growth of the economy. While this has been recognised, the institutional arrangement surrounding the fiscal rôle of the marketing boards has been subjected to some criticism.⁵ In particular, that a body, which is not subject to due legislative process, be allowed to exercise such profound taxing powers has been the object of severe criticism.

The Emergence of Oil

The foregoing discussion has emphasized the important rôle of agriculture to the overall development potential of the economy in the early years of independence. However, in the last few years before the outbreak of the Nigerian Civil War in 1967, the oil sector had begun to emerge as an alternative source of development finance. The rapid growth in the export of crude petroleum had begun to reduce the importance of the agricultural export sector as the major source of government finance, aggregate savings and foreign reserve acquisition. Tables 2-IV and 2-V summarize the emergence of oil as an important source of government finance and foreign exchange acquisition.

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SOME IMPLICATIONS OF OIL REVENUES FOR THE DOMESTIC
ECONOMY IN OIL EXPORTING COUNTRIES:
(AN APPLICATION TO NIGERIA

by

© Peter I. Ozo-Eson, B.Sc., M.A.

A thesis submitted to the Faculty of
Graduate Studies and Research in partial fulfilment
of the requirements for the degree of
Doctor of Philosophy

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2

Abstract

The oil price hike of 1974 and the Arab Oil embargo that preceded it, brought the Organisation of Petroleum Exporting Countries (OPEC) into international limelight. The role of oil in the economies of most OPEC countries, however, started long before the seventies.

This study analyzes the consequences of the oil revenues, accruing to the governments of these countries, for some aspects of their domestic economy. It is argued that government domestic budgetary decisions hold the key as to what amount of the foreign exchange counterpart of such revenues are monetized domestically. Such domestic monetization, through the real balance effect, leads to changes in the domestic price level and the non-oil balance of trade. For a small economy, the price of internationally traded goods is exogenous. Hence the pressure on the domestic price level leads to changes in the relative price of domestic (non-traded) goods as compared to that of internationally traded goods. An increase in the relative price of non-traded goods leads to a structural shift in domestic production in favour of non-traded goods.

First, the implications of oil revenues for the structure of domestic output is analyzed within the framework of a simple neo-classical two-sector model of production. Then, a simple macro-model is developed to test the implied consequences of oil revenues for the domestic price level and the non-oil balance of trade. It is shown that oil revenues will generate

a tendency for domestic production to become increasingly concentrated in the non-traded goods sector. This conclusion is shown to be consistent with the observed Nigerian situation.

Finally, the macro-model is subjected to empirical estimation, using Nigerian data. The empirical results obtained show that the domestic price level and the non-oil balance of trade are significantly affected by oil revenues.

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I would like to convey my sincere gratitude to the members of my thesis committee, Professors Keith Hay (Supervisor), E.U. Choudhri and Steve Ferris, and also to Professor Keith Acheson, for their encouragement and valuable supervision and for giving so freely of their time.

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Chapter 1

Introduction and a Review of Existing Research

The dramatic increase in the price of oil in 1973/74 and the subsequent increases that followed constituted, perhaps, the most significant shock to which the economies of the world have been subjected in the post-second world war era. A great deal of attention has been focused on the impact of the 'oil crisis' on the industrialized economies.¹ While some attention has been directed to the impact on the developing economies, such attention has been virtually directed towards the importing developing economies, with the main focus being the worsening debt position of these economies.²

With respect to the oil exporting economies, very little attempt has been made to analyze the impact of the huge rent transfers, which these economies receive, on the domestic economy.³ One consequence of the parsimony of such research was that analysts predicted severe international payments disequilibria (a transfer problem), without an explicit consideration of the degree of absorption which the OPEC economies could sustain. Following the increase in oil prices in late 1973 and early 1974, it was predicted that the OPEC countries would accumulate huge international reserves by 1980. Estimates of the magnitude of these reserves ranged

from a low of \$180 billion to a high of more than \$600 billion at 1974 prices.⁴ In 1974, OPEC reserves stood at \$68 billion. By 1978, they had declined to a mere \$6 billion.⁵ This amount was concentrated in only six of the twelve major OPEC economies. It is interesting to note that the current account position of the other six, high absorption countries, taken together was in a deficit position. These six high absorption countries are: Algeria, Indonesia, Iran, Nigeria, Oman and Venezuela. For these countries, the phenomenal degree of absorption which resulted in the erosion of the huge oil revenues that accrued to them between 1973 and 1978 is unprecedented.

An important implication of this trend for the global economy is that the high degree of absorption in the OPEC countries acts as a cushion which dampens the shock to which the world economy is subjected as a result of the 'oil crisis'. Given the limited domestic non-oil production base in most of the OPEC countries, a high rate of oil revenue absorption implies increased imports from the industrialized oil importing countries and hence an automatic amelioration of the international payments problem.

On the part of the OPEC countries, the expending of the huge oil rents has implications for various facets of their domestic economies. Since virtually all the countries

in this group are at an early stage in the developmental process, such implications need to be analyzed within the overall goal of stable long-run growth and development.

This study seeks to analyze the impact of oil revenues on some aspects of an OPEC economy. Specifically, we propose to examine the implications of the expending of such revenues on,

- (i) the structure of domestic non-oil output;
- (ii) the domestic price level, and;
- (iii) the non-oil balance of trade.

The Structure of Domestic Output:

One problem that faces most OPEC economies today is the poor performance of their traditional pre-oil growth sectors like agriculture and traditional crafts. In the case of Nigeria, before the emergence of oil sector dominance, the major growth sector of the economy was agriculture. In particular, the agricultural export sector was regarded as the major sector on which sustained overall economic growth could be based. To complement this, the domestic food sub-sector produced enough food such that Nigeria was virtually self-sufficient in food.

However, since the emergence of oil as a major source of export earnings, as from the early seventies, overall agricultural performance has been disappointing. At the same time, urban-based service sectors have experienced a rapid rate of expansion. A common official explanation for this trend has been changing tastes in favour of urban life and against rural life patterns. Since agricultural production is based largely in the rural areas, it is argued, the resulting rural-urban migration has led to declining agricultural output. This type of explanation does not recognise any relationship between increased oil sector performance and the problem of a shrinking agricultural sector. Of course, since oil production employs very little domestic factors of production, the decline in agriculture cannot be attributed to an outflow of factors of production from the agricultural sector and into the oil sector.

However, this study sets out, in part, to show that increased oil export revenues constitute the major source of the problems in the agricultural and other traded goods sectors. It will be demonstrated that increasing oil revenues set in motion forces which lead to the terms of trade, between traded and non-traded goods and between rural and urban sectors, being turned against the traded goods and rural

sectors. Such adverse terms of trade directly account for the poor performance of these sectors.

The Domestic Price Level and the Non-Oil Balance of Trade

Two other issues which have become prevalent in OPEC countries are excessively high rates of inflation and severe non-oil balance of payments deficits. The problematic nature of excessive rates of inflation is of course obvious. Non-oil balance of payments deficits, on the other hand, need not be regarded as constituting a serious problem as long as the value of oil exports are sufficiently large to lead to, at least, an overall balance of payments equilibrium. However, the behaviour over time of the non-oil balance of payments, is relevant in providing some indication of potential external equilibrium situation of the economy when oil ceases to be exported.⁶

With particular reference to Nigeria, inflation has been a serious problem since the early seventies. In this same period, the domestic money stock has experienced a very high rate of growth. This has led to an attempt to explain the inflationary problem as one that originates from excessive rates of money growth.⁷ However, during the period under consideration, Nigeria has operated on a fixed exchange rate regime. Under a fixed exchange rate regime, the domestic price level and hence the rate of inflation

are conventionally regarded as exogenous to any one economy, at least in the long-run. Hence any attempt to explain the behaviour of the domestic price level in Nigeria in terms of domestic money supply, needs to explicitly demonstrate why Nigeria (or any other OPEC economy) is able to sustain a domestic money supply that is in excess of its "natural share" of the world money stock.

It will be argued in this study that the unique nature of oil revenues, in that they accrue directly to governments, in OPEC economies and the practice of automatic sterilization of the foreign reserve counterpart of such revenues provide the mechanism that allows OPEC economies to sustain independent increases in their money supply even when they operate under a fixed exchange rate regime.⁸

In addition, this study goes further by providing a link between oil revenues and the domestic money supply and hence the domestic price level.

To provide some indication of the behaviour of the rates of growth of money supply and the price level in the period covered in this study, we summarize the behaviour of the two variables in Table 1-I.

Table 1-I

RATES OF CHANGE OF MONEY AND THE DOMESTIC PRICE
LEVEL, 1960-78 PERCENTAGES

Year	Narrow Money (M ₁)	Broad Money (M ₂)	Price Level
1961	0.9	6.1	6.6
1962	4.0	6.1	4.5
1963	6.4	8.7	-2.6
1964	18.2	19.1	0.8
1965	3.3	8.8	4.2
1966	8.9	10.9	9.7
1967	-9.7	-12.7	-3.9
1968	4.8	15.0	-0.5
1969	32.3	27.0	10.2
1970	43.6	47.8	13.8
1971	4.3	6.4	16.1
1972	11.5	15.6	2.6
1973	23.9	25.2	5.7
1974	51.1	57.3	12.5
1975	85.5	76.6	33.7
1976	44.6	36.9	22.0
1977	38.1	29.8	-21.5
1978	1.7	5.8	24.4

Source: Derived from IMF, Yearbook of International Financial Statistics, 1980.

Two things seem obvious from Table 1-I. First, a cursory examination of the table suggests that the rates of growth of both monetary aggregates are closely related to the rates of growth of the domestic price level. Secondly, the high rates of monetary expansion, particularly in the period corresponding to the oil boom years, points to a possible link between oil sector performance and the rate of monetary expansion. For example, in a comparison of the Nigerian rates of monetary growth with three other groups of countries, it was concluded that while the average rate in Nigeria was higher than the corresponding rates in most other OPEC countries, the rates of growth in all OPEC countries were much higher on the average than rates in either the industrialized or non-oil developing economies.⁹

The Framework of Analysis and Organization of Study

The object in this study, apart from analyzing the impact of oil revenues on the structure of domestic output, is to develop a simple macro-model, which is amenable to empirical testing, in order to explain the behaviour over time of the Nigerian domestic price level and the non-oil balance of trade. To do this, we seek to recognise the link between government budgetary decisions and the domestic money supply, and between money supply and both the price level and the non-oil balance of trade.

The remaining part of the study is organised as follows. In the remaining part of this chapter, we undertake a brief review of related studies. In chapter 2, we present a historical review of the Nigerian economy and the role of oil within it. Chapter 3 contains an exploratory analysis of some micro-foundations of an oil economy. This is followed in Chapter 4 by a theoretical analysis, within the framework of a neo-classical two-sector model of production, of the impact of oil revenues on the structure of domestic output. In Chapter 5, a simple macro-model is developed and analyzed. The model is aimed, mainly, at explaining the determinants of the domestic price level and the non-oil balance of payments. In Chapter 6, the model developed in Chapter 5 is applied to Nigerian data. The emerging empirical results are presented and analyzed. Finally, in Chapter 7, the main findings of the study are summarized.

Review of Literature

Two major studies of the impact of oil on the Nigerian economy exist. The first of these, based on economic planning literature, has focused, among other issues, on the extent to which oil revenues have enabled the formulation and execution of more grandiose development plans, either by providing more resources to be directed towards capital

expenditures or by relaxing foreign exchange and some other constraints on plan preparation and implementation.¹⁰

The second, within the strand of economic development literature, sought to calculate the linkages (forward and backward) between the oil sector and the rest of the economy.¹¹ The approach intended in this research is different from either of these.

The approach employed here derives, in part, from two other works. The macro-modelling in this study derives, to some degree, from an earlier developing country macro-model, which explicitly introduced the government deficit as the major source of money supply changes.¹² In an attempt to explain the inflationary process in a number of developing countries, this study developed a small (5 equations) simultaneous equations model in order to provide the link from government budgetary actions to the domestic money supply and from money supply to the domestic price level. This model, however, was not developed in the context of an OPEC economy.

The other study, based specifically on OPEC economies sought to emphasize the role of fiscal policy, in these economies, in the money supply process.¹³ The major innovations introduced in this study were the recognition of

the endogeneity of money in these economies, and the formalization of the concept of the government domestic deficit. It should be pointed out, however, that in the empirical application undertaken in this study, the money demand equation, the only equation estimated, was estimated by the ordinary least squares method.

Some ingredients of these two studies are included in the present study.

Conclusion to this Chapter

This introductory chapter has sketched the outline of the research undertaken in this study. A brief review of existing works, which are relevant to and from which the current study has benefited, has been presented.

We proceed now to Chapter 2, where a historical survey of the Nigerian economy is presented.

Footnotes to Chapter 1

1. Among these, see Pollack (1975), Willet (1975), and Park (1976).
2. See for example Hallwood and Sinclair (1981).
3. Among the few exceptions are Morgan (1979), Edens (1979) and recently Nagi (1982).
4. A discussion of these estimates can be found in Morgan (1979), pp. 55-57; Willet (1975), pp. 5-10, and Park (1976), pp. 45-51.
5. Derived from IMF, International Financial Statistics.
6. Earlier this year, for example, Nigeria's external payments situation came under severe strain due to falling oil exports emanating from the international oil glut. Severe import controls had to be introduced under the economic emergency powers granted the President.
7. For such an explanation, see Ajayi (1978).
8. With regard to automatic sterilization of oil-generated reserves, see Morgan (1979), p. 61 and with respect to Nigeria, Central Bank of Nigeria (1979), p. 116.
9. Oke and Nwade (1977).
10. Schatzl (1969).
11. Pearson (1970).
12. Aghevli and Khan (1978).
13. Morgan (1979).

Chapter 2

Oil and the Nigerian Economy: A Historical Perspective

The Early History of Oil

The history of oil in the Nigerian economy dates back to the years before independence.¹ The British Colonial administration granted the first oil concession, covering the entire land mass of Nigeria, to the Shell-d'Arcy Petroleum Development Company of Nigeria - an affiliate of the oil companies, Shell Petroleum and British Petroleum - in 1938. After some extensive geological surveys and preliminary wild cat drilling, Shell reduced its acreage to 40,000 square miles of Oil Prospecting Licenses. In 1960, the company converted 15,000 square miles of this into Oil Mining Leases, returning the remaining acreage to the Nigerian government by 1962. Even before this date, other international oil companies had started to show interest in Nigeria. Following the release of acreage by Shell, Tenneco, Gulf, Agip, Safrap, and later Phillips, Esso and Great Basins obtained Oil Exploration and Oil Mining Leases.

The commercial production of crude petroleum started in 1958. Since this date the relative importance of the oil sector within the overall economy has been on the increase,

culminating in its pre-eminent role since the early seventies. This chapter, presents a historical survey of the role of the oil sector in the overall Nigerian economy.

The Nigerian Economy: Early Post-Independence Years

The Role of Agriculture

At independence in 1960, the focal point of the Nigerian economy was agriculture. The 1952-53 Census (the last census before independence) estimated that 78 per cent of the adult male population was engaged in agriculture. In 1960, agriculture accounted for 60 per cent of the Gross National Product. The agricultural sector - which was identified as the prime mover of the economy - was important for the overall economy, not only for its direct contribution to GNP, but also because it constituted a base on which a large and growing service sector could be based.² Within the agricultural sector itself, export-oriented cash crops like Cocoa, Palm produce, Groundnuts (Peanuts), Cotton, Rubber and Timber among others were regarded as constituting the most viable basis for the long-term economic development of the overall economy. For one thing, the diversity of the export crops and the climatic and economic potential for the development of new ones like coffee, meant that, unlike in many one-export-commodity developing economies, the development fortunes of the Nigerian economy were not tied to the vicissitudes of the international market for a single commodity.

The potential of the agricultural export sector to stimulate sustained overall economic growth and development was regarded as enormous.

In the first place, this sector has strong direct linkages to such service sectors as transportation and distribution. Once produced in the rural areas, it divulged on urban middlemen and transporters to provide the link between the rural farmers and the exporters (mainly the marketing boards) located in the large urban areas. Hence, the growth of these service sectors was interwoven with the economic fortunes of these crops.

Secondly, the cash incomes which the agricultural activities generated led to a growth of the demand for manufactured products and the services associated with their marketing. This growth in the domestic market, coupled with a large domestic population, provided the hope for the development of a domestic manufacturing sector. In most developing countries, the major constraints on the development of domestic manufacturing enterprise are usually a small domestic market, low levels of savings which hinder capital accumulation and the dearth of foreign exchange needed to finance the importation of capital equipment. In the case of Nigeria, by contrast, there was a reasonably large domestic market, as already indicated. As for the other two constraints, it was thought, in the early years after independence, that the

agricultural export sector held the key to the relaxation of these constraints. It was thought that by a judicious taxing of agricultural export proceeds, reasonable levels of aggregate savings could be generated. The commodity marketing boards, through their administered price policy, became the most important taxing agency and soon accumulated huge surpluses.³ With regard to foreign exchange constraints, the agricultural exports became the single most important source of foreign reserve accumulation. The contribution of agricultural exports to the development potential of the economy, in the years before the Nigerian Civil war, is summarized in Tables 2-I through 2-III.

Table 2-I

EXPORTS OF PRINCIPAL AGRICULTURAL EXPORT CROPS
(1960-1966)

	Volume (Thousand Tons*)							Value (Million Naira, F.o.b.)						
	1960	1961	1962	1963	1964	1965	1966	1960	1961	1962	1963	1964	1965	1966
Groundnuts	332	494	530	614	544	512	573	46	64	64	73	68	75	82
Groundnut Oil	47	45	63	69	80	91	108	10	10	12	13	16	20	20
Groundnut Cake	53	75	88	85	139	113	133	3	4	5	6	9	11	19
Cocoa	154	184	195	175	197	255	190	74	67	65	65	80	85	57
Palm Kernels	418	411	367	398	394	416	394	52	40	34	42	42	53	45
Palm Oil	183	165	118	126	134	150	143	28	26	18	19	22	27	22
Rubber	57	55	60	63	72	68	70	28	22	23	24	24	22	23
Raw Cotton	27	46	23	40	25	14	23	12	22	12	20	12	7	10
Timber and Plywood	25	23	19	23	25	20	19	17	16	14	16	12	14	14
Hides and Skin	230	240	215	185	180	172	163	9	8	8	9	9	9	12
Total Value of Agricultural Exports:								279	279	255	286	299	323	294
Percentage of Aggregate Value of Exports:								84.3	82.1	77.7	77.3	71.0	61.4	53.0

Note: *The quantity measures are in thousand tons, except Timber and Plywood (million cubic feet) and Hides and Skins (cwt).

Source: Federal Office of Statistics, Annual Abstract of Statistics, various issues.

The predominant position of agricultural exports in aggregate exports and hence foreign reserve acquisition in this period is obvious from Table 2-I. What is also obvious is that although the value of agricultural exports remained relatively stable over the period, their share in overall export value experienced a steady decline. This is due to the gradual growth in the value of petroleum exports which was accounted for mainly by a growth in the volume of crude oil produced and exported.

To gain some insight into the contribution of agricultural exports to government finances and aggregate savings, Tables 2-II and 2-III analyze the prices which these commodities fetched in the international market as compared to the prices which the producers actually received as a result of the marketing board administered price policy.

Table 2-II
AVERAGE UNIT VALUE OF COMMODITY EXPORTS
(Naira per Ton*)

	1960	1961	1962	1963	1964	1965	1966
Groundnuts	138	130	122	119	126	148	142
Groundnut Oil	226	222	196	190	203	220	186
Groundnut Cake	59	51	56	64	67	93	71
Cocoa	478	367	342	370	407	335	297
Palm Kernels	125	97	92	105	106	127	114
Palm Oil	149	160	151	149	161	181	153
Rubber	498	400	381	373	338	324	327
Raw Cotton	460	480	504	476	482	488	463
Timber and Plywood	0.66	0.68	0.72	0.68	0.72	0.76	0.70
Hides and Skin	39	33	35	60	69	71	72

Note: *Prices are in Nigerian Naira per ton except Timber and Plywood (Naira per cubic feet) and Hides and Skin (Naira per thousand cwt).

Source: Derived from Table I.

Table 2-III

MARKETING BOARD ADMINISTERED PRICES OF MAJOR
AGRICULTURAL COMMODITIES: NET OF PRODUCE SALES TAX
(Naira per Ton)

	1960	1961	1962	1963	1964	1965	1966
Groundnuts	74	76	66	61	62	64	69
Cocoa	312	216	192	202	212	232	122
Palm Kernels	58	58	50	50	54	54	54
Palm Oil ¹	106	106	80	80	82	82	82
(a)							
(b)	88	88	68	68	70	70	70
Rubber ²	406	372	378	316	330	330	282

Notes: 1 (a) Special Grade Palm Oil.

(b) Technical Palm Oil.

2. Average World Price (c.i.f. London) adjusted for produce sales tax. There is no marketing board for rubber.

Source: World Bank, Nigeria: Options for Long-Term Development, p. 240.

Table 2-III excludes some commodities because of the absence of the relevant data. A comparison of the data in Tables 2-II and 2-III shows clearly, the severity of the effective tax burden which the farmers had to bear. Lewis aptly describes the plight of the farmers when he suggests that "the governments have had their hands on the throat of the goose which is laying the golden eggs".⁴ Be that as it may, however, the fact remains that the squeeze on farmers, nevertheless, provided the economy with the necessary government revenues and aggregate savings which were required to fuel the

growth of the economy. While this has been recognised, the institutional arrangement surrounding the fiscal role of the marketing boards has been subjected to some criticism.⁵ In particular, that a body, which is not subject to due legislative process, be allowed to exercise such profound taxing powers has been the object of severe criticism.

The Emergence of Oil

The foregoing discussion has emphasized the important role of agriculture to the overall development potential of the economy in the early years of independence. However, in the last few years before the outbreak of the Nigerian Civil War in 1967, the oil sector had begun to emerge as an alternative source of development finance. The rapid growth in the export of crude petroleum had begun to reduce the importance of the agricultural export sector as the major source of government finance, aggregate savings and foreign reserve acquisition. Tables 2-IV and 2-V summarize the emergence of oil as an important source of government finance and foreign exchange acquisition.

Table 2-IV
CRUDE PETROLEUM PRODUCTION AND EXPORTS, 1960-1966

	Production		Exports	
	Volume per day (thousand) barrels	Value (Million Naira)	Volume	Value (Million Naira)
1960	17	8.4	17	8.4
1961	46	22.6	46	22.6
1962	68	34.4	68	34.4
1963	76	40.2	76	40.2
1964	120	64.0	120	64.0
1965	270	138.2	266	136.2
1966	415	199.4	383	184.0

Note: The difference between production and export figures from 1965 is accounted for by the fact that the first local refinery came into production in that year.

Source: Pearson (1970), p. 56, (Values have been converted from Nigerian Pounds to Nigerian Naira).

An examination of Table 2-V shows the steady rise in the production and exports of crude petroleum both in terms of volume and value. The growth in the value of exports meant that the oil sector had begun to seriously compete with the agricultural export sector as the major contributor to foreign reserve acquisition just before the outbreak of the Nigerian Civil war. The growing importance of oil was not confined to its role as a foreign exchange earner. As the production and hence export of the sector increased, so did its contribution to government finances and hence aggregate savings. Table 2-V summarizes the role of the oil sector in government finances.

