THE EFFECT OF
EXCHANGE RATE POLICY
ON THE
ECONOMIC DEVELOPMENT OF KENYA

A Dissertation Submitted to the
College of Graduate Studies and Research
in Partial Fulfillment of the Requirement of the
Degree of Doctor of Philosophy
in the
Department of Agricultural Economics
University of Saskatchewan

By
Tom G. Porter

Spring, 1999

National Library
of Canada

Acquisitions and
Bibliographic Services

395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque nationale
du Canada

Acquisitions et
services bibliographiques

395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence

Our file Notre référence

0-612-37910-8

Canada

UNIVERSITY OF SASKATCHEWAN

College of Graduate Studies and Research

SUMMARY OF DISSERTATION

Submitted in partial fulfillment

of the requirements for the

DEGREE OF DOCTOR OF PHILOSOPHY

by

Tom G. Porter

Department of Agricultural Economics
University of Saskatchewan

Spring, 1999

Examining Committee:

Dr. W.J. Brennan	Dean's Designate, Chair College of Graduate Studies and Research
Dr. J.C. Stabler	Chair of Advisory Committee, Agricultural Economics
Dr. W.H. Furtan	Co-supervisor, Agricultural Economics
Dr. R.F. Lucas	Co-supervisor, Agricultural Economics
Dr. C. Echevarria	Department of Economics
Dr. G.G. Storey	Department of Agricultural Economics

External Examiner:

Dr. Terry Veeman
Department of Rural Economy
University of Alberta
515 General Services Building
Edmonton, Alberta T6G 2H1

The Effect of Exchange Rate Policy On the Economic Development of Kenya

This dissertation attempts to assess the negative effect that the Kenyan government's exchange rate policy had on aggregate output and on sectoral composition of output. The Kenyan government chose a macroeconomic policy set in order to achieve certain economic, political, and social goals as part of its development objectives. The policy mix included industrialization policies, a expansionary monetary policy, a pegged exchange rate, and other policies that created a bias against the agricultural sectors.

An empirical macroeconomic model was constructed to capture the economic processes that produce exchange rate fluctuations. The exchange rate is determined by Kenya's price level relative to the rest of the world and by Kenya's productivity relative to the rest of the world. Exogenous events and government policies that affect the price level and productivity will influence the exchange rate as well.

Given a calibrated model for Kenya's macroeconomy, a Simulation was used to compare Kenya's actual experience with a counter-factual exchange rate policy that produces no

relative price distortions. The results indicate, among other effects, that a floating exchange rate policy would have led to higher total output compared to the exchange rate policy that Kenya actually pursued.

BIOGRAPHICAL

September,1964 Born in Missouri, U.S.A.

April, 1987, B.A., Economics, University of Saskatchewan

October, 1992, M.A., Economics,University of Saskatchewan

Honours

Dollie Hantelman Postgraduate Scholarship in Agriculture, September, 1993

University of Saskatchewan Teaching Fellowship, September, 1987 through April, 1989

University of Saskatchewan Summer Research Scholarship, May 1988

PERMISSION TO USE

In presenting this thesis in partial fulfilment of the requirements for a Postgraduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis.

Requests for permission to copy or to make other use of material in this thesis in whole or part should be addressed to:

Head of the Department of Agricultural Economics
University of Saskatchewan
Saskatoon, Saskatchewan S7N 5A8

ABSTRACT

This dissertation attempts to assess the negative effect that the Kenyan government's exchange rate policy had on aggregate output and on sectoral composition of output. The Kenyan government chose a macroeconomic policy set in order to achieve certain economic, political, and social goals as part of its development objectives. The policy mix included industrialization policies, a expansionary monetary policy, a pegged exchange rate, and other policies that created a bias against the agricultural sectors.

An empirical macroeconomic model was constructed to capture the economic processes that cause equilbirium exchange rate fluctuations. The exchange rate is determined by Kenya's price level relative to the rest of the world and by Kenya's productivity relative to the rest of the world. Exogenous events and government policies that affect the price level and productivity will influence the exchange rate as well. A model of equilibrium exchange rate movements can then be used to assess exchange rate misalignment: *i.e.*, when the exchange rate undervalues or overvalues the domestic currency relative to foreign currency.

Given a calibrated model for Kenya's macroeconomy, a simulation was used to compare Kenya's actual experience with a counter-factual exchange rate policy that produces no relative price distortions. The results indicate, among other effects, that a floating exchange rate policy would have led to higher total output compared to the exchange rate policy that Kenya actually pursued.

ACKNOWLEDGEMENTS

The efforts I have made in completing the Agricultural Economics Ph.D. program are small compared to the support and advice that I have needed from my wife, Sarah. I have also received a wealth of advice and encouragement from my parents, brothers and sisters. I cannot put into words how important my family is or how grateful I am for their love.

I extend my most sincere thanks to Dr. Chris D. Gerrard for guiding the first two years of my research. The research would have been impossible without his efforts. Dr. Gerrard's vision of a general equilibrium approach for studying macroeconomic policy effects on African agricultural development and his considerable capabilities were absolutely necessary for directing my naïve struggles. I must also thank Dr. Richard Manning, of the Economic Development Institute of the World Bank. Dr. Manning recognized the need for developing the model for educational purposes, and generously funded the research.

The supervisors for the dissertation, Dr. Robert Lucas and Dr. Hartley Furtan, each provided theoretical and practical direction for the research. Dr. Lucas' clear and intricate understanding of macroeconomic theory and macroeconomic modelling were indispensible for completing the

dissertation. Dr. Furtan helped ground the model with respect to Kenya's agricultural development. He also pushed me to write the dissertation in such a manner that I understood what I was arguing and that others could understand the argument as well.

I thank Dr. Richard Gray because he was always available to offer advice and guidance for estimating and calibrating the model. Dr, Gray's amazing range of skills has taught me a great deal about econometrics and prior beliefs.

I would also like to thank Dr. Terry Veeman, the External Examiner for my defense. Dr. Veeman's questions were enlightening and significantly improved the final draft of my dissertation. The entire committee helped improve the final version with their questions and comments during the defense.

The colleagues that I have worked with since the beginning of my Ph.D. studies greatly contributed to the experience. I know more about economics and distant parts of the world because of the conversations, classes, and other trials that we shared.

The faculty of Agricultural Economics contributed to my education in many, and probably unknown, ways. I would like to particularly thank Dr. Jack Stabler for being available during the weeks leading to the defense, and Dr. Gary Storey for being available as a faculty member and as a friend.

The final note of thanks belongs to C. Arthur Battiste and Anne T. Ballantyne. Art and Anne have provided me with time, resources, and encouragement. Their professional and intellectual accomplishments inspire me. Having their friendship motivates me to excel.

To Sarah

Thank you, Sarah. There is no amount of knowledge that can compare to the love, support, and patience that you have provided.

There is no knowledge greater
than the love of family.

TABLE OF CONTENTS

Chapter 1

Introduction

Kenya's pegged exchange rate policy between 1964 and 1991 benefited the import-competing goods sector at the expense of the agricultural sectors. The fiscal and monetary policies of Kenya's development plan were inflationary thereby generating an overvalued domestic currency. The development policy of industrialization increased depreciation pressures by moving domestic resources from productive agricultural export industries to relatively unproductive uses in import-competing industries. An exchange rate depreciation would change the internal terms-of-trade against import-competing industries and in favour of agricultural sectors. The government pegged the exchange rate to defend its industrialization policies in spite of the negative effect on agricultural sectors.

Agricultural growth slowed and overall economic development slowed also. Agricultural development could contribute more to overall economic development if an optimal exchange rate policy kept the exchange rate close to its equilibrium rate. This counter-factual hypothesis will be simulated using an empirical macroeconomic model of

agricultural shares in total output within the context of overall economic growth.

1.1 Government Policy and Exchange Rates

Kenya's exchange rate policy caused a bias against agricultural development. The bias against agriculture was the result of most of Kenya's development policies.[1] Since independence in 1964, Kenya pursued rapid economic growth by developing import-substituting goods production. Kenya maintained a pegged exchange rate below its market rate because it wanted to subsidize capital-intensive industries and because a revaluation of foreign exchange would raise prices paid by import-competing industries and by residents in urban centers.[2] The theoretical base of these policies incorrectly suggested that resources could be drawn from agriculture without a decline in agricultural production, so that a bias against agriculture would speed overall development.[3] Import-substitution policies successfully encouraged resources to leave agricultural production. Agricultural output fell as a result.

Changing the internal terms-of-trade in favour of import-competing industries was the intended consequence of import-substitution policies. Theoretical and casual observers described rapid development to be an industrial revolution.[4] The prevailing description of poor countries as having separate economies - dualism - implied that

resources must be drawn from the "backward" traditional economy into the more productive modern economy.[5] Import-substituting trade policy drew on these theoretical views in order to justify the outright bans of certain imports, 100% *ad valorem* tariffs, and quotas. By 1979, Kenya's government recognized that its development plan had detrimental effects on the economy and that the agricultural sector was the dominant sector in Kenya's development.[6] However, many trade restrictions, particularly those on capital movements, were still in place in 1990.[7]

The pegged exchange rate policy contributed to the overall bias against agriculture. Undervalued foreign exchange discouraged exports - between 45% and 72% of Kenya's export receipts originate in agriculture[8] - as well as subsidized imports. The bias caused by the overvalued exchange rate was small between 1963 and 1972, but it grew as Kenya's fiscal, monetary, and import-substitution policies exerted upward pressure on the price of foreign exchange. The bias in the exchange rate against agriculture grew as the exchange rate became increasingly overvalued. The pegged exchange rate was devalued several times, but the underlying pressures of Kenya's macroeconomic and development policies entailed a continuing domestic currency depreciation.

Fiscal policy to support rapid industrialization was in disarray as budgetary demands could not be financed by the poorly functioning tax system. Fiscal policy created various

biases in the economy. Some of these biases were against the industrial sector, but most of the biases were against agriculture. The primary effect of fiscal policy, however, was to produce budgetary deficits that were an increasing percentage of GDP - from approximately 2.5% to 3% in 1964 to over 8% by 1990. Budget deficits were financed by borrowing from the private sector, foreign lenders, and the central bank.[9]

The budget deficits produced minor inflationary pressures in the first decade after independence, but higher deficits and government's attempt to encourage investment by expanding domestic credit,[10] eventually led to perennial high inflation (generally greater than 10%, occasionally higher than 20%). The differential between domestic and world inflation rates along with the fiscal policy implied an average 3% depreciation per annum and in some years implied a 10% depreciation. Thus, the devaluation pressure on the Kenyan pegged exchange rate continued to increase over this period.

Kenya's import-substitution policies caused additional devaluation pressures to the extent that these policies drove resources from the relatively productive agricultural sectors to the relatively profitable, but less productive, import-competing goods sector. Improvements in import-competing production were more than offset by declines in agricultural production. The draw on agricultural resources from the

import-competing goods sector lowered overall productivity adding devaluation pressures on the exchange rate.

The internal terms-of-trade bias against agriculture in favour of industrial production caused resources to move from relatively productive agricultural sectors to relatively unproductive import-competing industries. Kenya's comparative advantage relative to the rest of the world is in agriculture. Given Kenya's very high population growth (3.8%) and the absolute small size of the industrial sector, even if industrial employment quadrupled, agricultural employment would still have to double.[11] Agricultural export earnings comprise 45-72% of total exports, so a bias against agricultural exports quickly worsens the current account, without a corresponding fall in consumption. Most Kenyans subsist on agricultural production in rural areas, where they can not reduce consumption and where they import food only when necessary. Rapid population growth obviously exacerbates pressures on food production as well as on employment creation.

The primary effects of an overvalued exchange rate - depletion of foreign reserves and a low relative price of traded goods - disappear when the policies creating an overvalued exchange rate are abandoned. The effects on the capital stock, however, are much longer lasting: the agriculture sector suffers lower investment, and there is a permanent lowering of the growth path. As long as exchange

rate policy keeps agriculture unprofitable, investment will shift toward the relatively profitable, but less productive, importable goods sector. Overall economic growth is lower because exchange rate policy encourages relatively unproductive investments.

1.2 Model of Exchange Rate Fluctuation

An empirical macroeconomic model is needed to explain the effects of exchange rate misalignment on economic growth. Exchange rate fluctuations follow from many different events and from the interaction among these events. The exchange rate is determined by Kenya's price level relative to the rest of the world and by Kenya's productivity relative to the rest of the world. Exogenous events and government policies that affect the price level and productivity will influence the exchange rate as well. Also, these economic and policy fundamentals generate exchange rate fluctuations in the context of economic growth.

The stated goal of Kenya's economic policies was to speed economic growth. As policy was premised on growth, the model will be presented in the context of a growth-path: in particular, a growth-path determined by a Neo-classical growth model with endogenous capital accumulation - *i.e.*, savings. This portion of the model gives a growth-path for the capital stock and for the components of gross domestic product.

External shocks are modeled by their absorption into the current account of the growth component. These shocks may have short term effects only, or the effects may last years before being entirely absorbed into the system. Kenya's responsiveness, *i.e.* absorption elasticities, are calculated for terms-of-trade shocks, for changes of the world real interest rate, for changes in foreign aid, and for changes to the degree of exchange rate overvaluation. The permanent impacts of these shocks are found through the effects on capital accumulation or on relative productivity among sectors.

Monetary policy is also modeled in the growth portion of the model. Growth is driven by real variables with money acting as a medium of exchange. Capital accumulation and output remain unchanged given any growth rate of the money supply. However, some monetary dynamics can be introduced by altering the response to changes in the rate of growth of the money supply.

The growth component of the model provides aggregate output for a four sector aggregate translog profit function. This profit function together with a three sector almost ideal demand system (AID system) gives sector supply and demand, as well as relative price changes. The four sectors are: importable goods, exportable crops, food crops, and nontradable goods. The exportable crops sector is excluded from the AID system because there is no domestic demand.

Importable goods and the two agricultural sectors comprise tradable goods. Changes in any one sector affect the other sectors. A shift of resources toward the import-competing goods sector, for example, implies a shift of resources away from the other sectors, all other things being equal.

Macroeconomic policies affect savings and consumption decisions in the growth portion of the model. These decisions affect sector composition. Sectoral policies also affect sector composition and in turn affect investment decisions in the capital growth portion of the model.

1.3 Summary

A pegged exchange rate policy does not cause lower economic performance, nor does an overvalued exchange rate policy, by itself, affect growth. The particular set of macroeconomic policies in Kenya - expansionary monetary policies, sectoral bias against agriculture, and a pegged exchange rate - slowed agricultural development. Expansionary policies imply exchange rate devaluation, and a pegged exchange rate makes imports less expensive and lowers the producer price of exports. Together with other import-substitution policies, this policy of an overvalued exchange rate drove resources out of agriculture. Industrial investments were relatively more profitable, but less productive. Aggregate output declined somewhat given the loss of resources from the agricultural sector which was

relatively more productive, but relatively less profitable than the importable goods sector.

The research is presented in five chapters including this introduction. Chapter 2 contains an overview of Kenya's economic history, and is presented within the context of a theory of economic development. Theories of exchange rate fluctuation are discussed in chapter 3. An empirical model that incorporates capital growth, sectoral composition of output, and monetary variables is developed in Chapter 4. The final chapter reports a counter-factual simulation that exhibits the implied effect of Kenya's exchange rate policy on agricultural development relative to the effect of an optimal exchange rate policy on agricultural development.

Chapter 1: Endnotes

1. World Bank, Kenya: Agricultural Sector Report, Report 4629-KE, World Bank (Washington, D.C.; January 7, 1986), pp.32-34.

2. Gerald M. Meier, Leading Issues in Economic Development: Studies in International Poverty, Oxford University Press (1970), p.435.

3. C.D. Gerrard, Promoting Third World Agriculture: Lessons of Recent Experience, North-South Institute (Ottawa, 1983), p.3.

4. Phyllis Deane, "World Economic Growth," Chapter I.B.1 in Gerald M. Meier, Leading Issues in Economic Development, p.10.

5. Bruce Herrick and Charles P. Kindleberger, Economic Development (Fourth Edition), McGraw-Hill Book Company (Toronto, 1983), p.63.

6. *Ibid*, p.5.

7. Philip P. Cowitt, World Currency Yearbook 1988-89, International Currency Analysis (Brooklyn, N.Y.; 1991), pp.100-101.

8. United Nations, United Nations International Trade Statistics (Various Years), United Nations.

9. United Nations, United Nations National Accounts (Various Years), United Nations.

10. World Currency Yearbook 1988-89, p.101.

11. David G. Greene, Kenya, Growth and Structural Change, The World Bank (Washington, D.C.; 1983), p.343.

Chapter 2

Kenyan Agricultural Development and Macroeconomic Policy

This chapter will demonstrate that agricultural development was a relatively unimportant component of Kenya's overall macroeconomic and development objectives. An eclectic collection of development policies evolved that ranged from nationalization to capitalist business development to cheap food policies. These policies were motivated by the urgent need to satisfy various political interests. The non-economic motivations of Kenya's official development policy are evident in the name that Kenya's President, Jomo Kenyatta, used to describe the policies: "African Socialism."

The one economic argument used to defend African Socialism, as opposed to a social or political argument, was that the government should encourage private sector and capital intensive investments. By their economic characteristics, the type of investments that were encouraged were non-traditional and industrial investments. This one economic idea became the basis of Kenya's development objectives.

Kenyan economic development policies caused resources to shift among sectors in order to support industrial development. The shift of resources out of agriculture is a consequence of development. In a free market theory of development, resources shift from relatively less to relatively more productive sectors as a poor economy grows and consumption needs change. Kenyan development policy, conversely, is based on the idea that the shift of resources to the industrial sector causes relatively more rapid growth. The Kenyan government has not shown contempt for growth in the agricultural sector, but the promotion of industrial production implies that the government believed the agricultural sector was relatively less productive.

In a Neo-classical theory, development occurs as resources move to relatively more productive uses. The relatively productive sectors in most less developed countries (LDCs) such as Kenya are the agricultural sector. The bulk of the population and the labour force are rural, and food is scarce given population pressures. As the economy grows resources will begin to shift to industrial uses because the income elasticity of demand is lower for agricultural products than it is for industrial products. Resources will eventually shift out of the agricultural sector as a consequence of development. The policy prescription, therefore, is not to shift resources to or from agriculture but to remove constraints on resource movements

and to eliminate price distortions affecting efficient resource allocation.

The macroeconomic policy prescription of a Neo-classical theory of development is also less interventionist than Kenya's macroeconomic policy set. Macroeconomic policies in Kenya were a consequence of the development plan. In a Neo-Classical economic theory, the development plan is presupposed by the macroeconomic context. In Kenya, macroeconomic policies became constrained by the development objectives of the government. The objective of industrial development was met using fiscal policy measures. Fiscal policy can be an important part of any development plan, but, as will be shown below, Kenya's policy set included industrial subsidization, relatively low taxation, and trade protection. The price distortions thus created led to a misallocation of resources from an allocative efficiency perspective.

Kenya's macroeconomic policies supported fiscal policies that were meant to shift resources out of agricultural uses and into industrial uses. Given a small tax base, the fiscal policies were supported by government borrowing that eventually included the printing of money. Monetary policy, therefore, became an expansionary policy to support the fiscal policy of shifting resources toward industrial production. Kenya maintained a pegged exchange rate policy throughout this period, so the expansionary monetary policy

contributed to capital flight and the depletion of foreign reserves. Finally, a very restrictive set of currency laws were introduced in an attempt to prevent capital flight and the depletion of reserves. Each aspect of Kenya's macroeconomic policy evolved from the original fiscal policy.

An ideal development policy set, in contrast to Kenya's policy set, should evolve in the context of a stabilizing macroeconomic policy and overall economic growth. Relatively faster growth occurs as resources move toward relatively more productive uses. Monetary policy stabilizes prices and expectations. Fiscal and trade policies are used to eliminate price biases affecting efficient resource allocation. Exchange rate policy, also, should minimize biases that prevent resources from moving to relatively productive uses.

This chapter contains a brief history of Kenya's development policy (Section 2.1). The next section (Section 2.2) describes an ideal theory of development. The final section (Section 2.3) discusses the macroeconomic context of development, excluding exchange rates. A complete theory regarding exchange rate policy is presented in Chapter 3.

2.1 Kenya's Economic History (1964-1991)

Kenya's economic history begins in 1964 when Kenya became an independent nation. Development policy fundamentally changed in 1964 as Kenyans took control of

government operations. The aims of policy were to accelerate growth given certain political caveats. A short description of the success of Kenya's policies is presented in this section.

The history is separated into five periods in order to isolate government policy stances, external influences on the economy, or certain economic conditions. There was high growth in the first period (1964-1970) that was attributable to industrialization, infrastructure development, and other government investments that were absolutely productive and were not substitutes for private investments. Economic statistics during the second period (1971-1975) reveal that the industrialization policies were creating serious distortions in the economy, and that the distortions lowered the ability of the economy to adjust to the first major oil shock in 1974. Repeated shocks in the third period (1976-1979), including a major export price boom, masked the underlying problems created by the industrialization policies. The fourth period (1979-1984) is characterized by the recognition of aid organizations and senior government officials that overall growth depended on stable macroeconomic conditions and strong agricultural growth. There were no major external shocks to Kenya's economy in the last period (1985-1991), but persistent taxation of agriculture and expansionary monetary policy continued to constrain Kenya's agricultural and overall economic growth

prospects.

2.1.a Import-Substitution (1964-1970)

The economy grew at a rapid pace (6.87% per year) in the first period (1964-1970) because of a great number of productive investment opportunities in both the agricultural and industrial sectors, and because of obvious infrastructure improvements. Poor economic performance in the years prior to independence imply that measures of performance following independence overstate actual growth. Nonetheless, public investment and reinvestments provided sufficient growth during this "easy stage of development"[a] for Kenya to overcome its initial problems of colonial segregation policies, political instability, limited indigenous business experience, a narrow tax base, and low indigenous civil service skills. Kenya overcame many of the initial problems, but the rapid growth of this period permitted government policy to evolve in a manner that would inhibit growth once obvious investments opportunities were exhausted.

1. Initial Economic and Governing Conditions - The initial economic conditions were poor in Kenya. The British governor, in 1960, announced a timetable to achieve independence by 1964. The uncertainty thus created lowered

---

[a] The phrase "easy stage of development" is explained in more detail below. The phrase is widely used in the development literature, and used specifically for Kenya to include the years 1964 through 1972. John R.Burrows, Kenya: Into the Second Decade, John Hopkins University Press (Baltimore, 1975), p.*xi*.

gross investment from a 1960 level of 18% of GDP to a 1964 level of 15% of GDP with no growth of GDP.[1] Total public debt accounted for 30% of GDP in 1961 and continued to rise as a percent of GDP. The main factor contributing to rising debt was a poor functioning tax base.

Tax revenue was narrowly drawn from the small proportion of European and Asian ex-patriots living in Kenya, and from various visible sources such as excise taxes, custom duties, and licensing fees. Income tax revenue could not be easily expanded to cover African households whose incomes were largely from invisible sources and were very low. Local civil service skills were limited, and this also inhibited an expansion of the tax base.[2]

Distrust of the colonial civil service - comprised mainly of European ex-patriots - was an unavoidable outcome of economic segregation policies that reserved various resources for Europeans. For example, agricultural lands were designated as European or African until 1955. As a result of the segregation of quality lands, 3,600 European farmers (versus 950,000 African farmers) produced 80% of commercial output and almost half of total output if subsistence production is counted.[3] Land designations changed from European or African lands to "scheduled" or "non-scheduled" lands, but racial segregation continued until Kenya became an independent nation.

The agricultural sector was fragmented by segregation.

Development of the sector was directed to the scheduled lands until 1955. Beginning in 1955 specific attention was paid to African agricultural production on non-scheduled lands, and attempts were made to increase investments by Africans and to resettle Africans onto the scheduled lands.[4] In spite of these efforts and of the fact that the prospects for the sector were very large, incomes from agriculture for Africans remained barely above subsistence levels. Furthermore, European farmers continued to reduce their investments prior to independence.[5]

Gross investment in all sectors was declining between 1960 and 1964. Economic growth stalled because government could not increase investment to offset the decline in private investment.[6] Gross investment, as a percent of GDP, did not recover until 1967.[7] The reduction in private investment was most evident in the modern sector that comprises manufacturing and European agricultural production.

The manufacturing sector was small and showed limited potential for growth at independence. There were relatively few resources on which to build the manufacturing sector, but some local consumer demand and the East African community as a whole could have been served by Kenyan industrial production.[8] The agricultural sector showed more potential for growth, but investments in the agricultural sector such as the planting of tree crops (coffee, tea, sisal) could not yield benefits for a few years.

2. Evolution of Economic Policy - Policy had no philosophical base and operated as issues arose according to a presumption that capitalism was good for the country.[9] An eclectic collection of development policies evolved ranging from nationalization to capitalist business development to cheap food policies under the direction of the President, Jomo Kenyatta. These policies were motivated by the urgent need to satisfy various political interests.

> This stability was accomplished either through design or happenstance, by carrying out some land reform in the highlands, by controlling the provincial administration, by neutralizing opposition, by attracting economic aid from abroad, by keeping the support of the middle classes through appeals to their vested interests, and by keeping the politically restive Kikuyu (the President's native tribe) loyal to him and working for the regime.[10]

The newly independent Kenyan government invested in the areas of the economy that would produce the largest positive effects on the political constituencies. These investments included a land reform of scheduled lands, public infrastructure development, and investment in the modern industrial sector.

The land reform of scheduled lands was a minimal effort to establish a land tenure system with recognizable property rights. The land reform had to balance the Africanization of the modern agricultural sector with maintaining or reestablishing exclusive tribal rights to pastoral lands. Modern farming systems developed in the high potential areas formerly held by Europeans, but tribal problems effectively prevented developments in many non-scheduled areas that were

not formerly held by Europeans, and were reported to have medium to good potential for agricultural development.[11] The remarkable growth in agricultural output occurred in the scheduled areas, and was largely due to reinvestments and expansion of productive lands that offset the capital flight that occurred between 1960 and 1964.[12]

Infrastructure investments were an important part of Kenya's development plan. Investment projects were dominated by construction of roads, railroads, power transmission lines, and government buildings.[13] These infrastructure investment, while providing important economic benefits, were motivated by the visible nature of these public investments.[b]

Industrial production was also promoted because of the visible nature of the growth. Infrastructure investments and some investments through state-owned corporations became part of development policy.[c] Trade protection was the single most important industrial policy aimed at creating a substitution away from imported consumer products toward domestic production. Visible aspects of Kenyatta's "African Socialism" included developing an African entrepreneurial

---

[b] The visible nature of a public project is not the stated reason for the investment, but infrastructure development exceeded all other sectoral development by 1970. Kenya: Into the Second Decade, p.429.

[c] State-owned enterprises include corporations and organizations, created through legislation or through policy, that are in effect controlled and financed by government. Many agricultural organizations in Kenya were officially co-operatives, but are *de facto* state-owned enterprises.

spirit in the modern sector.[14] Each of these aspects promoting industrial development are part of an economic pragmatism that guided Kenyatta's "non-policy" for growth and that dealt with issues as the need arose.

Visible industrial development was promoted even though the agricultural sector held the greatest potential for growth at independence in 1964, according to the World Bank.

> After reviewing the resources of Kenya, we have concluded that the country's rate of growth and improvement in the levels of living will continue to depend, in the next few years ahead, on developments in the agricultural sector. It must, therefore, be accorded the highest priority in the allocation of resources, both financial and technical, in the over-all program of development.[15]

This strong statement, however, was made in the context of the long period of time needed for many agricultural investments to yield full benefits.

> Kenya has yet to reap the full benefit of the work undertaken since [1955].... Mixed farming...has included the production of tree crops which take several years to reach maturity....But investment in sisal has not been maintained and plants already in the ground will soon become overage.[16]

These statements were made in 1963 and indicate that agricultural investments require many years to yield benefits and that these investments can be made worthless in a short period of time through neglect. Given the more visible nature of industrial investments, the political climate, and the need to serve the vested interests of a growing urban middle class, Kenya policies promoted industrialization.

3. *Effects of Policy* - Kenya's economy grew at 6.87% per year from independence until 1970. This growth was partially attributable to government policies and partly in

spite of the policies. The government encouraged domestic investment and administered a land reform that redistributed land and expanded the land base.

Government policies and rapid economic growth were part of an easy stage of development.[17] Most government investments were marginally productive relative to the marginal cost of raising taxes and relative to many private investments. Further investment could not be encouraged with the same policies without causing substitution away from other more productive uses. In addition, the revenue structure was far too narrow to support the expanding development budget that the government was using to promote investment.

The redistribution of European scheduled lands was motivated entirely by political necessity. Consequently, the land tenure system never developed into a rational one in economic terms. Land holdings were too small,[18] tribal rights in certain districts prevented settlement, the landless or urban poor with little agricultural experience dominated settlements, and title to the land was often in dispute.[19] These problems together with disinvestment prior to independence led to a continuing fall in marketed agricultural output for two years after independence.

