An Extended RMSM-X Model for Egypt:
Quantifications of Market-Oriented Reforms

by

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Abstract

Egypt has recently embarked on a new reform strategy to stimulate growth and achieve a better allocation of resources. The reform policy is designed to correct internal and external imbalances within a medium-term time horizon. The initial conditions of the Egyptian economy as well as the ingredients of the reform package are quite similar to what is found in many reforming East European economies.

The paper documents how an extended version of the World Bank's RMSM-X model\(^1\) was built for Egypt. The revised model focuses on industry investment efficiency and the linkage between investment and growth. One peculiarity of the model is a sectoral growth module which binds together the overall macroeconomic performance with sectoral output and investment. To illustrate the model's properties, the paper presents a quantification of the reforms in Egypt. The simulation is presented as a risk scenario - showing what could happen in the case of a domestic policy slippage. The results show that the trend in GDP growth would be 2.1 percentage points lower in the second half of the decade under a failure to implement the reform strategy, while the export growth is estimated to be 1 percentage points lower - mainly because of lower manufacturing exports.

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\(^1\)RMSM-X stands for Revised Minimum Standard Model - Extended.
**RESUME**

L’Égypte a récemment adopté une nouvelle stratégie de réforme destinée à corriger, à moyen terme, les déséquilibres internes et externes afin de stimuler la croissance et d’assurer une meilleure allocation des ressources. La situation de départ de l’économie égyptienne et les diverses composantes du train de réformes sont semblables à celles que l’on trouve dans de nombreux pays de l’Europe de l’Est en voie de réforme.

Ce document montre comment on a construit une version élargie du modél macroéconomique standard de la Banque mondiale (RMSM-X) pour l’Égypte. Ce modèle se focalise sur l’efficacité des investissements industriels et les liaisons entre investissements et croissance. Une de ses particularités est qu’il comprend un module de croissance sectorielle liant la performance macroéconomique globale et la production et l’investissement sectoriels. Pour illustrer les propriétés du modèle, on a quantifié les effets des réformes. La simulation est présentée comme un scénario de risque indiquant ce qui pourrait arriver en cas de dérapage de la politique intérieure. Les résultats montrent que si la stratégie de réforme n’est pas mise en œuvre, la croissance du PIB sera de 2,1 points plus faible pendant la deuxième moitié de la décennie et celle des exportations sera de 1 point plus faible, principalement du fait du recul des exportations de produits manufacturiers.
Reversed matrix standard model-extended field (x-RSM-x)
### Definitions of variable names

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG</td>
<td>public consumption, constant 1987 prices</td>
</tr>
<tr>
<td>CP</td>
<td>private consumption, constant 1987 prices</td>
</tr>
<tr>
<td>CRG</td>
<td>credit to government from financial sector, Egyptian pounds</td>
</tr>
<tr>
<td>CRO</td>
<td>credit to non-government public sector from financial sector, Egyptian pounds</td>
</tr>
<tr>
<td>CRP</td>
<td>credit to private sector from financial sector, Egyptian pounds</td>
</tr>
<tr>
<td>CUP</td>
<td>local currency in circulation in private sector, Egyptian pounds</td>
</tr>
<tr>
<td>DTO</td>
<td>demand and time deposits of the government in financial sector, Egyptian pounds</td>
</tr>
<tr>
<td>DTP</td>
<td>demand and time deposits of the private sector in the financial sector, Egyptian pounds</td>
</tr>
<tr>
<td>E</td>
<td>nominal exchange rate, Egyptian pound per US dollar</td>
</tr>
<tr>
<td>F</td>
<td>foreign direct investment, current dollar</td>
</tr>
<tr>
<td>FS</td>
<td>stock of foreign direct investment, current dollar</td>
</tr>
<tr>
<td>GDP</td>
<td>gross domestic product, constant 1987 prices</td>
</tr>
<tr>
<td>GDP*</td>
<td>OECD Gross domestic product, constant 1987 prices</td>
</tr>
<tr>
<td>I</td>
<td>total investment, constant 1987 prices</td>
</tr>
<tr>
<td>IA</td>
<td>investment in agriculture, constant 1987 prices</td>
</tr>
<tr>
<td>IG</td>
<td>investment in public sector incl. public enterprises, constant 1987 prices</td>
</tr>
<tr>
<td>IM</td>
<td>investment in manufacture, constant 1987 prices</td>
</tr>
<tr>
<td>IP</td>
<td>investment in private sector, constant 1987 prices</td>
</tr>
<tr>
<td>K</td>
<td>stock of capital</td>
</tr>
<tr>
<td>KF</td>
<td>foreign direct investment, constant 1987 prices</td>
</tr>
<tr>
<td>KPS</td>
<td>stock of foreign direct investment, constant 1987 prices</td>
</tr>
<tr>
<td>M</td>
<td>total imports, constant 1987 prices</td>
</tr>
<tr>
<td>MC</td>
<td>total imports, current US dollar</td>
</tr>
<tr>
<td>M2</td>
<td>broad money (money plus quasi money)</td>
</tr>
<tr>
<td>MCA</td>
<td>capital goods imports, constant 1987 prices</td>
</tr>
<tr>
<td>MFO</td>
<td>food imports, constant 1987 prices</td>
</tr>
<tr>
<td>MIN</td>
<td>intermediate goods imports, constant 1987 prices</td>
</tr>
<tr>
<td>MNP</td>
<td>non-factor service imports, constant 1987 prices</td>
</tr>
<tr>
<td>MPE</td>
<td>petroleum imports, constant 1987 prices</td>
</tr>
<tr>
<td>MOS</td>
<td>other consumer goods imports, constant 1987 prices</td>
</tr>
<tr>
<td>pARG</td>
<td>value added deflator in agriculture</td>
</tr>
<tr>
<td>pCP</td>
<td>investment deflator</td>
</tr>
<tr>
<td>pGDP</td>
<td>GDP-deflator</td>
</tr>
<tr>
<td>pI</td>
<td>investment deflator</td>
</tr>
<tr>
<td>pM</td>
<td>price of total imports</td>
</tr>
<tr>
<td>pMCA</td>
<td>price of imported capital goods</td>
</tr>
<tr>
<td>pMFO</td>
<td>price of imported food</td>
</tr>
<tr>
<td>pMIN</td>
<td>price of imported intermediate goods</td>
</tr>
<tr>
<td>pMAN</td>
<td>value added deflator in manufactures</td>
</tr>
<tr>
<td>pMOC</td>
<td>price of imported other consumer goods</td>
</tr>
<tr>
<td>PRM</td>
<td>profit remittances, current US dollar</td>
</tr>
<tr>
<td>PX</td>
<td>price of total exports</td>
</tr>
<tr>
<td>PXMAN</td>
<td>price of manufacture exports</td>
</tr>
<tr>
<td>RES</td>
<td>foreign reserve holdings, current US dollar</td>
</tr>
<tr>
<td>q</td>
<td>real exchange rate, index 1987 = 100</td>
</tr>
<tr>
<td>sK</td>
<td>import share of capital goods to total investment</td>
</tr>
<tr>
<td>sC</td>
<td>import share of food to total consumption</td>
</tr>
<tr>
<td>sN</td>
<td>import share of intermediate goods to GDP</td>
</tr>
<tr>
<td>sO</td>
<td>import share of other consumer goods to total consumption</td>
</tr>
<tr>
<td>X</td>
<td>total exports, constant 1987 prices</td>
</tr>
<tr>
<td>XMAN</td>
<td>exports of manufacture, constant 1987 prices</td>
</tr>
<tr>
<td>XTO</td>
<td>tourist revenues, constant 1987 prices</td>
</tr>
<tr>
<td>YD</td>
<td>disposable income, constant 1987 prices</td>
</tr>
<tr>
<td>YP</td>
<td>potential output, constant 1987 prices</td>
</tr>
</tbody>
</table>
1. **Introduction**

1. This paper documents an upgraded RMSM-X model that was built to analyze economic reform in Egypt. The model developments were designed to include empirically determined private sector behavior and a sectoral post-module that disaggregates production into originating industries. To demonstrate the properties of our new model, the paper presents a quantification of the economic reform package currently under way in Egypt.

2. The presented model extensions took place in connection with the Public Sector Investment Review prepared by the World Bank in 1992. The focus for our model demonstration here, however, will be the Economic Reform and Structural Adjustment Program (ERSAP), which was initiated in 1991 and supported by a World Bank structural adjustment loan and an IMF stand-by agreement. These reforms constitute a comprehensive liberalization of foreign trade and financial markets, a deregulation of government controlled prices and production restrictions, and a reform of Public Enterprises (PEs). For the purpose of illustrating the properties of our new model, a quantification of the economic reform package is shown at the end of the paper. Effects are shown for macroeconomic aggregates and balance of payments components. Concurrently, the investment and output impact of the Egyptian production sectors is presented.

3. The paper is organized as follows: Section 2 gives a short description of recent economic events in Egypt. Section 3 offers a brief description of the sectors and the markets in the Egyptian RMSM-X model. Readers who are familiar with the accounting system of the RMSM-X models may wish to skip this section. Section 4 presents the model's behavioral equations. Specifications and estimation results of the behavior equations are documented here. In section 5, the RMSM-X model's ICOR mechanism is modified to explicitly consider differences between public and private sector ICORS as well as the depreciation of capital equipment and variations in the rate of capacity utilization. Section 6 presents the sectoral post-model which allocates the aggregate macro results into industries according to profitability, accumulated investments (stocks of capital), and technical innovations. Finally, as an illustration of the model's properties, the reforms are quantified using the upgraded RMSM-X model in section 7, and conclusions are summarized in section 8.

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*The paper builds on the work documented in "A RMSM-X Model for Egypt" by M. Giugale et al.(1991) (available at the Egyptian country desk). Here the standard RMSM-X model for Egypt is described.*
2. **Trends in the Egyptian Economy**

4. Since the 1950s, Egypt has pursued an economic policy of market regulation. To achieve its social welfare objectives, the government not only acted as a producer of goods and services but has also protected private industries through trade regulations and the subsidizing of socially important prices. In effect, this has led to a situation that resembles the structural difficulties of the former communist regimes in Eastern Europe and the former Soviet Union. The underlying development strategy has, in fact, been one of import substitution up to the late 1980s, despite the 'Open-Door' policy initiated in 1974 which partially liberalized the economy. The production of agricultural corps was heavily regulated, while the manufacturing sector was dominated by Public Enterprises. Since most foreign exchange earnings arrived from low employment activities (especially the oil sector and revenues from the Suez Canal) employment was concentrated in -- often inefficient -- import substitute producing industries and public services.

5. Egypt’s unique position as an oil exporter and a major tourist attraction has historically generated ample foreign exchange revenues. Other sources of foreign exchange were inflows of foreign assistance, Suez Canal revenues, and workers remittances. Thus the capacity to import remained high until the mid-1980s when oil prices began to fall and incentives to stimulate non-oil, non-factor exports were overshadowed by the objective of domestic industry protection and high employment levels.

6. The hike in oil prices during 1973-74 greatly increased Egypt’s capacity to import. During the same period growing foreign exchange earnings from workers remittances (which in particular arrived from neighboring oil-exporters) also contributed to the increased availability of foreign exchange. This laid the foundation to increase the living of standards through increased government spending. Hence, from 1973-74 to the mid-1980s the Egyptian economy boomed with GDP growing at an average rate of 8.5 percent per annum.