Table 2-V

PETROLEUM SECTOR CONTRIBUTION TO TOTAL GOVERNMENT REVENUES
(Million Naira)

	Total Government Revenues	Petroleum Revenues	Percentage Share of Petroleum Revenues
1960	253.2	2.6	1.0
1961	270.2	14.2	5.3
1962	281.2	17.0	6.0
1963	293.6	10.0	3.4
1964	357.0	24.6	6.9
1965	380.0	26.6	7.0
1966	394.2	37.4	9.5

Source: Pearson (1970), p. 73. (Values converted from Nigerian Pounds to Nigerian Naira.)

The information summarized in the preceding two tables suggests that while the role of the oil sector in the overall economy was still modest in the period before the war, such a role was undergoing rapid growth. It was this rapid growth that engendered the conclusion that along with the agricultural export sector, the petroleum sector had begun to assume the role of an engine of growth for the overall Nigerian economy. Against this background, it was argued that the rapid growth of oil exports held the key to even a more rapid rate of growth of the agricultural exports. For example, in a study of the agricultural sector, Eicher and Johnson concluded that the major problems facing

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agriculture in this period were the disincentives imposed by the taxing policy implicit in the marketing board pricing policy and the constraints imposed by inadequate domestic demand.⁶ The growth in oil exports, they concluded, held the key to the alleviation of these problems. On the one hand, it was thought that increased oil exports, and hence the resulting increased government revenues, would reduce the need to subject the agricultural export sector to the erstwhile severe tax burden. The resulting higher net unit prices to producers of these crops were expected to lead to increased production. On the other hand, the increased aggregate income which oil exports were to generate was expected to ease the constraint imposed on the agricultural food sector by low levels of effective demand. Thus, overall, it was expected that increased oil exports and revenues would have the potential effect of stimulating growth in the agricultural and other sectors of the economy.

That this expectation, particularly with respect to agriculture, has not been realized is of course obvious from present-day Nigerian economic evidence. The divergence between this conclusion and actual realized economic conditions is accounted for by the fact that Eicher and Johnson's analysis was confined to the traditional linkages approach and the fact that no explicit consideration had been given in their analysis to the impact of increased oil revenues on

relative price changes and the relationship between such relative price changes and the structure of domestic non-oil output.

Hence, a major contribution of this thesis to the framework of economic analysis of Nigerian developmental problems is the explicit development of the channel through which oil revenues affect the relative price of non-traded and traded goods and the sectoral response to such relative price changes.

An Overview of the General Economic Situation in the Pre-War Years

The discussion thus far has centered on the pre-war developments in the agricultural export and petroleum sectors. We turn now to a summary of the general economic situation in this period.

The major problem that faced the Nigerian economy at independence was how to promote a fast pace of economic growth. Shortly after independence, the First National Development Plan was launched in 1962. The major goal of the plan was the attainment of a plan target of a minimum annual growth rate of four per cent for the Gross Domestic Product. To attain this goal, the plan set a target rate of savings of fifteen per cent of the GDP and an investment rate of the same amount.⁷

Out of a total planned expenditure of 2,366 million naira about fifty per cent was expected to come from external sources. This high proportion of external sources of finance has been identified in retrospect, as the major weakness of the plan.⁸ The failure of external sources to generate the projected funds during the six-year plan period, then required that domestic sources of finance be stretched even far beyond what had initially been projected. This extra burden on domestic sources was exercised largely through monetary and fiscal policies.

In the early sixties, the goal of monetary policy was largely "the provision of 'cheap' money to finance government capital expenditure and the aiding of investment financing in the private sector".⁹ However, such a policy was obviously in conflict with the goal of "containing the pressure of consumption expenditure on the balance of payments and generally preventing an uncontrolled weakening of the external reserve position to a dangerous level".¹⁰ Hence, in this period, fiscal policy was increasingly employed both to complement monetary policy in generating domestic finance and to ease the pressure on external reserves which the 'cheap' money policy was helping to generate. Thus, for example, in August 1964, "steps were taken to restrain consumer demand by imposing higher custom duties on a wide range of imports".¹¹ This policy was initiated only after the Exchange Control Act which came into force in 1962 had failed to sufficiently protect the country's external

reserves.¹² As the country's external reserves remained under pressure, despite the increased tariffs of August 1964, further restrictions were imposed in April and again in August of 1965. These took the forms of increased tariff rates and outright bans on the importation of some goods.¹³

The aim here is neither a review of the planning experience nor a cataloguing of policies that were initiated in this period. Rather, the essence of the foregoing discussion is to highlight, from the policy makers' point of view, the major economic problems of this period. It should be pointed out that inflation was not a serious economic problem in the period under review. While the average annual rate of inflation in the 1960-1966 period was roughly 4 per cent, it was thought that some moderate rate of inflation was a normal, and maybe a necessary, feature of an economy in the early stages of development.

The War Years¹⁴

With the outbreak of war in mid-1967, the economy was placed on a war footing. To ensure adequate sources of funds required to prosecute the war, the Treasury Bills Act was amended to increase the limit of treasury bills as a percentage of estimated federal government revenues from 40 per cent to 50 per cent.¹⁵ Since the banking system was the major holder of these instruments, it was obvious that the implied injection of liquidity into the economy had the potential for generating inflationary pressures. To counter such pressures, export of

certain essential items, like beans, cassava flour, maize, rice and yam among others, were placed under restrictive export licences.

To bolster government revenues, taxes were increased. For example, a 20 per cent tax on gains accruing from the disposal of assets and a 10 per cent super tax on company profits were introduced in 1967. Since the cost of the war had a high foreign exchange content, further steps became necessary to conserve external reserves. Severe and increasing restrictions on imports were introduced as the war progressed. The main tools employed were tariffs and import licences, both on the basis of commodity and geographical origin. The pressure on the economy's external reserves were made even more severe by the maintenance of the Nigerian exchange rate in the face of the sterling devaluation of 1967. To compound the problem, the war led to a sharp curtailment of crude oil production and hence exports since a large part of the oil fields were located in the areas in which the war was being fought.

In general, during this period, government needs dictated the pace of development and policy. In particular, developments in the financial sector were dictated by the war financial needs of the government. As the government tightened its grips on the economy's financial and commercial operations, the Treasury Bills Act was again amended to raise the percentage of outstanding treasury bills issue from 50 per

cent to 85 per cent of estimated federal revenues.¹⁶ Further tax increases on companies' operation were introduced and extended to cover even those companies that had earlier been exempt on the basis of having been granted pioneer status.

Overall, the war years constituted the most trying period for the Nigerian economy. However, the severe restrictions placed on imports led to a rapid growth of manufacturing outside the war areas. As the war drew to a close in 1969, the stage was set for the blossoming of the oil sector which came to be realized in the early seventies. Thus in its review of the economy, a World Bank mission to Nigeria concluded that:

Nigeria emerged from the civil war with a sizeable but manageable internal debt; a negligible increase in external public debt; an increased level of economic activities, particularly in the manufacturing and petroleum sectors; and most importantly, with considerably increased confidence in both the underlying strength of its economy and the ability of the government to manage the large and diverse economy.¹⁷

The Post-War Period

The end of the civil war in 1969 saw the resurgence of a high degree of optimism regarding the prospects of the economy. The resilience of the economy in the face of adverse war conditions and in particular, the reopening of all the oil wells led to a new sense of the economic potential which the future held. First, the immediate and urgent goals

of policy were the reconstruction of the vital infrastructure damaged by the war and the resuscitation of the basic engines of growth of the economy. In 1970, the Second National Development Plan was launched, setting a target annual rate of growth of GDP at 6 per cent.¹⁸

As the stringent economic control of the war years began to be relaxed in 1969, the pent-up demand that had been held in check began to surface, leading to a generation of inflationary pressures. Hence, a major economic problem became the amelioration of inflation through policy. In May of 1970, price control was introduced on a wide range of commodities. However, inefficiencies in price control administration and the fact that the price control legislation was selective in nature denied the policy of any sting and inflation remained a serious problem.

In April of 1971, liberalization of imports of consumer goods was introduced in an attempt to slow the rate of inflation. While the resulting 60 per cent increase in the import of consumer goods the following year certainly had a dampening effect on inflation, it was still not sufficient to keep the problem under check. As inflation remained a virulent problem, other policies were initiated. First, a National Supply Company was established to intervene directly in the distribution of essential commodities. Secondly, credit

ceilings and credit guidelines were introduced to arrest the fast pace at which domestic liquidity was growing.

It is widely held that mismanagement and outright corruption doomed the National Supply ~~company~~^{company} to ineptness right from its inception. One thing that is certain is that it failed woefully to moderate the rate of inflation. As for credit control, suffice it to say that the Central Bank ceilings and guidelines were persistently not adhered to. For example, the ceiling on aggregate credit for 1971 required a maximum increase of 8.4 per cent over the aggregate credit levels of corresponding months in 1970. The actual credit expansion was in excess of this requirement by 66 per cent at the end of April and 32 per cent at the end of December 1971! The guidelines on the sectoral allocation of credit were also flaunted. Table 2-VI summarizes a comparison of sectoral guidelines and actual sectoral credit for 1971.

Table 2-VI

SECTORAL CREDIT GUIDELINES AND ACTUAL CREDIT ALLOCATION, 1971
(in Millions of Naira)

Sectors	Guideline	Actual	Excess of Actual Over Guideline %
Total (All sectors)	381.0	502.0	32.0
Agriculture, Forestry and Fishing	10.6	9.2	-13.0
Manufacturing, Mining and Construction	133.0	168.8	27.0
General Commerce	176.0	221.2	26.0
Other Services	22.0	35.4	61.0
Others	32.0	67.4	111.0

Source: World Bank (1974), p. 53.

With respect to Table 2-VI, two observations are in place. First, that actual credit expansion exceeded prescribed levels is due to two factors. On the one hand, the inability of the Central Bank to impose penalties on commercial banks not operating within prescribed margins meant that commercial banks still sought to maximise their profits without regarding such prescriptions as binding constraints. On the other, commercial banks were, at this period, holding excess reserves. Whereas the required liquidity ratio was 25 per cent, the actual liquidity ratio of all commercial banks combined was over 90 per cent during the first quarter of 1971.

Second, it should be pointed out that the actual sectoral figures in Table 2-VI are at best indicative. This is so because of the prevalent practice of borrowers raising loans for one purpose and using it for another.¹⁹ In particular, given the priority designation of agriculture, it was easier to raise a loan for a project in this sector. But once obtained, the borrower is usually able to commit such funds to other uses like financing, even, consumption goods.

However, the combination of the several anti-inflationary policies seemed to be working as the inflation rate declined in 1972 and rose only moderately in 1973. This turned out to be a transient respite, however, as other developments in the economy created new and even more severe inflationary pressures.

Oil Boom and Oil Dominance: A New Feature of the Economy

During the war, workers, particularly those in the public sector, had been forced to accept constant nominal wages. Furthermore, as part of the war effort, they had been required to contribute part of their incomes to government administered forced savings. Thus at the end of the war and at the wake of inflationary pressures, workers had begun to agitate for salary revisions across the board. A wages review commission was set up. In 1975 the Udoji awards were implemented, granting an average of 40 per cent increase in public sector wages with implications for the private sector. The award was applied retroactively, and lump-sum payments were made to workers. The resulting upsurge in aggregate demand most likely accounts for the high rate of inflation of 33 per cent in 1975. However, even by 1974, the inflationary pressure had taken an upward swing. This is most likely due to the phenomenal increase in oil revenues in 1974 due to the oil price hike. Developments in the petroleum sector since the outbreak of the civil war are summarized in Table 2-VII below.

The growth in the value of oil exports which began at the end of the war - first due mainly to a growth in volume and then to the huge jump in oil prices, beginning in late 1973 - led to a rapid growth in government revenues and the

proportion of such revenues emanating from the oil sector.
These developments are summarized in Table 2-VIII below.

Table 2-VII
PRODUCTION AND EXPORT OF CRUDE PETROLEUM, 1967-1978

Year	Production		Exports	
	Volume (Thousand (barrels per day)	Value	Volume	Value (Million Naira)
1967	319.3	157.2	300.0	147.7
1968	141.3	70.3	135.0	67.2
1969 ^a	540.3	265.5	542.2	266.4
1970	1 083.1	525.3	1 050.8	509.6
1971	1 531.2	994.6	1 482.4	962.9
1972	1 815.7	1 214.7	1 756.1	1 174.8
1973	2 054.3	2 007.2	1 978.1	1 932.7
1974	2 254.0	5 861.5	2 179.4	5 665.0
1975	1 783.2	4 988.0	1 713.3	4 792.5
1976	2 066.8	6 051.0	2 013.2	5 894.1
1977	2 085.1	7 232.7	2 030.2	7 046.2
1978	1 877.0	6 264.0	1 827.1	6 033.2

Note: (a) Volume of export exceeded volume of production in 1969 due to a carry-forward of previous year stock.

- Source: 1. Volume of Production and Exports: OPEC, Annual Report, 1980, Vienna.
2. Value of Exports: IMF, International Financial Statistical Yearbook, 1980.
3. Value of production figures are derived by multiplying volume of production by the implied unit price of exports.

Table 2-VIII
THE ROLE OF OIL REVENUES IN TOTAL GOVERNMENT
REVENUES, 1967-1978
(Millions of Naira)

Year	Total Revenues	Oil Revenues	Share of Oil Revenues in Total (Percentages)
1967	289.2	49.2	17.0
1968	355.0	29.6	8.3
1969	508.0	68.0	13.4
1970	779.6	196.4	25.2
1971	1 083.6	740.0	68.3
1972	1 513.6	576.2	38.1
1973	2 358.3	1 461.4	62.0
1974	5 162.9	4 183.8	81.0
1975	6 700.4	4 612.0	68.8
1976	9 718.0	5 484.0	56.0
1977	10 849.0	5 965.0	55.0
1978	7 295.0	4 285.0	58.7

Source: Derived from Federal and States' Revenue figures published in Central Bank of Nigeria, Economic and Financial Review (various) and Annual Report, (various).

Improved government revenues led to huge expansions in government expenditure programs, culminating in the grandiose Third National Development Plan in 1975. To finance the domestic component of government expenditure programs, increasing amounts of oil revenues - which accrue in foreign exchange - had to be monetized domestically. The resulting high rates of domestic liquidity expansion generated further inflationary pressures and phenomenal expansions of import

demand. Furthermore, the growth in urban demand has outstripped that of the rural areas, leading to a worsening of the terms of trade between the rural and urban economies. Agricultural production has either declined or stagnated, while urban-based service sectors like distribution and transportation have and continue to flourish. This is in spite of a concerted policy effort to stimulate agriculture.

Thus the Nigerian economy has moved, since independence from a diversification of exports to increasing dependence on petroleum. The dangers inherent in this pattern of extreme dependence on one commodity in terms of exports and one 'enclave' sector, in terms of overall economic development and growth, are forcefully highlighted by the near stagnation and near collapse of the Nigerian economy since the glut in the international oil market led to a sharp reduction of oil exports beginning 1980.²⁰

Conclusion to this Chapter

In this chapter, we have presented a brief review of the role of oil in the Nigerian economy since independence. The approach adopted has been historical and attempts have been made to highlight the evolution of, on the one hand, factors generating structural shifts in the economy's developmental path and on the other, the origins of some of the current economic problems and the policy environment in which they developed.

Footnotes to Chapter 2

1. For a comprehensive historical review of the development of petroleum in Nigeria, see Pearson (1970), especially Chapter 2. See also, Schatzl (1969).
2. See among others, Lewis (1967) p. 15 and Helleiner (1966) pp. 140-151.
3. For an extensive discussion of the fiscal role of the marketing boards, see Helleiner (1964).
4. Lewis (1967), p. 20.
5. See for example, Helleiner (1966), pp. 178-184.
6. Eicher and Johnson (1970).
7. See Federal Ministry of Economic Development (1963).
8. For example, see Aboyade (1962) and Olakanpo (1962).
9. Federal Ministry of Information (1970), p. 14.
10. Ibid., p. 14.
11. Ibid., p. 15.
12. Ibid., p. 15.
13. Ibid., pp. 15-16.
14. The Nigerian Civil War took place between 1967 and 1969. The hostilities leading to the war had begun in 1966.
15. See Federal Ministry of Information (1970), p. 17.
16. Ibid., p. 19.
17. World Bank (1974), p. 1.
18. See Federal Ministry of Information (1970), p. 40.
19. For evidence on this practice, see the discussion of "False Demand for Capital" in Schatz (1977), pp. 67-69. See also the following quote - "The mere prescription of a sectoral distribution of credit may not ensure that funds borrowed for production cannot be applied for consumption expenditures" - from Central Bank of Nigeria (1979), p. 127.

20. For a detailed general survey of the problems associated with Nigerian dependence on oil and the consequences of the international oil glut, see the Special Nigerian feature article in The Economist, Vol. 282, No. 7221, January 23, 1982.

CHAPTER 3

SOME MICRO FOUNDATIONS OF AN OIL ECONOMY

In this chapter, we employ very simple micro-economic tools in order to highlight some basic features of an oil-rentier economy. We conceive of the oil sector in this economy as an enclave in the sense that linkages between the sector and the rest of the economy are virtually non-existent, except in the sector's singular role as a source of external rent to the economy. The accruing rent is channeled to the economy through the government budget. Since the oil rent is collected in foreign exchange, the domestic expending of the accrued revenues by the government necessitates the domestic monetization of the foreign exchange counterpart of these revenues. Hence the channel through which oil rents impact on the other sectors of the economy is the domestic money market.¹

To simplify the discussion, assume that the non-oil sectors of the economy can be classified under two broad markets:²

(a) The Domestic Money Market

(b) The Goods Market

The goods market can, further, be subdivided into:

(i) The non-traded goods market, and

(ii) The internationally traded goods market.

Each of these markets can be represented by a set of demand and supply functions.

The Money Market

The demand for real money balances is a function of real non-oil income (y) ³, or

$$\left(\frac{M}{P}\right)^D = f(y) \quad f' > 0 \quad (3-1)$$

The supply of nominal money is determined outside the supply and demand framework by government budgetary decisions.⁴ Hence, nominal money supply is assumed here to be exogenously given, or

$$M^S = \bar{M} \quad (3-2)$$

Equilibrium in the domestic money market requires that,

$$M^D = M^S, \text{ or} \quad (8-3)$$

$$\bar{M} = P f(y) \quad (8-4)$$

Non-oil real income (y) is assumed to be fixed in the short-run and is given by the economy's fixed endowment of factors of production. Diagrammatically, we can characterize the money market by Figure 3-I.

On the Y-axis, we measure the domestic price level and on the X-axis, we measure the stock of nominal money. The exogenously given level of money supply is plotted as $\bar{M}$. The mm schedule shows the combinations of the price level and the stock of nominal money that will equilibrate the money market for any given level of real money demand. An increase (decrease) in the fixed level of real income will shift the mm schedule parallel to itself to the right (left).

The Non-Traded Goods Market

The fixed level of domestic non-oil output ($\bar{y}$) is allocated between the non-traded goods market and the traded goods market. The share allocated to each market is determined by the relative price between the two markets. Hence the supply of goods to the non-traded goods market is a function of non-oil output ($\bar{y}$) and the ratio of non-traded goods price to the price of traded goods, or

$$Q_S^{NT} = f_1\left(\bar{y}, \frac{P^{NT}}{P^T}\right), \quad f'_{11} > 0, \quad f'_{12} > 0 \quad (3-5)$$

The underlying assumptions in deriving (3-5) are first, that the economy under consideration operates under a fixed exchange rate regime;⁵ and second that domestic production consists of purely domestic goods (non-traded goods), whose prices are determined exclusively by domestic market conditions and traded goods, whose prices are determined largely by market conditions in the rest of the world.

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The aggregate demand for goods is determined by the domestic price level, the level of real income ($\bar{y}$) and the real excess supply of money (EX_m^S). This aggregate demand is made up of the demand for non-traded goods and the demand for traded goods. The allocation of the aggregate demand between the two types of goods depends on the relative price of both types of goods in terms of each other. Hence the demand for non-traded goods can be specified as,

$$Q_D^{NT} = f_2(\bar{y}, EX_m^S, \frac{P^{NT}}{P^T}), f_{21}' > 0, f_{22}' > 0, f_{23}' < 0 \quad (3-6)$$

Equilibrium in the non-traded goods market requires that,

$$Q_S^{NT} = Q_D^{NT} \quad (3-7)$$

Diagrammatically, the domestic goods market can be characterized as in Figure 3-II, where the demand curve is drawn for a given level of nominal money stock ($\bar{M}$).⁶

The vertical line denoted $\bar{y}_0$ is the fixed level of aggregate output. The function labelled S^{NT} is the supply curve of non-traded goods and D^{NT} is the corresponding demand curve. Hence at the relative price of p_0 , OQ_1^{NT} , of total output is the amount of non-traded goods sold and consumed domestically, and $Q_1^{NT}\bar{y}_0$ is the amount of traded goods produced both for domestic consumption and exports.

The Traded Goods Market

The world supply of traded goods to this economy is perfectly elastic. The total supply is made up of the domestic supply, which is identically equal to the difference between the fixed level of total domestic output ($\bar{y}$), and the quantity produced of non-traded goods, and the supply by the rest of the world.

The economy's demand for traded goods is some fraction of the total aggregate demand for goods. This fraction is determined by the relative price of traded goods to the price of non-traded goods. Hence, the demand for traded goods is a function of the level of real income ($\bar{y}$), the excess supply of real balances (EX_m^S), and the relative price of traded goods ($\frac{P^T}{P^{NT}}$), or

$$Q_D^T = f_3(\bar{y}, EX_m^S, \frac{P^T}{P^{NT}}), \quad f'_{31} > 0, \quad f'_{32} > 0, \quad f'_{33} < 0 \quad (3-8)$$

From the foregoing, the traded goods market can be represented diagrammatically as in Figure 3-III where once more the demand curve has been drawn for a given level of real income ($\bar{y}$) and a given level of nominal money stock ($\bar{M}$).

FIGURE 3-III

Equilibrium in this market requires that the balance of payments be in equilibrium. Under the assumption of exogenous capital flows, the non-oil balance of payments is determined by the volume of the domestic production of traded goods and the volume of the domestic consumption of these goods. More formally, the balance of payments condition can be expressed as,

$$Q_D^{T*} = Q_S^{T*} + \bar{K}_0 \quad (3-9)$$

where Q_D^{T*} and Q_S^{T*} are the domestic consumption and the domestic production of traded goods respectively. $\bar{K}_0$ is some fixed level of real capital flows:

It has to be recognized that our three markets are inter-related in a general equilibrium framework. Hence, the equilibrium situation in each of these markets has to be jointly determined. Before proceeding to analyze this interrelatedness, let us, by an appropriate choice of units, set the price of traded goods equal to unity. This is done without loss of generalization since this price is exogenous to this economy. Moreover, we introduce the simplifying assumption that, in the short-run, a fixed relationship exists between the price of non-traded goods and the domestic price level. Realize that the domestic price level can be represented as a weighted sum of the price of non-traded goods and the price of traded goods or,

$$P = P^{NT\lambda} P^T(1-\lambda) \quad (3-10)$$

Setting P^T equal to 1, we have,

$$P^{NT} = P \frac{1}{\lambda} \quad (3-11)$$

From (3-11), to simplify the diagrammatic exposition which follows, we approximate the price of non-traded goods by the domestic price level. This restrictive assumption will be dropped later in Chapter 4, where a formal analysis of the structure of domestic output is undertaken.

