AGRICULTURAL PRICING POLICIES IN DEVELOPING COUNTRIES: THE CASE OF COCOA PRICING IN GHANA

by

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THIS THESIS IS DEDICATED TO THE

MEMORY OF MY BELOVED MOTHER

COMFORT AFUA WAMPAH

ABSTRACT

The main theme of this thesis is the evaluation of the effects of alternative agricultural pricing policies on the economies of developing countries with, particular reference to cocoa pricing in Ghana. Whereas earlier studies of this nature have concentrated on the agricultural sector only, this study attmpts to evaluate the economic impact of such policies in a macro perspective. Towards this end, a macroeconometric model is constructed for the Ghanaian economy. A simulation technique is then used to evaluate the global effects of the policies. The importance of smuggling in the cocoa sector was also incorporated into the analysis.

As expected, the findings indicate that an increase in the cocoa producer price leads to a positive and significant supply response in this sector. The resultant increase in income helps to stimulate activity in other important sectors of the economy. Moreover, the expanded import capacity brought about by increased cocoa exports also contributes to the expansion of value added in other sectors. In order for the government to avoid excessive tax revenue loss due to increased producer prices, the study recommends changes in the exchange rate policy.

RESUMÉ

Cette étude porte sur l'évaluation des effets que des politiques alternatives de prix dans le secteur agricole ont sur les économies des pays en voie de dévéloppement, tout en mettant l'accent sur la détermination du prix de cacao au Ghana. Tandis que les études antérieures du même genre ont mis l'emphase sur le secteur agricole, la présente étude cherche à évaluer l'impact de ces politiques dans une perspective macroéconomique. À cette fin, nous proposons un modèle macroéconometrique de l'économie ghanéenne. Une technique de simulation nous permet par la suite d'évaluer les effets globaux de ces politiques. Le rôle de la contrebande dans la détermination des prix agricole fait aussi parti de l'analyse.

Comme prévu, les résultats empiriques démontrent qu'une hausse dans le prix offert aux producteurs de cacao aménera une hausse significative dans la quantité offerte de ce produit. Cette dernière se traduit en une augmentâtion du revenu dans ce secteur qui à son tour sert à stimuler les activités économiques dans d'autre secteurs importants de l'économie. En plus, l'expansion de la capacité d'importation dûe à l'augmentation du prix de cacao contribue à l'expansion de la valeur ajoutée dans d'autres secteurs. Cette dissertation propose que le gouvernement fasse des changements dans sa

politique de taux de change afin d'éviter une perte excessive de revenu d'impôt provoquée par la hausse du prix de cacao.

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PREFACE

In recent years there has been much concern among economists as well as politicians about the rapid decline in agricultural production in developing countries. Since agriculture is the major economic activity in these countries, the fall in production in this sector has lead to slow economic growth, high rates of unemployment and greater dependence on foreign aid. Agriculture also accounts for a high percentage of developing country exports, and hence its decline has contributed to shortages of foreign exchange and unfavourable balance of payments situations in these countries. As a result, manufacturing industries, which rely heavily on imported inputs, have also suffered a setback.

Several factors have contributed to this rapid decline, including drought, lack of adequate incentives and adverse pricing policies. This study focuses on the impact of pricing policies on the economies of developing countries. Much research has pointed to the existence of extensive interference by governments in the agricultural sectors of developing countries which has turned the domestic terms of trade against agriculture, with adverse effects on economic development, economic efficiency and income distribution. Arguments such as the existence of an optimal tax, stabilization of producer

prices and farmers' incomes and redistribution of income have been used to justify the tax on agriculture.

Many studies have shown, however, that the pricing policies have not often achieved what is expected of them. Fluctuations in farmers' incomes still exist, and for small producing countries, where the optimal tax argument does not hold, there is still evidence of heavy taxation. Other studies have indicated that income distribution in fact has been made worse by these policies.

Previous studies of agricultural pricing policies have been conducted within the framework of partial equilibrium analysis and they have centred on estimating the welfare effects of these policies in terms of producers' and consumers' surplus. These studies are useful in that they draw attention to pricing policies in the agricultural sectors, but because they are confined to the agricultural sectors, they are not capable of measuring the global impact of such policies. Given the existence of of extensive linkages between agriculture and the rest of the economy in developing countries, it will be useful for policy purposes to have some indication as to the impact of pricing policies in the agricultural sector on the rest of the economy. This is the focus of the dissertation.

Cocoa pricing in Ghana is used as a case study because past studies have pointed to heavy taxation in the cocoa sector. Furthermore, since cocoa is the major cash crop in Ghana, the linkages between this sector and the rest of the

economy are likely to be significant. A macroeconometric model is constructed for the Ghanaian economy and used in policy simulations to evaluate the impact of alternative cocoa pricing policies. The cocoa sector is treated separately, and consideration is given to the significant role played by smuggling. This phenomenon has been ignored in most past studies of this nature.

The thesis starts in Chapter 1 by a discussion of the role of agriculture in the economic development of LDC's followed by a review of past literature on agricultural pricing policies in developing countries. A discussion of the economic performance of Ghana from 1956 to 1981 is then given, with special emphasis on the role of the cocoa sector. Possible linkages between the cocoa sector and the rest of the economy are also discussed.

Chapter 2 discusses data handling and sources as well as the estimation methods used in the study. In Chapter 3 an econometric model, consisting of supply, demand, export price and smuggling relationships, together with several identities to determine quantities such as the cocoa tax per tonne and the cocoa export revenue, is constructed for the cocoa sector. A historical simulation is also conducted in this chapter to determine the tracking ability of the cocoa sector model. Chapter 4 performs policy simulations under different cocoa producer price and exchange rate regimes.

Chapters 5 and 6 deal with the macroeconomy of Ghana. The economy is divided into six sectors namely, the cocoa sector,

which is discussed in Chapters 3 and 4, the production sector, the aggregate demand sector, the foregn trade sector, money and prices and employment. After historical simulations are performed to determine the model's tracking ability, the model is used in Chapter 6 for policy experiments. Finally, Chapter 7 provides a summary of the findings and policy implications of the study.

DEFINITION OF VARIABLES

BOT = Balance of trade (₵mil)

BR = Bank reserves (₵mil)

CD = Domestic consumption of cocoa ('000 tonnes)

CFA = CFA francs per dollar

CIN = Real Change in Inventories (₵mil)

CIS = Change in world stock of cocoa ('000 tonnes)

CPI = Ghanaian consumer price Index

CPIT = Togolese consumer price index

CPIV = Consumer Price index of the Ivory Coast

CU = Ratio of Currency to Money Supply (%)

CXO = Official exports of cocoa ('000 tonnes)

CXS = Quantity of Cocoa Smuggled ('000 tonnes)

ER = Exchange rate (₵/$)

ERC = Exchange rate (₵/£)

FAN = Net foreign assets (₵mil)

FOL = Other foreign liabilities (₵mil)

FOR = Other foreign reserves (₵mil)

FR = Foreign exchange reserves (₵mil)

GDP = Gross domestic product at constant prices (₵mil)

GFI = Real gross fixed investment (₵mil)

H = High-powered money (₵mil)

KS = Real capital stock (₵mil)

LS = Labour force ('000)

M = Total real imports (¢mil)

MC = Real imports of services and consumer goods (¢mil)

MK = Real imports of capital goods (¢mil)

MR = Real imports of raw material and fuel (¢mil)

MS = Money supply (¢mil)

N = Number of unemployed persons ('000)

NCIN = Nominal Change in Inventories (¢mil)

NGDP = GDP at current prices (1968 prices) (¢'mil)

NGFI = Nominal gross fixed investment (¢mil)

NGI = Net government indebtedness (¢mil)

NM = Nominal imports of goods and services (¢mil)

NMC = Nominal imports of services and consumer goods (¢mil)

NMK = Nominal imports of capital goods (¢mil)

NMR = Nominal imports of raw material and fuel (¢mil)

NOL = Other net Bank of Ghana liabilities (net) (¢mil)

NPRC = Nominal private consumption (¢mil)

NPUC = Nominal public consumption (¢mil)

NVA = Nominal value added in agricultural sector (¢mil)

NVC = Nominal value added in construction (¢mil)

NVM = Nominal value added in mining and industry (¢mil)

NVS = Nominal value added in services (¢mil)

NVT = Nominal value added in transport and communication (¢mil)

NX = Nominal export earnings (¢mil)

PI = Implicit gdp deflator

PL = Accra-London spot price for cocoa (pounds/tonne)

PM = Import price index

POP = Population (mil)

POPA = Population over 15 years ('000)

PP = Nominal Ghanaian producer price of cocoa (¢/tonne)

PRC = real private consumption (¢mil)

PS = International price of sugar (us cents/lb)

PTO = Togolese price of cocoa(CFA francs)

PTVC = Border price of cocoa (¢/tonne)

PPTV = Ratio of cocoa producer price to border price (¢/tonne)

PUC = Real public consumption (¢mil)

PURB = Percentage of urbarn population

PV = Producer price of cocoa in the Ivory Coast (CFA francs)

PW = Index of world trade (%)

PX = Export price index

PXC = Export price of cocoa (¢/tonne)

PXCF = Export price of cocoa (Ø/tonne)

QDW = World demand for cocoa ('000 tonnes)

QSGT = Ghana's supply of cocoa (including smuggling) ('000 tonnes)

QSRW = Supply of cocoa by the rest of the world ('000 tonnes)

QTO = Supply of cocoa by Togo ('000 tonnes)

QV = Supply of cocoa by the Ivory Coast ('000 tonnes)

R = Total government revenue (¢mil)

RC = Tax proceeds from cocoa (¢mil)

RD = Direct taxes (¢mil)

RM = Import taxes (¢mil)

RN = Non-tax revenue (¢mil)

RNC = Non-cocoa export taxes (¢mil)

ROI = Other indirect taxes (¢mil)

RS = Ratio of reserves to total deposits (%)

TAX = Duty per tonne of cocoa (¢/tonne)

U = Number of persons employed ('000)

UR = Unemployment rate (%)

URB = Urban population (mil)

VA = Real value added in agricultural sector (¢mil)

VC = Real value added in construction (¢mil)

VI = Real value added in secondary sector (vc+vt+vm) (¢mil)

VM = Real value added in mining and industry (¢mil)

VS = Real value added in services (¢mil)

VT = Real value added in transport and communication (¢mil)

W = Nominal wage rate (¢)

X = Total real export earnings (¢mil)

XCO = Official cocoa export earnings (¢mil)

XNC = Real exports of goods and services excluding cocoa (¢mil)

XNC = Nominal exports of goods and services excluding cocoa (¢mil)

YCO = Cocoa farmers income (¢mil)

YD = Real Disposable income (¢mil)

YW = Income of major cocoa consuming countries ($mil)

Chapter I

AGRICULTURE AND ECONOMIC DEVELOPMENT

1.1 *THE ROLE OF AGRICULTURE IN ECONOMIC DEVELOPMENT*

Many studies have shown that agricultural growth plays an important role, both directly and indirectly, in the overall economic growth of LDC's. Directly, the agricultural sector forms a significant percentage of GDP in LDC's. In addition, other important sectors also benefit from a healthy agriculture sector. For example, the agricultural sector provides the market for an expanding manufacturing sector, as well as the capital requirements for other sectors through its contribution to imports.

The following Tables give some indication of the importance of the agricultural sector in LDC's for selected years, based on the availability of data. Table 1.1 gives the composition of GDP by major sectors for 1965 and 1981. For all developing countries, agriculture accounted for a little over 35 percent of total value-added as compared to about 16 percent for the manufacturing sector. By 1981, however, the contribution of agriculture had fallen to about 22 percent, while that of the manufacturing sector had risen to 23 percent, indicating increased diversification during the fifteen-year period. An examination of the contributions

TABLE 1.1

COMPOSITION OF GDP IN LDC'S (1965 AND 1981)

Component	1965			1981		
	I	II	III	I	II	III
Agriculture	35.1	46.0	32.8	21.7	36.6	31.3
Manufacturing	15.8	13.4	13.2	23.1	28.1	8.0
Exports	13.0	8.0	24.2	25.0	9.0	25.2
Imports	14.0	10.9	25.3	29.1	15.4	32.1

I: Developing Economies
II: Low Income Economies
III: Sub-Saharan Africa
Source: World Bank: World Tables 1983, Vol. 1.

of the various sectors for low-income countries and Sub-Saharan Africa, on the other hand gives a different picture.[1] While the contribution of agriculture fell from 46 percent in 1965 to 37 percent in 1981 for low income countries, it remained relatively stable for Africa south of the Sahara, falling by only about 1.5 percent. On the other hand, the manufacturing sector's contribution fell from 13.2 percent in 1965 to 8 percent in 1981 for Sub-Saharan Africa. Thus for the developing countries, agriculture is as important a contributor to GDP in 1981 as it was fifteen years earlier.

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[1] The classification of countries as developing, low income and industrial is according to World Bank definitions (see World Bank: *World Development Report*, Several Issues.

Agriculture is even more important as a source of exports. Table 1.2 shows that in 1965, 64.4 percent and 57.0 percent of the exports of low-income countries and Sub-Saharan Africa, respectively, was accounted for by agriculture. These contributions fell to 46 percent and 26 percent, respectively, in 1980. The fall to 26 percent for Sub-Saharan Africa is due to the emergence of oil as a major source of exports in some African countries, notably Nigeria, Gabon and Angola.

TABLE 1.2

AGRICULTURE'S CONTRIBUTION TO EXPORTS

Year	Developing Economy	Low Income Economy	Sub-Saharann Africa
1965	48.4	64.4	57.0
1970	41.3	55.5	46.4
1980	26.3	46.4	25.6

Source: World Bank: World Tables 1983, Vol. 1.

Considering that industries in LDC's rely heavily on imported capital and raw material input, agriculture as an important source of foreign exchange cannot be over-emphasized. Finally, Table 1.3 gives labour force indicators for the various regions. It is important to note that almost 78 percent of the total labour force in Sub-Saharan Africa in 1960 was employed

in agriculture. By 1981, this percentage had fallen by only ten percent. The figures for the other two regions are equally high (more than 68 percent). By contrast, the share of the labour force in manufacturing was between 8.8 percent and 17 percent.

TABLE 1.3

PERCENTAGE OF LABOUR FORCE IN AGRICULTURE AND INDUSTRY

Year	Agrculture			Industry		
	I	II	III	I	II	III
1960	69.0	76.5	77.6	12.2	13.6	17.0
1975	64.6	75.2	72.6	9.7	10.1	12.6
MRE	57.4	70.4	67.4	8.8	10.8	13.4

I: Developing Economies
II: Low Income Economies
III: Sub-Saharan Africa
MRE: Most recent estimate, may be 1979, 1980 or 1981.
Source: World Bank: World Tables 1983, Vol. 2.

The foregoing has provided a brief discussion of the contribution of agriculture to various economic aggregates. Several econometric studies have also indicated that agriculture contributes significantly to industrial growth, as well as to overall economic growth. Using the Chenery-Syrquin model, Hwa (1983: p.4) has shown that intercountry variation in agricultural growth explains a significant percentage of the

variation in industrial growth. His study also confirms the significant contribution of agriculture to overall productivity increases and hence to GDP growth [Hwa: 1983,p.1].

Many studies have also been done relating exports to growth in LDC's. Since agriculture is a major contributor to exports this also means a high positive correlation between agricultural growth and GDP growth.[2] The methodologies used range from a simple linear regression of export growth on GDP growth rate (Emery: 1967) to multiple regressions using several variables, including exports, as the explanatory variables (Balassa: 1978)

Some of the models mentioned above have added little more than what can be deduced from the fact that exports are a component of GDP. and that, as such, their growth should be positively related to the growth of GDP. Some of the models go beyond this simplistic representation, however. Ferder (1983) has actually specified and tested a model which indicates a substantial difference between marginal factor productivities in export-oriented and non export-oriented industries.

The framework of Ferder's analysis is the "sources of growth" technique. Two production functions for the economy, one for the export sector and the other for the non-export sector, were specified as follows [Ferder: 1983,p.61]:

$$N = f(K_n, L_n, X)$$

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[2] Imagawa (1985) has given a brief overview of most of these studies.

$$X = G(K_X, L_X)$$

Where N = non exports

X = exports

K_n, K_X = respective sector capital stocks

L_n, L_X = respective sector labor forces.

X was included in the non-export sector production function to reflect externalities such as, a steady flow of imported inputs. Using data from a group of semi-industrialised countries, Ferder arrived at the statistically significant result that it will be more productive on the average to invest in export industries than in non-export industries. Some of his results are presented in Table 1.4.

TABLE 1.4

SMPI IN EXPORTS OF SEMI-INDUSTRIALISED LDC'S, 1964-73

Share of export in GDP	SMPI*	
	Extended Sample	Limited Sample
0.10	0.479	0.512
0.15	0.383	0.412
0.20	0.335	0.362
0.25	0.306	0.332
0.30	0.287	0.312
0.35	0.273	0.298
0.40	0.263	0.287
0.45	0.255	0.279
0.50	0.248	0.270

*SMPI: Social Marginal product of Investment)
Source: Ferder (1983, p.69)

The social marginal product of investment in exports (SMPI) is defined as the total increment in GDP brought about by a marginal increase in capital allocated to the export sector. For both the limited sample (nineteen LDC's) and the extended sample (31 LDC's)[3] the increment in GDP is a decreasing function of the export share in GDP, though the contribution is significant in all cases. In 1981, agricultural exports accounted for about 25 percent of the exports of all developing countries, indicating that, countries with more favourable export policies follow better resource allocation and hence accelerated growth. Other results from this study show that the productivity gain due to export expansion contributed more than 1.8 percent to the growth of the countries examined, and that slightly less than half of this contribution was due to inter-sectoral externalities [Ferder: 1983,p.70].

Apart from cross-country studies, several studies on individual countries have been undertaken with generally similar results [Fajana: 1979; Lee: 1980; Rangarajan *et al:* 1976; Maizel: 1968]. Lee (1980) studied the contribution of exports to the rapid growth of GNP in the Ivory Coast. He concluded that, exports which were mainly agricultural, were the main engine of growth. They grew at about the same rate (7.2% anually) as GNP from 1960 to 1975 [Lee: 1980: p.607].

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[3] The limited sample consists of nineteen semi-industrialised countries, while the extended sample comprises 31 countries considered as marginally semi-industrialised. See Ferder (1983: pp.71-72) for the list of countries.

This growth was largely at the expense of the rural society, however, which benefited but little, though it produced the bulk of the agricultural output. Lee also observed that

> policies have also resulted in a high level of extraction of the agricultural surplus which reduced the extent of growth in rural incomes and led to vast intersectoral differences in productivity and incomes. [Lee: 1980,p.].

This observation is true for many LDC's, which rely on agricultural exports for most of the state revenue.

Despite its important role in the economic growth in LDC's, agricultural production has fallen by more than half in Sub-Saharan Africa since 1965. Table 1.5 below indicates the growth rate of some important aggregates for the periods 1965-70 and 1970-81. The figures are for developing, industrial, low-income and sub-Saharan African countries. The GDP growth rate has fallen during the 1970-1981 period as compared to the 1965-1970 period. However, the decline (from 6 to 2 percent) has been more drastic for developing countries as a whole than for other regions.

Population growth has been roughly stable for the four regions, indicating that the rapid decline in the growth of per capita GDP has been mainly due to lower GDP growth rates. For example, for Africa south of the Sahara, per capita GDP grew by less than one percent during the 1970-81 period, while for low income countries the figure was one percent.

Examining the growth-rates of the GDP components, it is clear that the major reason for the lower rate of growth of GDP

TABLE 1.5

AVERAGE ANNUAL REAL GROWTH RATES OF SELECTED ECONOMIC INDICATORS

Indicator	1965 - 1970				1970-1981			
	I	II	III	IV	I	II	III	IV
Population	2.5	2.5	2.5	0.9	2.1	1.9	2.8	0.7
GDP	6.0	4.7	4.8	4.8	2.0	3.4	3.3	3.0
GDP/Capita	3.5	2.2	2.3	3.8	2.8	1.0	0.4	2.3
Agriculture	3.2	4.3	2.5	2.1	2.8	2.4	1.4	2.2
Manufacturing	6.5	4.1	7.1	5.7	6.9	4.2	6.6	2.7

I: Developing Economies
II: Low Income Economies
III: Sub-Saharan Africa
IV: Industrial Economies
Source: World Bank: World Tables 1983, Vol. 1.

during second period was the sluggish growth in the agricultural sector. The growth rate of agricultural value added fell by about 13 percent in all developing countries, 50 percent in low income countries and 45 percent in Africa south of the Sahara, whereas it remained at about the same level for industrial economies. With the heavy dependence of the manufacturing industries in Africa on imported inputs, the declining growth rate of agriculture was translated into a slight decline in the growth rate of the manufacturing sector. The other regions recorded marginal increases in the manufacturing sector.

Many studies have indicated that the decline of the agricultural sector in many LDC's may be attributed largely to its neglect during the early sixties, when the usual tendency in development policy was to emphasize rapid industrialisation as the major route to economic self-reliance. In the early sixties, when the newly independent African countries were searching for means of rapidly modernising their economies, import substitution industrialisation seemed to be the obvious way out, and many economists of the era advocated the rapid expansion of the manufacturing sector in developing economies as the main engine of growth.

Their arguments were based on both historical and theoretical factors [World Bank: 1982]. Economic growth is inevitably accompanied by a declining share of agriculture in output and employment. The theoretical factors responsible for this include a tendency for the proportion of expenditure on food to decline as growth takes place, the invention of substitutes at lower costs to replace agricultural raw materials, and increased agricultural productivity, which releases labour from this sector without any significant effect on output. Historically, most developed countries have proportionately smaller agricultural sectors. Moreover, productivity tends to be lower in the agricultural sector than in industry in these countries. Thus all the factors point to a strengthening of industry rather than agriculture as the engine of growth.

In general, the success of the developed countries had lured development economists and administrators of the fifties and early sixties into emphasising manufacturing industries in their development programmes, most often at the expense of agriculture. Many of these studies, however, neglected the fact that agriculture had played an important role in the economies of the present-day developed countries before their industrialisation. Mellor (1966), Johnston and Kilby (1975) and others have shown that agriculture plays an important part in the transition process.

In recent times, the failure of import substitution programmes in many developing countries has turned many researchers to the task of finding ways of improving the agricultural sector in LDC's. Countries such as Ghana, which depended to a large extent on agriculture, have learnt a hard lesson that neglecting the agricultural sector in the name of diversification ultimately leads to stagnant growth in all sectors. Several factors are blamed for the poor performance of the agricultural sector in LDC's, including drought, lack of adequate incentives and investment opportunities and adverse pricing policies. Our study focuses mainly on pricing policies which are considered by many researchers in this field to be the single most important problem.[4]

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[4] Many studies have been undertaken by the World Bank staff over the past decade into the effects of pricing policies in LDC's. Some of these have been published in the Staff Working Papers: Scandizzo and Bruce (1980), Reca(1980), Bovet and Unnever (1981), Cuddihy (1980) etc.

1.2 *AGRICULTURAL PRICING POLICIES IN LDC'S*

Many case studies indicate that pricing policies in many developing countries were unfavourable to the agricultural sectors. The conclusions are generally similar and may be summarised in the following points [Scandizzo and Bruce: 1980, p.48].

1. Distortions created by such price policies are substantial.
2. Policy has turned the domestic terms of trade heavily against agriculture.
3. Income redistribution has favoured the urban sector, leading to increased rural-urban migration.
4. The policies have not achieved what they were expected to do.
5. Growth rates in agriculture are lower than they would be in the absence of such biased pricing.
6. Since agricultural products are often exported, such policies have tended to worsen the balance of payments of many LDC's.

1.2.1 *Reasons for Price Distortions*

A price distortion exists if domestic prices of goods and services are not equal to their international prices (World Bank: 1983) The many reasons for price interventions have been well documented [Schultz: 1978]. A popular argument is as

follows; where the agricultural commodity in question is an export crop, monopolistic benefits may be derived by keeping production low in order to maintain a high world price and hence maximise foreign exchange earnings. Of course a necessary assumption here is that the country produce a sufficiently large proportion of total world output to influence world prices by its price or output policies.

This argument is based on the existence of an optimal export tax and the idea may be presented in the figure below (Tolley *et al:* 1982, p.173).

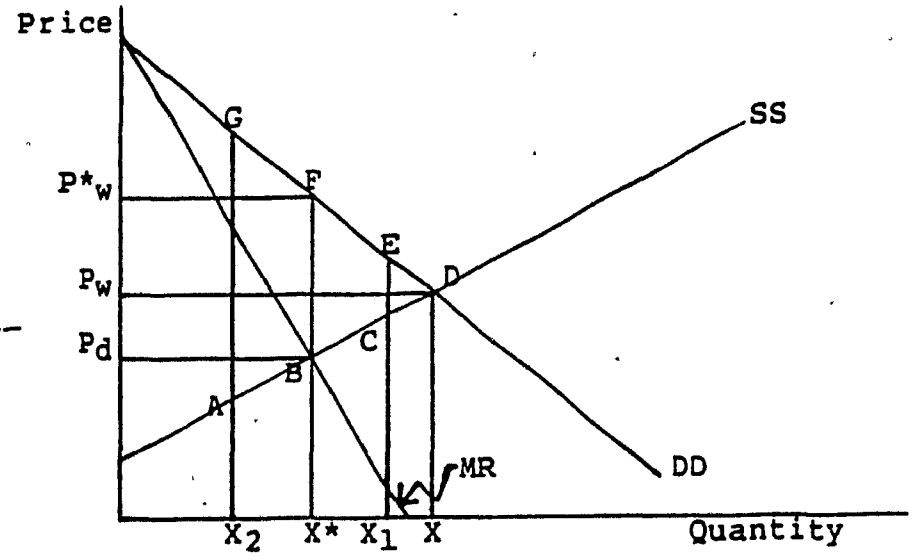

Figure 1.1: AN OPTIMAL EXPORT TAX

DD represents foreign demand for exports and SS the domestic supply of exports. MR is the marginal revenue curve corresponding to DD, while P_w represents the world price in the

absence of an export tax. X is the export volume corresponding to P_w. Since the demand curve facing the country is downward sloping, the appropriate optimal point of production is X* where MR=SS. A net welfare gain can be had by imposing a tax of BF, thus reducing supply to X* and raising the world price to P^*_w. P_d is the domestic producer price. Note that a tax greater than BF (AG for instance) will result in a welfare loss, which suggests that taxes should be reduced. Similarly, position X_1 would not be beneficial to the exporting country. Of course whether an export tax would lower or raise foreign exchange earnings depends on the foreign elasticity of demand for exports.

This analysis is only relevant, of course, when the exporting country accounts for a significant proportion of total world production. Yet in many developing countries in which agricultural exports account for only a small share of world production, taxes are still high in the agricultural sector. One common justification for this is that the elasticity of supply of agricultural commodities is rather low in LDC's. In some cases, it is even thought to be perverse (i.e. an increase in price leads to a reduction in supply).[5] Whether for reasons of inelastic or perverse supply functions, the argument is made by those in favour of taxing the

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[5] The reasoning behind a perverse supply function is that, farmers have a target income. Once this level of income is achieved, any increases in price would only lead to corresponding cuts in quantity supplied, such that the target income will be maintained.

agricultural sector that low prices will have very little effect on output. The government may thus finance its expenditure policies by taxing agricultural exports without any significant effect on total export earnings.

An obvious difficulty with this argument is that much research indicates that the assumption of a lack of price responsiveness by farmers in LDC's is incorrect. The findings of low price elasticicty have been based on the wrong choice of the price variable. Studies which have used relative prices (relative, say, to the border price) show significant supply responsiveness [Akiyama and Duncan: 1982; Franco: 1978]. The reason is that in many LDC's, smuggling of goods to neighbouring countries provides an effective way of evading the tax.

Farmers have also been heavily taxed for reasons which have little theoretical basis. One common excuse is for the stabilization of farmers' incomes. Marketing boards in Africa, and other developing countries have been formed ostensibly to protect farmers against fluctuating world prices by taxing farmers in times of high prices and subsidising them during periods of low prices.[6] A further reduction in the fluctuation of farmers' incomes would also be achieved by increasing unit prices of export crops during periods of low harvests. Unfortunately, very often the marketing boards do not fulfil the policies they were set up for. For example, Ewusi

[6] See Wampah (1983) for a discussion of the functions of the Ghana Cocoa Marketing Board.

[1977: p.47] and Killick (1978) have observed in their studies that the Ghana Cocoa Marketing Board has not followed its own rules. They show that producer prices have been pegged for long periods during the sixties despite a significant accumulation of funds (surplus) by the Board. Ewusi observed that many of the fluctuations in farmers' income during this period were due primarily to changes in output. In another study Bauer and Paish (1960) estimated that the fluctuation in farmers' incomes during the late 'fifties would have been lower without the Cocoa Marketing Board. This finding is due to the compensating behaviour of production and prices. In times of low output, prices are higher while they fall during bumper periods. The marketing boards negate this influence by pegging the producer prices. Thus marketing boards actually contribute to, rather than reduce the fluctuations in the incomes of primary producers.

A final explanation for high taxation of the agricultural sector is redistribution of income. It has been argued that income distribution in developing countries is usually skewed in favour of agriculture. Governments may therefore be able to redistribute incomes by taxing the rich agricultural sector and using the funds raised to subsidize the non-agricultural sectors. Many studies have indicated that this does not happen, however [see Dodoo: 1977; Ellis: 1982; Lipton: 1978].

In this section we have argued that governments in LDC's have pursued pricing policies which discriminate against

agriculture. There is often little theoretical justification for their actions, and furthermore, their objectives often are not achieved. Why then are such policies, which are opparently detrimental to growth, still practised? An obvious reason is to raise revenue to finance the policies followed by governments in developing countries. Because so much other economic activity takes place in the informal sector, agricultural exports often present the easiest means of raising revenue, and most countries find it difficult to resist the temptation. In fact, stories about low price elasticities, price and income stabilization, redistribution of incomes, and the existence of an optimal tax are often attempts by revenue maximising governments to rationalize their actions.

1.2.2 *Methodologies for Measuring Effects of Pricing Policies*

Many of the studies into the effects of agricultural price interventions have been undertaken by the staff of the World Bank. The methodology followed by these studies has been the same and is detailed in Scandizzo and Bruce (1982). The methodology is basically in the framework of partial equilibrium analysis involving the computation of various measures of protection coefficients, comparative cost and welfare transfers (using the concept of consumers' and producers' surplus).

The nominal and effective protection coefficients (NPC and EPC) are respectively the ratio of domestic price to its border

price and the ratio of value added expressed in domestic prices to value added expressed in border prices, while the producer subsidy equivalent (PSE) represents the net subsidy as a percentage of the market value of each commodity. An NPC or EPC less than one indicates disincentives to the commodities in question, while a negative PSE also shows adverse terms of trade against the agricultural sector. Most of the studies have computed negative PSE's, and NPC's and EPC's of less than one for LDC's, while the opposite is true for developed countries [Scandizzo and Bruce: p.ix].

The World Bank studies have also used the concept of domestic resource cost (DRC) defined as the "value of domestic resource .... in domestic currency units it takes to earn or save a unit of foreign exchange" [Scandizzo and Bruce: p.viii]. If the DRC is higher than an appropriate shadow price of foreign exchange, then a comparative cost advantage is said to exist in producing the particular commodity.

The final measure used by the World Bank also emerges from partial equilibrium methodology. The procedure follows the usual theoretical treatment of the effect of a distortion (such as a tax or subsidy) on welfare expressed in terms of consumers' and producers' surplus. As is well known, in general, the deadweight loss varies as the square of the distortion. Thus, the net economic loss in production (NLP) and net economic loss in consumption (NLC) are given by

$$NLP = 1/2 t_c^2 n_s V$$

$$NLC = 1/2 t_p^2 n_d W$$

Where t_c, t_p are average consumer and producer tax rates, n_s, n_d are elasticities of supply and demand and V and W represent value of production at domestic prices and the value of consumption at border prices. The estimates of demand and supply elasticities may also be used to compute the change in foreign exchange earnings and change in government revenue resulting from the distortions [Scandizzo and Bruce: 1980, pp.24-25].

Studies using the partial equilibrium approach have also confirmed that the agricultural sector in developing countries is very heavily penalised [Scandizzo and Bruce: 1981]. A similar approach was used by Bale and Lutz (1980) in a cross-country study of agricultural pricing policies in several developing and developed countries. The findings of this study are that while developed countries tended to subsidise their agricultural sectors, the opposite was true for developing countries. The result was that the developed countries had a net gain of foreign exchange through their protectionist policies, while the developing countries had a net loss of foreign exchange earnings.

Though the partial equilibrium studies described above throw some light on agricultural pricing policies in LDC's, they are obviously not appropriate for studying the effects of such policies on various sectors, and on economic aggregates such as income distribution, migration, economic growth, and the like. Such studies have to be undertaken in the framework of general equilibrium analysis.

Braverman *et al.* (1983) have attempted to extend the consumer-producer surplus methodology outlined above to include the behaviour of rural-urban income distribution, rice imports, and the government budget under different pricing alternatives, using a two sector multi-market model. Using cross-section data on farm household surveys demand, supply, and income functions were estimated for the rural and urban areas of Korea. Other relationships were estimated for the labour market and government deficits. Various policy scenarios for output prices and input prices were then examined for rice and barley production.

The methodology of Braverman *et al.* (1983) is a marked improvement over the use of protection coefficients but it still falls short of a complete general equilibrium or macroeconometric examination of the impact of government price interventions. Other researchers have tried to study pricing policies in a computable general equilibrium framework (Imam and Whalley: 1982), though the data requirements for some of these models inhibit their use in many third world countries. A consideration of the shortcomings of the partial equilibrium studies as well as the data requirement of general equilibrium studies has played an important part in our choice of methodology.

1.2.2.1 Methodology of this study

As noted in the previous section, while the partial equilibrium method of analysis provides useful information on the effects of pricing policies, it is not adequately equipped to study the macroeconomic effects of these policies. This study uses the macroeconometric approach to study the effects of alternate agricultural pricing policies on relevant variables. The framework is similar to those used for the studies of the effects of export instability on economic development in LDC's.[7] Basically, it involves the specification and estimation of a macroeconometric model for the country under study, and use of this model to evaluate the effects of alternate policies by means of dynamic simulations.

Of course other approaches may be used to examine the effects of various policies in a general equilibrium setting. The use of computable general equilibrium (CGE) models is a popular method at the moment for such studies [Taylor: 1979; Romain: 1985]. CGE models operate in the framework of Walrasian general equilibrium analysis and use data in the form of input-output tables or social accounting matrices (SAM). The theoretical arguments for and against the two approaches have been widely discussed (Taylor: 1979; Adams and Behrman: 1976) and will not be repeated here. One of the major disadvantages of the CGE approach as far as developing countries are concerned is the unavailability of required data as mentioned above. A major advantage of the macroeconometric approach is

[7] Many of these studies are reviewed in a book by Adams and Behrman (1982).

that it is easily adaptable to the data situation.

Cocoa pricing in Ghana is used as a case study in this paper. The choice of the cocoa sector of Ghana is based on several considerations. First and foremost, Ghana is a typical LDC in that in the past it has relied on a few agricultural commodities for foreign exchange needs. Furthermore, agricultural pricing in Ghana represents a special case of price intervention by the government. Much research has indicated the existence of overtaxation in the cocoa sector and it has been argued that this, much more than anything else, has been the major reason for the rapid decline of the cocoa sector, and consequently the whole economy.

A 1983 World Bank survey of developing countries ranked Ghana highest on a list of countries with price distortions [World Bank: 1983]. Not surprisingly, Ghana also had the worst performance in terms of GDP growth during the period under study. Though many studies have aimed at establishing a link between past pricing policies and the resulting output in the cocoa industry, few have attempted to estimate the impact of the declining cocoa industry on the rest of the economy.

The object of our study is, thus, the quantitative evaluation of the impact of past cocoa pricing policies on activity in the cocoa sector, as well as on other sectors of the economy, using a macroeconometric simulation model. Various policy scenarios will be examined and the results compared with a base run. Before embarking on such a study, it

is necessary to review the economy of Ghana during the period under study, so as to clearly see the role of the cocoa sector in the Ghanaian economy. The next section, thus, gives a brief discussion of the Ghanaian economy.

1.3 *PERFORMANCE OF THE GHANAIAN ECONOMY: 1956-1981*

Ghana is a former British colony situated on the west coast of Africa. Its population of about twelve million (1984 census) is mainly rural with agriculture as the principal occupation. Cocoa is the major export crop, accounting for about 60% of total exports. The current government is military with active participation by civilians. The study covers a period of 26 years, from 1956 to 1981. This period has been chosen for a number of reasons, including availability of data. Unless otherwise stated, the cedi (¢), which is the Ghanaian unit of currency, has been used throughout the study.[8]

There has been a gradual decline of the Ghanaian economy during the period under study. This phenomenon has accelerated during the 'seventies due to a variety of factors, including

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[8] One hundred pesewas is equivalent to one cedi. Prior to 1965 the Ghana pound, which was issued by the West African Currency Board and exchanged at par with the pound sterling, was the national currency. Thereafter, the cedi was introduced at the rate of ¢2.4 to £1. Later, the cedi was renamed the "new cedi" and its value appreciated to ¢2 to £1. Finally, the name was reverted to the cedi. The current exchange rate (1986) is ¢90 to $1. This rate resulted from a massive devaluation in 1983, after the Ghanaian government agreed to follow an economic programme prescribed by the IMF. Thereafter, the cedi was gradually devalued until the current rate was attained.

external shocks such as the oil crisis of the early 'seventies, fluctuating world commodity prices, adverse weather conditions and poor economic management by governments. Before 1970, the performance had been modest in terms of real GDP growth. The economy grew at about 3.3% per annum from 1956 to 1969. With the population growing at an annual rate of about 2.6%, however, per capita income exhibited a growth of less than one percent per annum. This level of performance is considerably less than the average for developing countries during the same period. Killick [1978; p.68] has observed that this performance occured despite an investment rate of 20% in 1960, a level considered high among developing countries. However, Killick goes on to suggest, and rightly so, that the failure of the economy to grow in the sixties can be attributed to the rapid decline of investment towards the end of the decade.

By the late 'seventies, the economic situation in Ghana had become critical. This period was characterised by high inflation rates, low productivity, falling exports and sluggish GDP growth. From 1970 to 1981, the annual rate of growth of real GDP was less than one percent, far lower than the population growth rate at about 3.1% per annum. Thus, GDP per capita fell by about 2.5% per annum during the decade. Of course, the performance of developing countries in general was not encouraging during this period. The growth rates of GDP/capita for developing economies as a whole, low income economies and Sub-Saharan Africa were 2.8%, 1% and 0.4%

respectively (see Table 1.5). Still, Ghana's performance was far below the average for the group. The following sections attempt to analyse some of the factors responsible for the dismal performance of the economy.

1.3.1 *The Structure of the Economy*

Table 1.6 below gives the composition of GDP at constant (1968) prices from 1956 to 1981. The principal component is agriculture, which accounted for more than 39 percent of GDP during the period under study. Thus the performance of the agricultural sector is crucial to overall economic growth. The contribution of agriculture fell from 58% in 1956 to about 39% in 1965 before rising to 54% in 1981. These changes reflect the diversification efforts of the post-independence era, when policies tended to emphasize manufacturing activities, thus increasing the manufacturing sector's share of GDP from 7% in 1956 to a little over 17% in 1970.

Unfortunately, many of the manufacturing industries rely on imported inputs made available through foreign exchange earnings provided by the agricultural sector. Thus, as growth in the agricultural sector slackened due to adverse pricing policies and unfavourable external events, productivity fell in the manufacturing sector, and most industries performed at very low capacity levels. By the end of the period, output in the manufacturing sector had fallen by almost 20% from the level attained in 1970; the sector's share of GDP fell from 17% in 1970 to 13% in 1981.

TABLE 1.6

GDP BY SECTORS AT 1968 PRICES

(¢million)

Sector	1956	1965	1970	1975	1980	1981
Agriculture	686.8 (58.0)	674.0 (39.3)	817.0 (42.4)	837.9 (39.9)	1126.5 (53.6)	1118.5 (54.2)
Mining & Manufacturing	82.9 (7.0)	213.0 (12.4)	331.0 (17.2)	337.2 (16.1)	275.0 (13.1)	268.1 (13.0)
Construction	59.0 (5.0)	99.0 (5.8)	89.0 (4.6)	126.0 (6.0)	47.2 (2.2)	63.8 (3.1)
Transport & Communication	6.4 (5.1)	63.0 (3.7)	79.0 (4.1)	88.0 (4.2)	68.0 (3.2)	62.6 (3.0)
Services	294.9 (24.9)	667.6 (38.9)	612.7 (31.8)	709.1 (33.8)	586.1 (27.9)	552.3 (26.7)
Total GDP	1184.0	1716.7	1928.7	2098.2	2102.9	2065.2

Percentages in parentheses

Source: See Appendix A

The situation in construction and transportation was similar to that in the manufacturing sector. Output increased at the beginning of the period and fell towards the end. The dramatic increase of activity in the services sector from 1956 to 1965 had been due mainly to the expansion of government sector activities. This level fell towards the end of the period mainly because the principal tax base (agricultural production) declined.

Table 1.7 shows the contribution of major expenditure categories to GDP for selected years of the study. The largest category is private consumption, which has accounted for more than 70% of total GDP during most of the period. From ¢876.8 million, private consumption increased by about 3.7% per annum to ¢1453.4 million in 1981. Government consumption was the least affected of all the categories; more than quadrupling by the end of the period. Most of the funds for government consumption, especially after 1975, were obtained by deficit financing. This becomes apparent when one notices that exports and imports, which provide the bulk of government revenue, have fallen drastically over the years.

Exports fell from ¢299.5 million (25% of GDP) in 1956 to a low of ¢192.8 million (9.3% of GDP) in 1981. The deterioration in export performance was due mainly to low producer prices in the cocoa sector, which have resulted in low productivity, and have played a major role in the escalation of illegal activities such as smuggling (see later sections). Due to the poor performance of exports, imports have also fallen by about 35% since 1956. Finally, gross fixed investment fell from ¢348.3 million (or 20% of GDP) in 1965 to only ¢182.4 million (or 8.8% of GDP) in 1981. All these have contributed to a sluggish GDP growth during the period of study.

1.3.1.1 Goverment Finances and Money Supply

TABLE 1.7

GDP BY MAJOR EXPENDITURE CATEGORIES AT 1968 PRICES

(¢million)

Category	1956	1965	1970	1975	1980	1981
Private Cons.	876.8 (74.1)	1175.5 (68.5)	1459.4 (75.7)	1599.9 (76.3)	1499.1 (71.3)	1453.4 (70.4)
Government Cons.	108.1 (9.1)	298.0 (17.4)	259.9 (13.5)	235.0 (11.2)	470.1 (22.4)	441.7 (21.4)
Gross Fixed Inv.	200.7 (17.0)	348.3 (20.3)	230.8 (12.0)	244.0 (11.6)	160.6 (7.6)	182.4 (8.8)
Exports	299.5 (25.3)	445.9 (26.0)	398.4 (20.7)	347.0 (16.5)	245.4 (11.7)	192.8 (9.3)
Imports	316.5 (26.7)	551.0 (32.1)	471.6 (24.5)	351.0 (16.7)	290.0 (13.8)	207.0 (10.0)
Total GDP	1184.0	1716.7	1928.7	2098.2	2102.9	2065.2

Percentages in parentheses

Source: See Appendix A

Table 1.8 gives government revenue and expenditure situations for the period 1956 to 1981. Clearly, government revenue has financed a decreasing proportion of expenditures over the years. In 1956, 85.6% of government expenditure was financed by revenue. This rose to 105.8% in 1970 and then fell to 36.3% in 1981. The budget deficit rose to about 10% of GDP in 1980. The large deficits were financed by sharp increases in the money supply, as is evidenced by Table 1.9. Total money supply[9] rose

[9] In this study, the narrow definition of money supply has been

by more than 800% between 1975 and 1981; an annual increase of roughly 45.6%.

TABLE 1.8

PUBLIC FINANCE INDICATORS

Indicator	1956	1965	1970	1975	1980	1981
Revenue as % of Current Expenditure	130.8	127.9	129.4	85.5	46.7	48.0
Revenue as % of total Expenditure	85.6	77.6	105.8	61.0	38.7	36.3
Budgetary deficit/surplus as % of GDP	-2.3	-5.5	1.1	-9.8	-10.0	-6.6

Source: See Appendix A

This high rate of increase in the money supply together with the low productivity has resulted in the high rates of inflation experienced towards the end of the period under study.