7. To retain the level of employment after the drop in oil prices in 1982, the Government of Egypt continued to stimulate the economy with public spending - this time financed by foreign borrowing. Ultimately, however, the regulatory system of trade protection and price controls with its disincentives for private sector efficiency led to severe structural problems. The tradeable sector became uncompetitive and much too small while foreign debt service increased rapidly. This situation was eventually reflected in the external as well as internal accounts. By the late 1980s, the current account balance averages 10 percent as a share of GDP, while the government budget deficit averaged 20 percent of GDP during most of the period from the mid-1970s to 1990. By fiscal year 1990, external debt has reached a level of $51 billion, equivalent to 144 percent of GDP.
8. In March 1990, the Government of Egypt initiated a comprehensive economic reform program. Egypt's program, like other developing countries engaged in reform, includes extensive liberalization of controlled prices, the deregulation of trade and investment, as well as liberalization of foreign exchange markets. The Government has also initiated a comprehensive public enterprise reform and an ambitious privatization program.

**The Economic Reform and Structural Adjustment Program (ERSAP)**

9. The main objective of the reform program initiated in 1991 is to restore macroeconomic balance through structural adjustment of the economy toward private sector- and export-led growth. The strategy should improve resource mobility, and in the longer term ensure an efficient allocation of resources. Measures are also being taken to minimize the effects of economic reforms on the poor.

10. The liberalization of financial markets is a major element of the reform program. Extensive deregulations have occurred since the beginning of 1991 on the domestic money market as well as on the market for foreign exchange. Initially domestic interest rates rose partly because of the liberalization of foreign exchange controls, and partly because domestic demand and supply factors for credit were free to determine rates of interests. At first the Egyptian pound depreciated somewhat against the dollar, but since 1991 has remained relatively stable due to large private capital inflows.

11. The plan is to gradually phase out protection of domestic industries from foreign competition during the reform period. Already, non-tariff barriers have come down significantly. By 1992, these barriers covered only about 13 percent of agricultural and manufacturing output, down from 53 percent in beginning of 1990.

12. The dismantling of price controls is central to achieving efficiency in resource allocation. Price liberalization is of particular importance in two areas. First, domestic energy prices have been highly subsidized. While encouraging overconsumption of energy products and creating incentives to install energy inefficient technologies, subsidized energy prices also raise questions of important environmental externalities. It is estimated that the implicit energy subsidy was 9.6 percent of GDP in fiscal 1991, which was almost half of the public sector's borrowing requirements. During that year, however, energy prices more than doubled in an effort to rise the prices to international levels. By mid-1992, average petroleum prices reached 80 percent of world prices.
13. The second area where important price liberalizations have taken place is in the agricultural sector. Deregulation of producer prices and other production controls have brought an attractive increase in the export of fruit and vegetables. Controls remain, however, in the production of sugar and cotton. In the 1990/91 harvest year farmers were only paid 60 percent of the world market price by the Government's monopsony. The regulation of cotton prices originates from the importance of Egypt's textile exports. The government has kept domestic cotton prices low in an effort to promote the export of textiles and keep costs down in the textile industry. Over time the regulations have become counter-productive since farming incentives have been to replace the production of cotton with other agricultural products.

14. Another element in the restoration of macroeconomic balance is promoting an efficient Public Enterprise (PE) sector. PEs are to be either privatized or brought to operate under general and competitive market conditions. Under the Public Enterprise Law of 1991, PEs are allowed to liquidate, with the role of the Government gradually limited to that of a major shareholder, thus transferring responsibilities of operating losses away from the fiscal budget to the managers of PEs. The privatization, if successful, will contribute to the reform program by attracting managerial skills and resources to the Egyptian industry, and by linking the operating performance directly to the ownership. In addition, market orientation of the PEs may help stimulate the transformation toward a more competitive and market-friendly economy. Tables 2.1 and 2.2 present some indicators of the Egyptian economy in summarized form.

Table 2.1: National Accounts components, percentage change in real terms.

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>10.4</td>
<td>4.7</td>
<td>2.5</td>
<td>2.3</td>
</tr>
<tr>
<td>o/w agriculture</td>
<td>2.4</td>
<td>2.4</td>
<td>1.7</td>
<td>1.8</td>
</tr>
<tr>
<td>o/w industry</td>
<td>13.9</td>
<td>4.2</td>
<td>4.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Exports of GNFS</td>
<td>10.8</td>
<td>4.3</td>
<td>5.4</td>
<td>8.0</td>
</tr>
<tr>
<td>Imports of GNFS</td>
<td>9.1</td>
<td>-1.7</td>
<td>1.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Total consumption</td>
<td>8.5</td>
<td>3.3</td>
<td>2.4</td>
<td>2.2</td>
</tr>
<tr>
<td>o/w Private</td>
<td>9.8</td>
<td>3.3</td>
<td>2.3</td>
<td>2.2</td>
</tr>
<tr>
<td>o/w Public</td>
<td>2.2</td>
<td>3.3</td>
<td>2.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Gross Domestic Investment</td>
<td>16.5</td>
<td>-0.1</td>
<td>-1.5</td>
<td>-0.5</td>
</tr>
<tr>
<td>Population</td>
<td>2.3</td>
<td>2.4</td>
<td>2.3</td>
<td>2.2</td>
</tr>
</tbody>
</table>

*) Preliminary data.
Note: All data are on fiscal year basis.
Source: Trends in Developing Economies (1992) and DEC Analytical Database.
Table 2.2: Balance of Payments indicators (as percentage of GDP).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports of GNFS</td>
<td>14.0</td>
<td>30.5</td>
<td>21.4</td>
<td>24.0</td>
<td>30.4</td>
</tr>
<tr>
<td>Imports of GNFS</td>
<td>19.2</td>
<td>42.9</td>
<td>38.9</td>
<td>41.1</td>
<td>43.8</td>
</tr>
<tr>
<td>Resource Balance</td>
<td>-4.5</td>
<td>-12.7</td>
<td>-15.3</td>
<td>-16.4</td>
<td>-13.8</td>
</tr>
<tr>
<td>Fiscal Deficit</td>
<td>-6.0</td>
<td>-11.7</td>
<td>-18.1</td>
<td>-16.5</td>
<td>-20.0</td>
</tr>
<tr>
<td>Interest Payments</td>
<td>0.7</td>
<td>3.7</td>
<td>4.7</td>
<td>4.1</td>
<td>7.6</td>
</tr>
<tr>
<td>Current Acct. Bal.</td>
<td>-1.9</td>
<td>-1.9</td>
<td>-9.3</td>
<td>-10.5</td>
<td>-7.3</td>
</tr>
<tr>
<td>Total Debt</td>
<td>20.4</td>
<td>89.5</td>
<td>151.6</td>
<td>113.0</td>
<td>123.5</td>
</tr>
</tbody>
</table>

*) Preliminary data.
Note: See Table 2.1.
Source: See Table 2.1.

Recent Developments

15. So far, the current account and the fiscal budget have both improved dramatically in response to the reforms. One reason is, that both balances have benefitted greatly from the debt reduction granted to Egypt by the Paris Club in May 1991, following the stand-by agreement between the IMF and the Egyptian government. Also, revenues from oil exports, the Suez Canal, and workers' remittances have helped improve the current account in 1991-92. The budget deficit has been reduced because of a significant reduction in public sector investment, as well as the introduction of various indirect taxes such as a general sales tax. Inflation, which initially rose in response to the price liberalization, is coming down substantially. In addition, the liberalization of the capital and foreign exchange markets have brought about rapid dollarization and portfolio adjustment, resulting in a substantial increase in Egypt's international reserves.

16. The private sector has yet to respond vitally to the reform package. Because of the government's tight monetary and fiscal spending, as well as the sharp, once and for all increase in prices of energy and other input materials, the economy has slowed down. Various reasons can be found for the private sector's sluggish response. Among those, a number of constraints remain on production, investment and trade. Moreover, increased foreign competition resulting from trade liberalization can, in general, have adverse effects on industry in the near term. Nevertheless, higher business confidence should materialize as the reform program progresses. Finally, the market orientation of the PEs is running at a relative slow pace. The public enterprise reform has encountered some bureaucratic resistance. Moreover, the relative size of
the PEs, which produce over 40 percent of the country's GDP and account for 55 percent of annual gross investment, suggests that social costs could be relatively high in the near term.

Despite the somewhat flat investment pattern of the last couple of years, investment efficiency may have improved already. The liberalized financial markets generate incentives toward a more efficient credit allocation. Moreover, greater external openness exposes industries to foreign competition. Investment incentives decline in industries producing import-substitutes and increase in export industries. As the reform program moves along investors are likely to gain further confidence and private investment could accelerate in the medium term.

3. **The Extended Egyptian RMSM-X Model**

17. The RMSM-X model represents the second generation of the World Bank's Revised Minimum Standard Model (-X: Extended) and is presently utilized throughout the World Bank for country projection and various accounting exercises. The model's flow-of-funds is constructed using a multi-sector accounting framework. Most often this includes - at a minimum - a private non-financial sector, a public sector, a financial sector, and an external sector. Frequently this skeleton is extended by introducing a non-government, non-financial public sector (i.e. the parastals) as well as a financial public sector (i.e. the central bank).

In its most simple version, the RMSM-X model has no behavioral relationships. Endogenous variables are projected using pre-set rates of growth, and the accounting framework ensures that the model's definitorial relationships are fulfilled. Hence, the model's major force, in its simple form, is to act as a control instrument of the consistency in the economic assumptions made during projections.

18. Evaluation of economic reform, however, needs an endogenous model. More specifically, to measure the benefit from reform in Egypt we need to design a reference case, which takes into account all relevant economic responses. To perform such a what-if type scenario within the framework of the RMSM-X model an extension is clearly required of the model's behavioral relations. This expansion should, at a minimum, include an endogenous set of core variables such as private consumption, private investment, export and imports. With respect to the Egyptian case, supply oriented dynamics should be included as well. Wide spread privatization of public enterprises, along with comprehensive liberalization of markets affecting private production and investment decisions cause comprehensive modifications in market

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3See "A RMSM-X Model for Egypt" by M. Guigale et. al(1991) for a description of the first version of the RMSM-X for Egypt.
incentives. To analyze such change, a description of the economy's supplyside including a consideration of the investment efficiency of the private sector is needed.

19. The major concern of this paper is the question of how a supplyside may be incorporated into the accounting framework of the standard RMSM-X model. A new technique is developed which maintains the model's basic structure and, thus, allows for the continued used of the model's data and presentational system, JAVELIN.

20. Specifically, the model is extended in two areas. One, investments are divided into two separate components, public and private, with private investments having a higher rate of efficiency than public. This distinction allows privatization programmes to enhance the economy's growth potential, since cuts in public sector investment programmes make room for - more efficient - private investment. To permit a more explicit analysis of public versus private investment patterns, the ICOR of the model has been adjusted for variability noise arriving from changes in the rate of capacity utilization and reinvestment. Two, structural reform not only entails shifts in control away from public and toward private sector management, it also seeks to augment the industrial base though changes in market access and price incentives. Here, we build a sector module that attempts to quantify the industry response from changes in price and cost signals. The module enables the model to produce forecast and scenario results for investment and production output in the manufacturing and the agricultural sector. These results are based on pure market incentives such as relative prices and production capacity, and - to the extent it was feasible - these relationships were established on empirical grounds.

21. The Egyptian RMSM-X model includes five accounting sectors: A non-financial government sector, a financial sector, a foreign sector, a non-government, non-financial public sector, and a non-financial private sector. The government sector consists of the Central Government of Egypt. The financial sector includes commercial banks, business and investment banks, specialized banks, and the Central Bank of Egypt. The foreign sector is defined according to the flows of the balance of payments. The non-government, non-financial public sector includes the public sector enterprises. Finally, the non-financial private sector includes the households and private non-financial enterprises of the private sector.