We can now analyze the three markets within one diagrammatic framework. Note, however, that since there are three markets, it suffices to carry out the analysis in terms of two of these mandates since equilibrium in two markets necessarily implies equilibrium

the third. Hence the general equilibrium analysis is carried out in terms of the money market and the non-traded goods market. First we extend Figure 3-II to incorporate the balance of payments equilibrium condition. This gives Figure 3-IV

The $bp = 0$ schedule is a locus of combinations of the relative prices of non-traded goods and output levels of non-traded goods that yield balance of payments equilibrium for some given level of capital flows. To see why the schedule is negatively sloped, let us start from some arbitrary balance of payments equilibrium position, such as point (A). Allow for an increase in the quantity of non-traded goods produced. Given a fixed level of aggregate output ($\bar{y}$), this implies a reduction of the level of output of traded goods. For a given level of demand for traded goods, a fall in their output level requires a fall in the quantities demanded of these goods if equilibrium in the balance of payments is to be maintained. To induce such a fall in the quantity demanded, the relative price of non-traded goods needs to fall, so as to induce

through the resulting substitution effect, the required fall in the quantity demanded of traded goods.

The analysis is represented graphically by Figure 3-V. Panel (a) is the earlier characterization of the money market. Panel (b) is the non-traded goods market, which is now extended to include a representation of the balance of payments condition.

FIGURE 3-V

Let us start from an initial general equilibrium situation, represented by E_{j1} ($j=a,b$). At this initial position, the stock of nominal money is $\bar{M}_1$. Given the supply of non-traded goods and the domestic demand for these goods, equilibrium in the non-traded goods market obtains at the domestic price level of P_1 . At this domestic price level, money market equilibrium is attained since desired nominal holding equals the stock of nominal money. At some given level of traded goods prices, the economy's traded goods market is in equilibrium in the sense that it can buy all the imports it desires and can sell all the exports it wishes to sell. Further, the economy's non-oil balance of payments account is in equilibrium.

Now, allow for an exogenous increase in the nominal money stock from $\bar{M}_1$ to $\bar{M}_2$. At the original price level (P_1), there is a real excess supply of money of $\bar{M}_1\bar{M}_2/P_1$ or a nominal excess of $\bar{M}_1\bar{M}_2$. Equilibrium in the money market requires a price level of P_2 or a reduction in the nominal money stock of $\bar{M}_1\bar{M}_2$ or a combination of a price increase and some reduction in the nominal money stock.

Under a fixed exchange rate regime, the Monetary Approach to the Balance of Payments provides the adjustment that leads to a restoration of equilibrium in the money market.⁷ Under long-run assumptions, the level of income is fixed and the domestic

price level is given by the world price level. Hence, the increased demand for goods generated by the real balance effect falls completely on imports. The increased quantity of imports, ceteribus paribus, leads to a deficit on the balance of payments. Since such deficits must, somehow, be financed, the economy's external reserves are drawn down by the amount of the deficit. This in itself leads to a reduction of the money supply, since external reserves constitute a part of the money base. Thus any disequilibrium-generating increase in the money supply must in turn lead to an outflow of that increase. It is in this sense that Monetarists argue that each country has its natural share of the world money supply in a world characterized by a fixed exchange rate system.⁸

While the foregoing represents the monetarist doctrine with regard to the long-run, it is recognized that in the short-run, a disequilibrium-generating increase in the money supply can lead to changes in both the domestic price level and the balance of payments.⁹

It should be obvious that the necessity to draw down external reserves in order to finance a current balance of payments deficit hinges on the presence of a binding external reserve constraint. In the case of OPEC countries (or any other rentier economy for that matter, where the rent accrues in foreign exchange), the need to finance a non-oil (or non-rent) balance of payments from past accumulated external reserves is no longer present, as long

as the current deficit is not greater than the current accruing rent. Under these circumstances, independent increases in the domestic money supply can be sustained, not just in the short-run but for a protracted length of time as long as a sufficiently large enough flow of rent continues to accrue in foreign exchange. For some time, this has been the case in OPEC economies and hence, it is both relevant and interesting to analyze the adjustment process that characterizes these economies when they are subjected to disequilibrium-generating increases in domestic money supply. We return now to the increase in money supply from $\bar{M}_1$ to $\bar{M}_2$.

Through equations (3-6) and (3-8), the excess supply of money of $\bar{M}_1\bar{M}_2$ leads to increases in the demand for non-traded goods and traded goods, or shifts in the demand curves for non-traded goods and traded goods to D_2^{NT} and D_2^T respectively. The non-traded goods market clears at a price of P_3 . At a domestic price level of P_3 , however, the domestic money market is in disequilibrium. There is an excess supply of nominal money of $\bar{M}_2\bar{M}_2$ or a real excess supply of $\bar{M}_2\bar{M}_2/P_3$. The traded goods market is also in disequilibrium since the real value of domestic consumption of traded goods exceeds the sum of the real value of the domestic production of these goods and the fixed real value of capital flows ($\bar{K}_0$).

Since at P_3 , the domestic goods market is in equilibrium, there is nothing in the system generating pressures on the domestic price level to change from P_3 . In the standard case of an economy operating under a fixed exchange rate regime, the factors propelling the system back to a general equilibrium is as follows. The deficit on the balance of payments is financed from the existing stock of the economy's external reserve holdings. This draw-down of external reserves, by reducing the money base, leads to a reduction in the stock of nominal money. This process must continue until there has been a reduction (an outflow) of $\bar{M}_1 \bar{M}_2$ of the nominal money stock. Thus, given an initial disequilibrium-generating increase in the money supply of $\bar{M}_1 \bar{M}_2$, after the outflow of this increase in the money supply, the domestic price level returns to its original level of P_1 .

Now consider the adjustment process in an OPEC (or any other rentier) economy. In this economy, there is no short-run external reserve constraint. With a domestic price level of P_3 , the non-oil balance of payments deficit can be financed from current oil revenues accruing in foreign exchange. Hence, the deficit does not lead to a draw-down of external reserves and the disequilibrium-generating increase in money supply can be sustained. Under such

circumstances, the non-oil economy can be out-of equilibrium, in the general equilibrium sense, for a protracted length of time as long as ample flows of oil rents continue to accrue in foreign exchange. Thus the situation in this economy is characterized by an excess supply of real money balances (in the sense that economic agents are off their demand curves for real money) which is offset in every period by an equi-proportional excess demand for traded goods. We can refer to this situation as a quasi-equilibrium since the sum of excess demands (supplies) in all markets is equal to zero. Changes over time in the value of the offsetting excess demands and supply will show up as changes in the domestic price level and the value of the balance of payments deficit.

Summary and Conclusion to this Chapter

To summarize the discussion thus far, let us recapitulate the main conclusions derived in this chapter. Under a fixed exchange rate regime, assuming the absence of a short-run external reserve constraint, this chapter has derived a quasi-equilibrium in which the domestic price level, unlike in the conventional framework of the Monetary Approach to the Balance of Payments, is affected by changes in the domestic money supply. Such changes in the money supply, have been shown to affect, in addition to the domestic price level, the balance of payments and the composition of domestic output between non-traded goods and traded

goods. The finding that economic agents can be off their demand curves for real money for a protracted length of time suggests that the empirical form of the demand for money function, in such economies, cannot be ascertained.¹⁰ This is so because in the absence of equilibrium in the money market, the supply of money can no longer be interpreted as an indication of the quantity of money demanded.

On the basis of the derived conclusions in this chapter, we proceed to undertake a formal analysis of the impact of oil revenues on the structure of domestic output in Chapter 4. Following this, in Chapter 5, we develop a simple testable macro-model to test the conclusion that domestic money supply affects both the domestic price level and the non-oil balance of payments.

FOOTNOTES TO CHAPTER 3

1. We abstract, here, from the impact of direct government purchases on sectoral demand.
2. It is assumed here that money is the only asset in this economy.
3. The concept of non-oil income is employed since it is assumed that oil exports do not affect private incomes.
4. For a detailed specification of the relationship between the government budget and the domestic money supply, see Chapter 5.
5. The analysis in this dissertation is confined to the case of a fixed exchange rate regime.
6. Given $Q_D^{NT} = f(y, EX_m^S, \frac{P^{NT}}{P^T})$, the relationship can be specified such that,

$$Q_D^{NT} = g(y, M, P^{NT}, P^T), \text{ since}$$

$$EX_m^S \equiv M/P = \alpha_0 y^{\alpha_1} \quad \text{and} \quad P = P(P^{NT}, P^T).$$
7. For a representative collection of articles, both theoretical and empirical, on the Monetary Approach, see Frenkel and Johnson (1976). For analysis incorporating non-traded goods, see Dornbusch (1980), Chapters 5 and 6.
8. A formalization of this Monetarist position is provided by Mundel (1971), pp. 147-169.
9. See for example, Blejer (1977).
10. The concept of monetary disequilibrium here has to be distinguished from the concept of disequilibrium on the basis of which a distinction is drawn between the short-run and long-run demand for money. For a detailed review of studies involving the latter type, see White (1981).

Chapter 4

The Impact of Oil Revenues on the Structure of Domestic Output: A Theoretical Analysis

One conclusion derived in Chapter 3 is that the accrual of oil rents, when monetized, will allow the economy to consume more than its current production of traded goods. In order to satisfy its increased demand for non-traded goods, it was shown that the economy will increase its production of these goods at the expense of traded goods. Hence, a continuing flow of oil rents will generate structural shifts in production in favour of non-traded goods. In this chapter, a formal analysis of the impact of oil revenues on the domestic structure of production is undertaken.

Diagrammatic Analysis

Assume that there are two non-oil commodities produced by our economy, using two factors of production. The two commodities are, respectively, traded goods (T) and non-traded goods (NT). Labour (L) and capital (K) are combined to produce each output. Our economy is endowed with a fixed amount of labour ($\bar{L}$) and capital ($\bar{K}$). The output of non-traded goods is traded, exclusively, in the domestic market, while the output of traded goods is traded internationally. Under these assumptions, and further assuming our economy to be small, the price of traded goods that our economy faces is

exogenously given by world market conditions.¹ On the other hand, the price of non-traded goods is endogenously determined by domestic market conditions.

Given the fixed endowment of the economy's factors of production, the attainable combinations of the output of both commodities can be represented by a production possibilities frontier (PF in Figure 4-1).² In the absence of oil revenues, the economy's consumption is constrained by its non-oil income. Hence, the consumption equilibrium must lie on the production possibilities frontier. This requirement follows from the condition for balanced trade. Note that the domestic production of traded goods can be traded for the foreign production of these goods, as long as the overall domestic consumption equals the domestic production. Given the price of traded goods determined by world market conditions, domestic market conditions determine the price of non-traded goods. These two prices give the relative price ratio p_0 . At this relative price ratio, the goal of profit maximization requires that domestic producers produce the combination of both commodities represented by the point C_0^*, P_0^* . At this combination of the outputs of both commodities, domestic producers equate their marginal rate of transformation between the two goods to the relative price ratio. The goal of utility maximization also requires that domestic consumption takes place at C_0^*, P_0^* , since at this combination of the two

commodities the marginal rate of substitution between the two commodities, in consumption, is equal to the relative price ratio, p_0 . Thus in the absence of oil revenues, the domestic economy is in equilibrium at $C_0^*P_0^*$.

Now, allow for oil revenues (or a cash gift in foreign exchange). A fraction (γ) of these revenues, whose value in real terms, measured in terms of traded goods, is equal to CP ($=LF$) is spent to finance current consumption. Since oil production is assumed not to employ any domestic factors of production, the production possibilities frontier of the economy remains at PF . However, the real consumption of the economy can now exceed the real value of domestic non-oil income. Given the accrued oil rents, the consumption locus (absorption frontier) or consumption possibilities frontier is now represented by CL . At the initial relative price ratio p_0 , domestic residents desire a consumption bundle represented by point B' . However, the consumption bundle consistent with balanced trade requirement is represented by point B . Point B is the intersection point between OE (the income consumption curve, or Engel curve, drawn for the constant relative price ratio, p_0) and CL , the absorption frontier.³ In the short-run, however, the domestic production of non-traded goods is fixed at ONT_1 . Hence, in the short-run and at the relative price of p_0 , an excess demand for non-traded goods, equal to DB and an excess supply of traded goods equal to AD develop. This excess demand exerts an upward pressure on

the price of non-traded goods, until the market clears at point A. At this point, the relative price of non-traded goods has risen to p_1 . At a relative price of p_1 , the economy maximizes its utility (given its previous production level) since the marginal rate of substitution is equated to the relative price ratio of the two commodities. On the production side, however, the output combination (C_0^*, P_0^*) of the two commodities is no longer a profit maximizing combination since the marginal rate of transformation is less than the relative price ratio ($p_1' = p_1$) between the two commodities. Hence, in the long-run, the production of non-traded goods must increase at the expense of traded goods. By how much will the production of non-traded goods increase? To answer this question, recall that at a relative price ratio of p_0 , the long-run consumptive optimum consistent with balance of trade equilibrium is represented by point B. For the demand for non-traded goods to be satisfied at point B, domestic production must shift to point P_1 . However, at a constant relative price of p_0 , this is inconsistent with the profit maximizing decisions of firms. Hence the equilibrium-sustaining relative price ratio must lie between p_0 and p_1 . Such an equilibrium price ratio is p_2 . At this price ratio, demand is at C_1^* and production is at P_1^* . Thus, the domestic market is in equilibrium. The new equilibrium, as compared to the initial equilibrium (C_0^*, P_0^*) , is characterized by an increase in the production of non-traded goods of $NT_1^{NT_2}$.

and a compensating decrease in the output of traded goods of $T_1 T_2$. Notice that the marginal rate of substitution and the marginal rate of transformation are now both equal to p_2 . A non-oil balance of trade deficit of $P_1^* C_1^*$, in terms of the traded commodity, develops.

To conclude this section, notice that the foregoing conclusions can also be derived for incremental changes in oil revenues. A mathematical analysis of this case is undertaken in Appendix 4-I.

Structure of Output When Some Oil Revenues Are
Used to Finance Capital Accumulation

The analysis, thus far, is based on the assumption that oil revenues are used, exclusively, to finance current consumption. An alternative scenario is one in which such revenues are used to finance partly current consumption and partly, capital accumulation.⁴ To attain an insight into the impact of oil revenues in this scenario, assume that some percentage (d) of such revenues is spent on the importation of capital equipment and the remaining percentage ($1-d$) of the revenues is spent on current consumption. To examine the effect of increased capital stock, financed by a part of oil revenues, on the structure of domestic production, a distinction is made between two cases. In case one, we analyze such effects under the assumption that at any set of relative prices, the production of the non-traded commodity is characterized by relatively higher capital-labour ratio when compared to the production of the traded commodity. In case two, the analysis is carried out under the alternative assumption that the production of the traded good is always more relatively capital-intensive.

Case I: Production of Non-Traded Goods is Capital-Intensive

The impact of oil revenues on the structure of domestic output can be broken down into two. First, the impact of capital accumulation on the structure of output can be examined. Secondly, we can analyze the impact of increased current consumption, financed by a fraction of oil revenues, on the structure of output. These analyses are carried out with the help of Figure 4-II.

In the absence of oil revenues, the economy's production possibility frontier is PF. Production and consumption equilibrium obtains at point A_0 . Now, allow for the accrual of some amount of oil revenues, a fraction (d) of which is used to finance the importation of capital. The increase in the economy's stock of capital shifts the production possibility frontier out to $P'F'$. At the initial equilibrium relative price ratio (p_0), by the Rybczynski theorem, domestic producers wish to produce a bundle of output represented by some point which must be to the right of R.⁵ At this same relative price ratio, however, domestic demand expands along A_0E_0 (an Engel curve drawn for the relative price of p_0). Hence, there is an excess supply of non-traded goods. The excess supply of non-traded goods bids down their relative price until at p_1 , both production and consumption are in equilibrium at point A_1 .

Now, allow for the possibility of increased current consumption made possible by the expending of the remaining fraction $(1-d)$ of oil revenues. The consumption locus now becomes $C'L$. By our earlier analysis with respect to Figure 4-I, consumption equilibrium will occur at some point in the range B_1C_2 . This defines the range for production equilibrium as A_1A_2 . To determine the changes in the levels of the production of both commodities, realize that the consumption and production ranges defined above can each be decomposed into two ranges. Decompose the consumption equilibrium range into B_1C_1 and C_1C_2 and the production equilibrium range into A_1R and RA_2 . If consumption equilibrium is realized in the range of B_1C_1 , and hence production equilibrium obtains in A_1R range, the absolute levels of the domestic production of both goods will increase. Even in this case, however, the share of non-traded goods in total production will rise and the share of traded goods will fall.⁶ Consider the alternative, where consumption equilibrium takes place in C_1C_2 range. In this case, production equilibrium obtains in the range of RA_2 . Hence, the domestic production of the non-traded goods will rise both in terms of their share in total production and in their absolute production levels, while correspondingly, the output of traded goods will fall on the two counts. The relevant question is, what determines the range in which equilibrium takes place? The equilibrium-sustaining range is determined, for any given supply and demand

patterns, by the fraction $(1-d)$ of oil revenues allocated to current consumption. The higher (lower) is this fraction, the more likely the possibility of equilibrium occurring in the $RA_2(A_1R)$ range. To appreciate this, take the two extreme cases, where the fraction of revenues spent on current consumption is either one or zero. When a hundred percent of the revenues is spent on consumption, equilibrium requires a fall in the absolute level of traded goods produced and an increase in the absolute level of non-traded goods produced. This corresponds to the RA_2 range. Under the alternative extreme, where none of the revenues is used to finance current consumption, the resulting capital accumulation will generate a new equilibrium where the absolute levels of the two goods produced will increase. This corresponds to the range of A_1R . Thus, by some appropriate choice of the value of d , equilibrium can be constrained to take place at whichever range is desirable.

Case II: Production of Traded Goods is Capital-Intensive

Under the alternative assumption that the production of traded goods is characterized by relatively more capital-intensive techniques as compared to the production of non-traded goods, the impact of capital accumulation, financed by oil revenues, on the domestic structure of production can be analyzed with the aid of Figure 4-III.

Once more, PF is the production possibilities frontier in the absence of oil revenues. Production and consumption equilibrium is at A_0 . The slope of the straight line $A_0\bar{S}$ measures the ratio of traded goods produced to non-traded goods at this equilibrium. First, consider an increase in the capital stock which is made possible by the expending of a fraction (d) of oil revenues. The increase in capital stock shifts out the production possibilities frontier to $P'F'$. At the initial equilibrium relative price ratio (p_0) , equilibrium in production must be to the left of point P_1 by the Rybczynski theorem.⁷ Demand, however, is represented by point C_0 . Hence an excess demand for non-traded goods bids up its relative price until, say at a relative price of p_1 , equilibrium is restored at point A_1 . At the new equilibrium, the production of both goods have increased. Note however, that it is not possible to determine unambiguously what has happened to the share of traded goods in total production, since the equilibrium-sustaining relative price ratio may be the one tangent to the production possibilities frontier in the range bounded by P_1 and C_0 . If equilibrium takes place in the range of P_1S_0 , the share of non-traded goods falls and if equilibrium occurs in the range of S_0C_0 , the share of non-traded goods rises. The range in which equilibrium takes place depends on the relative magnitudes of the price elasticities of demand and supply.

Now, allow for the expending of the remaining fraction of oil revenues on current consumption. The consumption locus (absorption frontier) becomes $C'L'$. By our earlier reasoning, consumption equilibrium will take place at some point between C_1 and C_2 . Hence, production will take place somewhere between A_1 and P_2 . This range for production equilibrium can be decomposed into the following smaller ranges: A_1S_0 , S_0P_0 and P_0P_2 . If equilibrium is in the A_1S_0 range, the amount produced of each commodity rises, but the share of the non-traded commodity in total production falls. In the S_0C_0 range, the level of output of each sector also increases, but the share of the non-traded goods sector in total production also increases. Finally, if equilibrium is in the range of P_0P_2 , both the level of output and the share in aggregate output of the non-traded goods sector declines.

The range in which equilibrium occurs, for any given value of d , depends on the relative values of the price elasticities of supply and demand. If the demand for non-traded goods is very elastic and the supply is highly inelastic, equilibrium occurs in the A_1S_0 range. On the other hand, if the demand is highly inelastic and the supply is highly elastic, equilibrium takes place in the range of P_0P_2 . For a combination of some intermediate values of the elasticities of supply and demand, equilibrium takes place in the intermediate range of S_0P_0 .

In the diagrammatic analyses undertaken in this chapter, it has been implicitly assumed that community tastes are biased in favour of non-traded goods (see the shape of the Engel Curves). That our conclusions, however, are not contingent on this assumption, is demonstrated in Appendix 4-II, where the same conclusions are derived under the assumption of homothetic tastes.

The foregoing analyses suggest that in an oil exporting economy, there is a strong tendency for domestic production to become increasingly biased in favour of non-traded goods. From the point of view of development, such a bias may be undesirable because when oil resources run out, such an economy will be faced with the grim prospects of a painful readjustment of its production structure and the attendant reallocation of productive resources which this entails.

Application to Nigeria

In the context of the Nigerian economy, such problems are further confounded by the rural-urban distribution of economic activities. The traded goods sector (consisting largely of agriculture) is concentrated mainly in the rural areas, while the non-traded goods sector (consisting mainly of services) is almost exclusively located in the urban areas.⁸ Given this pattern of economic geography, the analyses undertaken in this chapter suggest that the oil boom scenario,

which has characterized the economy since the early seventies, will lead to a concentration of an increasing percentage of the active work force in the urban areas. In these circumstances, a slack in the buoyancy of the oil sector could lead to grave social and economic upheavals in the urban areas. Even while such buoyancy is maintained, short-run constraints on the supply of urban social infrastructure could, by themselves, generate the same pattern of urban social problems.

Recent Nigerian experience conforms largely with the broad conclusions of our analyses.⁹ However, the dearth of appropriate data does not allow for a systematic test of these conclusions. Hence, to conclude this chapter, we undertake a heuristic review of the Nigerian evidence with regard to the theoretical conclusions derived earlier in this chapter.

With regard to the composition of aggregate output, there is no comprehensive data on the breakdown of output between traded and non-traded goods. As an approximation, we derive a breakdown of non-oil GDP according to the following classification:¹⁰

Traded Goods

Agriculture
Forestry
Fishing
Mining (other than
Petroleum)
Manufacturing and Crafts

Non-Traded Goods

Public Utilities
Building and Construction
Distribution
Transport and Communication
General Government
Education, Health and Other Services

On the basis of this breakdown, the share of traded goods in total non-oil GDP declined from 59 per cent in 1970 to 45.7 per cent in 1975, while the share of non-traded goods increased from 41 per cent to 54.3 per cent. It can be argued however that the growth in the government sector, which increased oil revenues have brought about, may be responsible for the growth of non-traded goods. The data does not support this view, however, since the share of non-traded goods, excluding Government Services, increased from 30.6 to 41.3 per cent in the period under review. While the unavailability of more recent detailed National Accounts data prevents us from determining the corresponding shares for post 1975 years, the evidence that does exist indicates that the trend indicated above has continued. On the basis of provisional 1977 data, the share of traded goods further declined to 38.3, while the non-traded goods share rose to 61.6, with the share of general government of 11.6 per cent. The situation in 1970 and 1975 is summarized in Table 4-I.