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used. i.e. the sum of demand deposits and currency outside banks.

TABLE 1.9

MONEY SUPPLY COMPONENTS

¢million

Year	Currency in Circulation	Demand Deposits	Money Supply
1956	76.0	33.0	109.0
1965	116.0	122.0	238.0
1970	151.0	151.0	302.0
1975	486.0	495.0	981.0
1980	3521.0	2090.0	5611.0
1981	6020.0	3310.0	9360.0

Source: See Appendix A.

1.3.1.2 Prices, Wages, Employment and Income Distribution

The rapid increase in the Ghanaian price level, especially since 1975, is among the highest in the world. The consumer price index (CPI) increased at over 75% per year from 1975 to 1981 and reached as high as 116% in 1981. Since the high inflation was not accompanyied by corresponding increases in wages, real incomes fell drastically. By 1981, the real wage rate had fallen to ¢6.47 per month as compared to ¢55.78 per month in 1956.

Though employment and income distribution figures are not complete for Ghana, the official unemployment rate stood at 8.5% in 1980 as compared to 2.3% in 1956. These figures are, however, likely to be downward biased as they include only

people actively looking for jobs at employment centres.[10] No comprehensive income distribution data has been compiled for Ghana in the late seventies. It is clear, however, that the poor are likely to be most affected by the adverse economic conditions during the seventies.

1.3.2 *Cocoa in the Ghanaian Economy*

The cocoa sector occupies a central place in the Ghanaian economy, accounting for about 60% of total export earnings during most of the period under study. Policies affecting this sector are therefore crucial to the overall performance of the economy. Table 1.10 provides some indication as to its importance to the Ghanaian economy.

Except for a few years (1965 and 1981 in Table 1.10), cocoa export revenue has contributed about 30% to government revenue during the period of study. The low contribution of revenue from the cocoa sector in 1981 was due to an attempt by the government to restore incentive to the cocoa sector by raising the producer price of cocoa (see below). Since the exchange rate was unchanged, cocoa export revenue fell to only 1.3% of total government revenue. A decline of activity in this sector is thus likely to seriously affect any government expenditure policies. Furthermore, in view of the fact that many of the manufacturing industries in Ghana rely heavily on

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[10] The employment centres in Ghana are mostly found in the urban centres, hence rural unemployment is not include in the statistics.

TABLE 1.10

INDICATORS FOR THE COCOA SECTOR

Cocoa as a percentage of	1956	1965	1970	1975	1980	1981
Domestic Exports	59.0	60.2	64.2	59.4	n.a	n.a
Government Revenue	30.6	6.3	39.2	33.6	26.2	1.3
Employment	20.4	19.4	17.4	n.a	n.a	n.a
GDP	n.a	n.a	16.8	10.9	10.1	9.7

n.a.: not available.
Sources: See Appendix A

imported inputs, the 60% contribution of cocoa to export earnings is very important to the survival of this industry. The cocoa sector also employs more than 17% of the labour force and constitutes more than 9% of GDP.

1.3.2.1 Pricing Policy in the Cocoa Sector

Despite the significant contribution of cocoa to the economy government policies in the past have not been favourable to this sector for reasons stated elsewhere.[11] Production as well as exports have declined drastically over the years, eroding the government's major tax base. Recorded production fell from

[11] see the section on reasons for price distortions.

an all time high of more than 550,000 tonnes in 1965 to a little over 250,000 tonnes in 1981. Low producer prices, together with the high rates of inflation, have acted as disincentives for the cocoa farmers. Table 1.11 shows the producer price deflated by various-indices from 1968 to the end of the period.

TABLE 1.11

PRODUCER PRICE OF COCOA DEFLATED BY VARIOUS INDICES

YEAR	NOMINAL PRODUCER PRICE (¢/tonne)	PRODUCER PRICE DEFLATED BY CPI (¢/tonne)	PRODUCER PRICE AS PERCENTAGE OF BORDER PRICE
1968	242.8	242.80	88.59
1969	265.1	247.30	94.29
1970	298.7	270.78	106.84
1971	298.7	248.90	92.09
1972	300.6	225.66	60.96
1973	373.5	238.35	65.94
1974	463.2	235.66	62.66
1975	560.0	232.95	44.69
1976	597.0	159.12	37.71
1977	771.0	94.95	26.29
1978	1308.1	93.05	16.04
1979	2526.0	116.37	11.44
1980	4000.0	122.77	12.06
1981	12000.0	170.13	23.45

Source: See Appendix A.

In nominal terms the producer price has increased from 242.8 cedis per tonne in 1968 to ¢4,000/tonne in 1980. However, due to rapid inflation, especially during the late

seventies and early eighties, the real producer price fell from a high of about 270 cedis per tonne in 1970 to 93 cedis per tonne in 1978 before rising to 122 cedis per tonne in 1980. In a bid to arrest the rapid decline in production, the government increased the nominal producer price by 200% from 1980 to 1981 (i.e. from ₵4,000 to ₵12,000). Despite this increase, the real producer price received in 1981 was still lower than that received in 1968.

The last column of Table 1.11 expresses the nominal producer price of cocoa as a percentage of the border price of cocoa. The Ghanaian producer price was lower than the border price during the whole period except in 1970 when it was about 7% higher. The lowest point was in 1979 when the producer price was only 11% of the border price. Despite the large increase in the nominal producer price in 1981, in that year the producer price was only 23% of the border price. Presumably as a result, replanting has been neglected, and as the average age of the existing stock of trees rose, their productivity also fell. Furthermore the low producer prices also acted as an incentive for illegal activities such as smuggling of cocoa to neighbouring countries which offer higher prices. Due to an acute shortage of foreign exchange earnings, a thriving black market for foreign exchange transactions has evolved during the 'seventies. and this has made smuggling even more lucrative.

1.4 *OBJECTIVES OF STUDY*

In view of the importance of the cocoa sector to Ghana, and the rapid decline of production in this sector, it provides an ideal case for our study. The aim of this study is not to establish whether or not adverse pricing is the major cause of the decline in cocoa production, since this has already been established by several studies [WB: 1984; Franco: 1978]. Instead we intend to estimate the effects of alternate pricing policies on the cocoa sector as well as on other sectors of the economy using a macroeconometric framework (see earlier section). Simulation studies will be used to evaluate the performance of the economy under alternate price and exchange rate policies.

The CMB, which is responsible for formulating policies for the cocoa sector, has two main objectives: maximising government revenue and export earnings from cocoa. These goals may conflict in the short-run, and during most of the period under study the board seemed to have followed the former. Admittedly, the cocoa sector provides the most convenient way of raising tax revenue in a developing nation such as Ghana, where income taxes are difficult to collect. To follow a price policy which would provide the right incentive for the cocoa sector, the government may have to forgo millions of cedis in tax revenue.[12]

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[12] Franco's study (1978) has indicated that an export maximising price for the cocoa sector would imply a subsidy by the CMB.

In order to pay incentive-inducing prices to cocoa farmers, as well as maintaining some level of revenue from the cocoa sector, we propose periodic adjustment in the exchange rate. Thus in the simulation exercises, we will use price policies together with exchange rate policies. Two price policies will be examined under three exchange rate regimes for purposes of comparison. The first policy is an *ad hoc* policy, the type usually followed by governments. Since production in the fifties and early sixties was satisfactory, the assumption has been made in the second experiment that the producer price during these years was high enough to maintain incentive in the industry. Thus, the second price policy will be designed to increase the nominal producer price so as to maintain the real producer price experienced in 1956. For the exchange rate regime, we have chosen three alternatives: no change, which may imply a subsidy to the sector; appropriate change so that the export price of cocoa increase by an equal amount; or an appropriate adjustment so that the export price will increase by 20%, a situation which may imply a partial subsidy.[13]

1.4.1 *Linkages Between the Cocoa Sector and Rest of the Economy*

As noted in an earlier section, the main objective of this study is to evaluate the macroeconomic effects of cocoa pricing policies. The dominance of the cocoa sector in the economy

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[13] The price policies together with the exchange rate policies imply six policy combination (see chapter 4).

implies that there must be strong linkages--direct or indirect--with the rest of the economy. This section attempts to enumerate some of the linkages that we shall try to capture in our simulation exercises. The linkages may be divided into production and final demand linkages (see Adams and Behrman; 1982).

Production linkages come in several types. "Forward linkages" occur when industries spring up to process the raw cocoa. Such linkages are not likely to be extensive, however, due to the primary nature of the cocoa sector in Ghana. Cocoa grinding accounts for less than 10% of total production in the sector, while the manufacture of cocoa products such as chocolate is done on a very limited scale in Ghana. The transportation industry, however, may be a big beneficiary of these kinds of linkages. Commercial activities such as buying and selling may also benefit from an expanding cocoa sector.[14]

"Backward linkages" refer to increases in activities of sectors that result from an expansion in the cocoa sector. The first impact will be an increase in aggregate demand and hence an expansion of the market for other industries. Initially, government revenues from the cocoa sector may fall but this tendency may be reversed as the cocoa tax base increases. In addition, an expansion of cocoa production will indirectly strengthen the general tax base by stimulating overall

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[14] During most of the period, the buying and grading of cocoa has been handled by buyers licenced by the Cococa Marketing Board.

expansion of economic activity. Many taxes such as income taxes, import duties, and sales taxes depend to a large extent on the level of economic activity.

Another important contribution by an expanding cocoa sector is through exports. Since cocoa is the major foreign exchange earner, an increase in production will result in increased foreign exchange earnings, which will greatly benefit sectors, such as manufacturing, which rely heavily on imported goods and raw material. It is also well known that countries with a healthy balance of payments attract the most capital from abroad. Thus, all sectors will benefit immensely through an improvement in the balance of payments.

Smuggling, rural-urban migration and income distribution are also likely to be affected by activities in the cocoa sector. Some of the gains mentioned above may be limited by inflationary pressures likely to result from an increase in the money supply created by the increase in foreign exchange reserves and credit expansion (see chapter 5).

The interrelationships enumerated above are depicted in the flow chart below.

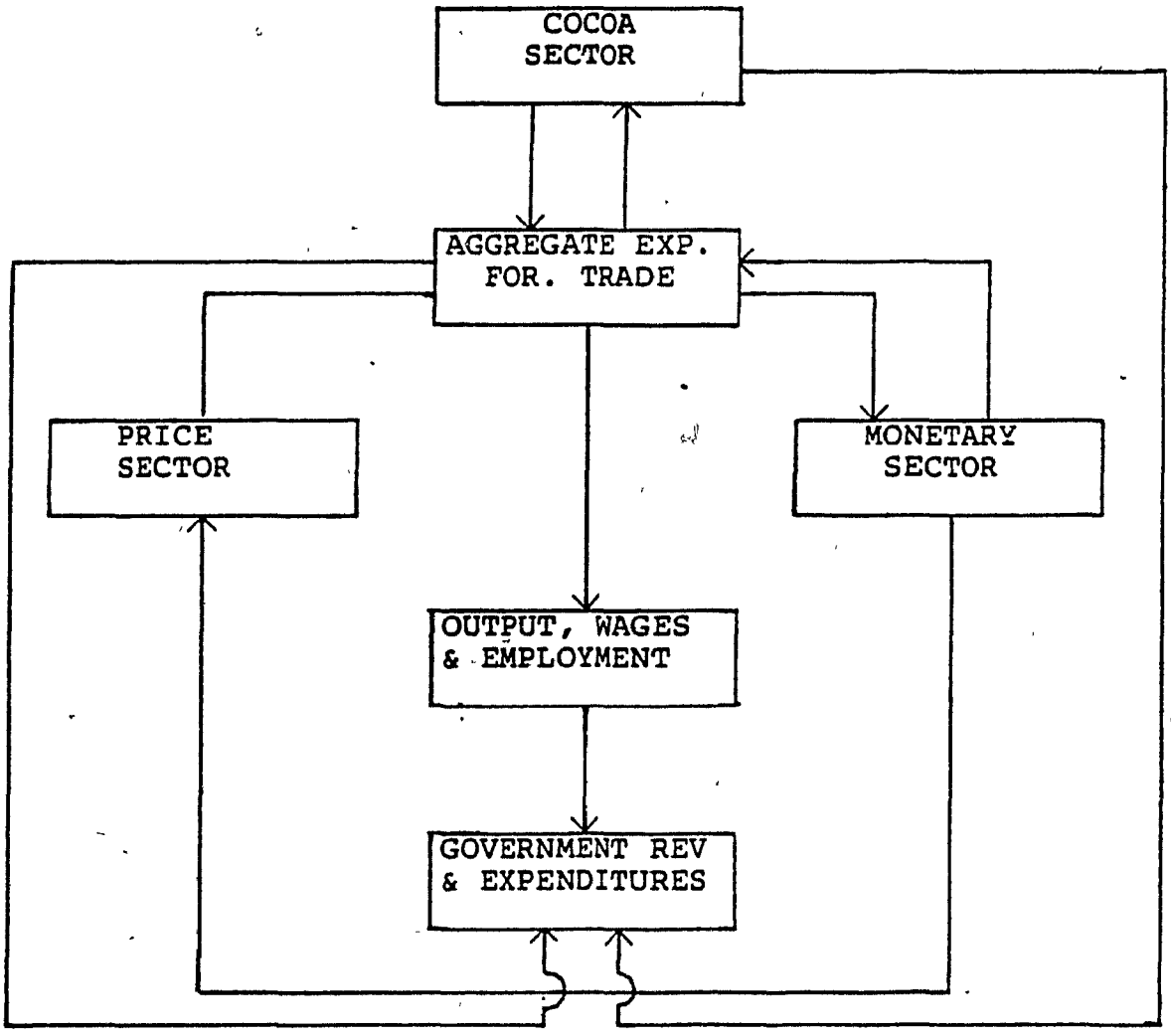

Figure 1.2: A FLOW CHART OF SECTORAL INTERRELATIONSHIPS

1.4.2 *Choice of Economic Goals for the Ghanaian Economy*

Since this study attempts to estimate quantitatively the impact of pricing policies in the cocoa sector on other sectors of the economy, it is important to clearly indicate all the variables of interest. Data availability has put a limit on the choice

of goals. The following goals are considered to be important for the Ghanaian economy.

1. Higher rate of GDP growth.
2. An improvement in the balance of payments situation and hence an increase in foreign exchange earnings.
3. A fall in the unemployment rate. As noted above this is only a partial measure since it does not take account of unemployment in the informal sector.
4. A decline in the level of smuggling.

In addition to the above, we will also examine the impact of the policies on production in each sector, government revenue, money supply and prices.

Chapter II

DATA SOURCES AND ESTIMATION METHODS

2.1 *DATA SOURCES, PROBLEMS AND LIMITATIONS*

Two major problems faced by researchers in third world areas are availability and reliability of data. It is therefore imperative in a study such as this to clearly indicate the sources and limitations of the data used. This study covers a period of twenty-six years, from 1956 to 1981, a period chosen mainly because any consistent effort at compiling comprehensive data on the Ghanaian economy dates only from 1956 [Brown: 1972]. Even then, data such as value added by sector are hard to come by, especially for the period before 1965.[15]

The main sources of data for this study are Ghanaian publications, mostly for earlier years, and International Monetary Fund (IMF) and World Bank publications for data on more recent years of the study. The Ghanaian sources used are mostly publications by the Central Bureau of Statistics (CBS) - especially ***Economic Survey of Ghana***. Other minor sources include The Bank of Ghana ***Annual Report***, The ***Quarterly Statistical Newsletters*** of the Ghana Commercial Bank, and ***Labour Statistics*** also published by the CBS. We have also made

[15] Data for 1956 to 1964 were obtained form ECA estimates (see Statistical Bulletin for Africa, ECA(several issues)

extensive use of two articles by Brown (1972) in the ***Economic Bulletin of Ghana***. These articles provide an extensive survey of data on macro-economic variables in Ghana from 1956-1969 period.

The major international sources used are IMF, World Bank and ECA publications. Data on monetary and price variables have been obtained mainly from several issues of the ***International Financial Statistics*** (IFS) published by the IMF. A World Bank country study on Ghana [World Bank: 1984] also provided considerable data on several variables, especially for the latter part of the period.[16]

2.1.1 *Data Transformations*

Some transformations were made to the raw data before the analysis. As a result the data used in the final analysis may not agree closely with the original sources. This section discusses briefly the various ways in which the data have been transformed.

The most difficult task was obtaining a continuous series of the components of real GDP. In the first place, we had to deal with three, or sometimes, four series with different base years. Moreover, the series were obtained from different sources which did not always correspond with each other. To

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[16] A more detailed list of the data sources is provided in the appendix, together with a definition of variables and all data used in the construction of the macro-econometric model.

solve the problem of different sources, we gave preference to official Ghanaian sources over all other sources, and whenever two series from the same source disagreed, we chose the more recent source. Thus any data revisions are incorporated in the analysis.

The second and probably more difficult problem was forming a continuous series out of the National Income data with a single base year. Several approaches may be used. Preferably one would want to obtain implicit deflators for each component, splice them and use them to deflate the components of GDP at current prices. Unfortunately, the component parts of the real GDP thus obtained may not always add up to real GDP obtained by applying the implicit GDP deflator to nominal GDP. Of course, we could overcome this problem by first summing up the real components so obtained to arrive at real GDP. The implicit GDP deflator would then be computed by dividing nominal GDP by real GDP.

Alternatively, we could first obtain the implicit GDP deflators and, assuming that all component deflators are the same, use these to deflate the nominal component parts to obtain their real values. This method, though simple, is not appropriate, however, since the various components often have different deflators. What we have done in this study is to compute the proportion of each component of real GDP for each series, obtain a continuous real GDP series by splicing, and, assuming each proportion will be the same for the new GDP

series, apply them to the GDP series to obtain the real values for the component parts.

Explicitly, we have for each series (assuming only 3 components):

$$(2.0) \quad X = X_1 + X_2 + X_3$$

where X is GDP for each series

X_1, X_2, X_3 are components of GDP for each series

Compute the following for each year.

$$x_1 = X_1/X \ , \quad x_2 = X_2/X \ , \quad x_3 = X_3/X$$

Let NX be the continuous (spliced) series of GDP. Then $NX_1=(x_1)(NX)$, $NX_2=(x_2)(NX)$, $NX_3=(x_3)(NX)$, where NX_1, NX_2, NX_3 are the respective final components of GDP. This method both ensures that each component maintains its deflator, and that the components sum up to total GDP. Both GDP by sector, and expenditure on GDP were computed this way.

Specific variables were also transformed or created in various ways. The capital stock variable in the employment and investment equations was created by the traditional method of generating data from a 'bench mark' estimate [Fair: 1984, p.112; Jorgenson: 1963, p.252]. In Ghana the 'bench mark' estimate most commonly used is that given by Szreszrewski (1960). His estimates are based on the assumptions that: i) the flow of investment during any time period is uniformly and

linearly distributed; ii) the rate of depreciation is linear and constant for capital of all vintages. Given these assumptions, we have:

$$(2.1) \quad K_t = (1-\delta)K_{t-1} + I_t$$

where K_t is capital stock in time t

δ is the rate of depreciation

I_t is investment in time t

Investment series are available from various publications. Earlier studies suggest that a value of 0.05 for d is appropriate for Ghana (Brown, 1972; Acquah, 1972; Attah, 1978). The series is then deflated by the Gross Fixed Investment (GFI) deflator to obtain capital stock in constant figures.

In the cocoa sector, most of the data are reported in crop years (extending from September of one year to August of the next). To make these data conform to other sections of the study, we have transformed the cocoa data into calendar years. Examination of some of the data (CMB *Annual Report*, 1964; Gill and Duffus, *Cocoa Market Report*, several issues) have indicated that about 15% of cocoa is harvested between January and August of the crop year, while the main crop between September and December accounts for the other 85%. Based on these figures, we transformed the crop year data as:

$$(2.2) \quad Q_t = .15Q_{t-1,t} + .85Q_{t,t+1}$$

where Q is the level of production

The producer price of cocoa used in the cocoa supply equation was deflated by the border price of cocoa. The concept of border price used in this study is along the lines of Little and Mirrlees (1974) and Hansen (1978). It is used to represent the price of a "tradeable" good at a country's border of entry in terms of either the domestic or foreign currency. A premium is usually included to reflect the scarcity of foreign exchange in the country in question. Usually, the world price of the good is used but in this study the border price is used to refer to the average producer price of cocoa in Togo and the Ivory Coast since these are the prices that matter to the Ghanaian cocoa farmer. An adjustment was made to take account of the rate of inflation in the various countries.[17] This adjustment is necessary since historical data on black market exchange rates, which would be more appropriate, are not available. The border price is computed by first obtaining a weighted average of the Togolese and Ivorian producer prices with the cocoa production level as weights. Since most smuggling is to the Ivory Coast, the choice of weights is probably appropriate. The border price is then computed as:

(2.3) $PTVC = (PPVC)(CPI)(CF)/CPITV$

where PPVC is the weighted average of producer prices in Togo and the Ivory Coast

CPI is the Ghanaian producer price index

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[17] Similar approaches were used by Bovet and Unnever [1981: p.26] and Franco (1981).

CPITV is an of average consumer price indices in Togo and the Ivory Coast

CF is the exchange rate (cedis per CFA francs).

Other transformations and creation of data in the cocoa sector are discussed under the section on smuggling.

2.2 *ESTIMATION METHODS*

This section provides an overview of the methodologies followed in estimating the equations of our model. The traditional classical methods of estimation have been followed throughout the study. These are basically the single equation methods of Ordinary Least Squares (OLS) and Two Stages Least Squares (2SLS) with principal components. While other more sophisticated and statically desirable methods such as three stage least squares and full information maximum likelihood methods would provide more efficient estimates, they have not been used in this study due to data limitations.[18]

2.2.1 *The Classical Linear Model*

OLS is the most common method used in estimating parameters of the Classical Linear Model (CLM) due to its simplicity. Consider the model:

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[18] These methods are feasible only if the number of observations (n) is large. Specifically, if n is greater than the number of equations in the model, singularity problems arise.

$$(2.4)\quad Y_t = B_0 + B_1X_{1t} + \ldots\ldots + U_t$$

where Y_t is independent variable in time t.

X_{it} is ith concomitant variable in time t.

U_t is an error term.

B_i are parameters to be estimated.

$i=1,\ldots,k \quad t=1,\ldots,n$

In matrix from, we have:

$$(2.5)\quad Y = XB + U$$

where

$$Y = \begin{bmatrix} Y_1 \\ . \\ . \\ Y_n \end{bmatrix} \quad X = \begin{bmatrix} 1 & X_{11} & \ldots\ldots & X_{1k} \\ . & . & & . \\ . & . & & . \\ 1 & X_{n1} & \ldots\ldots & X_{nk} \end{bmatrix} \quad B = \begin{bmatrix} B_0 \\ . \\ . \\ B_k \end{bmatrix} \quad U = \begin{bmatrix} U_1 \\ . \\ . \\ U_n \end{bmatrix}$$

It is assumed that the Y_i are independent and identically distributed (i.i.d.) with

$$E(Y) = XB$$

$$D(Y) = \sigma^2 I$$

where D(Y) is the dispersion matrix of Y.

Alternatively, the Ui's are i.i.d. with $E(U) = 0$, and $D(U) = \sigma^2 I$ The above assumptions imply the absence of autocorrelation and heteroscedasticity. We also assume that X is non-stochastic

and of full rank.[19]

Under the above assumptions, the OLS estimates are obtained by minimising the error sum of squares:

$$(2.6) \quad U'U = (Y - XB)'(Y - XB).$$

The solution gives:

$$(2.7) \quad \hat{B} = (X'X)^{-1}X'Y$$

$\hat{B}$ is unbiased and consistent for B. Under further assumption of normality of the errors, (i.e. U is $N(0,\sigma^2 I)$, we may determine the distribution of $\hat{B}$ as:

$$\hat{B} \text{ is } N[B, \sigma^2(X'X)^{-1}]$$

This result may be used in testing hypotheses concerning B.

In economic studies, several of the assumptions underlying the CLM are often violated, leading to wrong conclusions about the estimates and hence inappropriate policy recommendations. Some of these violations are difficult to deal with (e.g. multicollinearity, heteroscedasticity) while others such as serial correlation are easier [Johnston: 1972]. In our study we have encountered the problem of serial correlation in many of our models. It is thus proper to discuss how we took care of it.

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[19] This latter assumption is necessary to ensure that X'X has a regular inverse

Serial correlation exists if $E(U)=\sigma^2V$; where V is a positive semi-definite matrix, and it arises when the errors are correlated over time. Ignoring this problem leads to inefficient (but consistent) estimates. The Durbin-Watson Statistic (DW) provides a test for the existence of serial correlation (Durbin and Watson, 1950).

In our estimation, it is assumed that the errors follow an autoregressive process. Other processes such as the moving average (MA) and autoregressive integrated moving average (ARIMA) methods exist. Our choice is based on computational convenience. The Cochran-Orcutt iterative method is used to correct for autocorrelation. Again, computational considerations necessitated the use of this procedure.

2.2.2 *Simultaneous Equation Models*

Macro-econometric models are essentially multi-equation systems, involving relationships determining various variables of the model. Some of these relationships are stochastic while others are identities. Because dependent variables from one relationship may enter the righthand side of other equations, the assumption of a non-stochastic design matrix may be violated. Application of OLS will thus not produce asymptotically consistent estimators. Other methods which take the simultaneous characteristics of the model into account should therefore be used. In our study, the 2SLS is used to take care of this problem.

Suppose we have a model consisting of G endogenous variables, K predetermined variables and a vector of errors. Consider the estimation of the first equation of the system. The first equation may be expressed as:

$$(2.8) \quad y_1 = Y_1 B_1 + X_1 \Gamma_1 + U_1$$

where y_1 (nx1 vector of dependent variable)

Y_1 (matrix of endogenous variables)

X_1 (matrix of predetermined variables)

U_1 (nx1 vector of errors)

B_1 coefficients of endogenous variables

Γ_1 coefficients of exogenous variables

Application of OLS to (2.8) will yield estimates which are not asymptotically consistent since Y_1 may be correlated with U_1. The 2SLS replaces Y_1 with instruments which are not correlated with U_1 but are highly correlated with Y_1. The instruments are obtained by regressing each of the elements of Y_1 on all predetermined variables in the system and using $\hat{Y}_1$ as the instruments.

$$(2.9) \quad \hat{Y}_1 = X(X'X)^{-1}X'Y_1$$

Replacing Y_1 by $\hat{Y}_1$, we obtain

$$(2.10) \quad y_1 = \hat{Y}_1 B_1 + X_1 \Gamma_1 + U_1$$

$$\text{or} \quad y_1 = Z\Pi + U_1$$

where $Z = [\hat{Y}_1 \; X_1]$,

and $\Pi = \begin{bmatrix} B \\ \Gamma \end{bmatrix}$

Applying OLS to (1.9) gives the 2SLS estimates as:

$$(2.11) \quad \hat{\pi} = (Z'Z)^{-1}Z'y$$

is assymptotically consistent and all standard tests apply [Johnston: 1972].

2.2.3 *2SLS with Principal Components*

The creation of instrumental variables for Y_1 requires the regression of each element of Y_1 on all predetermined variables in the system. Very often macro-econometric models contain more predetermined variables than the number of observations. The X'X matrix may thus be singular. In the cocoa model, this is not a problem but with the main model, the problem exists. Even if n>k, we may still have too few degrees of freedom if n is very close to k. The first stage estimates may thus not be efficient.

One way of dealing with this problem is by using only a subset of X as the first stage regressors, which may be arbitrary; another is to use the first l principal components of X (l<k) (Kloek & Mennes, 1960). The principal components of a matrix X are formed by linear transformations of the component variables of X. They are the eigenvectors corresponding to the eigenvalues of the equation:

$$(2.12) \quad (X'X - \lambda I)a = 0$$

where λ is the eigenvalue

a is the eigenvector

and I is an identity matrix.

In some cases, only the principal components of the excluded predetermined variables are used. This is computationally inconvenient since new principal components have to be computed for each equation. Kloek and Mennes (1960) have shown that not much is lost when we use the principal components of all predetermined variables instead, a choice that reduces the amount of computation involved considerably. In this study we have used principal components to estimate several of the equations of the macro model.

2.2.4 *Recursive Systems*

Another approach we shall use to reduce the number of first stage regressors is to take into consideration the recursiveness (or block recursiveness) of the system (see Pindyck & Rubinfeld: 1981). A system is said to be recursive if its equations can be determined sequentially, or in other words, if the solution of the nth equation depends only on the first n equations.

If a system has been ordered recursively its equations can be estimated by ordinary least squares without any loss of consistency. Consider the 3 equation model:

$$(2.13) \quad Y_1 = f(X_1, U_1)$$

$$(2.14) \quad Y_2 = f(Y_1, X_2, U_2)$$

(2.15) $Y_3 = f(Y_1, Y_2, X_2, U_3)$

Each of the 3 equations can be estimated by OLS since (2.13) contains only an exogenous variables, (2.14) contains Y_1 which is not correlated with U_2 and (2.15) contains Y_1 and Y_2 which are not correlated with U_3. Thus the simultaneity problem is circumvented.

Many medium-to-large models (including ours) may not be totally recursive but block recursive. This situation is a combination of recursive and simultaneous systems. Unlike a purely recursive system where each equation feeds the next, in a block recursive system each block of equations feeds the next. The included blocks form simultaneous systems, however, and must be estimated by appropriate simultaneous equation methods such as 2SLS and 3SLS.

Example:

(2.16) $Y_1 = f(X_1, U_1)$

(2.17) $Y_2 = f(Y_1, Y_3, X_2, U_2)$

(2.18) $Y_3 = f(Y_2, X_3, U_3)$

(2.19) $Y_4 = f(Y_1, Y_2, Y_5, X_4, U_4)$

(2.20) $Y_5 = f(Y_1, Y_4, X_5, U_5)$

The set of equations (2.16) to (2.20) forms a system of 3 blocks. Block one contains equation (2.16) while block two is made up of equations (2.17) and (2.18). The third block comprises equations (2.19) and (2.20). (2.16) can be estimated with OLS. The second and third blocks can be estimated

separately with 2SLS. Thus, we can reduce significantly the number of equations to be estimated simultaneously.

2.3 *THE SIMULATION MODEL AND ITS EVALUATION*

Once an econometric model has been specified and estimated, it may be put to several uses including structural analysis, forecasting and policy evaluation. Structural analysis is basically descriptive, dealing with estimation and interpretation of the coefficient by means of comparative statics, elasticities, multiplier analysis and testing various theories [see Intriligator: 1978]. Forecasting on the other hand involves predicting values of the relevant variables beyond the sample period. Finally, policy evaluations (as the name suggests) compare the consequences of alternate policies to arrive at the best combination that should be adopted. These three uses of econometric models are by no means mutually exclusive, but the emphasis of each may be different. For example, structural analysis draws more heavily on theory than do forecasting and policy evaluation. The approaches are complementary, however, and are often carried out simultaneously.

Our study clearly falls into the category of policy evaluation. The simulation approach to policy evaluation is adopted here.[20] Simulation involves the mathematical solution

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[20] The instrument-targets and social welfare function approaches may also be used (Kirschen and Morrisens, 1965).

of a set of difference equations. Consider the model:

$$(2.21) \quad YB = X\Gamma + U$$

where Y = matrix of endogenous variables.

X = matrix of predetermined variables.

U = error

and

$$(2.22) \quad YB = Y_1\Gamma_1 + Z\Gamma_2 + R\Gamma_3 + U$$

where Y_1 is a matrix of lagged endogenous variables

Z is a matrix of exogenous variables

R is a matrix of policy variables

Assuming B is of full rank, the reduced form model may be obtained as follows:

$$(2.23) \quad Y = Y_1\Gamma_1B^{-1} + Z\Gamma_2B^{-1} + R\Gamma_3B^{-1} + UB^{-1}$$

To obtain a solution to the model above, we require values for Γ_1, Γ_2, Γ_3, B^{-1}. Z may be assigned their actual values if simulation is within the sample period, or they may be extrapolated by an appropriate method if simulation is outside the sample period. R is usually obtained by making various assumptions. We also need an assumption about the error term. Since we initially assumed that E(U)=0, we will set the values of the error term to zero when simulating the model. Our simulation is therefore deterministic.[21] Once values of the

[21] Most models make this assumption. Stochastic simulation on the other hand involves using many draws of error terms in

parameters, exogenous variables, lagged endogenous variables and policy variables have been obtained one way or the other, values of the endogenous variables can be calculated for each period.

The method described above is useful when the simulation model is linear (both in variables and paramters). This is, however, not the case for most medium to large models, which often include nonlinear relationships. Our model contains several non-linear equations. In such a situation, the reduced form is not easily obtainable, and simulation is done with the structural form. Several methods exist but, for computational convenience, we have used the Gauss-Seidel iterative method to simulate our models.

Consider a two-equation simulation model, such as follows:

$$(2.24) \quad y_1 = f_1(y_2, X_1, B_1, U_1)$$

$$(2.25) \quad y_2 = f_2(y_1, X_2, B_2, U_2)$$

All variables are defined as before. In the Gauss-Seidel technique, U_1, U_2 are set to zero while X_1, X_2 assume their actual or extrapolated values. (2.24) and (2.25) are estimated by an appropriate method, while starting values for y_1 and y_2 are provided by the researcher. The first step solves for y_1 and y_2 by substituting for the values on the RHS. Then the solutions obtained in the first iteration for y_1 and y_2 are substituted into the RHS for a second round of iteration. This

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the process of solving the model. [Fair: 1984].

continues until the percentage changes in y1 and y2 are very small.

i.e. $$\frac{y_1^n - y_1^{n-1}}{y_1^n} \leq \epsilon$$

where ϵ is the tolerance criterion.

In our study, we have chosen the value of .0001 for ϵ. This value is considered to be low enough for the desired accuracy.

2.3.1 *Evaluating the Predictive Accuracy of Simulation Models*

Before the model can be used for policy experiments, it must satisfy certain conditions. In particular, it should be able to track the historical data over the simulation period reasonably well. Other desirable properties include picking the turning points in the historical data, and conforming to theory. The most common statistics for evaluating predictive accuracy are the Root Mean Square Percentage Error (RMSPE), Mean Absolute Percentage Error (MAPE) and Theil's inequality index (U). Most recent studies use either the RMSPE or U because the MAPE penalizes large errors less than do the other measures. This study has used the RMSPE defined below to test for accuracy.

$$\text{RMSPE} = \sqrt{\frac{1}{n}\sum\left\{\frac{y^a - y^s}{y^a}\right\}^2} \times 100$$

where y^a = historical value

y^s = simulated value

The main problem with these statistics is that since their distributions are not known parametric testing of them is not possible. What is done traditionally is to compare them with those of similar studies, but as Fair (1984, p. 263) points out, this may also run into problems, since these measures are highly sensitive to the number of endogenous variables appearing as explanatory variables in each equation of the model. The less the number of endogenous explanatory variables, the better these measures are. Thus, care must be taken in interpreting them.

A model's ability to explain turning points is also widely used to determine its acceptability. This is best done by overlaying the graphs of simulated values with the historical ones.

2.3.2 *Policy Experiments*

Both the cocoa sector model and the complete macromodel will be subjected to policy experiments under various assumptions. The methodology is to make an assumption about the value of a particular policy variable, use it to simulate the model over the sample period, and then compare these results with some control solution. In this situation the control solution will be the case where all predetermined variables (including policy variables) assume their historical values.

The main policy variables in this study are the cocoa export tax and the official exchange rate. Various

combinations of these variables will be used to simulate the model. We shall also make certain assumptions about several exogenous variables in the model not directly controlled by the government.

Chapter III

A MODEL FOR THE COCOA SECTOR IN GHANA

This chapter is devoted to building an econometric model for the cocoa sector. Later on, this model will be integrated into the macro model for the whole economy. Since our main objective is to evaluate the impact of various cocoa policy scenarios on other sectors of the economy, it is obviously important to treat this sector separately from the rest of the economy.

3.1 *SPECIFICATION OF THE MODEL*

The cocoa sector model is a typical dynamic commodity model consisting of supply, demand, and price equations together with several identities determining relevant variables such as export volume, cocoa export tax proceeds, and earnings lost through smuggling. A supply function for Ghana's cocoa is estimated using the traditional adaptive expectations approach popularised by Nerlove (1958). A dynamic adjustment relationship is used to determine world demand for cocoa. World price and stock of inventory are assumed to be given, while quantity supplied by the rest of the world is treated as a residual.

3.1.1 *The Supply Function*

Agricultural supply functions are generally dynamic in nature since they seek to estimate the responsiveness of quantity supplied to changes in prices in the past. There must therefore be some expectation built into the system. Nerlove (1958) is mainly responsible for laying the groundwork in this area, while other contributions and empirical applications have been added in works by Behrman (1968) and Bateman (1965). It is noteworthy that Bateman's work largely involves estimations of supply functions for cocoa in Ghana. and that Ady (1953) and others have also provided empirical estimates. Most of these studies are based on the Nerlovian supply function.

Agricultural supply functions fall into two major groups--supply functions for annual crops and supply functions for perennial crops. The main difference between the two groups is that, whereas the latter involve a long gestation period before harvesting begins and continue to produce for a long time, (for example crops such as cocoa, coffee, bananas, etc.), the other group, comprising crops such as potatoes, rice, and peanuts, produce only once, usually annually.

Since cocoa is a perennial crop, we shall discuss the specification of supply functions falling under this category. French and Matthews (1971) have provided an analytical framework for constructing such models. Their guidelines include relationships determining yield, acreage, new plantings, and relationships linking expected and observed variables.

Two general approaches may be distinguished. The first, which is appropriate for estimating long-run elasticities, involves two relationships determining acreage planted and yield per acre. Total output is then obtained as a product of acreage and yield/acre. Most often, however, data on acreage planted is not available and one can only estimate a relationship for output.

In the first case, the equation for acreage response is based on the general Nerlovian adaptive expectations model. It assumes that a move to a new equilibrium area under cocoa cultivation in response to a change in the producer price of cocoa first affects the expected level of future prices, which in turn affects the long run equilibrium acreage planted. Finally, the change in long-run equilibrium acreage is translated into changes in current output. The relationship for acreage response is developed as follows:

Following Nerlove (1958), we assume that farmers form their price expectations in proportion to their mistakes in the previous year.

Then

$$P^*_t - P^*_{t-1} = b[P_{t-1} - P^*_{t-1}]$$

where P^*_t is expected producer price in year t

and b is the coefficient of expectation.

Rearranging, we have:

$$(3.0) \quad P^*_t = bP_{t-1} + (1-b)P^*_{t-1}$$

Equation (3.0) is a first-order difference equation in P^*_t whose solution is given by:

$$P^*_t = H(1-b)^t + \sum_{i=0}^{t} b(1-b)^{t-i}P_{i-1}$$

P* may be measured in deviations from the initial value such that H=0, reducing the equation above to:

$$(3.1) \quad P^*_t = \sum_{i=0}^{t} b(1-b)^{t-i}P_{i-1}$$

Assume that in each period, acreage under cultivation is adjusted in proportion to the difference between the output desired in the long run and actual output in the previous year.

Then

$$(3.2) \quad A_t - A_{t-1} = m[A^*_t - A_{t-1}]$$

where m is coefficient of adjustment

A_t is acreage in year t

A^*_t is desired acreage in year t

Equation (3.2) is a first-order difference equation in A_t whose solution, similarly to equation (3.1), is given by:

$$(3.3) \quad A_t = \sum_{j=0}^{t} m(1-m)^{t-j}A^*_j$$

A_t thus, depends on various A*'s in the past. Suppose Z_t is another variable apart from P* which influences A*, and let the relationship be as follows:

$$(3.4)\quad A^*_t = a_0 + a_1 P^*_t + a_2 Z_t + U_t$$

where U_t is an error term

Z may represent costs of production, inputs such as insecticides and fertilizers, or similar variables which tend to influence long-run productivity.

Solving the system consisting of equations (3.1), (3.3) and (3.4) gives the equation for A as:

$$(3.5)\quad A_t = a_0 + a_1 bm \sum_{i=0}^{t} (1-m)^{t-i} \sum_{j=0}^{i} (1-b)^{i-j} P_{j-1}$$

$$+ a_2 m \sum_{i=0}^{t} (1-m)^{t-i} Z_i + m \sum_{i=0}^{t} (1-m)^{t-i} U_i$$

Equation (3.5) may be transformed into:

$$(3.6)\quad A_t = a_0 bm + a_1 bm P_{t-1} + [(1-b)+(1-m)]A_{t-1}$$
$$- (1-b)(1-m)A_{t-2} + a_2 m Z_t - a_2(1-b)m Z_{t-1}$$
$$+ m[U_t-(1-b)U_{t-1}]$$

Equation (3.6) assumes that the errors follow a first order autoregressive process, and suggests a regression model of the form:

$$(3.7)\quad A_t = g_0 + g_1 P_{t-1} + g_2 A_{t-1} + g_3 A_{t-2} + g_4 Z_t$$
$$+ g_5 Z_{t-1} + V_t$$

where $V_t = m[U_t - (1-b)U_{t-1}]$

In functional form, we have:

$$(3.8) \quad A_t = f[P_{t-1}, A_{t-1}, A_{t-2}, Z_t, Z_{t-1}]$$

Whereas acreage under cultivation involves long-period decisions, yield per acre is a short-term phenomenon determined by factors such as natural conditions and current output and input prices. Such a relationship may be expressed as:

$$(3.9) \quad Y_c = f(R,P,V)$$

where Y_c is yield per acre

R is an index of meteorological conditions

V is a vector of input prices.

Given acreage planted (eq.3.8) and yield per acre (eq.3.9) above, total output of cocoa beans is given by:

$$(3.10) \quad QSG = (A)(Y_c)$$

where QSG = Ghana's supply of cocoa.

The alternative method (following Labys (1973)) assumes that supply can be explained as:

$$(3.11) \quad q^*_t = a_0 + a_1 p^*_t + a_2 Z_t + U_t$$

q^*, p^*, Z are as defined before.

The desired quantity supplied is determined by the stock adjustment relationship.

$$(3.12) \quad q_t - q_{t-1} = m[q^*_t - q_{t-1}]$$

P* is determined by the adaptive expectations model:

$$(3.13)\quad p^*_t - p^*_{t-1} = b[p_t - p^*_{t-1}]$$

The set of equations (3.11), (3.12), (3.13) is similar to (3.0), (3.2), and (3.4) and its solution will give the relationship for supply response as:

$$(3.14)\quad q_t = f[p_{t-1}, q_{t-1}, q_{t-2}, Z_t, Z_{t-1}]$$

This is essentially a short-run relationship since it assumes acreage planted as given. This means output can change in response to price and other variables only as a result of either better husbandry of existing trees (by means such as weeding, spraying, etc.) or by increased profitability of farming relative to other activities.

Although it would be desirable to estimate the quantity of cocoa supplied by the first method but due to the absence of data on acreage planted, our final equation is based on equation (3.14). In practice, the estimated relationship does not have to be exactly in the form of equation (3.14). Essentially, it should contain the variables p, q, Z though not necessarily with the same lags. For short-run estimates, lags up to five years are chosen depending on the significance of the lags. Various functional forms are also used, eg. linear, logarithmic, first differences, ratios of various prices, etc.[22]

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[22] See Labys (1973) for a review of a number of these studies.

The following linear relationship was estimated for this study:

$$(3.15) \quad QSG = a_0 + a_1 PPTV(-3) + a_2 YCO + a_3 t + U$$

PPTV, the price variable, is the nominal producer price deflated by the border price.[23] PPTV thus reflects the relative profitability of selling cocoa to the CMB rather than smuggling it into the neighbouring countries. We would expect a positive relationship between QSG and PPTV. Due to unavailability of data, variables which may be classified under Z such as use of fertilizer and insecticides, have been excluded from the relationship. A trend variable has been included to reflect any other secular changes that might have occurred over the sample, period such as the introduction of new varieties and new plantings. YCO is cocoa farmers' income and is included to capture any income effects, and also to test the hypothesis that farmers have a target income (see section 1.2.1).

3.1.2 *Demand and Inventory*

The demand for cocoa is a derived demand since cocoa is a raw material ultimately used in the manufacture of confectioneries. However, due to the difficulties involved in treating it as such, as well as data problems, we follow the general procedure [Akiyama: 1982; Blomqvist & Hassel: 1972; ICCO: 1975], by using

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[23] See section on data handling for the methodology used to convert the border price into local currency.

world cocoa grindings as a measure of world demand for cocoa.

