lag between two equilibria is assumed to be sufficiently long to a accommodate all adjustment ensuing from the hypothetical policy change so that the new equilibrium is reached. Results from the different experiments will be presented and analyzed in the part which follows. Results are compared to the base scenario and among scenarios. The simulation results are shown in Appendix B

First Experiment: Higher Capital Inflow

In the first experiment we simulated the impact of an exogenous increase in foreign capital inflow both the private (remittances) and public. This is done by increasing each by 30%. Results from the simulation show that such an increase in the flow of foreign capital by

30%, other things remaining equal, leads to an appreciation of the real exchange rate. The immediate effect of the experiment, however, is an increase in domestic spending of household. Household real consumption increased in all sectors, ranging between 2.8% and 10.8 %. As consumption increased, demand for both domestically produced and imported good rose.

The experiment resulted in an overall increase in the domestic sale of the composite commodity (composite of domestic production and imports). The percentage increase in the domestic sale of the two agricultural sectors is among the smallest among tradables, second only to the services sector. On the imports side, given fixed world price of domestic imports, the appreciation of the real exchange rate makes imports cheaper relative to domestic goods, and import demand increases across all the sectors. As relative prices move in favor of imports as a consequence of the appreciation of the real exchange rate, households substitute imported goods for domestically produced goods. With more income as a consequence of the additional inflow of foreign exchange households, however, tend to increase consumption of all goods domestically produced or imported.

On the exports side, the appreciation of the real exchange rate makes production for the domestic market more attractive than for export. As a consequence, exports from all sectors decline. While domestic output in some of the sectors may have increased, this increased production is sold domestically due to the wrong price signal generated by the real exchange rate over valuation. As a result, production for the domestic market of all exportables increased. Production for the domestic market of the sectors that can be classified as net importers (food processing and industry) also witnessed small increase, 33% and 4%,

respectively. Snap (1977) demonstrated that even though the Dutch disease could be expected to cause a decline of goods other than the non-tradables, production of some tradables, however, could rise due to non neutral technological change in the nontraded sector.

The simulation results generated by the model used in this study are more complex. In our case these tradables sectors seem to expand, however, for different reasons. The increase in production in these sectors were due to rise in domestic sales. The rise in domestic sales might be attributed to the spending effect of the exogenous increase in the inflow of foreign capital.

A closer look at the simulation results indicates that the food processing sector and the two agricultural sectors are among the hardest hit sectors by the decline of exports. On the supply side, gross outputs of some tradable sectors such as the two agricultural and the services sector expanded by 4 %, 2% and 13%, respectively. The remaining tradable sectors experienced contraction.

Experiment Two: Sensitivity to the Values of Trade Elasticities

In this experiment we attempt to verify whether the choice of trade elasticities plays an important role in our conclusions. These elasticities determine the extent of export and import movement following changes in relative prices and, consequently, whether it has an influence on the policy outcomes. The first experiment has been carried under relatively high trade elasticities, based on Egypt's experience on CGE modeling and a literature review of Lofgren (1994), this experiment then uses a relatively low trade elasticities.

The experiment showed that the choice of the low elasticities, in general, affects only the extent of, for example, the exchange rate over valuation and hence changes on prices and

quantities of imports exports and production. The experiment does not change the main conclusions. Higher capital inflow leads to real exchange rate over valuation and consequently, reduces exports and increases imports. The higher the trade elasticities the smaller the real exchange rate over valuation.

The implied required real devaluation that will restore the benchmark varies between 10.2 % and 15.1% for the first and the second experiment, respectively. For the different sectors, the ratio of exports to domestic output and imports to domestic sale in the first experiment (high elasticites) ranged from 1.1% to 52.7 %, and from 4.2% to 48.2%, respectively. In the second experiment (low elasticities), they ranged from 1% to 52% and from 3.8 % to 45.4 %, while in the base run it was 1.3% to 55.2% and 3.3% to 44%, respectively. These results, in general, are consistent with the diagnosis and advice of McKinnon (1996), which is that the authorities must keep tight control over both private capital inflow and be careful not to over absorb official development assistance as they can contribute to real exchange rate overvaluation.

Experiment Three: Food Price Shock

In Egypt self sufficiency for necessary food items such as wheat, edible oil and sugar were 40%, 17.26 and 71.3%, respectively, in 1992/93 (Fletcher, 1996). This, in turn, means a heavy and increasing burden on the balance of payments and the use of foreign exchange as well as increasing vulnerability to changing world prices. Given the dependence of the economy on food imports, change in terms of trade has profound effects on the over all

performance of the economy. As discussed in Chapter 2, one of the channels in which these effects takes place is the real exchange rate.