With regard to Table 4-I, two observations are in place here. First, the decline in the share of traded goods is due largely to the shrinkage of the agricultural sector. This is in spite of increasing subsidies to this sector through administered prices.¹¹ The performance of selected agricultural commodities is summarized in Table 4-II. Secondly, the period is characterized by reasonable increases

in the output of the manufacturing sector. This is due mainly to the high degree of protection accorded this sector as part of the overall strategy of import-substitution. Such protection - which in some cases takes the form of outright bans on the importation of competing imports - allows prices in this sector to be determined as if they were non-traded good prices.

Table 4-I

GDP AT PRODUCERS' VALUES (CONSTANT 1962 PRICES)

Sectoral Classification	Percentage Shares	
	1970	1975 ⁴
Agriculture, Fisheries	49.3	32.1
Mining and Quarrying (excluding Petroleum)	1.2	1.9
Manufacturing and Crafts	8.5	11.7
Total Traded Goods	(59.0)	(45.7)
Electricity, Gas and Water	0.7	1.1
Construction	7.2	12.9
Wholesale and Retail Trade	13.8	14.0
Transportation, Storage and Communication	3.7	6.0
Finance, Insurance and Other Services	5.2	7.3
Total Non-Traded Goods (excluding Government Services)	(30.6)	(41.3)
Government Services	10.4	13.0
Total Non-Traded Goods	(41.0)	(54.3)
	100.0	100.0

Source: Computed from data in United Nations, Yearbook of National Accounts Statistics, 1978.

Table 4-II

PERCENTAGE CHANGE IN PRODUCTION OF SELECTED
COMMODITIES (1971-1979)

Commodity (Metric Tons)	Percentage Change
Groundnuts (in shell)	-62.6
Seed Cotton	-40.5
Cotton lint	-30.6
Palm Kernels (1971-1978)	-16.7
Cocoa Beans	-31.0
Aggregate Production Index of Export Crops (1971-1977)*	-36.8

*Central Bank of Nigeria, Annual Report and Statement of
Accounts (Various Issues).

Source: F.A.O., Production Yearbook, Vol. 33, 1979.

Summary and Conclusion to this Chapter

In this chapter, the implications of the expending of oil revenues on the domestic structure of output has been analyzed. The major conclusion derived is that the spending of such revenues will lead to an increasing concentration of domestic production in the non-traded goods sector of the economy. A cursory examination of Nigerian evidence conforms to this conclusion. From the point of view of overall development and long-term stable growth, the resulting pattern of biased production could become problematic when oil revenues run out.

Finally, for an economy like Nigeria, the findings in this chapter are of significance since any countervailing policies need to be based on a proper understanding of the theoretical basis of the shift in productive resources away from the traditional prime-moving sectors of the economy like agriculture and into the services and other non-traded goods sectors.

The analysis in this chapter, further suggests that increasing oil revenues will exert an upward pressure on the prices of non-traded goods. Such pressure is inimical to a goal of a stable domestic price level. We move on now to chapter 5, where a simple macro model will be developed to analyze, among other things, the determinants of the domestic price level.

Footnotes to Chapter 4

1. When OPEC is considered collectively, the demand of members for traded goods may be significant enough to affect their prices in the world market. The rationale for the small country assumption here is that our analysis is for one OPEC member rather than for the collective members of the organization. Furthermore, we abstract from trade taxes and other policy-induced restrictions on trade which could allow the domestic prices of traded goods to diverge from their world prices.
2. For simplicity, it is assumed that oil is produced exclusively by foreign factors of production, so that changes in its output levels do not affect the production possibilities frontier drawn for the non-oil sectors.
3. Implicit in the shape of OE is the assumption that community tastes are biased in favour of non-traded goods. See appendix 4-II for a relaxation of this assumption.
4. This is, probably, a closer approximation of the situation in most OPEC countries. Also note, however, that oil revenues could also be invested abroad and the domestic economy consuming indefinitely the stream of their capitalized value.
5. See Rybczynski (1955).
6. This is so because any point in the equilibrium-sustaining range, A_1A_2 , necessarily lies to the right of the straight line from the origin and passing through point A_0 .
7. Rybczynski (1955).
8. For example, unpublished world bank estimates indicate that in 1966-67, traded goods accounted for 88.5 per cent of gainful employment in the rural areas, while the corresponding figure for urban areas was 42.8 per cent. The estimate for 1974 (available only for the urban areas) indicates that the contribution of traded goods to gainful employment had dropped to 29.5 per cent.

9. For a summary of similar evidence for Saudi Arabia, see Alam (1982), for some other OPEC countries, see Nankani (1979) and for Britain in relation to North Sea Oil, see Corden (1981).
10. This breakdown is at best a crude approximation since in the absence of adequate preservation methods, easily perishable agricultural crops are really non-traded and restrictive trade practices with respect to some manufactured goods turn them into non-traded goods.
11. Since the seventies, administered prices have usually been set higher than world prices to encourage domestic producers.

Chapter 5

Derivation of A Macro-Model

The discussion in Chapter 3 has highlighted the argument that in economies without a binding reserve constraint in the short-run, a quasi equilibrium can be derived in which there exists a non-zero excess supply of money balances. In other words, agents can be off their demand curve for money, as long as their excess demand for monetary assets is offset by an equi-proportional excess supply of goods and vice versa.

The aim in this chapter is to develop a simple macro model that is consistent with this conclusion. Although the analysis in Chapters 3 and 4 has been based on the explicit distinction between traded and non-traded goods and their prices, the model developed in this chapter shifts away from this explicit distinction. This is necessitated by constraints imposed by data availability. For example, concise time series data on the outputs and prices of traded and non-traded goods are not collected. Since the aim in this chapter is to present a model that can be applied empirically, the model has been developed in terms of aggregate price and output levels. The economy visualized here is a very simply one. There is only one asset (money) and one output.¹ The production of this output (y) is exogenously given by the productive resources of the economy. The economy is endowed with a second resource, oil. Oil is produced exclusively by foreign factors of production, such that output of y is not affected by the amount of resources committed to oil production.² The output of oil is exported to the rest of the world and the domestic economy receives a rent per unit of oil produced and exported. This per unit rent is exogenously determined, and is paid in foreign exchange to the domestic government.³

It is assumed that the foreign exchange counterpart of the oil revenues accruing to the government is automatically sterilized by the monetary authorities.⁴

Under these assumptions, the channel through which oil revenues are transmitted to the domestic economy is the government budget.⁵ To see this clearly, a distinction will be made between the domestic component of the government budget and its foreign component. The components of the model are developed as follows.

Money Supply

Changes in the domestic money stock arise from any or a combination of the following:⁶

- (a) Imbalance in the government domestic budget which is financed by either the monetization of the foreign reserve counterpart of oil revenues or borrowing from the domestic banking system. A third alternative for financing such imbalance is domestic borrowing from the non-bank public. This option, however, does not lead to changes in the money supply.
- (b) Changes in the net unclassified assets of the banking system will be transmitted into changes in the money supply since such changes represent direct changes in the money base.
- (c) Finally, fluctuations in the banking system multiplier will affect the money supply.

With the above in mind, the following identity holds:

$$\Delta M^S \equiv a[(GDD) + (\Delta CP')], \quad (5-1)$$

where M^S is money supply; 'a' is banking system multiplier; GDD is the government domestic deficit; CP' is the net unclassified assets of the banking system. All the variables on the right hand side of (5-1) are exogenously determined, except for GDD which is endogenous.

From (5-1)

$$M_t^S = M_{t-1} + a_t[(GDD_t) + (\Delta CP'_t)]. \quad (5-2)$$

Since the identity represented by (5-2) is non-linear in variables, its use will introduce non-linearities in the overall model. To avoid this, (5-2) is approximated by a log-linear relationship as follows:⁷

$$\begin{aligned} \log M_t^S &= K_0 + K_1 \log M_{t-1} + K_2 \log[a_t((GDD_t) + (\Delta CP'_t))] \\ &= K_0 + K_1 \log M_{t-1} + K_2 \log a_t + K_2 \log[GDD_t + \Delta CP'_t] \\ &= K_0 + K_1 \log M_{t-1} + K_2 \log a_t + K_2[h_0 + h_1 \log GDD_t \\ &\quad + h_2 \log \Delta CP'_t] \end{aligned} \quad (5-2')$$

or

$$\begin{aligned} \log M_t^S &= K_0 + K_1 \log M_{t-1} + K_2 \log a_t + K_2 h_0 + K_2 h_1 \log GDD_t \\ &\quad + K_2 h_2 \log \Delta CP'_t \end{aligned} \quad (5-2'')$$

(5-2'') remains an identity since the K's and h's are known and fixed values. For the derivation and computation of the K's and h's see appendix 5-I.

The Government Domestic Deficit

Consider the long-run budget constraint of the government:

$$GR = GE \quad (5-3)$$

where GR and GE are government revenues and expenditures respectively. Decomposing revenues and expenditures into domestic and foreign components, (5-3) can be written as:

$$GR^d + GR^f = GE^d + GE^f \quad (5-4)$$

where the upper case letters 'd' and 'f' indicate 'domestic' and 'foreign' respectively.

Rearranging the terms, we have

$$GE^d - GR^d = GR^f - GE^f \quad (5-5)$$

From (5-5), it is obvious that an overall balanced budget policy is consistent with a deficit or surplus in the domestic component of the budget.

In the short-run, however, the long-run overall budget balance requirement need not hold since the government can augment its revenues by deficit financing. The sources of such deficit financing are borrowing from the domestic non-bank public, the domestic banking sector and foreign sources. Hence the short-run budget requirement is:

$$GR + GE_N^d + GB_B^d + GB^f = GE \quad (5-6)$$

where GB is government borrowing and the lower case letters N and B are 'non-bank' and 'bank' respectively.

From (5-6)

$$GE^d - GR^d - GB_N^d = GR^f - GE^f + GB_B^d + GB^f \quad (5-7)$$

The left hand side of (5-7) is the amount of the domestic deficit which affects domestic money supply. Hence,

$$GDD = GE^d - GR^d - GB_N^d \quad (5-8)$$

Taking the log of (5-8), we have

$$\log GDD = \log(GE^d - GR^d - GB_N^d) \quad (5-8')$$

(5-8') can again be approximated by the following transformation:

$$\log GDD = W_0 + W_1 \log GE^d - W_2 \log GR^d - W_3 \log GB_N^d \quad (5-8'')$$

which remains an identity since the W's are fixed and known values.⁸

Since the two identities (5-2) and (5-8) have been transformed to be linear in logs, the remaining part of the model can be set out in logs.

In (5-8''), whereas GB_N^d is assumed to be exogenously determined, GE^d and GR^d are endogenous. We therefore require behavioural equations to explain GE^d and GR^d . We turn now to the determination of government domestic expenditures.

Government Domestic Expenditures

Desired domestic expenditures, (GE^{d*}) are posited to depend on the total revenues of the government, which is made up of domestic revenues and the exogenously given level of oil revenues (OR) according to equation (5-9).

$$\log GE^{d*} = g_0 + g_1 \log[GR^d + OR], \quad g_1 > 0 \quad (5-9)$$

The implicit assumption here is that the government desires to balance its budget in the long-run. However, due to lags in the execution of government projects, the change in the actual level of domestic expenditures is given by the following adjustment process.⁹

$$\Delta \log GE^d = v[\log GE^{d*} - \log GE_{t-1}^d], \quad 0 < v < 1 \quad (5-10)$$

Writing the $\log(GR^d + OR)$ as $q_0 + q_1 \log GR^d + q_2 \log OR$ and substituting (5-9) in (5-10), we obtain,

$$\begin{aligned} \log GE^d &= (vq_0 + vq_1 q_0) + vq_1 [q_1 \log GR^d + q_2 \log OR] \\ &\quad + (1-v) \log GE_{t-1}^d \end{aligned} \quad (5-11)^{10}$$

Government Domestic Revenues

Domestic revenues are a function of the value of domestic (non-oil) income.

$$\log GR^d = r_0 + r_1 [\log y + \log P], \quad r_1 > 0 \quad (5-12)$$

Domestic Price Level

Starting from the equilibrium condition in the money market,

$$\frac{M^S}{P} = m^D \quad (5-13);$$

real money demand (m^D) is a function of real domestic income.

The view adopted here is one where the demand for real balances is purely a transactions demand since by assumption, money is the only asset held. Hence (5-13) can be written as:

$$\frac{M}{P} = \alpha_0 Y^{\alpha_1} \quad (5-14).$$

Since as already argued, agents can be off their demand curve for money for a protracted amount of time, the concept of a money demand function can only be meaningfully interpreted as a function describing the amount of money agents desire to hold. Since equilibrium does not necessarily hold, the empirical form

of the demand function cannot be determined. In these circumstances, the money market condition determines the price level.

From the analysis in Chapter 3, the domestic price level is a weighted sum of the price of non-traded goods (P^{NT}) and the price of traded goods (P^T). This is represented as,

$$\text{Log} P = \lambda \log P^{NT} + (1-\lambda) \log P^T \quad (5-15),$$

where ' λ ' is the share of non-traded goods in aggregate production. Notice, however, that in the spirit of the analyses in Chapters 3 and 4, ' λ ' is itself a variable determined in the model. However, in order to facilitate the operationalization of the model, ' λ ' is treated here as a constant to be estimated. Thus the value of ' λ ' is approximated by its average value in the sample period.

The relative price of non-traded goods is posited to depend on the state of disequilibrium in the domestic money market according to,

$$\frac{\log P^{NT}}{P^T} = b_0 + b_1 \log EX_m^S, \quad b_1 > 0 \quad (5-16),$$

where EX_m^S is the excess supply of real money balances and is identically equal to $[(M/P)/m^D]$.

Hence,

$$\log P^{NT} = b_0 + b_1 [\log M - \log P - \log \alpha_0 - \alpha_1 \log y] + \log P^T \quad (5-17)$$

Substituting (5-17) into (5-15) and recalling from Chapters 3 and 4 that the price of traded goods (P^T) is exogenous to our economy, we obtain:

$$\log P = (b_0 - \lambda b_1 a'_0) + \lambda b_1 \log M - \lambda b_1 \log P - \lambda b_1 a_1 \log y + \log P^T \quad (5-18), \text{ or}$$

$$\log P = \frac{\lambda b_0 - \lambda a_0 b_1}{1 + \lambda b_1} + \frac{\lambda b_1}{1 + \lambda b_1} \log M - \frac{\lambda b_1 a_1}{1 + \lambda b_1} \log y + \frac{1}{1 + \lambda b_1} \log P^T \quad (5-19)$$

Non-Oil Balance of Trade

We assume that capital flows in this economy are exogenously determined. Since oil exports are also exogenously given, we can focus on the non-oil balance of trade. It is posited that the non-oil balance of trade is determined by the level of real income and the excess supply of real money balances according to:

$$\log BT = \beta_0 + \beta_1 \log y + \beta_2 \log [EX_m^S], \quad \beta_1 < 0, \beta_2 < 0 \quad (5-20)$$

or

$$\log BT = (\beta_0 - \beta_2 a'_0) + (\beta_1 - \beta_2 a_1) \log y + \beta_2 [\log M - \log P] \quad (5-21)$$

An examination of the balance of trade (non-oil) data for the period under study shows that it was always in deficit. Since the log of a negative value does not exist, (5-21) is respecified in terms of the balance of trade deficit, BTD_t , to facilitate empirical application. This results in the following equation:

$$\log BTD_t = (\beta_0 - \beta_2 \alpha'_0) + (\beta_1 - \beta_2 \alpha'_1) \log y_t + \beta_2 [\log M_t - \log P_t] \quad (5-22)$$

where now, $\beta_1 > 0$ and $\beta_2 > 0$.

The Complete Model

The equations that make up the complete model can now be reproduced as follows:

$$\log M_t^S = (K_0 + K_2 h_0) + K_1 \log M_{t-1} + K_2 \log a_t + K_2 h_1 \log GDD_t + K_2 h_2 \log \Delta CP_t \quad (5-23)$$

$$\log GDD_t = w_0 + w_1 \log GE_t^d - w_2 \log GR_t^d - w_3 \log GB_N^d \quad (5-24)$$

$$\log GE_t^d = (vg_0 + vg_1 q_0) + vg_1 [q_1 \log GR_t^d + q_2 \log OR_t] + (1-v) \log GE_{t-1}^d \quad (5-25)$$

$$\log GR_t^d = r_0 + r_1 [\log y_t + \log P_t] \quad (5-26)$$

$$\log P_t = \lambda \frac{b_0 - b_1 \alpha'_0}{1 + \lambda b_1} + \frac{\lambda b_1}{1 + \lambda b_1} \log M_t - \frac{\lambda b_1 \alpha'_1}{1 + \lambda b_1} \log y_t + \left(\frac{1}{1 + \lambda b_1} \right) \log P^T \quad (5-27)$$

$$\log BTD_t = (\beta_0 - \beta_2 \alpha'_0) + (\beta_1 - \beta_2 \alpha'_1) \log y_t + \beta_2 [\log M_t - \log P_t] \quad (5-28)$$

The above model consists of two identities (5-23) and (5-24) and four behavioural equations to solve for six unknowns (the endogenous variables). To appreciate the workings of the model, allow for an exogenous increase in the value of oil revenues. From equation (5-25), such an increase leads to an increase in the value of government domestic expenditures. At the original

level of government domestic revenues and domestic non-bank borrowing, such an increase triggers an increase in the level of government domestic deficit through equation (5-24). The higher level of the domestic deficit leads to an increase in the level of money supply, equation (5-25). The increased money supply, given a desired level of real balances and the earlier price level, in turn leads to an increase in the excess supply of real balances. This increased excess supply of real money, through the real balance effect, leads to increases in both the domestic price level and the non-oil balance of trade deficit. As to which of the two bears the relatively higher brunt of adjustment, this will depend on the degree of substitutability between domestic goods and traded goods in consumption and the degree and speed of substitutability between the two types of goods in domestic production. It is assumed for simplicity that there are no restrictions on trade. If this assumption is relaxed, the allocation of the burden of adjustment will also depend on the degree of trade restrictions.¹¹

One feature of the model to be pointed out is the presence of some element of two way causality between money and the price level. In the case of an exogenous increase in oil revenues, just analyzed, it should be noted that the resulting increase in the price level will in turn feed back to the money supply. The increase in the price level will, through equation (5-26), increase domestic revenues, which by

itself has a dampening effect on money supply by reducing the domestic deficit. However, increased domestic revenues also lead to increased domestic expenditures which would have an expansionary impact on money supply. Hence the net impact of the feed back from the price level to money cannot be predicted a priori, but would depend on the relative values of the coefficients of the price level in (5-26), and domestic revenue in (5-25).

The similarity between this aspect of the model and models of self-generating inflation, which have become increasingly popular in Latin American and Asian countries, is obvious.¹² As in these models, questions about the dynamic stability or convergence of the model is likely to be interwoven with the issue of whether the feed-back from the price level to money dampens over time for any given initial shock to the system. It is important, therefore, at this stage to determine what a priori restrictions have to be placed on the model in order for it to be stable.

Stability of the Model

To analyze the issue of stability, we rewrite the model, introducing the polynomial shift operator, E. The equations of the model can be written as follows:

$$[E - K_1] \log M_t - K_2 h_1 E \log GDD_t = (K_0 + K_2 h_0) + K_2 \log a_t + K_2 h_2 \log \Delta CP_t \quad (5-23')$$

$$\text{ElogGDD}_t - w_1 \text{ElogGE}_t^d + w_2 \text{ElogGR}_t^d = w_0 - w_3 \text{logGB}_N^d \quad (5-24')$$

$$[E - (1-v)] \text{logGE}_t^d - v g_1 q_1 \text{ElogGR}_t^d = (v g_0 + v g_1 q_0) + v g_1 q_2 \text{logOR}_t \quad (5-25')$$

$$\text{ElogGR}_t^d - r_1 \text{ElogP}_t = r_0 + r_1 \text{logy}_t \quad (5-26')$$

$$\text{ElogP}_t - \left(\frac{\lambda b_1}{1+\lambda b_1} \right) \text{ElogM}_t = \left(\frac{\lambda b_0 - b_1 \alpha'_0}{1+\lambda b_1} \right) - \left(\frac{\lambda b_1 \alpha_1}{1+\lambda b_1} \right) \text{logy}_t + \left(\frac{1}{1+\lambda b_1} \right) \text{logP}^T \quad (5-27')$$

$$\text{ElogBTD} - \beta_2 \text{ElogM}_t + \beta_2 \text{ElogP}_t = (\beta_0 - \beta_2 \alpha'_0) + (\beta_1 - \beta_2 \alpha_1) \text{logy}_t \quad (5-28)$$

In matrix notation, the system can be more compactly represented as:

$$P(E)X = f(t) \quad (5-29)$$

where,

$$P(E) = \begin{bmatrix} E - K_1 & -K_2 h_1 E & 0 & 0 & 0 & 0 \\ 0 & E & -w_1 E & w_2 E & 0 & 0 \\ 0 & E & E - (1-v) & -v g_1 q_1 E & 0 & 0 \\ 0 & 0 & 0 & E & -r_1 E & 0 \\ \left(\frac{\lambda b_1}{1+\lambda b_1} \right) E & 0 & 0 & 0 & E & 0 \\ -\beta_2 E & 0 & 0 & 0 & \beta_2 E & E \end{bmatrix}$$

$$X = \begin{bmatrix} \text{logM}_t \\ \text{logGDD}_t \\ \text{logGE}_t^d \\ \text{logGR}_t^d \\ \text{logP}_t \\ \text{logBTD}_t \end{bmatrix}$$

and,

$$f(t) = \left[\begin{array}{l} (K_0 + K_2 h_0 + K_2 \log a_t + K_2 h_2 \log \Delta C P_t' \\ w_0 - w_3 \log GB_{Nt}^d \\ (vg_0 + vg_1 q_0) + vg_1 q_2 \log OR_t \\ r_0 + r_1 \log y_t \\ \frac{\lambda b_0 - b_1 \alpha_0'}{(1 + \lambda b_1)} - \frac{\lambda b_1 \alpha_1}{(1 + \lambda b_1)} \log y_t + \left(\frac{1}{1 + \lambda b_1} \right) \log P^T \\ (\beta_0 - \beta_2 \alpha_0') + (\beta_1 - \beta_2 \alpha_1) \log y_t \end{array} \right]$$

The stability of the system depends on the homogenous part of the system. The homogenous part of the above system is,

$$P(E) \cdot X = 0$$

(5-30)

The system will be stable if and only if all the roots of the characteristic equation of the system in (5-30) lie within the unit circle in the complex plane.¹³ Alternatively stated, a necessary and sufficient condition for the system to be stable is that all the roots of the characteristic equation be less than one in absolute value.

