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The Adjustment of a Dependent, Oil Exporting Country to a Fall in World Oil Prices

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BY

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Abstract

In this paper we analyze the welfare impact of an adjustment by a small, dependent, oil exporting economy, facing foreign borrowing constraints, to a 30% drop in the world oil price. Two adjustment regimes are compared: devaluation and import rationing. Scenarios incorporating these two regimes are examined under fixed factor price closure and fixed factor quantity closure in the non-oil sector. A numerical comparison is made possible by the use of a simple, two sector, CGE framework encompassing rent-seeking. The CGE is calibrated to 1979 Egyptian data. The results indicate that, while a devaluation in response to a theoretical oil price fall would have had a smaller negative impact on Egyptian economic welfare in 1979 than import rationing under either adjustment regime, the degree of factor price flexibility would have been a more important determinant of the adjustment's welfare impact. This result is arrived at despite the fact that we include in the cost of rationing not just the standard deadweight loss, but also the entire rent generated.

Introduction

Since 1973, world oil prices have exhibited extreme volatility. As graph #1 shows,[1] the price of a barrel of oil in 1985 dollars, which had remained under $5 until 1973, then nearly quadrupled in a single year. By 1978 the price had dropped from its 1974 high of almost $19 to about $15. Over the next decade, however, oil prices again skyrocketed; reaching over $32 per barrel by 1981 before plummeting to almost $11 in 1986, followed once more by significant increases in 1987. Adjusting to these oil shocks has proved difficult for many countries, especially those LDCs with small, dependent economies. While the direction of an oil price drop on any particular country's economy will depend mainly on whether it is a net exporter or importer of oil, the magnitude of the shock will clearly depend on the method of adjustment chosen and the degree of flexibility in the economy.

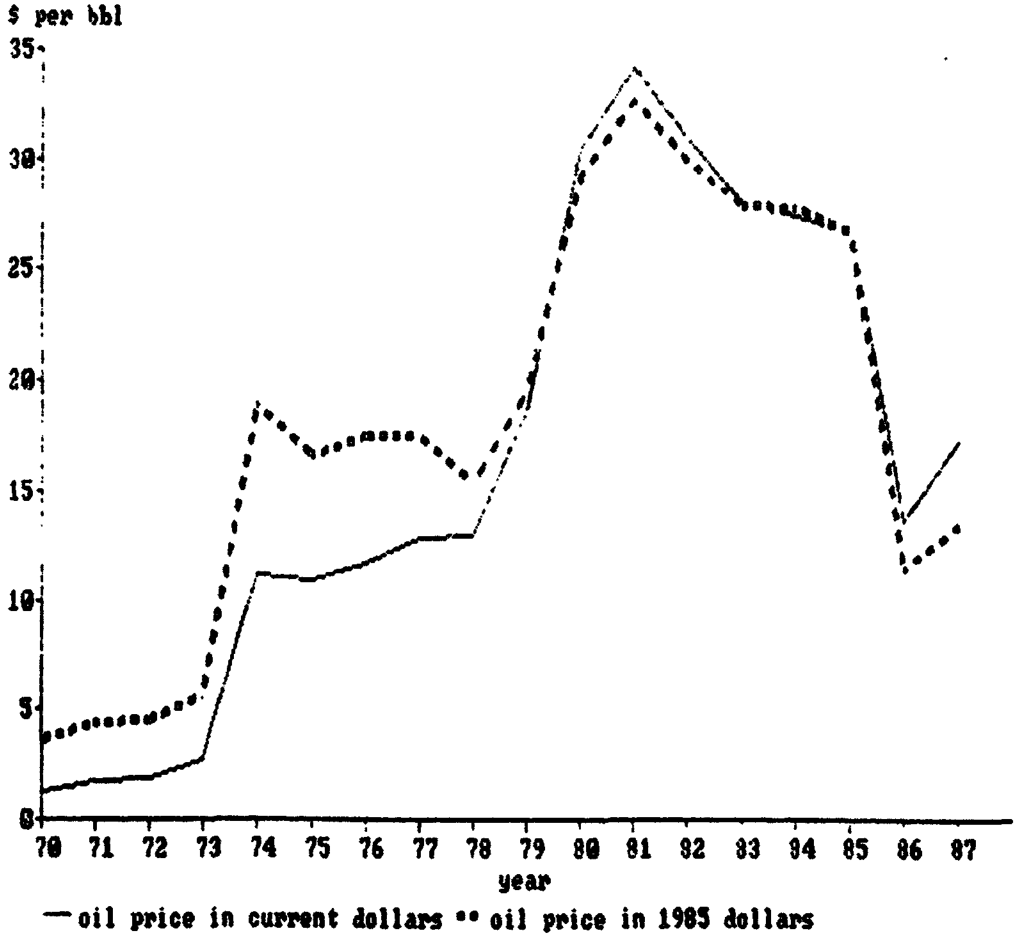
In this paper we model the adjustment of a small, dependent oil exporter to a 30% drop in the world oil price. Using comparative statics within a computable general equilibrium (CGE) framework, we compare the effects of adjustment through real devaluation vs. import rationing with rent-seeking on GDP and consumer welfare. We also compare the effects of fixed vs. flexible factor prices in the non-oil sector under both adjustment regimes. In all comparisons we assume that the country faces a foreign borrowing constraint fixed in foreign currency and that domestic investment along with government consumption remain constant in quantity.

The model is based on a 1979 social accounting matrix (SAM) for Egypt. The model's basic structure draws upon numerous CGE models previously developed at the World Bank to analyze the impact of trade distortions on the domestic

[1]Price data are from R. Duncan, "Primary Commodity Price Forecasts", p. 2. Data between 1970 and 1980 are from the World Bank's IECCM office.

GRAPH 1

WORLD OIL PRICES



economy (e.g. Amranand and Grais, 1984; Michel and Noel, 1984). Our method of imbedding rent-seeking within a standard CGE framework closely follows that used by Grais et. al. in incorporating the impact of rent-seeking in analyzing the relaxation of trade distortions in Turkey (Grais, de Melo and Urata, 1984).

The importance of rent-seeking activity to the social cost of a quota was analyzed first by Krueger (1974). Her work was extended and generalized to economic distortions besides quotas by Bhagwati and Srinivasan (1980) and later by Bhagwati (1982), among others. Among the most interesting results of Bhagwati and Srinivasan is that the social impact of rent (or revenue) seeking depends on the particular conditions under which the rents are sought. For example, the effect of rent-seeking on social welfare depends on whether all the rents are sought, on the economic environment in which the rents are sought, and on the degree of competition with which the rents are sought. Indeed, using a simple, two good, two economy, general equilibrium analysis, Bhagwati and Srinivasan show that - given incomplete specialization and initial trade distortions - incomplete but competitive rent-seeking can actually be welfare-improving.