To simulate the effect of an adverse terms of trade shock, world price of imports for the two agricultural sectors and the food processing sector increased by a hypothetical 25% and imports for industry by 5%. Following the discussion in Chapter 2, two real exchange rates were calculated: exportables real exchange rate and importables real exchange rate[15]. Results from the simulation show that such an increase in the world prices of food and industry imports, other things remaining equal, results into importables real exchange rate depreciation given the relatively high import substitution elasticities.

On the consumption side this leads to a reduction in domestic spending of household. Household real consumption is lower in all sectors. As consumption decreased consumers switch from the more expensive imports to domestically produced goods and, as a result, demand for most of the imported goods fall. The experiment resulted in an overall decrease in the domestic sale of the composite commodity (composite of domestic production and imports). On the import side with the higher import prices consumer income is lower. The depreciated imports real exchange rate makes imports more expensive relative to domestic goods. The substitution effect dominates and imports demand decrease across most of the sectors. As relative prices move against imports, households substitute domestically produced goods for imports.

On the export side, the export real exchange rate appreciated making production for the domestic market more attractive than for exports. As a consequence, exports from all sectors

[15] See Edwards (1989) for a discussion of this point.

decreased. Again, the ratio of imports to domestic sale and exports to domestic output range from 2.3% to 38% and from 1.2% to 55%, respectively.

Experiment Four: Sensitivity to Low Trade Elasticities

In this experiment, as done in experiment two, we used relatively low trade elasticities. Outcomes from the simulation show that such an increase in the world prices of food and industry imports, other things remaining equal, resulted in import real exchange rate depreciation given the relatively low imports substitution elasticities. The main difference in this case is that income effect dominates instead of the substitution effect in the first case. On the consumption side this leads to a reduction in domestic spending of household. Household consumption demand decreased for both domestically produced goods and imported goods. As consumption demand fall, real consumption decreased in all sectors.

The experiment resulted in an overall decrease in the domestic sale of the composite commodity (composite of domestic production and imports). On the import side, the higher import prices and the depreciated import real exchange rate makes imports more expensive relative to domestic goods, import demand decrease across all the sectors. As relative prices move against imports upon the depreciation of the real exchange rate, households substitute domestically produced goods for imports. With the lower income as a result of the higher import prices households, however, tend to reduce consumption of all goods domestically produced or imported.

On the export side, the export real exchange rate depreciates. This makes production for exports more attractive than for domestic market. As a consequence, exports from all

sectors increased except crop agriculture and food processing (a net importer). This increase in export occurs as producers switch from domestic production causing it to be lower, to produce for the more attractive exports. The ratio of exports to domestic output and import to domestic consumption ranged from 1.3 % to 55.4 %, and from 2.8 % to 40.3 %, respectively.

Experiment Five: Both Shocks and Sensitivity

In this experiment we combined both shocks, increase in foreign capital inflow and terms of trade shock. The main outcome from this experiment was dominated by the outcome of the first experiment. The combined shocks results into real exchange rate overvaluation lower share of exports to domestic output, higher share of imports to domestic consumption. The income effect resulting from the increase in the flow of foreign capital increases domestic demand, combined with overvalued exchange rate, expenditures on both domestic goods and imports increase.

The change in relative prices in favor of imports and non-tradables leads to lower production for exports purposes. For this experiment direction of change in the exportable and importable exchange rates are the same as the results of using single real exchange rate (they both appreciate). The above conclusion remains the same when the sensitivity analysis carried out under lower trade elasticities.

Experiment Six: Import Liberalization

In this experiment the level of import tariffs on industrial intermediate inputs was lowered by 75%. This experiment was carried jointly with the first experiment. One way to look at this experiment is as a policy response to neutralize the effect on the real exchange rate

caused by the first experiment. The experiment led to a depreciation of the real exchange rate by about 2%. This shows the bias against exports caused by these policies. It also shows the usefulness of tariffs as an open policy option for reducing the real exchange rate over valuation. The other indicators, namely the ratio of imports to domestic use and exports to domestic output, ranged from 4.2% to 42% and from 1.1% to 52.6%, respectively.

CHAPTER 7. CONCLUSIONS

This study used a general equilibrium model applied to the economy of Egypt to quantify the effects external shocks (increase in the inflow of foreign capital and an adverse terms of trade shock) and policy induced reforms (tariff reform) on the real exchange rate, exports, imports, production and consumption. The simulation results in the previous chapter showed that, when Egypt experiences a significant increase in foreign exchange inflow foreign aid that is spent domestically, an appreciation of the Egyptian real exchange rate results. This results in an increase in import demand and a shift in the production mix away from tradables in favor of domestic goods.