The characteristic equation of the system is:

$$|P(E)| = 0 \quad (5-31)$$

or

$$E^6 + \left[\frac{(1 + \lambda b_1)(v - 1 - K_1) + K_2 h_1 b_1 (r_1 w_2 - r_1 w_2 v)}{(1 + \lambda b_1) + K_2 h_1 \lambda b_1 (w_1 v g_1 q_1 r_1 - r_1 w_2)} \right] E^5 + \left[\frac{(1 + \lambda b_1)(K_1 K_1 v)}{(1 + \lambda b_1) + K_2 h_1 \lambda b_1 (w_1 v g_1 q_1 r_1 - r_1 w_2)} \right] E^4 = 0 \quad (5-32)$$

Equation (5-32) can be written as a polynomial in x which has the following general form:

$$f(x) = x^6 + \theta_1 x^5 + \theta_2 x^4 + \theta_3 x^3 + \theta_4 x^2 + \theta_5 x + \theta_6 = 0 \quad (5-33),$$

where the θ 's are given by the following expressions:

$$\theta_1 = \left[\frac{(1+\lambda b_1)(v-1-K_1) + K_2 h_1 \lambda b_1 (r_1 w_2 - r_1 w_2 v)}{(1+\lambda b_1) + K_2 h_1 \lambda b_1 (w_1 v g_1 q_1 r_1 - r_1 w_2)} \right] \quad (5-34),$$

$$\theta_2 = \left[\frac{(1+\lambda b_1)(K_1 - K_1 v)}{(1+\lambda b_1) + K_2 h_1 \lambda b_1 (w_1 v g_1 q_1 r_1 - r_1 w_2)} \right] \quad (5-35)$$

$$\theta_3 = \theta_4 = \theta_5 = \theta_6 = 0 \quad (5-36)$$

The roots of the polynomial are given by x . However, to exclude the trivial roots of zero, equation (5-33) can be reduced to the following second degree polynomial by dividing both sides by x^4 :

$$x^2 + \theta_1 x + \theta_2 = 0 \quad (5-37)$$

The stability of the system, therefore, requires that the two roots of (5-37), x_1 and x_2 , be each less than one in absolute value. A necessary and sufficient condition for this to hold is that the following two inequalities hold:¹⁴

$$D_1 = \begin{vmatrix} 1 & \theta_2 \\ \theta_2 & 1 \end{vmatrix} > 0, \text{ and}$$

$$D_2 = \begin{vmatrix} 1 & 0 & \theta_2 & \theta_1 \\ \theta_1 & 1 & 0 & \theta_2 \\ \theta_2 & 0 & 1 & \theta_1 \\ \theta_1 & \theta_2 & 0 & 1 \end{vmatrix} > 0$$

Evaluating D_1 , we obtain:

$$1 - \theta_2^2 > 0, \text{ or } \theta_2^2 < 1.$$

For θ_2^2 to be less than 1, θ_2 must be less than one in absolute value. Hence if,

$\theta_2 > 0$, θ_2 must be less than 1, and

$\theta_2 < 0$, θ_2 must be greater than -1.

All the coefficients in θ_2 are positive. The sign of θ_2 cannot be determined a priori. Recalling that 'v' is a positive fraction, the numerator of θ_2 must be positive. The denominator can, however, be either positive or negative. The required condition is, therefore, that

$$|\theta_2| < 1 \quad (5-38)$$

The condition in (5-38) is necessary, but not sufficient, to guarantee the stability of the system. In addition to (5-38), we require that the second determinant, D_2 , be positive.

Expanding D_2 , we obtain:

$$D_2 = (1 - \theta_2^2)^2 - \theta_1^2 (1 - \theta_2)^2 > 0.$$

Hence for the system to be stable, we require:

$$(1 - \theta_2^2)^2 > \theta_1^2 (1 - \theta_2)^2.$$

Dividing both sides by $(1 - \theta_2)^2$, we obtain

$$\theta_1^2 < \left(\frac{1 - \theta_2^2}{1 - \theta_2} \right)^2, \text{ or}$$

$$\theta_1^2 < \left[\frac{(1 - \theta_2)(1 + \theta_2)}{(1 - \theta_2)} \right]^2,$$

from which we derive the condition that,

$$\theta_1^2 < (1+\theta_2)^2,$$

if the system is to be stable.

Again, all the coefficients in θ_1 are positive. Note, however, that, a priori, we cannot determine its sign. Hence, for the model to be stable, it is sufficient that,

$$|\theta_1| < |1+\theta_2| \quad (5-39)$$

The Solution of The Model

We turn now to the solution of the model. In this section, we solve the model for the quasi-equilibrium values of the endogenous variables.

• The Quasi-Equilibrium Solution¹⁸

If $[P(E)]^{-1}$ exists, we can express it formally as

$$[P(E)]^{-1} = (1/|P(E)|)P(E)^+ \quad (5-40)$$

where $P(E)^+$ is the adjoint matrix of $P(E)$. The solution can be obtained by pre-multiplying on both sides of (5-29) by $[P(E)]^{-1}$ to obtain:

$$X = [P(E)]^{-1}f(t) \quad (5-41) \text{ or}$$

$$|P(E)|X = P(E)^+f(t) \quad (5-42)$$

where the $P(E)^+$ matrix is defined as follows:

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$$P(E)^+ = \begin{bmatrix} Q_{11} & Q_{12} & Q_{13} & Q_{14} & Q_{15} & Q_{16} \\ Q_{21} & Q_{22} & Q_{23} & Q_{24} & Q_{25} & Q_{26} \\ Q_{31} & Q_{32} & Q_{33} & Q_{34} & Q_{35} & Q_{36} \\ Q_{41} & Q_{42} & Q_{43} & Q_{44} & Q_{45} & Q_{46} \\ Q_{51} & Q_{52} & Q_{53} & Q_{54} & Q_{55} & Q_{56} \\ Q_{61} & Q_{62} & Q_{63} & Q_{64} & Q_{65} & Q_{66} \end{bmatrix}$$

whose elements, Q_{ji} , are derived in Appendix 5-IIa.

Recalling the value of $|P(E)|$, we have,

$$\begin{bmatrix} E^6 + \theta_1 E^5 + \theta_2 E^4 \end{bmatrix} \begin{bmatrix} \log M_t \\ \log GDD_t \\ \log GE_t^d \\ \log GR_t^d \\ \log P_t \\ \log BTD_t \end{bmatrix} = \begin{bmatrix} (Q_{ji}) \end{bmatrix} \begin{bmatrix} \bar{\sigma}_1 \\ \bar{\sigma}_2 \\ \bar{\sigma}_3 \\ \bar{\sigma}_4 \\ \bar{\sigma}_5 \\ \bar{\sigma}_6 \end{bmatrix}$$

6x1 6x6 6x1

where $\bar{\sigma}_i$ denotes some fixed value of the corresponding element in $f(t)$ thus:

$$\bar{\sigma}_1 = (K_0 + K_2 h_0) + K_2 \log \bar{a} + K_2 h_2 \log \Delta \bar{CP} \quad (5-43)$$

$$\bar{\sigma}_2 = w_0 - w_3 \log \bar{GB}_N^d \quad (5-44)$$

$$\bar{\sigma}_3 = (vg_0 + vg_1 q_0) + vg_1 q_2 \log \bar{OR} \quad (5-45)$$

$$\bar{\sigma}_4 = r_0 + r_1 \log \bar{y} \quad (5-46)$$

$$\bar{\sigma}_5 = \frac{\lambda(b_0 - b_1 \alpha'_0)}{1 + \lambda b_1} - \frac{\lambda b_1 \alpha_1}{1 + \lambda b_1} \log \bar{y} + \frac{1}{1 + \lambda b_1} \log \bar{P}^T \quad (5-47)$$

$$\bar{\sigma}_6 = (\beta'_0 - \beta_2 \alpha'_0) + (\beta_1 - \beta_2 \alpha_1) \log \bar{y}, \quad (5-48)$$

and a bar above a variable indicates a fixed value of that variable.

From the above, we obtain the following six equations;

$$[E^2 + \theta_1 E + \theta_2] \log M_t = Q_{11} \bar{\sigma}_1 + Q_{12} \bar{\sigma}_2 + Q_{13} \bar{\sigma}_3 + Q_{14} \bar{\sigma}_4 + Q_{15} \bar{\sigma}_5 \quad (5-49)$$

$$[E^2 + \theta_1 E + \theta_2] \log GDD_t = Q_{21} \bar{\sigma}_1 + Q_{22} \bar{\sigma}_2 + Q_{23} \bar{\sigma}_3 + Q_{24} \bar{\sigma}_4 + Q_{25} \bar{\sigma}_5 \quad (5-50)$$

$$[E^2 + \theta_1 E + \theta_2] \log GE_t^d = Q_{31} \bar{\sigma}_1 + Q_{32} \bar{\sigma}_2 + Q_{33} \bar{\sigma}_3 + Q_{34} \bar{\sigma}_4 + Q_{35} \bar{\sigma}_5 \quad (5-51)$$

$$[E^2 + \theta_1 E + \theta_2] \log GR_t^d = Q_{41} \bar{\sigma}_1 + Q_{42} \bar{\sigma}_2 + Q_{43} \bar{\sigma}_3 + Q_{44} \bar{\sigma}_4 + Q_{45} \bar{\sigma}_5 \quad (5-52)$$

$$[E^2 + \theta_1 E + \theta_2] \log P_t = Q_{51} \bar{\sigma}_1 + Q_{52} \bar{\sigma}_2 + Q_{53} \bar{\sigma}_3 + Q_{54} \bar{\sigma}_4 + Q_{55} \bar{\sigma}_5$$

$$[E^3 + \theta_1 E + \theta_2] \log BTD_t = Q_{61} \bar{\sigma}_1 + Q_{62} \bar{\sigma}_2 + Q_{63} \bar{\sigma}_3 + Q_{64} \bar{\sigma}_4 + Q_{65} \bar{\sigma}_5 + Q_{66} \bar{\sigma}_6 \quad (5-54)$$

Each of the above six equations is a linear difference equation with constant coefficients. Recalling that,

$Ek = k$, where k is a constant,

we can simplify the above equations to

$$[E^2 + \theta_1 E + \theta_2] \begin{bmatrix} \log M_t \\ \log GDD_t \\ \log GE_t^d \\ \log GR_t^d \\ \log P_t \\ \log BTD_t \end{bmatrix} = \begin{bmatrix} \Sigma_1 \\ \Sigma_2 \\ \Sigma_3 \\ \Sigma_4 \\ \Sigma_5 \\ \Sigma_6 \end{bmatrix}$$

The derivation of the elements of the right hand side scalar vector is provided in Appendix 5-IIb.

From the characteristic equation,

$$f(x) = x^2 + \theta_1 x + \theta_2 = 0,$$

we find the roots of the polynomial. Denoting these roots by x_1 and x_2 , the general solution of the i^{th} homogenous equation is given by,

$$X_i(t) = \delta_{i1} x_1^t + \delta_{i2} x_2^t, \quad i=1, \dots, 6,$$

where δ_{ij} 's are constants yet to be determined.

To find the general solution, we must first find a particular solution. To do this, we try $X_i^*(t) = k_i$, a constant for each variable. This yields:

$$\log M^* = \Sigma_1 / (1 + \theta_1 + \theta_2) \quad (5-55)$$

$$\log GDD^* = \Sigma_2 / (1 + \theta_1 + \theta_2) \quad (5-56)$$

$$\log GE^{d*} = \Sigma_3 / (1 + \theta_1 + \theta_2) \quad (5-57)$$

$$\log GR^{d*} = \Sigma_4 / (1 + \theta_1 + \theta_2) \quad (5-58)$$

$$\log P^* = \Sigma_5 / (1 + \theta_1 + \theta_2) \quad (5-59)$$

$$\log BTD^* = \Sigma_6 / (1 + \theta_1 + \theta_2) \quad (5-60)$$

Thus the complete solution is given by:

$$\log M(t) = \delta_{11}x_1^t + \delta_{12}x_2^t + \Sigma_1 / (1 + \theta_1 + \theta_2) \quad (5-61)$$

$$\log GDD(t) = \delta_{21}x_1^t + \delta_{22}x_2^t + \Sigma_2 / (1 + \theta_1 + \theta_2) \quad (5-62)$$

$$\log GE^d(t) = \delta_{31}x_1^t + \delta_{32}x_2^t + \Sigma_3 / (1 + \theta_1 + \theta_2) \quad (5-63)$$

$$\log GR^d(t) = \delta_{41}x_1^t + \delta_{42}x_2^t + \Sigma_4 / (1 + \theta_1 + \theta_2) \quad (5-64)$$

$$\log P(t) = \delta_{51}x_1^t + \delta_{52}x_2^t + \Sigma_5 / (1 + \theta_1 + \theta_2) \quad (5-65)$$

$$\log BTD(t) = \delta_{61}x_1^t + \delta_{62}x_2^t + \Sigma_6 / (1 + \theta_1 + \theta_2) \quad (5-66)$$

To determine the constants (δ_{ij}), we need to then specify a set of initial conditions for the model. From the equations of the model, we see that we require three (one more than the degree of the polynomial, ($|P(E)| = 0$), initial conditions. This would create difficulties, only if the model were intended for dynamic simulation.¹⁶ In terms of a pure estimation model, which is intended here, this should pose no difficulties.

Summary of the Chapter

In this chapter, a simple macro model has been derived to analyze the implications of oil revenues for the domestic price level and the non-oil balance of trade. To do this, an explicit consideration has been given to the implication of the government budget for domestic money supply. The stability conditions of the derived model have been analyzed. Finally the model was solved in order to obtain the equilibrium values of its endogenous variables. We proceed now to Chapter 6, where the model derived in this chapter is subjected to empirical testing.

FOOTNOTES TO CHAPTER 5

1. The assumption of the absence of assets other than money, apart from being a simplifying assumption, actually approximates conditions in most OPEC economies, especially Nigeria. Markets for other conventional assets, like bonds, are highly underdeveloped so that it is safe to assume their absence. The holding of government debt by individuals should therefore be regarded as exogenously determined in the sense that it is not the outcome of a conscious optimal portfolio decision.
2. This is a good approximation of the nature of the oil industry in most OPEC countries. In the Nigerian case, crude oil production accounts for less than 2% of the total domestic labour force. It accounts for even a smaller percentage of the indigenous work force.
3. Although it may be unrealistic to regard the per unit oil revenue, which depends on the posted price of oil, as outside the manipulation of OPEC when the organisation is considered as a whole, from the point of view of one exporting country, the price set by OPEC is regarded as given and hence the unit revenue is exogenous to such an economy.
4. Morgan (1979) indicates that this is actually the case in all OPEC countries. See also Central Bank of Nigeria (1979), p.11
5. See Morgan (1979) for a formal derivation of this conclusion. The direct impact of increased government expenditure on aggregate demand should, however, be recognised.
6. It should be recognised that a possible feed-back from the non-oil balance of payments to the money supply exists. This channel has been ignored here under the assumption that such surpluses or deficits are automatically financed by the current oil-generated reserves.
7. The transformation here involves a Taylor's expansion around the logarithmic means of M_{t-1} , ΔM , GDD and $\Delta CP'$. For employment of this method in other macro models, see Aghevli and Khan (1978). For the same methodology applied in a different context, see Chow (1974, pp. 131-134).
8. See Appendix 5-I for the derivation of the values of the w 's.
9. The OPEC countries are usually classified into high and low absorption countries. The value of v in (5-10) is a measure of the absorptive capacity of the country under study. In relative terms, v should be higher in the high absorption countries than in the low absorption countries. Nigeria belongs to the first group.

10. For the derivation of values of the q 's see Appendix 5-1.
- 10a. More appropriately, the relative price between non-traded and traded goods should be included as an argument in the balance of trade equation. This has not been done here because of the data limitation mentioned earlier.
11. Since the aim in this chapter is to develop a model which is amenable to empirical test and since the data does not allow us to distinguish between traded and non-traded goods and their prices, this issue has been analyzed in chapter 4 where a qualitative analysis of the impact of oil revenues on the structure of output within a purely theoretical framework has been carried out.
12. For the development and application of these models see Aghevli and Khan (1978), Aghevli (1977), Dutton (1971), and Olivera (1967) among others.
13. For a formal development and proof of this condition, see Kenkel (1974), pp. 174-177.
14. For a discussion of the application of the theorem, see Kenkel (1974), pp. 176-186 and Baumol (1970), pp. 303-305. For a proof of the theorem, see Samuelson (1947), pp. 434-435.
15. For the method of solution see Kenkel (1974), pp. 194-206.
16. The problem in this regard is that for any given period (t) , in addition to the lagged values of Money, $M(t-1)$, and Government Domestic Expenditures $GE^d(t-1)$, we need to specify the current Price Level, $P(t)$ in order to solve for the current values of the other endogenous variables.

CHAPTER 6

EMPIRICAL RESULTS¹

In this chapter, we present the empirical results obtained from applying the macro model developed in the preceding chapter to Nigerian data. Since the quality of any empirical estimates must depend significantly on the quality and precision of the data on which they are based, it must be pointed out from the onset that the form and quality of existing Nigerian data have imposed some constraints on the scope of empirical testing that could reasonably be undertaken. In this regard, it should be pointed out that this study originally set out to employ a model based on a distinction between public sector and private sector variables. Data constraints, however, rendered the operationalization of such a model impracticable. Moreover, within the model finally adopted here, data limitations have made it impossible to explicitly introduce the distinction between traded goods and non-traded goods into the macro model. Note also, as is pointed out later, that government domestic expenditures have had to be approximated by overall government expenditures. Finally, a drawback of the empirical results soon to be reported, is the smallness of the sample on which they are based. The employment of a quarterly (or for that matter, bi-annual) data series would be one way of avoiding this drawback. Unfortunately, we have been unable to do this since only annual observations are available for such key variables as national income and government expenditures and revenues.

Furthermore, an evaluation of the results presented in this chapter should be carried out under the recognition that some of the data, upon which the estimates are based, may be suspect. This problem of poor quality Nigerian data was succinctly highlighted recently when the Central Bank of Nigeria (CBN), observed that:²

Once again, we have to place on record that it has become increasingly difficult for the CBN to analyse the performance of the economy in general, and appraise the effectiveness of policy in particular, due to inadequate data. At the time of writing this report (April 1981), for example, no actual data on Federal Government revenue and expenditure was available for the whole of 1980; the situation as usual, was worse for state governments. External trade data in respect of 1980 similarly were unavailable. No firm data on domestic agricultural and manufacturing production are available on current basis. The available estimates are based on very scanty information and not much reliability can be placed on them. The data situation has in fact continued to deteriorate rather than improve...

The Transformation Parameters:

Before proceeding to estimate the equations of the model derived in Chapter 5, we first obtain the values of the transformation parameters, whose expressions are given in Appendix 5-I. As was pointed out in that appendix, the values of these parameters can be obtained either by evaluating the expressions in Appendix 5-I or by estimating their values. The latter procedure has been employed to obtain the values of the K_i 's, h_i 's, W_i 's and q_i 's. The values of these parameters are summarized in Table 6-1

TABLE 6-1

Estimated Values of Linearization Parameters

Equation	Parameters and their Estimated Values					
Money Supply Identity	K_0	K_1	K_2	h_0	h_1	h_2
(i) Narrow Money (M_1)	0.64	0.77	0.08	(		
(ii) Broad Money (M_2)	0.83	0.73	0.10	(0.53)	1.88	0.50
Government Domestic Deficit Identity:	W_0	W_1	W_2			
	-1.87	2.04	0.99			
Government Expenditure Equation	q_0	q_1	q_2			
	1.12	0.64	0.32			

Setting the linearization parameters to their respective values in Table 6-1, we can then estimate the model to obtain the structural parameter values. Since the model to be estimated is a simultaneous equations system, the model is estimated by the Two-Stage Least Squares technique. Since we cannot determine, a priori, the more appropriate definition of money, the model is estimated employing both the narrow definition of Money (M_1) and the broad definition (M_2).

The Model Under the Narrow Definition of Money:

Adopting the narrow definition of money, the estimated model consists of the following two identities,

$$\log M_t^S = 0.68 + 0.77 \log M_{t-1} + 0.08 \log a_t + 0.15 \log GDD_t + 0.04 \log \Delta CP_t$$

(6-1)

and

$$\log GDD_t = -1.87 + 2.04 \log GE_t - 0.99 \log GR_t^d - 0.03 \log GB_{Nt}^d \quad (6-2)$$

and the following four equations:

Government Revenue Equation:

$$\begin{aligned} \log GE_t = & 0.22 + 0.72 (1.12 + 0.641 \log GR_t^d + 0.32 \log OR_t)^* \\ & (1.13) \quad (6.23) \\ & + 0.29 \log GE_{t-1}^{**} + 0.10 \text{WAR}^{**3,4} \\ & (2.32) \quad (1.18) \end{aligned} \quad (6-3)$$

$$R^2 = 0.99; F = 638.41; D-W = 1.82; SEE = 0.13$$

In estimating (6-3), aggregate government expenditure data have been employed as a proxy for government domestic expenditure. This is necessitated by data availability because a breakdown of expenditures into domestic and foreign is not collected. A necessary condition for this proxy to be a valid approximation is that foreign expenditures as a share of aggregate expenditures be a stable fraction over time.⁵ It should be noted, however, that even when this condition holds, the estimate of g_1 will tend to be biased upwards if the share of foreign expenditures is high. With this in mind, the estimate of 0.72 has to be regarded as an upper limit in deriving the short-run elasticity of domestic expenditures with respect to aggregate revenues.

It was pointed out in Chapter 5 that (v) serves as a measure of the absorptive capacity of the economy under study. From the

estimated coefficient of the lagged dependent variable, we obtain a value of 0.71 for (v). This is in conformity with our a priori expectation and the usual classification of Nigeria as a high absorptive OPEC economy.

Finally, WAR is a dummy variable introduced exogenously into the equations of the model, to account for the abnormal situation of the war years. The variable takes on the value of unity in 1967, 1968, and 1969 (the three years of the Nigerian Civil War) and zero otherwise.

The overall estimates presented in (6-3) are in conformity with a priori expectations. All the estimated coefficients (except the intercept) are statistically significant at or above the 10% confidence level. The overall hypothesis represented by equation (5-22) satisfies the F test at the 1% confidence level. A final test of the appropriateness of the estimates is provided by the implied estimate of the long-run elasticity (g_1) of expenditures with respect to aggregate revenues. Under the goal of an overall long-run budget balance assumed in Chapter 5, the estimate of g_1 should approximately equal unity. The implied estimate of g_1 from the above results is 1.01, which to all intents satisfies the long-run budget balance condition. We turn now to the government revenue function.

Government Domestic Revenue Equation:

The estimation results for the government domestic revenue function are as follows:

$$\log GR_t^d = -4.05^* + 1.22 (\log y_t + \log P_t)^* + 0.05 \text{ WAR} \\ (-4.60) \quad (12.19) \quad (0.24) \quad (6-4)$$

$$R^2 = 0.92; F = 84.04; D-W = 1.86; SEE = 0.30$$

The estimated structural parameters of the government domestic revenue function are significant at the 1% confidence level except the war dummy variable. The estimated elasticity of revenues with respect to the nominal value of aggregate domestic income is greater than unity. The elasticity here should, however, not be confused with the concept of the marginal tax rate, which would be expected to be less than one.^{5a} Finally, the overall hypothesis represented by equation (5-23) also satisfies the F test at the 1% confidence level. We turn now to the determination of the domestic price level.