It is important, therefore, to clarify the method of modelling rent-seeking applied here. We model rent-seeking as fully competitive and complete. This is a typical empirical procedure which simplifies the measurement problem (Tollison 1985). Fully competitive and complete rent-seeking generally characterizes the long-run equilibrium under conditions of stable rents and free entry (Corcoran 1984).

The remainder of this paper is organized as follows. Part II presents an overview of the model, discussing the central equations and the model's core structure. Part III discusses briefly the theoretical underpinnings of the rent-seeking modelling technique used here. Part IV outlines the calibration and solution procedure for the model. The results of the base year calibration and the four scenarios described above are presented in detail in Part V. Part VI concludes the paper.

Part II: The General Equilibrium Model MQR

The MQR (Misr Quantity Rationing) model has two production sectors, hydrocarbons and the rest of the economy. Each of these sectors supplies domestic and foreign markets. The non-hydrocarbon sector also produces rent-seeking services. The domestically produced goods, other than rent-seeking services, are combined with imported hydrocarbons and non-hydrocarbons into composite goods. Domestic agents, households, government, investors and producers purchase the composite goods. Rent seekers/importers purchase the rent-seeking services up to the value of the rent the import rationing may generate given the resource endowments, the preferences and the technology in the economy. The production activities, including rent seeking, generate a value added that is distributed to households and government. The latter in addition receives tax revenues and a premium on exports of hydrocarbons due to the difference between their domestic and world prices. A given amount of foreign savings is allowed to flow into the economy and to finance investments jointly with the savings generated by the domestic agents. The resource flows captured by the model are fully described in table 2 which provides the Social Accounting Matrix underlying the model.

The complete set of equations of the MQR model is contained in the appendix. It follows the tradition of applied general equilibrium models as developed by Johansen (1960) and applied to developing countries by Dervis, de Melo and Robinson (1982). It is most closely related to the models developed by Bhattacharya et al. (1985) for Egypt and Grais, de Melo and Urata (1984) for Turkey. Production of non-hydrocarbons is modelled with a CES function covering intermediate inputs and value-added. Production takes place at the intersection of the marginal cost and marginal revenue schedules where the marginal revenue schedule is the dual of a constant elasticity of transformation, CET (Powell and Gruen (1967)), aggregation function. In a second step, producers allocate their sales so as to equate the marginal rate of transformation between exports, domestic supplies of goods, and supplies of rent seeking services. The output of hydrocarbons is assumed exogenous with Leontief cost shares. Supplies of hydrocarbons to the domestic and world markets are assumed perfectly substitutable. The price of domestically produced hydrocarbons is a policy parameter. Both production activities face perfectly elastic export demand functions.

Household consumption is allocated over hydrocarbons and other goods according to a linear expenditure system. Government consumption and total investment demand are fixed in quantity terms and allocated between the two goods with fixed proportions. The exogeneity of government consumption and investment demand is in line with the basic purpose of the analysis which aims at assessing the impact of a decline in the world price of oil under the assumption that the authorities do not adjust downwards their share of domestic absorption.

Foreign savings in foreign currency are determined exogenously in line with the assumption that the economy does not adjust through foreign borrowing. Jointly with export earnings, foreign savings determine the foreign exchange available to the economy. This is first used for required transfers abroad (e.g. interest payments) and for imports of hydrocarbons. The foreign exchange left determines then, together with world prices, the amount of imports of non-hydrocarbons the economy can afford. Thus, on the domestic market supplies of hydrocarbon imports are perfectly elastic at the going world price in domestic currency whereas those of non-hydrocarbons are perfectly inelastic.

The Armington assumption[2] is used to derive the notional demands of imports and domestically produced goods. Total domestic absorption of each good is a CES aggregation of imports and domestic goods. Import and domestic goods demands are derived by minimizing the cost of obtaining the composites of domestic absorption. For hydrocarbons the notional and effective demands coincide. For non-hydrocarbons, importers who obtained a license to import will supply a fixed quantity of imports. The price of the imports on the domestic market will rise above the landed price until it clears the market.

For a complete description of the MQR model, two other features, the investment-savings balance and the closure of factor markets, deserve attention. Given that the economy maintains its level of government consumption, investments and foreign borrowing in the face of a deterioration in the terms of trade, the investment-savings balance is obtained through adjustment in the consumption of households. The latter are required to generate the savings to accommodate the investment objective. Two versions of the MQR model are envisaged regarding the closure of factor markets. In one case, relative factor prices are kept constant and employment adjusts. In the second, factor prices are allowed to vary to maintain the level of factor employment. As the results below illustrate, factor price flexibility is critical in the adjustment of the economy to a deterioration in the terms of trade and may even compensate the loss of efficiency due to rationing and rent seeking. Finally, the MQR model is a real sector general equilibrium model where the numeraire is chosen to be the basket of goods consumed by households.

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[2]K. Dervis, J. de Melo and S. Robinson, <u>General Equilibrium Models for Development Policy</u>, pp. 221-227.

Part III: Modelling Non-Hydrocarbon Import Rationing

The rationing of imports of non-hydrocarbons is illustrated in figure 1. Denote the market clearing price of imports by Pv, their domestic currency price by Pm, the notional demand curve by Md and the level of rationing by So. If import licenses were free, importers could cash in a rent in the amount (Pv-Pm)*So. In order to obtain licenses, then, importers would be willing to pay under perfect competition exactly (Pv-Pm)*So for rent-seeking services. Let Pr be the price and Qr the quantity of rent-seeking services, respectively. The level of activity of rent seeking services will be determined in the model by the equilibrium condition:

$$(Pv-Pm)*So = Pr*Qr \qquad (1)$$

In essence, this specification of rent-seeking assumes that - while the official price of imports is Pm - consumers are actually paying the notional price Pv. The difference, Pv-Pm, is a rent going to importers who then spend this exact amount on rent-seeking services. Since our aggregate non-hydrocarbon production function exhibits constant returns to scale, the entire value of rent-seeking services is exhausted in payments for the intermediate goods and factors which go into producing them. Rent-seeking services, however, differ from other non-hydrocarbon products in that they do not appear as an element of final demand. The importers who consume them are no better off than they would have been had there been no rents (or equivalently no licenses) to seek in the first place.