The initial problems were temporary problems that eventually lessened, and real agricultural output later grew

at a very rapid pace (7.7%) through 1970.[d] The rapid grow is attributable to reinvestments by small and large farmers and to the improving farm practices of small farmers. Only half of the land was held as private land with title by the early 1970s, but a large sector of the farm society was producing for markets rather than for subsistence needs.[20] The land tenure reform created a market oriented agricultural sector, and this was necessary for reinvestments into the sector and for growth rates well above population growth rates.

The rate of domestic investment was higher than in most other countries. Domestic investment fell to 15% of GDP in 1964, but it rose to 20% by 1967 and remained at this level through 1970. High household savings reflect the willingness by Kenyans to participate in the new economy. However, much of the rapid growth of the economy is attributable to the reinvestments that followed the disinvestment that occurred just prior to independence.

Government development policy, while simply a reactive policy, created substitution among productive sectors and did not contribute to growth. The government development policy favoured the urban formal sector. This sector was synonymous with import-competing industrial production. The two main

---

[d] Marketed agricultural output grew at a rate in excess of 7.0% in this period. Subsistence output - production by households for households - grew only to match population growth. Kenya: Into the Second Decade, p.59 and p.448.

policy influences were trade protection for the industrial sector and high wage rates. Trade protection began as a means to encourage local industrial growth, but it soon developed as a means to improve Kenya's balance-of-payment position. High wage rates were part of several labour and social concessions to labour unions. The consequence, however, was to encourage capital intensive industrial production which inhibited employment growth.[21] The result of these policies created a substitution of some imported consumer products, but also a substitution away from labour intensive production and agricultural production.[22]

Government financing for development was as narrow as the benefits of development policies were short term. The initial efforts to finance development with local financial resources were good by developing country standards.[23] Government efforts to finance development by non-inflationary means could be considered successful until the early 1970s. Throughout the period, tax revenues were drawn from the visible monetary sector. This meant a reliance on urban income taxes, commodity excise taxes, and import duties. The tax system was elastic through 1970 - an elastic tax system is one where a percentage increase in GDP leads to a greater percentage increase in statutory, or built-in, taxes.[24] By the early 1970s, the statutory tax system was inelastic, though the overall tax structure was not.[25] Revenue growth was sustained by increases in visible taxes.

Kenya maintained control of growth in budgetary expenditures until the early 1970s. Together with a well-functioning tax system, Kenya did not have to depend on external or inflationary financing options. Macroeconomic policy, though not by design, created stability for the first ten years after independence. The economic stability was also in part due to political stability. Unfortunately, the political stability and the need to satisfy certain constituencies later contributed to budgetary problems.

Most aspects of Kenya's successful growth during the 1960s was attributable to an accidental collection of four events and policies rather than due to design of economic policy. First, revenue growth, while very good by developing country standards, was not sustainable. Second, government diligence in restraining expenditure growth eventually lapsed, given political pressures for expenditure growth. High growth following independence was partly due to reinvestments in areas where there were European disinvestments prior to independence. Third, investments in the agricultural sector were either reinvestments or investments at the extensive margin (through expansion of the land base) following redistribution of European lands. Fourth, infrastructure investment, while not a reinvestment, increases productivity once, so continuing infrastructure investment could not continually increase growth. Both of these investments were productive, but they were short term

efforts. All four of these major contributions to Kenya growth were not sustainable past the first decade following independence.

2.1.b Fiscal Imbalance and 1974 Oil Shock (1971-1975)

The great success of the 1960s raised expectations for the 1970s. The government development plan was based on projections of 7.5% annual growth. Growth slowed in the second period, however, to 2.5%. Growth slowed because government investments were no longer very productive, because government fiscal and monetary policy began to interfere with productivity, and because the 1974 OPEC crisis created the first major external shock to Kenya's macroeconomy. The policy climate of the 1960s inhibited growth and created Kenya's economic vulnerability to external influences.

Import-substitution continued to be the industrialization policy. The internal terms-of-trade had turned against agriculture by 1974 due to these policies.[26] The bias in favour of industrial production was sufficiently great that production for the domestic market was very profitable though socially unproductive. Indeed, the value of imported intermediate goods was greater than the value of goods for final consumption that had been previously imported.

Import-substitution polices, while intended to improve Kenya's external position, actually worsened the trade

balance. Agricultural growth had slowed to 1.8%, so it could not sustain the worsening foreign exchange problems caused by import-substitution and budgetary imbalance.

These problems occurred before the oil price shock of 1974. The trade balance was not sustainable, and the oil price shock precipitated a foreign currency crisis. The oil price shock did not create the external imbalance, but was such an obvious contributing factor that the oil price shock was seen to be the problem. The import-substitution policies actually became worse after 1974, turning the internal terms-of-trade further against agriculture, as the government tightened currency controls and increased tariff protection.

2.1.c Repeated External Shocks (1976-1979)

The third period (1976-1979), although a short period, featured three major external shocks: coffee price boom, demise of the East Africa Community, and a second OPEC crisis. There is no fundamental difference between this period and the previous period since the crises in this period masked the structural problems of Kenya's development policies just as the first oil shock masked problems in 1974. There was, however, a growing recognition that growth would not occur in the future as it had occurred during the first decade after independence.

Kenyan economic policy continued to be dominated by industrialization through import-substitution. Foreign exchange crises were met by increasing restrictions on

exchange and higher import duties. To a great extent, the import-substitution policies created the vulnerability to external influences.[27] The manufacturing sector depended on imported intermediate goods, yet produced mainly for a protected domestic market. Export sectors, primarily agricultural products, faced negative effective border protection in addition to having trouble attracting investment given the shift in the internal terms-of-trade.

Economic policy continued as it had since independence: as a reaction to current economic events. There was some recognition that exchange and trade controls produced long-term problems, but each Five Year Development Plan became progressively more optimistic about overall growth in spite of growing economic problems.[28] The government did not try to revise macroeconomic policy, but instead addressed specific problems as they arose.

In the agricultural sector, the government's approach to economic policy was to address land issues, institutional support, and other issues that were important to agricultural producers with small land holdings (smallholders). These policies were motivated by two related problems. First, population pressures on agricultural output were increasing and as a consequence Kenya began importing food stuffs by 1978. Agricultural policy was designed to increase agricultural production, and this included addressing the factors, including government policies, which were inhibiting

agricultural growth. Second, agricultural lands were not well distributed, so population pressures in areas with very high population density were leading to a growing class of landless and very poor agricultural workers.

The government of Kenya was beginning to recognize problems in the agricultural sector and was directing policy towards output growth. However, the fundamental problems of the anti-export bias and shift of the internal terms-of-trade against agriculture were not addressed by government policy. The fundamental problems did not have to be addressed immediately, because of the windfall gain from the world coffee price boom between 1976 and 1978. The negative effects of macroeconomic policy in the agricultural sector continued because fiscal policies continued to be motivated by immediate needs and because various external shocks masked many of the underlying problems.

2.1.d Agricultural Policy Adjustment (1979-1984)

The Kenyan government began to address the fundamental problems in the agricultural sector in the fourth period (1979-1984). Droughts in 1979, 1980, and 1984 enhanced the urgency to promote agricultural growth. The efforts to promote growth were directed to sector specific issues. Many macroeconomic policies persisted through this period, however, that negatively affected the agricultural sector.

The factors promoting rapid agricultural growth in the 1960s - reinvestments and land redistribution - could not be

exploited to accelerate growth in the late 1970s. By 1980, 75% of output was produced by the smallholders who accounted for 66% of the land and 70% of employment.[29] These farmers were more productive than large estate farms, but there was limited scope for continued redistribution. The positive effects of land redistribution were diminishing, and these effects would continue to diminish without adjustments to macroeconomic policy. Factors that could lead to accelerated growth depended on raising output of smallholder production.

The Kenyan government made many efforts to provide policy support to the agricultural sector. Policy support was provided through investment projects and minor redistribution schemes. There were mixed results of these policy efforts, because of a basic problem: the internal terms-of-trade were turning against agriculture throughout the period.[30]

The government recognized that smallholders responded to price incentives and, accordingly, kept taxes very low, except those on sugar.[31] The state-controlled marketing boards, however, offered low prices to producers. This low price was a consequence of a "cheap food" policy of the government since independence, rather than an attempt to extract revenues from agriculture.[32] Indeed, the marketing boards operated too inefficiently to act as an indirect tax collection agency.[33] Nonetheless, the total effect of tax and marketing policies was that food production was taxed

more heavily than non-agricultural production.

The total effect on exportable crops was significantly worse than for food crops.[e] Export crops were also marketed through state-controlled monopolies, but these crops were not subject to policies in support of providing cheap food to urban centres. Export crops faced explicit export taxes, but the main indirect tax on exportable crops was due to the overvalued exchange rate. There was a major devaluation in 1981 and repeated devaluations after that, but export prices were between 20% and 50% undervalued.[f]

2.1.e Continuing Fiscal Imbalance (1985-1991)

Kenya did not fully acknowledge the effect of an overvalued exchange rate on agricultural production through 1985. Kenya devalued the exchange rate in 1981 as conditions for Structural Adjustment Loans from the World Bank and the government began making periodic devaluations through 1985, but the overall set of macroeconomic policies continued to constrain agricultural growth. Fiscal policy continued to be used to protect industrial production, trade policy continued

---

[e] Calculations of the effective tax on economic sectors are contained in Appendix E. The total effective tax on industrial goods varied between -0.25% and 1.72%, on food crops varied between 0.52% and 1.06%, and on exportable crops varied between 2.26% and 10.56%. The total effective tax on exportable crops has been above 5% since 1973.

[f] Export prices were under-valued using import parity as a measure. Import parity is a measure of trade bias and is achieved when the domestic price of domestic production is equal to the domestic price of imported production. Kenya: Agricultural Sector Report, (Vol II), p.155.

to be an attempt to constrain imports, and monetary policy continued to be inflationary given perennial government budget deficits.

Agricultural policy conditions were better than during the previous decade, but macroeconomic policy continued to be formed in reaction to the consequences of other policies. The effect of macroeconomic policy continued to turn the internal terms-of-trade against rural sectors.[34] The government was lowering import restrictions and directly supporting the agricultural sector, but the internal terms-of-trade were still against agricultural sectors. Agricultural policy was underdeveloped in terms of institutional support, and existing institutions had been established mainly for large farm producers.

The fiscal policy set was the destabilizing force for the entire economy as well as for the agricultural sector.[35] The government continued to modernize and industrialize the economy, and to promote agricultural output. Industrialization was occurring at a slow pace relative to population growth, and the government met the demands for job growth by expanding the public sector.[36] Agricultural development expenditures were undermined to a great degree by the inefficient state-owned marketing system.[37] The tax-base was too narrow to support these growing expenditures,[38] so the central government budget deficit was growing (4.7% of GDP in 1990 and 6.8% of GDP in 1991).[39]

The fiscal deficit was financed partly by foreign aid, but the main source of financing came through inflationary borrowing from the Kenya Central Bank. This inflationary monetary policy produced devaluation pressures on the exchange rate. Kenya devalued the pound frequently, but the exchange rate continued to be overvalued. Indeed, the premium on the exchange rate in parallel markets was on average higher in the 1980s than anytime in the past. The bias against exports continued to be very high.

2.2 A Neo-Classical Theory of Development

A neo-classical theory of economic development relies on the relative scarcities, the relative prices, and the various factors or government policies that affect relative prices in order to explain faster or slower economic growth. Growth will be greatest when relative prices match relative scarcities so that the relative profitability of alternative investments is the same as the relative social productivity of the investments. The role of government in promoting economic development is to eliminate price distortions and make socially productive investments. Given the relative scarcities of land, labour, and capital in a poor and rural economy like that in Kenya, socially productive investments (whether made by private interests or by the government) will be in the agricultural sector.

The Neo-Classical theory of economic development

presented here is separated into two main components. The first component is about economic growth and concerns growth of capital and of output. The second component is about economic growth and the factors of growth in poor economies.

2.2.a Economic Growth

The production of goods and services depends on land, labour and capital. Kenya's land base is effectively stable and the population is growing at a rapid pace. Economic growth of output beyond population growth, therefore, depends on growth of the capital stock. Investment is the fundamental economic activity that leads to growth, so the theory of economic growth is fundamentally about the economic activities and conditions that promote investment into the capital stock.

Aggregate output grows with the capital stock and with increases in the productivity of land and labour. The productivity of land and labour increases as greater amounts of capital are applied to land and labour. Productivity also rises with the application of new technologies. New technologies enter the productive process through new capital investments, so economic growth depends absolutely on investment in the capital stock.

Investment is the necessary activity that leads to growth, but not all investments are productive and some investments are more productive than other investments. A relatively unproductive investment implies that aggregate

output would have been higher if the best alternative investment had been pursued instead: *i.e.*, the relatively unproductive investment has a high opportunity cost. While capital investment is the fundamental activity leading to growth, an investment into labour-saving capital items in a labour abundant economy, for example, will slow economic growth.

Economic growth is slower than necessary when explicit or implicit incentives are provided by government policy or when significant externalities distort relative prices. Private investors will direct resources to the most profitable use rather than to the most socially productive use. The most profitable investments are the same as the most socially productive investments only in the absence of price distortions.

Specific economic policies to accelerate growth of output depend on the government eliminating price distortions, eliminating other externalities, or creating the necessary conditions so relative prices will reflect relative scarcities in the economy. A Neo-Classical theory of development identifies these conditions for less developed countries, but the theory fundamentally relies on the accumulation of capital to explain growth of aggregate output.

2.2.b Economic Growth in Poor Economies

Economic development cannot occur without growth. All

aspects of development must, in some way, contribute to growth. The theory of economic development is an application of the theory of economic growth to the peculiar aspects of less developed countries.

There are four main implications from growth theory for less developed countries. First, productive investments should occur in agriculture. Second, government should eliminate price distortions, including trade biases. Third, there are significant opportunities for government investment into public goods. Fourth, investments will become more productive in non-agricultural sectors over time.

Investments will be more productive in labour-using sectors rather than in capital-using sectors, because Kenya faces relative scarcity of physical capital. The agricultural and non-traded goods sectors are labour-using sectors whereas the manufacturing sector is a more capital-using sector in Kenya. Economic growth will be greater if investments are made predominately in these labour-using sectors.

Alternative theories of development argue that productive investment opportunities have been exhausted in the agricultural sector and that investments should be encouraged in non-agricultural sectors. This was a common argument in development literature at the time of Kenyan independence in 1964.[40] The idea was that labour could be drawn into modern and industrial production without causing

agricultural production to fall, since there were little or no productive opportunities in the traditional agricultural sector. Empirical evidence since has demonstrated that the agricultural sector was more productive in Kenya[41] as well as in most other less developed countries.[42]

In an ideal theory of development price distortions should be eliminated so that investments will occur in the most socially productive opportunities. This is the second implication of growth theory for governments of developing countries. Identifying price distortions, however, is a very difficult task for governments in developing as well as in more developed countries. The efforts of developing countries in identifying productive investments on behalf of private interests through economic planning exercises are very poor.[43] The policy implication, therefore, is for developing countries to avoid introducing new distortions with taxes, subsidies, and other policy instruments.

An important relative price for Kenya was given by the external terms-of-trade. Kenya is a small open economy that depends on agricultural crops for most of Kenya's exported production, but the government created a situation where prices created a trade bias in favour of imports. Many of these effects were noted above. An additional effect for many less developed countries is that a trade bias changes the technology inherent in the accumulated capital stock. In Kenya's case, the trade bias encouraged accumulation of

labour-saving technologies that are socially unproductive for a labour-abundant economy.[44]

The third implication of growth theory for development is for government to invest in public goods. There are many possible investments, including investments in the public service. This kind of investment becomes more important as an economy grows, because the identification of price distortions and public goods becomes more difficult as more public sector capital is accumulated.

For very poor countries with limited institutional infrastructure, some public sector investments are relatively easy to identify. For example, the annual rates of return to public agricultural research are reported to be between 20% and 130% by various studies for less developed and more developed economies.[45] Establishing defensible property rights for agricultural lands is also an extremely productive public investment because it encourages private investments in agricultural production.[46] The benefits of public expenditures to improve legal frameworks are identifiable, but the implementation of these improvements are very difficult. Mistakes made by Iran in creating a reliable land registration system was cited as one factor contributing to the Islamic Revolution.[47] As a less developed country's institutional capabilities grow, new public investments are possible. Kenya continues to establish the legal framework for owning land twenty-five years after independence and

twenty-five years after identifying the problem.[48] The public benefits of land reform efforts by government could not have been realized if the government did not start with smaller and simpler aspects of land reform during the last twenty-five years.

Profitable private investments also change over time. The fourth implication of the theory of economic growth for economic development is that sectoral share of production changes as capital is accumulated. Kenya's comparative advantage in the agricultural sectors will change as the economy develops. The population mainly lives and works in rural areas, and the population depends on subsistence agricultural production for employment and food. These basic characteristics mean that socially productive investments are more likely to occur in the rural sectors of the economy.

As the economy grows, which means per capita income grows, the population will begin to demand goods and services other than food. The demand for food is inelastic, but Kenya is a very poor nation that produces food for subsistence. Investments are relatively productive in the rural sectors where increases in output have the greatest impact. Also, subsistence production is where most capital, especially human capital, was already in productive use. Output per capita could not grow quickly without promoting the activities Kenyans were already engaged in: namely, agriculture and other rural production.

As output per capita grows, consumption shifts from low income elasticity goods (subsistence food crops and non-traded goods) to higher income elasticity goods and services (other food and consumer goods). Consumer goods are produced in non-agricultural sectors. These goods cannot have a significant demand until incomes from the agricultural sector rise, because this is where the great majority of Kenyans live. The one economic argument in Kenya's development policy set - that capital should be accumulated in non-traditional and non-agricultural production - forced manufacture of goods for which there was no demand.

Albert Hirshman suggests unbalanced investments as a policy prescription for development. This idea is based on supply creating its own demand.[49] While there is some demonstrated merit to this approach, the evidence is always for microeconomic efforts and when a latent demand exists. The evidence at macroeconomic levels is overwhelmingly bad, partly due to misapplication of Hirschman's idea and partly because of a belief that agricultural producers did not respond to price signals.[50] After reviewing the empirical evidence, Ian M.D.Little noted that

> A priori postulation and premature stereotyping ran far ahead of empirical research. Hypotheses were accepted as facts, and it has taken years of patient work to undermine the myths thus created.
>
> One wonders why anyone thought that the pattern of LDC (Less Developed Country) output was inflexible. A priori and historical considerations should have suggested the opposite. Agriculture was much more important in LDCs than in MDCs (More Developed Countries), and farm output is more flexible than factory output.[51]

The Neo-Classical theory of economic development depends

on capital accumulation and on relative prices that reflect relative scarcities in order to direct investment toward its relatively productive use. At independence, the relatively productive use of new capital was in the agricultural sector.

2.3 Macroeconomic Policy for Development

The theory of economic development includes macroeconomic policy issues in addition to the policy implications identified in the theory of economic growth. Macroeconomic policy involves real factors, which are those discussed in the theories of growth and development, and involves nominal factors as well. Macroeconomic policy includes fiscal policy (expenditure and taxation policies), monetary policy, and exchange rate policy. These macroeconomic policies are the instruments that the Kenyan government could use to achieve its goals.

As noted in the first section, the Kenyan government did not address the fundamental interdependence that existed among its macroeconomic policies, and, as a consequence, it failed to reach most of its goals. Expenditures were directed towards non-agricultural investments. Taxation policy was guided by the need to pay for high expenditures and to shift resources to the non-agricultural sectors. Monetary policy was inflationary and merely a result of the imbalance between expenditures and revenues. Exchange rate policy was also a result of other macroeconomic policies.

Exchange rate policy was actually a result of conflicting policies: a pegged exchange rate lowered imported input costs for industrial production, but expansionary monetary policy created pressures for continued devaluation.

Growth and development depend on stable macroeconomic policy to encourage capital accumulation and to encourage investments where the opportunity cost is low. Every aspect of Kenya's macroeconomic policy either created instability or encouraged investments in relatively unproductive investments for the country as a whole. How each aspect of Kenyan macroeconomic policy created this situation is described below.

2.3.a Fiscal Expenditures

Government expenditures are part of macroeconomic policy, but government expenditures produce mainly microeconomic effects. Specific investments will produce specific returns to the sector that benefits from the investment. There are indirect benefits or costs to other sectors from these investments, but these indirect effects are not the reason that expenditure policy is part of macroeconomic policy. Government investments, rather, have macroeconomic effects when these expenditures change the relative productivity of a sector or change the relative prices between sectors. Government expenditures produce benefits by contributing directly to aggregate output, or by lowering costs for producers in one sector relative to

another sector.

Kenyan government projects, as noted above, have produced direct benefits in non-agricultural sectors and have produced indirect costs in agricultural sectors with the composite effect of lowering aggregate output. Several government investments were dedicated to the agricultural sector, but the total effect of all projects was negative for agricultural sectors and positive for non-agricultural sectors. Overall economic growth was slower than possible, because the majority of governments' investments were relatively unproductive.

Kenya enjoyed rapid economic growth in the first decade after independence. Growth was slower than possible because investments were relatively unproductive, but rapid growth was still achieved. Government investments produced rapid growth, because there was such a low level of government capital accumulation in the first years after independence that almost all investments were highly productive. The high returns to government investment did not continue once the most obvious and productive investment opportunities were exhausted. Returns to government investment diminished as capital was accumulated.

A problem with the early growth was that government expenditures put aggregate output on a lower growth-path than what was possible. Biased government expenditures act as productivity shocks on aggregate output.[52] Kenyan

government expenditures were biased towards non-agricultural sectors that were relatively less productive than agricultural sectors. Growth in the first decade after independence was slower than possible and Kenya was necessarily on a lower growth-path.

Growth after the first decade was affected in two ways. First, lower aggregate output means growth continues from a lower level. Second, growth will continue to be slower than possible until the capital stock employed in different sectors shifts towards the most socially productive use. In addition, these problems worsen as government expenditures maintain relative prices that deviate from relative factor scarcities.

2.3.b Fiscal Taxation

Taxation policies may produce sector biases that will have similar macroeconomic effects just as the biases created by fiscal expenditure policy. Taxes will have an overall negative wealth effect also, but sufficient revenues must be collected for government's recurrent expenditures. The macroeconomics of taxation policy involve effects on relative prices, effects on wealth and investment decisions, and effects on stability.

Taxation policies, as well as subsidies, have an immediate effect on relative prices.[9] Taxation of one sector

---

[9] Taxes and subsidies have exact opposite effects. For simplicity, therefore, taxation policy refers to both taxes and subsidies. The effects of taxation policy are the

relative to another will cause resources to shift between the sectors. If a relative price change due to tax policy causes resources to shift to relatively unproductive uses from a social point-of-view, aggregate output will fall.

An increase in taxes will not cause resource shifts if the tax increase is applied across all sectors and resources. Kenya's tax system operated too poorly to achieve this, and the government was trying to change relative prices as part of development policy. Taxation policy was partly driven by the development policy to promote non-agricultural and industrial production, but policy was also driven by the difficulty in raising revenues. Kenya taxed visible portions of the economy such as exports and certain high volume commodities. A significant portion of the economy did not depend on cash transfers or on receipts even when cash was used. The government had to raise revenues wherever possible, so it taxed visible trade excessively. Since exports, a visible economic activity, were dominated by agricultural exports, Kenya's approach to tax visibles increased the effective taxes on agriculture relative to non-agricultural enterprises.

Kenyans knew that taxes would continue to rise, since the government budget was in perennial deficit. The spectre of future taxes lowered investment by Kenyans and by non-residents in Kenya. Taxes did rise, but new or higher taxes

---

effects of taxes net of subsidies and other transfers.

produced new or exaggerated distortions. The tax system did not function well, so taxes rose on some items, but not on others. In addition, the government imposed controls on international capital flows when financial crises occurred.[h] The fiscal imbalance that existed between expenditures and revenues increased risk for private sector investors, so investment fell.

2.3.c Monetary Policy

Monetary policy can promote growth and development by maintaining macroeconomic stability. Monetary functions of the government cannot directly increase aggregate output. A stable macroeconomy reduces future risk and thereby lowers the cost of investing. Rather than creating an environment conducive to investment the Kenyan government used monetary policy in an attempt to compensate for the imbalance in the government's fiscal accounts.

The imbalance between expenditure and revenue policies produced monetary effects. The Kenyan government borrowed to cover its annual budget deficits. The government quickly exhausted non-inflationary sources of financing, so the budget imbalance forced monetary policy to become inflationary.

The fiscal imbalance, the government budget deficit, is not necessarily inflationary if the government can borrow

---

[h] Note the behaviour about import controls that occurred through the 1970s.

from the private sector or from non-residents. In the first decade after independence, the government constrained expenditures very well compared to most other less developed countries at that time.[53] For this reason, government was able to borrow from the private sector.

Non-inflationary borrowing can continue as long as the private sector and non-resident sector will lend to government. The government's fiscal imbalance started to become worse in the early 1970s, and the likelihood of higher taxes was increasing. Government investments were still productive, but non-productive consumption by government was increasing as the size of government grew. The private sector no longer wanted to lend to government, so the central government increasingly borrowed from the Central Bank.

Borrowing from the Central Bank was inflationary because the increase in government bonds held by the Central Bank was accompanied by an increase in the supply of money. The private sector was unwilling to hold the increase in the stock of money, so prices rose. Inflation benefits the government by lowering the real value of outstanding debt. In general, this did not appear to be a motive of the Kenyan government through the 1960s and 1970s. There have been no comments about whether the government was trying to lower the real value of the debt in the 1980s and 1990s. Rather, it is likely that Kenya's monetary policy developed because of the imbalance between government expenditures and revenues.

The government fiscal imbalance was not inflationary in the 1960s because the private sector, in the main, financed the government and because any increase in the stock of money was willingly held due to high growth in real income. After 1970, economic growth slowed. The private sector was less willing to hold increases in the stock of money and less willing to lend to government. The private sector was increasingly trying to hold foreign currency through the 1970s. The government, in response, tried to restrict foreign currency holdings.

Monetary policy developed in response to fiscal policy and eventually created a situation where the foreign exchange rate was undervalued. Chapter 3 provides a detailed analysis of the interaction between monetary policy, exchange rate policy, and the rate of growth of domestic output.

Chapter 2: Endnotes

1. International Bank for Reconstruction and Development, The Economic Development of Kenya, Johns Hopkins Press (Baltimore, 1964), pp.341-343.

2. *Ibid*, pp.284-285.

3. *Ibid*, pp.63-65.

4. *Ibid*, pp.14-15.

5. *Ibid*, p.2.

6. *Ibid*, p.42.

7. World Bank, Kenya: Into the Second Decade, Johns Hopkins University Press (Baltimore, 1975), pp.61-63.

8. The Economic Development of Kenya, p.153.

9. Norman N. Miller, Kenya: the Quest for Prosperity, Westview Press (Boulder, 1984), pp.37-38.

10. *Ibid*, p.38.

11. Kenya: Into the Second Decade, p.456.

12. *Ibid*, p.403.

13. *Ibid*, pp.36-37 and pp.62-63.

14. Kenya: The Quest for Prosperity, p.57.

15. The Economic Development of Kenya, p.63.

16. *Ibid*, p.41.

17. Ian M.D. Little, Economic Development: Theory, Policies and International Relations, Basic Books (New York, 1982), pp.140-141; and, Bruce Herrick and Charles P. Kindleberger, Economic Development (Fourth Edition),

McGraw-Hill (Toronto, 1983), p.423.

18. Kenya: Into the Second Decade, p.456.

19. Kenya: The Quest for Prosperity, pp.48-49.

20. *Ibid*, p.50.

21. Kenya: Into the Second Decade, pp.18-19.

22. Kenya: The Quest for Prosperity, p.119.

23. Kenya: Into the Second Decade, p.8.

24. *Ibid*, p.170.

25. David G. Greene, Kenya, Growth and Structural Change, The World Bank (Washington D.C., 1983), p.34.

26. *Ibid*, p.389.

27. Kenya: Into the Second Decade, p.299.

28. Kenya: The Quest for Prosperity, p.111.

29. World Bank, Kenya: Agricultural Sector Report (Vol. I), World Bank (Washington, D.C.; January 7, 1986), p.*iii*.

30. World Bank, Kenya: Agricultural Sector Report (Vol. II), World Bank (Washington, D.C.; January 7, 1986), p.11.

31. *Ibid*, p.1.

32. *Ibid*, p.151.

33. Barbara Grosh, Public Enterprises in Kenya, L.Rienner (Boulder, Co.; 1991), p.3.

34. World Bank, Kenya: Reinvesting in Stabilization and Growth Through Public Sector Adjustment (Vol. I), World Bank (Washington, D.C.; January 10, 1992), p.183.