The Domestic Price Level Equation:

The results obtained from the estimation of the price level equation are reported in equation (6-5).

$$\log P_t = 2.85^* + 0.48 \log M_{1t}^* - 0.65 \log y_t^* + 0.28 \log P_t^{T*6} - 0.10 \text{WAR}^*$$

(10.74) (14.93) (-6.82) (3.32) (-4.16)

(6-5)

$$R^2 = 0.99; F = 628.86; RHO = -0.59; D-W = 2.34; SEE = 0.04$$

All the estimated coefficients in (6-5) are statistically significant at the 1% confidence level. The estimates have been corrected for autocorrelated disturbances, using the Cochrane-Orcutt technique within the Two-Stage Least Squares method. Since a major hypothesis developed in Chapter 3 is that an increase in the domestic money supply will lead to a less than equi-proportional increase in the domestic price level; it is required that the

coefficient of the money supply be positive and less than unity. This requirement is satisfied by the results presented in (6-5). A further check on the appropriateness of the model is that the estimated coefficient of real income be negative and imply an income elasticity of money demand that is within a reasonable range. The income coefficient is expected to be negative because an increase in real income, ceteribus paribus, increases the demand for money and hence reduces the excess supply of real money balances. The estimated coefficient of real income in (6-5) is in conformity with this requirement. The above estimates imply a value of the income elasticity of money demand (α_1) of 1.35. The implied income elasticity of real money demand (α_1) is in the same range as has been found for many other developing countries.⁷ The overall hypothesis underlying the domestic price level determination process cannot be rejected at the 1% confidence level.

It should be recalled that under the conventional monetary approach for an economy operating under a fixed exchange rate system, the coefficients of the domestic Money Stock (M) and domestic income (y) would be expected not to be statistically different from zero in the long-run.^{7a} From the above results, while movements in international prices exert a significant impact on domestic price level movements, domestic money market variables exert even a greater impact on domestic price level movements. These results suggest that in the type of economies considered in this investigation a straight-forward application of the monetary approach is inadequate. We turn now to the non-oil balance of trade equation.

The Non-Oil Balance of Trade Equation:

The estimation results for the non-oil balance of trade deficit are reported in equation (6-6).

$$\log \text{BTD}_t = -0.43 + 2.68(\log M_{1t} - \log P_t) - 0.01 \log y_t - 0.91 \text{WAR}_t^8$$

(-0.13) (5.53) (-0.01) (-3.23)

(6-6)

$$R^2 = 0.96; F = 94.41; \text{RHO} = -0.20; \text{D-W} = 1.92; \text{SEE} = 0.39$$

Although the estimated coefficients in (6-6) have the signs expected of them, a priori, the results are obviously not satisfactory. The estimated coefficient of real domestic income is not statistically different from zero. From equation (5-25) of Chapter 5, this implies that β_1 is approximately equal to $\beta_2 \alpha_1$. Recalling the implied value of 1.35 for α_1 in the estimate of the domestic price level equation, the results in (6-6) imply a value of 3.62 for β_1 . This is unreasonably high. Likewise, the estimated value (2.68) of β_2 in (6-6), is much higher than the a priori expected value which is less than or equal to unity. On the basis of these results, it has to be conceded that we have not succeeded in obtaining reliable estimates for the non-oil balance of trade.

One possible explanation for this inability to obtain satisfactory estimates for the non-oil balance of trade equation may have to do with significant departures of the economy from the underlying assumption of free trade. For the period covered in this study, there have been significant restrictive trade practices in the form of tariffs, quotas and outright bans with regard to imports, as already indicated in Chapter 2. Furthermore, with

regard to exports, administered prices paid to producers of agricultural export crops have diverged significantly from the prices of these commodities in the world market. Such administered prices, when set above the world prices, constitute an export tax. The problem posed for the estimation of the balance of trade by these trade restrictive practices are further compounded by the fact that such practices have been subject to constant, and, at times, even erratic changes.

The Model Under the Broad Definition of Money:

As indicated earlier, the model was also estimated, employing the broad definition of money (M_2). The estimated model under this alternative definition of money is presented in equations (6-7) through (6-12). The two identities of the model are presented in equations (6-7) and (6-8).

$$\log M_{2t}^S = 0.88 + 0.73 \log M_{2t-1} + 0.10 \log a_t + 0.19 \Delta \log GDD_t + 0.05 \log CP_t' \quad (6-7)$$

$$\log GDD_t = -1.87 + 2.04 \log GE_t - 0.99 \log GR_t^d - 0.03 \log GB_{Nt}^d \quad (6-8)$$

The alternative estimates for the remaining four equations of the system are as follows:

$$\begin{aligned} \log GE_t &= 0.22 + 0.72 (1.12 + 0.64 \log GR_t^d + 0.32 \log OR_t) * \\ &\quad (1.12) \quad (6.19) \\ &\quad + 0.29 \log GE_{t-1}^{**} + 0.10 \text{WAR}^{**} \quad (6-9) \\ &\quad (2.36) \quad (1.18) \end{aligned}$$

$$R^2 = 0.99; F = 637.51; D-W = 1.82; SEE = 0.13$$

$$\log GR_t^d = -4.04^* + 1.21 (\log y_t + \log P_t)^* + 0.05WAR$$

(-4.59) (12.20) (0.23)

(6-10)

$$R^2 = 0.92; F = 84.03; D-W = 1.87; SEE = 0.31$$

$$\log P_t = 3.10^* + 0.61 \log M_{2t}^* - 0.74 \log y_t^* + 0.05 \log P_t^T + 0.14WAR^*$$

(12.59) (15.84) (-3.48) (0.52) (-6.43)

(6-11)

$$R^2 = 0.99; F = 697.14; RHO = -0.60; D-W = 2.44; SEE = 0.04$$

$$\log BTD_t = 6.51^{**} + 3.48 (\log M_{2t} - \log P_t)^* - 2.25 \log y_t^{**} - 1.48WAR^*$$

(2.23) (8.16) (-2.52) (-6.70)

(6-12)

$$R^2 = 0.97; F = 129.83; RHO = 0.60; D-W = 2.10; SEE = 0.34$$

The estimated model, using the broad definition of money is not significantly different from the estimated model when the narrow definition is used. One difference that should be noted is that under the broad definition, the estimated coefficient of the traded goods price variable in the domestic price level equation, is not statistically different from zero. The corresponding estimated coefficient, when the narrow definition of money is employed, is significantly different from zero at the 1% confidence level. Still, with respect to the domestic price level equation, the estimated elasticities of the price level with respect to the money stock and domestic income are higher when the broad definition of money is employed as compared to those obtained when the narrow definition is used. As for the non-oil balance of trade equation, the same broad conclusions, drawn on the basis of the estimates obtained, using narrow money, are also applicable to the

estimates based on broad money. If anything, the estimates based on broad money, are even more unsatisfactory as evidenced by the unusually high elasticities of the balance of trade with respect to both the money stock and domestic income.

Overall, the employment of the narrow definition of money seems to provide more satisfactory estimates of the model. The structural parameters implied by the alternative estimations are summarized in Table 6-2. We turn now to the issue of the stability of the model.

Stability of the Model:

In Chapter 5, the necessary and sufficient conditions, for the model to be stable, were derived. These took the form of sign restrictions which the parameters of the system would have to obey if the model is to be stable. These conditions,

TABLE-6-2

Estimated Values of Structural Parameters of the Model*

Parameters	Estimated Values	
	Narrow Definition of Money (M_1)	Broad Definition of Money (M_2)
g_0	0.31	0.31
g_1	1.01	1.01
v	0.71	0.71
r_0	- 4.05	- 4.04
r_1	1.22	1.21
α_1	1.35	1.21
β_1	3.62	1.96
β_2	2.68	3.48

*Note that the values of b_1 and λ cannot be uniquely determined from the estimates. The analysis of the stability condition later in this chapter is based on a value of 0.92 for λb_1

which were provided by equations (5-32) and (5-33) of Chapter 5, required that,

$$(a) \quad |\theta_2| < 1, \text{ and}$$

$$(b) \quad |\theta_1| < |(1 + \theta_2)|.$$

From Tables 6-1 and 6-2, we can substitute for the relevant parameters in θ_1 and θ_2 to obtain for both definitions of money,

$$\theta_1 = -1.04, \text{ and}$$

$$\theta_2 = 0.22$$

Given these values, it is obvious that conditions (a) and (b) are both satisfied. Hence we know the model is stable. Alternatively, we can now write the characteristic equation of the system as,

$$(c) \quad x^2 - 1.04x + 0.22 = 0$$

The stability of the system then requires that the roots of (c) be each less than one in absolute value. The roots of the polynomial in (c) are, $x_1 = 0.745$ and $x_2 = 0.295$, which are each less than one. Hence, we know the model is stable.

Conclusion to this Chapter:

In this chapter, we have subjected the macro-model developed in Chapter 5 to empirical test, using Nigerian data. The results obtained are in conformity with the hypothesis developed in this study. The only exception to this generalization is the non-oil balance of trade hypothesis. Possible explanations have been advanced for the unsatisfactory estimates in this case.

It was pointed out earlier in this chapter that the model employed in this study differs from the original model with which we started out. A summary of the initial model and some conditional estimates are presented in Appendix 6-I.

FOOTNOTES TO CHAPTER 6

1. The data employed covers the period 1960-1978. The data description and sources are provided in Appendix 6-II. '*' and '**' indicate significance at the 1% and 10% confidence levels respectively.
2. Central Bank of Nigeria, Annual Report, 1980.
3. The values in parenthesis are the usual t-ratios. It should be recognized that since the Two-Stage Least Squares Estimator does not possess small sample properties, the t-ratios are merely suggestive. More appropriately, tests of significance should be based on t-ratios computed from the asymptotic standard errors. For a comparison of the properties of alternative estimators applied to simultaneous equation systems, see Fair (1973).
4. In this equation and subsequent equations, where the lagged endogenous variable is included on the right hand side, the Durbin Watson statistic is not applicable as an indication of the presence or otherwise of autocorrelated disturbances. The statistic has been reported merely for completeness.
5. Irfan Harque, the co-ordinator of the Nigerian Desk at the International Bank for Reconstruction and Development, indicated to me in my discussion with him that the Bank estimates suggest that the foreign component of Nigerian government expenditures has remained in the range of 25% - 30% of total expenditures.
- 5a. This is because government domestic revenues include public sector investment incomes.
6. The import Price Index has been used as proxy for the price of traded goods.
7. In a study of four developing countries, for example, Aghevli and Khan (1978) estimate the income elasticity of money demand to be 0.94, 1.09, 1.38 and 2.15 for Brazil, Colombia, Thailand and Dominican Republic respectively. In a review of studies for Nigeria, Ajayi (1978) indicates a range of 1.1 to 1.5.
- 7a. Note that in the long-run, the domestic price level is exogenous to any one economy and hence will be unaffected by domestic variables.
8. Corrected for autocorrelated disturbances.
9. Corrected for autocorrelated disturbances.
10. Corrected for autocorrelated disturbances.

Chapter 7

Summary and Conclusions

This study has analyzed the implications of oil revenues for some aspects of the domestic economy of an oil exporting economy. Two distinct analytical frameworks have been employed. On the one hand, a theoretical analysis of the consequences of oil revenues for the domestic structure of output was carried out within the conceptual framework of a simple neo-classical two-sector model of production. The emerging conclusion from the analysis is that the expending of oil revenues generates a strong tendency for the structure of domestic output to become increasingly biased in favour of non-traded goods. Some summary evidence on the changing structure of Nigerian domestic output was presented. Such evidence, as exists, was shown to be consistent with the conclusion derived from the theoretical analysis.

It is the contention of this study that the resulting increasing concentration of domestic economic activity does not augur well for the development and stable long-run growth of the economy. In particular, this is so because oil is an exhaustible resource. When oil exports cease or experience a temporary setback, it becomes necessary for the economy to bear the costs of a painful readjustment of its production structure. In particular with respect to

Nigeria, the rural-urban dimension of the problem, which was pointed out earlier, confounds the costs associated with such a readjustment.

The second main thrust of this study was the determination of the major determinants of domestic price level changes and the underlying factors generating non-oil balance of trade disequilibria. It was shown that pressures on the domestic price level are due largely to excess supply conditions in the domestic money market. Government budgetary decisions were shown to be the major contribution to such money market excess supply situations. As long as the government seeks to spend all its revenues, particularly in the face of increasing revenues due largely to oil rents, which accrue in foreign exchange, pressures on the domestic money stock and hence the domestic price level will continue.

With respect to non-oil balance of trade deficits, the evidence also points to money market disequilibrium as a major underlying factor. It has to be pointed out, however, that on the empirical level, the non-oil balance of trade estimates have to be regarded as unsatisfactory. Serious departures from free trade and the often frequent, and at times erratic, changes in the degree of trade restrictions have been advanced as possible explanations for the inability to obtain satisfactory empirical estimates in this case.

Finally, it should be emphasized that the limited empirical applications undertaken in this study have been necessitated by data constraints. The interpretation and reliance placed on the estimates presented, also have to be conditional on the caveat that even the data employed may not be very reliable. Also, it is important to note that the macro-modelling has been influenced by practical considerations about the feasibility of empirical applications.

To conclude this chapter, we summarize the major policy implication of this study and some possible areas in which the analysis could be extended. The overriding conclusion has been that the spending of oil revenues will lead to an increase in the relative price of non-traded goods and hence the domestic production of these goods. The domestic spending of such revenues requires the monetization of their foreign reserve counterpart. The resulting increase in money supply creates pressures on the domestic price level and the balance of payments.

From the point of view of policy, one way of mitigating these adverse effects of oil-revenue-financed expenditures is to minimize the amount of such revenues spent on current government expenditures. Alternatively, the rate of oil extraction, and hence exports, can be lowered. In this regard, however, the optimal rate of extraction has to be determined on the basis of long-run goals of economic growth and the inter-temporal maximization of the real benefits associated with the fixed stock of oil deposits.

Finally, the analysis undertaken here can be extended in a number of ways. First, the macro-modelling can be modified to

explicitly incorporate the distinction between traded and non-traded goods, as the relevant data become available. Second, a more disaggregated analysis may be more insightful in determining the sectoral impacts of oil revenues. Even within the framework adopted in the present analysis, it would be interesting to analyze the implications of trade restrictions on the broad conclusions derived. Lastly, an interesting extension would be the relaxation of the full employment assumption of the present study.

Appendix 4-I

Analysis of Incremental Changes in Oil Revenues

The analysis in chapter 4, was based on a discrete change in oil revenue, starting from an earlier situation without such revenues. In this appendix, we consider the case of incremental changes in oil revenues.

We start from a specification of the domestic demand for non-traded goods. The demand is a function of the price of non-traded goods, the price of traded goods, real domestic income and the real value of oil revenues consumed, or

$$D^{NT} = D^{NT}(P^{NT}, X, P^T, \frac{Y}{P^T} OR), \quad D_{P^{NT}}^{NT} < 0;$$

$$D_{P^T}^{NT} > 0; \quad D_X^{NT} \equiv D_{OR}^{NT} > 0 \quad (A4-I-1)$$

The real value of domestic income (X), measured in terms of traded goods, is given by the endowment of the economy's factors of production and the relative price of non-traded goods and is defined as,

$$X \equiv \frac{P^{NT}}{P^T} X^{NT} + X^T \quad (A4-I-2)$$

Where X^{NT} and X^T are, respectively, the quantities of non-traded and traded goods produced domestically. The real value of the fraction (γ) of oil revenues (OR) consumed is also measured in terms of the traded commodity.

The supply of the non-traded commodity depends on its own price and the price of the traded commodity, or

$$X^{NT} = X^{NT}(P^{NT}, P^T), \quad X_{P^{NT}}^{NT} > 0, \quad X_{P^T}^{NT} < 0 \quad (A4-I-3)$$

The domestic production of traded goods is a function of their own price and the price of non-traded goods;

$$X^T = X^T(P^{NT}, P^T), \quad X_{P^{NT}}^T < 0; \quad X_{P^T}^T > 0 \quad (A4-I-4)$$

The domestic demand for traded goods depends on the two prices and aggregate income, or

$$D^T = D^T(P^{NT}, X, P^T, \gamma OR), \quad D_{P^{NT}}^T < 0; \quad D_X^T \equiv D_{OR}^T > 0; \\ D_{P^T}^T < 0 \quad (A4-I-5)$$

The expenditure constraint which our economy faces is that the real value of its consumption of the two goods be equal to the real value of its total income. Measuring both total consumption and total incomes in terms of the traded commodity, this constraint is represented by,

$$\frac{P^{NT}}{P^T} D^{NT} + D^T = X + \frac{\gamma}{P^T} OR \quad (A4-I-6)$$

Finally, equilibrium in the domestic non-traded goods market requires that,

$$D^{NT} = X^{NT} \quad (A4-I-7)$$

Under the assumption of a small country, the price of traded goods (P^T) is determined by demand and supply conditions in the rest of the world and hence is exogenous to our economy. Hence, without loss of generality, we may assume P^T to be constant and for simplicity, we set it equal to unity. Thus, our seven equations become:

$$D^{NT} = D^{NT}(P^{NT}, X, OR), \quad D_{P^{NT}}^{NT} < 0; \quad D_X^{NT} \equiv D_{OR}^{NT} > 0 \quad (A4-I-8)$$

$$X = P^{NT} X^{NT} + X^T \quad (A4-I-9)$$

$$X^{NT} = X^{NT}(P^{NT}), \quad X_{P^{NT}}^{NT} > 0 \quad (A4-I-10)$$

$$X^T = X^T(P^{NT}), \quad X_{P^{NT}}^T < 0 \quad (A4-I-11)$$

$$D^T = D^T(P^{NT}, X, \gamma OR), \quad D_{P^{NT}}^T > 0,$$

$$D_X^T \equiv D_{OR}^T > 0 \quad (A4-I-12)$$

$$P^{NT} D^{NT} + D^T = X + \gamma OR \quad (A4-I-13)$$

and

$$D^{NT} = X^{NT} \quad (A4-I-14)$$

Employing equations (A4-I-8) through (A4-I-14), we can analyze the implications of an increase in oil revenues on the domestic production of both commodities. Totally differentiating (A4-I-9)

$$dX = P^{NT} dX^{NT} + X^{NT} dP^{NT} + dX^T, \quad (A4-I-15)$$

from (A4-I-15),

$$\frac{dX}{dOR} = P^{NT} \frac{dX^{NT}}{dOR} + X^{NT} \frac{dP^{NT}}{dOR} + \frac{dX^T}{dOR} \quad (A4-I-16)$$

Equation (A4-I-16) shows the change in the real value of domestic income due to a change in oil revenues. Note, that although the economy's non-oil (domestic) income is constrained by the production possibilities frontier, changes in the combination of the output levels of both goods and in the price of non-traded goods lead to changes in aggregate real income. Hence, $\frac{dX}{dOR} \neq 0$, and in terms of a standard diagramatic analysis is represented by the change in the intercept of equilibrium relative price lines along the traded goods axis, in moving from one production equilibrium point to the other.

From (A4-I-13)

$$P^{NT} dD^{NT} + D^{NT} dP^{NT} + dD^T = dX + \gamma dOR \quad (A4-I-17)$$

Substituting (A4-I-15) in (A4-I-17),

$$P^{NT} dD^{NT} + D^{NT} dP^{NT} + dD^T = P^{NT} dx^{NT} + X^{NT} dP^{NT} + dx^T + \gamma OR \quad (A4-I-18)$$

from which we obtain,

$$P^{NT*} \frac{dD^{NT*}}{dOR} + D^{NT*} \frac{dP^{NT*}}{dOR} + \frac{dD^{T*}}{dOR} = P^{NT*} \frac{dx^{NT*}}{dOR} + X^{NT*} \frac{dP^{NT*}}{dOR} + \frac{dx^{T*}}{dOR} + \gamma \quad (A4-I-19)$$

Equation (A4-I-19) is a statement of the budget constraint requirement in moving from one equilibrium to another, following an increase in oil revenues. Simply, it requires that the change in total expenditures on the two commodities be equal to the sum of the changes in oil revenues spent and the induced change in domestic (non-oil) income when all are valued in terms of the traded commodity.

Starting from an initial equilibrium and following an increase in oil revenues, the attainment of a new equilibrium in the non-traded goods market requires that,

$$P^{NT*} \frac{dD^{NT*}}{dOR} = P^{NT*} \frac{dx^{NT*}}{dOR} \quad (A4-I-20)$$

where a star (*) denotes equilibrium values.

Utilizing (A4-I-20) in (A4-I-19), we have,

$$D^{NT*} \frac{dP^{NT*}}{dOR} + \frac{dD^{T*}}{dOR} = X^{NT*} \frac{dP^{NT*}}{dOR} + \frac{dX^{T*}}{dOR} + \gamma \quad (A4-I-21)$$

Totally differentiating (A4-I-11) and (A4-I-12) and dividing by dOR we have respectively,

$$\frac{dX^{T*}}{dOR} = \frac{\partial X^{T*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} \quad (A4-I-22)$$

and,

$$\frac{dD^{T*}}{dOR} = \frac{\partial D^{T*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} + \frac{\partial D^{T*}}{\partial X^{T*}} \frac{dX^{T*}}{dOR} + \gamma \frac{\partial D^{T*}}{\partial OR} \quad (A4-I-23)$$

Substituting (A4-I-22) and (A4-I-23) in (A4-I-21), we have

$$\begin{aligned} D^{NT*} \frac{dP^{NT*}}{dOR} + \frac{\partial D^{T*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} + \frac{\partial D^{T*}}{\partial X^{T*}} \frac{dX^{T*}}{dOR} + \frac{\partial D^{T*}}{\partial OR} \gamma \\ = X^{NT*} \frac{dP^{NT*}}{dOR} + \frac{\partial X^{T*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} + \gamma \end{aligned} \quad (A4-I-24)$$

Substituting for $\frac{dX^{T*}}{dOR}$ from (A4-I-16) into (A4-I-24) we obtain,

$$\begin{aligned} D^{NT*} \frac{dP^{NT*}}{dOR} + \frac{\partial D^{T*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} + \frac{\partial D^{T*}}{\partial X^{T*}} \left[P^{NT*} \frac{dX^{NT*}}{dOR} \right. \\ \left. + X^{NT*} \frac{dP^{NT*}}{dOR} + \frac{dX^{T*}}{dOR} \right] + \frac{\partial D^{T*}}{\partial OR} \gamma = X^{NT*} \frac{dP^{NT*}}{dOR} \\ + \frac{\partial X^{T*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} + \gamma \end{aligned} \quad (A4-I-25)$$

Totally differentiating (A4-I-10) and dividing by dOR we have,

$$\frac{dX^{NT*}}{dOR} = \frac{\partial X^{NT*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} \quad (A4-I-26)$$

Now, substituting (A4-I-22) and (A4-I-26) in (A4-I-25), and arranging terms, we obtain,

$$\begin{aligned} D^{NT*} \frac{dP^{NT*}}{dOR} + \frac{\partial D^{T*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} + mP^{NT*} \frac{\partial X^{NT*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} + mX^{NT*} \frac{dP^{NT*}}{dOR} \\ + m \frac{\partial X^{T*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} - X^{NT*} \frac{dP^{NT*}}{dOR} - \frac{\partial X^{T*}}{\partial P^{NT*}} \frac{dP^{NT*}}{dOR} = \\ \gamma - m\gamma \end{aligned} \quad (A4-I-27)$$

Where $m = \frac{\partial D^T}{\partial X} = \frac{\partial D^T}{\partial OR}$ is the marginal propensity to spend on traded goods.