Conceptually one can break down the loss to the economy from rationing and subsequent rent-seeking into separate parts. Consider figure 2 where the economy is aggregated into a single sector. Import rationing raises the market-clearing or notional price of imported intermediate inputs thereby raising production costs and inducing an inward shift in the aggregate supply curve. In figure 2

Figure 1
Household Import Demand Under Import Rationing

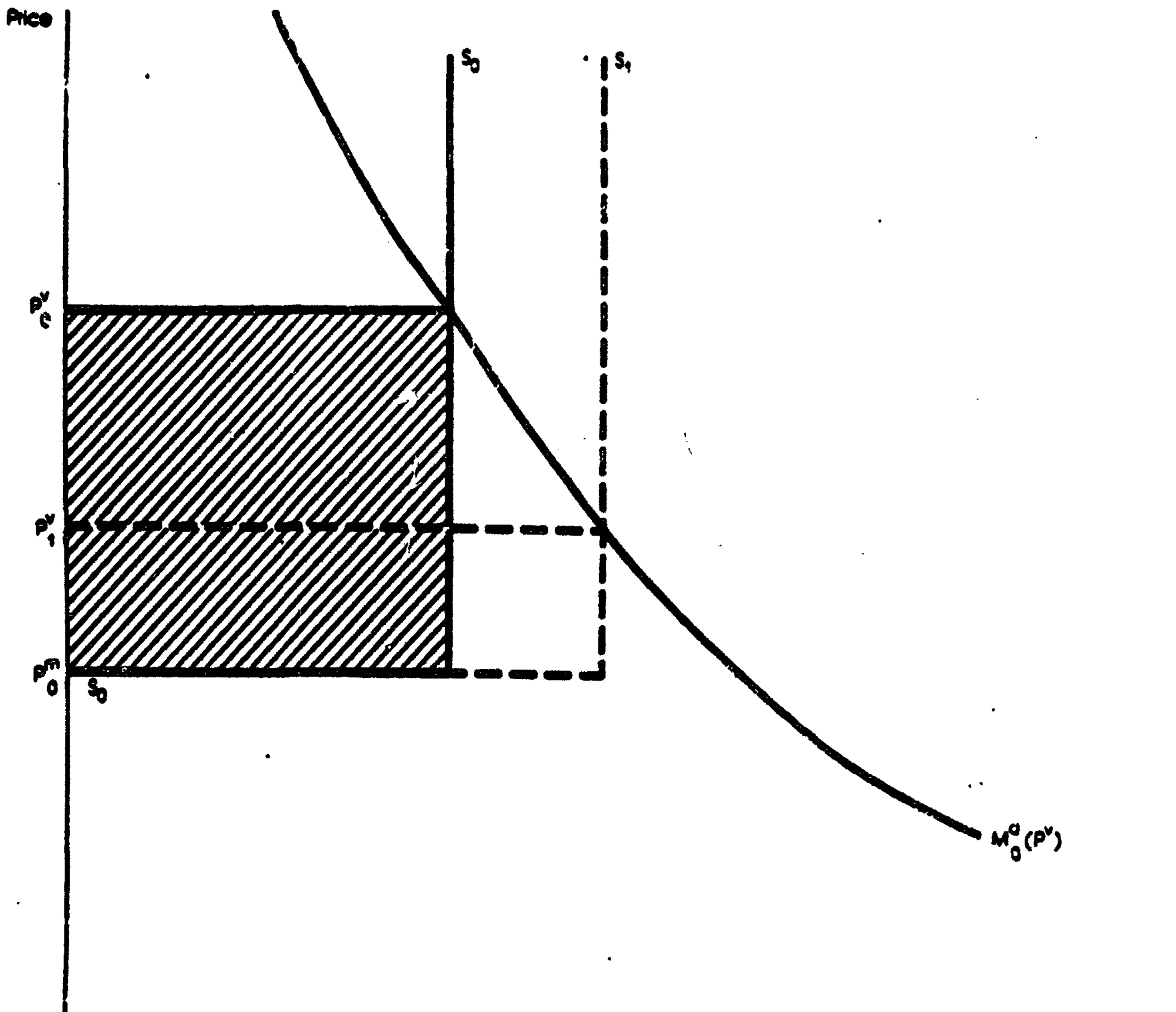
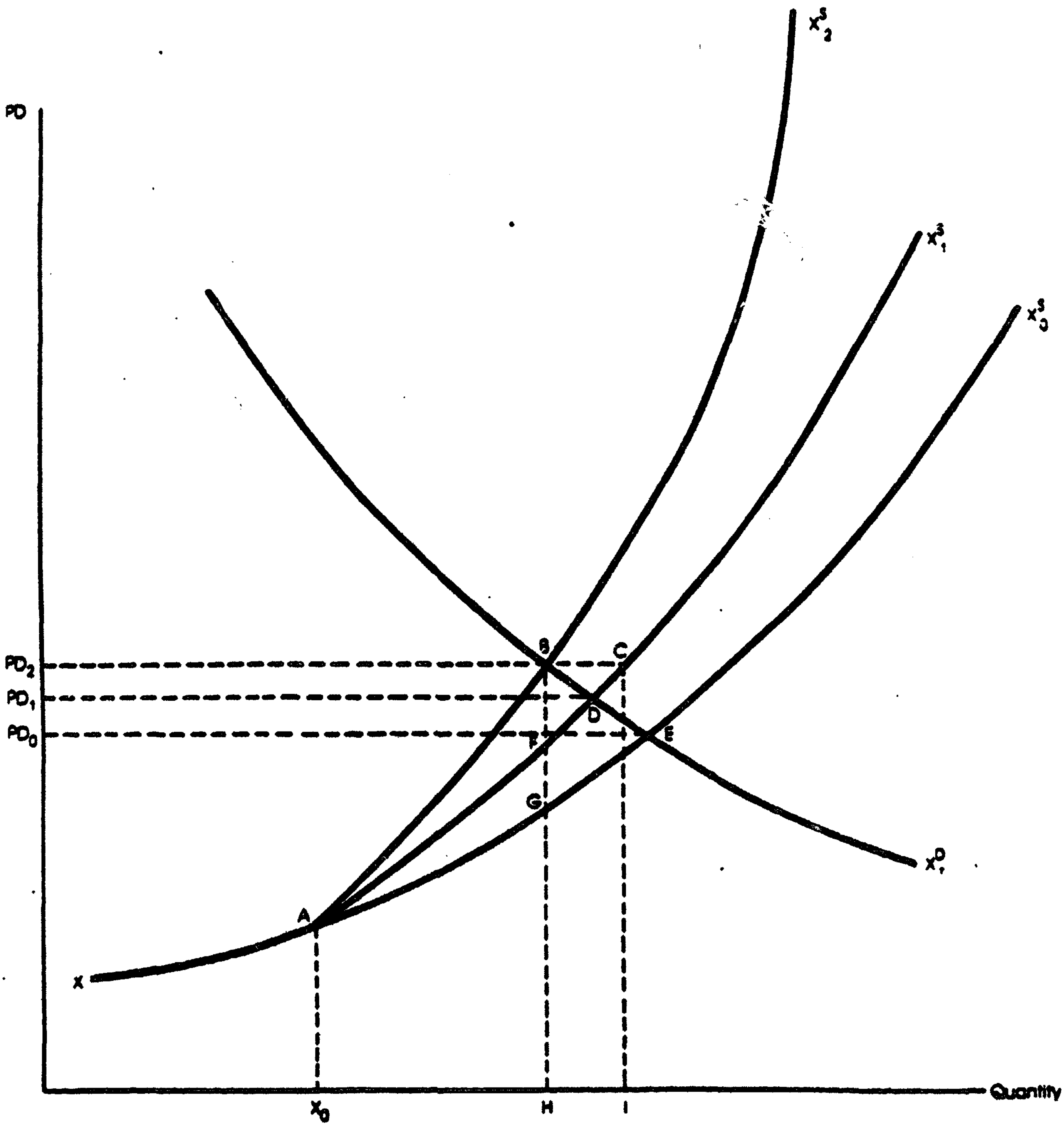