35. *Ibid*, p.*viii*.

36. *Ibid*, pp.14-15.

37. *Ibid*, p.4.

38. *Ibid*, p.28.

39. *Ibid*, p.*ii*.

40. Little, Economic Development, pp.86-87.

41. T. Ademola Oyejide, "Effects of Trade and Macroeconomic Policies on African Agriculture" in Romeo M. Bautista and Alberto Valdes (eds.), The Bias Against Agriculture: Trade and Macroeconomic Policies in Developing Countries, ICS Press (San Francisco, 1993), p.246.

42. Little, Economic Development, p.42.

43. *Ibid*, pp.125-127.

44. World Bank, Kenya: Growth and Structural Change, p.*xii*.

45. Yujiro Hayami and Vernon W. Ruttan, Agricultural Development: An International Perspective (Second Edition), Johns Hopkins University Press (Baltimore, 1985), pp.63-64.

46. For example, secure tenancy legislation can eliminate uncertainty of tenure. Traditional tenancy arrangements, therefore, will no longer carry disincentives for investment. P.K. Bardhan and T.N. Srinivasan, "Cropsharing Tenancy in Agriculture: A Theoretical and Empirical Analysis," American Economic Review 61:1 (March, 1971). p.48; and, Steven N.S. Cheung, "Private Property Rights and Sharecropping," Journal of Political Economy, 76 (December, 1968), pp.1107-1108.

47. Mohammad G. Majd, "Land Reform Policies in Iran," American Journal of Agricultural Economics, 69:4 (November, 1987), p.843.

48. World Bank, Agricultural Sector Report, p.53.

49. Albert O. Hirshman, Strategy of Economic Development, Yale University Press (New Haven, Conn.; 1958).

50. T.W. Schultz. Transforming Traditional Agriculture, Chicago University Press (Chicago, 1964), p.4.

51. Little, Economic Development, p.119.

52. Alain de Janvry, "Social Structure and Biased Technical Change in Argentine Agriculture", in Hans P. Binswanger and Vernon W. Ruttan (eds.) Induced Innovation: Technology, Institutions, and Development, Johns Hopkins University Press (Baltimore, 1978), p.301.

53. Kenya: Into the Second Decade, p.170.

Chapter 3

A Theory of Exchange Rate Fluctuation

The exchange rate is the relative price of foreign currency in terms of the domestic currency. Exchange rate policy can only produce real effects when the policy causes this price to deviate from its equilibrium value. The long-run equilibrium value of the exchange rate is the value that maintains external balance. External balance occurs where the balance-of-payments is sustainable in the long term. External balance is also described by equilibrium in the market for foreign currency, where supply of foreign exchange is determined by credits on the current account and demand of foreign exchange is determined by debits on the current account.

There are limitations of this theory that explains exchange rate fluctuations in currency used for trade and lending rather than for speculation. Speculative movements occur because of changes in a country's ability to sustain a current account deficit, government fiscal imbalances, or changes to the exchange rate regime. These are issues of the perceptions and expectations of exchange market participants and, therefore, are already part of the "routine business of

the exchange market."[1] In addition, this theory of exchange rates is presented in the context of long-term economic growth and development. Speculative changes, and the efforts to minimize unnecessary speculative fluctuations, are near term economic occurrences. The short-term and other seasonal fluctuations of exchange rates, while important economic phenomenon, are excluded in favour of the simplicity of annual data.

There are three theories of exchange rate fluctuations that offer somewhat competing explanations of the mechanism and significance of exchange rate deviations from equilibrium values. The first approach is an elasticity approach that is essentially used to explain the effect of exchange rate devaluation or revaluation on the balance-of-payments. The key component of the elasticity approach is the Marshall-Lerner condition regarding the aggregate of sector elasticities of demand for imports versus the elasticities of demand - from abroad - for exports. The second approach is the absorption approach that also attempts to explain the effects of devaluation of the balance-of-payments. The absorption approach deals specifically with aggregate output and demand, as well as other macroeconomic aggregates, in order to avoid tautological problems of summing partial equilibrium elasticities, which are microeconomic variables, to obtain macroeconomic implications. The third approach is a monetary approach. The proposition of the monetary

approach is that the exchange rate is a nominal variable determined by the relative supplies of national monies. As such, fluctuations in this variable do not generate real effects.

These three approaches may be synthesized in a Neo-Classical economic theory. A change of productivity in one sector in the economy relative to productivity in another sector will change the relative prices between the sectors, and the overall productivity of the economy will change depending on the elasticity of substitution among these sectors. Such changes in the productivity of the economy as a whole will produce depreciation or appreciation pressures on the exchange rate. Absorption describes adjustment to external shocks where these shocks do not produce direct effects on the prices in one sector relative to another, such as world real interest rates, and before the indirect effects of shocks are absorbed into sectoral prices. Absorption, therefore, describes a near term situation, where external shocks cause exchange rate fluctuations that are separate from sectoral productivity. An inflation in Kenya relative to the rest of the world will cause the exchange rate to depreciate assuming the rate is flexible, but this does not imply a relative price change between imports and exports.

This chapter is organized into two sections. The first section outlines the three approaches to exchange rate and balance-of-payments adjustment. The second section details

the synthesis of these three approaches.

3.1 Alternative Approaches to Exchange Rate Adjustment

There are many theories of exchange rate fluctuation,[a] but only three approaches are presented here. Many theories are theories of exchange rate determination in the context of flexible exchange rates rather than of exchange rate adjustment given balance-of-payments problems. Modern theories are extensions of the balance-of-payments approaches that dominated theoretical discussions prior to the collapse of the Bretton Woods System. Kenya's exchange rate was a managed peg through 1994, so the issues of devaluation and revaluation can be explained in terms of balance-of-payments adjustments rather than in terms of flexible exchange rate adjustment. In addition, many modern theories attempt to more carefully describe short term fluctuations that will not be discussed here in the context of Kenya's long term growth.

3.1.a Elasticity Approach

The Elasticity approach is a microeconomic approach that relies on sectoral elasticities to predict the effects of an exchange rate adjustment on the balance-of-payments. The domestic price level for tradeable goods moves with world prices, tariffs, and exchange rates. The demand and supply

---

[a] Some of the common theories are the Purchasing Power Parity theory, the Monetary theory, the Asset Market theory, the Specie-flow theory, the Elasticity theory, the Absorption theory, and the Portfolio theory. Some of these theories are variations on a theme.

response to domestic price changes caused by exchange rate movements will vary from sector to sector, as measured by supply and demand elasticities. An exchange rate depreciation will induce a balance-of-payments improvement, according to the Elasticity approach, if the sum of export and import elasticities exceeds one.

This condition, regarding the sum of elasticities, is the Marshall-Lerner condition. The sum of import and export elasticities reaches a critical point at one. If the sum is greater than one, then an exchange rate depreciation improves the balance-of-payments (*e.g.*, causes a balance-of-payments deficit to fall). If the sum is less than one, then a depreciation causes the balance-of-payments to worsen. This condition can be demonstrated beginning with a simple balance-of-payments identity that is manipulated to derive an export and import elasticity form.[2] The form is the Marshall-Lerner condition.

The Elasticity approach to the balance-of-payments is based on partial equilibrium elasticities. As such, the Elasticities approach fundamentally cannot predict exchange rate movements given shocks to the economy. A partial equilibrium framework holds economic conditions constant, except for the exchange rate. This implies that the capital stock and national income, among all other macroeconomic variables, are held constant. *Ceteris paribus* assumptions are not useful when microeconomic variables are aggregated

into macroeconomic variables.

In spite of this criticism, the Elasticities approach highlights the different effects that exchange rate fluctuations have on each sector in the economy. An exchange rate depreciation may have a positive effect on production in one sector of the economy and have a negative effect on production in another sector. The microeconomic elasticities within a sector will provide an indication of the effects of exchange rate fluctuation on supply and demand in that sector.

3.1.b Absorption Approach

The Absorption approach is a macroeconomic approach that explains the effect of exchange rate adjustment on the balance-of-payments in terms of the components of GDP rather than in terms of sectors of the economy. The Absorption approach is a Keynesian theory of exchange rate fluctuation developed by S.S.Alexander (1952). The approach was developed as a criticism of the Elasticity approach which is a microeconomic (or Marshallian) based theory of exchange rate fluctuation.

The Elasticities approach depends on microeconomic variables, so does not account for macroeconomic effects on income, consumption, or investment. In addition, to the extent that sector elasticities are partial elasticities, they ignore other direct or indirect effects. Alternatively, if the elasticities are total elasticities, then the

Elasticity approach predicts the effect of exchange rate adjustment *ex ante* using elasticities that may only be determined *ex post*.[3] Other macroeconomic effects are not considered. Yet, for an exchange rate depreciation, income from exports will rise, consumption of imports will fall, and total investment will rise or fall, among other effects. A macroeconomic theory of exchange rate fluctuation, according to Alexander, must explain how a change in the exchange rate becomes absorbed into the macroeconomy.

Alexander is credited with developing the Absorption approach, but macroeconomic effects of exchange rate fluctuation were discussed earlier by Joan Robinson and Fritz Machlup, among others.[4] Absorption of an exchange rate fluctuation in the macroeconomy has to involve the components of GDP since the balance-of-payments cannot change unless at least one other component changes as well.

$$Balance\text{-}of\text{-}Payments = Y-(C+I+G) \qquad 3.1$$

This is a Keynesian approach that requires an explanation of how and why other components change. The explanation by Robinson and Alexander was that of a rise or reduction in the autonomous portion of Keynesian aggregate demand.

There has to be an endogenous expenditure-switching mechanism in a Keynesian approach. There are several postulates about an expenditure-switching mechanism, but the debates were never resolved.[5] The Absorption approach had

no microeconomic foundation and did not address sectoral shifts. Further, the Absorption approach was a Keynesian approach and was subject to monetary criticisms about the exchange rate as a nominal variable. A rise or fall in the exchange rate produces no real effects unless the fluctuation produces a relative price change.

3.1.c Monetary Approach

The Monetary approach to balance-of-payments adjustment and exchange rate fluctuation rests on the premise that the exchange rate is a monetary variable. Monetary shocks to the economy may affect the exchange rate, but have no effect on the balance-of-payments. Real shocks will affect the balance-of-payments and may affect monetary variables by affecting relative prices.

The precise relationships among macroeconomic variables depends on whether the exchange rate is fixed or flexible. If the exchange rate is flexible and the monetary authority prints money to finance a government deficit, for example, then the printing of money will produce an inflation for non-traded goods and the exchange rate (defined as the domestic currency price of foreign exchange) will rise. As a consequence the domestic price of traded goods rises along with non-traded goods prices, there will be no relative price changes. If the exchange rate is fixed, then the printing of money will cause a draw-down of foreign currency reserves so that real money balances remain unchanged once full

adjustment has occurred.

If there is a real disturbance that creates a balance-of-payments surplus or deficit, then the relative price between domestically produced and goods produced abroad will change. If the exchange rate is flexible, then the balance-of-payments disequilibrium will be resolved by an exchange rate adjustment. The exchange rate will appreciate if the balance-of-payments is in surplus and the exchange rate will depreciate if the balance-of-payments is in deficit.

If the exchange rate is fixed, then adjustment occurs in the stock of foreign reserves. A balance-of-payments surplus leads to rising foreign exchange holdings, whether privately held or held by the monetary authority. A balance-of-payments deficit leads to drawing down of foreign reserves. The situation is only sustainable so long as reserves are positive. As reserves are drawn down, there will be increasing pressure for a depreciation of the exchange rate.

There are many qualifications that need to be made on this simple description of the Monetary approach. These qualifications and most criticisms of the Monetary approach will be addressed in the following section that synthesizes the Elasticities, Absorption, and Monetary approaches to exchange rate fluctuations.

3.2 Synthesized Approach to Exchange Rate Fluctuation

The synthesized theory of exchange rate fluctuations is

essentially a monetary theory that accounts for sectoral responses and accounts for absorption of exogenous shocks. The exchange rate is a nominal variable that moves with inflation and real shocks, when flexible. If the exchange rate is fixed, then adjustment occurs in foreign reserves. If there is intervention to prevent adjustment of the exchange rate or of foreign reserves, the intervention prevents adjustment by creating a price distortion and necessarily causes resources to become inefficiently distributed.

The effect of this price distortion or of a shock on productivity depends on the sectoral own-price and cross-price elasticities of supply and demand. Given a shock there will be a shift of resources away from relatively less profitable sectors and a shift of demand away from relatively expensive goods. An adjustment occurs whether there is intervention or not. Net exports will change in each tradeable goods sector and the balance-of-payments will change, also.

The synthesized theory is a Neo-Classical theory. This implies that the effects of an exogenous shock will be determined by how relative price changes induce resource shifts. There may be shorter term effects from certain exogenous shocks if these shocks induce responses to the autonomous components of macroeconomic variables, however. These changes, such as income-redistribution, money-illusion,

or real-balances effects, will affect aggregate consumption or investment. These changes are realized before resources shift between sectors in response to relative price changes. The changes of the autonomous component in aggregate variables are changes of absorption. A change in absorption, by identity, means that the balance-of-payments has changed producing pressure for the exchange rate to adjust also.

A precise explanation of exchange rate or equivalent adjustments follows in Section 3.2.a. A description of sector effects and the effects of other relative price changes on the exchange rate is contained in Section 3.2.b. How absorption may be included in this Neo-Classical theory of exchange rate fluctuation is described in Section 3.2.c.

3.2.a Exchange Rate Adjustment

Exchange rate adjustment occurs in response to nominal shocks, real shocks, some of which are the result of government policies. Adjustment will occur either in the exchange rate, in foreign reserve holdings, or in parallel market activity. Adjustment occurs in the exchange rate if it is flexible. If the exchange rate is fixed, then adjustment occurs in foreign reserve holdings. If the exchange rate is fixed and foreign reserves are zero or fixed, then adjustment occurs in parallel market activity. Adjustment will necessarily occur given nominal or real shocks.

1. *Nominal Shocks:* The exchange rate and foreign

currency reserves are nominal variables. A nominal shock, such as inflationary monetary policy, will cause a flexible exchange rate to rise (*i.e.*, causes the domestic currency to depreciate) by the same amount as all other prices. There are no relative price changes and, therefore, no incentive to shift resources from one activity to another. The exchange rate rises because the demand for domestic currency falls relative to the demand for foreign currency. The price of foreign currency - the exchange rate - rises until the balance is reached in the foreign exchange market.

Residents were unwilling to hold the additional domestic currency initially because of the monetary shock, preferring to hold foreign currency instead. This bids up the domestic price until residents were willing to hold the additional domestic currency. The domestic price of traded goods is determined by world prices, taxes and exchange rates according to:

$$P = (1+t)\varepsilon\overline{P} \qquad 3.2$$

where: P = domestic price level, ε = exchange rate,
t = ad valorem taxes, and $\overline{P}$ = world price level.

The price of traded goods are determined by world prices and a higher exchange rate that matches the rise in the price level.

If the exchange rate is fixed - *i.e.*, the price of foreign exchange cannot rise - then residents will reduce their holding of domestic currency in favour of foreign

currency. Private demand for money remains unchanged, so households purchase foreign currency assets with excess domestic money balances. This leads to a fall in foreign currency assets of the monetary authority which reverses the impact of a rise in domestic assets. The fall in resident holdings of domestic currency will match the magnitude of the initial monetary shock. The price level has not changed and there is no pressure on the exchange rate. The fixed exchange rate, however, means that the monetary authority cannot pursue a monetary policy that is independent from world events.

Given repeated external shocks, however, sterilization by monetary authority interventions will produce different adjustment dynamics in the macroeconomy then in the case of either a flexible or fixed exchange rate.[b] Given an external shock that causes selling pressure on the exchange rate, the monetary authority may attempt to stabilize the exchange rate by buying domestic currency to prevent adjustment. If a second shock occurs that reverses the selling pressure, then the monetary authority will be able to stabilize fluctuations by selling the domestic currency. Sterilization by the

---

[b] Speculation against the domestic currency that is not based on economic fundamentals (*eg.*, real or nominal shocks) may be considered to be part of a repeated external shock. The initial shock is speculation resulting from a negative perception, and a second shock is correction resulting from unrealized expectations. Therefore, sterilization may mitigate the effects of unsubstantiated speculation against the domestic currency.

monetary authority insolates the domestic currency from shocks, but it still represents adjustment of foreign exchange to a monetary shock. These attempts to sterilize foreign currency flows from the domestic money supply will succeed in stabilizing the exchange rate only as long as the monetary authority has sufficient reserves to cover selling pressures.

A one-time monetary shock has a limited effect on the exchange rate or on foreign currency reserves held in the economy or held by the monetary authority. If a monetary shock is repeated, however, such as continual printing of money to support a government deficit as was the case in Kenya, then the shock will continually affect the economy. Under a flexible exchange rate regime, the domestic currency will continually depreciate and under a fixed exchange rate regime will lead to a continual rise of resident holdings of foreign exchange. The switch towards foreign currencies will continue until the monetary authority exhausts its reserves of foreign exchange.

Adjustment invariably occurs, even if the monetary authority sterilizes foreign exchange market interventions. Governments frequently attempt to control both monetary policy and exchange rate policy. These attempts are usually in the context of expansionary monetary policy and a pegged exchange rate. Foreign reserves of the monetary authority fall until the authority cannot defend the exchange rate. At

this point, many governments introduce some form of foreign currency or exchange rate restrictions.[6] These restrictions affect the methods and practices to obtain foreign exchange, but these restrictions do not prevent adjustment, they just forestall it.

Foreign currency restrictions, ostensibly to prevent adjustment, shift adjustment to parallel market activities. These economic activities are usually illegal market activities such as an under-the-counter premium on foreign exchange dealings. Parallel market activities may include false labelling on import and export shipments or may be a legal secondary market for foreign exchange. The most common form of parallel market activity, however, is an illegal premium on foreign exchange dealings. If a monetary shock produces a domestic inflation under a fixed exchange rate, followed by low monetary reserves and currency restrictions, then adjustment in the market for foreign exchange will appear as a rise in the premium on foreign exchange. The premium will rise until the excess demand for foreign exchange is eliminated. These market dynamics are virtually identical to the dynamics in a flexible foreign exchange market.

Parallel market dynamics may be exactly the same as flexible exchange rate dynamics if the transactions costs associated with parallel markets are consistent across sectors. If the transactions costs are not the same, then a

rise in the parallel market premium produces effects on the real economy. This is true since a rise in the premium represents a relative price change even if the parallel market premium increased following a monetary shock. The conditions where this is possible are discussed in Section 3.2.b where sectoral effects on the exchange rate are discussed in detail.

2. *Unrealized Expectations in the Nominal Economy*: An exchange rate adjustment, by itself, has no effect on real variables. Price levels may change, but relative prices do not. However, if inflation is not fully expected, then monetary policy will produce real effects. In these cases, exchange rates will deviate from expected values.

Mistakes about inflation will affect the demand for money. The demand for money depends on nominal interest rates and real output, where the nominal interest rate is determined by real interest rates and expected inflation, and real output is determined given nominal output discounted by the price level. When individuals make mistakes about prices, there will be greater or lesser supply of money than expected. This leads to an unanticipated adjustment in the price level that is interpreted as a relative price change thus shifting resources between sectors or between consumption and investment. These responses produce real effects that are in response to a nominal shock.

Mistakes about the price level produce real effects.

This qualification does not alter the understanding of exchange rate fluctuations as described above because mistakes do not persist indefinitely. This qualification, however, does mean that the exchange rate will not always move exactly with prices when mistakes about inflation have occurred. The exchange rate fluctuates depending on the demand and supply of foreign exchange, so a mistake about inflation will affect supply and demand. This situation does not persist and the exchange rate will adjust again once mistakes have been realized.

3. *Real Shocks:* A real shock will produce an effect on exchange rates if the real shock produces a change in the price level relative to the rest of the world. An external shock that raises the price of all world goods will leave the price of traded goods relative to the rest of the world unchanged, but the price of non-traded goods will not have changed. The price level will, therefore, be lower relative to the rest of the world and a flexible exchange rate will appreciate. A negative internal shock, such as a bad crop year, implies that fewer goods are available for a given money supply and the exchange rate will depreciate.

The effects of these shocks on dynamics in the market for foreign exchange are the same as those dynamics described for nominal shocks. A flexible exchange rate will depreciate (rise) given a shock that raises the price level. If the exchange rate is fixed, then domestic currency will leave the

economy (purchased by the monetary authority) at the fixed exchange rate. If there are foreign currency restrictions intended to defend a fixed exchange rate, then the parallel market premium on foreign exchange dealings will rise. A real shock or nominal shock that produce identical effects on the price level will produce identical effects on the exchange rate, whether flexible or fixed.

3.2.b Sector Elasticities and Exchange Rate Fluctuation

The question of how real shocks affect the exchange rate is a matter of how real shocks affect the price level relative to the world price level. The latter depends on how real shocks affect productivity, particularly if a shock induces resources to shift between alternative uses. A positive shock will induce resources to shift to a relatively more productive use. This will cause the price level to change as prices will rise in some sectors of the economy and fall in other sectors. The extent that the price level changes depends on price elasticities in the sectors that are affected. Thus, a shock that causes resources to shift among sectors also causes the price level to change, so there will be pressure for the exchange rate to adjust.

Real shocks affect the price level as resources shift among relatively more or relatively less productive uses in the economy. An external shock, such as a rise in the world price of a tradeable good will cause the domestic price level to rise as well. The effect on the domestic price level will

be offset, somewhat, by substitution away from the relatively more expensive good. Substitution away from the more expensive good mitigates pressure for the price level to rise.

The rise in world prices will also be offset by substitution away from the more expensive good. The domestic price level may rise relatively more or less than the rise in the world price level. The extent that the domestic and world price levels change depends on own-price and cross-price elasticities of supply and demand. As the domestic price level changes relatively more or less than the world price level, there will be depreciation or appreciation pressures on the exchange rate.

The domestic price of traded goods is determined by world prices, by exchange rates, and by taxes. The domestic price level for all goods will not move with the world price level, however, because of supply and demand shifts to or from non-traded goods. If substitution towards non-traded goods occurs more easily in the domestic economy than abroad, then the domestic price level will rise less in the domestic economy than in other economies, and there will be appreciation pressures on the exchange rate.

If the cross-price elasticity of demand for non-traded goods with respect to the traded good is large and positive, then a world price shock will lead to a substitution toward non-traded goods. This implies a rise in net exports,

because domestic demand for traded goods has fallen. A fall in demand allows for greater export of domestic production or fewer imports.

Shifts in supply will also imply changes of the domestic price level relative to the rest of the world and changes of net exports. A world price rise of a tradeable good will affect the domestic economy depending on whether the country is a net exporter of the good or not. Also, the effect on the price level depends on how easily resources may shift from other sectors, particularly non-traded goods, to the sector enjoying the price rise relative to the ease of resource shifts in other countries. If resources shift more easily in the domestic economy than abroad, then the price level will rise less than rises in the rest of the world and the exchange rate will appreciate.

With respect to demand shifts or with respect to supply shifts, the effect of a world price shock on the domestic economy can be described in terms of price elasticities. Indeed, it can be shown that the domestic currency will appreciate relative to other currencies given a rise in the world price of a tradeable good if the sum of price elasticities of export demand are greater than the sum of price elasticities of import demand.[7] This is the Marshall-Lerner condition for an exchange rate depreciation to improve the balance-of-payments.

A demonstration of the Marshall-Lerner Condition is a

corollary of the Monetary approach. Appreciation or depreciation of the exchange rate, if flexible, occurs because of price changes in the economy. The price level changes, given a shock, reflecting shifts of demand and of supply toward less expensive uses and toward relatively more profitable uses.[c] The aggregate result of these movements include a rise or fall of net exports and a rise or fall in the demand and supply of foreign exchange. The relative price change caused by a shock induces shifts of resources that will lead to exchange rate adjustment, if flexible.

If the exchange rate is not flexible, then a world price shock manifests itself as a rise or fall in foreign reserve holdings. The monetary authority will sell domestic currency and buy foreign currency if there are appreciation pressures on the exchange rate. Relative prices change regardless of whether the exchange rate is fixed or flexible. The relative price change still causes demand and supply shifts, causes the price level to rise or fall to the extent that output does not change, and causes a rise or fall in net exports.

Thus, the Elasticities approach is reconciled with the Monetary approach. In the Monetary approach, differential moves between the domestic and world price levels creates pressure for exchange rate adjustment. Given a productivity shock, observable as a relative price change, resources are

---

[c] In the absence of price distortions, relatively more profitable uses are also relatively more productive uses.

induced to shift between sectors reflecting a shift and a movement along the production transformation curve. The domestic price level will change causing pressure on the exchange rate to change also, by the extent that the domestic price level moves differently than the world price level.

3.2.c Expenditure-Switching and Absorption

A criticism of the Elasticities approach is that the approach does not describe how adjustment occurs in the economic system. The Elasticities are either partial ones, in which case only a portion of activity is included, or total ones, in which case the elasticities are defined *ex post* with no description of adjustment. The reconciliation between the Monetary and Elasticities approaches in the last section addresses this criticism by combining productivity changes with price level changes and including resource shifts between sectors as described by own-price and cross-price elasticities of supply and demand.

The Absorption approach was developed as a necessary alternative to the Elasticities approach. An alternative approach became moot, however, as Alexander's criticism was addressed in the above reconciliation. In addition, Alexander's criticisms occurred in the context of a Keynesian macroeconomic theory and does not have the same meaning in a Neo-Classical theory. However, the ideas that Alexander and others[8] presented have merit and may be incorporated into the Monetary approach without altering the Neo-Classical

conclusions.

The Absorption approach can be utilized to capture the set of reactions of economic agents when expectations are not realized. An external shock to the economy may induce reactions that are not attributable to relative price changes and may better be described as an expenditure-switching response captured in the autonomous element of aggregate consumption, aggregate investment, and other GDP components. Such responses include a real-balance effect, an income-redistribution effect, a idle-resources effect, a reaction that is symptomatic of money illusion, or some other type of mistake in expectations.[9]

Irrespective of the source of the change in the autonomous element of GDP components, changes of expenditure are determined by relative price changes in a Neo-Classical theory of macroeconomics. The changes in the autonomous element are not attributable to relative price changes and are the manifestations of unrealized expectations, so the changes in the autonomous element of expenditure do not persist. The effects of external shocks on the macroeconomy are near term effects that dissipate as a new set of relative prices become understood.

The near term effects of changes in the autonomous elements of GDP components on exchange rates depends on the specific shock. The effect will not persist since exchange rate adjustment ultimately depends on the differential

movements of domestic and world price levels. The domestic price level will move with productivity changes or with inflation. If absorption of changes in the autonomous element of GDP components temporarily affects the price level, then there will be a temporary effect on the exchange rate. Exchange rate adjustment occurs in response to shocks that move the price level relative to the rest of the world. The price level will move differentially from the world price level given differential inflation, given differential productivity shocks (evident in relative price changes), and given mistakes in expectations (although the effects of mistakes are only temporary). A detailed description of these relationships is presented in the context of an empirical macroeconomic model that is outlined in the following chapter.

Chapter 3: Endnotes

1. Joan Robinson, "The Foreign Exchanges," Readings in the Theory of International Trade, The American Economic Association, The Blakiston Company (Toronto, 1950), p.84.

2. Giancarlo Gandolfo, International Economics II: International Monetary Theory and Open-Economy Macroeconomics (Second Edition), Springer-Verlag (New York, 1995), pp.90-92.

3. *Ibid*, p.159.

4. Peter B. Kenen, "Macroeconomic Theory and Policy: How The Closed Economy Was Opened," in Ronald W. Jones and Peter B. Kenen (eds.), Handbook of International Economics, Vol.II, North-Holland (New York, 1985), p.646.

5. *Ibid*, p.648.

6. Philip P. Cowitt, World Currency Yearbook, 1988-89, International Currency Analysis (Brooklyn, N.Y., 1991). The World Currency Yearbook discusses all world currencies and the restrictions that most developing countries have imposed since the 1960s.

7. Gandolfo, International Economics Vol. II, p.93.

8. Aside from Alexander, Fritz Machlup identified many of these issues when attempting to reconcile the Elasticities and Absorption approaches: Kenen, Handbook of International Economics, Volume II, p.649. Joan Robinson recognized some of the same issues prior to Alexander's criticism: *Ibid*, p.646.

9. Gandolfo, International Economics Vol. II, pp.160-161.

Chapter 4

An Empirical Model of Exchange Rate Fluctuation

An empirical macroeconomic model is needed to explain exchange rate adjustment. Exchange rate adjustments follow from many different events and from the interactions among these events. The exchange rate is determined by Kenya's price level relative to the rest of the world and by Kenya's productivity relative to the rest of the world. Overall economic productivity rises as resources shift toward relatively productive sectors in the economy and away from relatively unproductive sectors. The reverse also holds. Exogenous events and government policies that affect the price level and sectoral composition will also influence the exchange rate. Finally, these economic and policy fundamentals generate exchange rate fluctuations in the context of economic growth. Therefore, exchange rate adjustment will be modelled in an empirical model of Kenya's macroeconomic economy.