Following the theory of consumer demand (i.e. maximisation of utility based on some budget constraint), the demand for a commodity depends on its own price and prices of related goods (substitutes and complements), income and other variables, such as taste. Cocoa and sugar are the main ingredients used in the production of confectioneries. The inclusion of the price of sugar will thus capture any complementarity effects. Furthermore, more than 60% of world grindings and consumption take place in the OECD countries [Gill & Duffus: several issues]. It is thus appropriate to include the GDP of OECD countries to take care of income effects.

The relationship for estimating demand is given by:

(3.16) $QDW = f(PL, PS, YW)$

where QDW is world cocoa grindings

PL is the Accra-London spot price

PS is the price of sugar

YW is real GDP of OECD countries

The treatment of inventories is a major problem for many commodity models due to the fact that stockholders' behaviour differs depending on their motives. Furthermore, different results may be obtained according to whether the holders are consumers, producers or speculators. Yet stocks are not classified in these categories, which makes it difficult to

provide a general framework for analysing them. Labys (1973) has provided a comprehensive overview of the various types of inventories and studies which have incorporated them.

Since a substantial part of cocoa stocks are held in the major consuming countries, mainly for purposes of speculation and manufacturing, we may assume that they fall in the category of producer stocks. The usual way of dealing with this category of stocks is by way of an accelerator-stock adjustment principle [Goodwin: 1947], which assumes proportionality between desired stock and output in a particular period.

$$(3.17) \quad S^*_t = n_0 + n_1 q_t$$

and

$$(3.18) \quad S_t - S_{t-1} = a[S^*_t - S_{t-1}]$$

where a is the coefficient of adjustment.

Combining the two equations, we obtain:

$$S_t = an_0 + an_1 q_t + (1 - a)S_{t-1}$$

or

$$(3.19) \quad S_t = b_0 + b_1 q_t + b_2 S_{t-1} + U_t$$

It is also reasonable to expect that prices may be an important factor in determining the level of stocks. For example, an increase in the price level may cause manufacturers to use up some of their stocks. Thus an appropriate equation for stocks may be of the form:

$$(3.20)\quad S_t = b_0 + b_1 q_t + b_2 S_t + b_3 P^*_t + U_t$$

where p* may be current or lagged by appropriate period.

This suggests a functional form in terms of the variables of our model as:

$$(3.21)\quad CIS = f[QDW, CIS(-1), PL(-1)]$$

Alternatively, an inverted form of this equation may be used to determine price as follows:

$$(3.22)\quad \text{i.e.}\quad PL = f(QDW, CIS)$$

CIS may then be determined as an identity:

$$CIS = QSW - QDW$$

Preferably, a model for the Ghanaian cocoa sector should include a relationship such as equation (3.22) above, where the world price for cocoa is endogenously determined, since Ghana produces a significant percentage of world supply; and can thus not be assumed to be a price taker. Many attempts at estimating such a relationship, however, did not yield reasonable results. We have thus decided to treat PL as exogenous, and instead include Ghana's supply as one of the variables determining the cocoa export price (see next section).

3.1.3 *Export Price for Ghana's Cocoa*

The export price of cocoa is the third price included in the model. The other two are the world price of cocoa (PL) discussed above, and the producer price of cocoa, which are both treated as exogenous. There are several reasons why the export price of Ghana's cocoa may differ from the world price as represented by Accra-London spot price (PL). The most important is that PXCF is an average price for sales of Ghana's cocoa to various countries. These may differ due to preferential treatment given to these countries. Furthermore, PXCF will reflect prices on other major markets (e.g. New York spot price for cocoa).

In this study we expect the export price of cocoa (PXCF) to vary directly with the world price (PL), a time trend which will capture any secular effects, and a dummy variable (DUM2) which assumes a value of 1 after 1976 and zero elsewhere. DUM2 is included to take account of the sudden, unexplained jump in PXCF from 1977 to 1981. Lagged QSG is also included to take care of the fact that an increase in Ghana's supply of cocoa will lead to a fall in the export price. A log-linear relationship was estimated as follows:

$$(3.23)\quad \log PXCF = k_0 + k_1 \log PL(-1) + k_2 \log QSG(-1) + k_3 t + k_4 DUM2 + U$$

3.1.4 *Domestic Consumption of Cocoa and Other Identities*

An attempt at relating domestic consumption of cocoa in Ghana to GDP (reflecting the level of economic activity) and PXCF, which provides a measure of competition with foreign consumers, yielded poor results. Domestic consumption is therefore determined in the model as a residual.

(3.24) i.e. CD = QSG - CXO

Other identities were included to determine cocoa exports (CXO), cocoa export tax (TAX), cocoa export tax revenue (RC), cocoa export earnings (XCO) and earnings lost through smuggling An identity representing quantity supplied by the rest of the world (QSRW) closes the system. (XCS).[24]

3.2 *SMUGGLING*

Smuggling has received only a passing reference in the development literature, despite the fact that official sources and independent studies have indicated that it accounts for more than 20% of the total trade of many LDC's especially Asian and African countries. The reason for this lack of attention is the difficulty of detecting the volume of smuggling. To ignore it altogether, however, may result in incorrect estimation results and hence inappropriate policy implications.

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[24] these identities are defined below.

Consider the case where one is interested in estimating the supply function of an agricultural commodity. If one relies only on official records of production, which don't take account of smuggling, the resulting estimated supply functions will suffer from all the statistical deficiencies of measurement errors and hence leading to erroneous policy conclusions. There should thus be considerable effort put into incorporating smuggling into all relevant studies. As Simkin [1970: p. 157B] rightly puts it, "...attempts at quantitative estimation are necessarily hazardous. Complete neglect, however, is much worse; it implies a zero estimate which in the circumstances will be absurd".

3.2.1 *The Theory of Smuggling*

Before considering the task of detecting smuggling, a discussion of the theoretical background is important. The term smuggling as used in the literature may take various forms including over-invoicing, under-invoicing, misclassification of goods and clandestine physical movement of goods to avoid customs. Both imports and exports may be subject to smuggling.

Over-invoicing occurs when goods are deliberately declared at a higher value. The difference between the actual value and the declared value then accrues to the trader in the form of foreign exchange which can be traded on the free market or black market (if one exists). In the case of under-invoicing, goods are declared at lower values to avoid paying the full

custom duty. The third type of smuggling involves classifying goods under other categories which have lower rates of taxation.[25] The final type of smuggling needs no further explanation. It can involve both imports and exports and is probably the most significant in the case of exports.

Smuggling may take place for a number of reasons, including the avoidance of high tariffs, overvalued currencies, and high inflation rates. For the present, we will only consider the case where only high tariffs are the main cause of smuggling.[26]

The background to the theory of smuggling has been provided by the classic article of Bhagwati and Hansen (1972). Before that, the general belief was that smuggling necessarily avoids tariffs and hence must be a movement towards optimality. In other words, smuggling must improve welfare. This line of reasoning ignores the fact that smuggling involves a cost to society, however. In the case of exports for example, there is a loss for most primary exporting developing countries such as Ghana. The prices at which the smuggled goods are sold in the neighbouring countries (border prices) are usually lower than the world price for the good in question, though these border prices may be substantially higher than the prices in the

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[25] In certain LDC's, capital goods carry lower rates of taxation.

[26] This is only true for countries with floating rates, hence no difference between official and free/blackmarket rates. As we shall see later, this is not the case for most LDC's including Ghana. In such cases, the blackmarket premium may be considered as a tax/subsidy on foreign trade.

country from which the goods are illegally exported. There could therefore be substantial gain in foreign exchange by one country at the expense of another.

In addition, there is the usual optimal tax argument if the country from which the goods are smuggled is a monopolist in legal trade. An appropriate tax can thus lead to a welfare gain whereas smuggling constitutes a movement away from optimality by undermining such a tax. Thus, smuggling may and often does involve a welfare loss for the country involved.

Using the traditional Hicks-Samuelson framework, Bhagwati and Hansen (1972) have demonstrated that the presence of smuggling may lead to welfare loss as compared to a situation where smuggling is absent or negligible. In a situation where the smugglers' transformation curve is different from the domestic transformation curve, smuggling necessarily eliminates legal trade. In such a situation, one cannot say *a priori* whether smuggling raises welfare or not. However, in the more realistic situation of the coexistence of legal trade and smuggling, consumption is on a lower indifference curve as shown in Figure 3.1

In Figure 3.1, exports (X) and imports (M) are represented on the vertical and horizontal axis respectively. AB is the transformation curve. P_f, P_t and P_s denote price ratios on the free, domestic (tariff inclusive) and smugglers' markets; U_f, U_t, U_s, are corresponding community indifference curves while C_f, C_t, C_s are consumption points. $C_{s,t}$ and $U_{s,t}$ represent situations where smuggling and legal trade may co-exist.

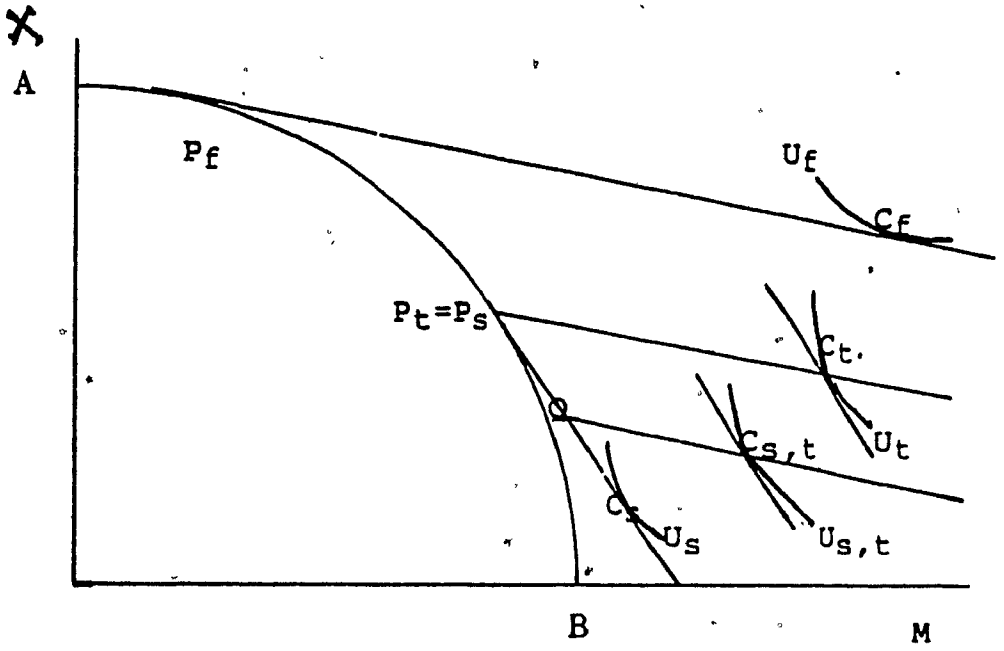

Figure 3.1: SMUGGLING IN THE PRESENCE OF LEGAL TRADE

Consider, without loss of generality, the situation where only imports are smuggled. Under free trade, the economy is at C_f on the U_f indifference curve. This is clearly the most desirable situation from the point of view of welfare, since there will always be a point on the P_fC_f line on a higher indifference curve than any other situation. Suppose that a tariff is introduced such that the domestic terms of trade are on a steeper line tangent to AB at P_t (i.e. $P_t=P_s$). Suppose further that the smugglers' transformation line coincides with the tangent at P_t. Then if consumption takes place at any point on the smugglers' transformation curve other than at $P_t(=P_s)$, legal trade will be completely eliminated. Such a point is at C_s on the U_s indiference curve. $C_{s,t}$ on the other hand represents a situation where both smuggling and legal

trade can co-exist. Here, smuggling is at Q, while legal trade leads to consumption at $C_{s,t}$ on $U_{s,t}$

Finally, if consumption takes place at C_t at welfare level U_t, then smuggling is completely eliminated. It is obvious from the diagram that $U_{s,t}$ is higher than U_s. It is also true that we can always obtain a situation in which no smuggling is always better than any amount of smuggling (i.e. $U_t > U_{t,s} > U_s$).[27] Thus, Bhagwati and Hansen arrived at the conclusion that:

> For non-prohibitive tariffs, and constant costs equal to the tariff-included price and perfect competition in smuggling, legal trade and smuggling may co-exist. In this case, no smuggling is better than any amount of smuggling; and the less the smuggling the better. [Bagwati and Hansen: 1975, p.14]

3.2.2 *Methods of Detecting Smuggling*

While there presently is some agreement on the welfare and balance of payment effects of smuggling, there is very little consensus on the methodology to be followed in quantifying smuggling. The most widely used method is partner-country data comparison (Bagwati). By this method, the recorded official trade of a country is compared with that of its trading partners. any discrepancy between the two, adjusted for freight insurance, etc., gives an indication of the magnitude

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[27] From Figure 3.1, a situation can arise in which Us,t is higher than U_t. However, since the P_tC_t line crosses the horizontal axis further right than the $QC_{s,t}$ line, there will be at least one equilibrium point on the P_tC_t line which is higher than $U_{s,t}$.

of smuggling out of and into the country.

This method is not without numerous criticisms. They include errors in estimating freight and insurance costs, different procedures and classifications used in recording trade, etc. Furthermore, in many circumstances, the smuggled goods usually are not recorded by the recipient country as imports but rather as its own production. This is especially true with primary exports where the final destination is often overseas. In the case of cocoa smuggling from Ghana to Togo, for example, the Togolese authorities record such activities as originating from Togo rather than as imports from Ghana.

Thus, in many cases, it is almost impossible to use partner-country data comparisons to detect smuggling. The only situation where the method may be applicable is when smuggling takes the form of over-invoicing and under-invoicing. In such a case, a fairly good indication may be obtained by comparing the country's official records with those of the partner country.

A second method, also quite popular, assumes that there exists some 'normal' level of production for a particular year of interest. Once this normal production level has been established, smuggling is determined by the difference between this level and the sum of official exports and domestic consumption. While this method is more suitable for estimating smuggling in most cases, the difficulty lies with estimating the 'normal' level of production. Many developing countries

have large sectors of small scale production, which are often difficult to monitor. The recorded official levels of production are thus estimated exports plus domestic consumption. The estimated exports often make allowance for unrecorded exports, which are established by the authorities in an *ad hoc* manner. Richter (1970) has documented the difficulties that plague such attempts at estimating quantities involved.

In estimating the quantity of cocoa smuggled in and out of Ghana, we will adopt the latter approach. Our main objective thus is to obtain a reasonable estimate of a 'normal' level of production, and then to obtain the level of smuggling by the difference between this and the recorded official level of production (exports plus domestic consumption).

So far, there have been only two explicit treatments of smuggling in related studies on Ghana. By this we imply not only the recognition of the significance of cocoa smuggling and consequent policy implication that it may have, but also a systematic attempt at its estimation and inclusion in subsequent analyses. A study by Franco (1978) includes the level of smuggling in estimating the supply function for cocoa in Ghana. His figures, obtained from various sources including his own estimates, were based on the assumption that all smuggling is to Togo, an assumption that is obviously not realistic. In the first place, official Ghanaian statements and those of other international bodies such as the World Bank,

indicate that large quantities of cocoa are smuggled into the Ivory Coast as well. Secondly, many estimates of total smuggling out of Ghana (including Franco's) have put the figures at levels much higher than the total official records of cocoa exports from Togo. For example, in the 1978/79 crop year, Franço arrived at a figure of 50,000 metric tons as the quantity of cocoa smuggled into Togo, while recorded Togolese exports amounted to less than 20,000 tonnes (Gill and Duffus). Since Togo does not process any of its produce, we can safely assume that Togolese exports are equal to its production plus smuggling. Thus, Franco's figure would mean that Togo's output (production level) in 1978/79 was zero and that the recorded level of exports was less than what was actually exported. This is unlikely to be true since he estimated smuggling as follows:

$$SM = XT - ST$$

where SM is smuggling cocoa from Ghana to Togo

XT is Togo's exports

ST is Togo's production

Furthermore he does not indicate how ST was determined.

Another study by Kumar (1973) operates on the assumption that because they have similar climatic, agronomic and technological conditions, production conditions in Ghana, Togo and the Ivory Coast are uniform. Any change in production ratios can only come about as a result of policies or phenomena

affecting cocoa tree population. These include fresh plantings, adoption of higher yielding varieties, or disasters, such as bush fires and diseases. Assuming that diseases and other natural disasters affect all tree countries evenly,[28] and that there has been no significant change by any of the countries towards a particular variety of the cocoa tree, Kumar assumes that any changes have been due to increases in new plantings. Based on this assumption, the amount of smuggling in or out of any of the three countries is estimated as a deviation of its production ratio from that for the whole region with an allowance for changes due to new plantings.[29]

The results obtained by Kumar show that a substantial amount of cocoa has been smuggled out of Ghana between the period 1962/63 and 1970/71, while between 1959/60 and 1961/62, there was smuggling into Ghana. Kumar's figures are significantly higher than Franco's (1978) and agree more closely with other independent estimates. They have their shortcomings, however, which we shall see below.

Our approach at estimating the quantity smuggled also relies on the idea of the existence of a 'normal' level of production. Following Kumar (1972), we assume that the annual percentage changes in production levels in the Ghana-Ivory

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[28] In 1983, bush fires devastated large acres of cocoa farms in Ghana due to a prolonged drought. Apart from this, there have not been any reported disasters which have not equally affected production in the three countries. In any case, 1983 is outside our sample period and hence will pose no significant problems.

[29] A more elaborate analysis will be presented later.

Coast-Togo region should be similar. In other words, any differences between countries should be due either to new plantings or to random error. Smuggling would then represent any unexplained differences.

Let $Q = QSG + QV + QTO$

where Q is total production in the region.

QSG, QV, QTO are production levels in Ghana, Ivory Coast and Togo respectively.

Production indices for each region and for each country are computed as follows:

$q_1 = QSG/QSG^*$, $q_2 = QV/QV^*$, $q_3 = QTO/QTO^*$, $q_4 = Q/Q^*$

where * denotes production in the base year.[30]

If each country is assumed to produce at a level consistent with the index for the whole region then one can take the 'normal' production for the three countries to be:

$$NQSG = q_4 . QSG^*$$

$$NQV = q_4 . QV^*$$

$$NQTO = q_4 . QTO^*$$

Smuggling is then determined in the following way:

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[30] A year when smuggling for all countries is assumed to be zero.

$$CXS = NQSG - QSG$$

$$CXSV = NQV - QV$$

$$CXST = NQTO - QTO$$

A negative value corresponds to smuggling into the country and vice-versa. The results, shown in the table below, indicate that before 1966, most of the smuggling was to Ghana while Togo and the Ivory Coast were the net losers.

Our results are similar to those obtained by Kumar. The differences could be attributable to the choice of base year for the calculation of production indices. The picture that is revealed by the estimated figures conforms to actual observations. Before 1966, smuggling was into Ghana. This was a period during which the Ghana pound (issued by the West African Currency Board and supported by Great Britain) was the legal tender. Since it was quite strong, there was no significant black market operation and hence there was little incentive for smuggling. However, after 1965, Ghana changed to the cedi. The cedi has been highly over-valued in some years, leading to high premiums on the black market. Smuggling thus became highly profitable.

Of course, our methodology does suffer from a number of drawbacks. In the first place, the results obtained are very sensitive to the choice of the base year. Thus one must be very careful to choose a year when there is very little or no smuggling. 1969 has been chosen as the base year because it is

was the year in which the Ghanaian producer price of cocoa was closest to the border price, and hence provided the least incentive for smuggling. A second disadvantage is that since Ghana dominated production in the earlier years, its production series follow that of the region more closely. Thus the calculations may be biased in Ghana's favour. The results are presented in the tables below.

TABLE 3.1

SUPPLY OF COCOA IN GHANA, TOGO AND THE IVORY COAST
('000 TONNES)

YEAR	QSG	QTO	QV	Q
1956	245.3	5.5	71.6	322.4
1957	257.9	4.7	67.7	330.3
1958	218.2	6.1	47.2	271.5
1959	270.1	7.9	56.7	334.7
1960	341.8	9.3	67.2	418.3
1961	435.1	12.5	91.5	539.1
1962	418.1	11.5	84.7	514.3
1963	428.3	11.8	101.9	542.0
1964	453.7	14.5	106.6	574.8
1965	552.8	17.0	141.7	711.5
1966	409.8	14.6	119.5	543.9
1967	377.2	16.6	149.2	543.0
1968	424.1	18.1	146.2	588.4
1969	424.8	19.8	150.7	595.3
1970	412.9	26.9	180.4	620.2
1971	416.9	28.1	187.1	632.1
1972	461.2	27.2	218.2	706.6
1973	406.4	18.2	185.7	610.3
1974	354.6	16.2	214.0	584.8
1975	380.4	15.4	239.3	635.1
1976	383.9	16.9	230.8	631.6
1977	311.2	14.5	242.6	568.3
1978	264.9	16.3	305.4	586.6
1979	256.0	13.3	323.4	592.7
1980	280.4	15.2	384.6	680.2
1981	251.5	15.7	419.5	686.7

TABLE 3.2

PRODUCTION INDICES

YEAR	q_1	q_2	q_3	q_4
1956	0.57745	0.27778	0.47512	54.158
1957	0.60711	0.23737	0.44924	55.485
1958	0.51365	0.30808	0.31321	45.607
1959	0.63583	0.39899	0.37624	56.224
1960	0.80461	0.46970	0.44592	70.267
1961	1.02425	0.63131	0.60717	90.559
1962	0.98423	0.58081	0.56204	86.393
1963	1.00824	0.59596	0.67618	91.047
1964	1.06803	0.73232	0.70737	96.556
1965	1.30132	0.85859	0.94028	119.520
1966	0.96469	0.73737	0.79297	91.366
1967	0.88795	0.83838	0.99005	91.215
1968	0.99835	0.91414	0.97014	98.841
1969	1.00000	1.00000	1.00000	100.000
1970	0.97199	1.35859	1.19708	104.183
1971	0.98140	1.41919	1.24154	106.182
1972	1.08569	1.37374	1.44791	118.696
1973	0.95669	0.91919	1.23225	102.520
1974	0.83475	0.81818	1.42004	98.236
1975	0.89548	0.77778	1.58792	106.686
1976	0.90372	0.85354	1.53152	106.098
1977	0.73258	0.73232	1.60982	95.464
1978	0.62359	0.82323	2.02654	98.539
1979	0.60264	0.67172	2.14599	99.563
1980	0.66008	0.76768	2.55209	114.262
1981	0.59204	0.79293	2.78368	115.354

TABLE 3.3

EXPECTED LEVELS OF PRODUCTION
('000 TONNES)

YEAR	NQSG	NQTO	NQV
1956	230.061	10.7232	81.615
1957	235.699	10.9860	83.615
1958	193.740	9.0302	68.730
1959	238.839	11.1323	84.729
1960	298.495	13.9129	105.893
1961	384.696	17.9308	136.473
1962	366.999	17.1059	130.195
1963	386.766	18.0272	137.207
1964	410.171	19.1182	145.510
1965	507.719	23.6649	180.116
1966	388.121	18.0904	137.688
1967	387.479	18.0605	137.460
1968	419.876	19.5705	148.953
1969	424.800	19.8000	150.700
1970	442.568	20.6282	157.003
1971	451.060	21.0240	160.016
1972	504.223	23.5019	178.876
1973	435.504	20.2989	154.497
1974	417.307	19.4508	148.042
1975	453.201	21.1238	160.775
1976	450.703	21.0074	159.889
1977	405.533	18.9020	143.865
1978	418.592	19.5106	148.498
1979	422.945	19.7135	150.042
1980	485.384	22.6238	172.192
1981	490.022	22.8400	173.838

TABLE 3.4

QUANTITY SMUGGLED
('000 TONNES)

YEAR	CXS	CXST	CXSV
1956	-15.239	5.2232	10.02
1957	-22.201	6.2860	15.92
1958	-24.460	2.9302	21.53
1959	-31.261	3.2323	28.03
1960	-43.305	4.6129	38.69
1961	-50.404	5.4308	44.97
1962	-51.101	5.6059	45.49
1963	-41.534	6.2272	35.31
1964	-43.529	4.6182	38.91
1965	-45.081	6.6649	38.42
1966	-21.679	3.4904	18.19
1967	10.279	1.4605	-11.74
1968	-4.224	1.4705	2.75
1969	-0.000	-0.0000	-0.00
1970	29.668	-6.2718	-23.40
1971	34.160	-7.0760	-27.08
1972	43.023	-3.6981	-39.32
1973	29.104	2.0989	-31.20
1974	62.707	3.2508	-65.96
1975	72.801	5.7238	-78.52
1976	66.803	4.1074	-70.91
1977	94.333	4.4020	-98.74
1978	153.692	3.2106	-156.90
1979	166.945	6.4135	-173.36
1980	204.984	7.4238	-212.41
1981	238.522	7.1400	-245.66

3.3 *THE COMPLETE MODEL*

The cocoa sector model comprises four behavioral equations and seven identities. The four stochastic equations determine Ghanaian cocoa production through official channels (QSG), world demand for cocoa (QDW), the export price of Ghana's cocoa in pounds/tonne (PXCF), and the quantity of cocoa smuggled out of Ghana (CXS). The rationale behind the relationships was given in earlier sections. The estimated equations are shown below. Identities determining tax/tonne, official export volume, official export earnings, cocoa export tax revenue, total Ghanaian supply of cocoa, supply by the rest of the world, and the export price of Ghana's cocoa in cedis/tonne are also shown below.

The exogenous variables of the system are CMB costs, domestic consumption, change in world stock of cocoa, farmers' incomes, income of major cocoa consuming countries, the world price of sugar, trend and dummy variables. The policy variables include the producer price of cocoa and the official exchange rate. The wold price cocoa (PL) is also treated as exogenous (see below).

The estimated equations of the cocoa sector are as follows:

$$(3.25)\quad QSG = 148.98 + 80.44(PPTV(-3) + 1.30YCO + 2.94t$$
$$(2.13)^{**} \qquad (3.93)^{***} \quad (.68)$$
$$R^2 = 0.8357 \quad \rho = .46 \quad OLS$$

(3.26) QDW = 478.64 - 0.135PL(-1) + 0.527YW - 2.85PS
(-5.05)*** (10.31)*** (-1.34)

R^2 = 0.8933 DW = 1.74 OLS

(3.27) LogPXCf=2.94+ .65LogPL(-1) -.25LogQSGT(-1)+ .035t+ .121Dum
(5.85)*** (-0.72) (2.06)** (1.02)

R^2 = 0.9831 DW = 2.53 OLS

(3.28) CXS = -36.87 - 32.37PPTV + 8.70t + 49.80DUM2
(-1.60)* (4.88)*** (2.80)**

R^2 = 0.9583 ρ = 0.29 OLS

Identities

(3.29) TAX = PXC - PP - CMBC

(3.30) QSGT = QSG + CXS

(3.31) CXO = QSG -CD

(3.32) XCO = (CXO)(PXC)

(3.33) RC = (CXO)(TAX)

(3.34) QSRW = QDW + CIS - QSGT

(3.35) PPTV = PP/PTVC

(3.36) PXC = (PXCF)(ER)

The recursive properties of the model were taken into account in estimating the model, thus avoiding any simultaneity

problems (see chapter on methodology). The model exhibits a recursive structure in the order; logPXCF, CXS, QDW, and QSG. Thus each equation was estimated by the OLS method, but at the same time retaining all properties of the Classical Linear Model. Hence all standard tests apply. The figures in parenthesis are the t statistics for each coefficient while the R^2 statistic is provided below each equation. In addition, either the DW statistic or the coefficient of autocorrelation (ρ) wherever correction is made is given below equation The significance of each coefficient is indicated by a *** (1%), ** (5%) or * (10%).

All the models provide good fits as indicated by the high R^2's. Furthermore, all the coefficients have their *a priori* expected signs. The relative producer price of cocoa (PPTV) has a strong and positive relationship with the official quantity of cocoa supplied (QSG) with a t-ratio which is significant at the 5% level. A positive relationship of QSG with YCO indicates the inappropriateness of the often held view that farmers' incomes are negatively related to price. The alleged reasoning is that farmers have a target income after which any increases in price will be matched by reductions in output so as to maintain this level of income. Even if that were the case, we can conclude from our results that the targeted income has not yet been attained, and that increases in income may still lead to increased production. A correction was made for first order autocorrelation by means of the Cochran-Orcutt iterative method.

The short-run elasticity of supply with respect to PPTV (computed at their mean values) is 0.19. This figure differs significantly from short-run supply elasticities obtained by earlier studies [Bateman: 1965; Behrman: 1968] but agrees roughly with that obtained by Akiyama and Duncan (1982). The differences may be due to the use of different sample periods and different definitions of price. In our study, the ratio of the producer price to border price is used, while most earlier studies neglected the influence of border prices. Akiyama and Duncan also used a similar definition of price but, estimated a log-linear relationship instead. In addition, part of the price response will be reflected in the equation determining smuggling.

The equation for the world demand for cocoa (QDW) also provides a good fit (R^2 = 0.8933), and does not exhibit autocorrelation. All coefficients have the expected signs, and all except the coefficient of PS are significant at the 1% level. PS is only significant at the 30% level but was retained because of its magnitude and theoretical relevance. Using average values, income and price elasticities of demand of .74 and -0.071 respectively were obtained. Again, these results do not agree closely with some earlier studies, but are not unreasonable. They however compare with those of Akiyama and Duncan (1985), who obtained income and price elasticities of demand of .354 and -0.075 respectively for Western Europe.

A logarithmic form of Ghana's cocoa export price (PXCF) was estimated with a high explanatory power of 95.8%. The equation again has a good fit and all coefficients have the expected signs. Though the coefficient of logQSGT(-1) is not significant, it was retained to capture some of the effect of changes in Ghana's production on world price lost through the treatment of PL as exogenous.

Finally, the estimated relationship for CXS indicates a strong and negative relationship with PPTV which is the *a priori* expectation. Thus, a fall in the producer price relative to the border price would lead to an increase in smuggling. Later we will show in policy experiments, how the producer price may be increased to reduce the level of smuggling. A correction was made for the presense of first order autocorrelation.

3.4 *HISTORICAL SIMULATION AND VALIDATION*

In order to be used for policy experiments, a simulation model must pass certain traditional (though not parametric) tests. After it has been ascertained that the model satisfies all theoretical and *a priori* expectations, it is then subjected to tests of its predictive accuracy. This includes examination of how well the model tracks actual historical data, picks turning points and reflects economic theory.[31]

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[31] see Chapter Two.

For reasons stated earlier, the Root Mean Square Percentage Error (RMSPE) has been used throughout this study to measure the predictive ability each model. Historical simulations are performed over the last ten years of the study since the policy experiments in Chapter Four are conducted for these years. Table 3.5 gives the RMSPE for the relevant variables of the cocoa sector

TABLE 3.5

STATISTICS OF FIT FOR THE COCOA SECTOR MODEL

Variable	RMSPE
QSG	7.19
QSGT	5.78
PXCF	12.81
QDW	3.49
QSRW	4.80
CXO	8.97
XCO	15.91
TAX	26.23
RC	27.21
CXS	22.89
PXC	12.80

As can be seen from table 5, most of the variables have acceptable RMSPE's. Though there are no tests presently available to indicate when a model should be rejected based on the RMSPE, values of about 30% have been frequently used in previous studies (see Behrman: 1977).

The graphs and tables below provide plots of actual vs. simulated values, and differences and percentage differences between actual and simulated values.[32] As can be seen from the graphs, all variables perform quite well in tracking their historical values. Furthermore, all turning points, except minor ones, are picked up by all variables. However, the turning points are not always picked up in the same year that they occur.

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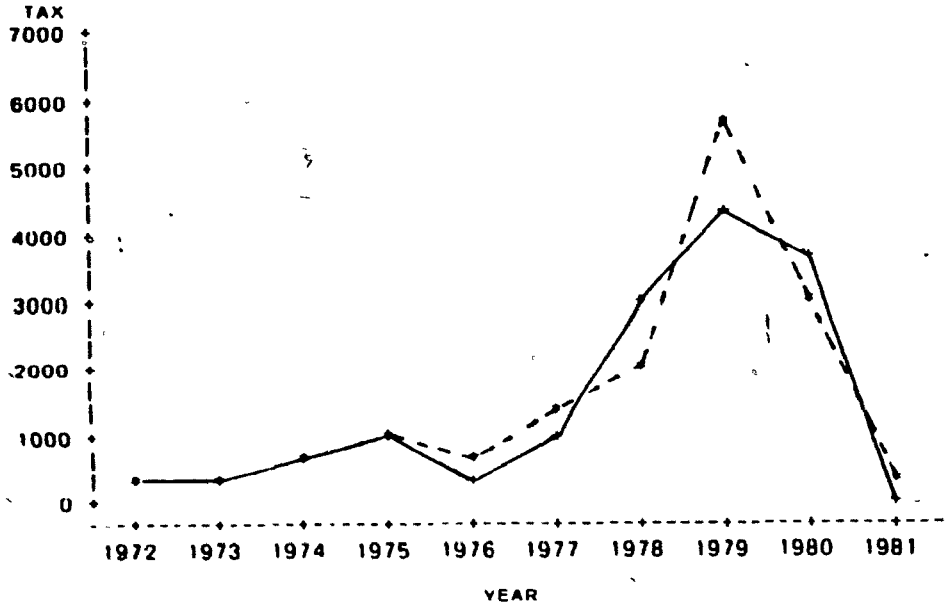
[32] Throughout the study, H appearing after a variable denotes simulated or predicted value, C or PC in front of a variable denotes the difference or percentage difference respectively between actual and simulated values. Thus QSGH, CQSG, and PCQSG represent simulated QSG, QSGH-QSG, and ((QSGH-QSG)/QSG)*100 respectively.

COCOA EXPORT TAX PER TONNE

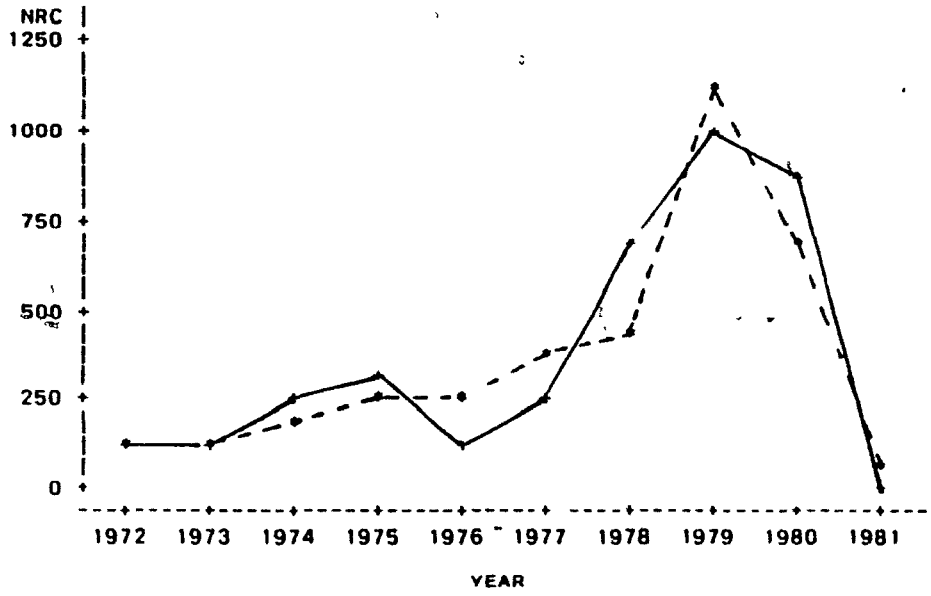
PLOT OF TAX*YEAR SYMBOL USED IS ---
PLOT OF TAXH*YEAR SYMBOL USED IS ———



YEAR	TAX	TAXH	CTAX	PCTAX
1972	323.13	410.36	87.2	26.995
1973	311 00	263.21	-47 8	-15.368
1974	630 30	634 76	4.5	0.707
1975	848.00	1033.90	185.9	21.922
1976	707.00	466.37	-240.6	-34.035
1977	1440.00	1083.79	-356 2	-24.737
1978	2164.00	3056.51	892.5	41.243
1979	5582.00	4340.53	-1241.5	-22.241
1980	2972 00	3697 49	725.5	24.411
1981	233.00	109.71	-123.3	-52.916

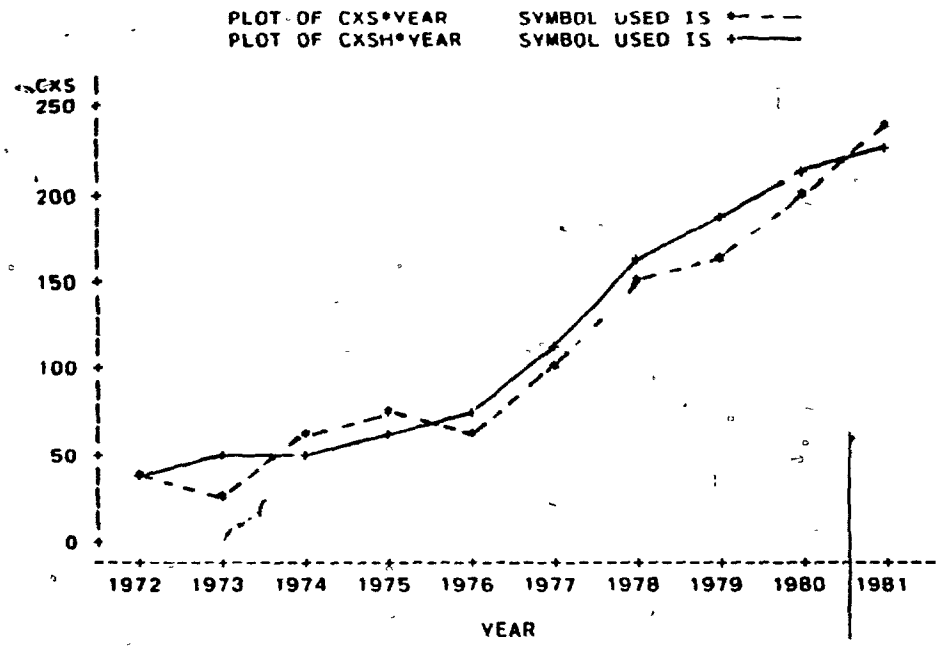
COCOA EXPORT TAX REVENUE

PLOT OF RC*YEAR SYMBOL USED IS ---
PLOT OF .RCH*YEAR SYMBOL USED IS ———



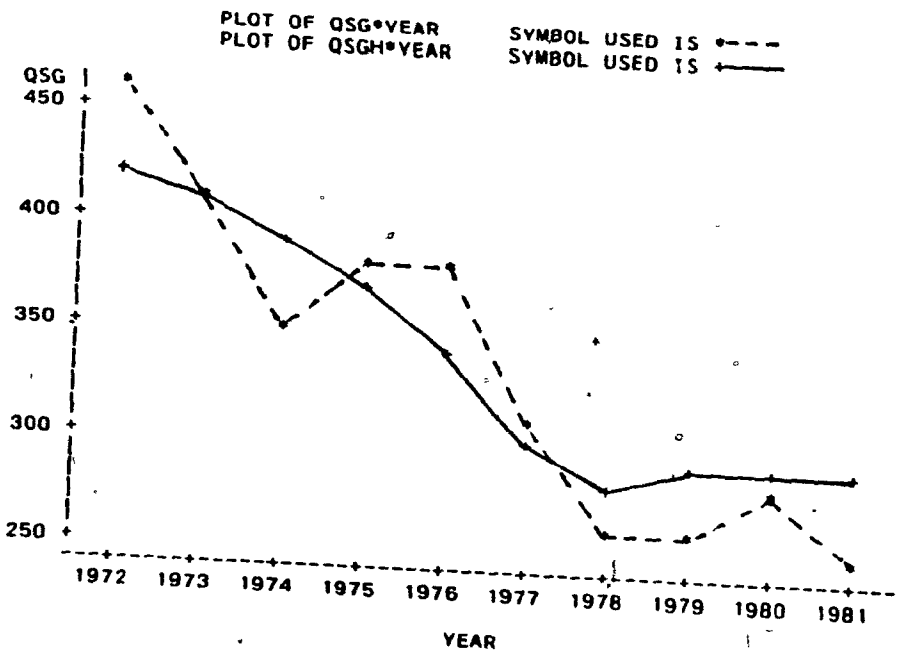
YEAR	RC	RCH	C RC	PC RC
1972	133 19	150 326	17 13	12 863
1973	116.25	100.553	-15.70	-13.505
1974	197.85	219.436	21.58	10.910
1975	273.23	322.317	49.09	17.967
1976	231.61	132.624	-98.99	-42.739
1977	364.32	261.813	-102 51	-28.137
1978	460 93	702 684	241.75	52.449
1979	1094.07	979.949	-114.12	-10 431
1980	677 62	862.007	184.39	27.212
1981	37.51	22.007	-15.51	-41 334

VOLUME OF SMUGGLING



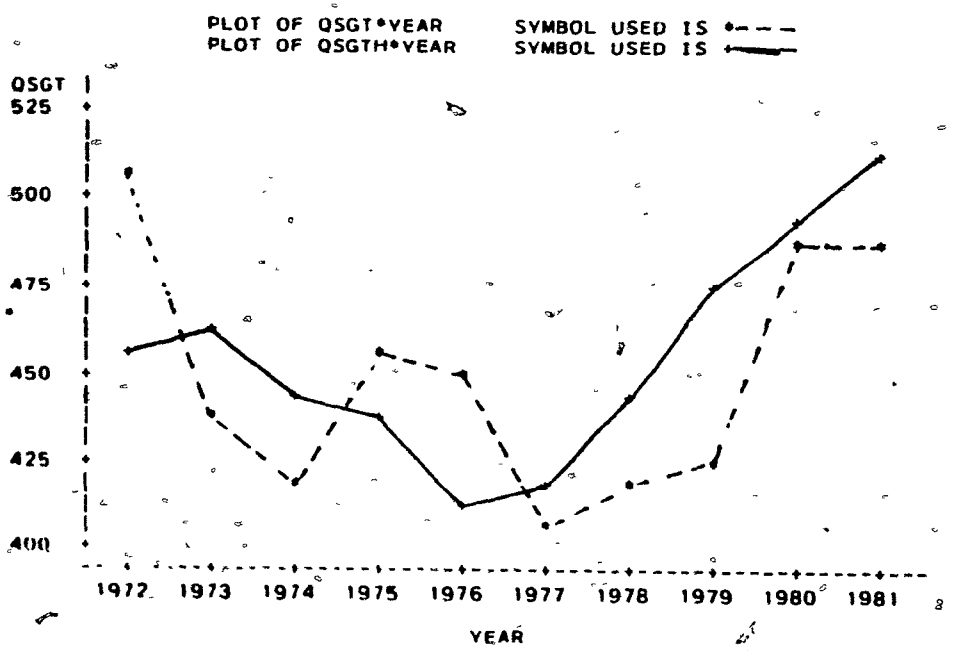
YEAR	QSG	QSGH	CQSG	PCQSG
1972	461.2	415.328	-45.872	-9.946
1973	406.4	414.630	8.230	2.025
1974	354.6	386.401	31.801	8.968
1975	380.4	369.948	-10.452	-2.748
1976	383.9	340.674	-43.226	-11.260
1977	311.2	299.771	-11.429	-3.672
1978	264.9	281 798	16.898	6.379
1979	256.0	285.767	29.767	11.628
1980	280.4	285.533	5.133	1.831
1981	251.5	291.103	39.603	15.747

RECORDED SUPPLY OF COCOA (GHANA)



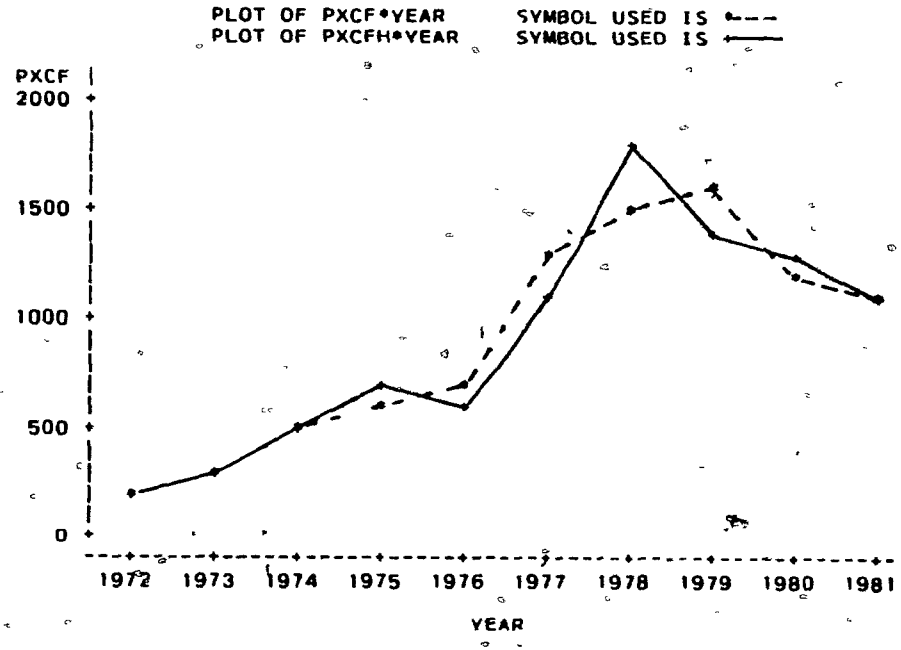
YEAR	CXS	CXSH	CCXS	PCCXS
1972	43.023	42.103	-0.970	-2.138
1973	29.104	47.204	18.100	62.193
1974	62.707	54.646	-8.061	-12.855
1975	72.801	64.784	-8.017	-11.012
1976	66.803	73.756	6.952	10.407
1977	94.333	116.221	21.888	23.203
1978	153.692	161.835	8.143	5.298
1979	166.945	190.541	23.596	14.134
1980	204.984	209.671	4.687	2.287
1981	238.522	222.444	-16.078	-6.741

TOTAL GHANAIAN SUPPLY OF COCOA



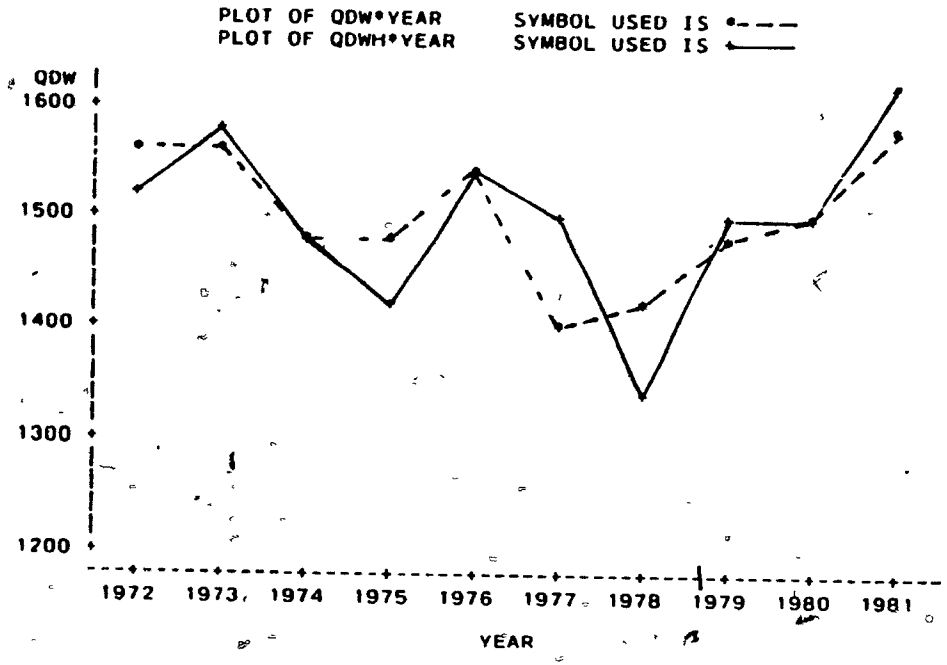
YEAR	QSGT	QSGTH	CQSGT	PCQSGT
1972	504.223	457.431	-46.792	-9.2800
1973	435 504	461.834	26.330	6.0460
1974	417.307	441.047	23.740	5.6889
1975	453 201	434.732	-18.469	-4.0753
1976	450.703	414.429	-36 274	-8.0483
1977	405.533	415.993	10.459	2.5792
1978	418 592	443.632	25 041	5.9821
1979	422.945	476 308	53.364	12.6172
1980	485.384	495 204	9.820	2.0232
1981	490.022	513.546	23.524	4.8007

EXPORT PRICE OF COCOA (FOREIGN CURR.)