Using a disasgregated real model, imports increase while exports decrease for all sectors, and production for the domestic markets is higher across all sectors. Using a somewhat low trade elasticities, the overall results of the experiment remain the same while the magnitude of the outcome changes with the values of the elasticities used. The results from this experiment, thus, are inline with the results from the analytical models of de Melo and Robinson (1989), Devarajan et al. (1990), and deMelo and Tarr (1992). This also contributes to the current debate about the exchange rate policy in Egypt and gives support to the opinion that calls for devaluation of the Egyptian pound to mention incentives for domestic production consistent with a given international price (Fletcher, 1996). In addition, as suggested by McKinnon (1996), the authorities have to keep tight controls over private capital inflows, particularly for short terms, as they move purposefully to restrict domestic

demand. The authorities must also be careful not to overabsorb official development assistance, which can also contribute to real exchange-rate overvaluation.

The other main simulation of adverse terms of trade shock, led to the overvaluation of the exportables real exchange rate and a reduction in exports assuming a relatively high substitution elasticities. The experiment also resulted in an importables real exchange rate depreciation and lower spending overall due to the lower income resulting from the higher import prices. As the income effect dominates, households tend to substitute domestic goods for imports. With the appreciated exportables real exchange rate producers switch to domestic production at the expense of exports. With relatively lower trade elasticites, however, the income effect dominates and the experiment leads to a depreciation in both rates, the economy contract domestic output and expanded exports.

On the other hand, the outcomes of the combined shocks—terms of trade and higher flow of foreign capital—are insensitive to the trade substitution elasticity values and are generally dominated by the results from the first experiment. As discussed before devaluation of the pound is one of the options that the government can use to adjust the RE.

Finally, trade liberalization in the form of lower tariff rates on industrial imported intermediate inputs is simulated as policy response. It turned out that this policy helps mitigate the detrimental effects of the shocks. The direct effect of this protection for industry is to raise the relative domestic prices of manufactured inputs and consumer goods bought by agricultural households, i.e., bias the domestic terms of trade against agriculture (Fletcher, 1996). To some degree, trade liberalization offsets the reduction in the volume of exports and imports but worsens the budget deficit of the central government. One of the

options that Egyptian government is currently pursuing to reduce the deficit. as mentioned in the section about Egypt economy is the full implementation of the value added tax.

While the model used in this study has been successful in quantifying the effect of external shocks and commercial policy reform on the real exchange and trade flows, it can be improved in various ways. In general, there are distortions in the economy that need to be incorporated in the model. First, the government has pervasive control over the Egyptian economy, both by direct ownership of industrial production units and by rules and regulations. Through modeling, for example, public companies would separately be one step toward incorporating these distortions. Second, the assumption of full employment is too strong given the high rate of unemployment that the Egyptian economy is experiencing. Finally, the same study can be done with financial variables included in the model in line with the work of (Bourguignon et al., 1991; de Janvry et al., 1991) for the interest rate and inflation in these models are endogenous, thus incorporating monetary policy is straightforward. Further, these models allow a natural definition of the exchange rate as the relative price of two assets. This makes it possible to simulate the impact of policies such as the devaluation of the nominal exchange rate in a more realistic way.

APPENDIX A. LOFGREN'S SAM, 1994

Abbreviations Key: HHOLD = Household; GOVT = Government; ROW = The Rest of the World; TARIFF = Tariffs; TAX = Taxes; SUB = Subsidies; S = Savings; I = Investment; A = Activities; DC = Domestic commodities; MC = Imports

	LABOR	CAPITAL	LAND	HHOLD	GOVT	ROW	AGRCR-A
LABOR					7994		4592
CAPITAL						2358	11750
LAND							2191
HHOLD	35014	81096	2191		13123	18695	
GOVT		8830		4443		3672	
ROW		4624		1190	3087		
AGRCR-A						890	
AGRAN-A						112	
FOOD-A						456	
OIL-A						8919	
OIND-A						4699	
TRN-A						8571	
OSER-A						16088	
ELE-A							
CON-A							
AGRCR-DC				10752	330		800
AGRAN-DC				6119	147		504
FOOD-DC				14037	382		
OIL-DC				4338	158		37
OIND-DC				19115	1301		1173
TRN-DC				4973	327		32
OSER-DC				32176	837		614
ELE-DC				2408	121		16
CON-DC				-1	142		9
AGRCR-MC				1364	16		448
AGRAN-MC				175			
FOOD-MC				6506	538		1
OIL-MC				213	255		
OIND-MC				1818	1619		184
TRN-MC				54	93		
OSER-MC				294	210		
TAX				10107			34
TARIFF							
SUB					4450		-247
S-I				34062	6147	-12089	
TOTAL	35014	94550	2191	154143	41277	52371	22138