Figure 2
Welfare Cost of Rationing and Rent-Seeking



this is shown by the shift from XX_0^S to XX_1^S beyond X_0, the point where rationing becomes effective. Therefore, rationing, without any rent-seeking, results in a deadweight loss in the domestic goods market given by ADE.

Rationing, however, creates rents which induce rent-seeking in accordance with equation 1. The diversion of resources away from productive output towards rent-seeking shifts the supply curve further leftwards to X_2^S. The result is a price increase (in terms of the numeraire) to PD_2. ABD is the additional deadweight loss from increased production of rent seeking services. At the new equilibrium, FG and BF are the added costs per unit of domestic goods output due to rationing and increased rent-seeking, respectively. Similarly, BC is the amount of output that is foregone in order to meet the increased demand for rent-seeking services. Finally, the area HCBI is equal to the value of the rents.[3]

Now consider the comparative statics of a tightening of the import quota. Any tightening of the quota will directly shift the aggregate supply curve further to the left as before. This will be accompanied by an induced shift through increased production of rent-seeking services only if the decreased ration (i.e. lower So) leads to higher rents, i.e., to an increase in the lefthand side of equation 1.

One should note several characteristics of modelling rent-seeking in this way. The first question is exactly what form is appropriate for the production function underlying rent-seeking. Lacking any detailed data for estimation, we assume that the production of rent-seeking utilizes the same technology as the production of non-hydrocarbons, or put differently, at equilibrium the production of rent-seeking utilizes the same ratio of value added to intermediate inputs

[3]See: W. Grais, J. de Melo and S. Urata, "A General Equilibrium Estimation of the Effects of Reductions in Tariffs and Quantitative Restrictions in Turkey in 1978", pp. 9-14, for a related discussion on modelling rent-seeking.

as the production of non-hydrocarbons. This result, which follows directly from the CES/CET production specification described above, would seem restrictive. Bhagwati and Srinivasan show, however, that as long as rent-seeking is complete and fully competitive, as assumed here, the economic cost of rent-seeking does not depend on the technology used to produce it.[4] Therefore, our assumption about rent-seeking technology seems justified.

Secondly, we assume that rent-seeking is totally unproductive, i.e., its output does not appear as a good in any agent's utility function. Clearly this assumption, although standard in the literature, affects the measurement of rent-seeking costs. We also assume that rent-seeking is fully competitive. It is uncertain whether traders would be ready to spend the total of the rent they may earn on purchasing licenses. The equilibrium condition identified above may not fully reflect actual behavior to the extent that traders would seek to fully cash at least a part of the rent. Finally, rent-seeking may be incomplete, i.e., it is possible that not all rents will be sought. As noted above, however, fully competitive rent-seeking of all available rents can at least be rationalized as a stable, long run equilibrium. In interpreting the results to follow, one must keep in mind that the approach to modelling rent-seeking chosen here is only one of a number of alternatives, each of which involves assumptions which could potentially affect the results.

[4]J. Bhagwati and T. N. Srinivasan, "Revenue Seeking: A Generalization of the Theory of Tariffs", p. 1075.

Part IV: Calibration and Solution Procedure

The model's base year is calibrated on the 1979 data for Egypt shown in table 2.[5] The base year calibration and subsequent scenarios are run on the Hercules algebraic modelling system. Hercules operates by combining the SAM's data with functional specifications describing the interaction between the various institutions and agents which make up the rows or columns of the SAM. In Hercules, these functional specifications are detailed by creating a second SAM and replacing the data entries with acronyms indicating the functional forms desired. Table 1 contains the acronyms chosen for the MQR model. The functional specification SAM (table 1), together with a list of closures (listed at the bottom of table 1 for the MQR model) are formally equivalent to the set of equations contained in the appendix. For more information about the Hercules system, including the set of functional specifications available, the rules governing their use, and a description of the numerical algorithm used, see Drud and Kendrick (1986).

Part V: Macroeconomic Results

Given our method of modelling rent-seeking and the theoretical results of Bhagwati and Srinivasan, it is not too surprising to report that--under the conditions of our model--Egypt, if faced with a drop in oil prices in 1979, would have been better off devaluing its currency rather than rationing imports through quotas. Somewhat more interesting, however, is the result of the model that import rationing combined with a moderate amount of factor price flexibility would have outperformed an equivalent devaluation (i.e. one which would meet the

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[5]The data in table 2 are from, A. Hallouda, M. Khorsid, H. Kheir-El-Din, and M. Abdel-Fadil, "Social Accounting Matrices and Economic Modelling for Egypt", p. 118.