4.1 Modelling Exchange Rate Misalignment

The model is constructed to explain exchange rate

adjustment in response to nominal shocks, real shocks, and the government policies which generate some of these shocks. Beginning with how monetary policy generates inflation, a model of exchange rate adjustment will detail how nominal shocks (*e.g.*, inflation) cause exchange rate depreciation. This model will also include the relationships between real and nominal variables, should intertemporal expectations not be realized. Other real shocks, from temporary external events to permanent shifts of aggregate production possibilities, will also be modelled. Finally, government policies affect the economy in many ways, so government influences appear throughout the model.

The model of exchange rate adjustment will, fundamentally, reflect the exchange rate as a nominal variable. An exchange rate adjustment, by itself, has no effects on real variables.[1] Liquidity will leave the country if the exchange rate is overvalued, or enter the country if the exchange rate is undervalued. Price levels may change, but relative prices do not. However, the effect of inflation on exchange rates may be mitigated depending on the government's nominal policy variables. Also, when inflation is not fully expected, monetary policy will produce real effects. In these cases, exchange rates will deviate from expected values.

There are many real sources of exchange rate fluctuation in addition to unrealized expectations from nominal

variables. The most obvious source of real shocks is from external economic events.[2] These include world price shocks (terms-of-trade shocks) or changes of the world real interest rate. There are also domestic shocks such as production shocks, the effect of trade bias on technology transfer, or changes in export tax policy or other tax policies. These real shocks directly affect exchange rates, but because the shocks also affect productivity, they will indirectly affect exchange rates as well.[3]

Productivity varies with sector composition of output as well as with exogenous shocks. Aggregate output will decline as economic resources move from relatively productive sectors to less productive sectors. This is true whether resource shifts are due to government policy or to shocks that are specific to one or just a few sectors in the economy. Such changes create effects on exchange rates, because the total productivity of Kenya has fallen.[4] The model will include how these many shocks are manifest as exchange rate fluctuations.

The pressures that cause exchange rate fluctuations may produce other adjustments instead depending on government exchange rate policies. The model will show some combination of three possible adjustments to the pressures that lead to exchange rate adjustment: official exchange rate adjustment, if there is relatively little intervention in the foreign exchange market; parallel market exchange rate adjustment, if

government intervenes to maintain the official exchange rate by fiat; or third, the price of non-traded goods adjusts relative to the domestic price of traded goods, if government intervenes to maintain the official exchange rate by managing the foreign exchange market.[5]

A description of the model begins in the next section (Section 4.2). Growth is presented next (Section 4.3) because it provides the context for exchange rate adjustment. Real shocks to the economy are modelled as part of the growth model and are discussed in this section also. Given this context of growth and real shocks, money and prices are added in Section 4.4. Sectoral productivity is modelled as supply and demand shares of output. The cause and effect of growth on sector shares, and of shifting shares on growth, are described in Section 4.5.

4.2 Model Overview and Structure

The empirical model is based on Neo-Classical theories and on common models of Neo-Classical theory. The model has three main components: the first component is growth of GDP components; the second component is money; and, the third component is sectoral shares of aggregate output and aggregate expenditures. The behavioural equations within each of these components produce values for various economic variables.

The data from behavioural equations are data for the

beginning of each period (year) in the model. The beginning-of-the-period values of the economic variables are disequilibrium values. Various shocks to the system or other unrealized expectations during the period also affect aggregate output supply and aggregate demand. Sectoral prices adjust within a period until equilibrium is restored at the end of the period.

The three components of the model are brought together as relative sectoral prices adjust to find equilibrium for the whole system. Sectoral prices adjust until aggregate output supply equals aggregate demand. There are three traded goods sectors and one non-traded goods sector. The traded goods sectors are each defined by world market conditions: therefore, the market clearing condition for a small open economy is equilibrium in the non-traded goods sector. When the non-traded goods sector is in equilibrium, then the model is in equilibrium also.

The fundamental market clearing condition for the model is that the quantity supplied of non-traded goods equals the quantity demanded of non-traded goods. This condition is met in the initial period and at the end of each period. Section 4.2.a provides an overview of the model assuming equilibrium in the non-traded goods market. Section 4.2.b introduces the effects of shocks on the system and discusses how equilibrium is restored in the model. Section 4.2.c describes the mechanics of the solution.

4.2.a Basic Market Clearing

The empirical model is ultimately based on a macroeconomic market clearing model. The variables of the market clearing model are calibrated to a growth-path that is derived from a Neo-Classical endogenous growth model. The growth portion of the model defines a growth-path of the capital stock and real output for the beginning of each period. The growth path is the path that maximizes intertemporal utility, where utility is a function solely of consumption. This real component of the model yields output, private consumption and investment, government consumption and investment, and borrowing to finance investment. The monetary component of the model simply follows this growth path given government's desired rate of growth of the money supply. The supply and demand component of the model outlines sector shares that are determined by an aggregate profit function and an aggregate expenditure function.

The market clearing problem, in the simplest expression of Walras' Law, is:

$$(C^d - Y^s) + \frac{B}{P} + \left(\frac{M^d}{P} - \frac{dM/dt \cdot M_{t-1}}{P}\right) = 0 \qquad 4.1$$

where: C^d = real consumption demand,
Y^s = real output supply,
B = nominal savings,
M^d = money demand, and
dM/dt = rate of growth of the stock of money.

Demand may not equal supply in any of the commodity, bond or money markets, in an open economy, though the sum of excess demand and supply must be zero. For Kenya, in the period

discussed, there is excess demand in the commodity market, excess supply in the bond market, and real money demand equals real money supply.[a]

Market clearing is reducible to the commodity market. The money market is in balance and the stock of outstanding bonds is determined by the level of capital accumulation necessary to maximize intertemporal utility. Output supply is the aggregate of four production sectors: food crop production, export crop production, importable goods production, and non-traded goods. The first three sectors are traded goods whose prices are determined in world markets. Therefore, the market clearing problem is reducible to equilibrium in the non-traded goods market whose price is determined domestically.

The market clearing condition is:

$$Q_{nt}^{S} = Q_{nt}^{D} \qquad 4.2$$

Adding the three traded goods sectors to the non-traded goods sector is aggregate output supply and aggregate demand in the commodity market.

---

[a] The rate of growth of the domestic nominal stock of money exceeds the rate of growth of nominal money demand.

$$Q_{nt}^{S} = Q_{nt}^{D}$$

$$Q_{f}^{S} = Q_{f}^{D} + NX_{f}$$

$$Q_{m}^{S} = Q_{m}^{D} + NX_{m}$$

$$Q_{x}^{S} = NX_{x}$$

$$\sum_{i=1}^{4} Q_{i}^{S} = Y^{S} = C^{D} + NX = \sum_{i=1}^{3} Q_{i}^{D} + \sum_{i=2}^{4} NX_{i} \qquad 4.3$$

There is no domestic demand for export crop production. Noting that aggregate demand is private consumption, government consumption, private investment, and government investment, then:

$$Y = C + I_{p} + G + I_{g} + NX \qquad 4.4$$

This expression can be manipulated to represent the Kenyan national accounts. Adding net investment from abroad, RB^{f}/P, to both sides creates GNP on the left side of the equation and aggregate demand (including the current account balance) on the right side of the equation (This treatment follows Barro and Lucas).[6]

$$Y_{t} + \frac{RB^{f}}{P} = C + I_{p} + G + I_{g} + \begin{matrix} Current \\ Account \end{matrix} \qquad 4.5$$

The final manipulation replaces the current account with the capital account. The capital account balance is distributed between foreign investment (bonds) and a rise or fall of foreign reserves. Thus, the two equation expression of the problem that will be used to create a national accounting framework is:

$$Y_t + \frac{\varepsilon_t r_t^w B_t^f}{P_t} = C_t + I_{p,t} + G_t + I_{g,t} + \frac{\varepsilon_t \Delta B_t^f}{P_t} + \frac{\varepsilon_t \Delta H_t}{P_t} \qquad 4.6$$

$$(1+\mu_t) M_{t-1} = P_t \cdot \Phi(Y_t, R_t, \ldots) \qquad 4.7$$

where:
- C = Private consumption,
- I_p = private investment,
- G = government consumption,
- I_g = government investment,
- ΔB^f = change in net holdings of foreign bonds,
- R = nominal interest rate,
- r^w = world real interest rate,
- ε = official exchange rate,
- M = nominal stock of money,
- μ = rate of growth of the money supply,
- $\Phi(\cdot)$ = demand for liquidity, and
- ΔH = accumulated of foreign currency reserves.

The basic equations of the simplified market clearing model are described in equations 4.8 through 4.22 that follow:

$$y_t = A k_{t-1}^{\alpha} \qquad 4.8$$

The capital stock, k_{t-1}, is the aggregate of capital accumulated by the private sector and by the government sector and financed by the private, government, or non-resident sectors. Labour does not appear as a factor of production because the capital stock is expressed in per capita terms. A complete explanation of capital and labour occurs in section 4.3.a.

$$i_{p,t} = \Delta k_{p,t} + (n+\delta) k_{p,t-1} \qquad 4.9$$

Private investment is a function of private capital growth financed by the private and non-resident sectors. The parameters, n and δ, are, respectively, population growth and depreciation.

$$i_{g,t} = \Delta k_{g,t} + (n+\delta)\, k_{g,t-1} \qquad 4.10$$

Government investment is a function of government capital growth financed by the private and non-resident sectors.

$$g_t = (1-v)\,(t_a + t_y \cdot y_t) \qquad 4.11$$

Government consumption is defined by a simple tax function of output with intercept, t_a, and marginal tax rate, t_y. The tax function is net of transfers to households, v.

$$nx_t = r_t^w \cdot k_{f,t-1} + \varepsilon_t \Delta h_t - \Delta k_{\varepsilon,t} \qquad 4.12$$

The growth path for net exports is bounded by capital accumulation that is financed by non-residents. This portion of the capital stock is financed by non-residents, so equation 4.12 is exactly equivalent to :

$$nx_t + r_t^w b_{t-1}^f = \varepsilon_t \Delta h_t + \Delta b_t^f \qquad 4.13$$

since accumulation of capital financed abroad is offset by a fall in holdings of non-resident bonds: $\Delta k = -\Delta b$.

$$c_t = y_t - i_{p,t} - i_{g,t} - g_t - nx_t \qquad 4.14$$

Private consumption is the residual.

Equations 4.8 through 4.14 form the real side of the economy as described in equation 4.6. The economic variables defined in these equations are calculated based on the capital stock growth path. There are four portions to the capital stock: the first two portions are private capital financed either by the private sector or by the non-resident sector; and, the second two portions are government capital financed either by the private sector or by the non-resident sector. All portions of the capital stock are state

variables: the capital stock is determined in the previous period, and, thus, are fixed - stated - in the current period.

Equations 4.15 and 4.16 define equation 4.7 above, but all variables in these three equations are endogenous variables.

$$M_t^d = P_t \cdot l_a R_t^{l_r} y_t^{l_y} \qquad 4.15$$

$$M_t = M_t^d \qquad 4.16$$

The endogenous variables are defined in the following six equations. The exogenous variables for equations 4.17 through 4.22 are the rate of growth of the money supply, the world price level, and the world real interest rate.

$$M_t = (1+\mu) M_{t-1} \qquad 4.17$$

$$P_t = (1+\pi) P_{t-1} \qquad 4.18$$

The stock of money is determined by the rate of growth of the money supply, μ. In a closed economy, the inflation rate, π, is an endogenous variable that is equal to the rate of change of the money supply. This equality holds for a small open economy with a floating exchange rate. However, the inflation rate is an exogenous policy variable of the government. The government could choose to fix the exchange rate, in which case, the domestic inflation rate is equal to the world inflation rate.

Whether the exchange rate is fixed or floating, the domestic inflation rate and the exchange rate are:

$$P_t = \varepsilon_t P_t^w \qquad 4.19$$

$$\Delta\varepsilon_t/\varepsilon_{t-1} = \pi_t - \pi_t^w \qquad 4.20$$

The domestic price level is the domestic value of the world price level. The rate of change of the exchange rate[b] is the spread between domestic and world inflation.

$$R_t - R_t^w = \Delta\varepsilon_t/\varepsilon_{t-1} \qquad 4.21$$

$$r_t = r_t^w + risk \qquad 4.22$$

Expected rates of change in the exchange rate will lead to a rise of domestic interest rates above world rates. The domestic real interest rate is determined by the world real interest rate plus a risk factor.

The complete and detailed equations for all economic variables appear in Appendix A: Kenya National Accounts. The above simplified equations are separated into five accounts: the Production Account, itemizes output and the GDP components; the Non-Resident Account; the Private Sector Account; the Government Account; and, the Monetary Authority, which is the Kenya Central Bank. These accounts detail the calculation of most economic variables, including shocks to the economic system.

The remaining variables are sector shares of profit and expenditure, and the domestic prices in each sector. Given aggregate output, aggregate demand, world prices for traded

---

[b] For a fixed exchange rate regime, $\pi - \pi^w = 0$, and, therefore, $R - R^w = 0$.

goods, and exchange rates, output shares are determined by an aggregate profit function, and demand shares are determined by an aggregate expenditure function. The non-traded goods price is determined by market clearing of non-traded goods. Sector shares are derived from aggregate output and expenditure, so the sum of net exports among the sectors exactly equals net exports determined in the growth portion of the model.

$$P_{d,t}nx_t = \sum_{i=1}^{4} P_{i,t}(q^s_{i,t} - q^d_{i,t}) \qquad 4.23$$

Sector shares of profit and expenditure are endogenous variables also and follow the growth path of the capital stock.

4.2.b Shocks to the Equilibrium Growth Path

The GDP components are determined at the beginning of each period given capital growth. A shock to the system will produce disequilibria where aggregate output supply is either greater than or less than aggregate demand. Since supply and demand in the traded goods sectors is determined by world market conditions, disequilibrium at the aggregate level can only be a manifestation of disequilibrium in the non-traded goods market. Equilibrium will be restored in the non-traded goods sector, as well as at the aggregate level, as the relative price between non-traded goods and traded goods adjusts to the shock.

Suppose a shock to the model creates depreciation pressures given a fixed official exchange rate. An over-

valued exchange results from exchange rate policies that lead to a parallel market premium over the official exchange rate. The domestic prices in the food crop sector and the import-substituting goods sector are determined by the world price of these goods and the parallel market premium. The domestic price of export crops (as opposed to food crops) is determined by the world price of these crops and by the official exchange rate. The price of non-traded goods is determined domestically by supply and demand in the sector. An over-valued exchange rate that creates a parallel market premium over the official exchange rate will change relative prices among traded goods and between the traded and non-traded goods.

The overvalued exchange rate will induce resources to shift from export crop and non-traded goods production to food crop and import substituting goods production. Demand in each sector will move in the opposite directions. Aggregate net exports, whether these rise or fall, will adjust so that the effect of changing production of the traded goods sectors is matched exactly by changing net exports, which is an aggregate demand component. The non-traded goods sector, however, is in disequilibrium. The price of non-traded goods will adjust - rise in this example - until equilibrium is restored.

A change in the parallel market premium over the official exchange rate effects a different set of relative

prices than a change in the price of non-traded goods. Each relative price change affects the relative price of non-traded goods to the price of traded goods, but one change will not be offset by the other, except by coincidence.

The market clearing condition is met as relative prices between non-traded goods and traded goods adjust. The relative price will adjust as: the price of non-traded goods change; the official exchange rate changes; or, the parallel market premium over the official exchange rate changes. In the example above both the parallel market premium and the price of non-traded goods are changing. Equilibrium in the model is restored when one or a combination of these prices adjust so the quantity supplied of non-traded goods equals the demand of non-traded goods.

4.2.c Solution

Restoring balance in the model requires behavioural equations for the price of non-traded goods, the official exchange rate, and the parallel market premium. Such an equation for the price of non-traded goods will be a function of the difference between supply and demand. A behavioural equation to calculate the official exchange rate and the parallel market premium depends on the difference between world and domestic inflation. If calculated with such a behavioural equation, the official exchange rate and the parallel market premium would be endogenous variables.

Behavioural equations for these three variables are not

possible because including these will over-identify the system. In the simplified version of the model presented in the overview, the trade bias on capital productivity was excluded in equation (3) above. The complete expression for output is detailed in section 4.3. A trade bias is defined by the degree domestic prices for traded goods are greater than the domestic value of world prices: $P_d > \mathcal{E}P^w$. Including the trade bias means that the capital stock is an endogenous variable depending on, for example, the over-valued exchange rate. Since the official exchange rate and the parallel market premium are both endogenous variables depending on growth paths of capital, of GDP and its components, and of money, the system is over-identified.

The behavioural equations for the official exchange rate and the parallel market premium are removed from the model. Instead, these variables are solved iteratively in reduced-form equations. The exchange rate and parallel market premium are found once the system has returned to equilibrium. Any behavioural equation could have been eliminated and the variable determined by that equation solved iteratively instead of the exchange rate. The behavioural equation for the exchange rate was eliminated because this variable is the focus of the model.

There will be no initial effect on the parallel market premium of the exchange rate from a shock that produces a trade bias: for example, a rise of import tariffs. The

official exchange rate and the parallel market premium are no longer endogenous variables once behavioural equations for these have been removed.

The over-valued exchange rate is one example of a shock to the system. Various shocks together with various government policies and responses to the shocks have many possible outcomes. The model, however, re-establishes equilibrium, no matter what the shock is, through iterative changes to the parallel market premium, the official exchange rate, or the price of non-traded goods. Each of these variables represents a change of the relative price of traded goods to non-traded goods.

The relative price changes that produce real effects are determined by iteratively solving reduced-form equations for the official exchange rate, for the parallel market exchange rate, or for the price of non-traded goods. Only one of these reduced-form equations is needed to solve the model. If the official exchange rate were allowed to depreciate (*i.e.*, the reduced-form equation is solved), then there would be no relative price changes among the sectors and the expansionary monetary policy would appear as an inflation producing no real effects. If the official exchange rate is fixed, then the parallel market rate will depreciate (this equation is solved instead), and there will be real effects as relative prices change.

The model is based on a capital growth path that

determines real GDP and its components. Around these paths, monetary variables are added to determine nominal values. Given output and expenditure, sector shares of supply and demand are found. If relative prices deviate from world relative prices, then sector shares shift to less socially productive uses. Total investment will decline and future output will proceed along a lower growth path.

4.3 Capital Growth and the Components of GDP

The stated goal of Kenya's economic policy is to speed economic growth. Since policy is premised on growth, the empirical model is based on a growth model, or, specifically, a neo-classical growth model with endogenous capital accumulation (*i.e.*, savings). This portion of the model gives a growth-path for the capital stock and for the components of gross domestic product. Temporary external shocks are modelled as deviations from this growth-path. This portion of the model does not explain variation of exchange rates, but it does provide the long term growth context for exchange rate adjustment.

4.3.a Neo-Classical Growth

A neo-classical growth model determines the growth-path for output (GDP) according to a Cobb-Douglas production function.

$$Y_t = AK_{t-1}^{\alpha}(L_t e^{gt})^{(1-\alpha)} \qquad 4.24$$

K_{t-1} = Capital stock accumulated at the end of period t-1 and used in production at period t,
L = labour force, and
g = Harrod-neutral technical factor.

The Cobb-Douglas production function, expressed as output and capital per unit of effective labour, is:

$$\hat{y}_t = A\hat{k}^{\alpha}_{t-1} \qquad \hat{y} = \frac{Y}{Le^{gt}}, \quad \hat{k} = \frac{K}{Le^{gt}} \qquad 4.25$$

Effective labour increases by the technical change factor, g. The growth-path for the model will be derived by convergence to the steady-state value of output.

This functional form is commonly used for growth models, since it meets Inada conditions for inputs and since it exhibits constant returns to scale.[7] Recent empirical studies using a Cobb-Douglas functional form demonstrate that this form provides reasonable a good first approximation for growth data.[8] Variations around the growth-path are modelled by shifting sector shares (explained in Section 4.5) and shocks to the economic system. Therefore, a growth-path defined by a generalized functional form makes the growth model more complicated than necessary. The Cobb-Douglas functional form, given initial conditions and assumptions about the steady-state, adequately models Kenya's growth beginning in 1964.

The steady-state is assumed to be equivalent to U.S. economic conditions existing in 1964. Kenya achieved independence in 1964, so this is the starting point for Kenyan economic growth policy. The steady-state, from

Kenya's point-of-view, is represented by the U.S. economy. Whether the U.S. economy is as it existed in 1964 or 1997 does not matter for the model, because convergence to this steady-state will occur after 200 years (in Section 5.2.c). The U.S. economic conditions in 1964 provide a sufficient target for modelling growth.

The rate by which Kenya converges to this steady-state is that which maximizes intertemporal utility. The rate of convergence is derived from an optimized Constant Relative Risk Aversion (CRRA), intertemporal, utility-function, following Blanchard and Fischer (1989).

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma}, \quad so \ s=\frac{1}{\gamma} \qquad 4.26$$

This function yields constant elasticity of substitution (s) between consumption in any two time periods. The form is commonly assumed[c] because the elasticity of substitution and, therefore, the rate of convergence do not vary with the level of consumption. The CRRA utility-function together with a Cobb-Douglas production-function in terms of effective labour provide the context for Kenya's long term growth.

The growth-path for capital in the model is defined by the simple adjustment process:

$$\hat{k}_t = \hat{k}_o^{e^{-xt}} \cdot \hat{k}_*^{1-e^{-xt}} \qquad 4.27$$

---

[c] This is the justification used by Barro and Martin: "We therefore follow the common practice of assuming the functional form..." Barro and Sala-i-Martin, Economic Growth, p.64.

where: k_o = initial capital stock
k_* = steady state capital stock
x = adjustment parameter.

The adjustment parameter is derived from a log-linear approximation of capital stock and consumption growth around the steady-state. The derivation for several different production functional forms can be found in Blanchard and Fischer (1989) or Barro and Sala-i-Martin (1990, 1995). For Cobb-Douglas technology the parameter is defined by:[d]

$$x = \frac{1}{2}\left[\left(\zeta^2 + 4(1-\alpha)s(\delta+r^*)\left(\frac{\delta+r^*}{\alpha} - (n+g+\delta)\right)\right)^{\frac{1}{2}} - \zeta\right] \qquad 4.28$$

$$\zeta = \rho - n - (1-\frac{1}{s})g \qquad 4.29$$

where: α = capital share
s = elasticity of intertemporal substitution
δ = depreciation rate
r^* = steady-state interest rate
ρ = time preference rate
n = population growth rate
g = rate of Harrod neutral technical change

A growth-path implies conditional convergence to the steady-state after 200 years (See discussion in Section 5.2.a). Convergence is modelled to be slow for Kenya because: first, the time preference rate in Kenya is higher than in the steady-state;[e] and, because only a small portion of Kenya's capital stock may be financed in any given period. These two

---

[d] The second equation (the transversality condition) ensures household assets are positive and approach zero as the planning horizon approaches infinity. Barro and Sala-i-Martin, Economic Growth, pp.65-66.

[e] Since the steady-state is assumed to be equivalent to US conditions in 1964, $\rho_K > \rho_{US}$.

assumptions are important for modelling Kenyan growth to represent higher current consumption relative to future periods. Other utility functions, such as a Constant Absolute Risk Aversion or a Stone-Geary utility-function, offer a more restrictive form of convergence.

Some flexibility is needed to model capital stock financing for two reasons. First, only a portion of desired capital accumulation may be financed in any one period, because the capital stock is broadly defined to include human capital and because human capital can rarely be chattel for financing. Second, capital is accumulated and financed by different sectors in the economy.

Capital stock is dissaggregated into five separate sources. Government objectives are separate from private sector objectives, and since the ways each sector accumulates capital have different effects, these must also be distinguished. A government will cause inflation or produce other effects depending on how it tries to finance its own consumption and investment. Capital is financed at the domestic interest rate, R_d, which is effectively the world interest rate plus a risk premium. The capital stock is disaggregated by assigning different time preference rates according to who accumulates capital (the private or government sector) and who finances capital (the private sector, non-residents, or the central bank). The capital, accordingly, is disaggregated into five sources: private

sector capital financed by the private sector (K_{pp}); private sector capital financed by non-residents (K_{pf}); government capital financed by the private sector (K_{gp}); government capital financed by non-residents (K_{gf}); and, government capital financed by the central bank (K_{gm}).

The different time-preference rates for each of the five sources for the capital stock reflect a modelling technique and does not imply segmentation of capital markets. The different rates do, however, imply different periods of convergence for each capital stock. Time-preference rates are greatest - and, therefore, the period until convergence is shortest - for the private capital stock financed by the private sector, and are least for the government stock financed by non-residents: $\rho_{pp} > \rho_{pf} > \rho_{gp} > \rho_{gf}$. Modelling a time-preference rate for accumulation financed by the Kenya Central Bank (KCB) is not necessary because the financing is determined by the printing of money, and this is a policy variable modelled elsewhere.

These different time-preference rates mean that private and government capital will be accumulated at different rates. There are five sources of capital accumulation: the total capital stock is the aggregate of these, and four of the five segregated capital stocks grow according to the neo-classical growth-path outlined above. The specific rate of growth varies with the time-preference rate. For example, the capital adjustment equation for private capital stock

financed by the private sector is:

$$\hat{k}_{pp,t} = (\hat{k}_{pp,t-1} + \hat{k}_{pf,o} + \hat{k}_{gp,o} + \hat{k}_{gf,o})^{e^{-x_1}} * \hat{k}_{pp,*}^{1-e^{-x_1}} - \hat{k}_{pf,o} - \hat{k}_{gp,o} - \hat{k}_{gf,o} \qquad 4.30$$

The private sector capital stock in any period is defined by the adjustment parameter, x_1, given previous capital accumulation from all sources relative to the steady-state private sector capital stock financed by the private sector.

The steady-state capital stock is derived from the Cobb-Douglas production function:

$$\hat{k}_{pp,t} = \left[\frac{(1-v)A\alpha}{\delta + r^*_{pp}}\right]^{\frac{1}{1-\alpha}} \qquad r^*_{pp} = \rho_{pp} + \frac{g}{s} \qquad 4.31$$

where:
v = marginal tax rate,
A = production function intercept
α = capital share in production
δ = depreciation rate
ρ = time-preference rate
g = rate of technical change
s = elasticity of intertemporal substitution

The adjustment parameter is defined as it is above except for the time-preference rate:

$$x_1 = \left[\zeta_1^2 + 4(1-\alpha)s(\delta + r^*_{pp})\left(\frac{\delta + r^*_{pp}}{\alpha} - (n+g+\delta)\right)\right]^{\frac{1}{2}} - \zeta_1 \qquad 4.32$$

$$\zeta_1 = \rho_{pp} - n - \left(1 - \frac{1}{s}\right)g \qquad 4.33$$

The higher time-preference rate for the private sector implies a faster convergence, albeit slow, but a lower steady-state capital stock.

The capital accumulation process for each source of financing are given by:

- Total Capital Stock:

$$\hat{K}_t = \hat{K}_{pp,t}+\hat{K}_{pf,t}+\hat{K}_{gp,t}+\hat{K}_{gm,t}+\hat{K}_{gf,t} \qquad 4.34$$

- Private Capital Stock financed by the Private Sector (detailed on previous page)

- Private capital Stock financed by Non-Residents

$$\hat{K}_{pf,t}=\frac{1}{\gamma_t}\left[\gamma_{t-1}\hat{K}_{pf,t-1}+\hat{I}_{p,t}-(\gamma_t\hat{K}_{pp,t}-\gamma_{t-1}\hat{K}_{pp,t-1})-\gamma_t(e^{n+\delta}-1)(\hat{K}_{pp,t-1}+\hat{K}_{pf,t-1})\right] \qquad 4.35$$

The term, γ, is used to model the effect of trade bias on technical change, and will be detailed in the following section.