AGRAN-A	FOOD-A	OIL-A	OIND-A	TRN-A	OSER-A	ELE-A	CON-A
615	802	447	4301	2243	10916	457	2647
1861	3094	11820	13502	11362	33327	1604	3872
4249	3446		1540	30	92		
71	1399		24	11	55		
1076	344		69	207	945		
8	17	1291	388	759	31	586	77
46	340	532	8887	857	1258	478	5177
10	34	95	256	185	2662	52	96
450	209	451	2906	317	6004	112	169
7	53	140	679	68	283	3	8
4	22	22	180	22	1064	51	2
66							
	6310		91				
		80	88	322			
	324	4	9048	604	1811	219	2776
				502			
		539			2898		
12	1135	792	531	323	479	2	85
-33		-58	-88				
8442	17529	16155	42402	17812	61825	3564	14909

AGRCR-DC	AGRAN-DC	FOOD-DC	OIL-DC	OIND-DC	TRN-DC	OSER-DC	ELE-DC
212148							
	8330						
		17073					
			7236				
				37703			
					9241		
						45737	
							3564
			498	2607			222
21248	8330	17073	7734	40310	9241	45737	3786

CON-DC	AGRCR-MC	AGRAN-MC	FOOD-MC	OIL-MC	OIND-MC	TRN-MC	OSER-MC
	1894	288	12699	955	22602	759	4273
14909							
1016				68	1827		
			747	33	3814		
15925	1894	288	13446	1056	28243	759	4273

TAX	TARIFF	SUB	S-I
		4024	
19738	4594		
			9
			13
			44
			1146
			519
			1492
			14408
			113
			98
			9836
			110
			332
19738	4594	4024	28120

APPENDIX B. SIMULATION RESULTS OF THE STUDY

Abbreviations Key: CR AGR = Crop Agriculture; AN AGR = Animal Agriculture; IND = Industry; FOD = Food Processing; TRN = Transportation; OIL = Oil; SER = Services; CON = Construction; ELE = Electricity; MRE = Importables Real Exchange Rate; ERE = Exportables Real Exchange Rate

Part A. Simulation Results

	Experiment One	Experiment Two	Experiment Three	Experiment Four	Experiment Five	Experiment Six
DOMESTIC GOOD PRICE						
CR AGR	1.1	1.9	0.6	-1	2	1
AN AGR	1.3	1.4	1.1	0.6	2.5	1.9
FOD	-2.5	2	7	3.4	4.4	2.5
OIL	-5.7	-9.6	-2.5	0.4	-8.1	-8.2
IND	-1.8	-1	-0.5	-0.1	-2.3	-0.8
TRN	-0.6	-3.1	-2	-0.3	-2.7	-2.8
SER	3.4	2.3	-1.6	-1	1.8	1.7
ELE	1.9	0.6	-1.6	-0.7	0.2	0.3
CON	-2.9	-3.9	-0.6	0.5	-3.4	-3
DOMESTIC PRICE OF IMPORTS						
CR AGR	-10.2	-15.1	21.6	26.2	9	8.7
AN AGR	-10.2	-15.1	21.6	26.2	9	8.7
FOD	-10.2	-15.1	21.6	26.2	-12.8	-13
OIL	-10.2	-15.1	-2.8	0.9	-8.5	-8.7
IND	-10.2	-15.1	2.1	6	-12.8	-13
TRN	-10.2	-15.1	-2.8	0.9	-12.8	-13
SER	-10.2	-15.1	-2.8	0.9	0	0
DOMESTIC PRICE OF EXPORTS						
CR AGR	-10.2	-15.1	-2.8	0.9	-12.8	-13
AN AGR	-10.2	-15.1	-2.8	0.9	-12.8	-13
FOD	-10.2	-15.1	-2.8	0.9	-12.8	-13
OIL	-10.2	-15.1	-2.8	0.9	-12.8	-13
IND	-10.2	-15.1	-2.8	0.9	-12.8	-13
TRN	-10.2	-15.1	-2.8	0.9	-12.8	-13
SER	-10.2	-15.1	-2.8	0.9	-12.8	-13