22. For each sector the accounting framework defines a current account and a capital account which contains the sectoral revenues and expenditures as well as capital receipts and payments. In the model's projection and scenario module (see appendix I) these accounts are integrated into a budget constraint for each sector.

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*For a description of the ICOR relevance in the RMSM-X model see, for instance, footnote 2.*
Table 3.1: The markets of the Egyptian RMSM-X model:

<table>
<thead>
<tr>
<th>(1) Market for goods and services:</th>
<th>GDP + M = CP + CG + IP + IG + X</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Money market</td>
<td>M2 = DTG + DTO + DTP + CUP</td>
</tr>
<tr>
<td>(3) Bond market</td>
<td>ΔBP = ΔBG</td>
</tr>
<tr>
<td>(4) Domestic credit market</td>
<td>CR = CRG + CRO + CRP</td>
</tr>
<tr>
<td>(5) Foreign credit market</td>
<td>ΔFT = ΔFGI + ΔFGU + ΔFM + ΔFO + ΔF</td>
</tr>
</tbody>
</table>

23. The model's markets include five distinct goods: (1) goods and services, (2) money, (3) domestic bonds, (4) domestic credit, and (5) foreign credit: The supply of goods and services arrives from domestic production (GDP) and imports (M), while the demand for goods and services consists of private and public consumption (CP and CG), private and public investment (IP and IG), and exports (X). The market clearing variable on the market for goods and services depends upon which of the model's closure rules are chosen. Under the normative closure public consumption is determined endogenously, while under the positive closure private investment is determined residually as the balancing item. (For a description of the model's closure rules see appendix II).

24. On the money market the supply of broad money (M2) is calculated as the sum of its components: demand and time deposits from the government (DTG); demand and time deposits from the non-government, non-financial public sector (DTO); demand and time deposits from the private sector (DTP); and the currency holdings in the private sector (CUP). Equilibrium implies that the money demand is determined residually from (2) as being equal to M2.

25. Clearance on the domestic bond market is achieved by determining the bond demand of the private sector (BP) as equal to the bond supply of the government (BG). The domestic credit market is cleared by the balancing item: credit to the private sector (CRP), given total domestic credit supply (CR), domestic credit to the government (CRG), and domestic credit to the non-government non-financial public sector (CRO).

26. Finally, the foreign credit market obtains its supply from the foreign sector (FT). Demand is allocated to identified and unidentified government credit (FGI and FGU), credit to the financial sector (FM), credit to the non-government non-financial government sector (FO),
and credit to the private sector (FP). The market clearing variable depends on the model closure. Under the requirement closure the total foreign credit supply is determined by the financing requirements of the current account balance (in a sense, the supply of foreign credit is totally elastic). In order to meet the financing requirements, unidentified government credit adjusts residually. Under the availability closure total foreign credit can not exceed credit already identified. Government unidentified credit is zero, and total foreign credit is given by the available foreign credit which already is identified. Under this closure, imports will adjust to meet to available foreign finance.

27. The clearance of each of the model’s markets has been built into the sectoral budget constraints and the national accounts constraint using the model’s accounting framework. For a more elaborate description of the RMSM-X model’s accounting framework and projection rules see appendix I.

28. The foreign exchange market is not explicitly described by the model. Instead, the exchange rate is determined by a real exchange rate rule which derives the rate of change in the exchange rate as the difference between the rate of change in the GDP-deflator and the price of total imports:

\[ \dot{e} = \dot{p}_{GDP} - \dot{p}_M + ADD \dot{e} \]

where \( e \) is the foreign exchange rate in units per U.S. dollar. To fit the model to the historic data an add-factor, ADD \( e \), was included. In addition, the add-factor permits the user of the model to diverge from the PPP exchange rate rule as specified in (3.1) in, for instance, scenarios analyzing a fixed exchange rate policy.

Finally, the goods market is cleared in nominal terms by determining the private consumption expenditure deflator as:

\[ p_{CP} = \frac{p_{GDP}GDP + p_M^M - p_X^X - p^I}{CP} \]
4.  The Model’s Behavioral Components

29. In its present version, the model includes empirical equations for private consumption; the domestic price level; four categories of imports; and manufactured exports. Obviously, the inclusion of these equations help increase the overall realism of the RMSM-X model. By implementing empirical equations for the model’s behavioral variables, the model itself will project values for these variables in forecasts and policy scenarios. Therefore, we need only examine these variables explicitly if there is reason to believe that they - in forecasts or scenarios - will deviate from their historical pattern, such as under a policy regime shift or in the case of changes in the behavioral patterns. To enable the adjustment of behavioral equations, we have introduced add-factors in each equation.

30. In specifying the model’s behavioral equations, we were severely constrained by the small number of available observations in the historic data. More precisely, this has posed rigorous constraints on the actual form of the final equations because few degrees of freedom means that few variables can be included on the equations’ right hand-side, and parameters have generally been estimated with modest or little accuracy.

31. Private Consumption

A log-linear error-correcting model was estimated for private consumption:

\[
(4.1) \quad CP = \beta_0 + \beta_1 YD + \beta_2 (\ln CP_{t-1} - \alpha_0 - \alpha_1 \ln YD_{t-1})
\]

where CP is private consumer expenditures, and YD is disposable income. Both variables are given in constant prices. The last term (in parenthesis) illustrates the long-term relationship between income and consumption. Deviations from the long-term relationship are adjusted in the following period with the speed of adjustment depending of \( \beta_2 \). A priori, \( \beta_2 \) must be between -1 and 0. The equation was estimated using the standard 2-step procedure suggested by Engle and Granger, where the long-term relationship is estimated in the first step, and lagged residuals of the first step are used to estimate \( \beta_2 \) in the second step. Estimation gave the following result:

\[
\begin{align*}
\text{dln CP}_t &= 0.0102 + 0.7142 \text{dln YD}_t - 0.652 (\ln CP_{t-1} - 1.484 - 0.8386 \ln YD_{t-1}) \\
(0.47) & \quad (2.30) & \quad (2.70) & \quad (6.41) & \quad (36.3)
\end{align*}
\]

\[\text{During the actual operation of the model, the value of the add-factors is set explicitly by the model user and is frequently used to tune the solution of the model to a particularly 'desired' forecast result.}\]
R-squared = 0.346, DW = 1.85, S.E. = 0.044, Estimation Period: 1971-90.

The t-statistics are given in parenthesis below the coefficients.

The results show that all coefficients are significant at a five percent level (excluding the intercept). Also, the level of the estimated parameters all come out within a priori acceptable ranges. In addition, the R-squared of 35 percent is adequate since the dependent variable is nominated in changes which evidently increases its variance.

32. **Export of Manufactures**

Manufactured exports are determined as a function of the relative export price and foreign income (which proxies the export market size):

\[(4.2) \quad X^m = \beta_0 + \beta_1 GDP^* + \beta_2 (pX^m - pGDP)\]

In effect, (4.2) describes the international demand curve for manufactured goods of Egyptian origin. The relative export price is defined as the world price of manufactured goods relative to the Egyptian GDP-deflator. Thus, the GDP-deflator is assumed to proxy the price of Egyptian manufactured export goods while the international price of manufactures is assumed to proxy the export price of Egypt's competitors on the export market. The specification encompasses the heterogeneity of manufactured goods, and allows Egypt to have some market power on their export markets.

The following log-linear specification was estimated:

\[
\ln XMAN = -16.23 + 1.073 \ln GDP^* + 0.185 \ln (pXMAN/pGDP)
\]

\[
(2.21) \quad (2.24) \quad (1.46)
\]

R-squared = 0.84, DW = 2.27, S.E. = 0.073, Estimation Period 1982-90.

XMAN is the export volume of Egyptian manufactures, GDP* is the export market size described by GDP of OECD, and pXMAN is the world price of manufactures defined as the manufacturing unit value (MUV). Because of the small number of observations (9), the relative price elasticity comes out with uncertainty since the elasticity from foreign GDP to exports of manufactures is statistically indifferent from one, (4.2) was estimated in a nested version restricting the market size elasticity to one. This seems plausible as long as we do not consider the removal of trade restrictions or the opening of foreign markets as an endogenous process. The nested equation was estimated by placing the term
\[
\ln X_{\text{MAN}} = -15.12 + 1.0 \ln GDP^* + 0.199 \ln (p_{X_{\text{MAN}}}/p_{\text{GDP}})
\]
\begin{align*}
(2.21) & \quad (2.54)
\end{align*}

R-squared = 0.52, DW = 2.26, S.E. = 0.067, Estimation Period 1982-90.

As results show, the significance of the relative price elasticity improves in the nested equation. Therefore, the restricted version was implemented in the model. However, the estimated price elasticity is quite low, probably due, in part, to measurement errors in the assessment of the trade prices. The international price of manufactured exports does not represent the price of Egyptian competitors perfectly. Furthermore, we use the Egyptian GDP-deflator to measure the price of Egyptian manufactured exports. This was done for simplicity in order to avoid introducing an additional price into the model.

33. Imports

Total imports consist of six components:

\begin{equation}
M = M_{\text{FO}} + M_{\text{OC}} + M_{\text{CA}} + M_{\text{IN}} + M_{\text{PE}} + M_{\text{NF}}
\end{equation}

While petroleum imports (MPE) and non-factor service imports (MNF) follow exogenous projection rules, the remaining components are derived according to behavioral relationships. We will assume that the demand for imports is driven by final demand. By modeling the components of imports individually, as opposed to constructing a 'macro'-import function, we gain insight into the way in which imports vary with specific components of demand. In addition, when components of GDP grow at different rates, macro-import functions become unstable and a more disaggregated approach is needed. For instance, if consumption shares and investment shares of GDP change, so will the aggregate 'macro'-elasticity of imports. Hence, the overall elasticity of imports with respect to GDP depends on elasticities of individual components of imports as well as the demand components' relative GDP weight. Furthermore, by disaggregation, we achieve a more detailed picture of how total imports allocate among products.

34. Specifically, the components of imports depend on their respective domestic demand components. Thus, imports of food and other consumer goods depend on private consumption, imports of capital goods depend on investment demand, and imports of intermediate goods depend on the domestic production level (i.e. GDP). In addition, imports of other consumer
goods, MOC, include revenues from the tourist exports, $X_{to}$. In total, the components of imports are represented by the following demand equations:

\[(4.4) \quad MFO = MFO_{-1} \cdot (CP/CP_{-1})^{ePO} \cdot (q/q_{-1})^{ePO} \]

\[(4.5) \quad MOC = MOC_{-1} \cdot (CP/CP_{-1})^{eOC} \cdot (q/q_{-1})^{eOC} \cdot (X_{to}/X_{to_{-1}})^{yo} \]

\[(4.5) \quad MCA = MCA_{-1} \cdot (I/I_{-1})^{eI} \cdot (q/q_{-1})^{eCA} \]

\[(4.6) \quad MIN = MIN_{-1} \cdot (GDP/GDP_{-1})^{eGDP} \cdot (q/q_{-1})^{eIN} \]

where the $e$, and $\delta$ are elasticities, and $q$ is the real exchange rate. The elasticities are determined by the model user and should be set with caution. For instance, demand elasticities above one produce growing imports shares which are unsustainable in the long run. To calibrate the model all demand elasticities were set to one. Relative price elasticities (i.e. elasticities with respect to $q$) were found insignificant in an estimation. This can be partly attributed to the extensive price regulation in the historic period. When running scenarios one may set the price elasticities in the zero to one range to reflect recent price liberalizations.