Table 1

EGYPT: SOCIAL ACCOUNTING MATRIX

Specifications and Closures

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1 State Salaries											VEXO																
2 Value Added: Energy														RENT													
3 Value Added: Non-Energy															CES												
4 Export Rent: Energy																							RENT				
5 Import Rents - A																						RENT					
6 Import Rents - B					VSHR																						
7 Enterprises		IDIST	IDIST					IDIST			VEXO															FEXO	
8 Households: Income	IDIST	IDIST	IDIST				IDIST				VEXO															FEXO	
9 Households: Disposable Income								IDIST																			
0 Households: Consumption									UNSPEC																		
1 State: Income			IDIST	IDIST			IDIST	IDIST																	IDIST	FEXO	
2 State: Consumption											UNSPEC																
3 Investment Agent							IDIST		UNSPEC		UNSPEC															FEXO	
4 Branch-Energy																		IO					IO				
5 Branch-Non-Energy						CET													CET					CET			
6 Composite Goods: Energy										LES		QSHR	QSHR	IO	CES												
7 Composite Goods: Non-Energy										LES		QSHR	QSHR	IO	CES												
8 Non-Traded Goods: Energy																CES											
9 Non-Traded Goods: Non-Energy																	CES										
0 Imported Goods: Energy																CES											
1 Imported Goods: Non-Energy - A																						IO					
2 Imported Goods: Non-Energy - B																	CES										
3 Exported Goods: Energy																										EXPINF	
4 Exported Goods: Non-Energy																										EXPINF	
5 Indirect Taxes														ITAX	ITAX			ITAX	ITAX	ITAX	ITAX						
6 Rest of the World			IDIST				IDIST	IDIST			VEXO									IMPORT							FICHE
7 Disposable Foreign Exchange																					IMPORT						
ACCOUNT TYPE	NF	NNF	NF	NNF	NNF	INSTC	INST	INST	INSTC	INSTC	INST	INSTC	INSTC	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC	TAX	ROW	ROW
VARIABLE: PRICE P	I	U	I	U	U	E	U	U	E	NP	U	E	E	I	E	E	E	E	E	E	E	E	E	E	U	I	I
VARIABLE: QUANTITY Q	E	U	E	U	U	E	U	U	E	E	U	I	I	I	E	E	E	E	E	E	E	E	E	E	U	E	E
VARIABLE: VALUE PxQ	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
ELASTICITY OF SUBSTITUTION CES															0.8	0.4	2										
ELASTICITY OF SUBSTITUTION CET															1.5												

<u>**Table 2**</u>

<u>**EGYPT: SOCIAL ACCOUNTING MATRIX**</u>

<u>**Base Year Calibration**</u>

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
1 State Salaries											1243																	1243
2 Value Added: Energy														300														300
3 Value Added: Non-Energy															8918													8918
4 Export Rent: Energy																							1608					1608
5 Import Rents - A																						1						1
6 Import Rents - B					1																							1
7 Entreprises		225	2241				3	30			567															4		3070
8 Households: Income	1243	75	6563				191				432															1750		10254
9 Households: Disposable Income								9255																				9255
10 Households: Consumption									8222																			8222
11 State: Income			27	1608			723	767																	602	105		3832
12 State: Consumption											836																	836
13 Investment Agent							1454		1033		601															1062		4150
14 Branch-Energy																		600					402					1002
15 Branch-Non-Energy						1													16793					1734				18528
16 Composite Goods: Energy										254		77	61	223	366													981
17 Composite Goods: Non-Energy										7968		759	4089	456	9073													22345
18 Non-Traded Goods: Energy																806												806
19 Non-Traded Goods: Non-Energy																	16950											16950
20 Imported Goods: Energy																175												175
21 Imported Goods: Non-Energy - A																						5394						5394
22 Imported Goods: Non-Energy - B																	5395											5395
23 Exported Goods: Energy																										2010		2010
24 Exported Goods: Non-Energy																										1734		1734
25 Indirect Taxes														23	171			206	157	29	16							602
26 Rest of the World			87				699	202			153									146							5378	6665
27 Disposable Foreign Exchange																					5378							5378
Row Total	1243	300	8918	1608	1	1	3070	10254	9255	8222	3832	836	4150	1002	18528	981	22345	806	16950	175	5394	5395	2010	1734	602	6665	5378	

<u>Source</u>: Hallouda, Khorsid, Kheir-El-Din and Abdel-Fadil, «Social Accounting Matrices and Economic Modelling for Egypt» CAPMAS, 1984, p. 118.

same foreign borrowing constraint) under conditions of complete factor price rigidity. In other words, simulation results indicate that factor price flexibility would have been a more important determinant of the welfare impact on Egypt of a fall in world oil prices than the choice between import rationing or devaluation.[6]

For the base year 1979 we assume that rent-seeking in Egypt was negligible (see table 2 for a matrix of the model's calibration data). The current account deficit is held constant in foreign currency in all cases. Additionally, government consumption and total investment are held constant in quantity terms. Consequently, except for valuation effects due to relative price movements, the entire domestic impact of the terms of trade deterioration falls on household consumption and rent-seeking. As rent-seeking services are assumed to be totally unproductive, we use the index of real household consumption as a short-term welfare indicator. Real household income and real GDP serve as somewhat longer-run indicators.

The accounting identity in equation 2 can help clarify our assumptions. In equation 2; Y, C, I, G, X, and M all have their standard interpretations while RS stands for rent-seeking services:

$$Y = C + I + G + X - M + RS \qquad (2)$$

A fall in the relative world oil price leads to a drop in X. Given a fixed trade deficit target, M must drop to compensate. If, however, as in our model domestic goods and imports are not perfect substitutes, M cannot fall without a reduction in absorption (C + I + G + RS). If absorption falls, then GDP will fall. Under our assumptions, therefore, a terms of trade deterioration causes GDP to fall. Since we hold I and G constant in quantity terms, excepting relative price

[6]Note that in this model in each sector all factors are aggregated into a single value-added quantity.

effects only the household consumption (C) and rent-seeking services (RS) components of absorption are affected in real terms by the oil price fall.

Table 3 presents selected results for the base year calibration (column 1) and four simulated adjustment scenarios following a 30% drop in world oil prices. Column 2 presents results for adjustment through devaluation with a constant relative factor price in the non-oil sector. Column 3 presents results for adjustment through import rationing--also with full relative factor price rigidity in the non-oil sector. Columns 4 and 5 in table 3 present comparable results for devaluation with full factor employment and import rationing with full factor employment, respectively.

Considering real GDP at factor cost, it is clear that a fall in oil prices has a negative impact in all scenarios relative to the base year--falling by a minimum of 5% under conditions of devaluation and fixed factor quantities in the non-oil sector to a maximum of 10% under conditions of import rationing and fixed relative factor prices. Devaluation outperforms import rationing under either factor market closure, e.g. under fixed factor prices GDP following devaluation is 10,953 million Egyptian pounds vs. 10,914 following import rationing and under fixed factor quantities the analogous numbers are 11,475 vs. 11,425. Similar comparisons hold for household disposable income.