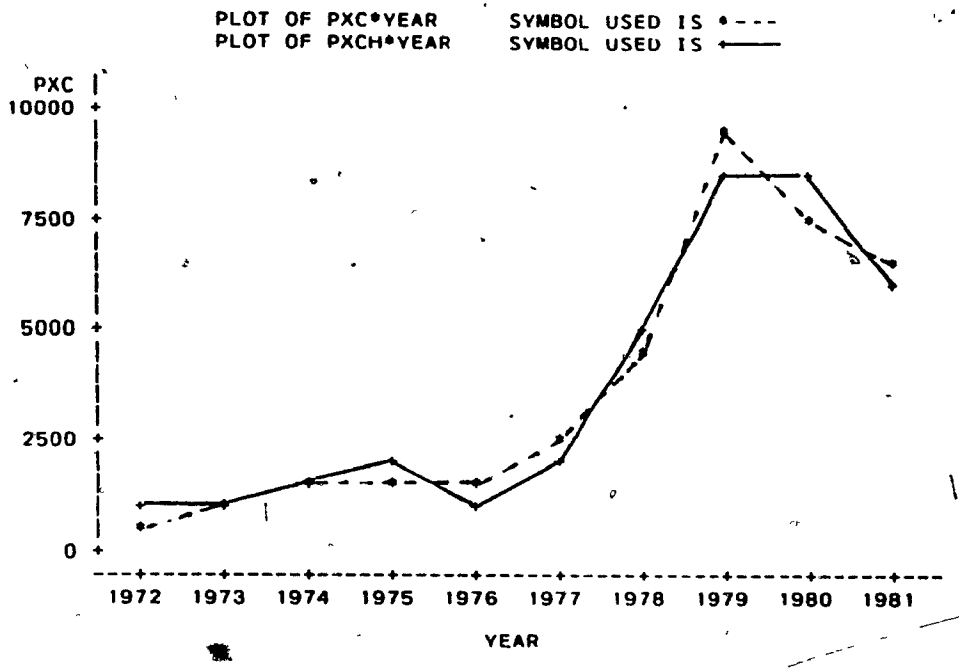
YEAR	PXCF	PXCFH	CPXCF	PCPXCF
1972	216.19	242.76	26 57	12.289
1973	293.34	276.54	-16.80	-5.729
1974	470.64	472.30	1 66	0 352
1975	623.88	696 64	72 76	11.663
1976	708.29	590.44	-115.85	-16.403
1977	1250.47	1073.01	-177 46	-14 192
1978	1493 87	1800.79	306 93	20 546
1979	1643.19	1430.43	-212.76	-12.948
1980	1207 10	1320.50	113.39	9 394
1981	1131.38	1109.27	-22.11	-1.954

WORLD DEMAND FOR COCOA



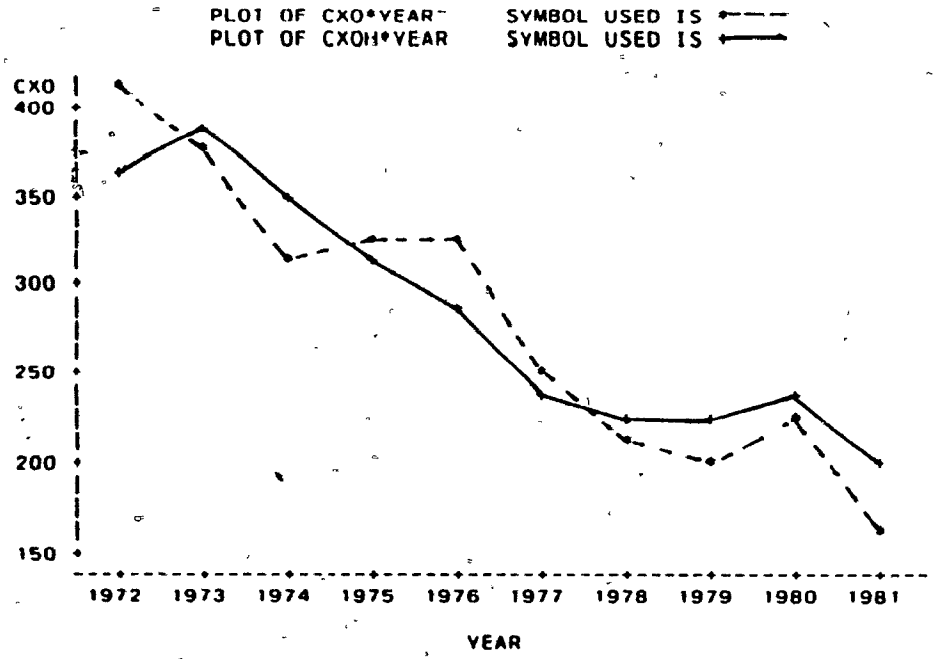
YEAR	QDW	QDWH	CQDW	PCQDW
1972	1567	1521.54	-45.464	-2.9013
1973	1551	1576.27	25.266	1.6290
1974	1489	1484.22	-4.784	-0.3213
1975	1471	1419.37	-51.628	-3.5097
1976	1536	1536.52	0.515	0.0335
1977	1393	1500.12	107.115	7.6895
1978	1418	1341.13	-76.874	-5.4213
1979	1471	1502.64	31.641	2.1510
1980	1507	1502.31	-4.692	-0.3114
1981	1588	1624.26	36.256	2.2831

EXPORT PRICE COCOA (DOMESTIC CURR.)



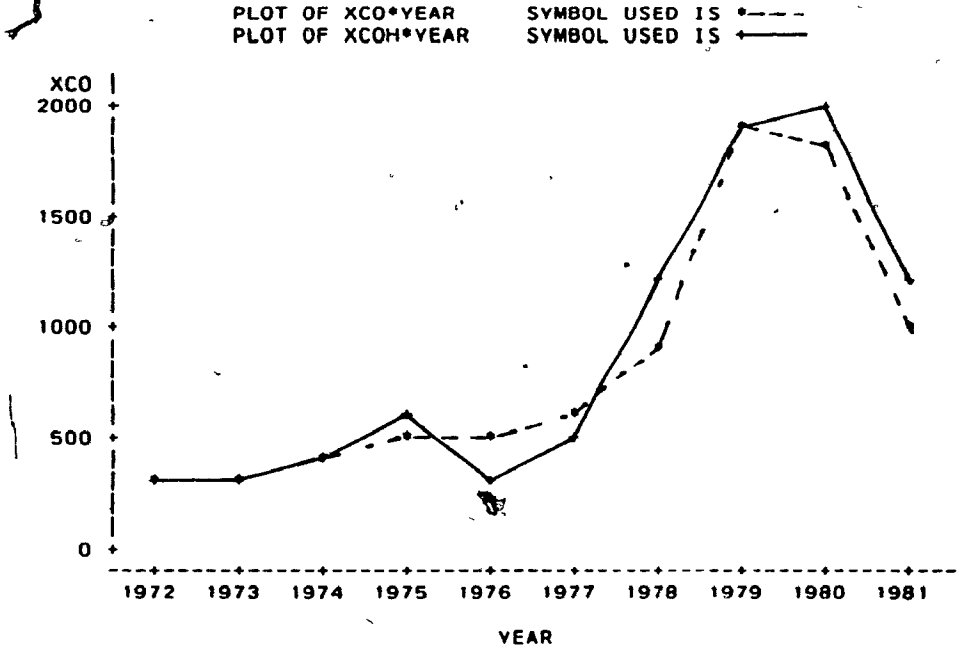
YEAR	PXC	PXCH	CPXC	PCPXC
1972	709.81	797.04	87.2	12.289
1973	834.30	786.51	-47.8	-5.729
1974	1265.90	1270.36	4.5	0.352
1975	1594.00	1779.90	185.9	11.663
1976	1467.00	1226.37	-240.6	-16.403
1977	2510.00	2153.79	-356.2	-14.192
1978	4344.00	5236.51	892.5	20.546
1979	9588.00	8346.53	-1241.5	-12.948
1980	7723.00	8448.49	725.5	9.394
1981	6310.00	6186.71	-123.3	-1.954

COCOA EXPORT VOLUME



YEAR	CXO	CXOH	CCXO	PCCXO
1972	412.2	366.328	-45.872	-11.129
1973	373 8	382.030	8.230	2.202
1974	313.9	345.701	31.801	10.131
1975	322 2	311.748	-10.452	-3.244
1976	327 6	284 374	-43.226	-13.195
1977	253 0	241 571	-11.429	-4 517
1978	213.0	229 898	16.898	7.933
1979	196 0	225 767	29.767	15.187
1980	228 0	233 133	5.133	2.251
1981	161 0	200.603	39.603	24.598

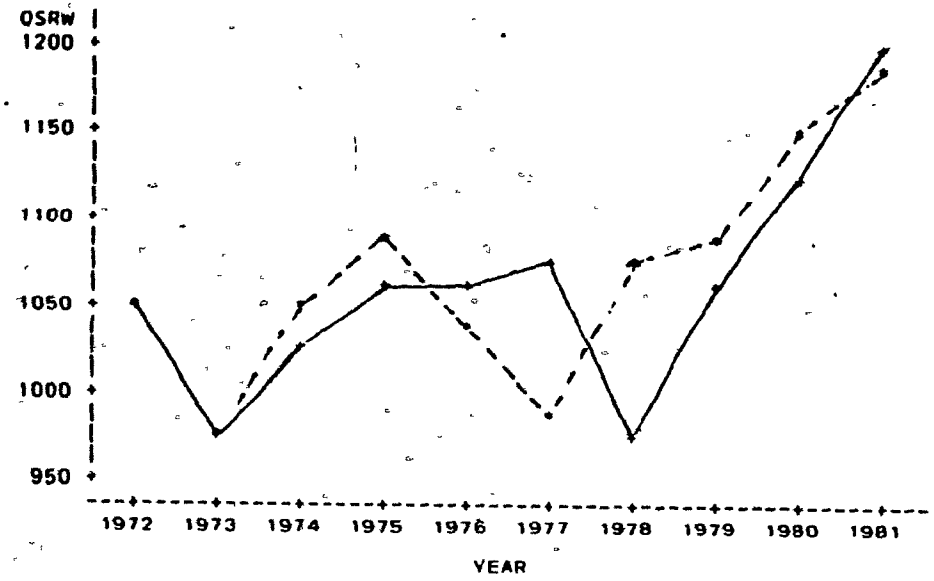
COCOA EXPORT EARNINGS



YEAR	XCO	XCOH	CXCO	PCCXO
1972	292.58	291.98	-0.61	-11.129
1973	311.86	300.47	-11 39	2.202
1974	397.37	439.16	41 80	10 131
1975	513.59	554.88	41.29	-3.244
1976	480.59	348.75	-131.84	-13.195
1977	635.03	520.29	-114 74	-4.517
1978	925.27	1203 86	278 59	7.933
1979	1879.25	1884.37	5.12	15.187
1980	1760 84	1969 62	208 78	2 251
1981	1015.91	1241.07	225.16	24 598

SUPPLY OF COCOA BY REST OF THE WORLD

PLOT OF QSRW*YEAR SYMBOL USED IS *---
PLOT OF QSRWH*YEAR SYMBOL USED IS +———



YEAR	QSRW	QSRWH	CQSRW	PCQSRW
1972	1047.18	1048.51		
1973	970.20	969.13	1.33	0.1269
1974	1047.89	1019.37	-1.06	-0.1097
1975	1089.50	1056.34	-28.52	-2.7220
1976	1031.90	1068.69	-33.16	-3.0435
1977	983.37	1080.02	36.79	3.5652
1978	1081.01	979.09	96.66	9.8291
1979	1083.66	1061.93	-101.91	-9.4278
1980	1144.62	1130.10	-21.72	-2.0046
1981	1184.38	1197.11	-14.51	-1.2679
			12.73	1.0749

Chapter IV

POLICY EXPERIMENTS WITH THE COCOA SECTOR

This section attempts to evaluate the behaviour of the cocoa sector in response to various policy scenarios. As stated earlier, the main policy variables are the producer price and the exchange rate (see chapter 1). Since the real producer price for cocoa has fallen drastically during the last decade, it is reasonable to assume that the increases in the nominal producer price that would induce the farmers to significantly alter their supply have to be substantial.

The immediate response of an increase in the producer price is a fall in the level of smuggling. This means an increase in the recorded supply and hence in cocoa export earnings. Total Ghanaian supply remains the same for the first three years, however, since PPTV enters the supply response equation with a lag of three years. Most of the cocoa sector variables such as the export price of cocoa, exports volume, export earnings, tax rate, and tax revenue are affected by the initial decrease in the volume of smuggling. After three years farmers increase their production in response to the increase in producer price. This reinforces the fall in the level of smuggling, thereby further increasing the change in the variables mentioned above.

In the policy experiments, two price policies are examined, each under three different exchange rate regimes.[33] The two price polices are:

1. a sustained, fifty percent increase in the producer price of cocoa.
2. appropriate yearly increases in the nominal producer price to maintain the real producer price in 1956.

The two price policies above are combined with the following exchange rate actions:

1. no change in the exchange rate.
2. appropriate change in the exchange rate to ensure an equal increase in the export price in terms of the domestic currency (i.e. PXC).
3. appropriate change in the exchange rate to ensure a twenty percent increase in PXC.

The first of the three exchange rate actions will be most unacceptable to the authorities, since it is likely to result in considerable losses in revenue. This can, however, be forestalled by changing the exchange rate (2nd and 3rd actions). The exchange rate actions, together with the two price policies, imply six policy experiments as follows:

1. PE-1: A fifty percent increase in the producer price with no change in the exchange rate.

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[33] see Chapter One for the rational behind the choice of policy experiments.

2. PE-2: A fifty percent increase in the producer price together with a change in the exchange rate to produce the same increase in PXC.
3. PE-3: A fifty percent increase in the producer price coupled with a change in the exchange rate to ensure a twenty percent increase in PXC.
4. PE-4: An increase in the producer price sufficient to maintain the real producer price in 1956 with no change in the exchange rate.
5. PE-5: An increase in the producer price sufficient to maintain the real producer price in 1956 with a corresponding change in the exchange rate to ensure an equal increase in PXC.
6. PE-6: An increase in the producer price sufficient to maintain the real producer price in 1956 with a corresponding change in the exchange rate to ensure a twenty percent increase in PXC.

The results of the six experiments are then compared with the control situation, where all policy variables assume their historical values. The scenarios are chosen in order to examine a number of alternative avenues open to the administrative authorities.

4.1 *THE IMPACT OF A 50% INCREASE IN THE PRODUCER PRICE OF COCOA*

The results of the six policy scenarios are presented in the tables that follow. The experiments cover the last ten years of the study. All the changes in the variables are in terms of deviations from the base solution.

4.1.1 *Results of Policy Experiment 1*

The immediate impact of PE-1, as evidenced by tables 4.1 and 4.2, is a fall in the tax rate of about ¢150/ton in the first year as compared with the control situation. Tax revenue from cocoa also falls accordingly by approximately ¢55 million cedis in 1972. This amounts in percentage terms to about 37% for both variables.

During the first three years tax revenue from cocoa (RC) falls by a slightly lower rate than the tax rate due to the fall in the level of smuggling. After 1974, the effect on RC is considerably lower than on the tax rate due to the effect of an expanding tax base (QSG). As a result of the policy action recorded Ghanaian supply increases by about 5,000 tonnes in the first three years. However, this is mainly as a result of of the cut in smuggling, and not due to any increases in production. Thus, total Ghanaian supply of cocoa is not affected until 1975. From 1974 onwards, farmers respond to the fifty percent increase in the producer price by raising their production levels.

TABLE 4.1

POLICY EXPERIMENT 1 (PE-1) - ACTUAL CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total supply of cocoa	0.00	0.00	0.00	19.69	21.30	20.24	14.43	12.2	8.5	5.2
QSG	Recorded supply of cocoa	4.89	5.29	5.03	23.27	24.32	22.35	15.72	13.1	9.5	7.1
PXC	Cocoa export price	0.00	-0.68	-0.73	-0.70	-9.13	-18.22	-49.75	-61.4	-52.5	-27.0
CXS	Volume of cocoa smuggling	-4.89	-5.29	-5.03	-3.59	-3.03	-2.11	-1.29	-0.9	-1.0	-1.9
CXO	Cocoa export volume	4.89	5.29	5.03	23.27	24.32	22.35	15.72	13.1	9.5	7.1
XCO	Cocoa export earnings	3.85	4.11	6.42	41.84	27.03	42.61	71.95	97.8	70.0	39.4
TAX	Cocoa export tax per tonne	-150.29	-186.75	-218.10	-280.00	-307.13	-403.30	-703.50	-1324.2	-2052.3	-6026.9
RC	Cocoa export tax revenue	-54.50	-71.35	-73.44	-70.29	-82.42	-78.89	-115.06	-238.6	-429.5	-1151.8
QSRW	Supply by rest the of world	-4.89	-5.29	-5.03	-23.27	-24.32	-22.35	-15.72	-13.1	-9.5	-7.1
	Old exchange rate	3.28	2.84	2.69	2.55	2.08	2.01	2.91	5.8	6.4	5.6
	New exchange rate	3.28	2.84	2.69	2.55	2.08	2.01	2.91	5.8	6.4	5.6

TABLE 4.2

POLICY EXPERIMENT 1 (PE-1) - PERCENTAGE CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total Supply of cocoa	0.000	0.000	0.000	4.484	5.177	5.034	3.369	2.636	1.757	1.0
QSG	Recorded supply of cocoa	1.166	1.271	1.299	6.234	7.224	7.732	5.829	4.819	3.500	2.6
PXC	Cocoa export price	0.000	-0.087	-0.057	-0.039	-0.748	-0.864	-0.937	-0.720	-0.606	-0.4
CXS	Volume of cocoa smuggling	-11.339	-11.015	-9.087	-5.461	-4.052	-1.867	-0.812	-0.482	-0.455	-0.8
CXO	Cocoa export volume	1.320	1.378	1.452	7.385	8.675	9.682	7.218	6.184	4.341	3.8
XCO	Cocoa export earnings	1.320	1.378	1.452	7.385	7.906	8.756	6.220	5.422	3.711	3.4
TAX	Cocoa export tax per tonne	-37.514	-73.894	-34.068	-26.626	-66.877	-38.838	-22.468	-29.326	-52.453	-2655.6
RC	Cocoa export tax revenue	-36.690	-73.534	-33.111	-21.207	-64.004	-32.916	-16.872	-24.955	-50.389	-2753.5
QSRW	Cocoa supply by rest of the world	-0.469	-0.548	-0.494	-2.212	-2.269	-2.043	-1.581	-1.217	-0.828	-0.6
	Old exchange rate	3.283	2.844	2.690	2.555	2.077	2.007	2.908	5.835	6.398	5.6
	New exchange rate	3.283	2.844	2.690	2.555	2.077	2.007	2.908	5.835	6.398	5.6

As explained earlier, this increase in production is brought about by better husbandry of existing trees, and not as a result of new plantings. The increases range from 24,000 tonnes (or 7%) in 1976 to 7,000 tonnes (or 3%) in 1981. Since domestic consumption of cocoa is treated as exogenous, the total increase in recorded supply is exported (i.e. $\Delta QSG = \Delta CXO$). This results in increases in export earnings of between ¢4 million in 1972 and ¢98 million in 1979.

Since Ghana produces a significant proportion of world cocoa supply, any increases in the Ghanaian supply must result in declines in the export price of cocoa. From 1973, the cocoa export price falls by between sixty-eight pesewas in 1974 and ¢61.4 per tonne in 1979. Thus all increases in recorded supply are not transformed into increases in cocoa export earnings. Supply by the rest of the world, which is treated as a residual, falls by the same magnitude as the increase in the Ghanaian recorded supply during the years of the experiment.

Since changes in the tax base that result from the increase in the producer price are not enough to compensate for the resulting fall in tax rate, the cocoa export tax revenue falls by between 17% in 1978 and 73% in 1973. In 1981, both the cocoa tax rate and revenue fall by more than 2,500% as compared to the base run, which implies a subsidy to the cocoa farmers from the government. However, this is not unexpected since 1981 is an unusual year; a year in which the government increased producer prices by 200% over the previous year.

During the ten years, total output increases by 101,000 tonnes while smuggling falls by 29,000 tonnes, thus increasing official exports by 130,000 tonnes. Consequently, total export earnings rise by ¢405 million, bringing in much needed foreign earnings. The government loses about ¢2,400 million in tax revenue, most of it going to the farmers as income. Due to the large decreases in tax revenue, the government may be reluctant to follow such a policy, especially since the cocoa export tax is a major source of revenue for the government. The government may be able to avoid some of the revenue losses by appropriately adjusting the exchange rate. These possibility is examined in the next two policy actions.

4.1.2 *Results of Policy Experiment 2*

In this experiment, the exchange rate is adjusted such that any revenue loss through lower taxes would be offset by increases in the cocoa export price in terms of the domestic currency. The adjustment in the exchange rate required to produce this result may also have some side effects on other sectors of the economy, which will be examined in the framework of a macroeconometric model in later chapters. The border price, which is a reflection of the blackmarket rate of the cedi, may also be affected by any changes in the official exchange rate. For example, a devaluation of the cedi is likely to result in a lowering of the value of the cedi on the blackmarket. However, experience shows that the rate of depreciation of the currency

TABLE 4.3

POLICY EXPERIMENT 2 (PE-2) - ACTUAL CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total supply of cocoa	0.0000	0.000	0.000	18.581	19.795	19.217	13.770	11.30	8.03	4.99
QSG	Recorded supply of cocoa	4.6176	4.919	4.776	22.003	22.603	21.213	15.010	12.18	8.93	6.38
PXC	Cocoa export price	0.0000	186.112	217.420	279.340	289.869	368.527	606.712	1204.37	1951.23	5974.41
CXS	Volume of cocoa smuggling	-4.6176	-4.919	-4.776	-3.422	-2.808	-1.995	-1.240	-0.88	-0.90	-1.39
CXO	Cocoa export volume	4.6176	4.919	4.776	22.003	22.603	21.213	15.010	12.18	8.93	6.38
XCO	Cocoa export earnings	60.0512	76.440	82.702	133.963	115.530	137.703	221.038	373.52	519.93	1179.52
TAX	Cocoa export tax per tonne	0.0000	0.000	0.000	0.000	-8.158	-16.585	-47.052	-58.45	-48.65	-25.46
RC	Cocoa export tax revenue	1.8499	1.243	3.057	23.139	7.909	17.848	36.044	41.89	23.91	-3.41
QSRW	Supply by rest the of world	-4.6176	-4.919	-4.776	-22.003	-22.603	-21.213	-15.010	-12.18	-8.93	-6.38
	Old exchange rate	3.2832	2.844	2.690	2.555	2.077	2.007	2.908	5.83	6.40	5.58
	New exchange rate	3.9099	3.529	3.150	2.953	2.589	2.377	3.269	6.71	7.88	10.91

TABLE 4.4

POLICY EXPERIMENT 2 (PE-2) - PERCENTAGE CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total Supply of cocoa	0.000	0.000	0.0000	4.2321	4.8120	4.7801	3.2144	2.4453	1.6621	0.992
QSG	Recorded supply of cocoa	1.100	1.181	1.2335	5.8931	6.7134	7.3396	5.5655	4.4807	3.3047	2.322
PXC	Cocoa export price	0.000	23.983	17.0419	15.5394	23.7745	17.4788	11.4235	14.1335	22.5218	94.773
CXS	Volume of cocoa smuggling	-10.702	-10.238	-8.6285	-5.2099	-3.7600	-1.7656	-0.7817	-0.4612	-0.4236	-0.608
CXO	Cocoa export volume	1.245	1.281	1.3783	6.9814	8.0614	9.1903	6.8916	5.7502	4.0996	3.462
XCO	Cocoa export earnings	20.572	25.654	18.7091	23.6449	33.7943	28.2956	19.1080	20.6985	27.5462	101.517
TAX	Cocoa export tax per tonne	0.000	0.000	0.0000	0.0000	-1.7764	-1.5972	-1.5028	-1.2946	-1.2434	-11.219
RC	Cocoa export tax revenue	1.245	1.281	1.3783	6.9814	6.1418	7.4463	5.2853	4.3812	2.8053	-8.146
QSRW	Cocoa supply by rest of the world	-0.443	-0.509	-0.4692	-2.0915	-2.1090	-1.9390	-1.5096	-1.1315	-0.7819	-0.528
	Old exchange rate	3.283	2.844	2.6897	2.5550	2.0770	2.0072	2.9079	5.8350	6.3980	5.577
	New exchange rate	3.910	3.529	3.1496	2.9529	2.5890	2.3772	3.2692	6.7058	7.8833	10.907

on the blackmarket is often much lower than the official rate of devaluation, especially when the currency in question is heavily overvalued.[34] In this study, we have assumed that only ten percent of the change in the official exchange rate is transmitted to the border price. This assumption is based on the observation that from 1981 to 1985, the cedi was devalued officially by about 3,173%, while the blackmarket rate fell by about 325%, which is approximately 10% of the official rate of devaluation.

The policy experiment PE-2 studies the effect on the relevant variables if an exchange rate policy is pursued stimultaneously with the price policy. The fifty per cent increase in producer price is countered by an equal increase in the export price of Ghana's cocoa, in domestic currency. This is achieved by adjusting the exchange rate by an appropriate amount. The new exchange rates (in cedis/pound) necessary to produce the required increases in the export price of cocoa are given in the last row of the tables.

Tables 4.3 and 4.4 show the results of PE-2. The increases in recorded supply are slightly lower than for PE-1 because of the increases in the border price that result fromt the exchange rate change. Increases in PXC range between 11% in 1978 and 95% in 1981 over the control solution. After 1973, the increases in PXC are slightly less than increases in the

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[34] In particular, if the difference between the official rate and the blackmarket rate is large the any changes in the exchange rate are not fully translated into changes in the blackmarket rate.

producer price due to the downward tendency in PXCF induced by the original change in PP. Export earnings increase by more than one hundred per cent in 1981 and between eighteen per cent and thirty-four percent in other years; an increase of a little over ₵2,900 million over the ten-year period.

For the first four years, the tax rate does not change, but from 1976, The increases in producer price still lead to falls in the tax rate of between one percent and eleven percent. These short falls are, however, more than compensated for by the increases in the tax base (cocoa export earnings). Thus, tax revenue from cocoa increases in all years except 1981; when an eight percent (₵3.4 million) occurs. The gain in tax revenue over the period is about ₵153 million. The required exchange rate changes range from 15% in 1975 to 95% in 1981.

4.1.3 *Results of Policy Experiment 3*

Tables 4.5 and 4.6 represent the impact of a fifty per cent increase in the producer price together with a depreciation in the exchange rate such that the export price of cocoa in domestic currency (PXC) increases by twenty per cent. This is in effect an approximate twenty percent depreciation of the exchange rate in each year of the study.

The percentage change in the export price of cocoa is, however, not exactly twenty percent due to effect produced by the change Ghanaian production. Total exports increase by an average of roughly 12% per year over the control situation

TABLE 4.5

POLICY EXPERIMENT 3 (PE-3) - ACTUAL CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total supply of cocoa	0.0000	0.000	0.000	18.642	19.952	19.056	13.680	11.31	7.89	4.9
QSG	Recorded supply of cocoa	4.6326	4.958	4.736	22.041	22.763	21.018	14.905	12.17	8.81	6.7
PXC	Cocoa export price	0.0000	166.220	252.495	318.145	284.746	484.899	821.857	1859.35	1495.77	1236.8
CXS	Volume of cocoa smuggling	-4.6326	-4.958	-4.736	-3.400	-2.812	-1.962	-1.225	-0.86	-0.92	-1.8
CXO	Cocoa export volume	4.6326	4.958	4.736	22.041	22.763	21.018	14.905	12.17	8.81	6.7
XCO	Cocoa export earnings	56.9389	68.742	94.963	147.125	114.218	166.527	270.478	520.14	415.40	278.5
TAX	Cocoa export tax per tonne	-8.3280	-19.890	35.080	38.800	-13.284	99.788	168.088	596.52	-504.11	-4763.0
RC	Cocoa export tax revenue	-1.2704	-6.482	15.352	36.263	6.427	46.955	85.783	188.54	-79.80	-908.3
QSRW	Supply by rest the of world	-4.6326	-4.958	-4.736	-22.041	-22.763	-21.018	-14.905	-12.17	-8.81	-6.7
	Old exchange rate	3.2832	2.844	2.690	2.555	2.077	2.007	2.908	5.83	6.40	5.6
	New exchange rate	3.8752	3.456	3.224	3.008	2.580	2.489	3.388	7.16	7.55	6.7

TABLE 4.6

POLICY EXPERIMENT 3 (PE-3) -- PERCENTAGE CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total Supply of cocoa	0.000	0.000	-0.0000	4.2458	4.8501	4.7400	3.1933	2.4485	1.634	1.0
QSG	Recorded supply of cocoa	1.104	1.190	1.2231	5.9033	6.7610	7.2722	5.5263	4.4785	3.260	2.4
PXC	Cocoa export price	0.000	21.419	19.7911	17.6981	23.3543	22.9982	15.4744	21.8197	17.265	19.6
CXS	Volume of cocoa smuggling	-10.736	-10.319	-8.5562	-5.1757	-3.7649	-1.7357	-0.7720	-0.4504	-0.431	-0.8
CXO	Cocoa export volume	1.249	1.291	1.3668	6.9934	8.1185	9.1059	6.8431	5.7474	4.044	3.6
XCO	Cocoa export earnings	19.506	23.071	21.4829	25.9681	33.4105	34.2185	23.3819	28.8233	22.008	24.0
TAX	Cocoa export tax per tonne	-2.079	-7.870	5.4795	3.6895	-2.8926	9.6096	5.3684	13.2107	-12.884	-2098.7
RC	Cocoa export tax revenue	-0.855	-6.680	6.9212	10.9409	4.9911	19.5905	12.5788	19.7174	-9.361	-2171.4
QSRW	Cocoa supply by rest of the world	-0.444	-0.513	-0.4652	-2.0951	-2.1239	-1.9212	-1.4989	-1.1310	-0.771	-0.6
	Old exchange rate	3.283	2.844	2.6897	2.5550	2.0770	2.0072	2.9079	5.8350	6.398	5.6
	New exchange rate	3.875	3.456	3.2235	3.0081	2.5802	2.4890	3.3878	7.1571	7.545	6.7

during the ten-year period, bringing in almost ₵2,133 million in foreign exchange earnings. Both the tax rate and tax revenue also record increases in most of the years. Except in 1981, all the falls in tax revenue are less than ten percent. The total gain in revenue from 1970 to 1980 amounts to ₵292 million. In 1981 a fall of ₵908 million occurs over the control solution. As was noted earlier, 1981 was an unusual year. This policy experiment is undertaken to indicate that, only moderate adjustments in the exchange rate are necessary to produce the desired effects on the relevant variables of the system. Tables 4.11 and 4.12 below also show the actual exchange rates and the new rates that are required to produce the effects discussed above.

4.2 *THE IMPACT OF CONSTANT REAL PRODUCER PRICES*

The next set of policy experiments (PE-4 to PE-6) examine the behaviour of the cocoa sector variables, within the context of relative prices. So far, we have considered the effect of a fifty per cent increase in the producer price. This percentage increase was arbitrarily chosen, without any consideration of other prices facing the farmer. In particular, replanting of old trees and new plantings are likely to compete with other farming activities for the same areas. Furthermore, better husbandry or care of existing farms, which leads to higher productivity is likely to take place depending on the purchasing power of the cedi.

Thus, one has to look at a price index when producer price policies are considered. For example, a fifty per cent increase in the producer price will have little effect if other prices in the economy increase proportionately. Several prices come into play, the most important being local food prices, the border price of cocoa and the consumer price index (representing all domestic prices). An index of local food prices, which is a rough measure of the opportunity cost of cocoa farming, was not used because of unavailability of a complete series. The border price is already incorporated in the study. The next set of policy experiment uses the consumer price index (CPI). The CPI, being a representative price, is most ideal for the purposes of our experiments.

Based on the assumptions above, we allow for changes in PP in subsequent years that would make the real producer price in each year equal to that of 1956 (ie. ¢602/tonne). This policy action is considered moderate, since it requires farmers' real income/tonne to remain constant for more than twenty five years (1956-1981). The effect of this price policy is examined under three exchange rate regimes in the following sections.

4.2.1 *Results of Policy experiment 4*

In the fourth policy experiment (PE-4), the producer price in each year is increased so as to maintain the real producer price in 1956 without any adjustment in the exchange rate. Tables 4.8 and 4.9 present the results of this experiment. The

impacts on the quantity variables are highly significant. The policy action results a fall in the level of smuggling of 16,000 tonnes in the first three years, resulting in the same increase in export volume and an increase of ₵12 million in export earnings. By 1975, farmers increase their production level by about 66,000 tonnes which, together with the fall in smuggling, results in an increase of about 77,000 tonnes in export volume. Export volume, export earnings, the level of smuggling and recorded supply are all favourably affected in other years. Over the ten-year period, exports increase by almost 600,000 tonnes while export earnings rise by about ₵2,431 million as compared with the base solution.

With the exchange rate unchanged, PXC is reduced by up to and 3 percent during the experimental years. Due to the high increases needed in the nominal producer price to maintain the real producer price in 1956, the tax rate and revenue are reduced drastically during all the years of study. The tax rate and revenue register falls of between eighty percent in 1970 and five hundred and fourty-four percent in 1980. In 1981, falls of thirteen thousand percent and eighteen thousand percent are recorded for the tax rate and the tax revenue respectively. The behaviour of these crucial variables, suggests that the government is unlikely to consider this policy action. To avoid such heavy losses, the exchange rate may be adjusted to prop up the cocoa export price.

TABLE 4.7

POLICY EXPERIMENT 4 (PE-4) - ACTUAL CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total supply of cocoa	0.00	0.00	0.00	65.71	65.0	63.0	45.8	68	91	57
QSG	Recorded supply of cocoa	16.33	16.16	15.65	77.08	81.9	85.5	59.9	75	98	66
PXC	Cocoa export price	0.00	-2.26	-2.23	-2.16	-28.6	-53.2	-145.9	-185	-264	-248
CXS	Volume of cocoa smuggling	-16.33	-16.16	-15.65	-11.37	-16.9	-22.5	-14.1	-8	-8	-10
CXO	Cocoa export volume	16.33	16.16	15.65	77.08	81.9	85.5	59.9	75	98	66
XCO	Cocoa export earnings	12.86	12.54	19.96	138.56	90.0	164.2	278.3	591	768	356
TAX	Cocoa export tax per tonne	-501.59	-570.19	-678.53	-887.76	-1689.6	-4169.9	-7300.8	-10729	-15885	-30726
RC	Cocoa export tax revenue	-187.62	-224.06	-235.70	-267.17	-574.5	-1230.3	-1839.8	-2741	-4637	-7684
QSRW	Supply by rest the of world	-16.33	-16.16	-15.65	-77.08	-81.9	-85.5	-59.9	-75	-98	-66
	Old exchange rate	3.28	2.84	2.69	2.55	2.1	2.0	2.9	6	6	6
	New exchange rate	3.28	2.84	2.69	2.55	2.1	2.0	2.9	6	6	6

TABLE 4.8

POLICY EXPERIMENT 4 (PE-4) - PERCENTAGE CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total Supply of cocoa	0.00	0.00	0.00	14.966	15.81	15.66	10.68	14.68	18.78	11
QSG	Recorded supply of cocoa	3.89	3.88	4.04	20.644	24.32	29.59	22.19	27.78	36.37	24
PXC	Cocoa export price	0.00	-0.29	-0.18	-0.120	-2.34	-2.52	-2.75	-2.17	-3.05	-4
CXS	Volume of cocoa smuggling	-37.84	-33.63	-28.27	-17.315	-22.57	-19.95	-8.88	-4.03	-3.55	-4
CXO	Cocoa export volume	4.40	4.21	4.52	24.457	29.20	37.05	27.48	35.65	45.11	36
XCO	Cocoa export earnings	4.40	4.21	4.52	24.457	26.34	33.74	24.06	32.74	40.71	31
TAX	Cocoa export tax per tonne	-125.20	-225.62	-105.99	-84.418	-367.90	-401.57	-233.17	-237.61	-405.97	-13539
RC	Cocoa export tax revenue	-126.31	-230.90	-106.26	-80.607	-446.14	-513.28	-269.77	-286.67	-544.00	-18371
QSRW	Cocoa supply by rest of the world	-1.57	-1.67	-1.54	-7.327	-7.64	-7.82	-6 02	-7.02	-8.60	-5
	Old exchange rate	3.28	2.84	2.69	2.555	2.08	2.01	2.91	5.83	6.40	6
	New exchange rate	3.28	2.84	2.69	2.555	2.08	2.01	2.91	5.83	6.40	6

4.2.2 *Results of Policy Experiment 5*

PE-5 also examines the same price policy as in PE-4, except that the exchange rate is appropriately adjusted so that PXC is increased by the increase in the producer price. Tables 4.9 and 4.10 represent the results of PE-5. The export price increases over the control solution from forty-nine percent in 1975 to one hundred and ninety-three percent in 1980 and four hundred and eighty percent in 1981. However, this does not prevent the tax rate from falling by uo to 5.7% per year during the first nine years and by about ninety percent in 1981. This is due to the downward pressure on PXC exerted by an increasing QSGT.

Due to an expanding tax base (XCO), tax revenue from cocoa increases in all years except 1981 despite the falls in the tax rate. The fall in 1981 is ¢36.5 million, (ie. about eighty-seven percent lower than the control solution). The total gain in tax revenue during the twelve year period is about ¢760 million.

The new exchange rates needed to produce the results above range between 3.81 cedis to the dollar in 1975 to 33.45 cedis per dollar in 1981. These compare with between 3.45 and 5.58 cedis per dollar for the actual exchange rate. High as the required adjustment may seem, they may be more realistic than the actual rates. This fact is born out by the low value of the cedi on the blackmarket (or as a colleague prefers to call

TABLE 4.9

POLICY EXPERIMENT 5 (PE-5) - ACTUAL CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total supply of cocoa	0.000	0.000	0.000	59.413	57.66	57.74	42.25	56.6	72.8	48.6
QSG	Recorded supply of cocoa	14.765	14.328	14.348	69.914	71.71	75.83	54.32	63.2	78.9	53.7
PXC	Cocoa export price	0.000	568.153	676.547	885.778	1636.48	4071.59	7023.52	10375.2	15397.4	30273.6
CXS	Volume of cocoa smuggling	-14.765	-14.328	-14.348	-10.500	-14.06	-18.09	-12.07	-6.6	-6.1	-5.1
CXO	Cocoa export volume	14.765	14.328	14.348	69.914	71.71	75.83	54.32	63.2	78.9	53.7
XCO	Cocoa export earnings	205.001	238.218	263.138	467.542	664.16	1409.01	2200.49	3391.3	5252.5	7543.8
TAX	Cocoa export tax per tonne	0.000	0.000	0.000	0.000	-24.64	-45.57	-132.05	-169.7	-223.5	-204.5
RC	Cocoa export tax revenue	5.915	3.621	9.186	73.523	24.26	64.77	134.15	238.6	242.3	-36.5
QSRW	Supply by rest the of world	-14.765	-14.328	-14.348	-69.914	-71.71	-75.83	-54.32	-63.2	-78.9	-53.7
	Old exchange rate	3.283	2.844	2.690	2.555	2.08	2.01	2.91	5.8	6.4	5.6
	New exchange rate	5.375	4.934	4.120	3.817	4.97	6.02	6.93	13.2	18.2	33.4

TABLE 4.10

POLICY EXPERIMENT 5 (PE-5) - PERCENTAGE CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total Supply of cocoa	0.000	0.000	0.000	13.532	14.016	14.362	9.863	12.242	15.068	9.650
QSG	Recorded supply of cocoa	3.517	3.440	3.706	18.725	21.300	26.237	20.141	23.244	29.183	19.536
PXC	Cocoa export price	0.000	73.213	53.029	49.275	134.221	193.111	132.243	121.755	177.723	480.232
CXS	Volume of cocoa smuggling	-34.218	-29.821	-25.924	-15.986	-18.824	-16.007	-7.606	-3.469	-2.854	-2.241
CXO	Cocoa export volume	3.982	3.732	4.141	22.183	25.577	32.852	24.940	29.829	36.203	29.129
XCO	Cocoa export earnings	70.230	79.950	59.528	82.523	194.277	289.527	190.224	187.928	278.280	649.265
TAX	Cocoa export tax per tonne	0.000	0.000	0.000	0.000	-5.364	-4.388	-4.217	-3.759	-5.713	-90.087
RC	Cocoa export tax revenue	3.982	3.732	4.141	22.183	18.841	27.022	19.671	24.949	28.422	-87.199
QSRW	Cocoa supply by rest of the world	-1.416	-1.483	-1.410	-6.646	-6.691	-6.931	-5.463	-5.870	-6.905	-4.447
	Old exchange rate	3.283	2.844	2.690	2.555	2.077	2.007	2.908	5.835	6.398	5.577
	New exchange rate	5.375	4.934	4.120	3.817	4.968	6.015	6.927	13.203	18.240	33.447

it the 'open market').[35]

A further indication of the appropriateness of the required exchange rates is the massive devaluation of the cedi upon the 'advice' of the IMF from ¢2.75 to ¢50 to the dollar in 1983. A year later, the official rate was further devalued to ¢53 to the dollar.[36] If the exchange policy outlined above were followed by the government, the change would have been gradual, rather than the sudden jump in 1983. This would have been politically less noticeable. At the sametime, the economic benefits would have been enormous; in terms of foreign exchange earnings, increased tax revenue and reduced smuggling.