35. The remaining two import categories, petroleum imports and non-factor services imports, follow exogenous projection rules:

\[(4.7) \quad MPE = (1 + gMPE) \cdot MPE_{-1} \]

\[(4.8) \quad MNF = (1 + gMNF) \cdot MNF_{-1} \]
36. **The Public Sector’s Demand**

Public consumption is projected according to an exogenous real rate of growth:

\[(4.9) \quad CG = (1 + gCG) \cdot CG_{-1}\]

On the investment side a constant share to GDP approach is applied:

\[(4.10) \quad IG = \nu \cdot (GDP \cdot pGDP) / pl\]

Note that public consumption is projected in real terms while public investment is projected in nominal terms.

37. **Domestic Prices**

The domestic price level follows implicitly from the equilibrium on the money market. As table 3.1 showed, money supply is determined as:

\[(4.11) \quad M2 = DTG + DTO + DTP + CUP\]

where DTG, DTO, and DTP are the deposits of the government, the non-financial non-government public sector, and the private sector in the banking sector. CUP is the private sector’s currency holding. The model derives all components of M2 according to exogenous projection rules:

\[(4.12) \quad DTG = (1 + gDTG) \cdot DTG_{-1}\]
\[(4.13) \quad DTO = (1 + gDTO) \cdot DTO_{-1}\]
\[(4.14) \quad DTP = (1 + gDTP) \cdot DTP_{-1}\]
\[(4.15) \quad CUP = (1 + gCUP) \cdot CUP_{-1}\]

Money demand is defined to meet transaction demand:

\[(4.16) \quad M2 = pGDP \cdot GDP / \nu\]

where \(\nu\) is the velocity of money.

Equilibrium on the money market implies that demand adjusts, since the money supply is determined from exogenous projection rules. With money demand given from its supply, the price level follows from (4.16), because GDP is predetermined from the past period’s investment and \(\nu\) is exogenous.
38. **Other Prices**

The model’s remaining prices consist of the unit values of the trade components and the deflators of the GDP expenditure components. The unit values in dollar terms follow the Bank’s standard commodity price and MUV projections - weighted according to the Egyptian export and import composition.

The local currency unit values follow from the commodity price projections in foreign currency terms:

\[(4.17) \quad pMFO = e \cdot \dot{pMFO} \]

\[(4.18) \quad pMOC = e \cdot \dot{pMOC} \]

\[(4.19) \quad pMCA = e \cdot \dot{pMCA} \]

\[(4.20) \quad pMIN = e \cdot \dot{pMIN} \]

The investment expenditure deflator is formed as a geometric average of domestic prices and the import price of capital goods using the overall import share, \(sca\), as a weight:

\[(4.21) \quad \Pi = pMCP^{sca} \cdot pGDP^{(1 - sca)} \]

Specifically, \(sca\) is defined as the lagged import share \((M_{t-1}/GDP_{t-1})\) to minimize the model’s simultaneity. Finally, the private consumption expenditure deflator is derived residually from the current price national accounts identity in order to ensure goods market equilibrium in nominal terms:

\[(4.22) \quad pCP = \frac{pGDP \cdot GDP + pM \cdot M - pX \cdot X - pI \cdot I}{CP} \]

Note that this equation is pure bookkeeping with no economic content. One can, however,
always check pCP against other prices to judge the consistency of a projection’s current price macroeconomic aggregate.

The exchange rate follows a real exchange rate rule which ensures that import prices and the GDP-deflator (both in local currency) grow at the same rate:

\[(4.23) \  \dot{e} = p_{\text{GDP}} - p_{\text{M}} \]

39. **Foreign Reserves**

The foreign reserve holdings by the Central Bank of Egypt follow a target rule in which the ratio of foreign reserves to nominal imports (measured in terms of months of imports) is kept constant:

\[(4.24) \ RES = \alpha MC/12 \]

where \(\alpha\) measures reserve holdings in number of months of imports. Normally, \(\alpha\) is set in the range of 6-7 months of imports\(^6\).

40. **Profit Remittances**

The model does not yet have a behavioral equation for foreign direct investment. An accumulated stock of foreign direct investment is derived, however. This stock is generated to help calculate the model’s profit remittances. Given the stock of accumulated foreign direct investment, we then calculate an imputed return to foreign investors according to a given market yield. Say foreign investors retain KFS of the domestic capital stock in constant prices. In each

---

\(^6\)Alternatively, an empirical import to reserve target could be implemented. Below is a specification where reserves in the short term drop in response import increases, but in the long term adjusts toward a constant ratio of reserves to imports.

\[
\ln R = -8.709 - 0.956 \ln (M_{p_{\text{m}}}) + 0.941 \ln (M_{i}/(p_{\text{m-1}} R_{i}))
\]

\[(0.94) \quad (1.08) \quad (0.95)\]

R-squared = 0.512, DW-stat. = 1.23, S.E. = 0.2206

The high volatility of foreign reserve holdings added some noise to the results. But, although the t-statistics are fairly low, the parameters came out at a priori expected levels.
period this capital stock in revised according to depreciation of the existing capital stock and the inflow of new investments:

(4.25) \[ KFS = (1-\delta)KFS_{-1} + KF_{-1} \]

where \( KF \) is the flow of new investments in real terms. The capital stock, \( KFS \), is defined beginning of period. If we assume that the nominal value of the capital stock follows the nominal value of new capital goods, current value of foreign owned capital stock is:

(4.26) \[ FS = pI [(1-\delta)KFS_{-1} + KF_{-1}] \]

As last period's capital stock measured in last period's prices, \( FS_{-1} \), equals the product of last period's real capital stock, \( KFS_{-1} \), and last periods capital goods price, \( PI_{-1} \), we can write (4.26) as:

(4.27) \[ FS = \frac{pI}{PI_{-1}} [(1-\delta)FS_{-1} + F_{-1}] \]

This explicit treatment of the rate of depreciation and the price of capital is particularly important under high inflation, where a simple accumulation of current investment would significantly underestimate the size of the capital stock.

41. For a proxy of the international yield on foreign investment in Egypt we will use the nominal US dollar LIBOR rate (6-month). This assumption produces the following equation for profit remittances:

(4.28) \[ PRM = USLIBR \times FS + ADDPRM \]

For flexibility in projections an add-factor is appended to (4.28).
5. **The Supply of Output: ICOR and the Capacity Utilization**

42. The RMSM-X model's dynamo of growth is the Incremental Capital-Output Ratio (ICOR). Together with investment of the previous period, the ICOR determines current period GDP. The ICOR is traditionally defined in the RMSM-X model as:

\[
(5.1) \quad ICOR = \frac{I - I_{-1}}{Y - Y_{-1}}
\]

where \( I \) is the total investment and \( Y \) is output (i.e. GDP). The underlying assumption is that past period's investment enhances the production capacity in the current period, and thus increases the output and incomes of the current period. Three objections may be raised to this simple specification. First, not all investments enlarge the stock of capital. Reinvestment does not increase production capacity but only restores obsolete equipment. Second, despite an enlargement of the capital stock which enables output to increase, we may not observe an increase in actual output. Excessive capacity may exist and may even fluctuate over time. Third, the dynamics of the production technology may not be as simple as embodied in the ICOR assumption. Even if it were, capital might not be the only limiting factor of production (the size of the labor force and the availability of imported intermediate goods may also play important roles). Taking the first two points into account, the ICOR definition can be modified to:

\[
(5.2) \quad ICOR = \frac{I - I_{-1} - \delta_{-1} K_{-1}}{\alpha - \frac{1}{\alpha} \cdot y - \frac{1}{\alpha} \cdot y_{-1}}
\]

where \( \delta \) is the rate of depreciation and \( \alpha \) is the rate of capacity utilization. \( K_{-1} \) is the stock of capital end of period \( t-1 \). The nominator describes the fixed net investment of period \( t-1 \), while the denominator describes the increase in potential, full capacity output from period \( t-1 \) to \( t \). To calculate the ICOR ex-post as defined in (5.2), we need series of the capital stock and the capacity utilization.

43. With help from the national account's fixed investment series we can derive the capital stock series. First, a bench mark value is calculated according to the formula of an endless row:

\[
(5.3) \quad \begin{align*}
K_t &= I_t + (1-\delta) I_{t-1} + (1-\delta)^2 I_{t-2} + (1-\delta)^3 I_{t-3} + \ldots \\
I_{t+j} &= (1+\alpha) I_{t+j-1}
\end{align*} \Rightarrow
\]
where \( t_0 \) is the benchmark year in which the investment series begin, \( i_0 \) is gross investment in the benchmark year, and \( \alpha \) the pre-benchmark year growth rate of investment (both \( \delta \) and \( \alpha \) are assumed constant in order to make the calculation possible). \( t_0 \) is set to 1960, \( \delta \) is assumed to be 4.6 percent\(^7\) and \( \alpha \) is calculated as the average growth of investment from 1960 to 1965. Having the capital stock in 1960, series are calculated from 1961 to 1989 according to:

\[
K_t = I_t - \frac{1}{1 - \frac{(1-\delta)(1+\alpha)}{(1+\delta)}}
\]

where \( I_t \) is gross investment in the benchmark year, \( t_0 \) is the benchmark year in which the investment series begin, \( i_0 \) is gross investment in the benchmark year, and \( \alpha \) the pre-benchmark year growth rate of investment (both \( \delta \) and \( \alpha \) are assumed constant in order to make the calculation possible). \( t_0 \) is set to 1960, \( \delta \) is assumed to be 4.6 percent\(^7\) and \( \alpha \) is calculated as the average growth of investment from 1960 to 1965. Having the capital stock in 1960, series are calculated from 1961 to 1989 according to:

(5.4) \( K_t = I_{t-1} + (1-\delta)K_{t-1} \)

where the stock of capital is defined beginning of period. This helps preserve the model's recursiveness. Figure 5.1 presents the output/capital ratio over the 1960-89 period using the calculated capital stock series. Some of the decline in the \( Y/K \) ratio that began in 1978 may reflect a lower investment efficiency which could be due to the growth of publicly owned enterprises in Egypt. Another reason for the observed drop in the \( Y/K \) ratio could be an accumulating increase in vacant capacity. The steady decline in GDP growth that has been observed since the 1975-77 boom supports this argument.

44. Under the assumptions of limitationality between capital and output we can calculate potential output as a proportion of the stock of capital\(^8\):

---

\(^7\)See Riordan (1991).

\(^8\)In addition, we make the assumption that the average and the marginal ICORs are the same.
\[ YP = \sigma \cdot K \]

\( \sigma \) may change over time, however, if the investment efficiency alters, or if sectoral changes cause the aggregated 'macro'-capital intensivity to change. It is, for instance, not unlikely that an increase in the size of the manufacturing sector relative to the agricultural sector would increase the aggregate capital to output ratio. Similarly, changes in the relative size of the (low capital consuming) service sector affect the aggregate K/Y ratio. Such a change could be attributed to the increased urbanization and industrialization of the Egyptian economy. From 1981 to 1989, for instance, valued added in manufacturing as share of total GDP increased from 11% to 18%. During periods of sectoral change toward more capital intensive industries, the k/y ratio will obviously increase. In addition, because of the non-fungibility of capital, sectoral change may cause scrapping of capital in declining production sectors. At the aggregate level the scrapping will be registered as falling capacity utilization unless it is explicitly taken into account by extraordinary depreciations of the capital stock.

45. The above suggests that the relation between full capacity output and the stock of capital only remains constant over the short to medium term. Here, however, we assume that the relationship between capacity and capital stock remains constant over longer periods of time. This eliminates the need for arbitrary adjustments of the output/capital ratio.