Devaluation diverts resources to exports rather than rent-seeking services. Following a drop in the terms of trade under either factor market closure, therefore, devaluation requires the diversion of fewer resources to restore net exports to their target value in foriegn exchange. Furthermore, devaluation does not generate deadweight losses. Consequently, adjustment under devaluation comes at a lower cost to GDP than adjustment under import rationing.

In comparing real household consumption, the difference between devaluation and rationing becomes greater, e.g., given fixed factor prices household

Table 3

Effects of a 30% Drop in the Price of Oil

	1	2	3	4	5
GDP Summary					
Oil Value-added*	300	311	312	311	312
Oil Rents	1608	1098	1083	1065	1026
Non-oil Valued-added	10161	9544	9519	10100	10087
GDP at Factor Cost	12069	10953	10914	11475	11425
Net Indirect Taxes	602	564	561	591	588
GDP at Market Prices	12671	11517	11475	12066	12013
Households					
. Consumption	8222	7147	7068	7707	7560
. Savings	1033	1696	1735	1557	1643
. Disposable Income	9255	8843	8803	9264	9203
Selected GDP Ratios					
. Domestic Savings	24.3	26.8	26.9	25.3	25.8
. Investment	32.8	36.1	36.2	34.4	34.6
. Current Account Deficit	8.4	9.3	9.3	9.1	8.8
. Non-oil Exports	13.7	14.6	14.2	15.1	14.5
. Oil Rents	12.7	9.5	9.4	8.8	8.5
. Import Quota Rents	----	----	0.7	----	1.6
Relative Prices					
. Exchange Rate	1.000	1.013	1.000	1.031	1.000
. Non-oil Sector					
Value-added	1.000	1.000	1.000	0.994	0.993
Non-oil Intermediates	1.000	1.002	1.002	1.002	1.002
Oil Intermediates	1.000	0.945	0.943	0.948	0.943
Gross Output	1.000	0.999	0.999	0.997	0.996

1. Initial State of the Economy in 1979.
2. Drop in the oil price; fixed quantity of real investment and of government expenditure; no increase in foreign borrowing; floating exchange rate; and fixed value added price.
3. Same as 2, except: i) fixed exchange rate ii) import rationing and rent seeking.
4. Same as 2, except fixed quantity of value added instead of fixed price.
5. Same as 3, except fixed quantity of value added instead of fixed price.

*First nine rows are in millions of 1979 Egyptian pounds.

disposable income falls by 0.5% in moving from devaluation to rationing while consumption falls by 1.1%. Devaluation allows the current account deficit--fixed in foreign currency--to fill a larger share of the fixed quantity investment demand. Devaluation also does not divert resources into rent-seeking. These effects, together with the smaller investment/GDP ratio under devaluation, take some of the pressure off household savings. Therefore, under the conditions of the model, the short-run differential impact of devaluation vs. import rationing on household consumption is greater than the longer run differential impact on household income. Clearly, the larger the devaluation, the greater the gap in differential impacts becomes. This effect is evident in the Domestic Savings/GDP ratios in table 3. The difference in savings rates between devaluation and import rationing is five times greater under fixed factor quantity closure than under fixed factor price closure.

While it is true that devaluation outperforms import rationing under either factor market closure, a comparison of columns 2 and 5 in table 3 shows clearly that import rationing under a fixed factor quantity closure produces higher welfare levels than a devaluation under a fixed factor price closure. This result, which holds for all three of our selected welfare indicators, provides the evidence for the assertion that factor price flexibility would have been more important than the choice between import rationing or devaluation for an Egypt faced with a 30% drop in world oil prices in 1979. Note that the degree of factor price flexibility involved is very modest. As table 3 shows, the relative factor price drop in moving from scenario 2 to scenario 5 is only 0.7%.

How can we analyze this result? In our model, GDP at factor cost consists of three components: oil sector value-added, oil sector rents, and non-oil sector valued-added. A comparison of these components for the two scenarios in question (table 3, rows 1-3, columns/scenarios 2 and 5) indicates that the increase in non-oil sector value-added under import rationing with fixed factor quantities is not nearly offset by slightly greater oil rents under devaluation with fixed factor prices.

What causes the difference in non-oil value-added? As noted, the oil price fall impacts negatively upon Egyptian absorption causing a drop in GDP. Part of this income effect falls on the demand for domestic non-oil output. In the model gross output in the non-oil sector is a CES-aggregation of non-oil valued-added, non-oil intermediate goods, and oil intermediate goods. The negative income effect on demand for non-oil gross output consequently is reflected in a fall in demand by non-oil producers for non-oil value-added, non-oil intermediates, and oil intermediates. If the relative price of any one of these components rises with respect to the relative gross output price, then the negative income effect on demand for that component is exacerbated by an accompanying, negative substitution effect. This is precisely what happens for non-oil value-added in scenarios 2 and 3.

In scenarios 4 and 5, a relative price-induced, positive substitution effect exactly offsets the negative income effect on demand for non-oil value-added in order to keep the quantity demanded of non-oil value-added constant. Under the conditions of the model, the required drop in the relative price of non-oil value-added is small. The result, therefore, is an increase in real non-oil value-added levels in scenarios 4 and 5 relative to scenarios 2 and 3.[7]

Under the assumptions of our model the positive substitution effect of flexible non-oil factor prices outweighs the deadweight loss of import rationing

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[7]In terms of equation 2, flexible factor prices allow substitution away from intermediates with their high import content; thereby cushioning the negative impact of a drop in imports on absorption and allowing the required trade target to be reached at a lower cost to GDP and consumption.

by more than enough to offset the sum of the negative substitution effect of fixed non-oil factor prices and the slightly positive income effect of devaluation on oil GDP. Furthermore, the difference is large enough to overwhelm import rationing's additional negative impact on consumption due to increased rent-seeking. For these reasons adjustment through import rationing with flexible factor prices outperforms adjustment through devaluation with fixed factor prices--whether welfare is measured in terms of GDP or household consumption.

Now, consider the state of the external sector in the four scenarios. The current account deficit, fixed in foreign currency, rises as a share of GDP under all four scenarios, though by equal or greater amounts under devaluation, as the added stimulus to domestic production of a devaluation relative to import rationing is not enough in percentage terms to keep up with its revaluation effect on the deficit. Non-oil exports rise as a share of GDP in all scenarios in reaction to the terms of trade deterioration with a fixed current account deficit. However, the rise is consistently greater under a devaluation. This result reflects the added stimulus of an increase in the relative price of non-oil exports or, conversely, the export bias of a quota.