4.2.3 *Results of Policy experiment 6*

The final policy experiment (PE-6) examines the effect of the same price policy as in PE-4 and PE-5, but this time, the exchange rate is adjusted such that the export price increased by twenty percent. Again increases in PXC are not exactly twenty percent due to changes in other variables affecting it, such as recorded Ghanaian supply. The results are presented in tables 4.11 and 4.12.

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[35] The value of the cedi on the blackmarket was reportedly, about ¢40/$ or ¢80 per pound in 1981

[36] Rumours had it that the IMF pressured for a much higher p percentage of devaluation (to about ¢100/$) but was resisted by the Rawlings government due to political considerations.

PE-6 is not effective in producing desirable effects on the tax revenue, because the change in PXC is too low to influence the tax rate significantly enough. The results however, show a slight improvement over those of PE-4. Changes in export earnings for example, are significantly higher for PE-6 than PE-4, and the decreases in the tax revenue are slightly less than those of PE-4.

TABLE 4.11

POLICY EXPERIMENT 6 (PE-6) - ACTUAL CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total supply of cocoa	0.00	0.00	0.00	63.85	62.8	60.9	44.5	65.6	88	56
QSG	Recorded supply of cocoa	15.87	15.60	15.15	74.90	79.1	82.9	58.3	73.1	96	65
PXC	Cocoa export price	0.00	164.67	251.02	316.71	265.6	450.5	727.1	1737.8	1288	1020
CXS	Volume of cocoa smuggling	-15.87	-15.60	-15.15	-11.05	-16.3	-21.9	-13.8	-7.5	-7	-9
CXO	Cocoa export volume	15.87	15.60	15.15	74.90	79.1	82.9	58.3	73.1	96	65
XCO	Cocoa export earnings	67.38	78.77	110.88	258.99	192.4	316.7	511.1	1118.2	1232	663
TAX	Cocoa export tax per tonne	-359.63	-403.33	-425.35	-568.96	-1395.5	-3666.3	-6427.9	-8806.9	-14332	-29458
RC	Cocoa export tax revenue	-132.69	-157.21	-144.12	-143.17	-465.3	-1064.0	-1592.2	-2178.6	-4118	-7326
QSRW	Supply by rest the of world	-15.87	-15.60	-15.15	-74.90	-79.1	-82.9	-58.3	-73.1	-96	-65
	Old exchange rate	3.28	2.84	2.69	2.55	2.1	2.0	2.9	5.8	6	6
	New exchange rate	3.88	3.46	3.22	3.01	2.6	2.5	3.4	7.2	8	7

TABLE 4.12

POLICY EXPERIMENT 6 (PE-6) - PERCENTAGE CHANGES

		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
QSGT	Total Supply of cocoa	0.000	0.00	0.000	14.542	15.26	15.16	10.38	14.20	18.25	11
QSG	Recorded supply of cocoa	3.780	3.74	3.912	20.059	23.48	28.67	21.61	26.89	35.35	24
PXC	Cocoa export price	0.000	21.22	19.676	17.618	21.78	21.37	13.69	20.39	14.87	16
CXS	Volume of cocoa smuggling	-36.771	-32.46	-27.366	-16.823	-21.83	-19.39	-8.71	-3.92	-3.47	-4
CXO	Cocoa export volume	4.279	4.06	4.371	23.764	28.20	35.90	26.76	34.50	43.86	35
XCO	Cocoa export earnings	23.083	26.44	25.084	45.712	56.28	65.08	44.19	61.97	65.27	57
TAX	Cocoa export tax per tonne	-89.768	-159.59	-66.440	-54.103	-303.86	-353.07	-205.29	-195.04	-366.30	-12980
RC	Cocoa export tax revenue	-89.330	-162.01	-64.973	-43.196	-361.35	-443.91	-233.47	-227.83	-483.09	-17515
QSRW	Cocoa supply by rest of the world	-1.521	-1.61	-1.488	-7.119	-7.38	-7.57	-5.86	-6.79	-8.37	-5
	Old exchange rate	3.283	2.84	2.690	2.555	2.08	2.01	2.91	5.83	6.40	6
	New exchange rate	3.875	3.46	3.224	3.008	2.59	2.50	3.40	7.18	7.57	7

Chapter V

A MACROECONOMETRIC MODEL FOR GHANA

The purpose of this is to extend the analysis of the previous chapter to the rest of the economy. The possible linkages of the cocoa sector with other sectors of the economy were discussed in an earlier chapter (see section 1.4.1). A discussion of recent developments in model building is presented before the specification and estimation of a macroeconometric model for Ghana.

5.1 *THE NATURE OF MACRO-ECONOMETRIC MODELS*

Macroeconomic models are currently widely used in developed countries, and their use is on the rise in less developed countries. The ground work for many of these works was layed down by early business cycle theorists such as Tinbergen (1939 and 1952), while Keynes' work in the *General Theory* also provided a means through which interrelations between various sectors of an economy may be effectively analysed.

Macroeconomic models may be classified according to theoretical orientation, size, purpose, or, obviously, by whatever type of economic region they are designed for (ie, western industrialised economies, LDC's, or centrally planned economies).

According to theoretical orientation,. Challen and Hagger (1983, pp 21) have suggested that macroeconometric models may be classified under five headings as follows:

(a) Keynes - Klein (KK)

(b) Phillips - Bergstrom (PB)

(c) Walras - Johansen (WJ)

(d) Walras - Leontief (WL)

(e) Muth - Sargent (MS)

The first name in each class represents the person responsible for the model's theoretical origin while the second name stands for the econometrician who provided the fundamental statistical framework.

KK models are generally demand oriented, with emphasis on relationships determining the components of national accounts; consumption, investment, government speding/ etc. The sixteen-equation model of the US economy constructed by Klein (1950) forms the background for such models. The second class identified by Challen and Hagger comprise the PB systems, developed mainly for the United Kingdom, Australia and New Zealand economies [Bergstrom and Wymer (1976), Johnson and Trevor (1979) and Spencer (1980)]. PB systems, like KK systems, are demand oriented, but in contrast, are formulated in continuous time and contain partial adjustment models for the relationships.

WJ and WL systems operate around input-output representations of general equilibrium systems. Both systems

are neoclassical in orientation, have explicit inter-industry relationships and adequate treatment of relative prices. While WJ systems are generally dynamic, and have been applied to both developed and developing countries [Johansen (1960) and Goreux (1977)], WL systems are mostly static, and have been more widely applied to developing economies [Taylor: 1979]. The final class of macroeconometric systems, the MS systems, are not widely used except for the United States and United Kingdom economies (Sargent, 1976 and Minford, 1980). As Challen and Hagger have noted however, they have the potential to become popular in the future and thus warrant mention. They differ from KK systems in their treatment of expectations. In these systems, all expectations are assumed to be rational which, of course, makes them difficult to handle because most of the expectation variables are not observable.

The foregoing classifications apply to most macroeconometric models, though some may make use of various characteristics of two or more of the prototypes described above. Many models for developing countries belong to this category. As the use of macroeconometric models became widespread in developing countries, several economists were quick to point out the shortcomings of the blind application of models originally designed for developed economies to developing economies. Because of the basically subsistence nature of many LDC's, models with emphasis on the supply side are thought to be more appropriate [Taylor, 1979].

It has been argued that Keynesian models generally are not applicable to LDC's due to a number of reasons including data problems, their heavy dependence on aggregate demand rather than supply, and their inadequate consideration of peculiar conditions existing in LDC's such as foreign exchange shortage and imperfect capital markets. It has also been argued that the importance of the foreign sector as a source of capital input has been generally overlooked by Keynesian models. (Behrman and Hansen, 1979). Instead, growth-oriented models based on the Harrod-Domar theory, static input-output, linear programming models and Chenery's two-gap models are often thought to be more appropriate. The reasoning is that developing countries should aspire towards long-run goals (such as growth) while short-run policies should be emphasized less.

In recent times, however, interest in short-run models for developing countries has intensified, due largely to the acute economic problems faced by LDC's, which themselves have been mainly a result of the oil crisis and the general world recession and are thus considered short-run phenomena. KK models have therefore gained considerable prominence. Klein (1965), Taylor (1979) and others have indicated, however, that the direct application of such models without adequate modification to reflect the peculiar characteristics of the area to which they are being applied should be avoided. On constructing a model for Israel, for example, Klein comments:

> A model of Israel should give great weight to population growth, through immigration and natural increase, unilateral international transfers,

> military expenditures for defense, the trade balance, and domestic capital formulation. In addition Israel has been a disequilibrium economy and this should be taken into account ....[Klein: 1965, p.183]

In a similar manner, models designed for other developing nations should be tailored to the needs of the particular economy. Several points need to be recognized in undertaking the exercise of model construction in LDC's. Taylor (1979) has proposed some stylized facts, reproduced below, as requirements that such models should have.

1. That a distinction be made between traded and home-goods production sectors with the realization that both may be highly dependent on intermediate imports not produced within the country.
2. That explicit interaction between agriculture and industry be incoporated.
3. That consideration be given to the poorly-developed capital markets in LDC's. Increases in government debt have to be financed by printing money due to the nature of the capital markets. The distinction between fiscal and monetary policy thus become obscure.
4. That important economic phenomena such as migration and income distribution must be incorporated as far as possible.
5. Finally, the model must deal adequately with the problem of structural change brought about by frequent political/economic disequilibria.

The model constructed in this study tries to describe the Ghanaian economy from 1956 to 1981. In doing so, an attempt is made to take account of most the points noted above. It differs significantly from previous models for Ghana, especially in the treatment of the supply side, monetary variables and the cocoa sector. Three previous models [Abbey and Clark: 1972; Acquah: 1972; Attah: 1978] have employed the aggregate production function approach in the treatment of supply. This approach is not suitable for our purposes, since it does not allow for inter-sectoral comparisons. Furthermore, smuggling has been completely ignored by all three models in the treatment of the cocoa sector, while the monetary sector has not been presented in a way that reflects the influence of the foreign sector.

The macroeconometric model constructed in this study combines features of KK systems with those of WJ and WL systems. The foreign sector is treated to reflect some of the foreign exchange problems currently faced by the Ghanaian economy. The monetary sector is based on the monetary approach to the balance of payments in order to portray the vulnerability of the economy to the uncertainties of the international economic system. Many of the relationships in the model are derived from theoretical considerations, while others are based on prior knowlegde of the characteristics of the Ghanaian economy.

5.2 *SPECIFICATION AND ESTIMATION OF THE GHANAIAN MODEL*

The Ghanaian model is considered under seven major sector as follows:

(1) The Cocoa Sector

(2) The Production Sector

(3) The Domestic Demand Sector

(4) The Foreign Trade Sector

(5) The Government sector

(6) Money and Price Sector

(7) Employment and Wages Sector

The specification and estimation of the cocoa sector variables was discussed in earlier chapters. This section deals only with the other six sectors.

Estimation methods used throughout this section are either OLS or 2SLS with principal components as described in the Chapter 2. The recursive properties of the model were used to determine whether a model should be estimated with OLS or 2SLS (see chapter 1). The whole non-cocoa sector model is made up of 33 equations, 19 of which are behavioural. Seven of the stochastic equations are recursive, while the other 13 form a simultaneous block and therefore must be estimated by an appropriate simultaneous equation estimation method. The recursive system was estimated using OLS, while the simultaneous block was estimated by 2SLS with principal components.

The method used to estimate each relationship is indicated beneath each equation together with either the DW or the value for the coefficient of autocorrelation ( ) if a correction was made.[37] Also provided with each equation are the R^2 and the t-ratios (in parenthesis). Three stars against a t-ratio indicate one percent level of significance, while two stars and one star indicate significance at the five and ten percent levels, respectively.

5.2.1 *The Production Sector*

Unlike earlier macroeconometric models of the Ghanaian economy, the construction of the production sector model uses the value-added approach. This enables us to examine the effect of the policy experiments on the various sectors. There is thus no aggregate production function; instead, total value-added is determined as a sum of sectoral value-added. For this purpose, the production sector has been further divided into five sub-sectors including agriculture, mining and industry, construction, transportation and services.

Value added in each sub-sector is a function of the components of aggregate demand. The approach is similar to Behrman and Klein (1970), who have interpreted these relationships as transformation of an input-output type of production process which are not completely demand oriented.

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[37] see Chapter Two for the method used to correct for autocorrelation

However, not all categories of final demand may be relevant to a particular sector.

Following Klein (1965) and Behrman and Klein (1970), the transformations may be presented as follows: The relationship between final demand categories and gross output by sector may be expressed in an input-output framework as;

$$(5.0) \quad (I-H)M = F$$

Where M is a vector of gross output by sector

F is a vector of final demand by categories

I is an identity matrix

H is a matrix of input-output coefficients

Let mj be gross output and vj be value-added in sector j

Then

$$(5.1) \quad v_j = m_j - \sum_{i=1}^{n} m_{ij}$$

where m_{ij} is intermediate input delivered to sector j by sector i and

n is the total number of sectors

We may rewrite the equation (5.1) as:

$$(5.2) \quad v_j = (1 - \sum_{i=1}^{n} h_{ij})m_j$$

Where h_{ij} is the proportion of the i'th sectors's input in sector j to the gross output of sector j

(ie. $h_{ij} = m_{ij}/m_j$)

In matrix form, we have:

(5.3) $V = BM$

where $B = dg(1-\Sigma h_{i1}, 1-\Sigma h_{i2}, \ldots, 1-\Sigma h_{in})$

V is nx 1 vector of sectoral value-added

M is nx 1 vector of sectoral gross outputs.

Let the share of ith sector final demand deliveries in any final demand category be:

(5.4) $k_{ij} = f_{ij}/g_j$

Thus equation (5.4) may be rewritten as:

(5.5) $f_i = \sum_{j=1}^{n} k_{ij} g_j$

In matrix form we have:

(5.6) $F = KG$

where G is an mx1 vector of GNP components demanded by each sector

K is nxm matrix whose column sums are unity

Using equations (5.0), (5.3) and (5.6) we have:

(5.7) $(I - H)B^{-1}V = KG$

(5.8) or $V = B(I - H)^{-1}KG$

We may write equation (5.8) as:

(5.9) $V = LG$

where $L = B(I - H)^{-1}K$

Equation (4.9) is a set of relationships which express value added in each sector as linear functions of the components of GDP demanded by each sector. Our model is based on these relationships. Since values for elements of G demanded by each sector are not available, we assume, following Klein and Behrman, that they may be approximated by GNP elements such as consumption, investment, exports, government expenditures, etc, to which they are closely related. In terms of our model ,we have:

$$V = \begin{bmatrix} VA \\ VM \\ VC \\ VT \\ VS \end{bmatrix} \quad L = \begin{bmatrix} B_{11} & B_{12} & \cdots\cdots & B_{19} \\ B_{21} & B_{22} & \cdots\cdots & B_{29} \\ . & . & & . \\ . & . & & . \\ B_{51} & B_{52} & \cdots\cdots & B_{59} \end{bmatrix} \quad G = \begin{bmatrix} PRC \\ PUC \\ GFV \\ XCO \\ XNC \\ MC \\ MR \\ MK \end{bmatrix}$$

Assuming L is reasonably stable, and with zero and linear restrictions on some of the coefficients, we obtain the relationships to be estimated for each sector. The restrictions are determined by the importance of each aggregate demand category to each value-added sector. The final demand

components that are used to explain value-added in the agricultural sector (VA) are cocoa exports (XCO) and government consumption (PUC). Value added in the cocoa sector forms a major part of VA, but unfortunately, available data are not appropriate for estimating value-added in the cocoa sector. We have therefore used total cocoa exports (XCO) as a regressor in the relationship for VA. The other explanatory variable in this equation is the government expenditures (PUC). This variable has been included to reflect the influence of government activity on the traditional sector. Both regressors are expected to be positively related to VA.

Value added in manufacturing (equation 5.11) is a function of total exports, (X), private consumption (PRC) and imports of raw material and spare parts (MR). The variables in this relationship were selected to reflect the heavy dependence of the manufacturing sector on foreign capital. X is a measure of foreign exchange resources of the country while MR reflects the heavy dependence on imported raw material. Most of the manufactured goods are designated for domestic use; hence the inclusion of PRC, which provides a rough measure of the extent of the market. X, PRC and MR should be positively related with VM.

The variables used to explain VT are exports and total imports. Exports are include for two reasons. Firstly, they provide the sort of backward linkage discussed in section 1.4.1. Secondly, they provide foreign exchange for spare parts,

which is a major factor in the smooth running of the country's transportation system. Imports also reflect the foreign content of the transportation industry, and hence are important for the determination of value-added in the transportation sector. VS is explained by total domestic consumption (ie. PRC+PUC) since most services originate from the domestic economy. Both VT and VS should be positively related to these variables.

5.2.1.1 Estimated Relationships for the Production Sector

Equations for value-added by sector are presented below. A discussion of these results follows.

(5.10) $\log VA = 5.09 + \underset{(2.12)^{**}}{0.172\ \log PUC} + \underset{(2.02)^{*}}{0.117\ \log XGO}$

$R^2 = 0.7745 \quad \rho = 0.35 \quad OLS$

(5.11) $\log VM = -1.36 + \underset{(2.25)^{**}}{0.271\ \log X} + \underset{(1.52)}{0.634\ \log PRC} + \underset{(0.85)}{0.619\ \log MR}$

$R^2 = 0.8343 \quad \rho = 0.59 \quad 2SLS$

(5.12) $\log VC = -0.883 + \underset{(2.10)^{**}}{.305\ \log GFI} + \underset{(2.66)^{**}}{1.17\ \log PRC} + \underset{(-3.80)^{***}}{.842\ \log PUC}$

$R^2 = 0.7344 \quad \rho = 0.49 \quad 2SLS$

$$(5.13)\quad \log VT = 3.55 + 0.052 \log X + 0.083 \log M$$
$$(0.39) \qquad (1.03)$$
$$R^2 = 0.5247 \qquad \rho = 0.69 \quad 2SLS$$

$$(5.14)\quad \log VS = 4.24 + 0.0292 \log(PRC+PUC)$$
$$(0.85)$$
$$R^2 = 0.8341 \qquad \rho = 0.70 \quad 2SLS$$

Equations (5.10) to (5.14) represent the estimated relationships for the five production sectors. All equations in this sector were estimated in their logarithmic forms. As is evident, the equation estimating value added in the agricultural sector provides a good fit with all coefficients significant at least at the ten percent level. The coefficient of XCO has the correct sign and is also significant. The right sign and significant coefficient indicate the appropriateness of the inclusion of PUC in the relationship for VA.

All variables except MR are significant at the 15 percent level in the equation determining VM. Though the coefficient of raw material imports is not significant, it has been retained on *a priori* grounds. Equation 5.13 determines value-added in the construction sector. All the coefficients are significant at the 5% level with an R^2 of 0.7844. VC shows strong and positive relationships with GFI and PRC. PUC, however, has an unexpected negative sign which may be explained by the fact that government consumption expenditure competes for funds with investment (and therefore construction)

activities. An increase in PUC will thus mean that less funds are available for construction purposes, leading to a fall in VC. Investment and private consumption on the other hand have the expected signs.

Finally, equations 5.13 and 5.14 determine value-added in the transportation and services sectors respectively. Though the coefficients in equations 5.13 and 5.14 are not significant, they have the expected signs.

Gross domestic product is determined by the following identity:

$$(5.15) \quad GDP = VA + VM + VC + VT + VS$$

5.2.2 *The Domestic Demand Sector*

Domestic consumption is determined in this sector. Consumption is separated into private and government categories.

Consumption in the private sector is based on Friedman's permanent income hypothesis [Friedman, 1957]. Under this assumption, private consumption is a linear function of permanent disposable income as follows:

$$(5.16) \quad PRC_t = \alpha_0 + \alpha_1 Yp_t + \epsilon_t$$

Where PRC_t is private consumption in period t

Yp_t is permanent disposable income in period t

ϵ_t is an error term

Since Yp is not directly observable, we assume that it is equal to disposable income in time t plus a weighted average of changes in disposable income received in the past with the weights decreasing geometrically backwards in time. The function may be derived as follows:

$$(5.17)\quad Yp_t = YD_t + \mu(YD_{t-1} - YD_t) + \mu^2(YD_{t-2} - YD_{t-1}) + \ldots.$$

Where YD_t is disposable income in year t and $0<\mu<1$

Equation 5.17 may be rewritten as;

$$(5.18)\quad Yp_t = (1-\mu)YD_t + \mu(1-\mu)YD_{t-1} + \mu^2(1-\mu)YD_{t-2} + \ldots.$$
$$= (1-\mu)[YD_t + \mu YD_{t-1} + \mu^2 YD_{t-2} + \ldots.]$$

Substituting equation 5.18 in 5.16, we obtain;

$$(5.19)\quad PRC_t = \alpha_0 + \alpha_1(1-\mu)[YD_t + YD_{t-1} + \ldots] + \quad t$$

Applying the Koyck transformation [see Johnston: 1972 p.298] to equation 5.18 yields;

$$(5.20)\quad PRC_t = \alpha_0(1-\mu) + \mu PRC_{t-1} + \alpha_1(1-\mu)YD_t + \varepsilon_t - \varepsilon_{t-1}$$

Equation 5.20 suggests the estimation of the following linear relationship;

$$(5.21)\quad PRC_t = \beta_0 + \beta_1 PRC_{t-1} + \beta_2 YD_t + U_t$$

Where $\beta_0 = \alpha_0(1-\mu)$, $\beta_1=\mu$,

$\beta_2=\alpha_1(1-\mu)$, $U_t = \varepsilon_t - \varepsilon_{t-1}$.

With $\beta_1 >0$, $\beta_2>0$

Equation 5.21 below presents the results of the estimated equation

$$(5.22) \quad PRC = -206.43 + .351\ PRC(-1) + .605\ YD$$
$$(1.98)* \qquad (3.20)***$$
$$R^2 = 0.8914 \quad DW = 1.72 \quad 2SLS$$

The results indicate a good fit with the absence of autocorrelation. The coefficient of lagged private consumption is significant at the ten percent level, while that of disposable income is significant at the one percent level. Furthermore, they are both of the right sign. The estimated long-run marginal propensity to consume is .92 [$(=\alpha_2/(1-\alpha_1))$] which agrees roughly with other estimates for the Ghanaian economy during the sample period.[38] During this period, the conditions were such that there is not likely to be much savings (see chapter one).

Public consumption in our model is a function of total domestic credit from the monetary sector, which is an indication of availability of funds, and total population (to reflect the fact that as population grows there is greater need for facilities such as education, hospitals and other social services). Both explanatory variables are expected to be positively related to PUC. The estimated relationship is given below.

---

[38] For example, the World Bank has estimated a saving rate of about 17% and 4% in 1960 and 1981 respectively for Ghana (see World Bank: 1983, p.156)

(5.23) PUC = 9.05 + 27.86 POP + 0.007 DCR

(1.48) (1.19)

R^2 = 0.8230 ρ = 0.54 OLS

Both coefficients have the right signs. However, the coefficient of population is only significant at the 16% level while that of DCR is significant only at the 25% level.

Disposable income is determined in this sector as the difference between GDP and direct taxes. Exports and imports are determined in the foreign sector, while gross fixed investment and change in inventory are treated as exogenous.

5.2.3 *The Foreign Trade Sector*

This sector comprises exports, imports and balance of trade identities. Exports of cocoa (XCO) are determined in the cocoa sector. Several attempts to estimate a function for non-cocoa exports (XNC) did not yield good results. This is probably because non-cocoa exports consist mostly of exhaustible resources such as gold, diamonds and timber, and hence may be explained mainly by natural factors. Thus, non-cocoa exports are assumed to be exogenous in this study. Total exports are then determined as an identity.

(5.24) X = XCO + XNC

Imports are separated into three categories namely, capital equipment (MK), raw materials and spare parts (MR), and consumer goods (MC). Imports of consumer goods are assumed to be given because they are largely determined by political decisions.[39] Imports of capital goods is explained by lagged foregn exhange reserves (FR) and relative prices (PM/PI).[40] FR provides a measure of the capacity to import and hence is expected to be positively related to MK. PM/PI, which is the import price index divided by the domestic price index, on the other hand, should have a negative sign since on average, imports are expected to fall if PM rises relative to PI. The equation for MR is similar to that of MK except that value-added in the secondary sector (VI) is included as one of the explanatory variables. The secondary sector, comprising mining and industry, construction, transportation and communication, makes the most use of the imports of raw material and spare parts and hence plays a significant part in determining MR. VI is also expected to be positively related to imports of raw materail. The estimated equations are presented below.

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[39] Past governments were known to keep imports of consumer goods high even in the presence of serious foreign exchange shortages for fear of losing popularity.

[40] This approach widely used in estimating import demand functions for developing countries (see Behrman: 1977).

(5.25) MK = 138.04 + 0.044 FR(-1) -0.598 PM/PI
(2.14)** (-7.27)***

R^2 = 0.8701 DW = 1.69 2SLS

(5.26) MR = 100.75 + 0.090 FR(-1) - 0.733 PM/PI + 0.231 VI
(2.43)** (-4.58)*** (3.00)***

R^2 = 0.8857 ρ = 0.36 2SLS

Both equations provide good fits with all explanatory variable having the right signs. Once MR and MK are determined, total imports (M) are determined as follows:

(5.27) M = MC + MK + MR

Other identities in this sector are as follows:

Balance of Trade (BOT):

(5.28) BOT = X - M

Foreign Exchange Reserves:

(5.29) FR = FR(-1) + BOT + NCM

where NCM is net capital movements

Net Foreign Assets (FAN):

(5.30) FAN = FR + FOR - FOL

where FOR is other foreign assets such as non-monetary gold.

FOL is other foreign liabilities.

FAN will be used later on in the determination of the money supply.

5.2.4 *Government Revenue Sector*

Government revenue is decomposed into six categories: direct taxes (RD), import duties (RM), cocoa export taxes (RC), non-cocoa export taxes (RNC), other indirect taxes (ROI) and non tax revenue (RN). Cocoa export taxes are determined in the cocoa sector, while non-cocoa export taxes are assumed to be exogenous. Direct taxes comprise personal and company income taxes, mineral duties, rent and payroll taxes, while other indirect taxes consist of sales, purchase, and excise taxes. Government expenditure is assumed to be exogenous.

The approach used in this sector is to relate the various taxes to their bases (or proxy bases). Nominal GDP is used as the base for direct taxes, other indirect taxes and non-tax revenue, while the base for import duties is assumed to be the level of imports. All equations are estimated in their logarithmic transformations and, as the results presented in the equations below show, they all provide good fits.

$$\text{(5.31)}\quad \log RD = -1.33 + 0.727\ \log NGDP$$
$$(7.10)^{***}$$
$$R^2 = 0.9528 \qquad \rho = 0.67 \quad 2SLS$$

(5.32) logROI = -1.95 + 0.806 logNGDP

(6.79)

R^2 = 0.9528 ρ = 0.70 OLS

(5.33) logRM = -0.275 + 0.756 logNM

(6.76)***

R^2 = 0.9080 ρ = 0.72 OLS

(5.34) logRN = -0.680 + 0.572 logNGDP

(14.31)***

R^2 = 0.9608 ρ = 0.41 OLS

The final equation in this sector is an identity determining total government revenue (R). This is done after taking the exponentials of the log transformations.

(5.35) R = RD + ROI + RM + RN + RC + RNC

5.2.5 *Money and Prices*

This sector determines the money supply and demand and prices endogenous to the model. The monetary approach to the balance of payments has been used here in the determination of the monetary variables. This approach takes into consideration the important role played by foreign reserves in the determination of the money supply in developing countries. An important feature to keep in mind in this type of exercise is the nature

of the capital market in developing countries. In many LDC's interest rates show little variability, sometimes remaining at a constant level for several years. In addition, money is the only financial asset in many LDC's, and hence, the cost of holding financial assets can be assumed equal to the rate of inflation.

The methodology employed for macromodels in LDC's varies according to the nature of data available. Most, however, make the money supply a function of credit availability to the private sector, foreign reserves and some measure of capacity utilization [see Priovolos: 1981, Acquah: 1972, Kwanashie: 1981] The demand for money relationship has generally been in the form of the demand for real cash balances except that the rate of interest as a determinant is often omitted. The methodology employed in this study is different.[41]

In presenting the monetary approach to the payments we may represent the balance sheet of financial flows of a typical country in Table 5.1 below [see Taylor: 1975, pp.24 ff.]

From Table 5.1, the total assets of the monetary system is $F + D + S + L$, while the total liability is $C + q_1 + q_2$. The money supply is either $C + Q_1$ or $C + Q_1 + Q_2$ depending on whether the narrow or wide definition is used. It is worth noting that there is no market for government bonds, and hence government deficits can only be met through borrowing from the

---

[41] A similar approach was used by Attah (1978)

TABLE 5.1

TYPICAL BALANCE SHEET OF THE MONETARY SECTOR

Assets		Liabilities	
Rest of the World			
Net credit to private sector	Z	Net foreign exchange deposits	F
Government			
		Outstanding government debt	D
Central Bank			
Net foreign reserves	F	Currency and coins	C
Credit to public sector	D	Reserves for demand deposits	q_1
Credit to Private sector	S	Reserves for near money	q_2
Rediscount	R		
Commercial Banks			
Reserves for demand deposits	q_1	Demand deposits	Q_1
Reserves for near money	q_2	Near money	Q_2
Lending to private sector	L	Rediscount	R
Private Sector			
Currency and coins	C	Credit from Central Bank	S
Demand deposits	Q_1	Credit from Commercial Bank	L
Near money	Q_2	Credit from abroad	Z

Source: Taylor (1975) p.24

central bank. Furthermore, a balance of trade deficit can only be financed by making use of net foreign reserves (F) or by an increase in Z (ie. credit to the private sector for import purposes). The variable Z is rigidly controlled in most LDC's,

which produces a direct linkage between the balance of trade and F.

5.2.5.1 Determination of Money Supply

Let $q = q_1 + q_2$, then the high-powered money is given by $H = C + q$. Also, the money supply is given by $MS = C + Q$ (where $Q = Q_1 + Q_2$). Let $CU = C/Q$ and $RS = q/Q$, then $MS/H = (CU+1)/(CU+RS) = m$, where m is the money multiplier and $MS = mH$ Since $r<1$, it follows that $m>1$ and hence $MS>H$. This is mainly a result of credit creation by commercial banks. The foregoing analysis may be used to show how little influence the central bank has on the money supply in LDC's. The major constraint is the impracticability of open market operations. Thus, the central bank is limited to either changing the monetary base (H) or influencing the parameters that determine MS. From table 5.1, the central bank can alter H by changing its asset holdings - F, D, or S. F and D are usually outside its control. S can be controlled in most LDC's, but this accounts for only a small proportion of the banks assets and hence is not very effective.

Alternatively the central bank may try to influence the parameters that determine MS (CU,RS). CU can only be changed by persuading people about the form in which to hold money (moral suasion). RS may be changed by regulating the commercial the banks regarding their reserve requirements. These actions very difficult to do in most LDC's. Because of

the inability of the central bank to control the MS and the close linkage between the balance of payments and the government deficit in LDC's, the money supply can be considered to be 'endogeneous' making monetary programming difficult [Taylor, 1979: p.27].

It is thus clear from the above that the central banks in LDC's can rarely determine the money supply. Instead the money supply is determined endogenously through the interaction of several factors as follows: Let NGI stand for net government indebtedness to the central bank (D in table 5.1). Then high powered money must satisfy the following identity:

$$H = FAN + NGI + S + R - q_2$$

where FAN is net foreign assets (or F)

The narrow definition of the money supply is used in this study (ie. $MS = C + Q_1$). Accordingly, we must define H as the sum of c and q_1.[42] If we define NOL as other net liabilities, then $NOL = q2 - S - R$, and

$$(5.36) \quad H = FAN + NGI - NOL$$

Since NOL is treated as exogeneous and FAN is determined in the foreign trade sector, the money supply will be known as soon as RS, CU and NGI are determined.

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[42] q_1 is equivalent to BR in this study.

Since CU is the ratio of currency outside banks to demand deposits, one would expect an inverse relationship between CU and the degree of monetization of the economy. Factors which influence the degree of monetization include the GDP (which gives an indication of the level of economic activity within the country), the number of commercial banks per head of population and the rate of urbanization. We areunable to acquire data on the number of commercial banks per head, so CU is made a function of nominal GDP and the percentage of urban population (PURB) as follows:

$$(5.37)\quad CU = 340.61 + \underset{(6.01)***}{0.002\ NGDP} - \underset{(-6.03)***}{8.09\ PURB}$$

$$R^2 = 0.6623 \qquad \rho = 0.51 \qquad 2SLS$$

Both coefficients have the right signs and are significant at the 1% level. RS is also made a function of GDP to reflect the level of economic activity. The equation estimated is:

$$(5.38)\quad RS = 51.11 + \underset{(2.08)**}{0.0005\ NGDP}$$

$$R^2 = 0.8166 \qquad \rho = 0.69 \qquad 2SLS$$

Finally, net government indebtedness (NGI) is determined in this study by public consumption and nominal GDP. Since the government mainly borrows to finance its consumption, its

indebtedness is expected to be possitively related to its consumption. Nominal GDP is also expected to have a positive influence on NGI since government activity increases in response to a general increase in economic activity. The estimated relationship is given by:

$$(5.39)\quad NGI = -1353.89 + 6.51\ PUC + 0.093\ NGDP$$
$$(-0.26)\quad (2.67)^{**}\quad (10.62)^{***}$$
$$R^2 = 0.9852 \qquad = 0.53 \quad 2SLS$$

All estimated parameters of NGI (except the intercept) are significant at the 5% level, and also have the expected signs. Furthermore, the equation provides agood fit, with an R^2 of 0.9852. H is determined as an identity in equation 5.22, while MS is determined as:

$$(5.40)\quad MS = [(1+CU)/(RS+CU)]H$$

5.2.5.2 Prices

All prices outside the cocoa sector are assumed to be constant except the GDP defator (PI), which is determined as a function of the money supply and real GDP. This approach is based on the simple quantity theory of money as follows:

$$(5.41)\quad (MS)(V) = (PI)(GDP)$$

where V is velocity

Identity 5.42 is then rewritten with PI as the subject:

(5.42) PI = (V)(MS)/GDP

If V is assumed to be constant, then PI may be considered as a direct function of MS, and inversely related to real GDP as follows:

(5.43) PI = f(MS,GDP)

This specification is appropriate for a developing country such as Ghana, where interest rates do not play any significant role. The estimated relationship is:

(5.44) PI = 981.06 − 0.574 GDP + 0.407 MS

(-2.73)** (23.13)***

R^2 = 0.9880 ρ = 0.50 2SLS

Both coefficients have the right signs and are significant at the 5% level.

5.2.6 *Employment and Wages*

Employment[43] is determined under the assumption of a fixed proportion production function with capital as the limiting factor. Thus employment will depend on capital alone. We have modified this assumption to include real GDP, a rough measure of capital utilization and the wage rate. The wage rate is expected to be negatively related to the level of employment (N), while capital stock (KS) and GDP are expected to have a

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[43] This represents only recorded employment (see chapter1).

positive influence on N. The estimated equation is given by:

$$(5.45)\quad N = 138.00 - 0.017\ W + 0.087\ GDP + 0.020\ KS$$
$$(-0.50)\quad (3.04)^{***}\quad (1.68)^{*}$$
$$R^2 = 0.8895 \qquad DW = 2.15 \qquad OLS$$

As can be seen from the results above, the wage rate (W) does not contribute significantly to explaining the variation in N. However we have retained it on *a priori* grounds. The wage rate is assumed to be exogenous since attempts to estimate a wage function did not yield meaningful results.

The labour force, which includes people who are actively looking for jobs at employment centres, is a function of the urban population and government expenditures. The rationale is that most, if not all of the employment centres are located in the urban areas.

$$(5.46)\quad LS = 295.00 + 16.76\ PURB$$
$$(9.78)^{***}$$
$$R^2 = 0.8421 \qquad \rho = 0.49 \qquad OLS$$

The unemployment level (U) and the unemployment rate (UR) are determined by the following identities:

$$(5.47)\quad U = LS - N$$

$$(5.48)\quad UR = U/LS$$

5.3 *HISTORICAL SIMULATION AND VALIDATION OF THE MACRO MODEL*

Dynamic simulations were performed for the period 1972 to 1981 in order to determine the tracking ability of the macromodel. Table 5.2 below gives the root mean square percentage errors (RMSPE) for the relevant variables of the model. Nineteen out of the thirty-two variables have RMSPE's of less than twenty percent, six variables have between twenty and thirty percent, while seven have RMSPE's of more than thirty percent. The high RMSPE's may be explained by the volatility of BOT, which fluctuated between -829.48 and 169.10 million cedis. Consequently, other variables affected by BOT, such as MS, and PI also had high RMSPE's.

An examination of the tracking abilities of the various models (shown in the graphs on the following pages) indicates, however, that many of the equations do quite well in predicting the general trend of the historical values.[44] In some of the graphs, the historical and simulated values seem to move in opposite direction at the end of the period. This may not be quite so, since a close examination of the graphs shows that the turning points are often picked up a year or two later by the simulated values. Thus, it may well be that the models would have picked up the turning points at the end of the period, had the sample period extended beyond 1981. In any case, since the model is not constructed for the purpose of

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[44] see footnote 28 for an explanation of the notation used in the graphs.

TABLE 5.2

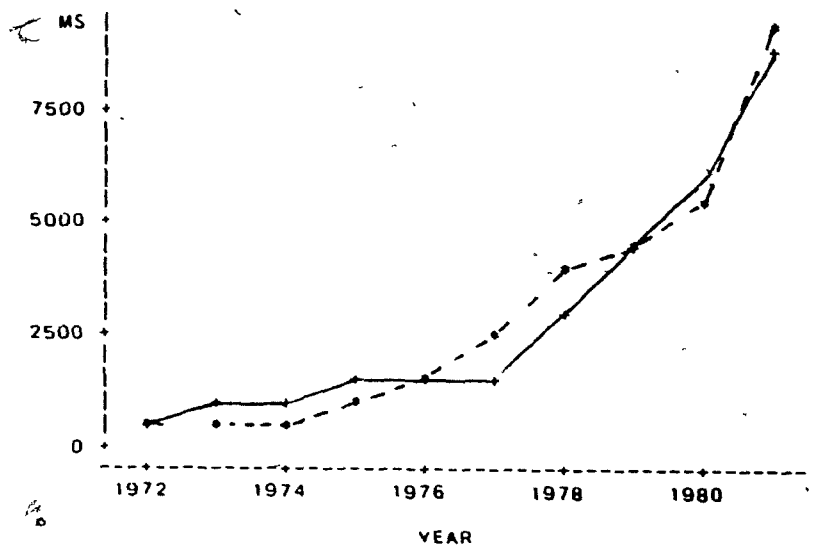
STATISTICS OF FIT FOR THE MACROECONOMETRIC MODEL

Variable	RMSPE	Variable	RMSPE
GDP	2.96	MS	34.29
VA	8.99	H	26.76
VM	10.38	FR	26.15
VC	27.98	FAN	42.80
VT	15.84	BOT	314.89
VS	9.25	LS	3.81
GDP1	4.33	NGI	40.38
PRC	10.79	RS	25.76
PUC	14.13	CU	9.18
N	2.64	R	9.41
M	9.30	ROI	21.07
MR	10.79	RM	30.53
MK	14.94	RN	15.90
X	7.18	RD	16.64
YD	4.72	U	38.56
PI	24.20	UR	36.84

forecasting this does not pose a serious problem.