46. To determine the level of potential output (or more precisely \( \sigma \) in equation (5.5)) we assume that full capacity utilization was reached in 1977, the year with the highest output/capital ratio. Taking ratios of actual and potential output gives the capacity utilization rates shown in figure 5.2. The figure shows a rising capacity utilization rate since 1986 which is consistent with the sharp decline in fixed investment in the late 1980s. Because capital is the only limiting factor of production according to the assumed technology, a rising capacity utilization may very well be consistent with, for instance, a declining employment rate.
47. The constructed series of the capital stock and the capacity utilization can now be used to derive ICOR rates as defined in equations (5.1) and (5.2). Figure 5.3 presents these two ICOR series. Not surprisingly, the ICOR defined as (5.2) is less in both magnitude and volatility. Figure 5.3 thus shows that by "filtering" the ICOR for depreciations in the capital stock and for changes in the rate of capacity utilization, it became fairly constant over time. In running projections, the revised ICOR makes it possible to calculate potential output more precisely. In addition, model acquires a more precise link between investment and growth.

48. In the model, the ICOR as defined in equation 5.2 is implemented. The determination
of GDP is now a little more complex relative to the standard RMSM-X model’s ICOR definition:

\[ Y' = \alpha \left[ \frac{I_{t-1} - \delta K_{t-1}}{ICOR} \right] + \frac{1}{\alpha_{t-1}} \cdot Y_{t-1} \]

Since the public investment makes up a large share of total investment expenditures, and since there are strong indications that it lags behind the private sector in terms of efficiency of investment, separate ICORs for the public and the private sectors are introduced. Hence, the aggregate ICOR is derived as:

\[ ICOR = (1 - \gamma)ICORg + \gamma ICORp, \quad \gamma = \frac{I_{t-1}}{I_{t-1}} \]

In calculating \( \gamma \) one investment period is lagged because the determination of GDP should depend on previous period’s investment.

6. **The Sectoral Post-model**

49. The standard way of describing industries in the RMSM-X model is to apply exogenous rates of growth at the individual sector level. Typically, this produces a set of value added projection for the major production sectors such as agriculture, industry, and services. This method ensures that industry projections do not interfere with the recursiveness of the RMSM-X model and macroeconomic projections are thus independent of the economy’s sectoral configuration and sectoral growth pattern.

50. Integrating the sectoral projections with the overall macroeconomic forecast, however, allows for consistency between macroeconomic and sectoral projections, and hence makes the sectoral industry projections more reliable. Closer attention to the RMSM-X model’s sectoral projections also permits closer linkages between RMSM-X projections and other sectoral work.

51. Industry sectors can be most simply modelled using a fixed coefficient approach. The implication of the method is that all sectors in the economy grow at the same rate. This is, however, not very convenient if the model is supposed to analyze sectoral change in response to, for instance, structural adjustment. The fixed coefficients approach also does not take
industry-specific capacity constraints into account. Most mining industries, including the petroleum sector, usually produce at their full capacity level, and therefore typically are not able to expand their production in line with the rest of the economy.

Alternatively, a fixed coefficient approach can be applied in current prices. This allows for sector responses to relative price changes. The approach, however, does not take into account technical change, nor does it allow for cross-sectoral relationships. On the other hand, a complete 'classical' determination of prices and quantities such as is found in the more complex CGE models is not possible within the RMSM-X model's recursive structure. The JAVELIN software poses severe constraint on the number of 'strong' simultaneous links one can include in the model. However, by combining sectoral value added and sectoral investment data, a simple sectoral production model can be established. A possible sequence of output and investment over the growth pattern is sketched below:

\[(6.1) \quad Y_{Pt} \rightarrow I_t \rightarrow I^i_t \rightarrow K^i_t \rightarrow Y_{Pt+1}^i \rightarrow Y_{Pt+1} \rightarrow I_{t+1} \rightarrow \ldots \]\n
Potential output is predetermined in period \( t \). Under the model’s positive closure total investment follows residually from the identity of the national accounts. Sectoral investment is subsequently determined in a sectoral post-model. With sectoral investments determined, sectoral stocks of capital can be updated. Finally, sectoral potential output of next period is derived from the sectoral capital stocks, and, by summing up, total aggregate potential output of the next period is found. In this paper we will implement a method to determine sectoral investment and production, thus leaving the feedback from sectors to overall production (the square brackets) for future analysis. We therefore determine total GDP in the traditional RMSM-X method from past periods’ investment and the ICOR. On the sectoral level this means that one sector must be determined residually due to the adding-up constraint.

The procedure presents two problems. First, how to determine the sectoral investment, and second, how to derive sectoral potential output from the sectoral investment series. To derive sectoral production output we chose a restricted cost function with a two output technology. We will follow the RMSM-X terminology and include only one factor input, namely the stock of capital:

\[9\]In the RMSM-X framework, a bottom-up mechanism could, for instance, follow from the combination of sectoral investments and sectoral ICORs.
\begin{equation}
(6.2) \quad \ln \text{cost} = \alpha_0 + \alpha_{km} \ln k_m + \alpha_{ka} \ln k_a + \alpha_m \ln m + \alpha_a \ln a + \alpha_t \ln t + \frac{1}{2} \sum_i \sum_j \alpha_{ij} \ln s_i \ln s_j
\end{equation}

$s_i$ and $s_j$ are elements in the vector $s$ comprising the cost functions' argument: the capital stock in manufacturing and agriculture ($k_m$ and $k_a$), output in manufacturing and agriculture ($m$ and $a$), and the time trend $t$. The capital stock is entered in levels because we will treat it as quasi-fixed factor of production, which only gradually adjusts to its long-run cost minimizing level. This approach requires that the adjustment of the capital stock be determined outside the trans-log cost function (see below).

54. Under the assumption of profit-maximization, this function, in first order derivatives, produces the supply shares of agriculture and manufactures relative to total value added\textsuperscript{10}:

\begin{equation}
(6.3) \quad \frac{p_m}{p_y} = \alpha_m + \alpha_{mt} \ln t_m + \alpha_{mk} \ln (k_m/k_a) + \alpha_{mp} \ln (p_m/p_a)
\end{equation}

\begin{equation}
(6.4) \quad \frac{p_a}{p_y} = \alpha_a + \alpha_{at} \ln t_a + \alpha_{ak} \ln (k_m/k_a) + \alpha_{ap} \ln (p_m/p_a)
\end{equation}

To limit the number of parameters to estimate, a few simplifying assumptions are imposed such as constant returns to scale. The inclusion of $t$ means that windfalls from greater efficiency and technology transfers can be manipulated by changing $t$. Because the present period stock of capital is predetermined by historic investment rates, equations (6.3) and (6.4) determine sectoral value added of manufactures and agriculture as a function of the relative price of manufactures and agriculture. Prices of manufactures and agricultural products are exogenous in the model, so production in the manufacturing industry and agriculture are determined recursively. In other words, because past investments and producer prices are exogenous, sectoral production can be determined without violating the recursive RMSM-X structure.

55. By including the capital stocks instead of the rental price of capital in the trans-log share functions, we assume that the capital factor is quasi-fixed, i.e. only adjusting gradually and

\textsuperscript{10}This follows from the fact, that $\frac{\partial C}{\partial y} = p_y$ under profit maximization, i.e. marginal costs equal marginal revenues.
determined outside the trans-log system. Sectoral investments, therefore, have to be derived in a separate set of equations. Specifically, we use a simple myopic profitability function:

\[
\begin{align*}
6.5 \quad dln I_m &= \alpha_0^m + \alpha_1^m dln \frac{P_m}{P_y} \\
6.6 \quad dln I_a &= \alpha_0^a + \alpha_1^a dln \frac{P_a}{P_y}
\end{align*}
\]

In equation (6.5) and (6.6) investment in manufactures and agriculture depend on the price of the sector's output relative to the GDP-deflator (which we here use to describe domestic costs). Since firms only adjust on the margin (i.e. new investment) toward optimal capital employment, the model obtains a putty-clay nature. This gives the model a more realistic character than using a standard production possibility frontier approach, which assumes an instant adjustment of the capital employment. One argument for a gradual adjustment of the capital stock is the uncertainty investors face about future market conditions and technology. Another is that there may be costs of adjustment involved in the installation of and adaption to new capital equipment. Current period investment, therefore, is allocated into sectors according to (6.5) and (6.6), and used to update the sectoral capital stocks.

56. Prices of agriculture and manufactures are taken from the Bank's standard commodity price projections to implement the trans-log technology. Output of agriculture and manufacture are taken as sectoral value added in constant prices. To the extent that public sector enterprises are privatized or managed under free market conditions, efficiency of production and investment in the public enterprises increases, allowing for a rise in $t_m$ in reform scenarios.

**Estimation Results**

57. Equations (6.3) and (6.4) are estimated as a system using seemingly uncorrelated regression (SUR). We will assume symmetry between the production of agriculture and manufactures such that:

\[
\alpha_{ak} = -\alpha_{mk} \quad \text{and} \quad \alpha_{ay} = -\alpha_{my}
\]

Since our analysis is partial (we are not including all sectors of the economy), no adding-up problem needs to be considered. Therefore both equation 6.3 and 6.4 are estimated without restrictions other than those imposed by cross-equation parameters.
Table 6.1: Estimates of the sectoral production system

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Share of Agriculture</th>
<th>Share of Manufacture</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_i$</td>
<td>0.203 (24.6)</td>
<td>0.120 (28.2)</td>
</tr>
<tr>
<td>$\alpha_k$</td>
<td>0.018 (5.9)</td>
<td>- (-)</td>
</tr>
<tr>
<td>$\alpha_p$</td>
<td>- (-)</td>
<td>0.108 (5.66)</td>
</tr>
<tr>
<td>$\alpha_{tk}$</td>
<td>0.194 (21.9)</td>
<td>0.194 (21.9)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.733</td>
<td>0.424</td>
</tr>
<tr>
<td>DW-stat.</td>
<td>2.20</td>
<td>0.97</td>
</tr>
<tr>
<td>s.e.</td>
<td>0.005</td>
<td>0.010</td>
</tr>
</tbody>
</table>

58. The system’s explanatory power is satisfactory. In particular, the system shows no significant bias toward any specific equation as often occurs with system regression (the $R^2$'s are 0.73 and 0.42 respectively). The Durbin-Watson statistics are acceptable. Because of the system’s non-dynamic formulation a high residual correlation might be expected, but this is apparently not the case at the first order level (Durbin-Watson’s are 2.0 are 1.0 respectively). Some problems, however, occurred in the estimation of $\alpha_{tk}$. A log-ratio test rejected the hypothesis of $\alpha_{mk} = -\alpha_{tk}$, and free regression of $\alpha_{tk}$ produced wrong signed and insignificant estimates. For this reasons, $\alpha_{tk}$ is bound to zero in the final result shown in table 6.1. Also, $\alpha_{mt}$ was set to zero because multicollinearity between $t$ and $k_m$ produced wrong signed parameter estimates.

Table 6.2: Partial elasticities for output shares, 1990.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Supply of Agriculture</th>
<th>Supply of Manufacture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>0.103</td>
<td>-</td>
</tr>
<tr>
<td>Capital Stock</td>
<td>-</td>
<td>0.694</td>
</tr>
<tr>
<td>Relative Price</td>
<td>0.115</td>
<td>0.244</td>
</tr>
</tbody>
</table>

Table 6.2 presents the partial supply elasticities for relative prices, capital stocks, and technology. In the trans-log cost function, elasticities vary with the underlying level of the function’s variables. For a derivation of the function’s elasticities see appendix IV.