- Government Capital Stock financed by the Private Sector

$$\hat{K}_{gp,t}=\hat{K}^{*}_{gp,t}-\hat{K}_{gf,t} \qquad 4.36$$

- Government Capital Stock financed by Central Bank

$$\hat{K}_{gm,t} = e^{-\pi_{d,t}}\frac{\hat{b}^{m}_{g,t-1}}{P_{d,t-1}}+\frac{\Delta\hat{b}^{m}_{g,t}}{P_{d,t}} \qquad 4.37$$

- Government Capital Stock financed by Non-Residents

$$\hat{K}_{gf,t}=\frac{1}{\gamma_t}\left[\gamma_{t-1}\hat{K}_{gf,t-1}+\hat{I}_{g,t}-(\gamma_t\hat{K}^{*}_{gp,t}-\gamma_{t-1}\hat{K}^{*}_{gp,t-1})-\gamma_t(e^{n+\delta}-1)(\hat{K}^{*}_{gp,t-1}+\hat{K}_{gf,t-1})\right] \qquad 4.38$$

where:
- k_o = initial capital stock (1964)
- k_* = steady-state capital stock (U.S. 1964)
- i_t = current investment (government or private)
- Δb_t = new borrowing in the current period
- x_1 = capital adjustment rate

There are four capital adjustment rates: x_1 through x_4 that represent faster or slower adjustment depending on lower or higher time-preference rate. One of these parameters defines the adjustment of private sector capital stock when financed by private sources. The remaining three adjustment parameters appear in three trend capital accumulation equations. These equations define trend capital stock growth-paths: the capital accumulation paths that would exist

in the absence of exogenous shocks to the system. The equations are omitted here for brevity and for the reason that the relationship between the above base equations and trend equations will be detailed below in the context of modelling Kenya's absorption of external shocks. All capital stock equations are outlined in Appendix B.

4.3.b Components of Aggregate Output

The components of GDP follow from the capital accumulation process. Investment by the private and government sectors is determined by the share of GDP that ensures the capital stock matches the capital growth-path. Both private and government investment are net investment financed by the private sector and by foreigners plus capital depreciation and depreciation due to technical obsolecense and the growing labour force. Private investment is:

$$\hat{I}_{p,t} = \gamma_t(\hat{K}_{pp,t}+\hat{K}_{pf,t}) - \gamma_{t-1}(\hat{K}_{pp,t-1}+\hat{K}_{pf,t-1}) + \gamma_t(e^{n+\delta})(\hat{K}_{pp,t-1}+\hat{K}_{pf,t-1}) \qquad 4.39$$

Government investment is similarly found by:

$$\hat{I}_{g,t} = \gamma_t(\hat{K}_{gp,t}+\hat{K}_{gf,t}) - \gamma_{t-1}(\hat{K}_{gp,t-1}+\hat{K}_{gf,t-1}) + \gamma_t(e^{n+\delta})(\hat{K}_{gp,t-1}+\hat{K}_{gf,t-1}) \qquad 4.40$$

The variables (k, n, *and* δ) are defined as above.

Investment and all other real components are expressed in terms of effective labour. If investment was expressed per capita, then depreciation due to technical obsolecense will disappear. If investment was expressed in total values instead of in either per capita or per effective labour terms, then only capital depreciation would appear with net investment.

The two new features are the trade bias, γ, and prime on most capital variables, indicating trend capital stock. Also, the investment figures are the trend values for investment as indicated by the prime over the variable. The relationship between the trend and actual GDP components will be detailed in the following section.

The remaining components of the production account are:

Trend government consumption - modelled as a simple tax function less transfers to the private sector.

$$\hat{g}'_t = (1-v)(t_a + t_y \cdot g\hat{d}p'_t) \qquad 4.41$$

where: v = proportion of transfers to private sector,
t_a = lump sum tax (intercept), and
t_y = marginal tax rate.

Trend private consumption - aggregate output less private investment, government investment, government consumption, and net exports, and is explained below:

$$\hat{c}'_t = g\hat{d}p'_t - (\gamma_t \hat{K}'_t - \gamma_{t-1}\hat{K}'_{t-1} + (e^{n+\delta}-1)\gamma_t \hat{K}'_{t-1}) - \hat{g}'_t + (\gamma_t \hat{K}'_{f,t} - \gamma_{t-1}\hat{K}'_{f,t-1}) - (e^{r'_{w,t}}-1)\hat{K}'_{f,t-1} - \frac{\varepsilon \Delta \hat{h}'_{y,t}}{P_{d,t}} \qquad 4.42$$

where: Δh_t = change in KCB foreign reserves, and
γ_t = trade bias on technical change so that

$$\gamma_t = e^{(g+\eta_\delta \cdot \ln \delta)}\gamma_{t-1} \quad , \quad \delta = \frac{\epsilon^m_t}{\epsilon^x_t} \qquad 4.43$$

η_δ = trade bias parameter, and
δ = trade bias (ratio of effective import to effective export exchange rates.

The calculation for trend consumption is an expansion of:

$$\hat{c}'_t = g\hat{d}p'_t - \hat{i}'_{p,t} - \hat{i}'_{g,t} - \hat{g}'_t - n\hat{x}'_t \qquad 4.44$$

The equations for trend investment are substituted into this

equation and demonstrate that, given capital growth, consumption is an intertemporal variable.

Net exports - net factor payments abroad plus changes in foreign reserves less net borrowing from abroad is modelled as:

$$n\hat{x}'_t = (e^{r'_{w,t}}-1)\gamma_{t-1}K^{\gamma}_{f,t-1} + \frac{\varepsilon_t \Delta h^{\gamma}_{y,t}}{P_{d,t}} - (\gamma_t K^{\gamma}_{f,t} - \gamma_{t-1}K^{\gamma}_{f,t-1}) \qquad 4.45$$

The trade bias, γ, that appears on most capital stock variables, models the effect of trade distortions on technical improvements. Trade bias lowers optimal technology adoption and innovation.[9]

4.3.c Absorption Elasticities

External shocks cause national income to deviate more or less from national expenditures. This is termed "absorption" by Alexander (1956). The effects on net exports, therefore, produce pressures on exchange rates separately from the effects of monetary policy or of import and export elasticities. As detailed in Chapter 3, long term pressures on exchange rates are reducible to monetary variables and relative to productivity (import and export elasticities), but short and medium term effects on national expenditures and income will also produce exchange variations. These absorption elasticities are modelled in the growth portion of the model, because these elasticities affect the GDP components.

Absorption elasticities of external shocks to the

economy are modelled as GDP component deviation from trend. Actual values of the GDP components will deviate from trend until each sector of the economy has adjusted to external shocks. Deviations occur for each component, though trend and actual values of net exports are modelled indirectly as residuals.

Any number of shocks can be modelled, but the most significant shocks are: world real interest rate changes; foreign aid; terms of trade shocks; and, the degree of exchange rate overvaluation.[f] The elasticities are constrained so effects on any one component are countered by effects on other GDP components. Also, the persistence of the effects is modelled with a lag variable, modified to account for both the deviation from trend as well as trend growth. Thus, actual values of the GDP components are:

Actual GDP

$$\hat{gdp}_t = \left[A\gamma_t \hat{K}_{t-1}^{\beta} \beta_t \left(\frac{\epsilon'_{t-1}}{\epsilon_{t-1}} \right)^{\eta_{Y,\epsilon}} \left(\frac{ToT}{100} \right)^{\eta_{Y,ToT}} \left(\frac{r_{w,t}}{r'_{w,t}} \right)^{\eta_{Y,r_w}} \right]^{\lambda} \left[\hat{gdp}_{t-1} \frac{\hat{gdp}'_t}{\hat{gdp}'_{t-1}} \right]^{1-\lambda} \qquad 4.46$$

where:
- γ = trade bias on technical change,
- β = production shocks (*eg.*, weather), and
- η = absorption elasticity for:
- ToT = terms of trade,
- ϵ, ϵ' = nominal and parallel exchange rates, and
- r_w, r'_w = real and trend real world interest rates.

---

[f] The degree of exchange rate overvaluation and terms-of-trade changes are not, strictly speaking, external shocks, but these are shocks on the external accounts.

Actual Private Consumption

$$\hat{C}_t = \left[\hat{C}'_t \left(\frac{e'_{t-1}}{e_{t-1}} \right)^{\eta_{c,e}} \left(\frac{ToT}{100} \right)^{\eta_{c,ToT}} \left(\frac{r_{w,t}}{r'_{w,t}} \right)^{\eta_{c,r_w}} \right]^{\lambda} \left[\hat{C}_{t-1} \frac{\hat{C}'_t}{\hat{C}'_{t-1}} \right]^{1-\lambda} (1+FA_t)^{\eta_{c,FA}} \qquad 4.47$$

where: FA_t = foreign aid as a percent of GDP.

Actual Government Consumption

$$\hat{G}_t = \left[\hat{G}'_t \left(\frac{e'_{t-1}}{e_{t-1}} \right)^{\eta_{g,e}} \left(\frac{ToT}{100} \right)^{\eta_{g,ToT}} \left(\frac{r_{w,t}}{r'_{w,t}} \right)^{\eta_{g,r_w}} \right]^{\lambda} \left[\hat{G}_{t-1} \frac{\hat{G}'_t}{\hat{G}'_{t-1}} \right]^{1-\lambda} (1+FA_t)^{\eta_{g,FA}} \qquad 4.48$$

Actual Private Investment

$$\hat{I}_{p,t} = \left[I'_{p,t} \left(\frac{e'_{t-1}}{e_{t-1}} \right)^{\eta_{I_p,e}} \left(\frac{ToT}{100} \right)^{\eta_{I_p,ToT}} \left(\frac{r_{w,t}}{r'_{w,t}} \right)^{\eta_{I_p,r_w}} \right]^{\lambda} \left[\hat{I}_{p,t-1} \frac{I'_{p,t}}{I'_{p,t-1}} \right]^{1-\lambda} (1+FA_t)^{\eta_{I_p,FA}} \qquad 4.49$$

Actual Government Investment

$$\hat{I}_{g,t} = \left[I'_{g,t} \left(\frac{e'_{t-1}}{e_{t-1}} \right)^{\eta_{I_g,e}} \left(\frac{ToT}{100} \right)^{\eta_{I_g,ToT}} \left(\frac{r_{w,t}}{r'_{w,t}} \right)^{\eta_{I_g,r_w}} \right]^{\lambda} \left[\hat{I}_{g,t-1} \frac{I'_{g,t}}{I'_{g,t-1}} \right]^{1-\lambda} (1+FA_t)^{\eta_{I_g,FA}} \qquad 4.50$$

4.3.d Summary

The Neo-Classical growth component of the model provides the context of growth for development policy. The growth component is the only portion of the model that does not contain some part of Kenya's macro-economic policies. The absorption component exhibits external and policy shocks to the model. Absorption elasticities depend on trend variables produced by the growth component, however. Other portions of the model depend on the growth component as well.

Monetary policy, like the absorption elasticities, is introduced into the model once trend - and actual - values of growth variables have been determined. Sectoral shifts, due

to price, tax, or other policy shocks, also depend on the growth component of the model. The shocks exhibited in these other components will in turn effect the growth component, but the growth component provides the context of growth in which macro-economic policies are modelled.

4.4 Money and Prices

Monetary policy builds on variables determined in the growth portion of the model. Growth is driven by real variables with money acting as a medium of exchange. Money is neutral, so any given growth rate of the money supply leaves capital accumulation and, hence, output unchanged. Money is not super-neutral, and some dynamics are introduced by response and adjustment to changes of the rate of growth of the money supply.

4.4.a The Demand for Money

The demand for money is based on a constant elastic function of nominal interest rates and real output.[10] All money demand equations are in terms of units of effective labour, but are not denoted this was to simplify the expressions.

$$\left(\frac{m}{P_d}\right)^d = l_a \cdot R^{l_R} \cdot \hat{gdp}^{l_Y} \qquad 4.51$$

The complete model includes actual and trend values for output and interest rates. There are three price variables in the model, so there are three formulations of money

demand. Each of these formulations is used in the complete model depending on whether the price is used to determine actual or trend values for output or to determine actual, trend, or expected values of interest rates.

1. *Trend money demand* depends on the trend nominal interest rate and real output. This is the real balance that exists in the absence of external shocks and changing monetary policy.

$$\left(\frac{m'}{P_d}\right)^d_t = l_a \cdot R'^{\,l_R}_{d,t} \cdot \hat{gdp}'^{\,l_Y}_t \qquad 4.52$$

Trend growth of the money demand is used to model expectations about the current period. Trend money demand, however, is not expected money demand because an adjustment process is added to the constant elasticity function.

2. *Expected money demand* is used to make current decisions and depends on beginning-of-the-period interest rates and expected output. This function uses trend output - expected output - rather than the actual output that prevails at the end of the period. A lag captures a portion of the adjustment process.

$$\left(\frac{m^*}{P_d}\right)^d_t = \left[l_a \cdot R^{l_R}_{d,t} \cdot \hat{gdp}'^{\,l_Y}_t\right]^{\lambda} \left[\left(\frac{m^*}{P_d}\right)^d_{t-1} \frac{(m'/P_d)_t}{(m'/P_d)_{t-1}}\right]^{1-\lambda} \qquad 4.53$$

3. *Actual money demand* is based on actual interest rates and actual GDP. The formulation is similar to the formulation of expected money demand:

$$\left(\frac{m}{P_d}\right)^d_t = \left[l_a \cdot R_{d,t}^{l_R} \cdot g\hat{d}p_t^{l_y}\right]^{\lambda} \left[\left(\frac{m}{P_d}\right)^d_{t-1} \frac{(m'/P_d)_t}{(m'/P_d)_{t-1}}\right]^{1-\lambda} \qquad 4.54$$

where:
l_a = money demand intercept
l_R = nominal interest elasticity of money demand
l_y = real output elasticity of money demand
λ = lag adjustment
R_d = domestic nominal interest rate
(m'/P_d) = trend money demand

This money demand function, together with money supply, determines the actual price level that prevails at the end of each period.

4.4.b The Monetary Base

The nominal stock of money grows with domestic credit and the accumulation of foreign reserves.[9] The change in the stock of money is found from changes in government borrowing from the KCB plus the change of the domestic value of foreign reserves.

$$\frac{\Delta m_t}{P_{d,t}} = \frac{\epsilon_t \cdot \Delta h_{e,t}}{P_{d,t}} + \frac{\epsilon_t \cdot \Delta h_{y,t}}{P_{d,t}} + \frac{\Delta b_{gm,t}}{P_{d,t}} \qquad 4.55$$

Domestic credit expansion is government borrowing from the KCB and is the rate that the KCB prints money. The continuous time calculation of domestic credit expansion is:

$$\frac{\Delta b^G_{m,t}}{P_{d,t}} = (e^{\mu_t} - 1)\frac{m_{t-1}}{P_{d,t}} \qquad 4.56$$

The price level will rise at the same rate as domestic credit expansion assuming two conditions: monetary expansion is

---

[9] The stock of money is the same as the monetary base. There are reliable statistics for Kenya's monetary base, but not for broader definitions of money.

fully anticipated; and, there is a constant transactions demand for money.

The rate of inflation will not match domestic credit expansion, because these two conditions are not exactly reached. The variations in the real value of the monetary base will appear as variations of foreign currency reserves. This occurs because increases in the monetary base must be willingly held. Monetary expansion beyond the real demand for money leads to a fall of foreign currency reserves, leaving the real value of the monetary base unchanged.

Foreign currency reserve fluctuations are determined by fluctuations of the domestic demand for money. The demand for money fluctuates with both expected and unexpected changes of output. The change in foreign reserves due to expected output growth is:

$$\frac{\epsilon \cdot \Delta h_{y,t}}{P_{d,t}} = e^{\mu_t}\left[\left(\frac{g\hat{d}p'_t}{g\hat{d}p'_{t-1}}\right)^{1_y} - 1\right]\frac{m_{t-1}}{P_{d,t}} \qquad 4.57$$

The change due to unexpected output growth is calculated as:

$$\frac{\epsilon_t \cdot \Delta h_{e,t}}{P_{d,t}} = \frac{(m_t - \tilde{m}_t)}{P_{d,t}} \qquad 4.58$$

The difference, $m_t - \tilde{m}_t$, is unexpected money balances. These balances are effectively a result of exchange rate fluctuations and adjustment, hence the distinction - $\Delta h_{\epsilon t}$. Prices adjust to equilibrate real money demand with money supply assuming complete adjustment of the exchange rate to shocks. If the exchange rate is fixed by fiat, then prices

adjust assuming adjustment on the parallel market exchange rate. If government intervenes to manage the exchange, then prices adjust assuming adjustment of the price of non-traded goods relative to the price of traded goods.[h] To the extent that one of these three adjustments to exchange rate devaluations (revaluation) pressures does not occur in the present period, there is an unanticipated fluctuation in the domestic currency value of foreign reserves.

This component of the monetary base together with the other two components algebraically reduce to show a simple relationship between real money demand and the monetary base:

$$\frac{\Delta m_t}{P_{d,t}} = \left(\frac{m}{P_d}\right)^d_t - \frac{m_{t-1}}{P_{d,t}} \qquad 4.59$$

The monetary base grows if real money demand grows.

4.4.c The Price Level

The price level is determined as an index of sectoral prices. Sectoral prices are determined by world prices and exchange rates, except for non-traded goods. Inflation does not effect the world price level, but domestic credit expansion affects exchange rates. The price level, therefore, changes by the extent that credit is not absorbed into the domestic economy.

---

[h] The relationships between the official exchange rate, parallel market exchange rate and price of non-traded goods was introduced in section 4.2 and fully discussed on the following two sections.

The price level is an ideal price index of sectoral prices. The index is ideal because it varies only with world prices, exchange rates, or taxes, and it does not vary with composition or level of output. The price index depends on the parameters of the production system (described in Section 4.5.c).

$$P_{d,t} = \sum_i \alpha_i \ln P_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j + \sum_i \beta_i \ln P_i \ln \hat{k} \qquad 4.60$$

This is the actual price level used in the model to convert real variables to nominal variables and vice versa.

The price level is observed at the end of each period. A separate price level calculation yields the expected price level that appears in decision variables. Decision variables are determined at the beginning of each period. The expected price level is that which equilibrates expected money demand and supply.

$$P^*_{d,t} = \frac{m^*_t}{(m^*/P_d)^d_t} \qquad 4.61$$

where

$$m^*_t = m^*_{t-1} \left(\frac{g\hat{d}p'_t}{g\hat{d}p'_{t-1}} \right)^{1_\gamma} e^{\mu_t} \qquad 4.62$$

This is the expected value for the price level, and it is a disequilibrium amount. The actual price level is that which restores equilibrium at the end of each period.

The actual price level depends on sectoral prices that vary with world prices, exchange rates, and taxes. For

example, the domestic price in the food sector is calculated by:

$$P_{f,t} = \frac{(1+t_t)\,e_t\,\overline{P}_{f,t}}{(1+\tau_t)} \qquad 4.63$$

where: τ_t = export taxes
t_t = domestic tariffs

Domestic tariffs are a composite of tariffs, various non-tariff measures, and excise taxes. Importable goods prices are also calculated this way. World prices for food crops and importables goods are converted at the parallel market exchange rate, ϵ'. There is sufficient parallel market activity in Kenya that the competitive foreign exchange price prevails for food crops and importable goods. The parallel market operates as the purchases of foreign exchange, under- or over-stated bills of lading for import or export shipments, or the purchase of foreign exchange licenses (see the discussion in Chapter 3).[11]

Export crop prices are converted at the official exchange rate because exports are entirely controlled by government marketing boards. Also, only export taxes effect the calculation since there are no tariffs on exported goods.

Non-traded goods prices do not depend on world prices, and are calculated depending on domestic inflation and KCB interventions in the foreign exchange market.

$$P_{NT,t} = \left[P_{NT,t-1}e^{\pi^{\cdot}_{d,t}}\right]^{\frac{1+\alpha-\alpha\beta}{1+\alpha}} P^{*}_{NT,t}{}^{\frac{\alpha\beta}{1+\alpha}} \qquad 4.64$$

This is not a structural equation, but a reduced-form

equation of structural relationships. A structural equation to find the end-of-period price of non-traded goods will over-identify the system.[i] The price of non-traded goods is, instead, solved iteratively by varying $P^*_{NT,t}$ to find equilibrium in the sector. The other two features of this equation are the expected inflation rate, π^*, and the KCB intervention parameters. The expected inflation rate is described above, and the intervention parameters are described in more detail below. For the moment, note that KCB's interventions effect the monetary base and prices.

The first term (without the exponent) in the above equation is the expected non-traded goods price, that adjusts with expected inflation. The expected price is, as mentioned previously, a disequilibrium price. Equilibrium is restored in this market as P^*_{NT} is adjusted. This is the case because as the change in the non-traded goods price is a relative price change that produces effects on sectoral composition that will restore equilibrium in the non-traded goods market. The calculation for the non-traded goods price is not a structural equation, but the non-traded goods price remains a variable determined, albeit residually, by the interaction of supply and demand for non-traded goods.

The traded goods sectoral outputs change also, but

---

[i] The structure of the model is explained in section 4.2. A review of why a structural equation over-identifies the system appears in the following section where reduced-form equations for the official and parallel market exchange rates appear.

excess demand or supply in the traded goods markets is met with imports or exported abroad. Net exports are determined by world market conditions for the non-traded goods markets, therefore equilibrium in the non-traded goods markets means that the system is in equilibrium also.

The equilibrium non-traded goods price is one of three prices that solve market clearing conditions in the model. The remaining two prices that solve equilibrium in the model are the official and parallel market exchange rates. Changes in either one of the three prices can solve the model, because each price change produces a relative price change between non-traded and traded goods.

4.4.d Exchange Rates

The official and parallel market exchange rates are calculated in a similar manner as the non-traded good price. There is a beginning-of-the-period disequilibrium value that is adjusted, iteratively, until an end-of-the-period equilibrium value is reached. The official and parallel market rates are, respectively:

$$\epsilon_t = (\rho\epsilon_{t-1})^{\frac{\alpha}{\alpha+\beta}} \epsilon_t^{*\frac{\beta}{\alpha+\beta}} \qquad 4.65$$

and

$$\epsilon_t' = \epsilon_t \cdot \left(\frac{\epsilon_t'}{\epsilon_t}\right)^{1-\beta} \qquad 4.66$$

The exponent parameters, α and β, are KCB intervention parameters. The adjustment parameter, ρ, is a counter-valuation parameter that models official exchange rate

movements when these are in the opposite direction of economic pressures.

The actual exchange rate values are solved as the second term in each equation, ϵ^* or $(\epsilon'/\epsilon)^*$, is varied to find equilibrium. These are not structural equations, but they are reduced forms of the structural relationships between supply and demand for goods or money.

Structural equations for exchange rates will over-identify the system. Structural equations for equations for exchange rates or for the price of non-traded goods will over-identify the system, because changes here will affect the trade-bias parameter on the productivity of the capital stock. Structural equations for exchange rates or the price of non-traded goods would ultimately depend on the capital stock.

Simultaneity in the system could be eliminated by converting any of the key structural equations to a reduced-form equation. The equations for exchange rates were converted to reduced-form equations since the effect of exchange rate policy on Kenya's agricultural development is the object of the study. A structural equation for the price of non-traded goods was also converted because exchange rate adjustment pressures will appear as changes in the price of non-traded goods depending on government exchange rate policy.

Government deficit financing from the central bank, for

example, produces inflationary effects throughout the macro-economy, and these will be observed as changes of exchange rates or of the domestic price level. Government borrowing from the KCB creates a domestic credit expansion that is expected to lead to a corresponding rise of prices. Decisions are based on these expectations in the real side of the economy. To the extent that these expectations are realized, there are no effects on real variables.

In this case, the reduced-form equations for exchange rates or non-traded goods price will move to exactly match domestic credit expansion. If, however, economic agents do not adjust immediately to a new rate of domestic credit expansion, then exchange rates or the non-traded goods price will adjust to the lessor degree determined by the economic agents' response. In any event, equilibrium for the entire system is restored because exchange rates and the non-traded goods price are reduced-form equations.

Adjustment to shocks on the system will appear as changes in the exchange rates or the price of non-traded goods depending on government exchange rate policy. If the official exchange rate is allowed to float freely, then adjustment to shock will occur entirely in the official exchange rate market. If government fixes the exchange rate through legislation, then adjustment will occur entirely in the parallel exchange market. If government fixes the official exchange rate by intervening in the foreign exchange

market, then a parallel market will not develop and adjustment will occur entirely in the price of non-traded goods. Kenya has pursued each of these approaches at different times since independence, but, in general, has chosen a combination of these policies. Shocks to Kenya's economy has produced adjustments in the official and parallel exchange rate markets and in the price of non-traded goods.

Intervention is a combination of the degree that the official rate is allowed to fluctuate and the degree the official rate overvalues domestic currency. Undervaluation is not modelled because it has not occurred in Kenya and is not a common policy in any country.[j] However, the official rate was revalued in 1973 in spite of devaluation pressures.[k] A counter-valuation parameter is included in the official exchange rate reduced-form equation to accommodate this uncommon policy decision.

The two intervention parameters, ϕ and η, indicate the degree of management and overvaluation, respectively. Both parameters vary between zero (no intervention) and one (complete intervention). These parameters enter the reduced-form equations according to:

---

[j] Of 149 countries listed in the World Currency Tables in 1988, only the Norwegian Krone was undervalued - undervalued by 1% compared to the official rate.

[k] The Kenya Pound was tied to the US Dollar in 1973 when the Dollar was devalued. Kenya choose to revalue to Pound in terms of gold even though the Pound continued to face devaluation pressures. Kenya reversed the action by lowering the gold content of the Pound about six months later.

$$\alpha = \frac{\phi}{\phi - 1} \quad , \quad \beta = 1 - \eta \qquad 4.67$$

As phi and eta approach zero, the exchange rates approach their market values. As phi approaches one, the official exchange rate is fixed so adjustment occurs in the parallel market. As phi and eta approach one, the official exchange rate is managed by the buying and selling of foreign exchange and adjustment occurs in the price of non-traded goods. Whether adjustment occurs in any one or a combination of these three prices, the relative price between traded and non-traded goods is changing until equilibrium is reached in the non-traded goods sector.

4.4.e Interest Rates

The nominal interest rate is equal to the real interest rate plus inflation. The real interest rate is equal to the world real interest rate plus a risk premium for Kenya. Inflation is the rate of change of the domestic price level. This is the basic understanding of interest rates, but the calculations for inflation are not straight-forward.

Inflation is essentially based on the rate of domestic credit expansion. However, the economy does not adjust instantaneously to changes in the rate of change of the money supply. Thus the nominal interest rate is a function of the world real interest rate, risk, inflation, and an adjustment factor.

Domestic actual inflation, domestic expected inflation,

and world inflation are calculated as the continuous-time rate of change of the actual and expected price levels (defined in Section 4.4.c).

$$\pi_{d,t} = \ln(P_{d,t}/P_{d,t-1}) \qquad 4.68$$

$$\pi^{*}_{d,t} = \ln(P^{*}_{d,t}/P^{*}_{d,t-1}) \qquad 4.69$$

$$\pi_{w,t} = \ln(P_{w,t}/P_{w,t-1}) \qquad 4.70$$

Trend inflation, however, is a reduced-form structural equation that includes KCB intervention parameters and the trend rate of change of the money supply. This inflation rate is not a trend variable that exists in the absence of shocks, but it is the result of a shock. The shock is a change in the rate of growth of the money supply. This variable gives the best estimate of inflation for the period based on the trend rate of growth of the money supply. The trend rate of growth is itself the best estimate of money growth. The trend rate of growth of the money supply is the average of trend and actual growth of the money supply in period (t-1). These calculations are

$$\pi'_{d,t} = \mu'_t - (\mu'_t - \pi_{w,t})\frac{\alpha\beta}{1+\alpha} \qquad 4.71$$

$$\mu'_t = \frac{(\mu'_{t-1} - \mu_{t-1})}{2} \qquad 4.72$$

where: α, β = KCB intervention parameters,
I_R = interest rate elasticity, and
π_w = world real inflation.

As the KCB intervenes, the trend inflation rate approaches the world inflation rate, $\pi_{w,t}$. If the KCB allows the exchange rate to float, then trend inflation approaches

the trend rate of domestic credit expansion, μ_t'. The adjustment equation models a simple log adjustment of expectations towards a new rate of growth of the money supply.

The nominal interest rate is a function of this inflation rate and of the real world interest rate at Nairobi, which includes risk

$$R_{d,t} = r_{w,t} + \pi'_{d,t} + r_{w,t}\pi'_{d,t} \qquad 4.73$$

4.4.f Summary and Policy Implications

The inflation rate depends on the extent that credit expansion is not absorbed into the domestic economy. Kenya has pursued an expansionary monetary policy, which implies higher domestic inflation, but Kenya has also fixed the exchange rate, which implies lower domestic inflation. These contradictory policies have persisted through KCB intervention and currency restrictions.

Intervention can succeed as long as sufficient reserves are available to the KCB to balance exchange rate supply and demand. Reserves of the KCB fell, and Kenya resorted to the more drastic policy of currency restrictions. These restrictions did not prevent effective exchange rate devaluation through parallel markets. The restrictions fractured the exchange market, however. The sectors (food crops and importable goods) with greater contact with non-residents can trade at the parallel market exchange rate, and the sector without contact (export crops) trades at the

official rate. A fractured exchange rate market means there are relative price changes between sectors.

Money is neutral in the model, but an expansionary monetary policy together with a fixed exchange rate will produce relative price changes among sectors in the economy. The effects of the relative price changes and other policy variables are modelled in the supply and demand framework as described in the following section.