MON EY SUPPLY

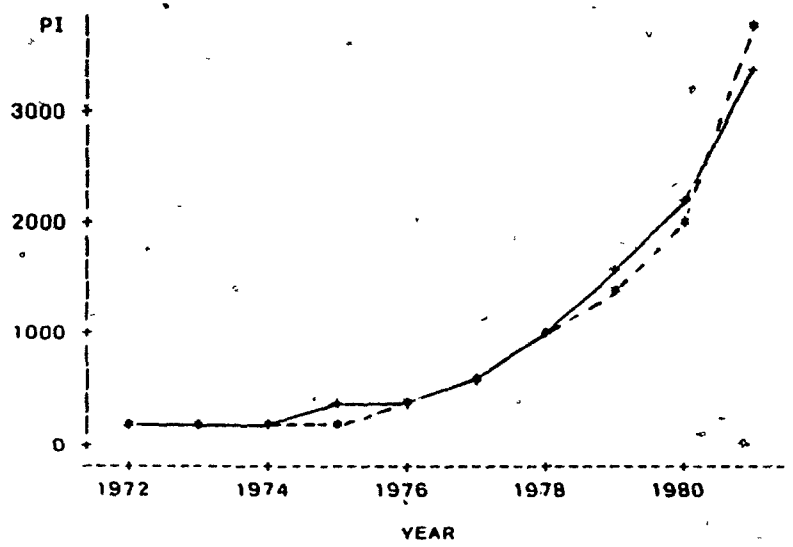
PLOT OF MS*YEAR SYMBOL USED IS *
PLOT OF MSH*YEAR SYMBOL USED IS +



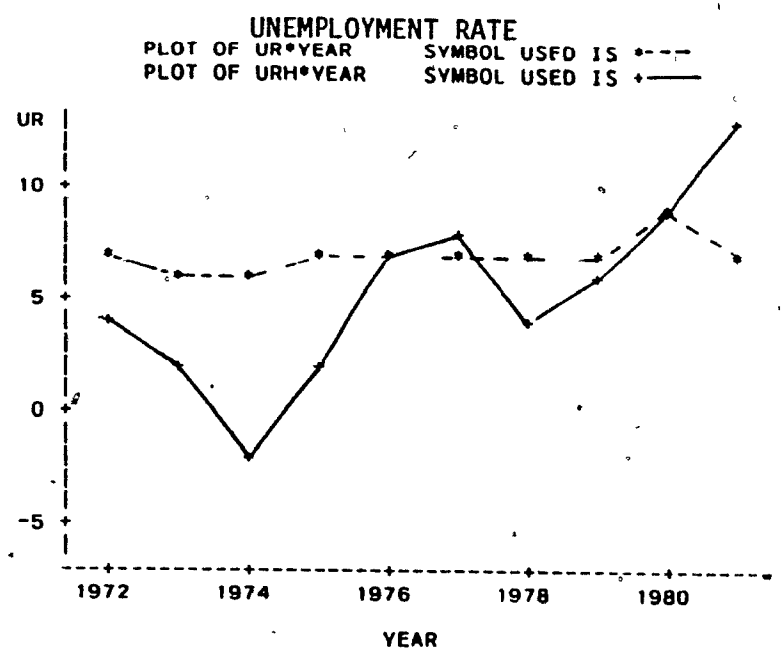
YEAR	MS	MSH	CMS	PCMS
1972	459	623.78	164 78	35 899
1973	536	865.74	329 74	61.518
1974	656	1078 00	422.00	64.330
1975	981	1334 96	353.96	36 082
1976	1386	1386 01	0 01	0 001
1977	2276	1727 18	-548 82	-24.113
1978	3909	3055 09	-853 91	-21.845
1979	4332	4685 53	353 53	8.161
1980	5611	6085 13	474 13	8 450
1981	9360	8923 99	-436 01	-4 658

IMPLICIT GDP DEFLATOR

PLOT OF PI*YEAR SYMBOL USED IS *
PLOT OF PIH*YEAR SYMBOL USED IS +



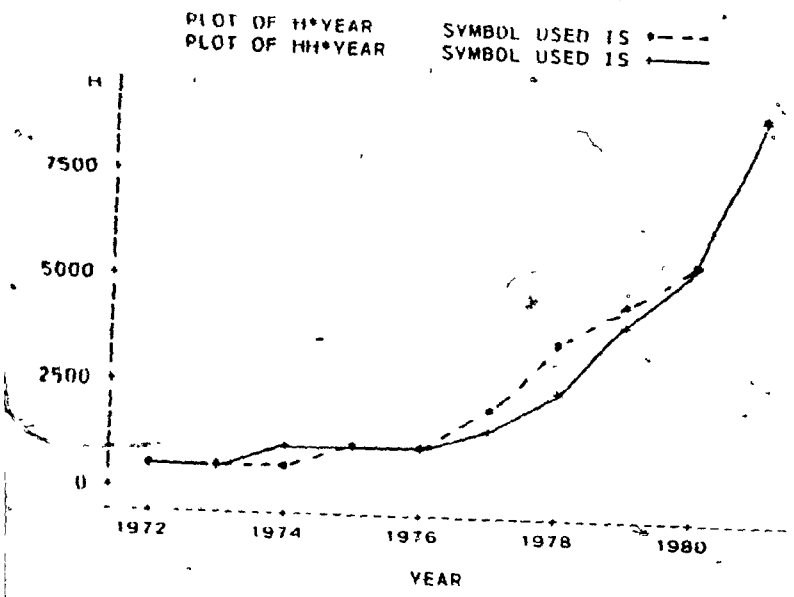
YEAR	PI	PIH	CPPI	PCPI
1972	142.31	215.06	72.75	51.121
1973	167.67	215.24	47.57	28.371
1974	211.43	174.38	-37.05	-17.526
1975	251.79	335.36	83 57	33.190
1976	329.77	429.45	99.68	30.228
1977	557.61	562.02	4.41	0.791
1978	967.91	978.05	10 14	1.047
1979	1349 52	1642.32	292 80	21.697
1980	1949.49	2230.93	281 44	14.437
1981	3711 70	3430.78	-280 92	-7 569



YEAR	N	NH	CN	PCN
1972	424.666	410.414	-14.252	-3.3561
1973	409.144	423.150	14.006	3.4231
1974	450.138	448.630	-1.508	-0.3349
1975	431.432	436.586	5.154	1.1946
1976	430.636	421.473	-9.163	-2.1279
1977	423.074	421.024	-2.050	-0.4846
1978	432.626	448.270	15.644	3.6160
1979	428.646	445.503	16.857	3.9325
1980	429.840	438.372	8.532	1.9850
1981	433.820	423.905	-9.915	-2.2855

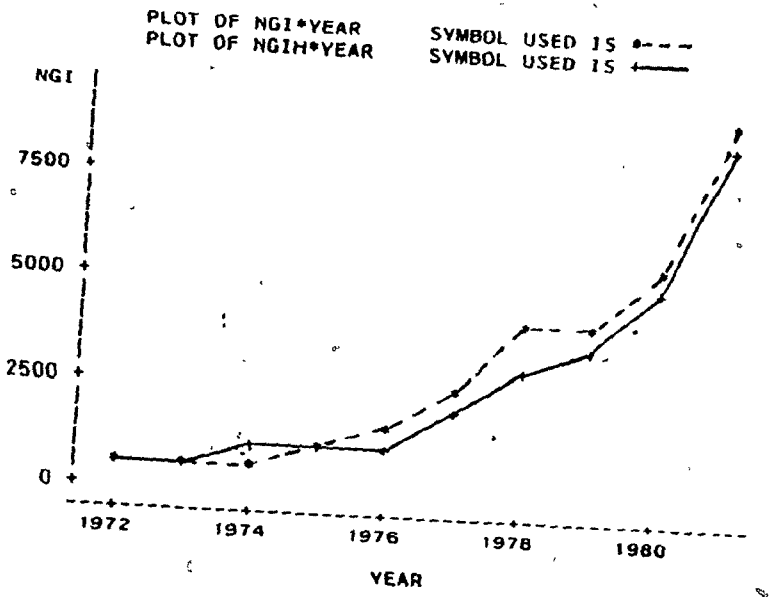
YEAR	UR	URH	CUR	PCUR
1972	6.85168	4.2173	-2.6344	-38.45
1973	6.04629	2.4780	-3.5683	-59.02
1974	5.91351	-1.7314	-7.6449	-129.28
1975	6.60068	2.3985	-4.2021	-63.66
1976	7.05771	7.0899	0.0322	0.46
1977	7.01793	8.4642	1.4463	20.61
1978	7.44503	3.8616	-3.5835	-48.13
1979	6.80413	6.0659	-0.7382	-10.85
1980	8.51568	8.6379	0.1223	1.44
1981	6.94951	12.8016	5.8521	84.21

HIGH POWERED MONEY



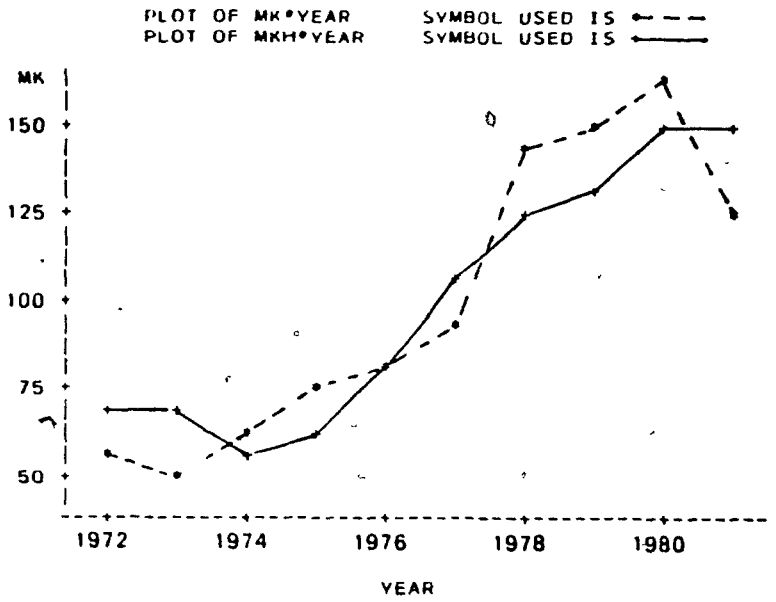
YEAR	H	HH	CH	PCH
1972	352	467 70	115.7	32 871
1973	437	649.11	212 1	48.538
1974	594	811.93	217.9	36.689
1975	879	1003 77	124.8	14.194
1976	1249	1038.68	-210 3	-16 839
1977	2015	1328 69	-686 3	-34.060
1978	3720	2486 34	-1233 7	-33.163
1979	4396	3941 69	-454 3	-10 335
1980	5742	5410 78	-331 2	5 768
1981	8924	8759 86	-164 1	-1.839

NET GOVERNMENT INDEBTEDNESS



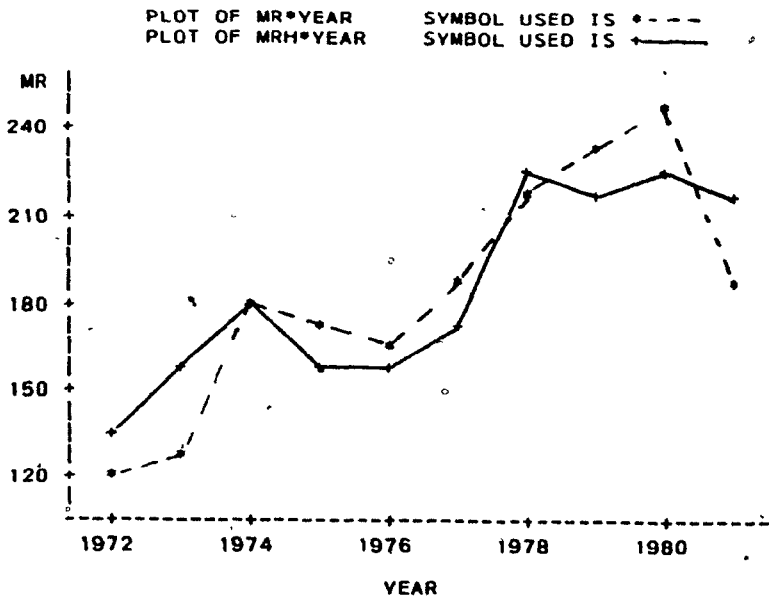
YEAR	NGI	NGIH	CNGI	PCNGI
1972	292	435.97		
1973	309	597.94	144.0	49.304
1974	534	803.84	268.9	93.507
1975	823	957.27	769.8	50.532
1976	1402	1215 68	134.3	16.315
1977	2441	1790 79	-186.3	-13.289
1978	4155	2902.34	-650.2	-26.637
1979	4196	3690 98	-1252 7	-30 148
1980	5447	5015 89	-505.0	-12.036
1981	8959	8732 74	-431.1	-7.915
			-226.3	-2.526

IMPORTS OF CAPITAL GOODS



YEAR	MK	MKH	CMK	PCMK
1972	57.579	69.134	11.555	20.068
1973	50.013	66.105	16.092	32.176
1974	62.200	56.563	-5.638	-9.064
1975	74.932	62.642	-12.290	-16.401
1976	82.976	84.179	1.203	1.450
1977	95.345	105.141	9.795	10.273
1978	141.070	122 593	-18.478	-13.098
1979	151.959	134.160	-17.800	-11.713
1980	159.668	148.438	-11.230	-7.033
1981	124.421	152.846	28.425	22.846

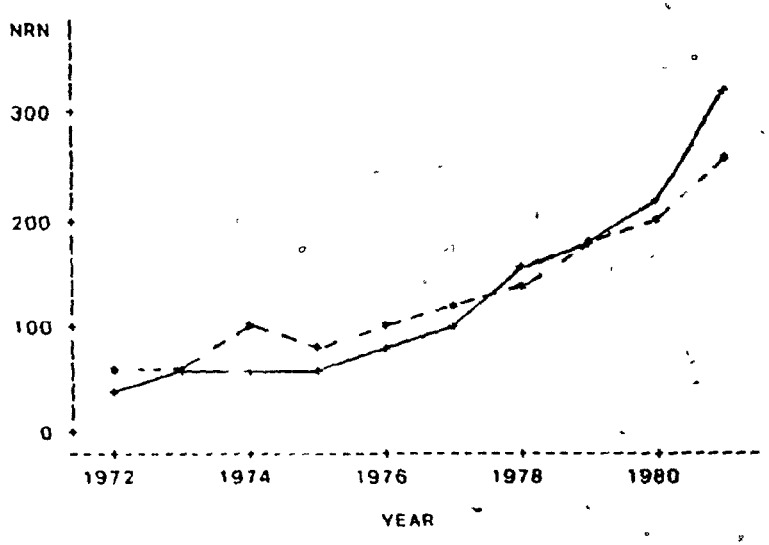
IMPORTS OF RAW MATERIAL



YEAR	MR	MRH	CMR	PCMR
1972	118.728	132.334	13.607	11.4603
1973	130.434	154.456	24.022	18.4171
1974	178.529	177.821	-0.708	-0.3968
1975	168.910	154.732	-14.177	-8.3933
1976	168.650	153.772	-14.878	-8.8218
1977	188.823	174.470	-14.353	-7.6012
1978	215.482	227.740	12.258	5.6888
1979	232.122	220.235	-11.887	-5.1210
1980	243.888	223.018	-20.871	-8.5575
1981	190.045	218.903	28.858	15.1850

NON-TAX REVENUE

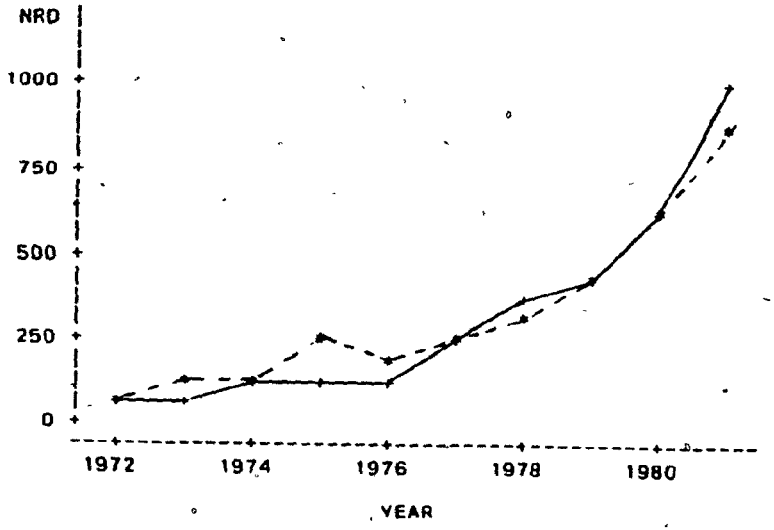
PLOT OF RN*YEAR SYMBOL USED IS ---
PLOT OF RNH*YEAR SYMBOL USED IS ———



YEAR	RN	RNH	C RN	PC RN
1972	59.2	48.524		
1973	53.3	53.437	-10.676	-18.033
1974	92 5	62.557	0.137	0.257
1975	75.0	67.088	-29 943	-32.370
1976	105.4	75 940	-7.912	-10.549
1977	114 0	104.442	-29 460	-27.950
1978	145.8	151.985	-9.558	-8.384
1979	189 4	181.058	6.185	4.242
1980	200 0	226.315	-8.342	-4.404
1981	264 7	328.383	26 315	13.157
			63.683	24.058

DIRECT TAXES

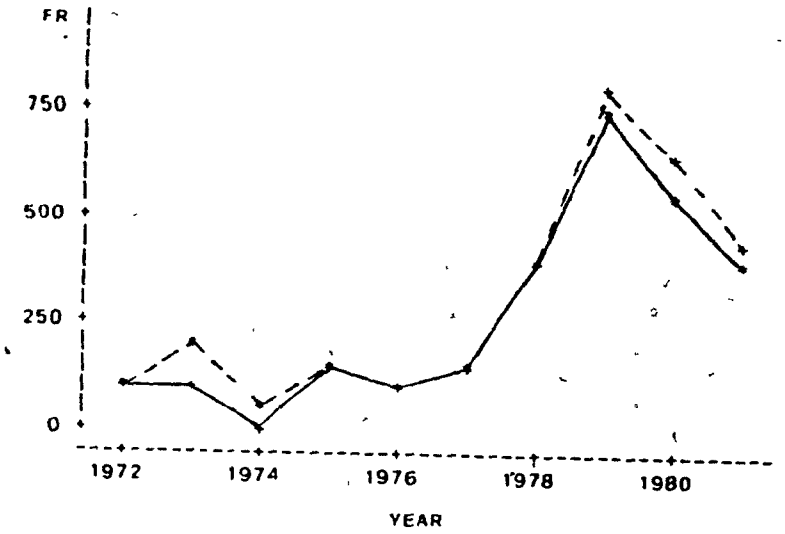
PLOT OF RD*YEAR SYMBOL USED IS ---
PLOT OF RDH*YEAR SYMBOL USED IS ———



YEAR	RD	RDH	C RD	PC RD
1972	89.4	74.862		
1973	106.0	89.109	-14.54	-16.262
1974	131.2	111.658	-16.89	-15.935
1975	259.4	123.361	-19.54	-14.895
1976	205.8	145.614	-136.04	-52.444
1977	239.3	221.358	-60.19	-29.245
1978	309.1	361.999	-17.94	-7.498
1979	407.7	455.424	52.90	17.114
1980	613.5	610.033	47.72	11.706
1981	898.0	993.124	-3.47	-0.565
			95.12	10.593

FOREIGN EXCHANGE RESERVES

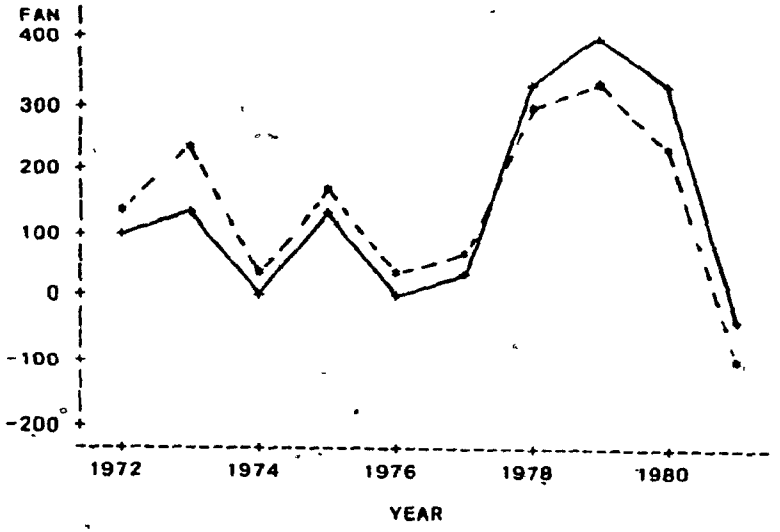
PLOT OF FR*YEAR SYMBOL USED IS ---
PLOT OF FRH*YEAR SYMBOL USED IS ———



YEAR	FR	FRH	CFR	PCFR
1972	118.635	90.372	-28.263	-23.824
1973	189.399	112.574	-76.825	-40.562
1974	71.297	19.387	-51.910	-72.808
1975	154.554	145.049	-9.505	-6.150
1976	103.381	79.374	-24.007	-23.222
1977	164.558	128.457	-36.101	-21.938
1978	404.636	423.636	19.000	4.696
1979	752.475	803.187	50.711	6.739
1980	540.704	640.592	99.888	18.474
1981	405.116	467 239	62.123	15.335

OTHER NET FOREIGN ASSETS

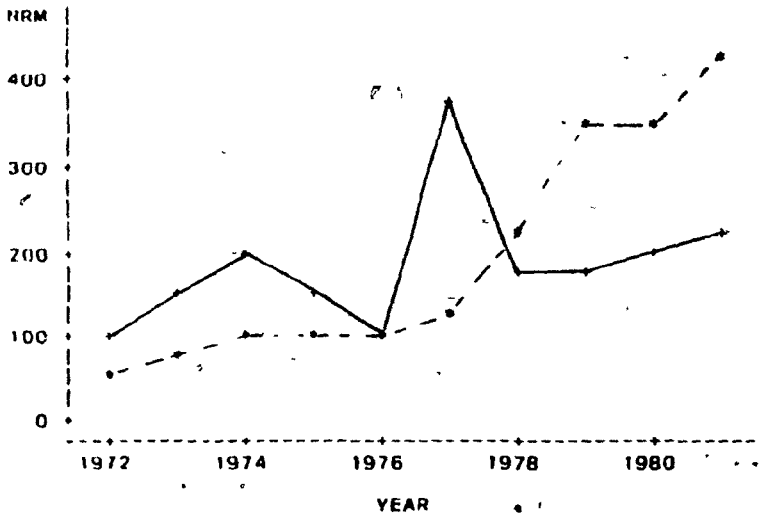
PLOT OF FAN*YEAR SYMBOL USED IS ---
PLOT OF FANH*YEAR SYMBOL USED IS ———



YEAR	FAN	FANH	CFAN	PCFAN
1972	139	110.737	-28.263	-20.33
1973	221	144.175	-76.825	-34.76
1974	37	-14.910	-51.910	-140.30
1975	151	141.495	-9.505	-6.29
1976	40	15.993	-24.007	-60.02
1977	69	32.899	-36.101	-52.32
1978	304	323.000	19.000	6.25
1979	341	391.711	50.711	14.87
1980	243	342.888	99.888	41.11
1981	-91	-28.877	62.123	-68.27

IMPORT DUTIES

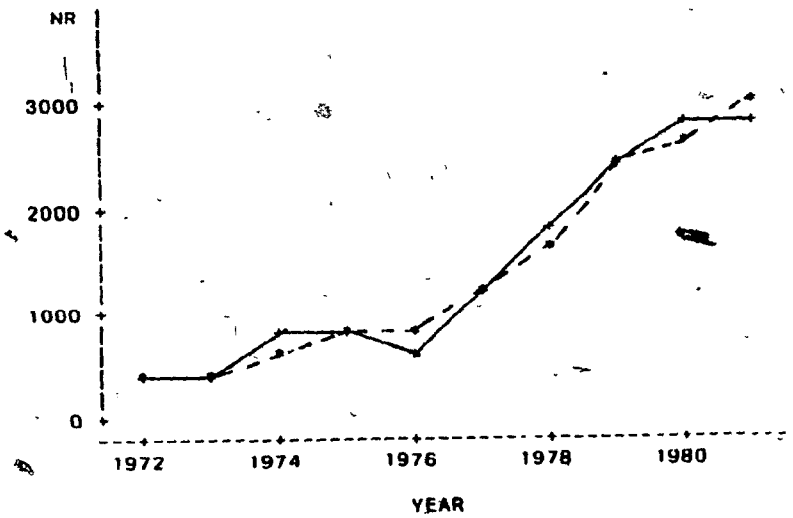
PLOT OF RM*YEAR SYMBOL USED IS *---
PLOT OF RMH*YEAR SYMBOL USED IS +——



YEAR	RM	RMH	C RM	PC RM
1972	57 0	102.128	45.13	79.173
1973	71.4	139.511	68.11	95.393
1974	107.5	197.180	89.68	83.423
1975	107.7	146.689	38.99	36.201
1976	96.3	107.731	11.43	11.870
1977	116.6	375.567	258.97	222.098
1978	223 9	172 405	-51 50	-22.999
1979	344.9	164.225	-180.67	-52.385
1980	359 2	204.665	-154.53	-43.022
1981	429.2	215.801	-213.40	-49.720

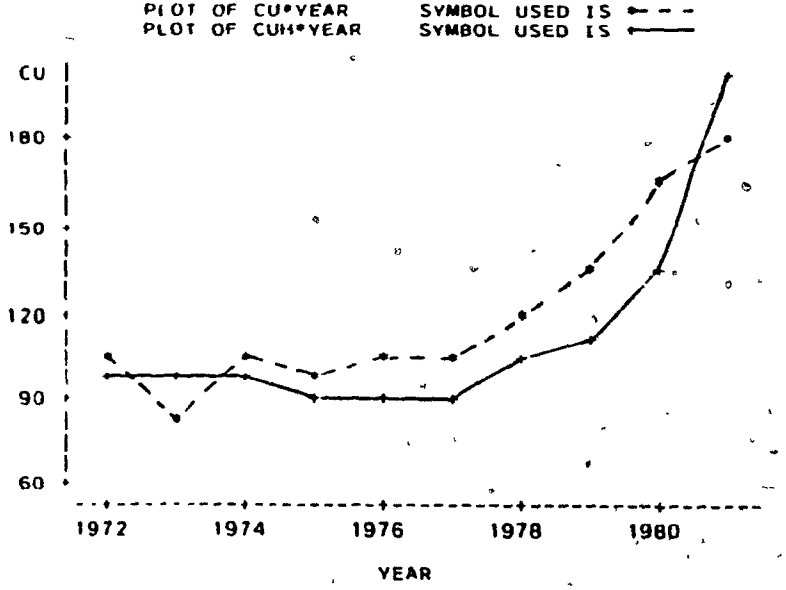
TOTAL TAX REVENUE

PLOT OF R*YEAR SYMBOL USED IS *---
PLOT OF RH*YEAR SYMBOL USED IS +——

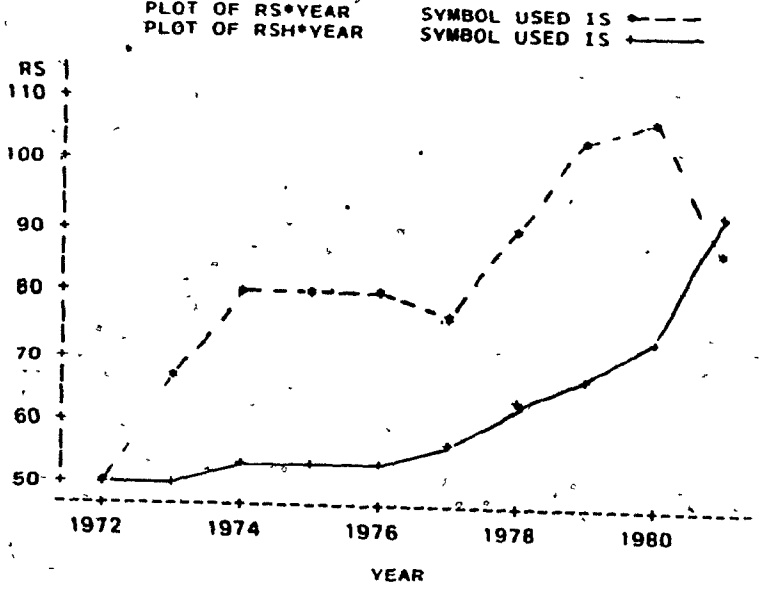


YEAR	IR	RH	C R	PC R
1972	433.99	476.79	42.79	9.860
1973	468.85	497.20	28.35	6.047
1974	683.05	739.68	56.63	8.290
1975	812.43	818.74	6.31	0.777
1976	871.01	638.59	-232.42	-26.684
1977	1161.62	1221.68	60.06	5.170
1978	1512.83	1849.14	336.31	22.231
1979	2484.67	2376.99	-107.68	-4.334
1980	2589.52	2708.58	119.07	4 598
1981	2905.31	2863.04	-42.28	-1.455

RATIO OF CURRENCY TO MONEY SUPPLY



RATIO OF RESERVES TO TOTAL DEPOSITS

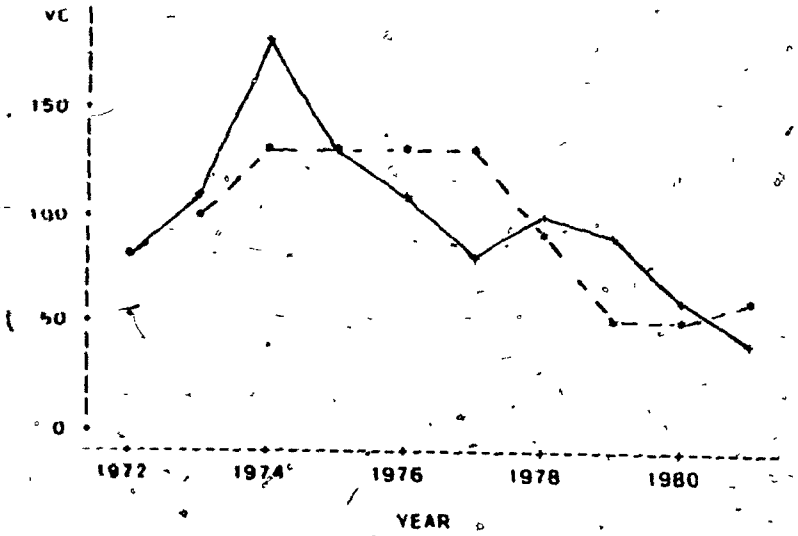


YEAR	CU	CUH	CCU	PCCU
1972	108.636	98.458	-10.178	-9.369
1973	84.192	95.542	11.350	13.481
1974	105.000	94.590	-10.410	-9.914
1975	98.182	91.503	-6.679	-6.802
1976	104.124	86.270	-17.854	-17.147
1977	103.396	90.273	-13.123	-12.692
1978	118.747	104.747	-14.000	-11.789
1979	131.287	113.472	-17.814	-13.569
1980	168.469	138.049	-30.420	-18.057
1981	182.779	201.799	19.020	10.406

YEAR	RS	RSH	CRS	PCRS
1972	51.364	50.3446	-1.019	-1.984
1973	65.979	51.0713	-14.908	-22.595
1974	80.625	51.9719	-28.653	-35.539
1975	79.394	52.4894	-26.905	-33.887
1976	79.823	53.3208	-26.503	-33.201
1977	76.676	56.1006	-20.575	-26.834
1978	89.424	61.8831	-27.541	-30.798
1979	103.417	66.1110	-37.306	-36.073
1980	106.268	73.6195	-32.648	-30.723
1981	86.828	94.4495	7.622	8.778

VALUE ADDED IN CONSTRUCTION

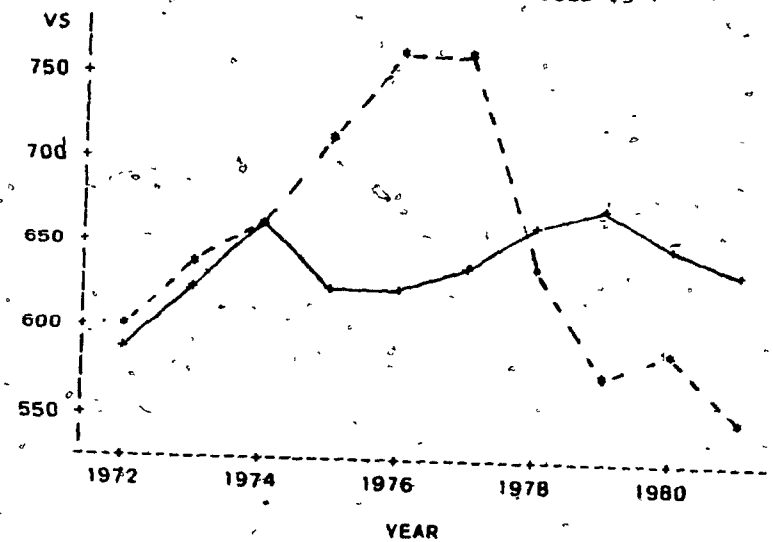
PLOT OF VC*YEAR SYMBOL USED IS *
PLOT OF VCH*YEAR SYMBOL USED IS —



YEAR	VS	VSH	CVS	PCVS
1972	603 987	587 527	-16 46	-2 225
1973	632 115	621.786	-10.33	-1 634
1974	665 296	660.684	-4.61	-0.693
1975	709.125	624.672	-84.45	-11.909
1976	764 006	624 304	-139 70	-18.286
1977	764 072	632 271	-131.80	-17.250
1978	632 097	666 274	34 18	5.407
1979	579 579	670 939	91 36	15.763
1980	586 112	653 195	67 08	11.446
1981	552 315	636 482	84 17	15.239

VALUE ADDED IN SERVICES

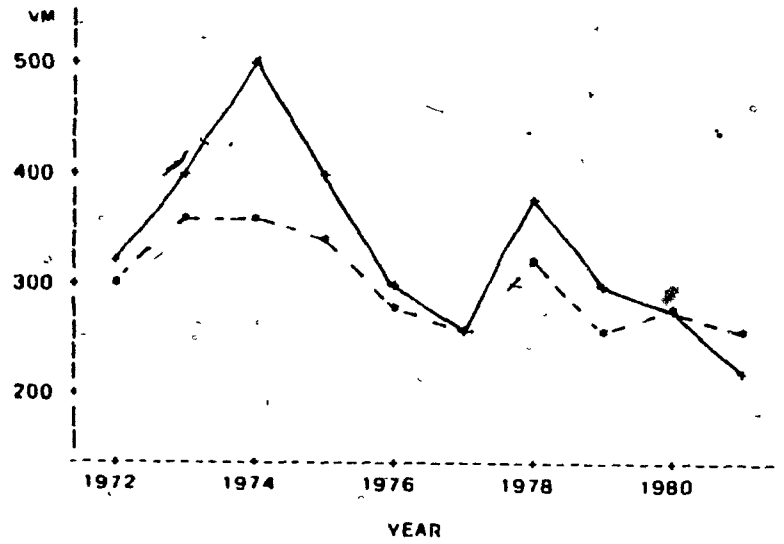
PLOT OF VS*YEAR SYMBOL USED IS * — —
PLOT OF VSH*YEAR SYMBOL USED IS —



YEAR	VC	VCH	CVC	PCVC
1972	84 998	81.232	-3.766	-4.431
1973	100.002	108.754	8.752	8.752
1974	129.999	181.241	51.242	39.417
1975	125.987	132 605	6.618	5 253
1976	131.001	105.378	-25.623	-19.556
1977	127.112	81 310	-45.802	-36.03
1978	85.252	97.759	12.507	14.670
1979	48.394	86 413	38.019	78.560
1980	47 242	62.615	15.373	32.541
1981	63 758	44.031	-19.727	-30 940

VALUE ADDED IN MANUFACTURING

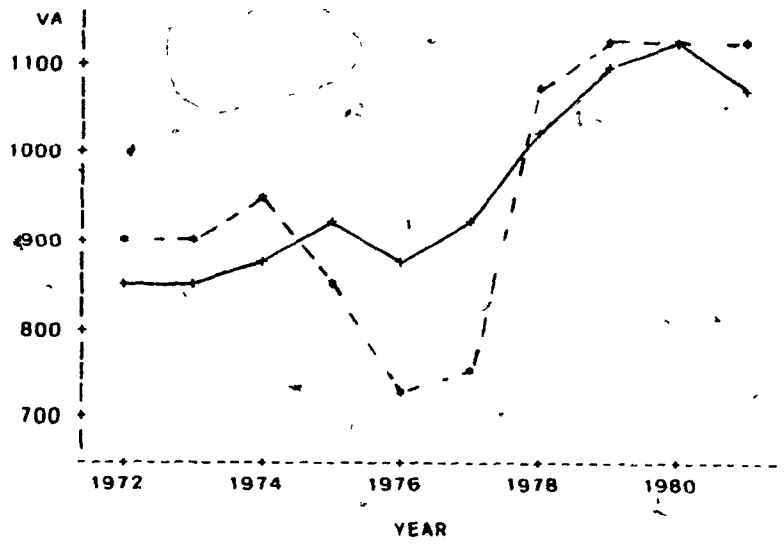
PLOT OF VM*YEAR SYMBOL USED IS ---
PLOT OF VMH*YEAR SYMBOL USED IS ———



YEAR	VM	VMH	CVM	PCVM
1972	301.393	324.818	23 425	7.772
1973	358 008	408 952	50 943	14 230
1974	355.798	506 597	150 799	42 383
1975	337.164	400 905	63 741	18.905
1976	273.002	292.021	19.019	6.967
1977	264.925	257 167	-7 758	-2.928
1978	310.672	373.041	62 369	20.075
1979	266.553	299 897	33 345	12 510
1980	275 004	270 648	-4 356	-1 584
1981	268.091	227 022	41 069	-15 319

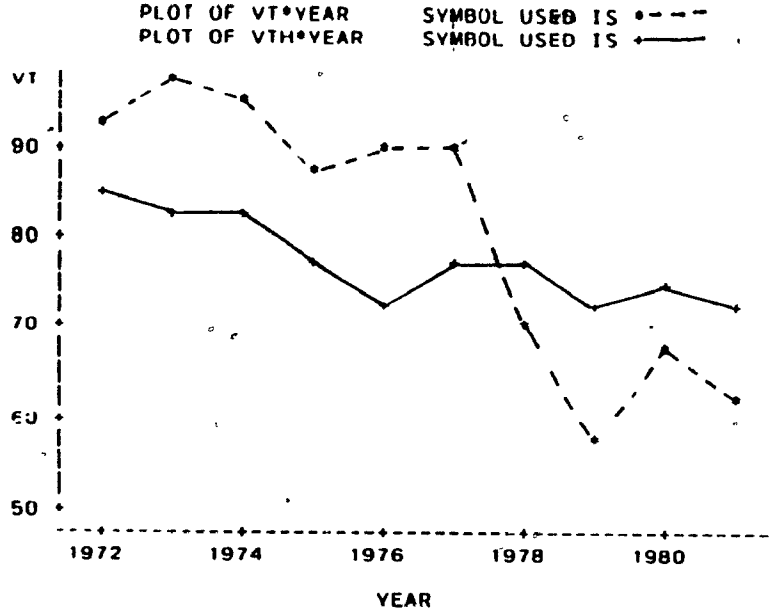
VALUE ADDED IN AGRICULTURE

PLOT OF VA*YEAR SYMBOL USED IS ---
PLOT OF VAH*YEAR SYMBOL USED IS ———



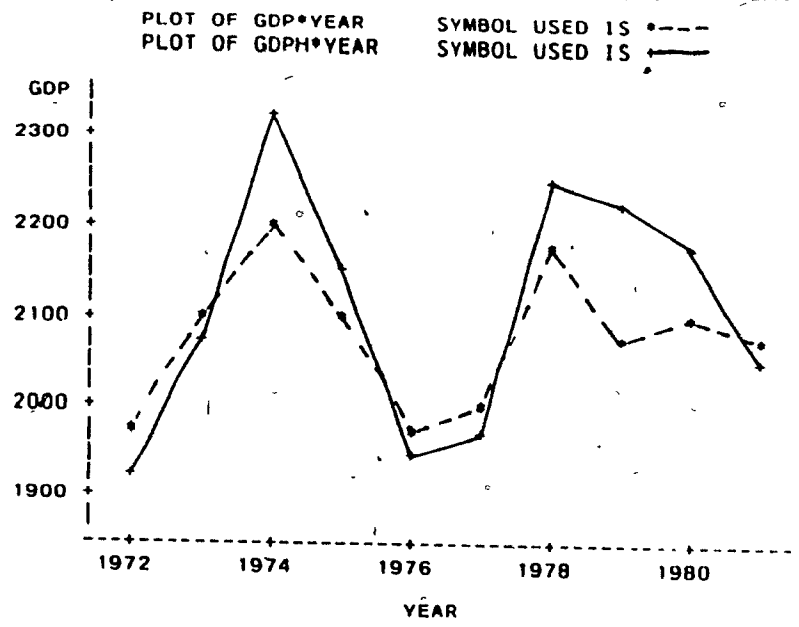
YEAR	VA	VAH	CVA	PCVA
1972	894 98	851.39	-43 588	-4.8703
1973	900.02	843.87	-56 155	-6.2393
1974	956.99	885 63	-71 360	-7.4566
1975	837.91	914 52	76 610	9.1430
1976	720.01	865 15	145 146	20 1590
1977	756.07	914.50	158.433	20.9547
1978	1070.65	1032 22	-38 430	-3.5894
1979	1135 34	1099 79	35 558	-3.1319
1980	1126 52	1112 75	-13 767	-1 2221
1981	1118 46	1065 17	-53 290	-4 7646

VALUE ADDED IN TRANSPORTATION



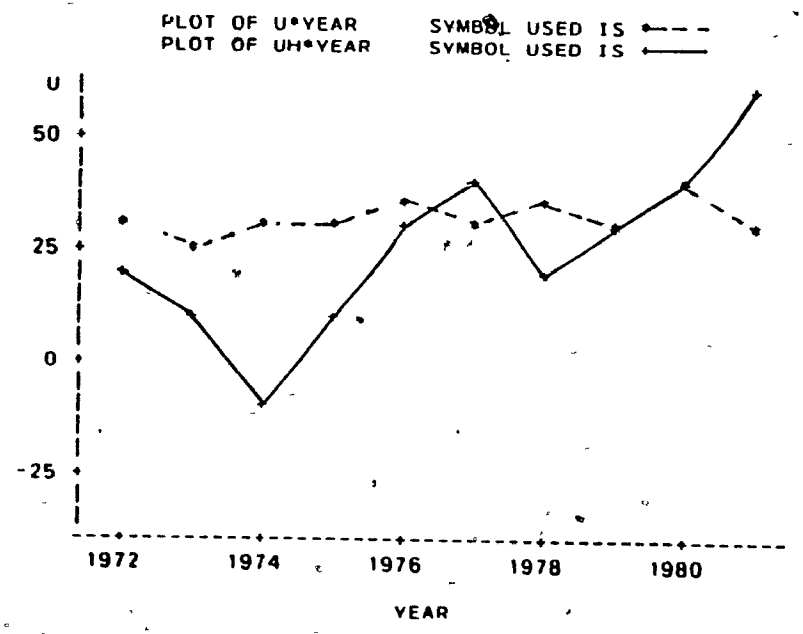
YEAR	VT	VTH	CVT	PCVT
1972	92.9980	84.8861	-8.112	-8.723
1973	98.0023	83.3653	-14.637	-14.935
1974	95.9994	82.0913	-13.908	-14.488
1975	87.9907	78.3104	-9.680	-11.001
1976	91.0007	73.0746	-17.926	-19.699
1977	90.0084	78.5719	-11.437	-12.706
1978	69.5076	77.0754	7.568	10.888
1979	57.6122	73.3040	15.692	27.237
1980	67.9828	74.3125	6.330	9 311
1981	62.6059	73.5074	10.902	17.413

GROSS DOMESTIC PRODUCT- VAUE ADDED APPROACH



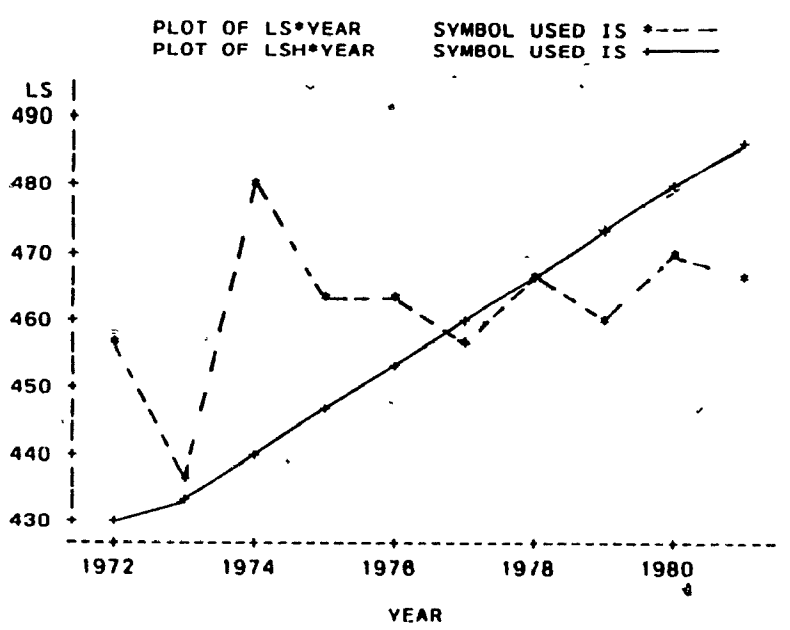
YEAR	GDP	GDPH	CGDP	PCGDP
1972	1978.36	1929.86	-48.501	-2.4516
1973	2088.15	2066.72	-21.426	-1.0261
1974	2204.09	2316.25	112.161	5.0888
1975	2098.18	2151.01	52.835	2.5182
1976	1979.02	1959.93	-19.086	-0.9644
1977	2002.19	1963.82	-38.364	-1.9161
1978	2168.18	2246.37	78.189	3.6062
1979	2087.48	2230.34	142.857	6.8435
1980	2102.86	2173.52	70 663	3 3603
1981	2065.23	2046.21	-19 016	-0 9208

NUMBER OF UNEMPLOYED PERSONS



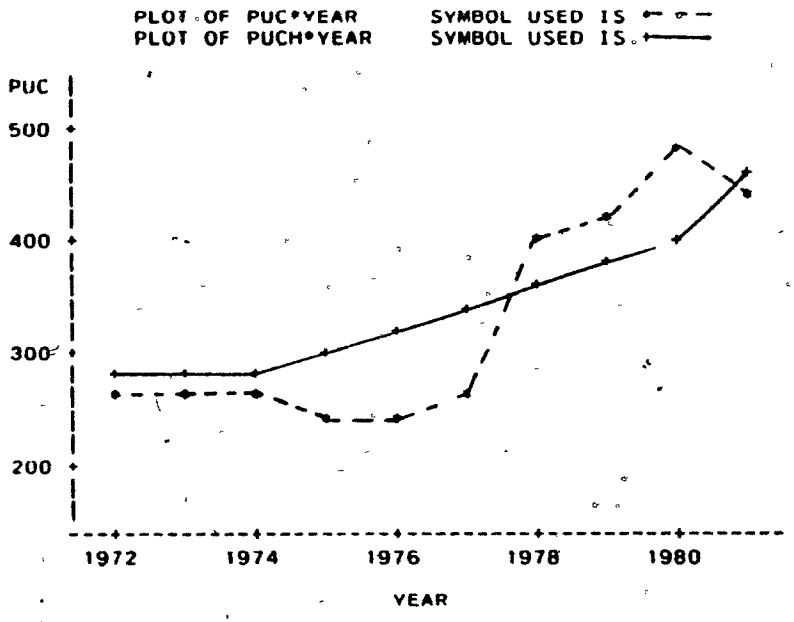
YEAR	U	UH	C2U	PCU
1972	31 737	18 0704	-13.167	-42.15
1973	26 330	10 7520	-15.578	-59.16
1974	28.292	-7.6354	-35.927	-126.99
1975	30 490	10 7291	-19.761	-64.81
1976	32.701	32.1624	-0.539	-1 65
1977	31 932	38 9315	6.999	21.92
1978	34 800	18 0056	-16.794	-48 26
1979	31 295	28 7690	-2 526	-8.07
1980	40 011	41.4464	1.435	3.59
1981	32 400	62.2335	29 834	92 08