The sectoral ‘profitability’ investment functions were estimated on a single equation basis.

$$d\ln IA = 0.172 + 2.898 d\ln \left(\frac{pAGR}{pGDP}\right)$$

\( (2.12) \quad (2.09) \)
R-squared = 0.594, DW-stat. = 1.135, S.E. = 0.128.

dln IM = -0.079 + 3.157 dln (pMAN / pGDP)
     (1.20)     (2.52)

R-squared = 0.679, DW-stat. = 2.016, S.E. = 0.147.

The results demonstrate that a price increase in sectoral output relative to the GDP-deflator increases investment in agriculture and manufactures by 2.9 and 3.2 percent respectively.

7. **Model Application: A Downside Policy-slippage Scenario**

59. Important elements of the policy reform package in Egypt have been implemented, and effects -- most of which are in terms of short-term adjustment costs -- have already begun to show up. Thus, the estimated 0.3 percent GDP growth in 1992 may be an adjustment price already paid to the new market-friendly environment of fiscal restraint and increased foreign competition. The liberalization of price controls also imposed adjustment costs to the extent it upheld a high level of inflation in 1992, despite domestic recession. On the positive side, the debt reductions negotiated in the Paris Club cut foreign interest payments into half in 1992. This also helped improve the fiscal budget balance, as more than half of the foreign debt is held by the central government. In 1992, for the first time in decades, simultaneous surpluses materialized on the fiscal budget and the current account.

60. The properties of the revised RMSM-X model will be illustrated by generating a scenario to quantify the effects of the structural adjustment program. The scenario is designed as a downside illustration of what might happen if the commitment to reform in Egypt stalls. In our example, the downside portrays a failure to implement various aspects of the ERSAP such as the public expenditure cuts, the price and trade liberalization, and the PE reform program.

61. A vital element of the reform package is the expected efficiency improvement of public enterprises. To this end, the government has initiated a widespread privatization program, as well as re-orienting the remaining public enterprises toward the marketplace. The program should increase the operating efficiency of public enterprises. Moreover, increased independence from public enterprises means that their operating losses can be removed from the fiscal accounts and thus strengthen the fiscal budget. The government is planning to tighten easy credit availability (known as the 'soft budget-constraint') and eventually remove it. Companies will be forced to acquire credit at market terms and market costs. In addition, public enterprises will begin operating under free market prices for the marketing of output products and for the purchase of factor inputs. The downside scenario reflects the privatization program and the
market-orientation of public enterprises - or better the reversal of these programs - in three different ways. First, instead of lowering public investment, the share of public investment to GDP is sustained at its 1992 level throughout the scenario period. Second, the model's public sector ICOR remains constant at its 1992 level to maintain the investment efficiency in the public sector of 1992. Third, to accommodate the downside scenario's relaxation of fiscal spending, the rate of capacity utilization is increased in the near term (by 0.5 percent in 1993).

62. The reforms' freer domestic markets and increased foreign competition are assumed to increase private sector investment efficiency. In the downside scenario, continued protection of domestic industries produces an absence of private investment efficiency improvement. Hence, the private sector's ICOR remains at its 1992 level.

63. Table 7.1 presents the results of the downside scenario for major macroeconomic indicators in terms of differences from the reform baseline. The extension of the model, which were presented in section 4, 5, and 6, make it possible to implement the policy-slippage scenario without model add-factoring or other ad-hoc judgements. In particular, the sector-module, presented in section 6, generated the sectoral downside results autonomously.

64. As table 7.1 illustrates, the domestic recession is reversed in the near term with domestic absorption growing faster in 1993 -- in part because of higher fiscal spending, and in part because of the continuation of domestic industry protection. In the medium term, however, growth declines significantly. The downside scenario estimates that GDP growth falls by 2.6 percentage points on average from 1996 to 2001.
Table 7.1: Domestic policy slippage. RMSM-X downside scenario.
Percentage points change from a reform baseline.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>0.6</td>
<td>0.2</td>
<td>-1.2</td>
<td>-2.6</td>
</tr>
<tr>
<td>o/w agriculture</td>
<td>0.7</td>
<td>0.1</td>
<td>-1.4</td>
<td>-1.9</td>
</tr>
<tr>
<td>manufacture</td>
<td>0.8</td>
<td>0.1</td>
<td>-1.7</td>
<td>-2.7</td>
</tr>
<tr>
<td>Total consumption</td>
<td>1.0</td>
<td>0.3</td>
<td>-1.0</td>
<td>-1.8</td>
</tr>
<tr>
<td>Private consumption</td>
<td>1.2</td>
<td>0.3</td>
<td>-1.1</td>
<td>-2.0</td>
</tr>
<tr>
<td>Investment</td>
<td>2.8</td>
<td>-8.4</td>
<td>-7.3</td>
<td>-4.8</td>
</tr>
<tr>
<td>o/w Private</td>
<td>4.7</td>
<td>-25.9</td>
<td>-15.8</td>
<td>-8.5</td>
</tr>
<tr>
<td>o/w Public</td>
<td>0.7</td>
<td>4.1</td>
<td>-0.2</td>
<td>-1.6</td>
</tr>
<tr>
<td>Imports</td>
<td>1.0</td>
<td>-3.6</td>
<td>-3.0</td>
<td>-0.5</td>
</tr>
<tr>
<td>Exports</td>
<td>-1.1</td>
<td>-0.2</td>
<td>-0.7</td>
<td>-1.0</td>
</tr>
<tr>
<td>o/w manufactures</td>
<td>0.0</td>
<td>-1.0</td>
<td>-3.6</td>
<td>-5.6</td>
</tr>
<tr>
<td>Current Acct / GDP</td>
<td>-0.6</td>
<td>0.6</td>
<td>1.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Fiscal Deficit / GDP</td>
<td>0.0</td>
<td>0.2</td>
<td>0.0</td>
<td>-1.6</td>
</tr>
</tbody>
</table>

65. Another element of the downside scenario is a reversal of the Paris Club debt forgiveness. A failure to meet the terms of the debt agreement reduces the debt write-off by 50 percent effective from 1995. This is considered on the current account balance by doubling the foreign interest payments from 1995 and on. Moreover, official grants are also assumed to be reduced by 50 percent from that year.

66. A reduction in import bans has already affected foreign trade. Temporary import tariffs have been introduced to soften the transition toward freer, unregulated markets. On the export side, the phasing out of restrictions includes the elimination of remaining export bans and a decrease in export quotas. The downside scenario envisages a three to four year adjustment period in which Egyptian producers and consumers accommodate their spending to the new trade regime. Because of the increased efficiency in the export sector from greater foreign and domestic competition as well as increased investment efficiency, exports in manufactures are capable of accelerating growth significantly in the medium term. The downside scenario foresees a reverse of this pattern. Here, trade regulations persist and the efficiency gains in manufacturing never materialize. Short-term adjustments in import shares (particularly in 1993 and 1994) never appear, and the medium-term export effects vanish.

67. The scenario shows how manufacturing exports grow faster than manufacturing output under reform. Opening the trade regime cause import shares to increase and import substituting industries to contract.
Another important element of reform is the liberalization of prices. Figure 7.1 shows the change in the rate of inflation in the downside scenario. By abolishing the price controls, the economic distortions can be adjusted and the long-term growth prospects improve. By mid-1995 practically all price controls should be phased out. The downside scenario shows that in the absence of price liberalizations prices remain lower in the near term. However, prices rise in the medium term because the efficiency gains never take place.

Figure 7.2: Domestic Absorption in downside. Percentage difference from baseline.

An attempt to measure the welfare implications of the policy-slippage scenario the level of domestic absorption is shown in figure 7.2. The figure indicates that by 2001 domestic absorption is 16 percent lower in the downside than in the reform baseline, thus indicating
significant costs in terms of domestic consumption potential and resource availability in the case of a reform failure.

8. **Concluding Remarks**

69. This paper has shown how the standard RMSM-X model of the World Bank may be extended to include a more detailed supply-side. A new market-based technique has been developed to determine sectoral investment and industry responses to privatization and price liberalization. Specifically, the procedure allows for the analysis of overall growth effects as well as sectoral change resulting from alterations in industry profitability and investment efficiency. In addition, to add more realism to the model’s projections, behavioral relationships for the major components of the demand-side were established as well.

70. As part of the validation of the model, we simulated a policy slippage scenario representing a halt in the current reform effort in Egypt. The results show - despite their openness to further discussion - that the model is able to generate realistic policy scenarios for an economy as the Egyptian. It is worth emphasizing, that the presented scenario was produced solely by the model, i.e. without the add-factoring of equations or other exogenous adjustments made by the model user.

71. The presented extensions of the standard RMSM-X model all serve to increase the model’s capabilities as a toll for policy planning. As the scenario illustration showed, the model proved capable of generating a sensible policy downside to the Egyptian reform program with a minimum of ad-hoc judgements supplied by the user of the model. On that basis, we think that the model is able to contribute to the analysis of structural and sectoral change within the framework of the RMSM-X model. Finally, the model’s primary objective was to serve as a policy tool for the Egyptian economy; evaluating reforms and other policy alternatives within Egypt. This underscores the fact that numerous other scenarios than the presented policy slippage illustration could be analyzed using the model. One obstacle remains, however. The basic virtually recursive structure of the RMSM-X model restricts its further development. As a possible direction for future extensions, one suggestion is to let investment expenditures follow from the sectoral capacity adjustments, thus following a bottom-up approach.
References


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World Bank, "Report and Recommendation of the President of the IBRD to the Executive Directors on a Proposed Structural Adjustment Loan (SAL) to the Arab Republic of Egypt," June 1991.


APPENDIX I: THE RMSM-X ACCOUNTING FRAMEWORK

The RMSM-X model is built upon an accounting framework encompassing a number of distinct sectors of a country's economy. To produce "what if" projections and analytical policy scenarios, behavioral equations, and projection rules are defined in accordance with the model’s endogenous variables. Other endogenous variables are solved according to the sectoral budget constraints and by market clearing conditions, thus ensuring that scenarios are consistent with the accounting framework. The accounting framework also facilitates a consistent analysis of the flow of funds between various sectors of the economy for the historical period. Because reconciliation of the sector accounts has top priority, the data is not necessarily entirely compatible with official statistics. For example, the interest payment of the government’s foreign debt on the balance of payments also appear in the fiscal accounts, despite its difference with the interest payments on foreign debt that are found in the fiscal budget numbers. Data reconciliation therefore leads to sectoral balances, i.e. the fiscal budget balance, which may be different from balances found in official statistics.

The Egyptian RMSM-X model includes five sectors: A non-financial government sector, a financial sector, a foreign sector, a non-government, non-financial public sector, and a private sector. The government sector consists of the Central Government of Egypt. The financial sector includes commercial banks, business and investment banks, specialized banks, and the Central Bank of Egypt. The foreign sector comprises the flows of the balance of payment. The non-government, non-financial public sector includes the public sector enterprises. Finally, the private sector includes the households and the non-financial enterprises of the private sector.

For each sector a budget constraint is put forward. The constraint includes all flows for each sector in a manner consistent with the model’s accounting framework. The flows are split into a current account and a capital account for each sector.