4.5 Sector Supply and Demand

The neo-classical growth model provides the intertemporal path for aggregate output and the components of GDP. Sectoral supply is defined by shares of GDP, and sectoral demand is defined by shares of aggregate expenditures. Output and expenditures are disaggregated into agricultural and non-agricultural output growth. Sector policies, including exchange rate policy, are built upon these output paths.

Output is actually dissaggregated into four sectors: food crop production, export crop production, importables production, and non-traded goods production. Food and export crop production together comprise agricultural production. Agricultural production is divided into two sectors because government tax policy, fiscal policy, and exchange rate policy differ for these two sectors. Importable goods production is non-agricultural, and non-traditional

production can be used to substitute for imported goods. The stated aim of many government policies was to promote import substituting production. Non-traded goods production is non-agricultural but is traditional goods production. The price of non-traded goods is determined domestically.

The disaggregation allows comparisons of responses to exchange rates policy or to influences on exchange rates of agricultural versus industrial production, or traded goods versus non-traded goods production. The various effects are modelled with an aggregate profit function, which yields sector shares of total output, and an aggregate expenditure function, which yields sector shares of domestic consumption and investment.

Modelling sectoral supply and demand as shares of aggregate output and expenditure links price changes (including exchange rate changes) to resource shifts between sectors. Domestic policies that alter relative prices between sectors will cause resource shifts and affect aggregate productivity. For example, relative sector taxation alters relative sector profitability so that resources shift from relatively more socially productive uses to less socially productive but more profitable uses. Thus, the fall of productivity lowers Kenya's international trade offer curve and the demand for Kenyan Pounds. This implies devaluation of the Pound.

These effects in the supply and demand framework affect

capital accumulation. Given fallen productivity, in the above example, less output is available for consumption and investment. The capital accumulated in this period, according to the supply and demand framework, is the basis for next period's growth, and, given this growth, it is the basis for the next period's sectoral output. If investment falls, then capital accumulation and output growth in future periods continue along a lower growth-path.

4.5.a Domestic Prices

Price changes are modelled in a perfect producer price index[1] that decomposes a change in the price of one commodity into its relative and absolute components. If, for example, the price of one commodity increases while the prices of other commodities remains the same, then production in this sector increases and production in the other sectors declines. The producer price index will change absolutely to the precise extent that output remains unchanged. Inflation does not effect real output or its sectoral composition.

Composition changes with world prices, relative sectoral taxation or subsidization, or exchange rate policy. Prices for traded goods are determined in world markets. The price for non-traded goods are determined by domestic market clearing. Adjustment of these four prices, through exchange rate changes or non-traded goods price changes, solve the

---

[1] A perfect price index has the same functional form as the aggregate production function. These functions are detailed in the following section, Section 4.5.b

model. The domestic value of world prices is the Kenyan value of world prices adjusted by import tariffs and export taxes. Repeating the example given in Section 4.4, the domestic price in the food sector is given by:

$$P_{f,t} = \frac{(1+t_t)\,e_t\bar{P}_{f,t}}{(1+\tau_t)} \qquad 4.74$$

where: τ_t = export taxes
t_t = domestic ad valorem tariffs

Non-traded goods prices do not depend on world prices, and they are given by a reduced-form equation, also described in Section 4.4

$$P_{NT,t} = \left[P_{NT,t-1}e^{\pi^*_{d,t}}\right]^{\frac{1+\alpha-\alpha\beta}{1+\alpha}} P^*_{NT,t}{}^{\frac{\alpha\beta}{1+\alpha}} \qquad 4.75$$

Similar reduced-form equations of structural relationships exist for both parallel and official market exchange rates. The price of non-traded goods and each exchange rate are solved iteratively to find equilibrium. Prices in each sector depend on the KCB sterilization parameters (α and β). The KCB manages the official exchange rate and manages the degree the parallel market exchange rate is over-valued. The expected inflation rate and the intervention parameters are described in more detail in Section 4.4 above. For the moment, recall that KCB's sterilization efforts can isolate domestic prices or manage the two exchange rates, but not all three.

4.5.b Sectoral Supply

The producer price index, a divisia price index

following Alston and Chalfant, has the same functional form as the profit function, which delineates supply, and the expenditure function, which delineates demand.

In an economy with more than one production sector, nominal GDP per capita, or profits, is equal to

$$\pi = \Sigma_i P_i y_i \qquad 4.76$$

where y_i is output per capita in each sector, and P_i is the price of output in each sector. In the general sense, the term profits refers to the payments to the fixed factors of production. For a macroeconomy at a given point in time, with all domestic factors of production (such as capital and labour) fixed, this equals nominal GDP per capita. The growth portion of the macroeconomic model provides capital and output growth-paths that are stated - *i.e.*, fixed - at the beginning of each period, so sector shares of output may be dissaggregated using a profit function.

The form of the profit function is[12]

$$\begin{aligned} \ln\pi &= \ln A + gt + \alpha_K \ln\hat{k} + \Sigma_i \alpha_i \ln P_i + \tfrac{1}{2}\Sigma_i \Sigma_j \gamma_{ij} \ln P_i P_j + \Sigma_i \beta_i \ln P_i \ln\hat{k} \qquad 4.77 \\ &= \ln y + \ln PPI \end{aligned}$$

where

$$lny = \ln A + gt + \alpha_K \ln\hat{k} \qquad 4.78$$

$$lnPPI = \Sigma_i \alpha_i \ln P_i + \tfrac{1}{2}\Sigma_i \Sigma_j \gamma_{ij} \ln P_i \ln P_j + \Sigma_i \beta_i \ln P_i \ln\hat{k} \qquad 4.79$$

and,
- A = production function intercept,
- g = Harrod-neutral technical change factor,
- α_K = capital share,
- β_i = Rybczynski parameters,[13]
- α_i = own-price parameters, and
- α_{ij} = cross-price parameters.

Equation 4.78 is the logarithm of the per capita aggregate

Cobb-Douglas production function used in the growth model. Equation 4.79 is the logarithm of a perfect producer price index (or GDP deflator) which perfectly decomposes a change in the price of one commodity into its relative and absolute components. The parameters, β_i, indicate how output shares change as the economy grows and relative prices are constant.

By Hotelling's lemma,[14] the long-run output shares are

$$\begin{aligned} S_i^* &= (P_i y_i^*)/\pi \\ &= (\partial \ln \pi)/(\partial \ln P_i) \\ &= \alpha_i + \Sigma_j \gamma_{ij} \ln P_j + \beta_i \ln \hat{K} \end{aligned} \qquad 4.80$$

and the long-run supply functions become:

$$y_i^* = \pi(\alpha_i + \Sigma_j \gamma_{ij} \ln P_j + \beta_i \ln \hat{K})/P_i \qquad 4.81$$

By using a simple Nerlovian partial adjustment process that maintains completeness, the short-run supply functions become

$$y_{i,t} = \lambda y_{i,t}^* + (1-\lambda)\,[\pi_t/(\Sigma_i P_{i,t} y_{i,t-1})]\, y_{i,t-1} \qquad 0 \le \lambda \le 1 \qquad 4.82$$

Profits, π_t, in these equations excludes investment so that shares are based on

$$\pi_t = g\hat{d}p_t - i_{p,t} - i_{g,t} \qquad 4.83$$

Investment is excluded because capital is employed in the sector that produced it. This is assumed to simplify the number of consumption variables. Demand variables are final consumption variables, and investment in the expenditure shares are excluded (described in Section 4.5.c). The assumption can be justified because the human capital share is approximately 50% of output, and human capital is acquired

within each sector (see Section 5.2.a).

The profit function yields three sets of elasticities. These are not used in the model, but they are needed to estimate that profit function as described in Chapter 5. The long-run own-price elasticities of supply are

$$\varepsilon_{ii} = -1 + \gamma_{ii}/S_i^* + S_i^* \qquad 4.84$$

The long-run cross-price elasticities of supply are

$$\varepsilon_{ij} = \gamma_{ij}/S_i^* + S_j^* \qquad 4.85$$

The elasticities of supply with respect to aggregate output are

$$\varepsilon_{i,\pi} = 1 + \beta_i/(S_k S_i^*) \qquad 4.86$$

Note that $\Sigma_j \varepsilon_{ij}=0$, and $\Sigma_i S_i^* \varepsilon_{i,\pi}=1$. Also, the elasticities are functions of sector shares, so price elasticities change as the economy grows.

4.5.c Sectoral Demand

Sectoral demand is defined by the expenditure function of an Almost Ideal Demand System (AID system). The demand system is constructed analogously to the supply system. The AID system[15] is

$$\begin{aligned} \ln e &= \alpha_0 + \Sigma_i \alpha_i \ln P_i + \tfrac{1}{2}\Sigma_i \Sigma_j \gamma_{ij} \ln P_i \ln P_j + u\alpha_K \Pi_j P_j^{\beta_j} \\ &= \ln CPI + u\alpha_K \Pi_j P_j^{\beta_j} \end{aligned} \qquad 4.87$$

where: α_o = inital sector share,
α_i = own-price parameter,
γ_{ij} = cross-price parameter,
β_i = parameter on scale variable (*i.e.*, expenditure),
α_K = capital share, and
u = utility.

As in the translog production system, the CPI becomes a

perfect consumer price index. This index perfectly decomposes a change in the consumer price of one commodity into its relative component (the first term) and its absolute component (the second term).

By Sheppard's lemma, the expenditure shares are

$$\begin{aligned} W_i &= (P_i c_i)/e \\ &= (\partial \ln e)/(\partial \ln P_i) \\ &= \alpha_i + \Sigma_j \gamma_{ij} \ln P_j + \beta_i (u \alpha_K \Pi_j P_j^{\beta_j}) \end{aligned} \qquad 4.88$$

Using the expenditure function to substitute ln(e/CPI) for $(u\beta_0 \Pi_j P_j^{\beta j})$, the expenditure shares become

$$\begin{aligned} W_i &= \alpha_i + \Sigma_j \gamma_{ij} \ln P_j + \beta_i \ln(e/CPI) \\ &= \alpha_i + \Sigma_j \gamma_{ij} \ln P_j + \beta_i \ln c \end{aligned} \qquad 4.89$$

The expenditure function is based on final consumption, and excludes investment (as described above)

$$e_t = \frac{P_{d,t}(c_t + g_t)}{CPI_t} \qquad 4.90$$

For a given nominal expenditure, e, the real Marshallian demand functions become

$$c_i = e[\alpha_i + \Sigma_j \gamma_{ij} \ln P_j + \beta_i \ln(e/CPI)]/P_i \qquad 4.91$$

The own-price elasticities of demand are

$$\eta_{ii} = -1 + [\gamma_{ii} - \beta_i(\alpha_i + \Sigma_k \gamma_{ik} \ln P_k)]/W_i \qquad 4.92$$

The cross-price elasticities of demand are

$$\eta_{ij} = [\gamma_{ij} - \beta_i(\alpha_j + \Sigma_k \gamma_{jk} \ln P_k)]/W_i \qquad 4.93$$

and the income elasticities of demand are

$$\eta_{ie} = 1 + \beta_i / W_i \qquad 4.94$$

4.5.d Productivity Shifts

The supply and demand framework models sectoral policy shocks as relative price changes. This framework models relative sectoral taxation or subsidization in the calculation of sector price. Exchange rate policy effects are modelled, since the price of exportable crops is calculated using official exchange rates and since food crop and importable goods prices use parallel market rates. The effect of other policies will also be revealed themselves as relative price changes between non-traded and traded goods prices.

Relative price changes, as separate from absolute price changes, cause resource shifts among the sectors. If these price changes cause shifts from socially productive to unproductive uses, aggregate output will fall. This decline in productivity reduces available output for consumption and investment. A fall in investment means the neo-classical growth-path of output will proceed, beginning the following period, along a lower convergence path.

A socially productive resource distribution is defined by relative world prices. Socially unproductive resource uses, therefore, occur when relative domestic prices differ from relative world prices. This is captured in the trade bias parameter, γ_t.

$$\gamma_t = e^{(g+\eta_6 \cdot \ln\beta)} \gamma_{t-1} \quad , \quad \beta = \frac{e_t^m}{e_t^x} \qquad 4.95$$

where: η_β = trade bias parameter, and
β = trade bias (ratio of effective import to effective export exchange rates.

This equation was introduced in Section 4.3, but two of the key components - the effective import and export exchange rates - were not defined.

$$\varepsilon_t^M = \frac{P_{f,t}\hat{y}_{f,t-1} + P_{m,t}\hat{y}_{m,t-1}}{\varepsilon_t\left(\overline{P}_{f,t}\hat{y}_{f,t-1} + \overline{P}_{m,t}\hat{y}_{m,t-1}\right)} \qquad \varepsilon_t^X = \frac{P_{x,t}\hat{y}_{x,t-1}}{\varepsilon_t\overline{P}_{x,t}\hat{y}_{x,t-1}} \qquad 4.96$$

where: ε_t = official exchange rate
$P_{f,t}$ = domestic price of food (m denotes importables and x denotes export crops)
$y_{f,t}$ = domestic production of food
$\overline{P}_{f,t}$ = world price of food

Policy shocks such as an overvalued exchange rate will cause each effective exchange rate to change because domestic prices are changing relative to other domestic prices while relative world prices do not change.

The trade bias models the productivity effects of policy shocks. Relative domestic prices differ from relative world prices, so resources are shifting from socially productive, but unprofitable, to socially unproductive, but profitable uses. Less total output is available for desired consumption and investment. The system is in equilibrium, but a lower level of capital accumulation, due to falling investment, means that the economy will proceed along a lower capital and output growth path.

4.5.e Supply and Demand Equilibrium

The market for non-traded goods is in equilibrium where

supply and demand clear. The price of non-traded goods adjusts to clear domestic excess supply or demand. The prices of traded goods are determined in world markets. Given supply and demand, which are defined by aggregate profit and expenditure functions, and given world prices, excess supply and demand in traded goods market will totals net exports. Therefore, once the market clearing condition is reached for non-traded goods, then the model is in equilibrium also.

Marketing clearing in the non-traded goods sector is achieved as the price of non-traded goods adjusts relative to the price of traded goods. The relative price change induces resources to move into non-traded goods production, if prices rise, or leave the sector if prices fall. The relative price of non-traded goods changes: if the absolute price of non-traded goods changes holding the price of traded goods constant; if the prices in each traded goods sector changes due to changes in the official exchange rate; or, if the prices of food crops and of importable goods change due to changes in the parallel market exchange rate. Any one of these price changes represents a relative change between the price of traded and non-traded goods, and, in turn, will cause a shift in resources between sectors until equilibrium is reached in the non-traded goods sector.

Chapter 4: Endnotes

1. Charles Adams and Bankim Chadha, "On interpreting the Random Walk and Unit Root in Nominal and Real Exchange Rates," IMF Staff Papers, Vol.38, No. 4 (December, 1991), pp.901-902.

2. Moshin S.Khan and Jonathan D.Ostry, "Repsonse of the Equilibrium Real Exchange Rate to Real Disturbances in Developing Countries," World Development, Vol.20, No.9 (1992), p.1325.

3. Sebastian Edwards and Sweder van Wijnbergen, "Disequilibrium and Structural Adjustment," Handbook of Development Economics (Vol.II), edited by H. Chenery and T.N. Srivivasan, Elsevier Science Publishers B.V. (New York, 1989), p.1483.

4. *Ibid*, pp.1486-87.

5. Sebastian Edwards, Real Exchange Rates, Devaluation and Adjustment, MIT Press (Cambridge, 1989), pp.1-4.

6. Robert J. Barro and R.F. Lucas, Macroeconomics (Canadian Edition), Irwin (Boston, 1994), pp.142-152.

7. Oliver Blanchard and Stanley Fischer, Lectures on Macroeconomics, MIT Press (Cambridge, Mass; 1989), p.38, and Robert J. Barro and Xavier Sala-i-Martin, Economic Growth, McGraw-Hill (Toronto, 1995), p.16.

8. N.Gregory Mankiw, David Romer, and David N.Weil, "A Contribution to the Empirics of Economic Growth," NBER Working Paper 3541, December 1990, p.1.

9. Yujiro Hayami and Vernon W. Ruttan, Agricultural Development: An International Perspective (Second Edition), Johns Hopkins University Press (Baltimore, 1985), p.95.

10. David Laidler, The Demand for Money: Theories and Evidence (4th Ed.) Harper and Row (New York, 1993).

11. Philip P. Cowitt, World Currency Yearbook, 1988-89, International Currency Analysis (Brooklyn, N.Y.; 1991), pp.103-4.

12. L.R. Christensen, D.W. Jorgenson, and L.J. Lau, "Transcendental Logarithmic Production Frontiers." Review of Economics and Statistics, Vol. 55, No. 1, 1973.

13. T.B. Rybczynski, "Factor Endowments and Relative Commodity Prices," Econometrica 22(4), December 1954, pp.336-341.

14. Hal R. Varian, Microeconomics (Second Edition), W.W. Norton & Co. (New York, 1984), p.52.

15. Angus Deaton and John Muellbauer, "An Almost Ideal Demand System," American Economic Review, 70(1980), pp.312-26.

Chapter 5

Calibrating and Testing A Macroeconomic Model for Kenya

The empirical macroeconomic model is calibrated for Kenya between 1964 and 1991. A complete data set was created for estimating all aspects of the model. The complete model supports counter-factual experiments for testing the effect of Kenya's exchange rate policy on agricultural development.

The first stage in estimating the model was collecting a complete and consistent data set. The importance and specifics of this data set are described in Section 5.1. The estimation methods and the results of these estimations are described in Section 5.2. The outcomes of counter-factual experiments are described in Section 5.3. Conclusions about the effect of exchange rate policy on Kenyan agricultural development are made in Section 5.4.

5.1 Complete Macroeconomic Data Set

The data set was built around the national accounts for Kenya. This data set includes both real and nominal values for most of the data needed to estimate the model. Sources

for monetary data, capital stock data, and exogenous data, that are not part of the national accounts are also described in this section and described in order of importance for estimating the model.

5.1.a National Accounts

A complete and consistent data set is important for estimating the model. A complete data set was ensured by using Kenya's system of national accounts.[1] By using this data set, the model captures all economic activity and measures the activity only once. The data set was originally compiled by Kenya's Bureau of Statistics. Some corrections were made to this data set in order to make the data consistent from 1964 to 1991.

Basic market clearing in the model was manipulated so it could be represented by Kenya's national accounts (Section 4.2.a).

$$Y_t + \frac{\varepsilon_t r_t^w B_t^f}{P_t} = C_t + I_{p,t} + G_t + I_{g,t} + \frac{\varepsilon_t \Delta B_t^f}{P_t} + \frac{\varepsilon_t \Delta H_t}{P_t} \qquad 5.1$$

The national accounts are constructed to capture all economic activity, so the market clearing conditions of the model, which use all data series from the national accounts, represent market clearing in the macroeconomy.

These data and the sources are detailed in Appendix C according to the national accounting framework that is presented in Appendix B. The data set was created from tables compiled by Kenya's Bureau of Statistics. Kenya

collects statistics according to United Nations (UN) and International Monetary Fund (IMF) definitions.[2] These sources provide sufficient detail for constructing the data set that is needed for the market clearing conditions in the model.

The UN and IMF definitions used to create the national accounts contain several minor revisions since 1964 and one major revision in 1972. The data are not completely consistent, however. Certain data problems, detailed below, are the outcome of inconsistencies in the data. The inconsistencies are likely the result of the major revision of national accounting definitions and other data problems. Many data series in the national accounts are sufficiently consistent between 1964 and 1991 to support econometric analyses. These estimations and those estimations where data inconsistency was a problem are detailed below in Section 5.2 and in Appendix D.

5.1.b Money and Prices

The national accounts include both real and nominal values, so monetary variables (prices and money) are derived from the national accounts also. Five price series are collected from the national accounts data: the domestic price level, export crop sector prices, food crop sector prices, importable goods sector prices, and non-traded goods sector prices. These prices are all constructed from real and nominal data series of GDP at factor price. The stock of

money and net factor payments abroad are part of the national accounts, also, so all data needed to compute monetary variations were included in the data set.

5.1.c Capital Stock

All real variables except for the capital stock are constructed using Kenya's national accounts. The capital stock data are estimated using a simple Cobb-Douglas aggregate production function, using investment series for Kenya, and using existing estimations for parameters of the U.S. economy in 1964.[a]

5.1.d Exogenous Data

Exogenous data series are determined outside of the economic system. Exogenous variables include world interest rates, world price level, exchange rates, and population growth. These data series are not collected from the national accounts, but from international sources, such as the IMF - International Financial Statistics, or from Kenya's Central Bureau of Statistics.

5.2 Estimations for the Model

Estimations for the major parts of the model are described below. Based on the functional forms detailed in Chapter 4, the following sections describe the estimation

---

[a] The U.S. economy in 1964 is taken to be the steady-state from Kenya's point-of-view (see Section 4.3). Estimates for the U.S. capital stock are detailed in Section 5.2.a, and are derived from Barro and Sala-i-Martin, Economic Growth.

techniques and summarize the results of these estimations. The estimations are presented in the same order as they appear in Chapter 4. The complete results of the estimations are detailed in Appendix D.

5.2.a Capital Stock

The capital stock is not estimated using econometric techniques. The base capital stock is inferred from estimates and parameters for the United States in 1964. Estimates for portions of the capital stock financed by the private, government, and non-resident sectors are found using higher or lower time-preference rates (see Section 4.3.a).

1. Aggregate Initial Capital Stock - The state of the U.S. economy in 1964 is taken as a proxy for the steady-state from Kenya's point-of-view. The intercept term for the Cobb-Douglas production functional form is constant, so the value at the steady-state is the same as in the initial period. The steady-state capital stock is found using the following relationship, that was outlined in Section 4.3.a.

$$\hat{y}_t = A\hat{K}_{t-1}^{\alpha} \qquad 5.2$$

$$\hat{k}_{64}^{US} = \frac{(1-v)\,\alpha\,\hat{y}_{65}^{US}}{\delta + r^*} \qquad 5.3$$

$$A = \frac{\hat{y}_{65}^{US}}{\hat{K}_{64}^{US\ \alpha}} \qquad 5.4$$

where:
- A = Cobb-Douglas intercept,
- α = capital share,
- δ = depreciation,
- r^* = steady-state interest rate, and
- v = government transfers to the private sector.

Kenya's initial capital stock is calculated to be (in terms of Kenya Pounds - K£):

$$\hat{K}_{64} = \frac{\hat{y}_{65}^{\frac{1}{\alpha}}}{A} = \frac{2,571\,K£^{\frac{1}{0.8}}}{2.61} = 5,510.4\,K£ \qquad 5.5$$

2. *Disaggregated Initial Capital Stock* - There are five components of the capital stock. The five components represent five separate sources of financing the aggregate capital stock. The five sources are: private sector capital financed by the private sector (K_{pp}); private sector capital financed by non-residents (K_{pf}); government capital financed by the private sector (K_{gp}); government capital financed by non-residents (K_{gf}); and, government capital financed by the central bank (K_{gm}).

The initial stock of four of these series is inferred from a combination of three variables: first, the steady-state value for each of these four capital stocks; second, the time-preference rate for each capital stock; and third, the rate of accumulation for each capital stock. The last source of financing, K_{gm}, is identified solely by the rate of accumulation with an initial balance of zero.

3. *Capital Accumulation* - Capital accumulation is determined by a simple adjustment process (described in Section 4.3.a). The adjustment parameter for each of four financing sources is defined by the same set of equations,

but with different time-preference rates:

$$x=\frac{1}{2}\left[\left(\zeta^2+4(1-\alpha)s(\delta+r^*)\left(\frac{\delta+r^*}{\alpha}-(n+g+\delta)\right)\right)^{\frac{1}{2}}-\zeta\right] \qquad 5.6$$

$$\zeta = \rho-n-(1-\frac{1}{s})g \qquad 5.7$$

$$r^* = \rho+\frac{g}{s} \qquad 5.8$$

There are three sources for the values of these parameters

(1) Estimates for the US (Barro and Sala-i-Martin)
- α = capital share (80%)
- s = elasticity of intertemporal substitution (1.1%)

(2) Estimates from Kenyan Sources (Bureau of Statistics)
- r^* = steady-state interest rate (6%)
- n = population growth rate (3.5%)
- g = Harrod-neutral technical change factor (1.65%)

(3) Inferred for Convergence
- ρ_{gf} = time preference rate (4.5%)
- δ = depreciation rate (5%)

The time-preference rate used in the above example models government capital stock financed by non-residents. Higher time-preference rates are assumed for the other three sources of capital financing. The time-preference rates for each source of financing was determined by matching convergence from the initial stock toward the steady-state stock for each source of financing. The time-preference rate for the four sources of financing were:

ρ_{pp} = 5.77%
ρ_{pf} = 5.02%
ρ_{gp} = 4.68%
ρ_{gf} = 4.50%

The capital accumulation financed by the Kenya Central Bank was determined by the printing of money, and is described in the following section.

A growth-path, with these time-preference rates and other parameter values, implies conditional convergence to the steady-state after 200 years. Convergence to the steady-state is slow primarily because the capital share includes human capital. The capital share is estimated to be approximately 35% for the U.S. if human capital is excluded and approximately 80% if human capital is included.[3] These results are supported by empirical work using a multi-country set of output data.[4] This empirical work estimated that the capital share using is 60%, using precisely the same Cobb-Douglas functional form that appears in equation 4.24 . The human capital share, if included in a similar Cobb-Douglas production function, is estimated to be between 33% and 50%.[5] This implies that a broadly defined capital stock may reasonably be expected to contribute between 70% and 80% to aggregate output.

The higher capital share of 80% delays convergence by 200 years. Convergence is much less sensitive to the reasonable range of values for other parameters, n and g, which are directly estimated for Kenya. The remaining values are inferred from the steady-state, which are estimates of Cobb-Douglas technologies for the U.S. in 1964.

Convergence is slow for Kenya because time preference is presently greater in Kenya than in the steady-state,[b] and

---

[b] Since the steady-state is assumed to be equivalent to US conditions in 1964, $\rho_K > \rho_{US}$.

because only a small portion of Kenya's capital stock may be financed in any given period. These two assumptions are important for conditional convergence. The relatively greater time preference rate in Kenya versus the U.S. leads to a higher current consumption relative to future periods. This assumption captures the dependence on food stocks and a number of cultural influences which discourage savings (*eg.*, most administrated activities are accompanied by graft).[6]

5.2.b Trend Components of GDP

The components of GDP follow from the capital accumulation process. Investment by the private and government sectors is determined by the share of GDP that ensures the capital stock matched the capital growth-path. The separation between private and government investment is a result of the modelling technique for the five portions of the capital stock. Net exports is also determined by the financing model for the capital stock. Consumption is the residual source for output after investment and net exports were accounted for.[c] In the theoretical model, consumption drives the process, since economic agents maximize utility which is solely a function of consumption.

A behavioural equation was estimated for government consumption in order to complete the set of GDP components.

---

[c] Coincidentally, aggregate consumption is determined as a residual in Kenyan national accounts, as reported by the United Nations: United Nations National Accounts, United Nations (1982), p.997: "Private consumption expenditure is obtained as a residual."

This is necessary in order to create a separation between private and government consumption. As described in Section 4.3.b, government consumption is modelled to be equivalent to a simple tax function less transfers to the private sector.

$$\hat{g}'_t = (1-v)\,(t_a + t_y \cdot g\hat{d}p'_t) \qquad 5.9$$

where: v = 80% = transfers to the private sector,
t_a = -734 = lump sum tax (intercept), and
t_y = 64% = marginal tax rate.

This equation was estimated using data from the national accounting framework.

5.2.c Absorption Elasticities

Three parameters for modelling absorption elasticities are estimated for GDP, and four parameters for modelling absorption elasticities were estimated for each GDP component. GDP components are assumed to move with foreign assistance (net unrequited transfers from abroad) where GDP does not, so the GDP components include a parameter to model the absorption of foreign assistance into the current account. The remaining three parameters represent absorption of changes in the parallel market premium on foreign exchange, changes in the terms-of-trade, and changes in the world real interest rate. The form for these equations are detailed in Section 4.3.c.

The equations were estimated in a Seemingly-Unrelated-Regression (SUR) system using ordinary-least-squares (OLS) estimation method. The results are not robust, and the sign and magnitude of many of the parameters were unexpected.

There are three possible reasons for this outcome. First, the data compiled from the national accounts are not consistent. Second, the true elasticities are low or zero, so the results are spurious. The implication of the second explanation is that there are no changes to the autonomous components of variables in the current account. Third, there are various other factors that are captured in the absorption portion of the model that are not captured in other portions of the model. For example, the SUR results indicated that government consumption fell when foreign aid increased. A more likely explanation for the relationship is that a significant fall in government revenues due to a severe negative production shock induced non-residents to increase foreign assistance. The causality of many of the relations are difficult to capture.