Finally, consider rents in the economy. Given a fixed level of domestic oil output, oil rents fall as the drop in world prices narrows the gap between the world price and the fixed, lower domestic price. Devaluation, however, works in the opposite direction, widening the gap between the domestic price and the equivalent of the world price in domestic currency. Therefore, oil rents are consistently higher in real and percentage terms under devaluation than under import rationing. Relative to an equivalent import ration, devaluation actually increases this distortion! As for import rents, they are higher in percentage terms under fixed factor quantities than under fixed factor prices. Clearly, the higher GDP under the former closure results in a greater demand for imports at the official price, which - with the fixed real exchange rate - cannot be fully offset by increased exports. The result is higher notional prices and greater rents. Therefore, a higher degree of rent-seeking can be fully consistent with a higher welfare level--even under conditions of complete rent-seeking--as long as there are sufficient unused factor resources.

Part VI: Conclusion

In this paper we have analyzed the welfare impact of an adjustment by a small, dependent, oil exporting economy, facing foreign borrowing constraints, to a 30% drop in the world oil price. Two adjustment regimes have been compared: devaluation and import rationing. Scenarios incorporating these two regimes were examined under fixed factor price closure and fixed factor quantity closure in the non-oil sector. A numerical comparison was made possible by the use of a simple, two sector, CGE framework for Egypt encompassing rent-seeking. The CGE was calibrated to 1979 data. The results indicate that, while a devaluation in response to a theoretical oil price fall would have had a smaller negative impact on Egyptian economic welfare in 1979 than import rationing under either adjustment regime, the degree of factor price flexibility would have been a more important determinant of the adjustment's welfare impact. This result is arrived at despite the fact that we include in the cost of rationing not just the standard deadweight loss, but also the entire rent generated.

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APPENDIX

THE EQUATIONS OF THE MQR MODEL

This appendix presents the complete set of equations describing the model. Exogenous variables and parameters are denoted by Roman letters with a bar or Greek letters. The hydrocarbon and nonhydrocarbon sectors have subscripts 1 and 2 respectively.

Input Demands

$INT_{i,1} = \alpha_{i,1} X_1$; $i = 1,2$; — demands by the hydrocarbon sector for intermediate inputs;

$INT_{i,2} = \alpha_{i,2}^{\sigma_2} (PD_2/P_i)^{\sigma_2} X_2$; $i = 1,2$; — demands by the nonhydrocarbon sector for intermediate inputs;

$VA_2 = \alpha_{0,2}^{\sigma_2} (PD_2/PN_2)^{\sigma_2} X_2$; — demand by the nonhydrocarbon sector for value added;

Supplies of Goods and Services

$S_2^d = \beta_{2d}^{\theta_2} (PD_2/PD_2)^{\theta_2} X_2$; — supply of non-hydrocarbon to the domestic markets; $\theta_2 < 0$; X_2 is total output;

$S_2^e = \beta_{2e}^{\theta_2} (PD_2/PE_2)^{2} X_2$; — supply of nonhydrocarbon exports; $\theta_2 < 0$; X_2 is total output;

$S_2^r = \beta_{2r}^{\theta_2} (PD_2/PR_2)^{\theta_2} X_2$; — supply of rent-seeking services; $\theta_2 < 0$; X_2 is total output;

$X_1 = \bar{X}_1$; — fixed supply of hydrocarbons.

Demands for Domestic and Imported Goods and Services

$V_1^m = \xi_{1m}^{n_1} (P_1/PM_1)^{n_1} Q_1$;

demand for imported hydrocarbons; $n_1 > 0$; $0 < \xi_1 < 1$; Q_1 is real demand for composite hydrocarbons;

$V_1^d = \xi_{1d}^{n_1} (P_1/\widetilde{PD}_1)^{n_1} Q_1$;

demand for domestic hydrocarbons; $n_1 > 0$; $0 < \xi_1 < 1$;

$V_2^m = \xi_{2m}^{n_2} (P_2/PV_2)^{n_2} Q_2$;

notional demand for imports of non-hydrocarbons; $n_2 > 0$; $0 < \xi_2 < 1$; PV_2 is the black market price of imports; Q_2 is real demand for composite hydrocarbons;

$V_2^d = \xi_{2d}^{n_2} (P_2/\widetilde{PD}_2)^{n_2} Q_2$;

demand for domestic nonhydrocarbons; $n_2 > 0$; $0 < \xi_2 < 1$;

Relations Between Prices

$\widetilde{PD}_1 = \overline{PD}_1 \ (1 + \bar{\tau}_1)$; Market price of domestic hydrocarbons;

$\widetilde{PD}_2 = PD_2 \ (1 + \bar{\tau}_2)$; Market price of domestic nonhydrocarbons;

$PM_i = \overline{\pi}_i^m \ (1 + \overline{\tau m_i}) \ \overline{ER}$; $i = 1,2$;

Landed prices of imports;

$PV_2 \ . \ M_2 = M_2 \ . \ PM_2 + RM_2$

Virtual price (PV_2) of rationed imports of nonhydrocarbons and the associated rent (RM_2);

$PE_i = \overline{\pi}_i^e \ \overline{ER}$; $i - 1,2$;

Export prices in domestic currency;

$PE_1 \ . \ E_1 = \widetilde{PD}_1 \ E_1 + RE_1$

Rent RE_1 on the differential between the domestic PD_1 and export (PE_1) prices of hydrocarbons;

$$P_1 = \left\{ \xi_{1m}^{n_1} PM_1^{1-n_1} + \xi_{1d} \ \widetilde{PD}_1^{1-n_1} \right\}^{1/1-n_1}$$

Price of the hydrocarbon composite;

$$P_2 = \left\{ \xi_{2m}^{n_2} PV_2^{1-n_2} + \xi_{2d} \ PD_2^{1-n} \right\}^{1/1-n_2}$$

Price of the nonhydrocarbon composite;

$$PD_2 = \left\{ \beta_{2d}^{\theta_2} \ \widetilde{PD}_2^{1-\theta_2} + \beta_{2e}^{\theta_2} \ PE_2^{1-\theta_2} + \beta_{2r}^{\theta_2} \ PR_2^{1-\theta_2} \right\}^{1/1-\theta_2}$$

Marginal revenue of the nonhydrocarbon sector, including revenue for rent-seeking services;

$$PD_2 = \left\{ \alpha_{0,2}^{\sigma_2} PN_2^{1-\sigma_2} + \alpha_{1,2}^{\sigma_2} P_1^{1-\sigma_2} + \alpha_{2,2}^{\sigma_2} P_2^{1-\sigma_2} \right\}^{1/1-\sigma_2}$$

Marginal cost of the nonhydrocarbon sector;

$$\overline{PD}_1 \overline{X}_1 = P_1 \cdot INT_{1,1} + P_2 \, INT_{2,1} + RX_1$$

Production rent (RX_1) of the hydrocarbon sector;

$$PG = P_1\overline{G}_1 + P_2\overline{G}_2$$

Price index of Government consumption;

$$PC = P_1^h \, P_2^h$$

Consumer price index;

$$PI = P_1\overline{i_1} + P_2\overline{i_2}$$

Price index of investments.