Table 2.1: The budget constraints of the Egyptian RMSM-X model:

<table>
<thead>
<tr>
<th>1. Government sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Financial sector</td>
</tr>
<tr>
<td>3. Foreign sector</td>
</tr>
<tr>
<td>4. Non-government, non-financial public sector</td>
</tr>
<tr>
<td>5. Private sector</td>
</tr>
</tbody>
</table>
For each sector the accounting framework defines a current account and a capital account which contains the sectoral revenues and expenditures as well as capital receipts and payments. In the model's policy and projection module (see appendix I) these accounts are integrated into a budget constraint for each sector.

Equation 1 describes the budget constraint of the government sector's accounts with the current account placed on the left hand side of the equation sign and the capital account placed on the right hand side.

\[
TD + TI + NTR + NTRpaut - Cg - PFg - iPYMTg - SUB - GASC = Ig + NKIg + AREXPg + dDTDg - KOG - DIVo - INVRECt - KTpg - dAFg - dCRg - AFdsocsec - dBpg
\]

The government current account's revenues consist of direct taxes (TD), indirect taxes (TI), central government non-tax revenues (NTR), and revenues from public sector authorities (NTRpaut). The direct taxes include transferred profits from EGPC (TDegpc), Suez canal (TDsuez), and other public sector enterprises (TDoth), personal income taxes (TDit), and property taxes (TDpt). The model determines the profits from EGPC and Suez canal as a pre-defined share of nominal GDP. Other corporate profits as well as personal income and property taxes are projected using the growth in nominal GDP.

Indirect taxes include consumption taxes (TIct), sales taxes (TIsale), custom duties (TIcdt), stamp taxes (TIst), and other indirect taxes (TIoth). Consumption taxes, custom duties, and other taxes are projected following nominal GDP. Revenues from sales taxes are derived from a 5 percent tax on food imports and a 20 percent tax on imports of other consumer goods.

The central government's non-tax revenues consist of the profit and losses of the financial sector transferred to the government sector (P&Lm), other non-tax revenues (OthNTR), and interest received on time deposits in the financial sector (IRECg). In projections the total non-tax revenues follow a GDP share rule. Profit and losses of the monetary sector follows from the financial sector's balance sheet, and interest receipts from the financial sector follow as a GDP share. Other non-tax revenues follow residually from the total non-tax revenues minus the net profits and interest receipts from the financial sector.

The current account's expenditures of the government sector include government consumption (Cg), payments to pension funds (PFg), interest payments on government debt (iPYMTg), subsidies (SUB), and GASC bank borrowing (GASC). Government consumption is projected using an exogenous rate of growth in real terms. Nominal government consumption is derived by multiplying real government consumption with the GDP-deflator. The components
of government consumption are wages and salaries (W&Sg), materials and supplies (MSg), defense (DEFENg), and other expenses (OTHexp). The first three are projected using GDP share rules, while other expenses follow residually from the total government consumption. Payments to pension fund are projected as a share of GDP. Interest payments on government debt is the sum of domestic interest payments (iCRg) and foreign interest payments (iFg). Domestic interest payments are taken from the financial sector and projected as GDP shares because the model does not include any domestic interest rates. Foreign interest payments are taken from the foreign sector and include two elements: interest payments from the model’s debt-module and unidentified interest payments accrued under the requirement closure. Subsidies include transfers to GASC (SUBgasc), transfers to public sector authorities (SUBpau), other transfers (SUBboth), payment arrears BB (SUBpabb), and net exchange rate subsidies (SUBner). All categories of subsidies are projected using shares to GDP rules.

The receipts of the capital account include official capital grants (KOG), transferred profits (DIVo), self-financed investment of public sector enterprises (INVRECr), and capital transfers to the private sector (KTpg). Transferred profits consist of three elements: profits from EGPC (DIVegpc), profits from Suez canal (DIVsuez), and profits from other public sector enterprises (DIVexpoth). The official capital grants arrives from the foreign sector and follows an exogenous rate of growth. Self-financed investment and capital transfers of the private sector, as well as the components of transferred profits, all follow a share to GDP projection rule.

The expenditures of the capital account include Public Sector investment (Ig) which is projected as a share of GDP; other capital transfers to the private sector (NKIg) (which is set to zero in projections); adjustment related transfers to the private sector (AREXPG) (which follows a share to GDP rule); and the change in the government’s demand and time deposits (dDTdg), taken from the financial sector’s accounts and following an exogenous growth rate.

The financing requirements of the government’s deficit are met by either foreign borrowing (dAFg), bank monetization (dCRg), social security withdrawals (AFdsocsec), or bonds from the private sector (dBpg). Foreign financing of the deficit is derived from the financing requirements of the balance of payments. Bank monetization follows the change of the government’s liabilities to the financial sector, which is projected using an exogenous rate of growth. Social security withdrawals are projected according to an exogenous GDP share. Finally, bond financing from the private sector is the residual financing item, determined by financing requirements minus other sources of finance.

The budget constraint of the financial sector is described by equation 2:

\[
\text{(2) } \text{intRES}_m + \text{iCRg} + \text{iCRp} + \text{iCro} - \text{iFm} - \text{iTDp} - \text{iTDg} - \text{iTDo} - \text{P&Lm} = \text{dARESm} + \text{dCRT} + \text{dUNASST} - \text{dAFm} - \text{dM} - \text{dNUNLIB}
\]
Current account revenues of the financial sector include interest receipts on the foreign reserve holdings (intRESm), interest earnings on credit to the government (iCRg), the private sector (iCRp), and the non-government, non-financial public sector (iCRo). Interest receipts on foreign reserves are derived using the implicit rate of interest on outstanding foreign debt (interest payments are divided by the outstanding stock of debt). All components of domestic credit follow GDP share rules in projections because the model has no domestic interest rates. Current account expenditures of the financial sector include interest payments on foreign debt (iFm) and interest payments on time deposits held by the private sector (iTDp), the government (iTDg), and the non-government, non-financial public sector (iTDo). Interest on foreign debt arrives from the balance of payments and is determined in the model’s debt-module. Interest payments on time deposits by other sectors follow GDP share rules, again because of the absence of domestic interest rates in the model. Finally, the share of profits and loses transferred to the government (P&Lm) is calculated as a current account expenditure.

The capital account’s asset flows include foreign reserve financing of the balance of payments (dARESm), changes in outstanding domestic credit to the other sectors (dCRt), and other unclassified asset flows (dUNASST). The stock of foreign reserves follows a target measured in terms of import months. The target is the variable AD TRESm. Domestic credit is the residual account on the financial sector’s balance sheet. Specifically, credit to the private sector (dCRp) is determined residually, while credit to the government (dCRg) and credit to the non-government, non-financial public sector (dCRo) follows exogenous rates of growth. Unclassified asset flows are also projected using an exogenous growth rate. The capital account’s liability flows include foreign borrowing (dAFm), changes in the broad money supply (dM), and other unclassified liabilities (dNUNLIB). In projections, foreign borrowing arrives from the balance of payments and follows exogenously the already identified flows in the model’s debt-module. The change in money supply includes changes in currency in circulation (dCUp), changes in the private sector’s demand and time deposits (dDDp and dTDp), changes in government sector’s time deposits (dTDg), and changes in the non-government, non-financial public sector’s time deposits (dTDo). In projections, each component of broad money is derived using exogenous growth rates. The last capital account item, unclassified liabilities, is also projected using an exogenous rate of growth.

The financial sector’s profits and losses are defined as the sector’s net interest receipts, i.e. interest receipts from foreign reserves and credits to other sectors minus the sector’s interest payments on foreign debt and other sectors’ time deposits. Part of the sector’s net profits is transferred to the government (P&Lm) and part is added to the financial sector’s net wealth. The actual fraction of net profits allocated to the government is the variable ARE. Equation 3 specifies the budget constraint of the foreign sector:

\[]
The foreign sector's current account revenues consist of goods and non-factor services imports (IMt), interest payments on foreign debt (iFt), and profit repatriations (PR). The model's imports of goods and non-factor services include foods imports (IMfood), other consumer goods imports (IMocg), capital goods imports (IMcap), intermediate goods imports (IMint), petroleum imports (IMpet), and non-factor services imports (IMnfs). Imports of food, other consumer goods, capital goods, and intermediate goods all follow estimated import equations (see Section 4 of this paper). The remaining categories follow exogenous growth rates. Interest payments on foreign debt include identified payments on government (iFgi), monetary (iFm), private (iFp) and public enterprise (iFo) debt, which are all taken from the debt-module. In addition, interest payments on unidentified government debt (iFgu) are added under the requirement closure. Profit repatriations are derived from the accumulated foreign direct investments, using an imputed return equal to the 6-month US$ LIBOR. The foreign sector's current account expenditures include exports of goods and non-factor services (Xt), workers remittances (WRp), net other current transfers to the private sector (Otfp), interest receipts on foreign reserves (intRESm), and net other factor income (OFIfp). Export of goods and services includes cotton exports (Xcot), other agricultural exports (Xothagr), Egyptian oil exports (Xoil), textile exports (Xtex), other manufactures exports (Xothman), Suez revenues (Xsuez), tourism revenues (Xtour), and other non-factor services exports (Xnfs). The other manufactures exports follows an empirically determined relationship between export growth, export market size and relative prices between Egyptian goods and competitors goods on the export market. Other export categories follow exogenously determined growth rates. Workers remittances, net other transfers to the private sector, and net other factor income, all follow exogenous rates of growth. Interest receipts on foreign reserves follow, as discussed above, an imputed return on the stock of foreign reserves.

The capital account of the foreign sector includes official grants (KOG), foreign direct investment to the private sector and the public sector enterprises (DFIp) and (DFIo), net long-term borrowing (LT dFt), net short term borrowing (dST), capital flows not elsewhere identified (dF n.e.i.), and the change in foreign reserves (dRESm). Official grants and the two categories of foreign direct investment follow exogenously projected rates of growth. Net long-term borrowing includes the identified flows from the debt-module plus the unidentified borrowing of the government sector under the requirement closure. Short-term borrowings are derived from the debt-module, while the capital-flows-not-elsewhere-identified are projected as a share of GDP. Finally, foreign reserve financing of the balance of payments follows the change in the stock of foreign reserves. The stock is determined from a target value measured in terms of months of imports, as discussed above.
The non-government, non-financial public sector's budget constraint is described by equation 4:

\[(4) \quad FYo + iTDo - iCRo - iFo - NTRpaut - TDegpc - TDsuez = DIVo + INVRECt + dDTDo - dCRo - DFlo - dAFo - KTpo\]

The current account of the non-government, non-financial public sector's budget constraint includes factor income of the public sector enterprises (FYo); interest receipts on time deposits (iTDo) minus interest payments on credit achieved from the financial sector (iCRo); interest payment on foreign debt (iFo); non-tax transfers to the government (NTRpaut); and direct taxes from EGPC and Suez to the government (TDegpc and TDsuez). Factor income is derived as a set share of GDP at factor costs. Interest receipts on time deposits in the financial sector are derived as a share of GDP. On the expenditure side, interest payments on credit from the financial sector follow a share of GDP rule, while foreign interest payments are determined in the model's debt-module. Non-tax transfers as well as direct taxes follow GDP share projection rules.

The capital account of the sector consists of profits transferred to the government (DIVo), investment self-financing (INVRECt), and demand and time deposits made on accounts in the financial sector (dDTDo). The transferred profits include profits from EGPC (DIVegpc), Suez canal (DIVsuez), and other public sector enterprises (DIVexpoth). Each of the profit categories as well as the self-financed investment are projected as GDP shares; the increase in the demand and time deposits follows an exogenous rate of growth.