From (A4-I-27)

$$\begin{aligned} \frac{dP^{NT*}}{dOR} (D^{NT*} - X^{NT*}) + \frac{\partial D^{T*}}{\partial P^{NT*}} + mP^{NT*} \frac{\partial X^{NT*}}{\partial P^{NT*}} + \\ mX^{NT*} + (m-1) \frac{\partial X^{T*}}{\partial P^{NT*}} = \gamma - m\gamma \end{aligned} \quad (A4-I-28)$$

Hence, from (A4-I-28),

$$\frac{dp^{NT*}}{d\sigma} = \left[\frac{\gamma(1-m)}{\{(D^{NT*} - X^{NT*}) + \frac{\partial D^{T*}}{\partial p^{NT*}} + m p^{NT*} \frac{\partial X^{NT*}}{\partial p^{NT*}} + m X^{NT*} + (m-1) \frac{\partial X^{T*}}{\partial p^{NT*}}\}} \right] \quad (A4-I-29)$$

Since, $0 < m < 1$ and $\gamma > 0$, the numerator of (A4-I-29) is positive. To determine the sign of the denominator, recall that domestic goods market equilibrium requires,

$$D^{NT*} = X^{NT*}$$

$$\text{Hence } (D^{NT*} - X^{NT*}) = 0.$$

Since there are only two goods, assuming gross substitutability between them in consumption,

$$\frac{\partial D^{T*}}{\partial p^{NT*}} > 0;$$

$\frac{\partial X^{NT*}}{\partial p^{NT*}}$ is the slope of the supply curve of non-traded goods and

hence is positive; since m and p^{NT*} are each positive values,

$$m p^{NT*} \frac{\partial X^{NT*}}{\partial p^{NT*}} > 0; \quad m X^{NT*} \text{ by definition must be non-negative.}$$

Finally, $(m-1) \frac{\partial X^{T*}}{\partial p^{NT*}}$ is positive since $0 < m < 1$ (hence $(m-1) < 0$)

and $\frac{\partial X^{T*}}{\partial P^{NT*}} < 0$ since the two goods are necessarily gross

substitutes in production. From the foregoing, the denominator is also positive and hence,

$$\frac{dP^{NT*}}{dOR} > 0$$

It is now straightforward to determine the impact of an increase in oil revenues on the domestic production of the non-traded commodity. Since as just established,

$\frac{dP^{NT*}}{dOR} > 0$, from (A4-I-26) the sign of $\frac{dX^{NT*}}{dOR}$ depends on the sign of $\frac{\partial X^{NT*}}{\partial P^{NT*}}$, which is of course positive since it is the

slope of the supply curve. Hence (A4-I-26) is positive. Thus, an increase in oil revenues leads to an absolute increase in the domestic resources committed to the production of non-traded goods. However, given the constraint on aggregate production imposed by the production possibilities frontier, such increase necessarily entails an absolute reduction in the domestic production of, and resources committed to, the traded goods sector.

Appendix 4-II

In drawing the Engel Curves in the graphical analysis in Chapter 4, it is implicitly assumed that community tastes are biased in favour of non-traded goods as income increases. This assumption is based on the observation that in OPEC countries, government expenditures are highly intensive in non-traded goods since such expenditures are directed largely at the provision of services and basic infrastructure.

However, the conclusions derived in Chapter 4 still stand up if this assumption is dropped.

More generally, the three diagrams in Chapter 4 can be re-drawn under a less restrictive assumption about taste patterns. These diagrams are re-drawn here under the assumption of homothetic community tastes. Figure A4-II-i corresponds to Figure 4-I. Figure A4-II-i has been labelled such that it is directly comparable to Figure 4-I. It is obvious that the discussion relating to Figure 4-I carries over completely to Figure A4-II-i.

With respect to Figure 4-II, note also that Figure A4-II-ii can be substituted for the earlier diagram and the discussion relating to Figure 4-II remains unaltered.

Finally, substituting Figure A4-II-iii for Figure 4-III, the discussion is, basically, still not altered. Note, however, that in this case, the schedules OS and A_0E_0 in Figure 4-III now collapse to the single schedule OA_0S_0 , $C_0\bar{S}, E_0$ in Figure A4-II-iii and hence points S_0 and C_0 of Figure 4-III collapse to the single point S_0, C_0 in Figure A4-II-iii.

In all cases, the conclusions derived in Chapter 4 remain unaltered. The only assumption concerning tastes that is required is that non-traded goods be normal in consumption (that is, that they be not inferior).

Figure A4-II-i

Figure A4-II-ii

Figure A4-II-iii

APPENDIX 5-1

Take a relationship such as:

$$Y = Z_1 + Z_2 + \dots + Z_n \quad (\text{A5-I-1}), \text{ or}$$

$$\log Y = \log(Z_1 + Z_2 + \dots + Z_n) \quad (\text{A5-I-2})$$

In order to make (A1 - I₂) linear in the logarithms of the individual Z's, it can be expanded by finding a relationship which approximates the values of the log of Y by some expression which is a function of the logs of the individual Z's. Wymer (1976) has shown that such an expression is provided by:

$$\log Y = C_0 + C_1 \log Z_1 + C_2 \log Z_2 + \dots + C_n \log Z_n \quad (\text{A5-I-3}),$$

where the C's are constants which are derived from the mean values of the logarithms of the Z's. The C's are provided by the following expressions:

$$C_0 = \log(e^{\overline{\log Z_1}} + e^{\overline{\log Z_2}} + \dots + e^{\overline{\log Z_n}}) \\ - \left(\frac{1}{e^{\overline{\log Z_1}} + e^{\overline{\log Z_2}} + \dots + e^{\overline{\log Z_n}}} \right) (e^{\overline{\log Z_1} \cdot \overline{\log Z_1}} + \dots + e^{\overline{\log Z_n} \cdot \overline{\log Z_n}})$$

$$C_1 = \left(\frac{e^{\overline{\log Z_1}}}{e^{\overline{\log Z_1}} + e^{\overline{\log Z_2}} + \dots + e^{\overline{\log Z_n}}} \right)$$

⋮

$$C_n = \left(\frac{e^{\overline{\log Z_n}}}{e^{\overline{\log Z_1}} + e^{\overline{\log Z_2}} + \dots + e^{\overline{\log Z_n}}} \right), \text{ and}$$

$$\overline{\log Z_i} \equiv \frac{1}{n} \sum_{i=1}^n \log Z_i$$

The values of the K's can, then, either be computed or estimated.

The Transformation of the Money Supply Identity

Applying the process of transformation discussed above to equation (5-2), yields equation (5-2"). The expressions for the K's and n's are given by the C's above and an appropriate substitution of variables for the Z's in these expressions.

Hence,

$$K_0 = \log(e^{\overline{\log M}_{t-1}} + e^{\overline{\log \Delta M}}) - \left(\frac{e^{\overline{\log M}_{t-1}} \cdot \overline{\log M}_{t-1} + e^{\overline{\log \Delta M}} \cdot \overline{\log \Delta M}}{e^{\overline{\log M}_{t-1}} + e^{\overline{\log \Delta M}}} \right) \quad (A5-I-4)$$

$$K_1 = \left(\frac{e^{\overline{\log M}_{t-1}}}{e^{\overline{\log M}_{t-1}} + e^{\overline{\log \Delta M}}} \right) \quad (A5-I-5)$$

$$K_1 = \left(\frac{e^{\overline{\log \Delta M}}}{e^{\overline{\log M}_{t-1}} + e^{\overline{\log \Delta M}}} \right) \quad (A5-I-6)$$

$$h_0 = \log(e^{\overline{\log GDD}} + e^{\overline{\log \Delta CP'}}) - \left(\frac{e^{\overline{\log GDD}} \cdot \overline{\log GDD} + e^{\overline{\log \Delta CP'}} \cdot \overline{\log \Delta CP'}}{e^{\overline{\log GDD}} + e^{\overline{\log \Delta CP'}}} \right) \quad (A5-I-7)$$

$$h_1 = \left(\frac{e^{\overline{\log GDD}}}{e^{\overline{\log GDD}} + e^{\overline{\log \Delta CP'}}} \right) \quad (A5-I-8)$$

and,

$$h_2 = \left(\frac{e^{\overline{\log \Delta CP'}}}{e^{\overline{\log GDD}} + e^{\overline{\log \Delta CP'}}} \right) \quad (A5-I-9)$$

Transformation of the Government Domestic Deficit Identity

Similarly, identity (5-8) is transformed into a relationship linear in logs to obtain (5-8"), where

$$w_0 = \log(e^{\overline{\log GE^d}} - e^{\overline{\log GR^d}} - e^{\overline{\log GB_N^d}}) - \left(\frac{e^{\overline{\log GE^d}} \cdot \overline{\log GE^d} - e^{\overline{\log GR^d}} \cdot \overline{\log GR^d} - e^{\overline{\log GB_N^d}} \cdot \overline{\log GB_N^d}}{e^{\overline{\log GE^d}} - e^{\overline{\log GR^d}} - e^{\overline{\log GB_N^d}}} \right) \quad (A5-I-10)$$

$$w_1 = \left(\frac{e^{\overline{\log GE^d}}}{e^{\overline{\log GE^d}} - e^{\overline{\log GR^d}} - e^{\overline{\log GB_N^d}}} \right) \quad (A5-I-11)$$

$$w_2 = \left(\frac{e^{\overline{\log GR^d}}}{e^{\overline{\log GE^d}} - e^{\overline{\log GR^d}} - e^{\overline{\log GB_N^d}}} \right) \quad (A5-I-12)$$

$$w_3 = \left(\frac{e^{\overline{\log GB_N^d}}}{e^{\overline{\log GE^d}} - e^{\overline{\log GR^d}} - e^{\overline{\log GB_N^d}}} \right) \quad (A5-I-13)$$

Transformation of Government Domestic Expenditure Equation

Equation (5-9) is transformed to be linear in logs in deriving equation (5-11). This involves recognising that total revenues (R) are the sum of domestic and oil revenues,

$$R = GR^d + OR.$$

Approximating the log of $(GR^d + OR)$ by

$q_0 + q_1 \log GR^d + q_2 \log OR$ allows the expenditure function to remain linear in logs. The q's are given by:

$$q_0 = \log(e^{\overline{\log GR^d}} + e^{\overline{\log OR}}) - (e^{\overline{\log GR^d}} \cdot \overline{\log GR^d} + e^{\overline{\log OR}} \cdot \overline{\log OR}) \quad (A5-I-14)$$

$$q_1 = \left(\frac{e^{\log GR^d}}{e^{\log GR^d} + e^{\log OR}} \right)$$

(A5-I-15); and

$$q_2 = \left(\frac{e^{\log OR}}{e^{\log GR^d} + e^{\log OR}} \right)$$

(A5-I-16).

APPENDIX 5-II

(a) Derivation of Q_{ji} Values

The elements of the adjoint matrix $[P(E)^+]$ of the matrix $[P(E)]$ are derived as follows. The element, Q_{ji} , of the adjoint matrix is the signed determinant of the cofactor of the element, $P_{ij}(E)$ of $P(E)$. To take an illustrative example, consider the element, Q_{23} . From $P(E)$, obtain the cofactor of $P_{32}(E)$ by eliminating the 3rd row and the 2nd column. Denoting this cofactor matrix by F_{32} , we have

$$Q_{23} = (-1)^{3+2} \cdot |F_{32}|. \quad (A5-IIa-1)$$

$$F_{32} = \begin{bmatrix} E-K_1 & 0 & 0 & 0 & 0 \\ 0 & -W_1 E & W_2 E & 0 & 0 \\ 0 & 0 & E & -r_1 E & 0 \\ -\frac{\lambda b_1}{1+\lambda b_1} E & 0 & 0 & E & 0 \\ -\beta_2 E & 0 & 0 & \beta_2 E & E \end{bmatrix}$$

Hence,

$$Q_{23} = (-1) |F_{32}|. \quad (A5-IIa-2)$$

Expanding the determinant we obtain,

$$Q_{23} = (-1) (E) (E-K_1) (-W_1 E) (E^2) = W_1 E^5 - W_1 K_1 E^4 \quad (A5-IIa-3)$$

By similar procedures the following expressions are derived for the Q_{ji} 's:

$$Q_{11} = E^5 - (1-v)E^4 \quad (A5-IIa-4)$$

$$Q_{12} = K_2 h_1 E^5 - (K_2 h_1 - K_2 h_1 v) E^4 \quad (A5-IIa-5)$$

$$Q_{13} = K_2 h_1 w_1 E^5 \quad (A5-IIa-6)$$

$$Q_{14} = (K_2 h_1 w_1 v g_1 q_1 - K_2 h_1 w_2) E^5 + (K_2 h_1 w_2 - K_2 h_1 w_2 v) E^4 \quad (A5-IIa-7)$$

$$Q_{15} = (K_2 h_1 w_1 v g_1 q_1 r_1 - K_2 h_1 w_2 r_1) E^5 + (K_2 h_1 r_1 w_2 - K_2 h_1 r_1 w_2 v) E^4 \quad (A5-IIa-8)$$

$$Q_{16} = 0 \quad (A5-IIa-9)$$

$$Q_{21} = \left[\frac{\lambda b_1 r_1 (w_1 v g_1 q_1 - w_2)}{1 + \lambda b_1} \right] E^5 + \left[\frac{\lambda b_1 r_1 w_2 (1-v)}{1 + \lambda b_1} \right] E^4 \quad (A5-IIa-10)$$

$$Q_{22} = E^5 + (v-1-K_1) E^4 + (K_1-K_1 v) E^3 \quad (A5-IIa-11)$$

$$Q_{23} = w_1 E^5 - w_1 K_1 E^4 \quad (A5-IIa-12)$$

$$Q_{24} = (w_1 v g_1 q_1 - w_2) E^5 + (w_2 - w_2 v - K_1 w_1 v g_1 q_1 + K_1 w_2) E^4 + (w_2 K_1 v - w_2 K_1) E^3 \quad (A5-IIa-13)$$

$$Q_{25} = (r_1 w_1 v g_1 q_1 - r_1 w_2) E^5 + (r_1 w_2 - r_1 v w_2 - r_1 K_1 w_1 v g_1 q_1 + r_1 K_1 w_2) E^4 + (r_1 K_1 v w_2 - r_1 K_1 w_2) E^3 \quad (A5-IIa-14)$$

$$Q_{26} = 0 \quad (A5-IIa-15)$$

$$Q_{31} = \frac{\lambda b_1 r_1 v g_1 q_1}{1 + \lambda b_1} E^5 \quad (A5-IIa-16)$$

$$Q_{32} = \frac{K_2 h_1 \lambda b_1 r_1 v g_1 q_1}{1 + \lambda b_1} E^5 \quad (A5-IIa-17)$$

$$Q_{33} = E + \left[\frac{\lambda b_1 K_2 h_1 w_2 r_1 - (K_1 + K_1 \lambda b_1)}{1 + \lambda b_1} \right] E^4 \quad (A5-IIa-18)$$

$$Q_{34} = v g_1 q_1 E^5 - K_1 v g_1 q_1 E^4 \quad (A5-IIa-19)$$

$$Q_{35} = r_1 v g_1 q_1 E^5 - K_1 r_1 v g_1 q_1 E^4 \quad (A5-IIa-20)$$

$$Q_{36} = 0 \quad (A5-IIa-21)$$

$$Q_{41} = \frac{r_1 \lambda b_1}{1 + \lambda b_1} E^5 - \left(\frac{r_1 \lambda b_1 - r_1 \lambda b_1}{1 + \lambda b_1} \right) E^4 \quad (A5-IIa-22)$$

$$Q_{42} = \frac{K_2 h_1 r_1 \lambda b_1}{1 + \lambda b_1} E^5 - \left(\frac{K_2 h_1 r_1 \lambda b_1 - K_2 h_1 r_1 \lambda b_1 v}{1 + \lambda b_1} \right) E^4 \quad (A5-IIa-23)$$

$$Q_{43} = \frac{w_1 K_2 h_1 \lambda b_1 r_1}{1 + \lambda b_1} E^5 \quad (A5-IIa-24)$$

$$Q_{44} = E^5 + (v - 1 - K_1) E^4 + (K_1 - K_1 v) E^3 \quad (A5-IIa-25)$$

$$Q_{45} = r_1 E^5 + (r_1 v - r_1 - r_1 K_1) E^4 + (r_1 K_1 - r_1 K_1 v) E^3 \quad (A5-IIa-26)$$

$$Q_{46} = 0 \quad (A5-IIa-27)$$

$$Q_{51} = \frac{\lambda b_1}{1 + \lambda b_1} E^5 + \left(\frac{v \lambda b_1 - \lambda b_1}{1 + \lambda b_1} \right) E^4 \quad (A5-IIa-28)$$

$$Q_{52} = \frac{K_2 h_1 \lambda b_1}{1 + \lambda b_1} E^5 + \left(\frac{K_2 h_1 \lambda b_1 v - K_2 h_1 \lambda b_1}{1 + \lambda b_1} \right) E^4 \quad (A5-IIa-29)$$

$$Q_{53} = \frac{\lambda b_1 w_1 K_2 h_1}{1 + \lambda b_1} E^5 \quad (A5-IIa-30)$$

$$Q_{54} = \left(\frac{\lambda b_1 K_2 h_1 w_1 v g_1 q_1 - \lambda b_1 K_2 h_1 w_2}{1 + \lambda b_1} \right) E^5 + \left(\frac{\lambda b_1 K_2 h_1 w_2 - \lambda b_1 K_2 h_1 w_2 v}{1 + \lambda b_1} \right) E^4 \quad (A5-IIa-31)$$

$$Q_{55} = E^5 + (v - 1 - K_1) E^4 + (K_1 - K_1 v) E^3 \quad (A5-IIa-32)$$

$$Q_{56} = 0 \quad (A5-IIa-33)$$

$$Q_{61} = \left[\frac{(1+\lambda b_1) \beta_2 - (\beta_2 \lambda b_1)}{1+\lambda b_1} \right] E^5 + \left[\frac{(\beta_2 \lambda b_1 - v \beta_2 \lambda b_1) + (v \beta_2 - \beta_2) (1+\lambda b_1)}{1+\lambda b_1} \right] E^4 \quad (A5-IIa-34)$$

$$Q_{62} = \left[\frac{(1+\lambda b_1) (\beta_2 K_2 h_1) - \beta_2 \lambda b_1 K_2 h_1}{1+\lambda b_1} \right] + \left[\frac{(1+\lambda b_1) (\beta_2 K_2 h_1 v - \beta_2 K_2 h_1) + (\beta_2 \lambda b_1 K_2 h_1 - \beta_2 \lambda b_1 K_2 h_1 v)}{1+\lambda b_1} \right] E^4 \quad (A5-IIa-35)$$

$$Q_{63} = \left[\frac{(1+\lambda b_1) (\beta_2 w_1 K_2 h_1) - \beta_2 \lambda b_1 w_1 K_2 h_1}{1+\lambda b_1} \right] E^5 \quad (A5-IIa-36)$$

$$Q_{64} = \left[\frac{(1+\lambda b_1) (\beta_2 K_2 h_1 w_1 v g_1 q_1 - \beta_2 K_2 h_1 w_2) + (\beta_2 \lambda b_1 K_2 h_1 w_2 - \beta_2 \lambda b_1 K_2 h_1 w_1 v g_1 q_1)}{1+\lambda b_1} \right] E^5 + \left[\frac{(1+\lambda b_1) (\beta_2 K_2 h_1 w_2 - \beta_2 K_2 h_1 w_2 v) + (\beta_2 \lambda b_1 K_2 h_1 w_2 v - \beta_2 \lambda b_1 K_2 h_1 w_2)}{1+\lambda b_1} \right] E^4 \quad (A5-IIa-37)$$

$$Q_{65} = \beta_2 (K_2 h_1 r_1 w_2 - 1 - K_2 h_1 r_1 w_1 v g_1 q_1) E^5 + \beta_2 (K_2 h_1 r_1 w_2 v - K_2 h_1 r_1 w_2 - v + 1 + K_1) E^4 + \beta_2 (K_1 v - K_1) E^3 \quad (A5-IIa-38)$$

$$Q_{66} = \left[\frac{(1+\lambda b_1) \beta_2 + \lambda b_1 K_2 h_1 r_1 (w_2 - w_1 v g_1 q_1)}{1+\lambda b_1} \right] E^5 + \left[\frac{\beta_2 (1+\lambda b_1) (v - 1 - K_1) + \lambda b_1 K_2 h_1 r_1 w_2 (v-1)}{1+\lambda b_1} \right] E^4 + \beta_2 K_1 (1-v) E^3 \quad (A5-IIa-39)$$

(b) The Values of Σ_i

$$\begin{aligned} \Sigma_1 = & v\bar{\sigma}_1 + K_2 h_1 v \bar{\sigma}_2 + K_2 h_1 w_1 \bar{\sigma}_3 + K_2 h_1 v (w_1 g_1 q_1 - w_2) \bar{\sigma}_4 \\ & + K_2 h_1 v r_1 (w_1 g_1 q_1 - w_2) \bar{\sigma}_5 \end{aligned} \quad (A5-IIb-1)$$

$$\begin{aligned} \Sigma_2 = & \frac{\lambda b_1 r_1 v (w_1 g_1 q_1 - w_2)}{1 + \lambda b_1} \bar{\sigma}_1 + v(1-K_1) \bar{\sigma}_2 + w_1(1-K_1) \bar{\sigma}_3 \\ & + [w_1 v g_1 q_1 (1-K_1) + w_2 v (K_1 - v)] \bar{\sigma}_4 \\ & + [r_1 w_1 v g_1 q_1 (1-K_1) + r_1 v w_2 (K_1 - 1)] \bar{\sigma}_5 \end{aligned} \quad (A5-IIb-2)$$

$$\begin{aligned} \Sigma_3 = & \frac{\lambda b_1 r_1 v g_1 q_1}{1 + \lambda b_1} \bar{\sigma}_1 + \frac{\lambda b_1 r_1 v g_1 q_1 K_2 h_1}{1 + \lambda b_1} \bar{\sigma}_2 \\ & + \frac{\lambda b_1 (1 + K_2 h_1 w_2 r_1 - K_1) + (1-K_1)}{1 + \lambda b_1} \bar{\sigma}_3 \\ & + v g_1 q_1 (1-K_1) \bar{\sigma}_4 + r_1 v g_1 q_1 (1-K_1) \bar{\sigma}_5 \end{aligned} \quad (A5-IIb-3)$$

$$\begin{aligned} \Sigma_4 = & \frac{r_1 v \lambda b_1}{1 + \lambda b_1} \bar{\sigma}_1 + \frac{K_2 h_1 r_1 \lambda b_1}{1 + \lambda b_1} \bar{\sigma}_2 + \frac{w_1 K_2 h_1 \lambda b_1 r_1}{1 + \lambda b_1} \bar{\sigma}_3 \\ & + v(1-K_1) \bar{\sigma}_4 + r_1 v(1-K_1) \bar{\sigma}_5 \end{aligned} \quad (A5-IIb-4)$$

$$\begin{aligned} \Sigma_5 = & \frac{v \lambda b_1}{1 + \lambda b_1} \bar{\sigma}_1 + \frac{K_2 h_1 \lambda b_1}{1 + \lambda b_1} \bar{\sigma}_2 + \frac{w_1 K_2 h_1 \lambda b_1}{1 + \lambda b_1} \bar{\sigma}_3 \\ & + \frac{K_2 h_1 v \lambda b_1 (w_1 g_1 q_1 - w_2)}{1 + \lambda b_1} \bar{\sigma}_4 + v(1-K_1) \bar{\sigma}_5 \end{aligned} \quad (A5-IIb-5)$$

$$\Sigma_6 = \frac{v\beta_2}{1+\lambda b_1} \bar{\sigma}_1 + \frac{K_2 h_1 v \beta_2}{1+\lambda b_1} \bar{\sigma}_2 + \frac{K_2 h_1 \beta_2 (v-1)}{1+\lambda b_1} \bar{\sigma}_3$$

$$+ \left[\frac{K_2 h_1 \beta_2 \{ (w_1 v g_1 q_1 - w_2) + w_2 \lambda b_1 (1-v) \}}{1+\lambda b_1} \right] \bar{\sigma}_4$$

$$+ \left[\frac{K_2 h_1 r_1 \lambda b_1 (w_2 - w_1 g_1 q_1) + \beta_2 (K_1 + v + v \lambda b_1 - K_1 v - K_1 v \lambda b_1)}{1+\lambda b_1} \right] \bar{\sigma}_6$$

(A5-IIb-6)

APPENDIX 6-I

The empirical results presented in Chapter 6 are based on the final macro-model which is presented in Chapter 5. Since this study had started out with a slightly different model, this appendix summarizes this earlier model and some tentative estimates of that model.