DOMESTIC SUPPLY PRICE						
CR AGR	0.1	0.4	2.1	1.1	2.5	1.7
AN AGR	0.9	0.8	1.7	1.3	2.7	2.1
FOD	-6.1	-5.7	13	13	6.4	5.2
OIL	-6.2	-10.3	-2.5	0.4	-8.6	-8.8
IND	-5.1	-6.5	0.5	2.2	-4.7	-3.9
TRN	-1.4	-4.1	-2.1	-0.2	-3.5	-3.6
SER	2.2	0.8	-1.7	-0.8	0.5	0.4
ELE	1.9	0.6	-1.6	-0.7	0.2	0.3
CON	-2.9	-3.9	-0.6	0.5	-3.4	-3

DOMESTIC OUTPUTPRICE						
CR AGR	0.7	1.3	0.5	-0.9	1.4	0.5
AN AGR	1.2	1.2	1.1	0.6	2.3	1.7
FOD	-2.7	1.6	6.8	3.4	4	2.2
OIL	-8.1	-12.6	-2.6	0.7	-10.6	-10.8
IND	-2.7	-2.5	-0.7	0	-3.4	-2.1
TRN	-5.2	-8.7	-2.4	0.3	-7.4	-7.6
SER	-0.1	-2.1	-1.9	-0.5	-1.9	-2
ELE	1.9	0.6	-1.6	-0.7	0.2	0.3
CON	-2.9	-3.9	-0.6	0.5	-3.4	-3

REAL EXCHANGE RATE						
	-10.2	-15.1	MRE+7.8 ERE-2.8	MRE+11.9 ERE+0.09	-12.8	-13

VALUE ADDED PRICE						
CR AGR	1.06383	1.99063	0.841	-1.3317	1.87573	0.82938
AN AGR	5.78778	5.48387	0.278	-5.7762	1.01351	0.67797
FOD	-0.4525	14.6154	0.231	-11.000	3.47826	-1.3699
OIL	-10.48	-16.769	0.738	0.78431	-13.793	-14.135
IND	-1.4493	0.9434	0.411	-2.439	-3.4483	-0.9615
TRN	-5.8172	-10.405	0.741	-0.1311	-9.1429	-9.4556
SER	0	-2.2857	0.698	-0.9873	-2.432	-2.5788
ELE	6.47249	6.01626	0.566	-2.1201	4.46281	4.30464
CON	-0.2294	-0.6912	0.430	-1.3921	-1.8648	-1.8648

DOMESTIC SALE OF DOMESTIC OUTPUT						
CR AGR	0.96481	1.56127	0.8895	-0.0094	1.87041	1.52021
AN AGR	2.23005	2.27593	-1.1164	-1.3875	1.1276	1.05713
FOD	0.33857	4.86459	1.94459	-2.1662	2.13803	0.85366
OIL	4.802	5.92824	0.2764	-0.5419	5.08919	5.1514
IND	0.41732	1.66658	0.08487	-0.3193	0.4515	1.35528
TRN	2.63407	2.90007	0.04329	-0.1952	2.66484	2.66484
SER	1.49257	1.25437	-0.1181	0.00656	1.3566	1.34383
ELE	1.92625	1.92625	-0.1122	-0.1686	1.81818	1.81818
CON	0.01341	-0.0201	-0.0134	0.00671	-0.0067	0

QUANTITY OF IMPORTS						
CR AGR	21.9613	14.9529	-30.834	-21.41	-12.071	-4.4101
AN AGR	23.2	15.2941	-31.597	-21.519	-11.628	-4.3478
FOD	15.5773	9.9759	-20.958	-19.776	-6.672	-3.9104
OIL	13.7871	17.1141	0.91093	-1.6461	14.6067	14.8276
IND	7.36754	6.09648	-1.9609	-2.1106	5.49513	3.77736
TRN	10.2837	12.6582	0.65876	-1.2	10.9155	11.0199
SER	6.00528	7.16924	0.28083	-0.6359	6.27331	6.3144

QUANTITY OF EXPORTS						
CR AGR	-14.249	-22.59	-3.1461	2.1978	-18.509	-17.881
AN AGR	-13.131	-20.43	-5.3571	-0.9009	-20.43	-19.149
FOD	-17.526	-37.349	-15.789	-7.2941	-40.308	-37.764
OIL	-5.1149	-6.7377	-0.3027	0.59073	-5.5253	-5.6003
IND	-7.0631	-11.193	-1.7451	0.50815	-9.0255	-9.6105
TRN	-5.6062	-7.9471	-0.56	0.81009	-6.3004	-6.4192
SER	-4.2577	-6.4232	-0.5843	0.77099	-4.9446	-5.0473