Some restrictions were made in the SUR system in order to improve the results. These restrictions did not materially improve the results, however. The following set of elasticities are the elasticities derived according to the regression described in Appendix D and are used in the counter-factual experiments.

Table 5.1: Absorption Elasticities

	ε'/ε	ToT	r_w	FA
GDP	-25.5%	7.6%	2.8%	
Private Consumption	55.8%	-9.2%	8.8%	16.9%
Private Investment	-92.9%	47.8%	-8.1%	-30.6%
Government Investment	-32.3%	72.3%	35.6%	-6.8%
Government Consumption	-63.0%	19.1%	8.5%	-13.8%
Exports	-99.6%	5.2%	18.6%	-6.5%
Imports	-90.4%	43.7%	40.7%	-0.6%

The calibrated model is sensitive to the parallel market premium on the exchange rate. Small changes in this parameter significantly affected calibration of the model. Aside from this absorption elasticity, small changes in the values of the absorption parameters did not materially change calibration of the model.

5.2.d The Demand for Money

The demand for money was estimated using a log-linear form with the demand for the monetary base regressed on nominal interest rates and real GDP. The specific regression form is:

$$\ln\left(\frac{M}{P}\right)_t = \lambda \ln\left(\frac{M}{P}\right)_{t-1} + I_R \ln(R_t) + I_y \ln(GDP_t) + (1-I_y)\ln(POP_t) - \lambda \ln(POP_{t-1}) + I_a \qquad 5.10$$

where:
- M/P = the monetary base,
- R = government treasury bill rate,
- GDP = real GDP at market prices,
- POP = total population, and
- I_a = intercept.

This form was the log-linear version of the demand for money equation that appeared in Section 4.4.c:

$$\left(\frac{m}{P_d}\right)^d_t = \left[l_a \cdot R_{d,t}^{l_R} \cdot \hat{gdp}_t^{l_y}\right]^{\lambda} \left[\left(\frac{m}{P_d}\right)^d_{t-1}\right]^{1-\lambda} \qquad 5.11$$

The regression results are detailed in Appendix D. The key results are:

R^2 = 0.9048 R^2-Adjusted - 0.8858

	Coefficient	T-Ratio 15 DF
lambda	= 0.717820	1.4834
ln(R)	= -0.058565	-1.2504
ln(gdp)	= 1.782480	2.8324

The results are weakly significant for the lag coefficient and for the nominal interest rate elasticity, but the results are very close to existing results for Kenyan money demand.[7] The coefficients listed above are used in the calibrated model.

5.2.e Sectoral Supply

Sector supply is determined using a translog profit function estimated in a three equation SUR system using OLS. Several estimation techniques and data sources are used in order to obtain reasonable results.[d] The results did not represent a profit function - as described below.

The translog profit system is based on three of the

[d] The estimation results yielded coefficients that were higher or lower than expected, or had the wrong sign.

following four equations from Section 4.5.b:

$$S_1 = \lambda S^{I}_{1,t-1} + (1-\lambda)(\alpha_1 + \gamma_{1,1}\ln P_1 + \gamma_{1,2}\ln P_2 + \gamma_{1,3}\ln P_3 + (0-\gamma_{1,1}-\gamma_{1,2}-\gamma_{1,3})\ln P_4 + \beta_1 \ln gdp) \quad 5.12$$

$$S_2 = \lambda S^{I}_{2,t-1} + (1-\lambda)(\alpha_2 + \gamma_{1,2}\ln P_1 + \gamma_{2,2}\ln P_2 + \gamma_{2,3}\ln P_3 + (0-\gamma_{1,2}-\gamma_{2,2}-\gamma_{2,3})\ln P_4 + \beta_2 \ln gdp) \quad 5.13$$

$$S_3 = \lambda S^{I}_{3,t-1} + (1-\lambda)(\alpha_3 + \gamma_{1,3}\ln P_1 + \gamma_{2,3}\ln P_2 + \gamma_{3,3}\ln P_3 + (0-\gamma_{1,3}-\gamma_{2,3}-\gamma_{3,3})\ln P_4 + \beta_3 \ln gdp) \quad 5.14$$

$$\begin{aligned} S_4 = {} & \lambda S^{I}_{4,t-1} + (1-\lambda)((1-\alpha_1-\alpha_2-\alpha_3) + (0-\gamma_{1,1}-\gamma_{1,2}-\gamma_{1,3})\ln P_1 + (0-\gamma_{1,2}-\gamma_{2,2}-\gamma_{2,3})\ln P_2 \\ & + (0-\gamma_{1,3}-\gamma_{2,3}-\gamma_{3,3})\ln P_3 + (\gamma_{1,1}+\gamma_{2,2}+\gamma_{3,3}+2\gamma_{1,3}+2\gamma_{2,3}+2\gamma_{1,3})\ln P_4 \\ & + (0-\beta_1-\beta_2-\beta_3)\ln gdp) \end{aligned} \quad 5.15$$

where: S_i = Sector share of output,
γ_{ij} = own-price and cross-price coefficients,
β_i = Rybczynski parameter, and
λ = Adjustment parameter.

Several restrictions are required to ensure the system represents a profit system. Some restrictions appear in the second and third equations, and the remaining restrictions appear in the fourth equation. The fourth equation is dropped in the estimation, because the system will be over-identified if it is included. The adjustment term is not a true lag, since the shares from the past period are based on the current period price. The lag is based on current prices in order to maintain homogeneity restrictions.

$$S^{I}_{i,t-1} = \frac{P_{i,t}y_{i,t-1}}{\sum_i P_{i,t}y_{i,t-1}} \quad 5.16$$

The capital stock data series is created by transforming GDP according to the per capita form of the aggregate Cobb-Douglas production function.

$$y = (Y/L) = Ae^{gt}\hat{k}^{\alpha} \quad 5.17$$

$$\ln\hat{K} = \frac{1}{\alpha}\ln y - \frac{\ln A}{\alpha} - \frac{g}{\alpha}t \quad 5.18$$

All other data is readily available, so estimation of the system did not appear to require any other modification.

The results from the first attempt at estimating the system appeared to provide coefficients that represented a profit system. These first results are:

Table 5.2: Translog Profit Function Initial Coefficients

	Intercept	Non-Traded	Food Crop	Importable	Export Crop	Capital
Non-Traded	3.300	0.373	-0.056	-0.213	-0.104	0.085
Food Crop	7.533	-0.056	0.152	-0.056	-0.040	0.209
Importable	-5.181	-0.213	-0.056	0.322	-0.054	-0.158
Export Crop	-4.650	-0.104	-0.040	-0.054	0.197	-0.136
Lambda	0.375					

Table 5.3: Translog Profit Function Initial Elasticities

	Non-Traded	Food Crop	Importable	Export Crop	Capital
Non-Traded	0.581	0.059	-0.403	-0.237	1.369
Food Crop	0.067	-0.148	0.113	-0.033	2.029
Importable	-0.348	0.086	0.299	-0.037	0.410
Export Crop	-0.553	-0.067	-0.101	0.720	-0.387

The signs of the coefficients of the translog profit function are as expected, but the magnitudes are small so that elasticities based on these coefficients do not have the expected signs.[e] Because some own-price elasticities are negative and some cross-price elasticities are positive, the estimation probably did not describe a profit function. In addition, the magnitude of each of the Rybczynski parameters is unexpected and the parameter on export crops is the wrong sign.

These results could indicate problems with the data set or problems with the estimation. Several alternative approaches were considered in order to estimate a set of coefficients that represented a profit function, but none

[e] The calculations for own-price, cross-price, and output elasticities are described in Section 4.5.b.

were successful. The time frame for the estimation was very short, 1964-1990, so minor data problems associated with certain international crises, such as the 1974 oil shock, or other structural changes could have affected the estimation. Different estimation techniques, including Bayesian estimation, were also considered.

All of these attempts failed to produce a set of coefficients for the translog profit function. Each attempt is described below, followed by a discussion of what the underlying data and estimation problems are and how a rubric set of coefficients was chosen.

1. *Minor Data Problems* - The initial estimates of own-price and cross-price coefficients, duplicated above, appear to be close to what the final set of coefficients should be: that is, only minor revisions needed to be made in order to find the parameters for the translog profit function. Two years in the time period (1977 and 1980) could be excluded because the predicted values of sector shares for these two years were far from the actual values, although the actual values could not be considered outliers. In addition, the data set was reviewed to ensure that conversions between base years and methodology changes by the Kenya Central Bureau of Statistics were properly accounted for. Minor revisions to the data set did not change the underlying problem that the own-price and cross-price parameters are too low and that the Rybczynski parameters are far from expected ranges for these

values.

2. *Structural Changes and Additional Variables* - Other possible solutions were considered that required testing for major data problems or for structural changes during the time period. There was reason to believe that a structural break occurred in 1972 since the methodology for collecting national accounts data changed significantly in 1972, since the easy stage of Kenya's development was over by 1972 (see Section 2.1.a), and since the Bretton Woods system collapsed in 1971. An additional trend variable could also be included since the government was reforming land tenure between 1964 and 1980, and that land structure continued to evolve after 1980 through private consolidation of traditional tribal land tenure structures (see Section 2.1).

Tests for a structural change in 1972 or in 1980 were not significant, although the parameters for own-prices and cross-prices were rising absolutely. This result implied that the estimation was beginning to look like an indirect profit function. Also, the effect of these various corrections and estimation techniques provided information or clues about what factors were actually influencing the results. The Rybczynski parameters, for example, continued to be outside the range of expected values, so alternative data series for the capital stock were used.

In addition to alternative data series for the capital stock, restrictions in the SUR were changed, and some

different functional forms for aggregate output were used. None of these efforts significantly changed the results or produced new problems. For example, the implication of the Rybczynski parameter for exports was that export crops declined absolutely as output rose. This result was probably reflecting the years when export commodity prices were rising as per capita output was falling (between 1976 and 1978, and between 1985 and 1989).

3. *Estimation Techniques* - Alternative estimation techniques were employed in order to develop a set of parameters that represented a profit function. Several minor changes were made that included correcting for autocorrelation in some estimations or included different sets of restrictions. Maximum likelihood estimation techniques were also attempted, which required significant reformulations but which make certain econometric methods, such as correcting for autocorrelation, somewhat easier to program.

Some issues were solved using maximum likelihood estimation, but other problems persisted. The maximum likelihood technique corrected for autocorrelation in a system of equations and allowed non-linear restrictions to be imposed. These efforts did not produce a reasonable set of parameters, however. The data set contained only 27 observations, and is too small to claim that the maximum likelihood estimators are efficient. There are no reasons,

therefore, to accept that the maximum likelihood results are closer to the true parameters.

4. *Bayesian Estimation* - A Bayesian estimation became a logical solution to the estimation problems since this method formally incorporates prior beliefs. The attempts to correct estimations that are described above are informal attempts designed to impose a set of parameters that are believed to represent an indirect profit function. A Bayesian method uses a Monte Carlo experiment to derive a set of parameters that match the prior belief about the profit function. In this case, the prior belief is that the determinant of the matrix of supply elasticities is positive-definite. If the matrix is positive-definite and certain restrictions are met, then the parameters describe a profit function. The estimation technique depends on programming information from Chalfant, Gray and White.[8]

Restrictions are imposed on the determinant of the matrix of elasticities produced by the Bayes method. The Bayesian method generated parameters as does an OLS or maximum likelihood method, but the Bayesian results cannot be tested for statistical significance in the same manner that OLS and maximum likelihood results can be tested. Instead, the results are reported according to the probability that the restriction on the matrix of elasticities is true. In this case, the probability that the elasticity matrix is convex, *i.e.* the matrix is positive-definite, is zero.

This outcome indicates that there probably is no formulation for estimating the profit function that will yield a reasonable set of parameters.

5. Fundamental Data Problems - The many methods that were used to estimate a set of parameters for the profit function failed to produce a set of parameters that represented a profit function. There are at least three factors that inhibited the estimation efforts: first, the major revision to the methodology for collecting national accounts data; second, the land base and the land tenure system were changing through most of the period; and third, there were too many policy switches and external shocks within a short time frame that parameters could not capture the responsiveness of economic agents to world price fluctuations. The first factor could be corrected with dummy variables or other estimation techniques. The second factor could be corrected if an appropriate proxy variable could be found. The third factor could not be corrected for.

The most serious of these three factors is the changing land base, rather than the short time frame. The combination of a structural change in 1972 and relatively few observations is sufficient in itself to undermine estimation techniques, but the changing land base implies that the aggregate production function is inappropriate for duplicating Kenya's macroeconomy over the period. The Cobb-Douglas formulation that was used assumes constant

elasticities of substitution among the factors of production - land, labour and capital.

While this is a serious concern, data series for land and labour are not available for Kenya. A proxy for land use may be possible to construct, but labour data are only available for the modern urban sectors and these data are probably inconsistent. The implication of these data problems is that an estimation of parameters for a profit function are impossible to derive.

6. Final Parameter Set - The final set of parameters was derived from *a priori* considerations. These same considerations are used to judge the results of attempts to estimate the profit function using econometric means. The final set of parameters produces a smaller set of elasticities than originally anticipated, but the parameters are sufficient for developing a reasonable profit function in the calibrate model.

There are three *a priori* considerations that were used to derive the set of translog profit function parameters. First, output in each sector in the economy is price responsive. This is not intended to mean that the elasticity is greater than one, but that markets are efficient and that price changes induce resource shifts among sectors. Second, the share of export crop and importables goods production in total output grows with output and that the share of food crops and non-traded goods production falls with output.

Third, resources would shift more easily between non-traded, food crop, and export crop sectors than between importable goods production and the other three sectors.

An initial set of parameters is created using *a priori* considerations. These first elasticities were too high - the variation of output shares due to price changes is too high relative to the variation of actual output shares - so the initial set of parameters were lowered. The parameters were lowered proportionately. Also, the own-price or cross-price parameters in specific sectors were changed when variation in the specific sector was too high.

A final set of parameters evolved with lower elasticities than originally expected, and much lower own-price elasticities for the export crops sector and for the importable goods sector. These lower own-price elasticities are necessary given the fluctuation in world prices and taxes for export crops and for importable goods. The final set of parameters and set of elasticities are presented below.

Table 5.4: Translog Profit Function Final Coefficients

	Intercept	Non-Traded	Food Crop	Importable	Export Crop	Capital
Non-Traded	0.187	0.229	-0.066	-0.083	-0.080	0.000
Food Crop	0.677	-0.056	0.194	-0.073	-0.056	-0.047
Importable	0.324	-0.083	-0.073	0.230	-0.074	0.000
Export Crop	-0.188	-0.080	-0.056	-0.074	0.210	0.047
Lambda	0.400					

Table 5.5: Translog Profit Function Final Elasticities

	Non-Traded	Food Crop	Importable	Export Crop	Capital
Non-Traded	0.181	-0.058	-0.048	-0.075	1.000
Food Crop	-0.066	0.126	-0.050	-0.010	0.724
Importable	-0.041	-0.037	0.081	-0.003	1.000
Export Crop	-0.073	-0.008	-0.004	0.085	1.233

The coefficients in the final set have smaller values

than initially expected. If the values of the final set of parameters are close to the true values of parameters for the profit function, then any data problems would present prohibitive problems for estimating these parameters since a distortion could make the sign of a small value (*eg.*, positive) appear opposite to the true sign (*eg.*, negative). Also, the many severe external shocks to the Kenyan macroeconomy present problems for estimating the true parameters. The shocks may have been normally distributed over a long period of time; however, the time frame used to estimate the profit function parameters is too short, and the magnitude of the oil shock, of the coffee price boom, of high world real interest rates, and of the adjustment to independence each distorts the results.

The own-price elasticity with respect to export crop production was expected to be higher than food crop or non-traded goods production. However, the high variability of world prices for export crops and the small sector share of export crop production means that an approximately equal own-price coeficient (see Table 5.4) translates into a relatively smaller own-price elasticity. In addition, many export crops require several growing seasons before new plants and trees (coffee, tea, and sisal) mature. The delay in sector shifts that these long investments may be partially reflected in the own-price parameter rather than becoming captured in the Nerlovian adjustment parameter, λ.

5.2.f Sectoral Demand

The method for estimating sectoral demand is similar to the econometric method that was used, initially, to estimate sectoral supply. In the case of the demand system, however, a set of parameters is estimated using Kenya's national accounts. The results are generally good in that the results represents a demand system, although some corrections were made to expenditure elasticities.

The demand system is based on the following system of three equations describing expenditure shares for non-traded goods, for food crops, and for importable goods.

$$w_1 = \alpha_1 + \gamma_{1,1}\ln P_1 + \gamma_{1,2}\ln P_2 + (0-\gamma_{1,1}-\gamma_{1,2})\ln P_3 + \beta_1 \ln\left(\frac{e}{CPI}\right) \qquad 5.19$$

$$w_2 = \alpha_2 + \gamma_{1,2}\ln P_1 + \gamma_{2,2}\ln P_2 + (0-\gamma_{1,2}-\gamma_{2,2})\ln P_3 + \beta_2 \ln\left(\frac{e}{CPI}\right) \qquad 5.20$$

$$w_3 = (1-\alpha_1-\alpha_2) + (0-\gamma_{1,1}-\gamma_{1,2})\ln P_1 + (0-\gamma_{1,2}-\gamma_{2,2})\ln P_2 + (\gamma_{1,1}+\gamma_{2,2}+2\cdot\gamma_{1,2})\ln P_3 + (1-\beta_1-\beta_2)\ln\left(\frac{e}{CPI}\right) \qquad 5.21$$

where: w_i = Sector expenditure shares,
e = Total expenditure, and
CPI = Consumer Price Index.

The same restrictions that are used to ensure convexity in prices for the profit system were used here to ensure concavity in prices for the demand system. The consumer price index (CPI) is calculated using a Stone index as a linear approximation for a perfect price index,[9] and takes

the form:

$$\ln(CPI) = \sum_{i=1}^{n} w_{it} \ln\left(\frac{P_{it}}{\bar{P}_i}\right) \qquad 5.22$$

The system is estimated using ordinary-least-squares (OLS) as a seemingly-unrelated-regression (SUR) on two of the three equations. Symmetry and homogeneity restrictions were imposed and completeness restrictions implied the results for the excluded equation. A maximum likelihood method is not used because of the relative few number of observations (27 observations from 1964 to 1990). Autocorrelation was found in the first estimation, and there was some evidence of a structural break in 1972. A trend variable is added to minimize the impact of autocorrelated error terms. A dummy variable is not added, since this correction does not materially affect the coefficients. The following results are used in the calibrated model:

Table 5.6: AID System Final Coefficients

	Non-Traded	Food Crops	Importables	Expenditure
Non-Traded	0.030	-0.024	-0.006	-0.040
Food Crops	-0.024	0.065	-0.041	-0.040
Importables	-0.006	-0.041	0.047	0.080

Table 5.7: AID System Hicksian Elasticities

	Non-Traded	Food Crops	Importables	Expenditure
Non-Traded	-0.59	0.16	0.43	0.821
Food Crops	0.16	-0.41	0.24	0.802
Importables	0.17	0.10	-0.27	1.139

The full results for the SUR estimation are detailed in Appendix D. A simple presentation of coefficient T-ratios, goodness-of-fit for each equation, and goodness-of-fit for

the system are reported below. The number of observations is small so large-sample tests of the model were not performed.

Table 5.8: Estimation Results

	R^2	$\gamma_{NT,j} ln P_{NT}$	$\gamma_{F,j} ln P_F$	$\gamma_{M,j} ln P_M$	(e/CPI)
W_{NT}	0.87	0.0300 (3.38)	-0.0241 (-2.82)	-0.0059 (-0.67)	-0.104 (-3.01)
W_F	0.97		0.0649 (2.53)	-0.0408 (-1.78)	-0.0833 (-2.88)
W_M	0.96			0.0467 (2.05)	0.1876 (7.14)

The constant terms were lowered to match initial expenditure shares in the counter-factual simulation. The coefficients on the scale variable (real expenditures) were also lowered; otherwise, expenditure shares varied too widely given income fluctuations.

5.3 Counter-Factual Experiments

The model replicates certain economic processes in Kenya between 1964 and 1991: flexible exchange rates adjust as sector shares shift; exchange rate policy changes may affect sector composition; and, flexible exchange rates also adjust with inflation. The model replicates all of these processes, and it does so in the context of a growing economy. The model is calibrated to represent Kenya's economic growth since independence. Given these baseline economic conditions, counter-factual government policies or other exogenous changes can be tested using the model.

Baseline economic conditions may be contrasted with the

economic conditions that would have occurred if the counter-factual policies had been pursued. The difference between baseline and counter-factual economic data series provide an estimate of the magnitude of the costs and benefits of government policies. The next section describes the baseline case, and a counter-factual experiment is presented following the baseline case.

5.3.a Baseline Case

The data series generated from the baseline case replicates Kenya's economy between 1964 and 1991. The baseline case data series do not exactly duplicate actual data series, but the results are sufficiently close that the baseline case reproduces much of Kenya's economic history, as described in Chapter 2. The baseline case replicates the effect of the government policies and exogenous shocks on exchange rates and on sectoral composition.

The baseline data series (detailed in Appendix E) differs from the actual data series (detailed in Appendix B). Data for sector output, for sector prices, and aggregate output are presented in charts on the following pages. The differences between baseline and actual data series were clear in Chart *5.1: Aggregate Output*. The baseline data series for output is too low in the late 1970s and too high for parts of the 1980s. Nonetheless, the baseline data series tracks the growth of the Kenyan economy. Chart *5.2* includes figures for each sector, and these figures show that

the sector shares of output from the baseline scenario tracks the actual shares fairly well except for food and export crop shares from 1984 to 1990. Chart 5.3 shows the rise in prices for each sector. The baseline price series tracks actual price series closely.

The differences between baseline and actual data series are due to random error in each of the processes described by the model and are due to data problems described above (see Section 5.2.e). The differences in the two data series are most evident after 1976. The error is largely reducible to differences in the food crop and export crop sectors. Charts 5.2.b and 5.2.c show the shares of food crop and export crop production in the baseline case diverge from the actual values. These results reflect that world prices for food crops rise fourfold between 1976 and 1991 (see Appendix E) and that the price for exports falls over the same period. Charts 5.3.a through 5.3.d show that the price level in food crops and importable goods sectors rises to over 1600 (1964=100), and that the price level in the export crop sector reaches only 700. This large relative price change implies a shift of resources out of export crop production into food crop production. The supply system is too responsive to these changes, so the baseline case produces data series for export crop and food crop shares of total output that deviate from actual data series beginning in 1976.

A reasonable picture of Kenya's economic history is evident in the baseline scenario, however. Aggregate output grew at an average annual rate of approximately 7%, in the baseline case, and by approximately 6%, in the actual data series. Sector shares of output for both export crops and food crops are volatile; sector shares for importable goods production rose over the time period; and sector shares for non-tradeable goods fell during the time period. Thus, the macroeconomic features of Kenya's economic history are duplicated in the baseline case, as evidenced in the various charts.

The baseline scenario is capable of supporting counter-factual experiments. Results of the experiments will be meaningful if the experiments provides data series that are different in magnitude from the baseline data series. This is necessary so that errors in the calibration of the model will be small compared to differences between experiment and baseline data series. If the differences between experiment and baseline data series are large, then the counter-factual experiments will provide evidence concerning the macroeconomic effects of Kenya's exchange rate policy regime.