Market-Clearing Conditions

$$C_1 + G_1 + I_1 + INT_{1,1} + INT_{1,2} = Q_1$$

Demand for composite hydrocarbon;

$$C_2 + G_2 + I_2 + INT_{2,1} + INT_{2,2} = Q_2$$

Demand for composite nonhydrocarbon;

$$E_1 = \overline{X}_1 - V_1^d$$

Exports of hydrocarbons are the excess of production X_1 over domestic demand V_1^d;

$$S_2^d = V_2^d$$

Equilibrium on the domestic market of domestically-produced nonhydrocarbons;

$$S_2^e = E_2$$

The supply of nonhydrocarbon exports faces a perfectly elastic world demand at world price π_2^x;

$$PR_2 \cdot S_2^r = RM_2$$

The value of the supply of rent-seeking services ($PR_2 \cdot S_2^r$) exhausts the available rents to be sought (RM_2).

$$VA_2 = \overline{VA}_2$$

The nonhydrocarbon sector factor endowment is given;

$$VA_1 = \overline{VA}_1$$

The hydrocarbon sector factor endowment is given;

$$RX_1 = \overline{VA}_1 \cdot PR_1$$

The rent price relates nominal hydrocarbon production rents to the quantity of value added used in production;

$$\overline{ER}\,(\overline{F}_1 + \overline{F}_2 + \overline{F}_3) + \overline{ER} \cdot \overline{FS} + PE_1 \cdot E_1 + PE_2 \cdot E_2 =$$
$$F_2A + EA + HA + \overline{GA} + \overline{ER}\,\overline{\pi}_1^m M_1 + \overline{ER}\,\overline{\pi}_2^m M_2$$

Balance of payments, with given foreign savings in foreign currency FS.

The Generation of GDP

$Z_1 = RX_1$	Production rent in the hydrocarbon sector;
$Z_2 = PN_2 \cdot VA_2$	Value added in the nonhydrocarbon sector;
$Z_3 = RE_1$	Rent due to the differential between the domestic and world price of hydrocarbon exports;
$GDP = Z_1 + Z_2 + Z_3$	GDP at factor cost;

Distribution of GDP

$F_1E = (\overline{f_1e})\ Z_1$	Hydrocarbon value added distributed to enterprises;
$F_1H = (\overline{f_1h})\ Z_1$	Hydrocarbon value added distributed to households;
$F_2E = (\overline{f_2e})\ Z_2$	Non-Hydrocarbon value added distributed to enterprises;
$F_2H = (\overline{f_2h})\ Z_2$	Non-Hydrocarbon value added distributed to households;
$F_2G = (\overline{f_2g})\ Z_2$	Non-Hydrocarbon value added distributed to Government;
$F_2A = (\overline{f_2a})\ Z_2$	Non-Hydrocarbon value added distributed to abroad;
$F_3G = Z_3$	Rent on hydrocarbon exports distributed to Government:

Distribution of Institutions Incomes

$EH = (\overline{eh})\ Y_E$	Enterprises income distributed to households (dividends);
$EG = (\overline{eg})\ Y_E$	Enterprises income distributed to Government (taxes);
$ES = (\overline{es})\ Y_E$	Enterprises income share saved (savings);
$EA = (\overline{ea})\ Y_E$	Enterprises income distributed to abroad;

$HE = (\overline{he})\ Y_H$ — Households income distributed to enterprises (interest payments);

$HDI = (\overline{hdi})\ Y_H$ — Households disposable income;

$HG = (\overline{hg})\ Y_H$ — Households taxes;

$HA = (\overline{ha})\ Y_H$ — Households transfers to abroad;

$HDI = HDIC + HDIS$ — Households disposable income is exhausted by their consumption and savings;

$P_iC_i = \overline{h}_i\ HDIC\ ,\quad 0 < h_i < 1\ ,\quad i = 1,2\ ,\quad h_1 + h_2 = 1$

Allocation of household expensitures between the two composite goods;

$\overline{GE}$ — Government transfers to enterprises;

$\overline{GH}$ — Government transfers to households;

$\overline{GA}$ — Government transfers to abroad;

$G_i = \overline{g_i}\ \overline{G}\ ,\quad 0 < f_i < 1\ ,\quad i = 1,2$

$GC = FG\ .\ \overline{G} = P_1G_1 + P_2G_2$

) Allocation of Government consumption ( ) between the two composite goods;

$I_j = i_j\overline{I}\ ,\quad 0 < i_j < 1\ ,\quad j = 1,2$

$INV = PI\ .\ I = P_1I_1 + P_2I_2$

) Investment demand by ( ) sector of origin;

<u>Institutions Revenues</u>

$Y_E = F_1E + F_2E + HE + GE + AE$

Enterprises revenues;

$Y_H = F_1H + F_2H + EH + GH + AH$

Households revenues;

$Y_G = F_2G + F_3G + EG + HG + NIT + AG$

Government revenues;

$NIT = \overline{\tau_1}\ \overline{PD_1}.V_1^d + \overline{\tau_2}\ \overline{PD_2}.V_2^d + \overline{\tau m_1}\ \overline{\pi_1^m}\ ER\ M_1 + \overline{\tau m_2}\ \overline{\tau_2^m}\ ER\ M_2$

Net indirect taxes;

$AE = ER\ \overline{F}_1$ — Transfers from abroad to enterprises;

$AH = ER\ \overline{F}_2$ — Transfers from abroad to households;

$AG = ER\ \overline{F}_3$ — Transfers from abroad to Government;

Investment-Savings Balance

$$INV = ES + GS + HDIS + \overline{ER} \cdot \overline{FS}$$