QUANTITY OF GOODS SUPPLIED DOMESTICALLY						
CR AGR	2.98482	2.71157	-1.9316	-1.6427	0.83133	1.04759
AN AGR	3.07052	2.73138	-2.2279	-2.0123	0.73716	0.88557
FOD	7.52098	7.07043	-8.5062	-9.6662	-1.6047	-1.2239
OIL	5.87857	7.28826	0.3413	-0.6758	6.24	6.30996
IND	3.13953	3.34165	-0.7104	-1.0138	2.41844	2.28073
TRN	3.22268	3.67017	0.09	-0.2707	3.3069	3.31625
SER	1.86806	1.74467	-0.086	-0.048	1.76783	1.75818
ELE	1.9425	1.9171	-0.1057	-0.1587	1.81535	1.81535
CON	0.01256	-0.0188	-0.0188	0.00628	-0.0063	0

QUANTITY OF DOMESTIC OUTPUT						
CR AGR	0.45863	0.83763	0.73177	0.08575	1.24019	0.90864
AN AGR	2.06497	2.0536	-1.1846	-1.381	0.91549	0.84567
FOD	-0.0457	4.16074	1.50037	-2.2934	1.42279	0.18222
OIL	-0.3666	-0.5665	-0.0433	0.08659	-0.4165	-0.4289
IND	-0.3265	0.47413	-0.1156	-0.2269	-0.4715	0.31268
TRN	-1.061	-1.8527	-0.247	0.29667	-1.3312	-1.3831
SER	0.13246	-0.5072	-0.2394	0.20822	-0.1198	-0.1539
ELE	1.92625	1.92625	-0.1122	-0.1686	1.81818	1.81818
CON	0.01341	-0.0201	-0.0134	0.00671	-0.0067	0

INTERMEDIATE DEMAND						
CR AGR	0.83635	2.35176	-1.2932	-1.3102	0.91002	0.54986
AN AGR	0.14514	3.09859	-1.5504	-1.5748	1.29125	0.3861
FOD	0.19865	3.25238	-1.7914	-1.8241	1.10455	0.18764
OIL	-0.1631	-0.3541	0.05429	0.05426	-0.2995	-0.2176
IND	-0.1485	0.27801	-0.1305	-0.1307	-0.208	0.16581
TRN	-0.102	-0.5638	0.15291	0.15267	-0.3067	-0.3067
SER	0.06812	-0.116	0.02045	0.02045	-0.1092	-0.0068
ELE	-0.2392	0.15886	-0.1591	-0.1594	-0.3192	0.07949
CON	0.14514	-0.2185	0.07267	0.07262	-0.0727	0

CONSUMPTION EXPENDITURE FOR HOUSEHOLDS						
	4.949214	3.48891	-0.898	-0.9061	3.23652	3.11432

CONSUMPTION DEMAND						
CR AGR	4.88303	3.10301	-1.9478	-1.9865	0.79424	1.51195
AN AGR	4.11335	2.72025	-2.2085	-2.2583	0.58443	1.09994
FOD	10.7098	8.94464	-12.311	-14.039	-2.926	-1.915
OIL	10.8696	13.3968	-1.3404	-1.3586	11.5796	11.6482
IND	9.79488	9.80654	-3.0765	-3.1741	7.79226	6.8651
TRN	6.28262	7.42173	-0.6763	-0.681	6.5787	6.59606
SER	2.81935	2.71161	-0.0862	-0.0863	2.74075	2.68537
ELE	3.13757	2.90323	-0.1661	-0.1664	2.98147	2.78563

Part B. Sectors tradability: Deviations from Base Scenario

EXPERIMENT 1.		EXPERIMENT 2.		EXPERMENT 3.	
M/X	E/XD	M/X	E/XD	M/X	E/XD
0.019901	-0.00518	0.01178	-0.00768	-0.02412	-0.00155
0.008759	-0.00178	0.004956	-0.00248	-0.01004	-0.00056
0.042044	-0.00387	0.014219	-0.00786	-0.05996	-0.00443
0.010311	-0.02494	0.013325	-0.03192	0.000638	-0.00143
0.017588	-0.00697	0.011305	-0.01163	-0.00485	-0.00181
0.005974	-0.02071	0.007811	-0.02717	0.000431	-0.00151
0.003761	-0.01096	0.004993	-0.01447	0.000314	-0.0009
0	0	0	0	0	0
0	0	0	0	0	0