The deficit of the non-government, non-financial public sector is financed by credits from the financial sector (dCRo), foreign direct investment (DFlo), foreign borrowing (dAFo), and capital transfers to the private sector (KTpo). Credits from the financial sector and foreign direct investment follow exogenous rates of growth, while foreign borrowing is determined in the model's debt-module. Capital transfers to the private sector are the residual component of the financing items derived as the difference between the deficit and the sum of other sources of finance.

Equation 5 describes the budget constraint of the private sector:

\[(5) \quad FYp + WRp + Otfp + PFg + GASC + iTDp + OFIfp - iCRp - iFp - PR - TDpt - TDpi - TDoth - OthNTR - Cp = KTpg + AFdsocsec + dBpg + KTpo + dCUp + dDDp + dTDp + dNUNLIB + Ip - NKIg - AREXPg - dCRp - dUNASST - DFIp - dF n.e.i. - dAFp\]

Current account revenues include factor income (FYp), workers remittances (WRp), other foreign transfers to the private sector (Otfp), payments from the pension fund (PFg), GASC bank
borrowing (GASC), interest received on time deposits (ITDp), and net other foreign factor income (OFIfp). Private sector factor income is derived as the share of GDP at factor costs not going to the public sector enterprises. Workers remittances and the other foreign transfers to the private sector follow an exogenous rate of growth, while the pension fund payments and the GASC borrowing follow GDP share rules. The interest on time deposits includes interest on foreign currency deposits (ITDpf) and local currency deposits (ITDplc), both modelled using GDP shares. Finally, net other foreign factor income follows an exogenous rate of growth.

**Expenditures on the current account** consist of interest payments on debt to the financial sector (iCRp), interest payments on foreign debt (IFp), profit remittances (PR), property taxes (PDpt), personal income taxes (PdIt), other direct taxes (PDoth), and other non-tax transfers to the government sector (OthNTR).

Current account revenues minus expenditures produce the disposable income of the private sector which is then allocated into private consumption and private saving. Schematically this means we have the savings of the private sector on the left hand side of equation 5, while the savings on the right hand side are allocated into assets and liabilities.

**Assets on the capital account** include capital transfers to the government sector (KTpg); social security transfers (AFdsocsec); bond financing of the government sector's deficit (DBpg); capital transfers to the non-government, non-financial public sector (KTpo); change in currency in circulation (dCU); change in demand deposits (dDDp); change in time deposits (dTDP); change in unclassified liabilities (dNUNLIB); and private investment outlays (IP). Capital transfers to the government and social security transfers both follow GDP shares in projections. The government sector's deficit financing is derived from the government sector's accounts. Capital transfers to the public sector enterprises are the balancing item on the non-government, non-financial public sector's accounts. The change in currency in circulation, demand, and time deposits, as well as the change in unclassified liabilities, are taken from the financial sector's exogenous growth rate projections. The last item, private investment, is derived from the national accounts (see below).

**Liabilities on the capital account** are comprised of capital transfers and adjustment-related expenditures of the government into the private sector (NKlg and AREXPG); domestic borrowing (dCRP); change in unclassified assets in the financial sector (dUNASST); identified and unidentified foreign direct investment into the private sector (DFIp and DFN); and foreign borrowing (DAFP). The capital transfers are set to zero in projections while the adjustment related expenditures follow a share to GDP rule. The share to GDP rule is also applied to the private sector's credit from the financial sector and to the unidentified foreign investment within the private sector. Identified foreign investment follows an exogenous rate of growth, and the
private sector's foreign borrowing is determined by the model's debt-module.

The final model "constraints" encompass the National Accounts. Equations 6 and 7 describe the National Accounts in nominal and real terms respectively.

\[
(6) \quad \text{GDP}_{mp} = Cg + Cp + Ig + Ip - IMt + Xt
\]

\[
(7) \quad K \text{GDP}_{mp} = K Cg + K Cp + K Ig + K Ip + K IMt + K Xt
\]

The model derives the nominal gross domestic product (GDP_{mp}) from real GDP and the GDP-deflator. Nominal government sector consumption (Cg) is also derived from its real value and the GDP-deflator. For the purpose of consistency the nominal GDP identity needs a residual. Nominal private sector consumption (Cg) is chosen as the residual item on this account, which in turn produces the private consumption expenditure deflator as the ratio between nominal and real consumption. Nominal public sector investment (Ig) is determined as a share to nominal GDP, while private investment (Ip) is derived from its real value multiplied by the investment deflator. Nominal imports (IMt), and exports (Xt), are taken from the foreign sector's budget constraint.

Real gross domestic product (K GDP_{mp}) is determined in each period by the model's Incremental Capital to Output Ratio (ICOR) and the previous period's public and private investments. The residual component of the real GDP identity depends on the model closure (see appendix II). In the normative closure government consumption is residually determined. Private investment is residually determined in the positive closure. Government sector consumption (K Cg) is under the positive closure, projected by an exogenous rate of growth, while private sector consumption follows the model's empirically determined consumption function. The government sector's investment is derived from the nominal investment deflated by the investment deflator. In the normative closure private sector investment is given exogenously. Real imports (K IMt) and exports (K Xt) are taken from the foreign sector's accounts.
APPENDIX II: THE RMSM-X FILE SYSTEM

The RMSM-X model runs on the Javelin software package. Files in Javelin are organized in modules. Each such module consists of a time series database organized around a set of worksheets. Figure AI.1 illustrates in the connection between the RMSM-X's modules:

![Figure AI.1: An Overview](image)

The **DB-modules** consist of historical data for the model's sectors. There are a total of five historical database modules. DB_GOVT.MDL contains historical data for the fiscal accounts, DB_MON.MDL contains data for each of the subsectors of the consolidated financial sector, DB-BOP includes the historical balance of payments series, DB-NA.MDL includes historical national accounts series, and DB-MISC.MDL includes an historical miscellaneous series.

In the historical consistency module, **HDCONSIS.MDL**, historical data is integrated into the RMSM-X accounting framework, thus generating a consistent flow of funds between each of the model's five sectors. Specifically, data from the DB-modules is imported into HDCONSIS.MDL by running a pre-defined set of Javelin import building-blocks.

The historical flow-of-funds are imported into the **POL&PROJ-module** before policy assumptions are made and model projections can be produced. POL&PROJ.MDL also needs a set of debt variables in addition to the historical flow of funds data from HDCONSIS.MDL.
These debt variables are imported from the debt-module and include external disbursements, interest payments and outstanding debt stocks for each of the model's sectors (as well as foreign interest rates)\(^{11}\).

To update the RMSM-X database, data is loaded into the DB-modules, consolidated in the HDCONSIS module, and imported into the POL&PROJ module. In addition, the model's DEBT-module must be updated and the debt series imported into the POL&PROJ module. Also, the base year has to be changed if necessary. This sequence is stated below:

1. **DB-modules:**
   a) Change base year if necessary.
   b) Update data.

2. **DEBT-module:**
   a) Change base year if necessary.
   b) Update data.

3. **HDCONSIS-module:**
   a) Import data from DB-modules to consolidate with the RMSM-X accounts.

4. **RMSM-X model (POL&PROJ-module):**
   a) Import data from HDCONSIS module.
   b) Import data from DEBT-module.
   c) Simulate the model.

\(^{11}\)For a more detailed description see "A RMSM-X Model for Egypt" by M. Giugale et.al.(1991).
APPENDIX III: CLOSURE REGIMES OF THE RMSM-X MODEL

Table AIII.1: Alternative model regimes

<table>
<thead>
<tr>
<th>Availability</th>
<th>Normative</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>IV</td>
</tr>
</tbody>
</table>

NORMATIVE CLOSURE:

Target values for GDP and inflation are set. The model solves for the policies necessary to achieve the targets. The investment level follows from the GDP target and the ICOR. While private investment follows a set target, public investment follows residually from the total investment and the private investment. Exports are determined by the standard set of assumptions on export capacity and external market growth and price competitiveness. Private consumption follows the model’s consumption function. The remaining components, i.e. public consumption and imports, are found in a simultaneous fashion under the constraint of the national accounts identity.

The inflation target is met by applying the quantity theory. From the target value of GDP, the target value of inflation, and the model’s velocity total, domestic money demand can be found. To arrive at the total domestic money demand, the model adjusts the government’s domestic money demand. Total domestic supply of credit is matched with its demand by solving the supply components for the credit supply of the financial sector.

In total, the normative closure determines public investment, public consumption and the supply of domestic credit.

POSITIVE CLOSURE:

Domestic fiscal policies (government consumption and investment) and monetary policies (the supply of credit) are set. This closure is useful to evaluate alternative policy packages. The solving sequence is as follows. GDP is predetermined within each period given the past period’s investment level and the ICOR. Over time, however, GDP develops according to the endogenous private investment level which again depends on
the development of other GDP components. While fiscal policies, i.e. public consumption and public investment, follow a scheduled, pre-set plan, private consumption is determined by the model's consumption function. Exports are given by the external assumptions. Imports, with the exception of imports of capital goods, follow GDP and private consumption. Private investment and imports of capital goods are subsequently derived in a simultaneous fashion.

In this closure the model determines the domestic rate of inflation from activity, i.e. GDP growth, import prices in local currency, and the growth in credit supply.

In sum, the positive closure determines inter-period GDP, private investment and the domestic rate of inflation.

**Requirement Closure:**

Any amount of foreign credit is available to meet the financing requirements of the current account balance. Specifically, foreign credit requirements exceeding flows already identified in the DEBT-module are financed by the government and accounted as unidentified net foreign credit demand by the government.

**Availability Closure:**

Foreign credit availability is limited to commitments already identified in the DEBT-module. This closure operates symmetrically in the sense that all available credit will be spent despite, for example, a regime III projection which did not need the available foreign finance. As the capital account is predetermined in this closure, the current account solves for import of other consumer goods.

(I) Solves for public investment, public consumption, and domestic credit supply with unidentified financing needs meet by the government.

(II) Solves for inter-period GDP, private investment, and rate of inflation with unidentified financing needs meet by the government.

(III) Solves for public investment, public consumption, and domestic credit supply with external financing restricted to already identified foreign credit.

(IV) Solves for public investment, public consumption, and domestic credit supply with external financing restricted to already identified foreign credit.
APPENDIX IV: THE PARTIAL SUPPLY ELASTICITIES

The output shares are defined as the first order derivatives of the cost function:

\[
\frac{p_i y_j}{R} = \alpha_i + \alpha_u \ln t + \alpha_a \ln (k_j / k_i) + \alpha_{p_i} \ln (p_i / p_j), \quad j \neq i.
\]  

Differentiating \( y_i \) with respect to its price yields:

\[
\frac{\partial y_i}{\partial p_i} = -s_i \frac{R}{p_i^2} + \frac{\alpha_{p_i} R}{p_i^2}
\]

By multiplying with \( p_{i_i} / y_i \) on both sides we obtain the own price elasticity:

\[
\varepsilon_{y_i-p_i} = \frac{p_i}{y_i} \left[ -s_i \frac{R}{p_i^2} + \frac{\alpha_{p_i} R}{p_i^2} \right]
\]

\[
= -1 + \frac{\alpha_{p_i}}{s_i}
\]

The supply elasticities with respect to the stock of capital are found in a similar manner:

\[
\frac{\partial y_i}{\partial k_i} = \alpha_k \frac{R}{p_i k_i}
\]

From which the elasticity follows:

\[
\varepsilon_{y_i-k_i} = \frac{p_i}{y_i} \left[ \alpha_k \frac{R}{p_i k_i} \right]
\]

\[
= \frac{\alpha_k}{s_i}
\]

Same result applies to the supply elasticities with respect to technology:

\[
\varepsilon_{y_i-s_i} = \frac{\alpha_u}{s_i}
\]