Derivation of the Alternative Model:

An understanding of the impact of oil revenues on domestic economic activity requires a clear specification of the channel through which revenues accruing in foreign exchange impact on the level of domestic money supply under a regime of fixed exchange rates. We posit that external reserves generated by oil revenues affect domestic money supply only via the government budget. To determine the degree of monetization of external reserves, we distinguish between domestic government revenues and external revenues and also between domestic government expenditures and external expenditures. The difference between domestic revenues and domestic expenditures constitutes the amount of external reserves monetized in any given time period as a result of government budgetary operations.¹ This argument along with other sources of domestic liquidity changes is summarized in the following equation:

$$M^S_t = m_t \{ \Delta C_{pt} + BP_{pt} + (Gd_t - Rd_t - Ld_t) + \Delta NUA_t + H_{t-1} \} \dots (A6-I-a)$$

which is derived from equations A6-I-1 and A6-I-2, and where, M^S is money supply; m is money multiplier; ΔC_p is change in the claims

of banking sector on private sector; BP_p is balance of payments of the private sector; G_d is government domestic expenditures; R_d is government domestic revenues; L_d is government borrowing from non-bank domestic sector; ΔNUA is change in unclassified assets of banking system (net); and H is high powered money (money base).

The conventional representation of the money supply process is presented in (A6-I-b)

$$M_t^S = m_t (D_t + F_t) \quad (A6-I-b)$$

where D is the net domestic assets of the central bank and F is external reserves.

The analytical difference between (A6-I-a) and (A6-I-b) is highlighted by the hypothetical example presented in Table A6-I-1. In explaining the big jump in domestic liquidity between 1972 and 1973, formulation (A6-I-a) emphasises the domestic budget deficit as the main underlying cause. The conventional formulation (A6-I-b) on the other hand, regards the increase of \$680 billion in foreign reserves as the major determinant of the increase in domestic liquidity with the overall government budget surplus offsetting part of that effect. From the point of view of policy formulation aimed at controlling domestic liquidity, the two formulations would tend to lead to different policy prescriptions.²

The major point of departure in the model developed below is the explicit choice of the above alternative formulation as the appropriate one for an OPEC economy.

TABLE A6-I-1

Hypothetical OPEC Economy: Government Sector
Operations and Domestic Liquidity, 1972/73

	<u>1972</u>	<u>1973</u>
Total Government Revenues (R)	200	800
Domestic (Rd)	(100)	(100)
Foreign or Oil (OR)	(100)	(700)
Total Government Expenditures (G)	250	500
Domestic (Gd)	(230)	(480)
Foreign (Gf)	(20)	(20)
Overall Budget Surplus/Deficit (+/-)	-50	+300
Financing:		
Domestic Banking System Claims on Government	+40	-300
Domestic Non-Bank Private Sector Claims on Government	+10	0
Effect of Government operations on Domestic Liquidity	+120	+380
Alternative formulation (Gd-Rd-Ld)	+120	+380
Conventional formulation		
ΔF	(+80)	(+680)
ΔD	(+40)	(-300)

Money Supply Determination

$$M_t^S = m_t H_t \quad (A6-I-1)$$

$$\Delta H_t = \Delta C p_t + B P p_t + (G d_t - R d_t - L d_t) + \Delta N U A_t \quad (A6-I-2)$$

From (A6-I-2),

$$H_t = \Delta C p_t + B P p_t + (D d_t - R d_t - L d_t) + \Delta N U A_t + H_{t-1} \quad (A6-I-3)$$

Combining (A6-I-3) and (A6-I-1),

$$M_t^S = m_t \{ \Delta C p_t + B P p_t + (G d_t - R d_t - L d_t) + \Delta N U A_t + H_{t-1} \} \quad (A6-I-4)$$

Since we intend to specify the model in logs and because using (A6-I-4) will lead to non-linearities in variables, (A6-I-4) is transformed to give:³

$$\log M_t^S = \log m_t + K_0 + K_1 \log \Delta C p_t + K_2 \log B P p_t + K_3 \log C g_t + K_4 \log \bar{C}_t$$

$$\text{where } \bar{C}_t = \Delta N U A_t + H_{t-1} \quad (A6-I-5)$$

$$K_0 = \log A_1 - \frac{1}{A_1} (B_1)$$

$$K_1 = \frac{e^{\log \Delta C p}}{A_1}$$

$$K_2 = \frac{e^{\log B P p}}{A_1}$$

$$K_3 = \frac{e^{\log C g}}{A_1}$$

$$K_4 = \frac{e^{\overline{\log C}}}{A_1}$$

$$\text{and } A_1 = e^{\overline{\log \Delta C_p}} + e^{\overline{\log B P p}} + e^{\overline{\log C g}} + e^{\overline{\log C}}$$

$$B_1 = (e^{\overline{\log \Delta C_p}} \cdot \overline{\log \Delta C_p}) + (e^{\overline{\log B P p}} \cdot \overline{\log B P p}) + (e^{\overline{\log C g}} \cdot \overline{\log C g}) \\ + (e^{\overline{\log C}} \cdot \overline{\log C})$$

$$C g_t = (G d_t - R d_t - L d_t) \quad (A6-I-6)$$

By a similar transformation:

$$\log C g_t = C_0 + C_1 \log G d_t - C_2 \log R d_t - C_3 \log L d_t \quad (A6-I-7)$$

where,

$$C_0 = \log A_2 - \frac{1}{A} (B_2)$$

$$C_1 = \frac{e^{\overline{\log G d}}}{A_2}$$

$$C_2 = \frac{e^{\overline{\log R d}}}{A_2}$$

$$C_3 = \frac{e^{\overline{\log L d}}}{A_2}$$

$$\text{and } A_2 = e^{\overline{\log G d}} - e^{\overline{\log R d}} - e^{\overline{\log L d}}$$

$$B_2 = (e^{\overline{\log G d}} \cdot \overline{\log G d}) - (e^{\overline{\log R d}} \cdot \overline{\log R d}) - (e^{\overline{\log L d}} \cdot \overline{\log L d})$$

Government Sector

We assume that desired government domestic expenditures, in real terms, is an increasing function of its real aggregate revenues:

$$\log(Gd/P)_t^* = g_0 + g_1(R/P)_t \quad (A6-I-8)$$

However, due to lags in the formulation and execution of government projects and other constraints on project implementation, only a fraction of desired domestic expenditure increase is actually expended:

$$\Delta \log(Gd/P)_t = \lambda \{ \log(Gd/P)_t^* - \log(Gd/P)_{t-1} \} \quad (A6-I-9)$$

Using (A6-I-8) and (A6-I-9) gives,

$$\log(Gd/P)_t = \lambda g_0 + g_1 \log(R/P)_t + (1-\lambda) \log(Gd/P)_{t-1} \quad (A6-I-10)$$

or

$$\log Gd_t = \lambda g_0 + \lambda g_1 \log R_t + (1-\lambda g_1) \log P_t + (1-\lambda) \log(Gd/P)_{t-1} \quad (A6-I-11)$$

$$R_t = OR_t + Rd_t \quad (A6-I-12)$$

Again, to avoid non-linearities, (A6-I-12) is approximated by (A6-I-13) by transformation to give

$$\log R_t = r_0 + r_1 \log OR_t + r_2 \log Rd_t \quad (A6-I-13)$$

where

$$r_0 = \log A_3 - \frac{1}{A_3} (B_3)$$

$$r_1 = \frac{e^{\log OR}}{A_3}$$

$$r_2 = \frac{e^{\log Rd}}{A_3}$$

$$\text{and } A_3 = e^{\overline{\log OR}} + e^{\overline{\log Rd}}$$

$$B_3 = (e^{\overline{\log OR}} \cdot \overline{\log OR}) + (e^{\overline{\log Rd}} \cdot \overline{\log Rd})$$

Potential domestic government revenue is a positive function of domestic nominal income such that

$$\log R^P_{dt} = t_0 + t_1 (\log Y_t + \log P_t) \quad (\text{A6-I-14})$$

However, due to lags and inefficiency in revenue collection, the actual change in domestic revenue is some fraction of the change in potential revenue.⁴ Hence,

$$\log Rd_t + T \{ \log R^P_{dt} - \log Rd_{t-1} \} \quad (\text{A6-I-15})$$

Employing (A6-I-14) in (A6-I-15) gives

$$\log Rd_t = T t_0 + T t_1 (\log Y_t + \log P_t) + (1-T) \log Rd_{t-1} \quad (\text{A6-I-16})$$

Determination of Domestic Price Level

Following the monetarists, this model takes the view that the domestic price level is determined by the state of excess demand in the money market. While the merit of an approach which distinguishes between the domestic and the import components in the aggregate price index is recognized, the available data does not as of now lend itself to such analysis. Demand for real money balances is posited to depend on domestic income and the expected rate of inflation. The expected rate of inflation is selected over the rate of interest as a measure of the opportunity

cost of holding money primarily because of the relatively under developed nature of the capital market.⁵ In such a situation, holding of real assets becomes the relevant hedge against inflation. Thus real money demand is specified as

$$\log(M/P)_t^D = a_0 + a_1 \log Y_t - a_2 \pi_t \quad (A6-I-17)$$

The change in the real stock of money balances adjusts to the real excess demand for money according to the following mechanism:

$$\Delta \log(M/P)_t = V \{ \log(M/P)_t^D - \log(M/P)_{t-1} \} \quad (A6-I-18)$$

using (A6-I-17) in (A6-I-18) gives

$$\log(M/P)_t = Va_0 + Va_1 \log Y_t - Va_2 \pi_t + (1-V) \log(M/P)_{t-1} \quad (A6-I-19)$$

or

$$\log P_t = -Va_0 - Va_1 \log Y_t + Va_2 \pi_t - (1-V) \log(M/P)_{t-1} + \log M_t \quad (A6-I-20)$$

The change in inflationary expectations is specified to follow the following adaptive specification:⁶

$$\Delta \pi_t = \beta \{ \Delta \log P_t - \pi_{t-1} \} \quad (A6-I-21)$$

From which

$$\pi_t = \beta \Delta \log P_t + (1-\beta) \pi_{t-1} \quad (A6-I-22)$$

Determination of Private Expenditures

In consonance with the monetarist school, real private expenditures are determined by the level of real income and the excess supply of real money balances:

$$\log(E/P)_t = \epsilon_1 \log Y_t + \epsilon_2 \{ \log(M/P)_{t-1} - \log(M/P)_t^D \} \quad (A6-I-23)$$

$$\log E_t = -\epsilon_2 a_0 + (\epsilon_1 - \epsilon_2 a_1) \log Y_t + \epsilon_2 \log (M/P)_{t-1} + \epsilon_2 a_2 \pi_t + \log P_t \quad (A6-I-24)$$

Private Sector Reserve Flow Determination

Following the Monetary Approach to the Balance of payments, private sector balance of payments is assumed to be determined by the state of disequilibrium in the money market. Employing the money market equilibrium condition,

$$\log M_t^S = \log M_t^D \quad (A6-I-25), \text{ and}$$

substituting (A6-I-5) and (A6-I-17) into (A6-I-25),

$$\log m_t + K_0 + K_1 \log \bar{A} C_p t + K_2 \log B P p_t + K_3 \log C g_t + K_4 \log \bar{C} t = a_0 + a_1 \log Y_t - a_2 \log \pi_t + \log P_t \quad (A6-I-26)$$

From (A6-I-26)

$$\begin{aligned} \log B P p_t = & \frac{(a_0 - K_0)}{K_2} + \left(\frac{a_1}{K_2}\right) \log Y_t - \left(\frac{a_2}{K_2}\right) \log \pi_t + \left(\frac{1}{K_2}\right) \log P_t \\ & - \left(\frac{1}{K_2}\right) \log m_t - \left(\frac{K_1}{K_2}\right) \log C p_t - \left(\frac{K_3}{K_2}\right) \log C g_t - \left(\frac{K_4}{K_2}\right) \log \bar{C} t \end{aligned} \quad (A6-I-27)$$

Determination of Domestic (Non-Oil) Income

The domestic income identify is:

$$(Y P)_t = E_t + G d_t + B P p_t \quad (A6-I-28)$$

or

$$\log (Y P)_t = e^{\log (E_t + G d_t + B P p_t)} \quad (A6-I-29)$$

Again, using (A6-I-28) with the other equations of the model will lead to non-linearities in variables. To avoid this, a transformation is applied to (A6-I-28)

$$\log (Y P)_t = y_0 + y_1 \log E_t + y_2 \log G d_t + y_3 \log B P p_t \quad (A6-I-29')$$

or

$$\log Y_t = y_0 + y_1 \log E_t + y_2 \log Gd_t + y_3 \log BPP_t - \log P_t \quad (A6-I-30)$$

where

$$y_0 = \log A_4 - \frac{1}{A_4} (B_4)$$

$$y_1 = \frac{e^{\log E}}{A_4}$$

$$y_2 = \frac{e^{\log Gd}}{A_4}$$

$$y_3 = \frac{e^{\log BPP}}{A_4}$$

and,

$$A_4 = e^{\log E} + e^{\log Gd} + e^{\log BPP}$$

$$B_4 = (e^{\log E} \cdot \log E) + (e^{\log Gd} \cdot \log Gd) + (e^{\log BPP} \cdot \log BPP)$$

THE COMPLETE MODEL

We can now put together the final equations that make up our model:

$$\log M_t^S = K_0 + \log m_t + K_1 \log \Delta C p_t + K_2 \log BPP_t + K_3 \log Cg_t + K_4 \log \bar{C}_t \quad (A6-I-31)$$

$$Cg_t = c_0 + c_1 \log Gd_t - c_2 \log Rd_t - c_3 \log Ld_t \quad (A6-I-32)$$

$$\log Gd_t = \lambda g_0 + \lambda g_1 \log R_t + (1 - \lambda g_1) \log P_t + (1 - \lambda) \log (Gd/P)_{t-1} \quad (A6-I-33)$$

$$\log R_t = r_0 + r_1 \log OR_t + r_2 \log Rd_t \quad (A6-I-34)$$

$$\log Rd_t = Tt_0 + Tt_1 (\log Y_t + \log P_t) + (1 - T) \log Rd_{t-1} \quad (A6-I-35)$$

$$\log P_t = -va_0 - va_1 \log Y_t + va_2 \Pi_t - (1 - v) \log (M/P)_{t-1} + \log M_t \quad (A6-I-36)$$

$$\Pi_t = \beta \Delta \log P_t + (1-\beta) \Pi_{t-1} \quad (\text{A6-I-37})$$

$$\log E_t = -\epsilon_2 a_0 + (\epsilon_1 - \epsilon_2 a_1) \log Y_t + \epsilon_2 \log (M/P)_{t-1} + \epsilon_2 a_2 \Pi_t + \log P_t \quad (\text{A6-I-38})$$

$$\begin{aligned} \log BPP_t = & \left(\frac{a_0 - K_0}{K_2} \right) + \left(\frac{a_1}{K_2} \right) \log Y_t - \left(\frac{a_2}{K_2} \right) \Pi_t + \left(\frac{1}{K_2} \right) \log P_t - \left(\frac{1}{K_2} \right) \log m_t \\ & - \left(\frac{K_1}{K_2} \right) \log \Delta C p_t - \left(\frac{K_3}{K_2} \right) \log C g_t - \left(\frac{K_4}{K_2} \right) \log \bar{C}_t \end{aligned} \quad (\text{A6-I-39})$$

$$\log Y_t = y_0 + y_1 \log E_t + y_2 \log G d_t + y_3 \log BPP_t - \log P_t \quad (\text{A6-I-40})$$

DEFINITION OF VARIABLES

All variables are in nominal values except otherwise stated.

- M - Money
- m - Money multiplier
- Cp - Banking Sector Credit to Private Sector
- BPp - Private Sector Balance of Payments
- Gd - Government Domestic Expenditures
- Rd - Government Domestic Revenues
- Ld - Government Borrowing from Domestic Non-Bank Private Sector
- CP' - Net Unclassified Assets of the Central Bank
- H - High Powered Money (Monetary Base)
- D - Domestic Assets of the Central Bank
- F - Foreign Reserves held by the Central Bank
- P - Domestic Price Level (CPI)
- R - Total Government Revenues
- OR - Oil Revenues Accruing to Government
- Y - Real Non-Oil Sector National Income
- Π - Expected Rate of Inflation (Percentages)
- E - Private Sector Aggregate Expenditures
- e - Exponent Operator
- subscript 't' - time period '0'
- superscript 'D' signifies Demand
- super (*) signifies Desired
- super (p) signifies potential

Empirical Application

One feature of the above model is the distinction between private and public sector variables. Such a distinction, however, also makes the empirical application of the model difficult. In the case of Nigeria, no such data classification exists. However, the World Bank estimates that on average, in the period under study, roughly 20 per cent and 50 per cent of aggregate current and capital expenditures respectively were spent on imports.⁷ By using these crude estimates to distinguish between domestic and foreign government expenditures and by excluding the value of oil exports from private GNP, some preliminary estimates of the model, reported below were obtained.

Some Preliminary Estimates

Since the results below are just exploratory estimates, we have used OLS technique. No results are reported for the private sector balance of payments equation since all attempts at estimating this equation produced nonsensical results. Ignoring the identities, the following results were obtained:

$$\log Gd_t = 0.89 + 0.59 \log R_t + 0.49 \log P_t + 0.29 \log (Gd/P)_{t-1} \quad (A6-I-41)$$

(0.38) (4.50) (1.26) (0.77)

$$R^2 = 0.99; F = 494.90; D-W = 1.50$$

$$\log Rd_t = -2.13 + 0.79 \log (YP_t) + 0.27 \log Rd_{t-1} \quad (A6-I-42)$$

(-2.41) (3.41) (1.24)

$$R^2 = 0.91; F = 78.09; D-W = 2.13$$

$$\log P_t = 2.40 - 0.31 \log Y_t + 0.11 \log \Pi_t + 0.32 \log (M/P)_{t-1} + 0.32 \log M_t$$

(8.17) (-3.04) (0.94) (2.15) (3.51)

(A6-I-43)

$$R^2 = 0.98; \quad F = 607.05; \quad D-W = 1.66$$

$$\log E_t = 0.88 + 0.94 \log Y_t - 0.07 \log (M/P)_{t-1} + 0.04 \log \Pi_t + 1.02 \log P_t$$

(0.28) (24.12) (-0.74) (1.56) (9.82)

(A6-I-44)

$$R^2 = 0.99; \quad F = 5455.43; \quad D-W = 2.22$$

$$\Pi_t = 0.2 \Delta \log P_t + 0.8 \Pi_{t-1}$$

(A6-I-45)

FOOTNOTES TO APPENDIX 6-I

1. The implicit assumption in this formulation is that government borrowing from the domestic non-bank sector (Ld) is zero. Where this does not hold, the amount monetized is the domestic budget deficit less Ld.
2. For a further discussion of the importance of this distinction, see Morgan, D., 1979.
3. The transformation here involves a Taylor's expansion around the logarithmic means of ΔC_p , $B P_p$, C_g and $\bar{C}$. For employment of this method in other macro models, see Aghevli, B. and Khan, M., 1978. For the same methodology applied in a different context, see Chow, G., 1974, pp. 131-134.
4. Among reasons for such lags is manpower constraints that delay tax assessment and collection.
5. For a similar reason for the use of the expected rate of inflation, see Aghevli, B. and Khan, M., op.cit.
6. The choice of an adaptive expectations scheme as opposed to a rational scheme is based on the consideration that a rational scheme involves a relatively more efficient technology of information. In the context of a developing economy, it seems appropriate to assume the absence of such a highly efficient technology.
7. This was communicated to me verbally by an official of the bank, since the country report on which they were based remains unpublished and hence a secret document.

APPENDIX 6-II

DATA DESCRIPTION AND SOURCES

- M_1 - Money Supply (Narrow Definition), IMF (1980).
- M_2 - Money Supply (Broad Definition), IMF (1980).
- a - Money multiplier, Generated.
- GDD - Government Domestic Deficit ($\equiv GED - GRd - GB_N^d$).
- GED - Government Domestic Expenditure. Proxied by total government expenditure (Federal and States), Central Bank of Nigeria, Economic and Financial Review (various) and World Bank data files.
- GRd - Government Domestic Revenues. Total government Revenues, *ibid.*, less oil Revenues (OR), IMF (1980).
- GB_N^d - Government borrowing from non-bank public, Central Bank of Nigeria, Economic and Financial Review (various issues) and Annual Report (various issues).
- y - Non-oil income. GNP, IMF (1980) less value of oil exports, deflated by P.
- P - Consumer price index (combined rural and urban), IMF (1980).
- BTD - Non-oil Balance of Trade Deficit. Aggregate Balance of Trade deficit (imports less exports), less oil exports. All data from IMF (1980).
- P^T - Price of Traded goods. Proxied by Import Price Index, derived from Central Bank of Nigeria, Economic Indicators, 1978 and IMF, (various issues).
- WAR - Dummy variable for Civil War years, value of 1 in 1967, 1968 and 1969, and '0' otherwise.
- CP - Banking sector credit to the private sector, Central Bank of Nigeria, (various issues).
- NUA - Net unclassified Assets of the Banking System, *ibid.*

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