LABOUR SUPPLY



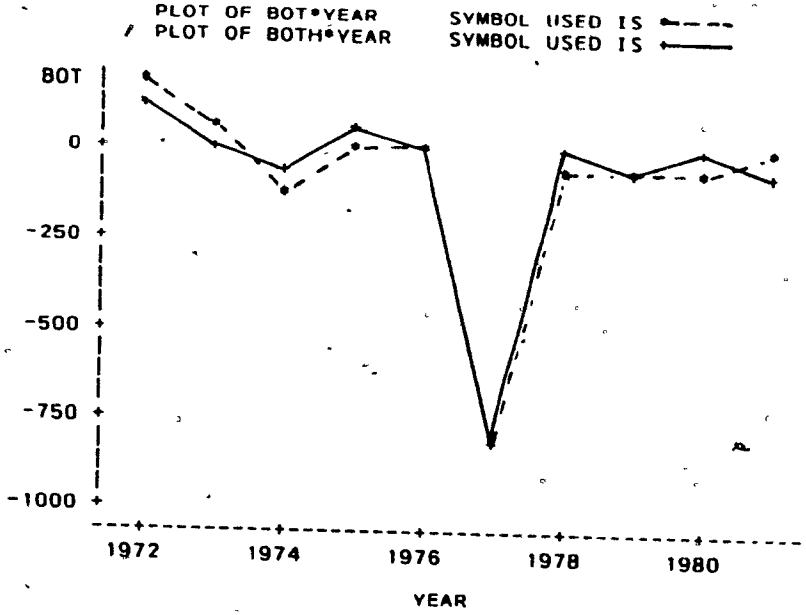
YEAR	LS	LSH	CLS	PCLS
1972	455 903	428 484	-27 419	-6 0142
1973	435.474	433 901	-1.573	-0.3611
1974	478.430	440.995	-37.435	-7 8246
1975	461 922	447 315	-14.607	-3.1622
1976	463 337	453.635	-9 702	-2.0939
1977	455.006	459.955	4.949	1 0877
1978	467.426	466 275	-1 151	-0.2462
1979	459 941	474.272	14 331	3.1158
1980	469.851	479 819	9.968	2 1214
1981	466 220	486.139	19 919	4 2724

PUBLIC CONSUMPTION



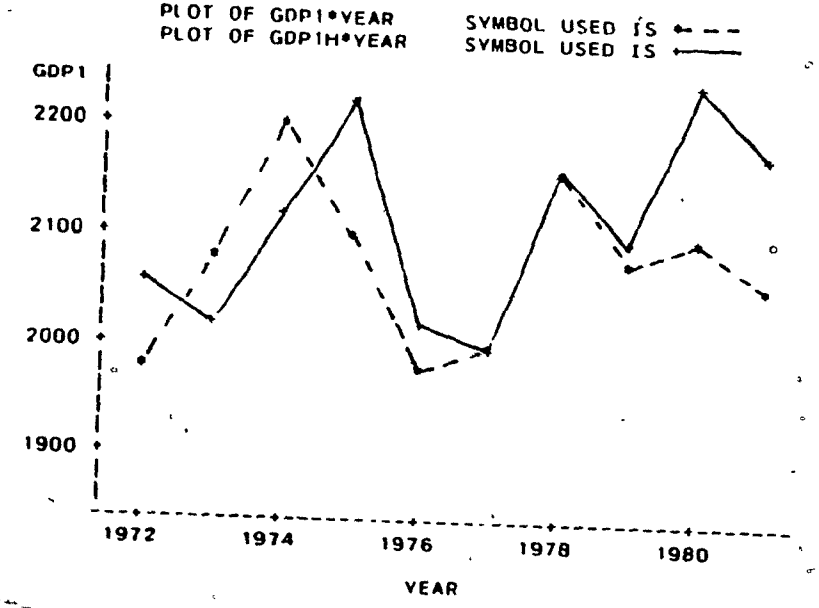
YEAR	PUC	PUCH	CPUC	PCPUC
1972	266.694	279.222	12.527	4.697
1973	263.306	282.331	19.025	7.225
1974	269.098	288.551	19.452	7.229
1975	234.975	296.745	61.770	26.288
1976	244.402	314.121	69.719	28.526
1977	254.324	332.702	78.378	30.818
1978	409.365	360.470	-48.895	-11.944
1979	417.113	376.871	-40.241	-9.648
1980	470.118	395.265	-74.853	-15.922
1981	441.698	454.777	13.079	2.961

BALANCE OF TRADE



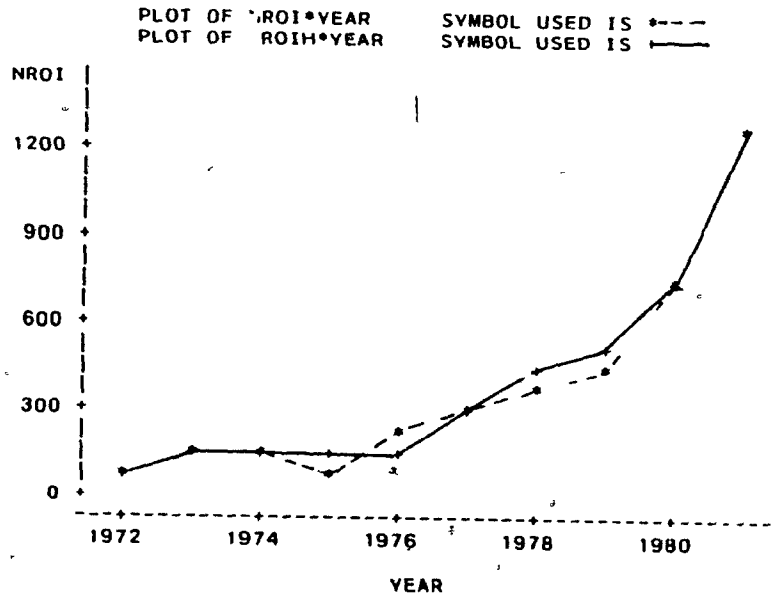
YEAR	BOT	BOTH	CBOT	PCBOT
1972	169.10	140.83	-28.263	-16.7
1973	71.90	23.34	-48.562	-67.5
1974	-94.50	-69.58	24.915	-26.4
1975	-4.00	38.41	42.405	-1060.2
1976	-14.20	-28.70	-14.502	102.1
1977	-829.48	-841.57	-12.094	1.5
1978	-53.76	1.34	55.101	-102.5
1979	-84.11	-52.40	31.711	-37.7
1980	-44.55	4.62	49.176	-110.4
1981	-14.21	-51.98	-37.765	265.7

GROSS DOMESTIC PRODUCT- AGG. DEMAND APPROACH



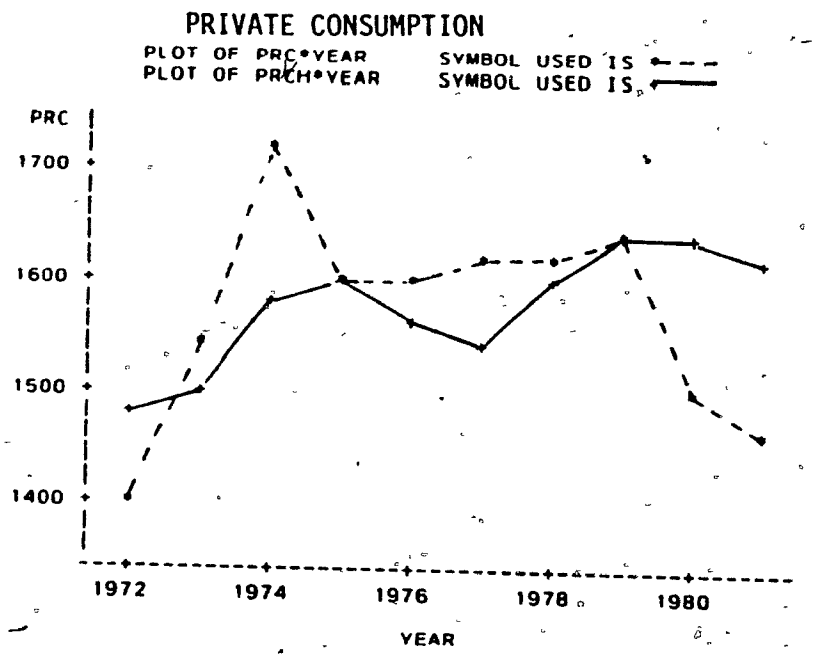
YEAR	GDP1	GDP1H	CGDP1	PCGDP1
1972	1978 36	2063 29	84 929	4.2929
1973	2088.15	2016.85	-71.300	-3.4145
1974	2204 09	2115.88	-88.203	-4.0018
1975	2098 18	2213.27	115.092	5.4853
1976	1979 07	2019.92	40.900	2.0667
1977	2002 19	1997.84	-4 343	-0.2169
1978	2168 18	2150.41	-17 762	-0.8192
1979	2087 48	2101 14	13.661	0 6544
1980	2102 86	2242 42	139 559	6 6366
1981	2065 23	2183 37	118 147	5 7208

OTHER INDIRECT TAXES (NON-COCOA)



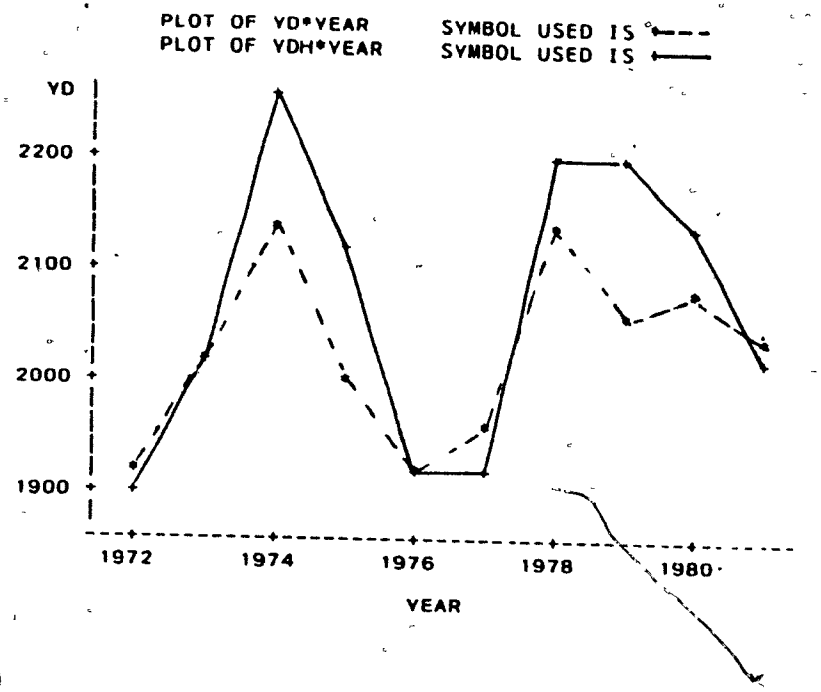
YEAR	ROI	ROIH	C ROI	PC ROI
1972	94.2	103.51	9.314	9.887
1973	118.3	114.56	-3.740	-3.162
1974	144.9	137.58	-7.318	-5.051
1975	90.3	146.80	56.502	62.571
1976	224.1	170.47	-53 632	-23.932
1977	319.9	262 79	-57.113	-17 853
1978	365.3	441.28	75 980	20 799
1979	440.2	560.08	119 880	27 233
1980	733 1	763 26	30 159	4 114
1981	1274 1	1287.98	13.875	1 089

PRIVATE CONSUMPTION



YEAR	PRC	PRCH	CPRC	PCPRC
1972	1392.27	1480.10	87.83	6.3086
1973	1549.64	1508.79	-40.85	-2.6358
1974	1721.39	1582.82	-138.57	-8.0500
1975	1599.93	1600.16	0.23	0.0142
1976	1591.61	1566.80	-24.82	-1.5593
1977	1618.65	1543.67	-74.98	-4.6323
1978	1617 11	1596.31	-20.80	-1.2863
1979	1631 58	1630.57	-1.01	-0.0617
1980	1499.08	1640.38	141.30	9.4260
1981	1453.38	1616.12	162.74	11.1975

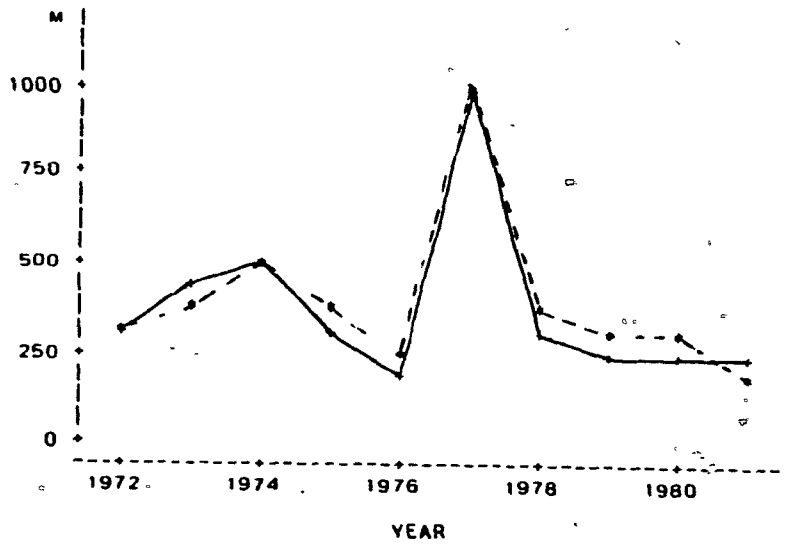
DISPOSABLE INCOME



YEAR	YD	YDH	CYD	PCYD
1972	1915.54	1895.05	-20.491	-1.0697
1973	2024.93	2025.32	0.394	0.0194
1974	2142.03	2252.21	110.181	5.1438
1975	1995.15	2114.23	119.073	5.9681
1976	1916.61	1926.02	9.414	0.4912
1977	1959.27	1924.44	-34.835	-1.7780
1978	2136.24	2209.35	73.112	3.4225
1979	2057.27	2202.61	145.337	7.0645
1980	2071.39	2146.18	74.788	3.6105
1981	2041.03	2017.26	-23.770	-1.1646

TOTAL IMPORTS

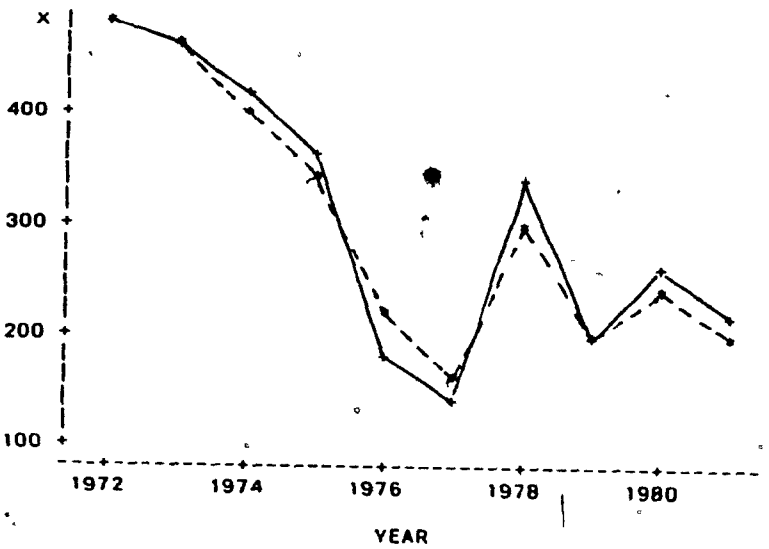
PLOT OF M*YEAR SYMBOL USED IS *- - -
PLOT OF MH*YEAR SYMBOL USED IS *———



YEAR	M	MH	CM	PCM
1972	312 393	337 555	25.161	8.054
1973	391 009	431.123	40.114	10.259
1974	498.297	491.951	-6.346	-1.274
1975	350 963	324.496	-26.467	-7.541
1976	230 702	217.027	-13.675	-5.927
1977	983.592	979 035	-4.558	-0.463
1978	349 842	343 623	-6 219	-1.778
1979	284 220	254.534	-29.686	-10.445
1980	289 983	257.883	-32.100	-11 070
1981	207 022	264 305	57.283	27.670

TOTAL EXPORTS

PLOT OF X*YEAR SYMBOL USED IS *- - -
PLOT OF XH*YEAR SYMBOL USED IS *———



YEAR	X	XH	CX	PCX
1972	481.490	478.388	-3.102	-0.8812
1973	462.911	454.464	-8.447	-1.9330
1974	403.798	422.366	18.569	3.1260
1975	346.963	362.901	15.938	1.8132
1976	216.502	188.325	-28.177	-2.2560
1977	154.114	137 463	-16 652	-0.8264
1978	296.079	344.961	48.882	1.3140
1979	200 106	202.131	2.025	0.0461
1980	245.429	262.506	17 076	0.2974
1981	192.811	212 329	19 518	0 2187

As a further check on the appropriateness of the simulation model, we have estimated the gross domestic product firstly as the sum of aggregate demand components (called GDP1), and secondly as the sum of value-added by sector (called GDP). If the model is a good representation of the real world, then these two approaches should yield reasonably close results. Table 5.3 below shows the percentage differences between simulated values of GDP and GDP1 during the sample period. The table shows that, for most of the period (except five years) gross domestic product computed from the two approaches differed by less than four percent; an indication of the overall appropriateness of the model.

TABLE 5.3

PERCENTAGE DIFFERECES BETWEEN THE TWO APPROACHES TO MEASURING GDP

Year	Percentage Difference
1972	2.46
1973	3.74
1974	-7.72
1975	1.50
1976	0.60
1977	0.03
1978	-3.50
1979	-5.91
1980	2.69
1981	5.40

5.4 *THE COMPLETE MODEL*

The complete model, including the cocoa sector sub-model is reproduced below for easy reference.

(5.49) $QSG = 148.98 + 80.44(PPTV(-3) + 1.30YCO + 2.94t$

$(2.13)^{**} \quad (3.93)^{***} \quad (.68)$

$R^2 = 0.8357 \quad \rho = .46 \quad OLS$

(5.50) $QDW = 478.64 - 0.135PL(-1) + 0.527YW - 2.85PS$

$(-5.05)^{***} \quad (10.31)^{***} \quad (-1.34)$

$R^2 = 0.8933 \quad DW = 1.74 \quad OLS$

(5.51) $LogPXCf = 2.94 + .65LogPL(-1) - .25LogQSGT(-1) + .035t + .121Dum$

$(5.85)^{***} \quad (-0.72) \quad (2.06)^{**} \quad (1.02)$

$R^2 = 0.9831 \quad DW = 2.53 \quad OLS$

(5.52) $CXS = -36.87 - 32.37PPTV + 8.70t + 49.80DUM2$

$(-1.60)^{*} \quad (4.88)^{***} \quad (2.80)^{**}$

$R^2 = 0.9583 \quad \rho = 0.29 \quad OLS$

(5.53) $logVA = 5.09 + 0.172\ logPUC + 0.117\ logXCO$

$(2.12)^{**} \quad (2.02)^{*}$

$R^2 = 0.7745 \quad \rho = 0.35 \quad OLS$

(5.54) logVM = -1.36 + 0.271 logX + 0.634 logPRC + 0.619 logMR
(2.25)** (1.52) (0.85)
R^2 = 0.8343 ρ = 0.59 2SLS

(5.55) logVC = -0.883 + .305 logGFI + 1.17 logPRC + .842 logPUC
(2.10)** (2.66)** (-3.80)***
R^2 = 0.7344 ρ = 0.49 2SLS

(5.56) logVT = 3.55 + 0.052 logX + 0.083 logM
(0.39) (1.03)
R^2 = 0.5247 ρ = 0.69 2SLS

(5.57) logVS = 4.24 + 0.0292 log(PRC+PUC)
(0.85)
R^2 = 0.8341 ρ = 0.70 2SLS

(5.58) PRC = -206.43 + .351 PRC(-1) + .605 YD
(1.98)* (3.20)***
R^2 = 0.8914 DW = 1.72 2SLS

(5.59) PUC = 9.05 + 27.86 POP + 0.007 DCR
(1.48) (1.19)
R^2 = 0.8230 ρ = 0.54 OLS

(5.60) MK = 138.04 + 0.044 FR(-1) -0.598 PM/PI
(2.14)** (-7.27)***
R^2 = 0.8701 DW = 1.69 2SLS

(5.61) MR = 100.75 + 0.090 FR(-1) - 0.733 PM/PI + 0.231 VI

(2.43)** (-4.58)*** (3.00)***

R^2 = 0.8857 ρ = 0.36 2SLS

(5.62) logRD = -1.33 + 0.727 logNGDP

(7.10)***

R^2 = 0.9528 ρ = 0.67 2SLS

(5.63) logROI = -1.95 + 0.806 logNGDP

(6.79)***

R^2 = 0.9528 ρ = 0.70 OLS

(5.64) logRM = -0.275 + 0.756 logNM

(6.76)***

R^2 = 0.9080 ρ = 0.72 OLS

(5.65) logRN = -0.680 + 0.572 logNGDP

(14.31)***

R^2 = 0.9608 ρ = 0.41 OLS

(5.66) CU = 340.61 + 0.002 NGDP - 8.09 PURB

(6.01)*** (-6.03)***

R^2 = 0.6623 ρ = 0.51 2SLS

(5.67) RS = 51.11 + 0.0005 NGDP

(2.08)**

R^2 = 0.8166 ρ = 0.69 2SLS

(5.68) NGI = -1353.89 + 6.51 PUC + 0.093 NGDP

(2.67)** (10.62)***

R^2 = 0.9852 ρ = 0.53 2SLS

(5.69) PI = 981.06 - 0.574 GDP + 0.407 MS

(-2.73)** (23.13)***

R^2 = 0.9880 ρ = 0.50 2SLS

(5.70) LS = 295.00 + 16.76 PURB

(9.78)***

R^2 = 0.8421 ρ = 0.49 OLS

Identities

(5.71) TAX = PXC - PP - CMBC

(5.72) QSGT = QSG + CXS

(5.73) CXO = QSG -CD

(5.74) XCO = (CXO)(PXC)

(5.75) RC = (CXO)(TAX)

(5.76) QSRW = QDW + CIS - QSGT

(5.77) PXC = (PXCF)(ER)

(5.78) GDP = VA +VM + VC + VT + VS

(5.79) M = MC + NK + MR

(5.80) R = RD + ROI + RM + RN + RCO + RNC

(5.81) H = FAN + NGI - NOL

(5.82) MS = [(1+CU)/(RS+CU)]

(5.83) BOT = X - M

(5.84) FR = FR(-1) + BOT + NCM

(5.85) FAN = FR + FOR - FOL

(5.86) U = LS - N

(5.87) UR = U/LS

Chapter VI

THE IMPACT OF COCOA PRICE POLICIES ON THE MACROECONOMY

6.1 *THE WORKING OF THE MODEL*

The model estimated in Chapter 5 is used to study the effects of the policy scenarios described in Chapter 4 on macroeconomic variables such as the gross domestic product, balance of trade, foreign exchange reserves, value added in various sectors and the price level.

Though the cocoa sector model is estimated separately from the rest of the economy, the interrelationships are obvious. For example, an increase in the producer price in the cocoa sector first leads to a fall in the level of smuggling, and subsequently to an increase in the official (or recorded) supply of cocoa. These in turn imply an increase in the volume of cocoa exports and hence an increase in the cocoa export tax revenue. The initial price policy, however, lowers the cocoa export tax rate. Thus a fall in the cocoa export revenue may occur if the increase in the tax base (which is cocoa exports) is not high enough to compensate for the fall for the lower tax rates.

The increased production in the cocoa sector thus produced sets several factors into motion. In the first place, it leads

directly to an increase in GDP by raising value added in the agricultural sector (or by raising total exports). Other components of GDP are also affected. The increase in export level leads initialy to an improvement in the balance of trade position, and consequently to an increase in the foreign exchange reserves. Since imports of raw material and capital goods are functions of the level of foreign exchange reserves, total imports are also positively affected, partly offsetting the gains in balance of trade and foreign exchange reserves. All the above imply an increase in private consumption, which is a function of disposable income. The manufacturing, construction, services and transportation sectors, which depend on the components of aggregate demand and foreign trade, are also positively affected.

The increase in foreign exchange reserves also affects the monetary sector. An upward pressure is exerted on the money supply, which depends on foreign assets as well as on domestic economic activity. This in turn has an upward influence on the overall price level, thus offsetting some of the economic gains mentioned above. Part of the increase in the price level, however, is mitigated by the increase in real GDP. The employment level also rises in response to the increase in GDP. Government revenue from non-cocoa sources also increase due to an expansion in the tax bases (GDP and total imports).

The six policy experiments discussed in section 1.4 and again in Chapter Four are examined in this chapter using the

macroeconometric model of Ghana constructed in the previous chapter. They are reproduced below for quick reference. rate policies as follows:

1. PE-1: A fifty percent increase in the producer price with no change in the exchange rate.
2. PE-2: A fifty percent increase in the producer price together with a change in the exchange rate to produce the same increase in PXC.
3. PE-3: A fifty percent increase in the producer price coupled with a change in the exchange rate to ensure a twenty percent increase in PXC.
4. PE-4: An increase in the producer price sufficient to maintain the real producer price in 1956 with no change in the exchange rate.
5. PE-5: An increase in the producer price sufficient to maintain the real producer price in 1956 with a corresponding change in the exchange rate to ensure an equal increase in PXC.
6. PE-6: An increase in the producer price sufficient to maintain the real producer price in 1956 with a corresponding change in the exchange rate to ensure a twenty percent increase in PXC.

The results of the policy experiments are presented in tables 6.1 to 6.12 The experiments are conducted over the last ten years of the period under study. Due to the nature of the specification of the cocoa supply relationship, there is a

three period lag before the major part of the impact is felt.[45] Thus the tables show actual and percentage deviations from the control solution from 1975 to 1981. The policy variables are changed for each of the ten years of the experiment. Except government revenue and its components, all other variables are at constant 1968 prices. As the responce of the cocoa sector to the various policies has already been examined in Chapter Four, only changes in the non-cocoa sector variables are shown.

6.2 *THE EFFECT OF A 50% INCREASE IN THE PRODUCER PRICE OF COCOA*

The first policy expeirment (PE-1), which examines the impact of a fifty percent increase in the producer price of cocoa, has the expected effect on all variables except total government revenue (R), as indicated by Tables 6.1 and 6.2 The changes produced are not very high because the increase in the producer price is not high enough to call forth a large increase in cocoa supply. Gross Domestic product shows an increase over the base solution of about one percent per year from 1975 to 1981. This amounts to a total increase of about ¢156 million during the seven-year period. The increase in GDP comes about as a result of the effect of the cocoa price policy on value added in all five production sectors. Total export earnings also rise by about ¢56 million during the seven-year period. The foreign exchange reserves and the employment level are positively

[45] see chapter three for the specification of the cocoa sector model.

affected. The unemployment rate falls by 3% in 1981 up to 15% in 1975.

One of the effects of the overall increase in the level of economic activity is an increase in the money supply, which depends on the level of economic activity as well as on total foreign reserves.[46] The increases in the money supply in turn result in higher price levels in all years except in 1975, when a negligible fall occurs. Thus, the increases in some of the variables are partially offset by a general rise in the price level.

All sources of revenue (except the cocoa export tax revenue) show increases over the control solution. These amount to about ₵200 million during the seven-year period. However, these increases are not high enough to compensate for the loss in tax revenue from the cocoa sector. Thus, government revenue falls by about 7% in 1975 and by almost 42% in 1981.

In the second experiment, the producer price is again increased by fifty percent during each of the years of the experiment, but this time the exchange rate is adjusted so as to bring about an equal increase in the export price of Ghana's cocoa in terms of the domestic currency. The results of this experiment are presented in Tables 6.3 and 6.4

Again all variables respond as expected. The changes are, however, significantly higher for PE-2 than for PE-1. Due to higher increases in the money supply, the price level is also

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[46] see section 5.2.5.

higher than in PE-1. The adjustment in the exchange rate also means that total government revenue is higher in all years than the control solution. Thus a higher level of economic activity is achieved together with an increse in tax revenue.

From Tables 6.5 and 6.6 it can be seen that the impact of experiment three is roughly the same as that of experiment two except in 1981. This is because prior to 1981, only about a 20% downward adjustment in the exchange rate is needed to raise the cocoa export price high enough to compensate for the fifty percent increase in the producer price in PE-2. In 1981 however, a ninety-five percent adjustment is required.

TABLE 6.1

RESULTS OF PE-1 - ACTUAL CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	20.871	19.591	22.814	27.709	25.13	22.51	17.7
X	Total export earnings	14.958	6.130	6.220	13.581	6.82	5.30	2.8
MK	Imports of capital goods	0.000	0.401	0.511	0.610	0.89	0.96	1.0
MR	Imports of raw material	2.344	2.263	2.585	4.013	3.76	3.82	3.2
M	Total real imports	2.344	2.664	3.095	4.622	4.65	4.78	4.2
PRC	Private consumption	4.964	8.095	11.003	14.173	15.71	16.13	15.2
VA	Value added in agriculture	8.928	8.961	10.490	8.529	8.00	5.33	3.6
VM	Value added in industry	9.364	7.032	8.110	13.270	10.92	10.91	8.7
VC	Value added in construction	1.243	1.574	1.507	2.503	2.51	2.57	1.9
VT	Value added in transport	0.208	0.185	0.205	0.228	0.22	0.16	0.1
VS	Value added in services	1.126	1.839	2.502	3.178	3.49	3.55	3.3
PI	Implicit GDP deflator	-1.970	0.457	0.523	2.366	4.03	4.58	4.7
MS	Money supply	16.776	21.457	24.964	34.605	36.06	34.70	30.0
BOT	Balance of brade	12.614	3.466	3.125	8.958	2.17	0.52	-1.4
FR	Foreign exchange reserves	12.614	16.080	19.205	28.163	30.33	30.85	29.4
N	Employed persons	1.850	1.737	2.022	2.456	2.23	2.00	1.6
UR	Unemployment rate	-0.414	-0.383	-0.440	-0.527	-0.47	-0.42	-0.3
R	Total government revenue	-64.433	-73.466	-67.992	-91.418	-213.02	-415.66	-1198.1
RM	Import taxes	0.839	1.049	0.940	1.838	2.37	2.94	2.6
ROI	Other indirect taxes	2.685	8.209	11.907	24.327	34.19	38.24	41.9
IRD	Direct taxes	0.324	0.979	1.395	2.729	3.71	4.07	4.3
RN	Non-tax revenue	0.078	0.230	0.312	0.541	0.67	0.70	0.7
	New exchange rate	2.555	2.077	2.007	2.908	5.83	6.40	5.6

TABLE 6.2

RESULTS OF PE-1 - PERCENTAGE CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	0.976	1.012	1.1979	1.269	1.1455	0.989	0.803
X	Total export earnings	1.453	0.573	0.4544	0.536	0.1709	0.097	0.032
MK	Imports of capital goods	0.000	0.471	0.4812	0.492	0.6592	0.642	0.637
MR	Imports of raw material	1.554	1.529	1.5786	1.823	1.7293	1.567	1.315
M	Total real imports	0.729	1.256	0.3194	1.370	1.8382	1.707	1.444
PRC	Private consumption	0.315	0.524	0.7264	0.907	0.9829	0.981	0.921
VA	Value added in agriculture	0.976	1.036	1.1470	0.826	0.7273	0.479	0.342
VM	Value added in industry	2.422	2.587	3.7045	3.871	3.8307	3.225	2.778
VC	Value added in construction	0.985	1.642	2.2797	2.853	3.0928	3.088	2.897
VT	Value added in transport	0.266	0.253	0.2614	0.296	0.2959	0.216	0.161
VS	Value added in services	0.178	0.292	0.3994	0.494	0.5331	0.530	0.484
PI	Implicit GDP deflator	-0.556	0.100	0.0860	0.230	0.2400	0.208	0.140
MS	Money supply	1.225	1.504	1.4029	1.112	0.7603	0.567	0.336
BOT	Balance of brade	30.373	-14.571	-0.3757	116.983	-4.2735	-2.973	1.834
FR	Foreign exchange reserves	7.391	14.631	11.3813	5.989	3.5629	4.628	6.286
N	Employed persons	0.425	0.414	0.4864	0.555	0.5037	0.446	0.358
UR	Unemployment rate	-15.654	-5.055	-4.5765	-10 391	-6 9596	-6.193	-3.233
R	Total government revenue	-7.881	-11.539	-5.5790	-4.951	-8.9650	-15.268	-41.615
RM	Import taxes	0.576	0.992	0.2524	1.082	1.4505	1.347	1.140
ROI	Other indirect taxes	1.829	4.815	4.5309	5.513	6.1045	5.011	3.254
RD	Direct taxes	0.262	0.672	0.6301	0.754	0.8150	0.667	0.438
RN	Non-tax revenue	0.117	0.303	0.2989	0.356	0.3709	0.308	0.211
	New exchange rate	2.555	2.077	2.0072	2.908	5.8350	6.398	5.577

TABLE 6.3

RESULTS OF PE-2 - ACTUAL CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	92.487	94.435	85.898	102.650	99.885	127.977	268.167
X	Total export earnings	45.933	25.171	19.394	40.244	24.903	38.925	103.967
MK	Imports of capital goods	2.743	3.646	3.889	3.978	4.574	4.694	5.128
MR	Imports of raw material	14.750	13.875	12.698	17.502	16.531	20.559	35.527
M	Total real imports	17.493	17.521	16.586	21.479	21.105	25.253	40.655
PRC	Private consumption	44.179	53.209	57.304	63.937	67.677	76.920	116.776
VA	Value added in agriculture	25.743	33.397	30.357	24.011	27.485	35.631	100.193
VM	Value added in industry	44.622	37.460	33.806	51.922	45.417	61.779	124.920
VC	Value added in construction	11.361	10.671	8.107	11.674	11.174	12.763	15.617
VT	Value added in transport	0.773	0.868	0.651	0.766	0.838	0.975	2.250
VS	Value added in services	9.991	12.040	12.977	14.279	14.973	16.829	25.185
PI	Implicit GDP deflator	22.926	26.439	29.785	28.478	29.130	19.740	-19.870
MS	Money supply	152.708	163.427	162.852	176.994	175.741	181.643	229.038
BOT	Balance of brade	28.440	7.650	2.807	18.765	3.798	13.671	63.312
FR	Foreign exchange reserves	114.822	122.472	125.279	144.044	147.842	161.513	224.826
N	Employed persons	8.198	8.371	7.614	9.099	8.854	11.344	23.770
UR	Unemployment rate	-1.833	-1.845	-1.655	-1.951	-1.867	-2.364	-4.890
R	Total government revenue	112.401	107.001	125.769	186.908	233.125	274.663	588.561
RM	Import taxes	6.230	6.852	5.032	8.498	10.689	15.434	25.395
ROI	Other indirect taxes	71.221	80.183	88.676	122.541	156.168	208.628	507.461
RD	Direct taxes	8.553	9.533	10.361	13.718	16.928	22.162	52.458
RN	Non-tax revenue	2.051	2.223	2.302	2.704	3.049	3.772	8.274
	New exchange rate	2.953	2.589	2.378	3.272	6.712	7.895	10.952

TABLE 6.4

RESULTS OF PE-3 - PERCENTAGE CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	4.324	4.880	4.510	4.703	4.553	5.619	12.180
X	Total export earnings	4.462	2.354	1.417	1.589	0.624	0.716	1.187
MK	Imports of capital goods	4.329	4.289	3.665	3.211	3.372	3.130	3.337
MR	Imports of raw material	9.775	9.373	7.755	7.950	7.612	8.440	14.619
M	Total real imports	5.443	8.260	1.711	6.368	8.344	9.019	14.055
PRC	Private consumption	2.805	3.446	3.783	4.094	4.234	4.681	7.055
VA	Value added in agriculture	2.815	3.860	3.320	2.326	2.499	3.202	9.406
VM	Value added in industry	11.541	13.781	15.442	15.144	15.936	18.268	39.976
VC	Value added in construction	8.998	11.128	12.260	13.310	13.786	15.311	23.651
VT	Value added in transport	0.988	1.190	0.829	0.995	1.144	1.305	3.044
VS	Value added in services	1.578	1.913	2.071	2.221	2.287	2.517	3.682
PI	Implicit GDP deflator	6.471	5.795	4.899	2.771	1.733	0.898	-0.590
MS	Money supply	11.154	11.455	9.151	5.687	3.705	2.971	2.566
BOT	Balance of brade	68.481	-32.160	-0.337	245.045	-7.476	-78.169	-82.303
FR	Foreign exchange reserves	67.281	111.438	74.244	30.632	17.365	24.227	48.001
N	Employed persons	1.882	1.996	1.831	2.056	2.002	2.534	5.431
UR	Unemployment rate	-69.370	-24.366	-17.231	-38.492	-27.662	-35.200	-49.060
R	Total government revenue	13.747	16.807	10.320	10.122	9.811	10.089	20.443
RM	Import taxes	4.280	6.476	1.351	5.002	6.541	7.066	10.958
ROI	Other indirect taxes	48.515	47.037	33.744	27.770	27.883	27.334	39.400
RD	Direct taxes	6.933	6.547	4.681	3.789	3.717	3.633	5.282
RN	Non-tax revenue	3.057	2.928	2.204	1.779	1.684	1.667	2.520
	New exchange rate	2.953	2.589	2.378	3.272	6.712	7.895	10.952

TABLE 6.5

RESULTS OF PE-3 - ACTUAL CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	98.081	94.718	96.734	117.096	124.163	121.340	114.08
X	Total export earnings	50.395	24.898	23.391	49.103	34.561	31.086	23.94
MK	Imports of capital goods	2.727	3.752	3.977	4.156	4.965	5.282	5.44
MR	Imports of raw material	15.399	14.056	13.776	19.475	19.614	20.837	19.37
M	Total real imports	18.127	17.808	17.753	23.631	24.579	26.119	24.81
PRC	Private consumption	45.383	54.118	60.504	69.587	77.352	81.944	83.30
VA	Value added in agriculture	28.005	33.077	35.862	28.830	37.023	29.041	29.09
VM	Value added in industry	47.309	37.668	37.829	59.089	56.124	59.858	55.25
VC	Value added in construction	11.680	10.860	8.578	12.753	12.853	13.640	10.91
VT	Value added in transport	0.829	0.869	0.765	0.891	1.065	0.880	0.82
VS	Value added in services	10.262	12.245	13.698	15.534	17.100	17.921	18.01
PI	Implicit GDP deflator	22.377	27.821	28.191	28.538	27.840	26.974	22.33
MS	Money supply	157.152	167.138	170.148	192.131	197.736	192.663	173.63
BOT	Balance of brade	32.269	7.090	5.638	25.472	9.982	4.968	-0.87
FR	Foreign exchange reserves	118.164	125.253	130.892	156.363	166.345	171.313	170.44
N	Employed persons	8.694	8.396	8.574	10.379	11.006	10.755	10.11
UR	Unemployment rate	-1.944	-1.851	-1.864	-2.226	-2.321	-2.242	-2.08
R	Total government revenue	126.553	108.382	160.140	253.013	420.804	165.742	-677.57
RM	Import taxes	6.455	6.963	5.386	9.344	12.432	15.958	15.58
ROI	Other indirect taxes	71.963	82.599	91.613	133.535	181.660	210.285	260.11
RD	Direct taxes	8.641	9.819	10.703	14.945	19.684	22.338	26.94
RN	Non-tax revenue	2.072	2.289	2.377	2.944	3.542	3.802	4.27
	New exchange rate	3.008	2.580	2.491	3.391	7.167	7.554	6.71

TABLE 6.6

RESULTS OF PE-3 - PERCENTAGE CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	4.586	4.894	5.079	5.364	5.660	5.328	5.182
X	Total export earnings	4.896	2.329	1.709	1.939	0.866	0.572	0.273
MK	Imports of capital goods	4.305	4.414	3.748	3.355	3.660	3.522	3.540
MR	Imports of raw material	10.205	9.495	8.413	8.847	9.032	8.554	7.972
M	Total real imports	5.640	8.396	1.832	7.006	9.717	9.328	8.578
PRC	Private consumption	2.882	3.505	3.994	4.456	4.839	4.986	5.032
VA	Value added in agriculture	3.062	3.823	3.922	2.793	3.366	2.610	2.731
VM	Value added in industry	12.236	13.858	17.280	17.235	19.693	17.700	17.681
VC	Value added in construction	9.251	11.325	12.973	14.541	15.857	16.363	16.521
VT	Value added in transport	1.059	1.191	0.975	1.158	1.454	1.178	1.106
VS	Value added in services	1.621	1.946	2.187	2.416	2.612	2.681	2.633
PI	Implicit GDP deflator	6.316	6.097	4.637	2.777	1.656	1.227	0.663
MS	Money supply	11.479	11.715	9.561	6.173	4.169	3.151	1.945
BOT	Balance of brade	77.699	-29.806	-0.678	332.628	-19.647	-28.403	1.137
FR	Foreign exchange reserves	69.239	113.969	77.570	33.252	19.538	25.697	36.389
N	Employed persons	1.996	2.002	2.062	2.345	2.488	2.403	2.310
UR	Unemployment rate	-73.566	-24.439	-19.405	-43.910	-34.386	-33.374	-20.871
R	Total government revenue	15.478	17.024	13.140	13.701	17.709	6.088	-23.535
RM	Import taxes	4.434	6.582	1.445	5.500	7.608	7.306	6.724
ROI	Other indirect taxes	49.020	48.454	34.862	30.261	32.435	27.551	20.195
RD	Direct taxes	7.005	6.743	4.835	4.129	4.322	3.662	2.712
RN	Non-tax revenue	3.089	3.015	2.276	1.937	1.956	1.680	1.300
	New exchange rate	3.008	2.580	2.491	3.391	7.167	7.554	6.708

6.3 *THE EFFECT OF CONSTANT REAL PRODUCER PRICES*

The results of the effect of an increase in the nominal producer price so as to maintain the real producer price in 1956 are presented in tables 6.7 to 6.12 Though GDP and many of the variables above respond positively in experiments four and six (PE-4 and PE-6 respectively), they are clearly not viable due to the large short-falls in total government revenue. Despite gains by some components of government revenue, they are not high enough to compensate for the fall in the cocoa export revenue.

Policy experiment five, however produces the expected results for all variables of interest. GDP is between 5% and 22% higher than the control solution during the seven years of experiment, while total exports show increases between 23% and 43% during the same years. Other variables register similar changes.

The results of the six policy experiments indicate that significant changes in the variables of interest can result by following different cocoa producer price policies than those followed by the government from 1972 to 1981. The changes in the producer price required to achieve the results are not excessive. They require that the producer price be adjusted annually, such that they remain constant in real terms at the price offered in 1956. However, there is an indication that these policies result in losses in tax revenue by the government. Thus, adjustments in the exchange rate are required to make the policies viable.