EXPERIMENT 4.		EXPERIMENT 5.		EXPERIMENT 5.	
M/X	E/XD	M/X	E/XD	M/X	E/XD
-0.01333	0.000868	-0.00428	-0.00641	-0.00942	-0.0067
-0.00536	6.31E-05	-0.00168	-0.00223	-0.0037	-0.00235
-0.03719	-0.00121	-0.01139	-0.00717	-0.02093	-0.00774
-0.00107	0.0028	0.011241	-0.02704	0.011013	-0.02673
-0.00414	0.000819	0.005993	-0.01003	0.012545	-0.00869
-0.0007	0.002491	0.006571	-0.02277	0.006483	-0.02249
-0.0005	0.001476	0.004155	-0.01212	0.004107	-0.01196
0	0	0	0	0	0
0	0	0	0	0	0

EXPERIMENT 6.	
M/X	E/XD
0.019913	-0.00518
0.008702	-0.0018
0.055785	-0.00316
0.010459	-0.02519
0.034767	-0.00464
0.00591	-0.02074
0.003758	-0.01098
0	0
0	0

REFERENCES

Adelman, I., & Robinson, S. (1988). Macroeconomic adjustment and income distribution: Alternative models applied to two economies. *Journal of Development Economics, 29*, 1-22.

Agenor, P. R, & Montel, P. (1996). *Development macroeconomics.* Princeton, NJ: Princeton University Press.

Armington, P. (1969). A theory of demand for products distinguished by place of production. *International Monetary Fund (IMF) Staff Papers,* 16, 159-176.

Ahamed, L.. (Ed .). (1986*). Economic adjustment and exchange rates in developing countries.* Chicago, IL: University of Chicago Press.

Bautista, R. M., & Valdes, A. (1993). The bias against agriculture: Trade and macroeconmic policies in developing countries. San Francisco: ICS Press for the International Center for Economic Growth and the International Food Policy Research Institute.

Bergman, L., Jorgenson, D., & Zalai, E. (1990). *General equilibrium modeling and economic policy analysis.* Cambridge, MA: Basil Blackwell.

Bourguignon, F, de Melo, J., & Morrisson, C., (1991). Adjustment with growth and equity: A symposium. Washington, DC: World Development.

Brooke, A. D., Kendrick, D., & Meerans, A. (1988). *CAMS: A user's guide.* Redwood, CA: The Scientific Press.

Chowdhury, A., & Kirkpatrick, C. (1994). *Development policy and planning: An introduction to models and techniques.* New York: Routledge.

Dervis, K., de Melo, J., & Robinson, S. (1982). *General equilibrium models for development policy.* Cambridge, MA: Cambridge University Press.

Dethier, J. J. (1989). *Trade exchange rate and agricultural pricing policies in Egypt, vols. I and II.* Washington, DC: World Bank Comparative Studies.

Devarajan, S., Lewis, J. D., & Robinson, S. (1989). Policy lessons from two-sector models. *Journal of Policy Modeling, 12,* 625-657.

Devarajan, S., Lewis, J. D., & Robinson, S. (1991*). From stylized to applied models: Building multisector.* (CGE Models for Policy Analysis, Working Paper No. 616). Berkeley: University of California: Giannini Foundation of Agricultural Economics.

Devarajan, S., & de Melo, J. (1987). Adjustment with a fixed exchange rate. *Cameroon Corte devoire and Senegal World Bank Economic Review, 1*(3), 447-487.

Diakosavvas, D., & Kirkpatrick, C. (1990). The effects of trade and exchange rate policies on production incentives in agriculture. Washington, DC: FAO Economic and Social Policy Department, Policy Analysis Division.,

Edwards, S. (1986). The order of liberalization of the current and capital account of the balance of payments. In A. M Choksi, & D. Papageorgiou (Eds), *Economic liberalization in developing countries.* Oxford, Great Britain: Basil Blackwell.

Edwards, S. (1989). *Real exchange rates: Devaluation and adjustment exchange rate policy in developing countries.* Cambridge, MA: MIT Press.

Fletcher, L. B. (Ed.). (1996). Egypt's agriculture in a reform era. Ames: Iowa State University Press.

Gunning, J, & Keyzer, M. (1995). Applied general equilibrium models for policy analysis. In J. Behman, & T. N. Srinivasan (Eds.), Handbook of development economics, vol. 3A. New York: Routledge.

Harberger, A. C. (1986). Economic adjustment and the real exchange rate. In S. Edwards, & L. Ahmed, *Economic adjustment and exchange rates in developing countries.* Chicago: University of Chicago Press.

Harberger, A. C. (1989). *Trade policy and the real exchange rate.* Washington, DC: Economic Development Institute, World Bank.

Henderson, J., & Quandt, R. (1980). Microeconomic theory: A mathematical approach (3rd ed.). New York: McGraw-Hill Book Company.

de Janvry, S., Fargeix, P., & Sadoulet, E. (1991). *Adjustment and equity in Ecuador.* Washington, DC: Organization of Economic Cooperation and Development (OECD).