TABLE 6.7

RESULTS OF PE-4 - ACTUAL CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	66.70	57.40	67.6	85.0	115.0	157.4	123.6
X	Total export earnings	49.92	18.31	19.1	42.7	39.9	60.5	29.8
MK	Imports of capital goods	0.00	1.34	1.7	2.0	2.9	3.5	4.6
MR	Imports of raw material	7.66	6.98	8.0	12.6	15.6	22.2	19.4
M	Total real imports	7.66	8.33	9.7	14.5	18.5	25.8	24.0
PRC	Private consumption	15.89	24.68	33.1	43.1	57.0	76.6	81.9
VA	Value added in agriculture	27.77	25.11	30.0	25.4	42.0	52.5	35.5
VM	Value added in industry	30.65	21.29	24.9	41.5	49.9	74.1	58.7
VC	Value added in construction	4.01	4.85	4.6	7.8	9.3	12.7	10.7
VT	Value added in transport	0.67	0.55	0.6	0.7	1.1	1.3	0.9
VS	Value added in services	3.60	5.60	7.5	9.6	12.6	16.8	17.7
PI	Implicit GDP deflator	-5.25	4.11	4.1	9.0	5.3	0.4	10.7
MS	Money supply	56.21	69.72	80.2	110.5	132.3	164.2	154.7
BOT	Balance of brade	42.27	9.98	9.5	28.2	21.4	34.7	5.8
FR	Foreign exchange reserves	42.27	52.25	61.7	89.9	111.3	146.0	151.8
N	Employed persons	5.91	5.09	6.0	7.5	10.2	13.9	11.0
UR	Unemployment rate	-1.32	-1.12	-1.3	-1.6	-2.1	-2.9	-2.3
R	Total government revenue	-248.72	-546.14	-1208.6	-1830.8	-2797.3	-4813.2	-8020.8
RM	Import taxes	2.74	3.27	2.9	5.8	9.4	15.8	15.1
ROI	Other indirect taxes	10.31	28.64	39.2	77.6	136.8	220.0	263.1
RD	Direct taxes	1.24	3.41	4.6	8.7	14.8	23.4	27.2
RN	Non-tax revenue	0.30	0.80	1.0	1.7	2.7	4.0	4.3
	New exchange rate	2.55	2.08	2.0	2.9	5.8	6.4	5.6

TABLE 6.8

RESULTS OF PE-4 - PERCENTAGE CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	3.118	2.966	3.551	3.895	5.24	6.9:	5.61
X	Total export earnings	4.850	1.713	1.399	1.688	1.00	1.11	0.34
MK	Imports of capital goods	0.000	1.579	1.563	1.582	2.11	2.36	3.02
MR	Imports of raw material	5.074	4.718	4.889	5.717	7.20	9.13	7.98
M	Total real imports	2.382	3.925	0.997	4.312	7.31	9.21	8.30
PRC	Private consumption	1.009	1.598	2.186	2.757	3.56	4.66	4.95
VA	Value added in agriculture	3.036	2.902	3.282	2.460	3.82	4.72	3.33
VM	Value added in industry	7.928	7.834	11.367	12.116	17.52	21.91	18.79
VC	Value added in construction	3.175	5.062	6.968	8.839	11.53	15.25	16.23
VT	Value added in transport	0.854	0.751	0.775	0.906	1.43	1.70	1.23
VS	Value added in services	0.569	0.890	1.200	1.498	1.93	2.51	2.59
PI	Implicit GDP deflator	-1.481	0.900	0.670	0.877	0.31	0.02	0.32
MS	Money supply	4.106	4.887	4.509	3.551	2.79	2.69	1.73
BOT	Balance of brade	101.771	-41.974	-1.140	368.309	-42.11	-198.27	-7.55
FR	Foreign exchange reserves	24.766	47.543	36.585	19.126	13.08	21.90	32.41
N	Employed persons	1.357	1.214	1.442	1.702	2.30	3.12	2.50
UR	Unemployment rate	-50.025	-14.811	-13.566	-31.879	-31.85	-43.28	-22.60
R	Total government revenue	-30.421	-85.782	-99.174	-99.142	-117.72	-176.81	-278.60
RM	Import taxes	1.879	3.091	0.788	3.394	5.73	7.21	6.51
ROI	Other indirect taxes	7.021	16.800	14.933	17.587	24.42	28.83	20.43
RD	Direct taxes	1.006	2.343	2.075	2.402	3.26	3.83	2.74
RN	Non-tax revenue	0.447	1.054	0.981	1.130	1.48	1.76	1.32
	New exchange rate	2.555	2.077	2.007	2.908	5.83	6.40	5.58

TABLE 6.9

RESULTS OF PE-5 - ACTUAL CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	298.246	388.579	505.079	703.840	717.40	1080.78	1759.99
X	Total export earnings	161.330	141.288	187.595	380.923	224.80	400.93	675.23
MK	Imports of capital goods	8.721	11.995	14.255	17.439	25.18	27.58	33.45
MR	Imports of raw material	49.511	58.115	73.050	119.737	123.99	188.60	307.57
M	Total real imports	58.233	70.110	87.304	137.176	149.17	216.18	341.02
PRC	Private consumption	136.999	187.815	250.274	340.330	404.66	535.41	787.16
VA	Value added in agriculture	75.002	127.851	171.005	148.884	161.83	210.93	316.44
VM	Value added in industry	152.630	173.883	233.757	401.327	380.39	632.56	1115.59
VC	Value added in construction	37.451	41.207	40.336	74.352	82.63	117.27	155.73
VT	Value added in transport	2.425	3.624	4.215	4.924	5.31	6.75	10.01
VS	Value added in services	30.738	42.016	55.766	74.354	87.24	113.28	162.22
PI	Implicit GDP deflator	77.962	79.149	76.732	98.629	116.44	25.58	-166.61
MS	Money supply	502.422	599.083	713.970	974.389	1032.54	1184.65	1413.58
BOT	Balance of brade	103.097	71.178	100.291	243.747	75.63	184.74	334.21
FR	Foreign exchange reserves	377.775	448.953	549.244	792.991	868.63	1053.37	1387.58
N	Employed persons	26.436	34.443	44.769	62.387	63.59	95.80	156.00
UR	Unemployment rate	-5.910	-7.593	-9.733	-13.380	-13.41	-19.97	-32.09
R	Total government revenue	380.842	385.020	520.198	971.934	1458.12	2094.78	3517.65
RM	Import taxes	20.486	26.800	26.294	52.616	72.34	124.95	197.26
ROI	Other indirect taxes	246.278	293.463	382.783	706.434	1003.61	1518.77	3016.97
RD	Direct taxes	29.345	34.601	44.318	78.266	107.70	159.45	307.15
RN	Non-tax revenue	6.887	7.885	9.599	14.988	18.87	26.27	46.45
	New exchange rate	3.816	4.978	6.040	6.966	13.27	18.37	33.80

TABLE 6.10

RESULTS OF PE-5 - PERCENTAGE CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	13.95	20.08	26.52	32.24	32.70	47.5	79.94
X	Total export earnings	15.67	13.21	13.70	15.04	5.63	7.4	7.71
MK	Imports of capital goods	13.77	14.11	13.43	14.08	18.56	18.4	21.76
MR	Imports of raw material	32.81	39.26	44.61	54.39	57.10	77.4	126.56
M	Total real imports	18.12	33.05	9.01	40.67	58.97	77.2	117.90
PRC	Private consumption	8.70	12.16	16.52	21.79	25.32	32.6	47.55
VA	Value added in agriculture	8.20	14.78	18.70	14.42	14.71	19.0	29.71
VM	Value added in industry	39.48	63.97	106.78	117.06	133.47	187.0	357.00
VC	Value added in construction	29.66	42.97	61.00	84.77	101.94	140.7	235.86
VT	Value added in transport	3.10	4.97	5.37	6.40	7.24	9.0	13.53
VS	Value added in services	4.86	6.68	8.90	11.56	13.33	16.9	23.71
PI	Implicit GDP deflator	22.01	17.35	12.62	9.60	6.93	1.2	-4.95
MS	Money supply	36.70	41.99	40.12	31.31	21.77	19.4	15.84
BOT	Balance of brade	248.25	-299.24	-12.06	3183.05	-148.86	-1056.3	-434.46
FR	Foreign exchange reserves	221.36	408.51	325.50	168.64	102.03	158.0	296.26
N	Employed persons	6.07	8.21	10.77	14.09	14.38	21.4	35.64
UR	Unemployment rate	-223.70	-100.26	-101.32	-263.93	-198.68	-297.3	-321.98
R	Total government revenue	46.58	60.48	42.68	52.63	61.36	76.9	122.18
RM	Import taxes	14.07	25.33	7.06	30.97	44.27	57.2	85.11
ROI	Other indirect taxes	167.76	172.15	145.66	160.09	179.19	199.0	234.24
RD	Direct taxes	23.79	23.76	20.02	21.62	23.65	26.1	30.93
RN	Non-tax revenue	10.27	10.38	9.19	9.86	10.42	11.6	14.14
	New exchange rate	3.82	4.98	6.04	6.97	13.27	18.4	33.80

TABLE 6.1

RESULTS OF PE-6 - ACTUAL CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	148.154	137.57	147.67	183.4	227.5	276.4	239.9
X	Total export earnings	90.830	40.13	39.53	83.4	74.8	95.7	57.1
MK	Imports of capital goods	2.727	4.84	5.33	5.8	7.3	8.3	9.7
MR	Imports of raw material	21.555	19.78	20.42	29.9	34.3	43.5	39.7
M	Total real imports	24.282	24.62	25.75	35.7	41.6	51.9	49.4
PRC	Private consumption	57.350	72.64	85.43	102.6	124.7	151.4	160.9
VA	Value added in agriculture	46.983	49.85	56.12	46.2	71.8	77.0	62.3
VM	Value added in industry	72.022	55.27	58.70	93.7	104.9	138.0	119.2
VC	Value added in construction	14.878	14.76	12.32	19.2	21.4	26.3	22.1
VT	Value added in transport	1.322	1.28	1.22	1.4	2.0	2.1	1.7
VS	Value added in services	12.955	16.41	19.30	22.8	27.5	32.9	34.6
PI	Implicit GDP deflator	19.806	32.88	33.54	37.0	30.8	23.4	28.7
MS	Money supply	202.741	224.12	236.23	281.9	312.2	344.7	320.0
BOT	Balance of brade	66.547	15.51	13.77	47.7	33.2	43.9	7.7
FR	Foreign exchange reserves	152.442	167.96	181.73	229.4	262.6	306.5	314.2
N	Employed persons	13.132	12.19	13.09	16.3	20.2	24.5	21.3
UR	Unemployment rate	-2.936	-2.69	-2.85	-3.5	-4.3	-5.1	-4.4
R	Total government revenue	-35.119	-338.47	-937.10	-1430.4	-1990.1	-4000.0	-7330.7
RM	Import taxes	8.630	9.60	7.81	14.1	20.9	31.4	30.8
ROI	Other indirect taxes	82.877	108.20	125.76	197.7	302.7	421.4	521.7
RD	Direct taxes	9.947	12.85	14.68	22.1	32.7	44.7	53.9
RN	Non-tax revenue	2.382	2.99	3.25	4.3	5.9	7.6	8.5
	New exchange rate	3.008	2.59	2.50	3.4	7.2	7.6	6.8

TABLE 6.12

RESULTS OF PE-6 - PERCENTAGE CHANGES

		1975	1976	1977	1978	1979	1980	1981
GDP	Gross domestic product	6.93	7.109	7.753	8.401	10.371	12.14	10.90
X	Total export earnings	8.82	3.753	2.887	3.293	1.874	1.76	0.65
MK	Imports of capital goods	4.30	5.695	5.026	4.658	5.371	5.56	6.33
MR	Imports of raw material	14.28	13.359	12.471	13.597	15.798	17.87	16.33
M	Total real imports	7.56	11.606	2.657	10.585	16.443	18.52	17.09
PRC	Private consumption	3.64	4.704	5.640	6.567	7.799	9.21	9.72
VA	Value added in agriculture	5.14	5.762	6.137	4.477	6.528	6.92	5.85
VM	Value added in industry	18.63	20.332	26.814	27.333	36.819	40.82	38.15
VC	Value added in construction	11.78	15.392	18.633	21.905	26.348	31.58	33.49
VT	Value added in transport	1.69	1.759	1.553	1.829	2.709	2.80	2.32
VS	Value added in services	2.05	2.607	3.081	3.550	4.193	4.93	5.06
PI	Implicit GDP deflator	5.59	7.206	5.516	3.603	1.830	1.06	0.85
MS	Money supply	14.81	15.709	13.275	9.058	6.582	5.64	3.59
BOT	Balance of brade	160.24	-65.220	-1.656	623.046	-65.315	-250.79	-9.97
FR	Foreign exchange reserves	89.32	152.824	107.698	48.792	30.847	45.97	67.07
N	Employed persons	3.02	2.908	3.148	3.672	4.560	5.47	4.86
UR	Unemployment rate	-111.12	-35.495	-29.623	-68.763	-63.009	-76.03	-43.89
R	Total government revenue	-4.30	-53.164	-76.892	-77.460	-83.751	-146.93	-254.63
RM	Import taxes	5.93	9.070	2.095	8.280	12.791	14.38	13.28
ROI	Other indirect taxes	56.46	63.473	47.857	44.791	54.039	55.21	40.51
RD	Direct taxes	8.06	8.824	6.630	6.104	7.190	7.32	5.43
RN	Non-tax revenue	3.55	3.933	3.111	2.854	3.240	3.34	2.59
	New exchange rate	3.01	2.590	2.500	3.401	7.189	7.59	6.75

Chapter VII

SUMMARY AND CONCLUSIONS

7.1 *SUMMARY*

The objective of this thesis was to examine the impact of agricultural pricing policies on various economic aggregates in developing countries. Chapter One discussed the importance of the agricultural sector in the economic development of LDC's. Various indicators were used to show that over the period of 1956-1981, agriculture has contributed significantly to gross domestic product, exports and employment in developing countries. For low income countries, agriculture accounts for about 40% and 50% of GDP and total exports respectively during the period of study, while it employs 70% of the labour force. The importance is even greater for sub-Sahara Africa. Despite its important role, the growth rate of agriculture has declined from 4.3% per annum between. 1965 and 1970 to 2.4% per annum between 1970 and 1981. For Sub-Saharan Africa, the figures are 2.4% and 1.4% respectively.

A review of previous studies has indicated the widespread existence of adverse pricing policies in the agricultural sectors of many developing countries. Due to the desire of many

LDC's during the immediate post-independence era to modernize their economies, agriculture has suffered considerably, as the sector was heavily taxed to finance the manufacturing industries. Most of the studies were conducted within a partial equilibrium framework (using the concept of consumers' and producers' surplus).

Cocoa pricing in Ghana was chosen as a case study for evaluating the impact of alternative pricing policies because it provided an ideal case of heavy dependence on agriculture, declining GDP and agricultural growth and heavy taxation in the the cocoa sector. Furthermore, it was shown that the cocoa sector contributed significantly to GDP, exports and employment during the 26-year period.

Chapter Two presented a summary of the sources of data used and the estimation methods. In chapter Three, a model was constructed for the cocoa sector in Ghana. Supply, demand, export price and smuggling relationships were estimated for the cocoa industry, in addition to several identities determining export tax rate and revenue, cocoa exports, etc. Ahistorical simulation of the cocoa sector model indicated a reasonably good tracking ability. Chapter Four examined the impact of various policy scenarios on output, tax revenue, and the level of smuggling in the cocoa sector. The findings of this chapter indicate that an increase in the producer price of cocoa would lead to an increase in the level of cocoa production, while the level of smuggling would fall. The level of government revenue

fell, however, in all the policy experiments except those in which the exchange rate was adjusted to compensate for the fall in the tax rate.

A macroeconometric model, consisting of 18 behavioral equations (excluding the cocoa sector) and several identities, was constructed for the Ghanaian economy to examine the impact of the cocoa price policies on the rest of the economy. Most of the relationships provided good tracking abilities. The results of the policy experiments in Chapter Six Shows higher levels of GDP, exports, imports, value added in all sectors, employment level, foreign exchange reserves etc., in response to an increase in the producer price of cocoa. Due to an increase in the general tax base, there was an increase in non-cocoa tax revenues to partially offset the fall in the cocoa tax revenue. Again, if the producer price policy is combined with an exchange rate policy, total government revenue also increased. However, some of the gains mentioned above were achieved at the expense of a higher price level due to the increase in the money supply.

7.2 *CONCLUSIONS AND RECOMMENDATIONS*

This study confirms the presently held belief among development economists that the agricultural sectors in developing countries are heavily taxed and that this has been partly responsible for the dismal performance of the economies of many developing countries. Using Ghana as a case study it is clear

that the cocoa sector in particular and the economy as a whole can benefit from a lowering of the cocoa export tax rate. Many economic variables including the gross domestic product, the balance of payments and the foreign exchange reserves responded positively to a lower cocoa export tax rate. There is also an indication that the level of snuggling would fall with a fall in the cocoa export tax rate since farmers' expected profit margin from smuggling activities would fall considerably.

However, the study indicates that these price policies cannot be pursued without an accompanying exchange rate policy. Since the government relies heavily on the cocoa sector for its revenue, any lowering of the export tax rate would result in considerable loss of revenue. This is probably the main reason why past governments have been reluctant to increase the cocoa producer price. However, since the cedi is heavily overvalued (as is evidenced by the difference between the official and black market exchange rates), the results suggest that the government can avoid any losses by periodic devaluations of the cedi. A rise in the general price level is likely to accompany the policy actions, but the disadvantages of this rise are likely to be outweighed by the advantages to be derived from a general increase in the level of economic activity.

Of course the study has its draw backs. The accuracy of the results depend to a large degree on the assumptions underlying the construction of the macroeconometric model. The cocoa supply relationship, for example, may not in fact be

correct and the approach used in determining the level of smuggling may not be appropriate. Furthermore all other relationships were estimated under various assumptions, which may not hold. This is true, however, for all economic studies. What the study does provide is a framework for studying the effects of agricultural pricing policies on other sectors of the economy in a developing country. It gives a rough idea of the extent of the quantitative impact of alternative pricing policies, and hence a guidance to policy makers who are reluctant to pursue such policies because they do not know what the results would be.

The results are, however, tentative and hence must be interpreted with care. For example, they cannot be used for forecasting for purposes of policy prescriptions. To do this a more rigorous treatment is required.

Appendix A

DATA SOURCES

Several issues of various statistical publications were consulted in collecting data for the macroeconometric model. In addition, many of of the variables have been transformed in various ways (see Chapter 2). Thus, sum of the variables may not correspond with their sources.

1. QSG, CXO, CD, QSRW, QDW, CIS, PP, PW, PXCF, PL, XCO.
   Sources: Gill and Duffus, World Bank(1984), CBS: Economic survey.

2. PTO, PV, QTO, QV.
   Source: Bulletin de l'Afrique Noire (several Issues), Paris.

3. CPI, ER, CFA, CPIT, CPIV, CUR, DD, BR, H, NCM, FR, FOR, FTR, FAN, NOL, NGI.
   Sources: I.M.F.: International Financial Statistics, CBS: Economic Survey, World Bank(1984).

4. POP, POPA, URB.
   Sources: United Nations: Demographic Yearbook,

5. N, LS, U.

Sources: I.L.O.: Monthly Bulletin of Labour Statistics, C.B.S.: Labour Statistics

6. VA, VM, VC, VT, VS, PRC, PUC, GFI, CIN, M, X, GDP, NGDP, DEP, MC MR, MK, R, RC, ROI, RD, RN, RNC, XNC.

Sources: United Nations: Statistical and Economic Information Bulletin for Africa, U.N.: Yearbook of National Accounts Statistics, World Bank(1984), C.B.S.: Economic Survey, Brown (1972).

Appendix B

DATA FOR MACROECONOMETRIC MODEL OF GHANA

DATA FOR MACROECONOMETRIC MODEL OF GHANA

YEAR	QSGT	QSG	CXS	CXO	CD	QSRW	QDW	CIS	YW	YCO	PP	PTVC	PPTV	PW
1956	230.061	245.3	-15.239	238.1	7.2	634.44	837	27.5	1031.8	147.734	296.9	226.8	1.30931	94.048
1957	235.699	257.9	-22.201	264.4	-6.5	654.10	921	-31.2	1064.6	154.561	298.5	238.7	1.25053	96.429
1958	193.740	218.2	-24.460	200.5	17.7	615.56	858	-48.7	1065.3	117.611	268.4	205.9	1.30364	93.651
1959	238.839	270.1	-31.261	254.2	15.9	706.26	874	71.1	1125.0	139.136	263.7	161.4	1.63406	94.841
1960	298.495	341.8	-43.305	307.7	34.1	777.61	931	145.1	1170.3	148.290	224.3	171.4	1.30872	94.048
1961	384.696	435.1	-50.404	411.9	23.2	796.00	1026	154.7	1217.4	177.851	224.0	163.3	1.37188	94.048
1962	366.999	418.1	-51.101	428.0	-9.9	779.10	1120	26.1	1285.0	156.351	224.0	131.7	1.70088	93.651
1963	386.766	428.3	-41.534	411.1	17.2	799.13	1154	31.9	1344.6	153.996	224.0	134.9	1.66066	94.841
1964	410.171	453.7	-43.529	387.6	66.1	870.43	1195	85.6	1428.2	144.770	224.0	153.1	1.46301	96.429
1965	507.719	552.8	-45.081	501.9	50.9	952.38	1335	125.1	1518.9	139.602	224.0	192.0	1.16688	98.016
1966	388.121	409.8	-21.679	397.9	11.9	859.18	1388	-140.7	1593.5	61.061	149.3	166.6	0.89618	100.397
1967	387.479	377.2	10.279	334.9	42.3	964.02	1386	-34.5	1652.6	33.702	168.6	434.9	0.38769	100.397
1968	419.876	424.1	-4.224	335.3	88.8	914.92	1410	-75.2	1748.8	102.971	242.8	274.1	0.88594	100.000
1969	424.800	424.8	-0.000	305.7	119.1	850.00	1353	-78.2	1834.6	105.051	265.1	281.2	0.94289	103.175
1970	442.568	412.9	29.668	367.4	45.5	1003.33	1355	90.9	1893.9	111.805	298.7	279.5	1.06840	107.937
1971	451.060	416.9	34.160	314.2	102.7	1062.24	1438	75.3	1965.6	103.763	298.7	324.3	0.92088	114.286
1972	504.223	461.2	43.023	412.2	49.0	1047.18	1567	-15.6	2076.9	104.075	300.6	493.1	0.60957	124.603
1973	435.504	406.4	29.104	373.8	32.6	970.20	1551	-145.3	2202.4	96.867	373.5	566.4	0.65938	153.175
1974	417.307	354.6	62.707	313.9	40.7	1047.89	1489	-23.8	2217.9	83.564	436.2	696.1	0.62660	212.698
1975	453.201	380.4	72.801	322.2	58.2	1089.50	1471	71.7	2151.3	88.612	560.0	1253.0	0.44691	231.349
1976	450.703	383.9	66 803	327.6	56 3	1031.90	1536	-53.4	2254.5	61 084	597.0	1583.3	0.37706	236.111
1977	405 533	311.2	94.333	253.0	58.2	983.37	1393	-4.1	2340 2	29.549	771.0	2932.8	0.26288	256.746
1978	418.592	264.9	153.692	213.0	51.9	1081.01	1418	81.6	2433.8	24.649	1308.1	8153.0	0.16044	282.143
1979	422.945	256.0	166.945	196.0	60.0	1083.66	1471	35.6	2509.2	29.790	2526.0	22080.1	0.11440	330.556
1980	485.384	280.4	204.984	228.0	52.4	1144.62	1507	123.0	2539.3	34.424	4000.0	33180.8	0.12055	396.825
1981	490.022	251.5	238.522	161.0	90 5	1184.38	1588	86.4	2590.1	42.787	12000 0	51177 9	0.23448	393.254

DATA FOR MACROECONOMETRIC MODEL OF GHANA CONT'D

YEAR	PXC	PXCF	PS	PL	XCO	CPI	PI	PX	PM	ER	CFA
1956	443.51	221.75	3.48	218.0	105.60	49.3	59.63	94.737	105.797	1.4000	175.00
1957	378.91	189.46	5.15	243.0	100.18	49.8	59.77	90.789	105.797	1.4000	180.82
1958	608.59	304.29	3.50	347.0	122.02	49.8	65.45	126.316	105.797	1.4000	209.87
1959	560.90	280.45	2.97	281.0	142.58	51.2	65.14	115.789	108.696	1.4000	246.85
1960	451.03	225.51	3.14	222.0	138.78	51.7	64.78	97.368	111.594	1.4000	246.85
1961	349.82	174.91	2.70	177.0	144.09	54.8	66.87	80.263	111.594	1.4000	246.85
1962	316.81	158.40	2.80	167.0	135.59	59.9	68.27	72.368	107.246	1.4000	246.85
1963	327.58	163.79	8.31	205.0	134.67	62.3	72.87	73.684	104.348	1.4000	246.85
1964	357.19	178.60	5.73	188.0	138.45	70.2	80.13	80.263	108.696	1.4000	246.85
1965	275.00	137.50	2.03	138.0	138.02	88.7	85.42	63.158	110.145	1.4000	246.85
1966	263.00	131.50	1.81	193.0	104.65	100.2	92.39	61.842	97.101	1.4000	246.85
1967	381.00	163.87	1.92	238.0	127.60	188.7	88.81	72.368	112.609	1.1900	246.85
1968	565.00	230.71	1.90	320.0	189.44	100.0	100.00	100.000	100.000	0.9800	246.85
1969	723.00	295.22	3.20	415.8	221.02	107.2	111.35	117.105	117.391	0.9800	259.71
1970	834.60	340.79	3.69	306.0	306.63	110.3	117.14	131.579	144.928	0.9800	277.71
1971	725.58	289.77	4.50	232.0	227.98	120.0	123.22	105.263	155.072	0.9722	277.13
1972	709.81	216.19	7.27	270.0	292.58	133.2	142.31	100.000	168.116	0.7620	252.21
1973	834.30	293.34	9.48	585.0	311.86	156.7	167.67	134.211	210.145	0.8622	222.70
1974	1265.90	470.64	29.70	990.0	397.37	185.1	211.43	214.474	298.551	0.8696	240.50
1975	1594.00	623.88	20.90	723.0	513.59	240.4	251.79	239.474	320.290	0.8696	214.32
1976	1467.00	706.29	11.56	1399.0	480.59	375.2	329.77	232.237	329.855	0.8696	238.98
1977	2510.00	1250.47	8.09	2944.0	635.03	812.0	557.61	397.500	358.696	0.8696	245.67
1978	4344.00	1493.87	7.84	2006.0	925.27	1405.8	967.91	553.158	384.348	0.6601	225.64
1979	9588.00	1643.19	9.65	1727.0	1879.25	2170.7	1349.52	512.500	490.000	0.3636	212.72
1980	7723.00	1207.10	28.59	1270.0	1760.84	3258.2	1949.49	529.211	640.580	0.3636	211.30
1981	6310.00	1131.38	16.89	1127.0	1015.91	7053.6	3711.70	373.553	669.420	0.3636	271.73

DATA FOR MACROECONOMETRIC MODEL OF GHANA CONT'D

YEAR	RM	RC	RNC	ROI	RD	RN	R	NXNC	NMC	NMK	NMR	BOT
1956	31.2	29.45	1.1	6.7	13.9	14.0	96.35	76.40	116.4	27.0	54.6	-16.98
1957	31.3	23.64	1.2	8.8	15.4	16.4	96.74	91.82	130.6	25.0	58.4	-6.17
1958	31.1	50.98	1.3	12.4	15.8	18.0	129.58	97.98	112.8	23.6	53.6	-27.79
1959	35.0	51.35	1.5	13.9	15.0	18.2	134.95	97.42	139.8	42.4	69.8	-54.03
1960	44.8	52.15	1.7	16.5	15.7	20.2	151.05	107.22	166.0	56.2	73.8	-73.52
1961	58.6	49.60	1.5	13.7	22.8	22.7	168.90	99.91	181.6	53.4	91.0	-67.66
1962	60.7	44.29	1.0	18.7	24.2	24.2	173.09	104.41	148.4	42.6	79.0	61.36
1963	68.1	44.67	1.0	23.8	21.4	27.7	186.67	99.33	132.0	64.5	93.5	-5.88
1964	68.2	30.48	1.3	26.9	56.6	30.0	213.48	108.55	121.3	64.9	96.8	-1.45
1965	107.5	17.75	0.8	59.3	67.2	27.9	280.45	113.08	181.6	96.6	113.6	-105.11
1966	75.4	15.22	0.8	61.1	54.0	38.5	245.02	117.35	124.8	76.6	96.4	-6.70
1967	66.5	30.50	0.7	69.7	52.2	28.5	248.10	134.10	124.1	59.9	115.5	-83.70
1968	56.3	55.18	0.6	70.9	61.3	31.7	275.98	156.06	130.1	78.3	145.1	-8.00
1969	59.7	91.80	0.8	73.5	67.1	32.6	325.50	226.18	180.3	82.7	164.7	-55.03
1970	79.9	180.10	0.6	84.5	67.3	47.5	459.90	216.57	246.2	102.3	190.1	-73.20
1971	107.2	111.38	0.7	105.3	67.8	49.4	441.78	215.32	217.7	118.8	199.7	-38.50
1972	57.0	133.19	1.0	94.2	89.4	59.2	433.99	355.22	187.1	96.8	199.6	169.10
1973	71.4	116.25	3.6	118.3	106.0	53.3	468.85	507.94	256.2	105.1	274.1	71.90
1974	107.5	197.85	9.1	144.9	131.2	92.5	683.05	558.63	342.5	185.7	533.0	-94.50
1975	107.7	273.23	6.8	90.3	259.4	75.0	812.43	509.01	232.8	240.0	541.0	-4.00
1976	96.3	231.61	7.8	224.1	205.8	105.4	871.01	544.61	263.1	273.7	556.3	-14.20
1977	116.6	364.32	7.5	319.9	239.3	114.0	1161.62	535.97	269.7	342.0	677.3	-829.48
1978	223.9	460.93	7.8	365.3	309.1	145.8	1512.83	828.73	662.6	542.2	828.2	-53.76
1979	344.9	1094.07	8.4	440.2	407.7	189.4	2484.67	1379.75	910.0	744.6	1137.4	-84.11
1980	359.2	677.62	6.1	733.1	613.5	200.0	2589.52	1760.16	1249.9	1022.8	1562.3	-44.55
1981	429.2	37.51	1.8	1274.1	898.0	264.7	2905.31	1346.09	1017.9	832.9	1272.2	-14.21

DATA FOR MACROECONOMETRIC MODEL OF GHANA CONT'D

YEAR	MS	CUR	DD	BR	H	CU	RS	FR	FOR	FTR	FAN	NOL	NGI	ERC
1956	109	76	33	5	81	230.303	15.152	228.643	0.357	229	229	1	-147	2.00000
1957	97	65	32	7	72	203.125	21.875	194.929	0.071	195	195	1	-122	2.00000
1958	101	64	37	10	74	172.973	27.027	200.571	0.429	201	201	1	-126	2.00000
1959	114	75	39	13	88	192.308	33.333	213.357	3.643	217	217	1	-128	2.00000
1960	134	87	47	15	102	185.106	31.915	190.500	8.500	199	199	3	-94	2.00000
1961	147	87	60	12	99	145.000	20.000	103.429	13.571	117	117	6	-12	2.00000
1962	165	96	69	21	117	139.130	30.435	125.786	-4.786	121	115	11	13	2.00000
1963	173	98	75	15	113	130.667	20.000	145.500	-53.500	92	83	-9	21	2.00000
1964	240	133	107	32	165	124.299	29.907	85.643	-0.643	85	61	-53	51	2.00000
1965	238	116	122	35	151	95.082	28.689	77.357	8.643	86	14	-25	112	2.00000
1966	247	116	131	40	156	88.550	30.534	75.357	7.643	83	-1	-35	122	2.00000
1967	240	119	121	42	161	98.347	34.711	69.748	26.252	96	-35	-13	183	2.32496
1968	258	125	133	43	168	93.985	32.331	97.449	10.551	108	-51	21	240	2.44898
1969	289	151	138	50	201	109.420	36.232	71.939	10.061	82	-53	-21	233	2.44898
1970	302	151	151	80	231	100.000	52.980	53.367	21.633	75	-2	-40	193	2.44898
1971	318	159	159	79	238	100.000	49.686	39.395	55.605	95	-9	74	321	2.50401
1972	459	239	220	113	352	108.636	51.364	118.635	29.365	148	139	79	292	3.28329
1973	536	245	291	192	437	84.192	65.979	189.399	40.601	230	221	93	309	2.84412
1974	656	336	320	258	594	105.000	80.625	71.297	73.703	145	37	-23	534	2.68974
1975	981	486	495	393	879	98.182	79.394	154.554	58.446	213	151	95	823	2.55497
1976	1386	707	679	542	1249	104.124	79.823	103.381	25.619	129	40	193	1402	2.07705
1977	2276	1157	1119	858	2015	103.396	76.676	164.558	85.442	250	69	495	2441	2.00724
1978	3909	2122	1787	1598	3720	118.747	89.424	404.636	379.364	784	304	739	4155	2.90789
1979	4332	2459	1873	1937	4396	131.287	103.417	752.475	64.525	817	341	141	4196	5.83498
1980	5611	3521	2090	2221	5742	168.469	106.268	540.704	47.296	588	243	-52	5447	6.39796
1981	9360	6050	3310	2874	8924	182.779	86.828	405.116	106.884	512	-91	-56	8959	5.57728

DATA FOR MACROECONOMETRIC MODEL OF GHANA CONT'D

YEAR	POP	POPA	URB	PURB	N	LS	U	UR	W	DEP	KS
1956	6.02	3340.2	1.25818	20.9	267.854	274.139	6.285	2.29263	27.50	30.5	3006.95
1957	6.20	3433.7	1.33300	21.5	277.406	284.866	7.460	2.61878	30.70	33.9	3144.54
1958	6.39	3529.8	1.41219	22.1	292.530	301.447	8.917	2.95807	31.20	38.4	3269.88
1959	6.58	3628.7	1.49366	22.7	319.594	328.354	8.760	2.66785	32.40	43.4	3455.80
1960	6.85	3730.3	1.59605	23.3	333.126	344.383	11.257	3.26874	34.80	53.5	3677.73
1961	6.85	3842.3	1.63030	23.8	349.842	364.585	14.743	4.04378	38.98	65.7	3894.74
1962	6.93	3957.7	1.69092	24.4	356.210	371.702	15.492	4.16785	41.22	71.1	4071.76
1963	7.01	4076.6	1.75250	25.0	374.120	389.554	15.434	3.96197	42.60	78.2	4245.30
1964	7.40	4199.0	1.89440	25.6	387.254	400.877	13.623	3.39830	44.93	91.9	4503.01
1965	7.74	4325.1	2.02014	26.1	396.010	407.311	11.301	2.77454	47.04	104.6	4732.80
1966	7.91	4457.7	2.11197	26.7	361.384	372.862	11.478	3.07835	50.99	128.0	4822.05
1967	8.08	4594.4	2.21392	27.4	361.384	378.097	16.713	4.42029	54.90	157.9	4818.81
1968	8.26	4735.2	2.31280	28.0	391.234	408.633	17.399	4.25785	62.80	184.0	4823.70
1969	8.44	4742.0	2.41384	28.6	400.786	415.813	15.027	3.61388	65.91	129.4	4886.86
1970	8.61	4553.3	2.50551	29.1	398.000	414.513	16.513	3.98371	72.91	134.3	5008.05
1971	8.86	4784.4	2.63142	29.7	396.408	414.794	18.386	4.43256	77.38	145.2	5153.38
1972	9.09	4899.5	2.75427	30.3	424.666	455.903	31.237	6.85168	81.11	170.4	5207.80
1973	9.39	5051.8	2.90151	30.9	409.144	435.474	26.330	6.04629	87.96	216.4	5241.28
1974	9.61	5160.6	3.03676	31.6	450.138	478.430	28.292	5.91351	94.80	256.1	5378.52
1975	9.87	5374.6	3.18801	32.3	431.432	461.922	30.490	6.60068	101.60	322.9	5487.06
1976	10.31	5532.7	3.40230	33.0	430.636	463.337	32.701	7.05771	114.00	378.2	5575.14
1977	10.63	5696.1	3.58231	33.7	423.074	455.006	31.932	7.01793	214 96	524.6	5703.90
1978	10 97	5865.2	3.77368	34.4	432.626	467.426	34 800	7 44503	226.13	731.9	5804.27
1979	11.32	6041.1	3.98464	35.2	428.646	459 941	31.295	6.80413	285.83	1064 0	5847.42
1980	11.45	6129.5	4.11055	35.9	429.840	469.851	40 011	8 51568	361 29	1412.1	5887.23
1981	12.06	6293.6	4 41396	36.6	433.820	466.220	32.400	6 94951	456 67	2124.3	5917.40

DATA FOR MACROECONOMETRIC MODEL OF GHANA CONT'D

YEAR	VA	VM	VC	VT	VS	GDP	NVA	NVM	NVC	NVT	NVS	NGDP
1956	686.76	82.893	58.967	60.3561	294.989	1183.97	400.0	55.90	35.20	37.20	177.7	706.0
1957	718.15	86.604	61.750	63.1390	308.439	1238.08	419.3	58.40	37.00	39.10	186.2	740.0
1958	691.28	83.361	59.433	60.8224	296.857	1191.75	442.0	61.60	38.90	41.20	196.3	780.0
1959	792.60	95.563	68.083	69.6267	340.414	1366.29	504.3	70.30	44.40	47.00	224.0	890.0
1960	856.11	103.227	73.524	75.2881	367.618	1475.76	554.6	66.87	47.63	48.77	238.1	956.0
1961	724.24	195.326	105.164	89.8677	413.744	1528.34	581.7	76.15	52.42	55.57	256.2	1022.0
1962	758.50	220.596	104.016	89.1149	430.235	1602.46	623.0	80.96	60.67	58.32	271.0	1094.0
1963	756.90	247.449	102.773	91.7458	458.876	1657.75	668.4	100.95	60.10	65.71	312.9	1208.0
1964	760.91	244.859	97.914	95.2956	494.519	1693.50	739.8	107.63	65.03	76.34	368.2	1357.0
1965	674.04	213.012	99.005	63.0034	667.637	1716.69	598.0	191.50	81.00	66.00	529.9	1466.4
1966	684.99	216.996	83.998	57.9989	599.488	1643.47	657.0	205.30	73.60	61.50	521.0	1518.4
1967	718.97	243.991	80.997	61.9978	587.879	1693.84	605.0	233.60	74.00	60.00	531.7	1504.3
1968	710.00	272.800	73.000	62.6000	581.800	1700.20	710.0	272.80	73.00	62.60	581.8	1700.2
1969	756.63	307.037	72.772	72.7719	587.558	1796.77	916.1	312.32	75.76	79.75	616.8	2000.7
1970	817.01	331.003	89.001	79.0007	612.706	1928.72	1060.0	319.00	93.80	96.90	689.6	2259.3
1971	859.00	354.000	111.000	89.9999	615.299	2029.30	1104.6	338.86	117.95	111.96	827.2	2500.5
1972	894.98	301.393	84.998	92.9980	603.987	1978.36	1313.0	395.00	104.00	124.00	879.4	2815.4
1973	900.02	358.008	100.002	98.0023	632.115	2088.15	1715.0	519.99	131.00	127.00	1008.3	3501.2
1974	956.99	355.798	129.999	95.9994	665.296	2204.09	2383.0	632.00	213.00	163.00	1269.1	4660.1
1975	837.91	337.164	125.987	87.9907	709.125	2098.18	2518.3	873.00	235.60	206.00	1450.1	5283.0
1976	720.01	273.002	131.001	91.0007	764.006	1979.02	3300.1	992.50	261.80	258.90	1712.9	6526.2
1977	756.07	264.925	127.112	90.0084	764.072	2002.19	6275.0	1346.22	422.34	330.63	2790.2	11164.4
1978	1070.65	310.672	85.252	69.5076	632.097	2168.18	12741.0	2007.00	517.00	553.00	5168.0	20986.0
1979	1135.34	266.553	48.394	57.6122	579.579	2087.48	17022.0	3348.00	651.00	758.00	6392.0	28171.0
1980	1126.52	275.004	47.242	67.9828	586.112	2102.86	25008.0	3735.40	931.00	914.60	10406.0	40995.0
1981	1118.46	268.091	63.758	62.6059	552.315	2065.23	39028.0	5296.00	1481.00	1602.00	29248.0	76655.0

DATA FOR MACROECONOMETRIC MODEL OF GHANA CONT'D

YEAR	PRC	PUC	GFI	CIN	X	M	GDP	NPRC	NPUC	NGFI	NCIN	NX	NM	NGDP
1956	876.78	108.054	200.673	15.436	299.465	316.445	1183.97	540.0	60.0	112.0	10.0	182.0	198.0	706.0
1957	954.03	115.780	192.967	-18.525	331.904	338.079	1238.08	596.0	66.0	112.0	-12.0	192.0	214.0	740.0
1958	915.42	118.866	188.333	-3.087	274.782	302.569	1191.75	572.0	70.0	110.0	-2.0	220.0	190.0	780.0
1959	1012.75	129.682	247.013	30.877	336.555	390.589	1366.29	650.0	78.0	154.0	20.0	240.0	252.0	890.0
1960	1020.51	141.165	285.271	102.345	361.736	435.259	1475.76	694.0	96.0	194.0	22.0	246.0	296.0	956.0
1961	1106.06	152.966	294.166	42.801	405.949	473.607	1528.34	804.0	110.0	210.0	-20.0	244.0	326.0	1022.0
1962	1037.24	166.543	265.884	71.438	473.331	411.974	1602.46	830.0	122.0	184.0	-12.0	240.0	270.0	1094.0
1963	1093.89	185.256	317.582	66.898	452.848	458.729	1657.75	916.0	138.0	218.0	-8.0	234.0	290.0	1208.0
1964	1043.16	194.956	321.532	135.305	394.277	395.732	1693.50	987.0	160.0	232.0	14.0	247.0	283.0	1357.0
1965	1175.46	298.016	348.319	0.000	445.924	551.030	1716.69	1132.9	212.0	262.2	0.0	251.1	391.8	1466.4
1966	1143.08	257.995	249.395	-0.300	398.292	404.992	1643.47	1201.0	198.0	195.2	0.0	222.0	297.8	1518.4
1967	1341.25	260.391	175.894	0.000	339.888	423.585	1693.84	1162.0	225.0	155.1	0.0	261.7	299.5	1504.3
1968	1234.10	285.300	188.800	0.000	345.500	353.500	1700.20	1234.1	285.3	188.8	0.0	345.5	353.5	1700.2
1969	1353.86	270.851	210.440	16.648	326.078	381.105	1796.77	1460.6	284.7	195.3	40.6	447.2	427.7	2000.7
1970	1459.41	259.902	230 802	51.800	398.404	471.604	1928.72	1664.7	290.3	271.4	48.3	523.2	538.6	2259.3
1971	1483.90	282.300	262.400	39.200	414.499	452.999	2029.30	1915.7	324.5	310.7	42.5	443.3	536.2	2500.5
1972	1392.27	266.694	172.696	-22.400	481.490	312.393	1978.36	2095.3	354.9	244.4	-43.5	647.8	483.5	2815.4
1973	1549.64	263.306	172.304	31.001	462.911	391.009	2088.15	2618.5	382.3	267.8	48.2	819.8	635.4	3501.2
1974	1721.39	269.098	278.198	29.900	403.798	498.297	2204.09	3588.2	569.3	554.5	53.3	956.0	1061.2	4660.1
1975	1599.93	234.975	243.974	23.298	346 963	350.963	2098.18	3913.4	688.5	613.8	58.5	1022.6	1013.8	5283.0
1976	1591.61	244.402	175.101	-17.900	216.502	230.702	1979.02	5216.3	799 0	640.8	-62.0	1025.2	1093.1	6526.2
1977	1618.65	254.324	102.910	855.780	154 114	983.592	2002.19	8638.0	1409.4	1049.0	186 0	1171.0	1289.0	11164.4
1978	1617.11	409.365	224.652	-29.186	296.079	349.842	2168.18	17766.0	2371 0	1355.0	-227 0	1754 0	2033.0	20986.0
1979	1631.58	417.113	156.705	-33.799	200 106	284.220	2087.48	23649.0	2891.0	1482.0	-318 0	3259 0	2792.0	28171.0
1980	1499.08	470.118	160.547	17.668	245 429	289.983	2102.86	34232 0	4866.0	1964 0	247.0	3521.0	3835.0	40995.0
1981	1453.38	441.698	182.440	1.920	192.811	207.022	2065.23	68126.0	6619 0	2603.0	68 0	2362.0	3123 0	76655.0

DATA FOR MACROECONOMETRIC MODEL OF GHANA CONT'D

YEAR	PV	PTO	CPIT	CPIV	QV	QTO
1956	65.0	65.0	69.286	56.786	71.6	5.5
1957	70.0	70.0	70.857	56.786	67.7	4.7
1958	95.0	95.0	72.571	78.929	47.2	6.1
1959	90.0	90.0	74.429	83.750	56.7	7.9
1960	95.0	100.0	76.143	84.464	67.2	9.3
1961	95.0	95.0	77.429	94.286	91.5	12.5
1962	70.0	65.0	78.857	93.036	84.7	11.5
1963	70.0	62.5	80.286	93.929	101.9	11.8
1964	70.0	70.0	81.143	94.464	106.6	14.5
1965	70.5	70.5	82.143	95.714	141.7	17.0
1966	59.0	40.2	83.143	101.071	119.5	14.6
1967	70.0	55.0	81.286	103.393	149.2	16.6
1968	70.0	70.0	80.000	108.750	146.2	18.1
1969	73.0	80.0	86.429	113.750	150.7	19.8
1970	82.0	88.0	90.143	124.464	180.4	26.9
1971	85.0	98.0	96.143	122.500	187.1	28.1
1972	85.0	93.0	103.571	122.857	218.2	27.2
1973	93.0	93.0	107.286	136.607	185.7	18.2
1974	126.0	95.0	121.000	160.179	214.0	16.2
1975	175.0	115.0	142.857	178.571	239.3	15.4
1976	177.0	120.0	159.429	200.179	230.8	16.9
1977	198.0	130.0	195.286	255.000	242.6	14.5
1978	250.0	150.0	196.143	288.214	305.4	16.3
1979	263.0	200.0	210.857	336.071	323.4	13.3
1980	300.0	220.0	237.000	385.179	384.6	15.2
1981	300.0	220.0	285.714	419.286	419.5	15.7

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