Khan, M .S. (1986). Developing country exchange rate policy responses to exogenous shocks. *American Economic Review, 76*, 84 - 87.

Khan, M. S., & Lizondo, J. S. (1987). Devaluation fiscal deficit and the real exchange rate. *World Bank Economic Review, 1*(2), 357-374.

Khan, M. S., & Montiel, J. (1987). Real exchange rate dynamics in a small primary-exporting country. *IMF Staff Papers, 34*(4), 687-710.

Khedr, H., Ehrich, R., & Fletcher, L. (1996). Nature, rationale and accomplishments of the agricultural policy reforms,1987-1994. In L. Fletcher (Ed.), *Egypt's agriculture in a reform era*. Ames: Iowa State University Press.

Krueger, A. O. Schiff, M., & Valdez, A. (1988, January). Agricultural incentives in developing countries: Measuring the effect of sectoral and economy-wide policies. *World Bank Economy, 2*(1), 255-271.

Lofgren, H. (1994a). A social accounting matrix for Egypt, 1991/92. Washington, DC.

Lofgren, H. (1994b, December). *A brief survey of elasticites for CGE models.* Paper presented to the Ford Foundation. Washington, DC.

Lofgren, H. (1995). Macro and micro effects of subsidy cuts: A short-run CGE analysis for Egypt. *Middle East Business and Economic Review, 7*(2), 18-39.

McKinnon, R. (1996). Issues in financial reforms and sequencing in economic transitions. In L. Fletcher (Ed.), *Egypt's agriculture in a reform era.* Ames: Iowa State University Press.

de Melo, J. (1988). Computable general equilibrium models for trade policy analysis in developing countries: A survey. *Journal of Policy Modeling, 10*(4), 469.

de Melo, J., & Robinson, S. (1989). Product differentiation and the treatment of foreign trade in computable general equilibrium models of small economies. *Journal of International Economics, 27*(1-2), 47-67.

de Melo, J., & Tarr, D. (1992). *A general equilibrium analysis of U.S. foreign trade policy.* Cambridge, MA: MIT Press.

Mercenier, J., & Srinivasan, T. N. (1994). *Applied general equilibrium and economic development*. Ann Arbor: The University of Michigan Press.

Mitra, P. (1994). *Adjustment in oil-importing deveoping countries*. Great Britain: Cambridge University Press.

Mundlak, Y., Cavallo, D., & Domenech, R. (1990). Effects of macroeconomic policies on sectoral prices. *World Bank Economic Review, 4*(1), 55-79.

Payatt, G., Round J., & Denes, J. (1984). *Improving the macro economic data base: A SAM for Malaysia, 1970.* Washington, DC: The World Bank: Staff Working Paper No. 646.

Payatt, G., & Round, J. (1985). *Social accounting matrices: A basis for planning.* Washington, DC: The World Bank.

Robinson, S. (1989). Computable general equilibrium models of developing countries: A survey. In H. Chenery, & T. N. Srinivasan (Eds.), *Handbook of development economics*. Amsterdam: North Holland Publishing Co.

Robinson, S. (1991). Macroeconomics, financial variables, and computable general equilibrium models. *World Development, 19*(11): 1509-1525..

Rodriguez,, C. A. (1980). The role of trade flows in exchange rate determination: A rational expectation approach. *Journal of Political Economy, 88*(6), 1148-1158.

Sadoulet, E.. (1995). *Quantitative development policy analysis.* Baltimore: Johns Hopkins University Press.

Sadoulet, E., & Fargeix, P. (1991). *Adjustment equity in Ecuador*. Washington, DC: Development Center of the Organization for Economic Cooperation and Development, Publications and Information Center.

Salter, W. E.G. (1959, August). Internal and external balance: The role of price and expenditure effects. *Economic Record, 35*, 226-238.

Samuelson, P. A. (1953). Prices of factors and goods in general equilibrium. *The Review of Economic Studies, 21*, 1-20.

Shoven, J., & Whalley, J. (1992). *Applying general equilibrium*. Cambridge, Great Britain: Cambridge University Press.

Snape, R. (1977). Effects of mineral development on the economy. *Australian Journal of Agricultural Economics, 21*(3), 147-156.

Srinivasan, T. N., & Whalley, J. (1986). *General equilibrium trade policy modeling*. Cambridge, MA: The MIT Press.

Taylor, L. (1990). *Socially relevant policy analysis.* Cambridge, MA: MIT Press.

World Bank. (1993). *Arab Republic of Egypt: An agricultural strategy for the 1990s.* Washington, DC.

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