Chart 5.1: Aggregate Output

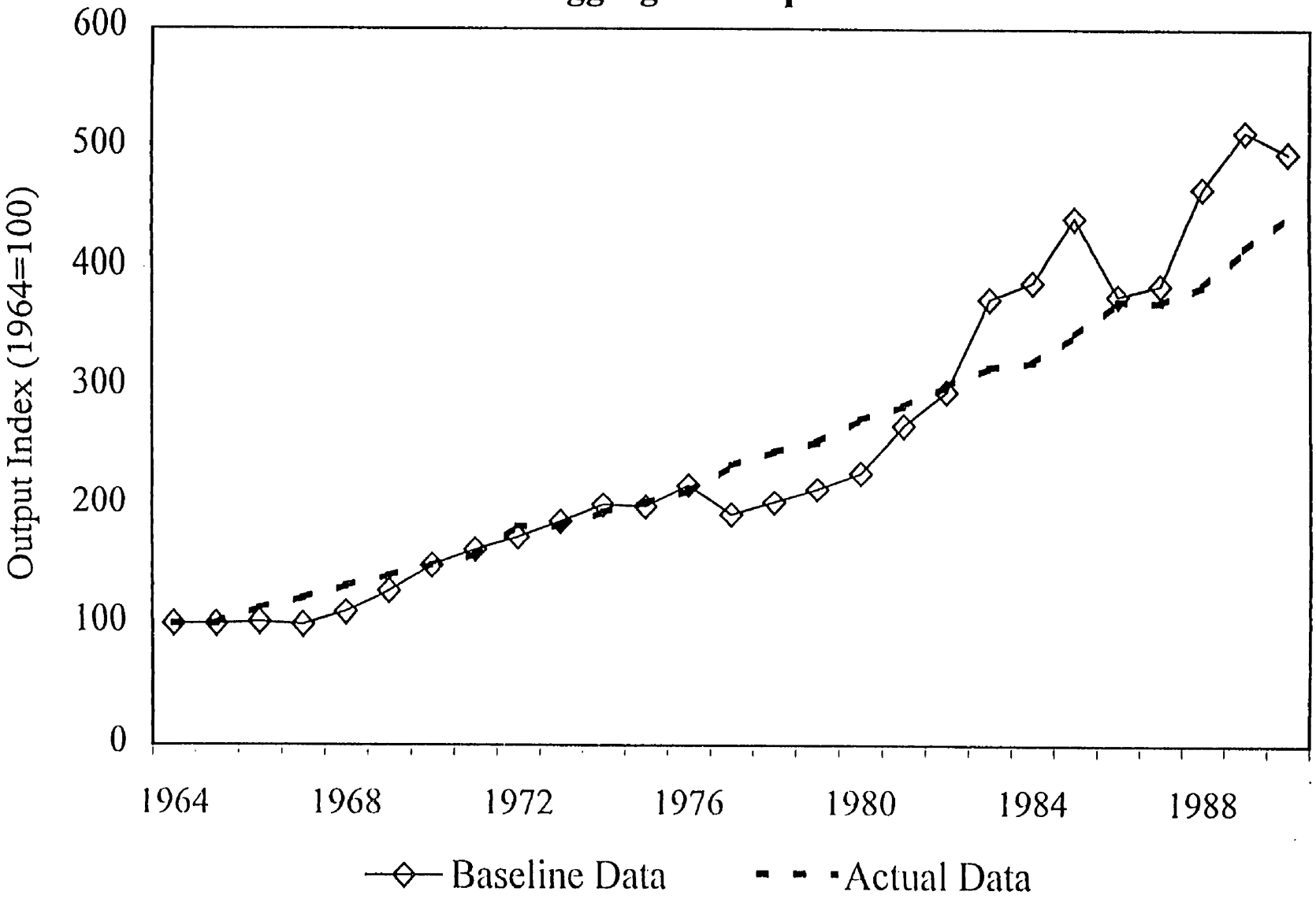


Chart 5.2.a: Non-Traded Goods Share of Output

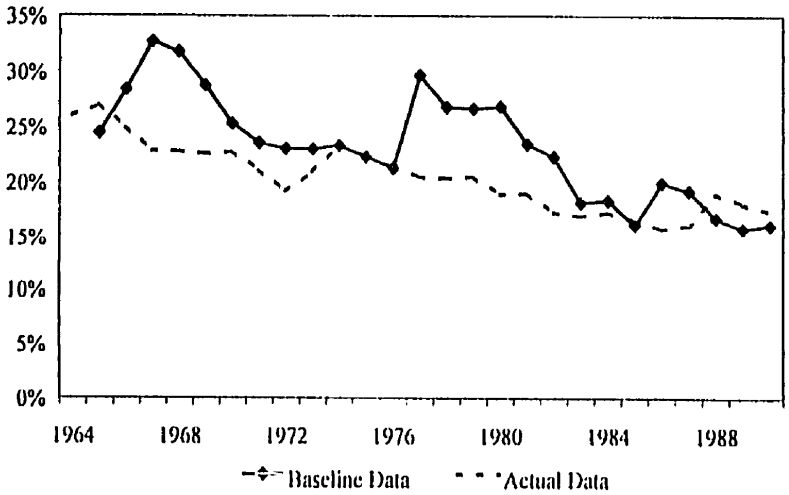


Chart 5.2.b: Food Crops Share of Output

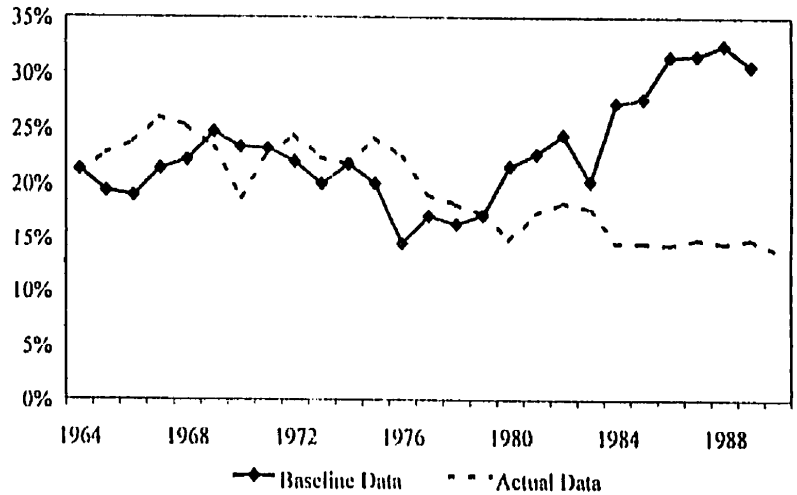


Chart 5.2.c: Export Crops Share of Output

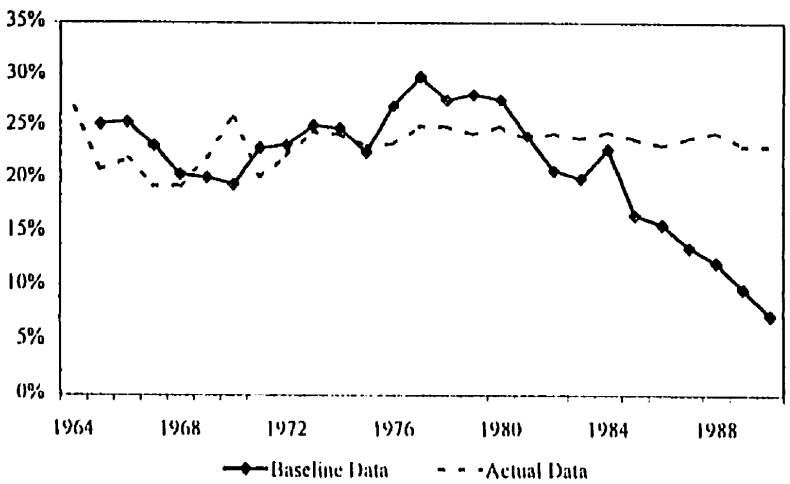


Chart 5.2.d: Importable Goods Share of Output

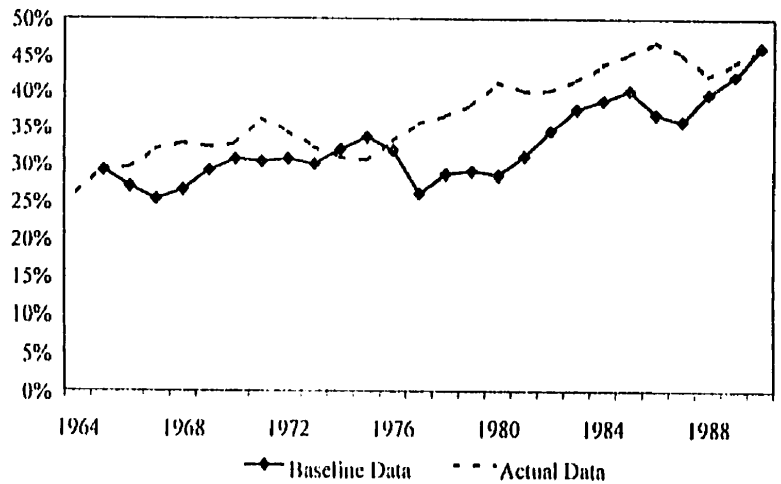


Chart 5.3.a: Non-Traded Goods Price Level

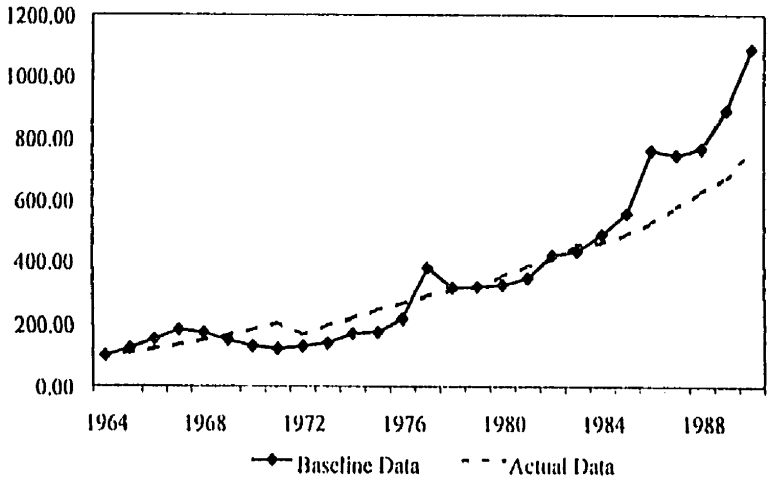


Chart 5.3.b: Food Crops Price Level

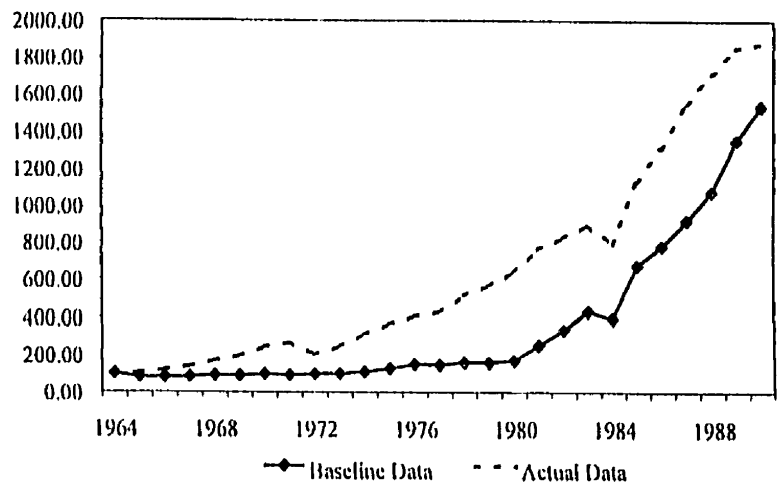


Chart 5.3.c: Export Crops Price Level

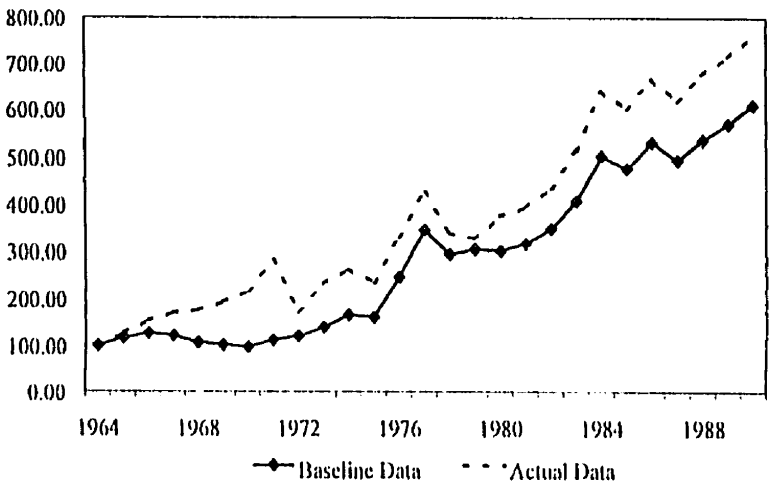
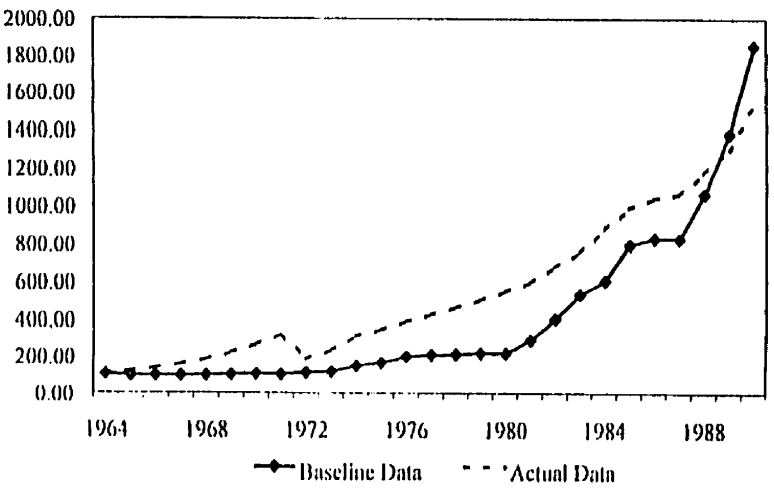


Chart 5.3.d: Importable Goods Price Level



5.3.b Floating Exchange Rate Policy

This experiment is to change certain parameters and exogenous variables in the model in order to observe the effect of a floating exchange rate policy on total output and sectoral composition relative to the baseline scenario. This experiment models a change in exchange rate policy only. Other government policies and exogenous shocks are consistent between the two scenarios. The results indicate, among other effects, that a floating exchange rate policy would have led to higher total output compared to the exchange rate policy that Kenya actually pursued. The real value of output in each sector rose, as did consumption, investment, government spending, and net exports. These results were expected, but the sector composition of output did not change contrary to expectations.

These expectations are based on two hypotheses: that Kenya's exchange rate policy created a price distortion that encouraged imports; that the policy led to a less efficient distribution of productive resources among sectors. The results of the counter-factual experiment indicate substitution from imported goods to domestic production. Net exports in the experiment data series turned positive in 1970, where net exports in the baseline case turned positive in 1983.

There is no significant substitution among sector production or among sector consumption, except in the non-

traded goods sector. The fall in output from the baseline case to the counter-factual case is the result of a small substitution from the non-traded goods sector to each of the remaining three sectors. These substitutions represent the change in productivity that is also manifest as higher net exports in the counter-factual case. These results are presented in Chart *5.4* through Chart *5.6* on the following pages, and the data series are contained in Appendix F.

The counter-factual experiment produces significant changes in the data series for aggregate output, for net exports, and for the non-traded goods sector. The effect of the policy switch on other data series is small. The positive effect on output reflects the positive effect on net exports. The change in the relative price of exports created a substitution from imported goods to domestic production. The effect of the policy switch on productivity is only minimally apparent in the results of the counter-factual experiment.

Chart 5.4: Aggregate Output

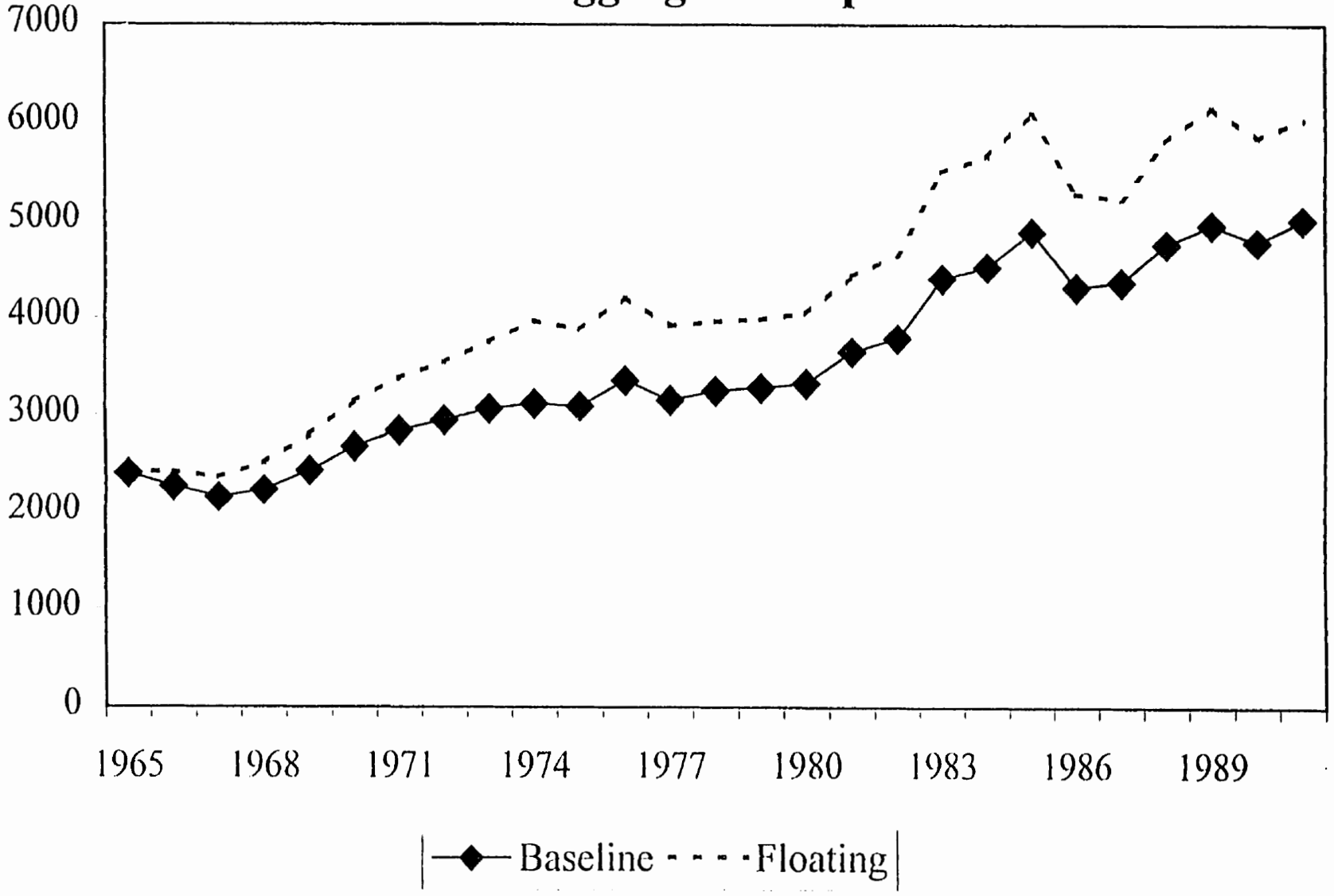
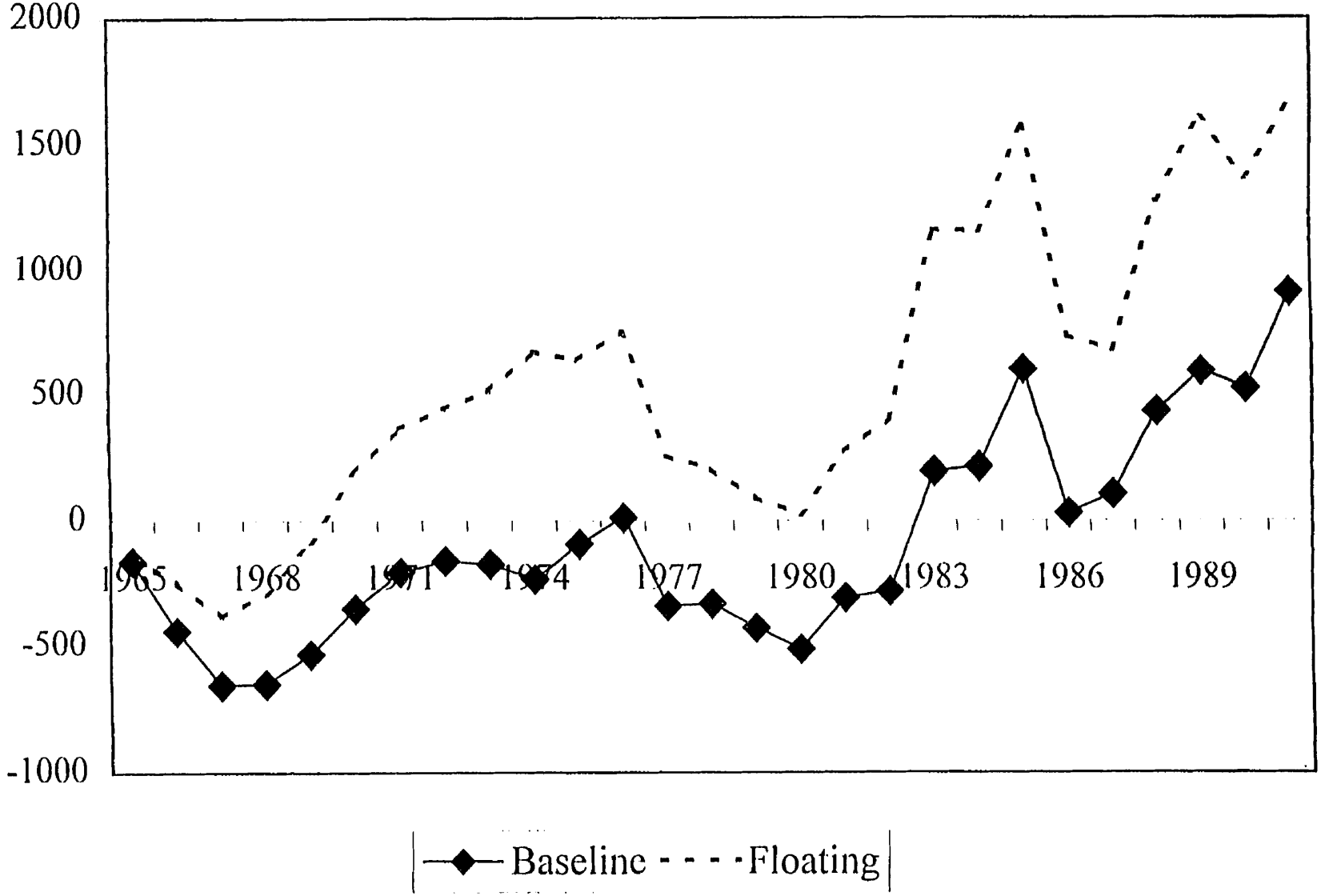


Chart 5.5: Net Exports



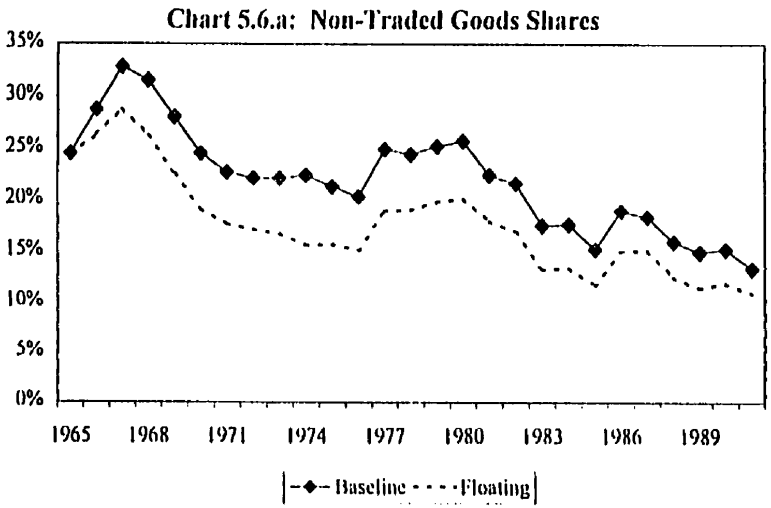


Chart 5.6.a: Non-Traded Goods Shares
35%
30%
25%
20%
15%
10%
5%
0%
1965 1968 1971 1974 1977 1980 1983 1986 1989
Baseline
Floating

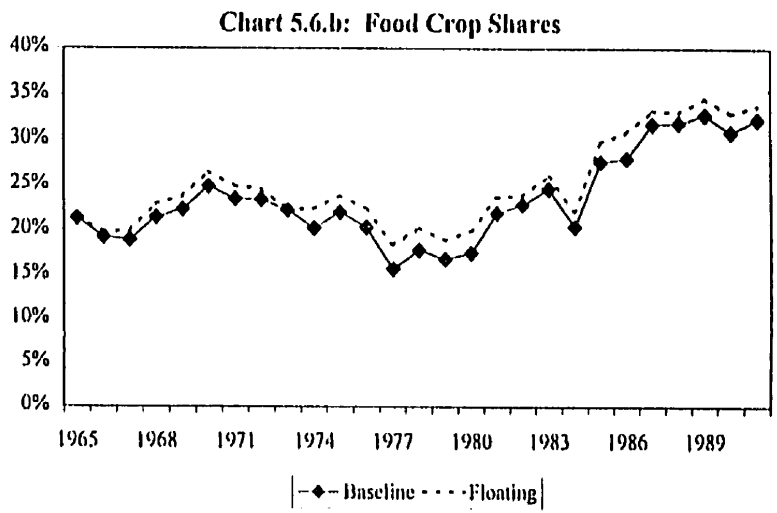


Chart 5.6.b: Food Crop Shares
40%
35%
30%
25%
20%
15%
10%
5%
0%
1965 1968 1971 1974 1977 1980 1983 1986 1989
Baseline
Floating

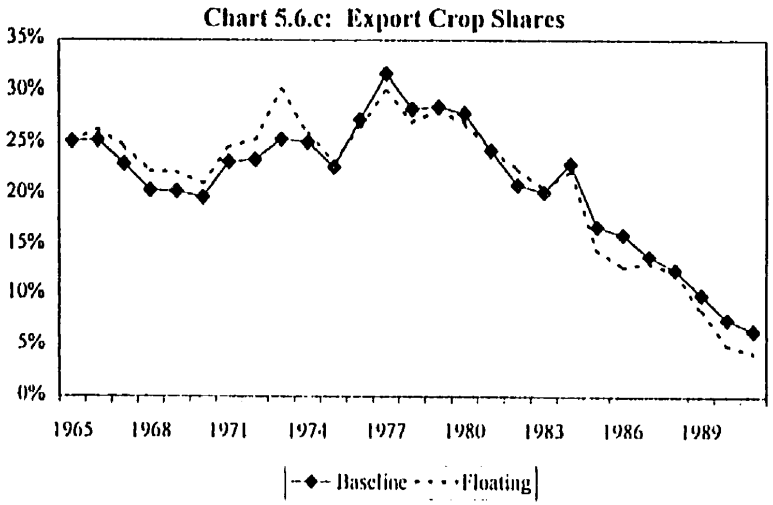


Chart 5.6.c: Export Crop Shares
35%
30%
25%
20%
15%
10%
5%
0%
1965 1968 1971 1974 1977 1980 1983 1986 1989
Baseline
Floating

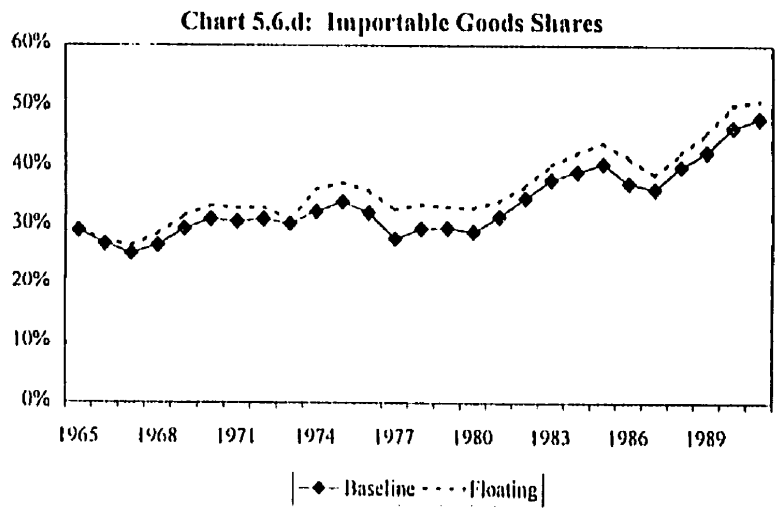


Chart 5.6.d: Importable Goods Shares
60%
50%
40%
30%
20%
10%
0%
1965 1968 1971 1974 1977 1980 1983 1986 1989
Baseline
Floating

5.4 Conclusion

The calibrate model was used to assess the efficacy of Kenya's exchange rate policy as it relates to three macroeconomic relationships: productivity shifts associated with sectoral composition of output, monetary processes, and autonomous shifts in the components of GDP. The important relationships were calibrated using econometric techniques in all but one of the key pieces of the model. The conclusions that may be drawn from a counter-factual experiment of Kenyan exchange rate policy rely on the degree that the model duplicates macroeconomic relationships and on the degree that the model duplicates Kenyan conditions. With respect to the degree that the empirical model duplicates Kenyan processes, the main result of the counter-factual experiment indicates that aggregate output is higher given a floating exchange rate policy compared to a managed exchange rate policy similar to what Kenya actually pursued.

The conclusions that may be drawn from the counter-factual experiments depended on the degree to which Kenya's economic processes are duplicated in the simulation. The three relationships modelled are necessary for simulating exchange rate movements and the effect of exchange rates on sectoral composition of output. Other aspects of the economy were modelled using simple techniques.

No conclusions are made about other aspects of the model. The nature of the model means that there are three

limitations with respect to conclusions about a counter-factual experiment using the model. First, any conclusions based on the model must be restricted to the three macroeconomic relationships and cannot be extended to other aspects of the macroeconomy. The model, for example, offers no discussion of the effect of exchange fluctuation on income distribution.

Second, counter-factual experiments offer little relevant information about the macroeconomy if policy changes induce fundamental shifts in economic behaviour. This is an expression of the 'Lucas Critique,' and this criticism may be applied to the results for the profit function. Low own-price supply elasticities may represent activity on the part of economic agents adjusting to frequent modifications to the pegged exchange rate regime. In the absence of these policy influences, economic agents may become more responsive to world price changes.

Third, the model did not include information to model the effects of exchange rate risk. This weakness is a combination of the second limitation of the model and the exclusion of exchange rate speculation in the model. Shifts in economic behaviour may not be fully accounted for in the model.

The model simulates several macroeconomic relationships that produce exchange rate fluctuations, however, and conclusions concerning these fluctuations are valid. The

model simulates exchange rate fluctuations where Kenya's price level changes relative to the rest of the world and where Kenya's productivity changes relative to the rest of the world. Exogenous events and government policies that affect the price level and productivity are also captured in the model. Also, these economic and policy fundamentals are described in the context of economic growth. Useful counter-factual experiments could be performed to understand the effects of exchange rate policy on sectoral composition and aggregate output.

Conclusions concerning the counter-factual experiments also rely on the degree that the macroeconomic relationships are modelled to represent Kenyan conditions. Conclusions are relatively more difficult to defend if the model could not be closely calibrated to Kenya. In this case, all but one of the relationships described in the model were calibrated to reasonable standards of statistical inference.

The failure to calibrate one relationship, sectoral share of output, is sufficient to undermine conclusions concerning sector shifts in the counter-factual experiments. The failure to calibrate this process is due to at least two separate data problems: first, the macroeconomic data for Kenyan sectoral output is not consistent over a sufficiently long period; and second, the assumption of constant elasticity of substitution among factors of production does not reflect the changing land base and land tenure structure

in Kenyan agriculture. Investment in the agricultural sectors is affected by stability of land tenure: the land tenure system was stable in the 1960s when lands held by Europeans before independence where redistributed to Kenyans; land tenure was not stable in the 1970s and early 1980s as population pressures led to conflicts between agricultural producers and tribal pastoral lands; and, conflicts were more easily resolved after 1985. An alternate modelling technique could be used, but the inconsistent data set cannot support any complicated model that requires long data series.

The simulation does not capture the effect of exchange rate policy on sectoral composition of output, except for non-traded goods. Any effects identified in the counter-factual experiments are small, so these effects can easily be attributed to data error. This is the main conclusion following from the counter-factual experiment of a floating exchange rate policy on Kenya sector composition of output. A second set of conclusions may be made, however, concerning future work to model the distribution of resources and resource shifts among sectors. A different model could assume that elasticities-of-substitution are not constant, could assume that own-price elasticities fall rapidly as sector shares diminish, could assume that cross-price relationships are not symmetric, or could add a component to the model that captures the change in behaviour of economic agents in the face of anticipated policy shifts.

The final conclusion concerns the effect of exchange rate policy on aggregate output. This effect can be easily identified in the simulation. The model captures relative price changes among sectors and between domestic and foreign goods. The problems of modelling sector shifts are noted above. The model appears to have captured the effects of a relative price change between domestic and foreign goods: that is, Kenya's exchange rate policy induced substitution from sectors whose output is relatively more expensive to produce towards sectors whose output is relatively inexpensive to produce or import. Substitution away from expensive domestic production towards relatively inexpensive foreign production actually raises net exports if this substitution releases domestic resources for relatively more efficient uses. Under the counter-factual simulation of a floating exchange rate policy, Kenyan residents increased consumption of domestic production. The effect of resource-shifts and of consumption-switches would have been to decrease imports, which, would increase net exports. Thus, in the counter-factual case, the long term effect is a significant rise in real output.

The counter-factual experiment weakly supports the hypothesis that Kenya's pegged exchange rate policy between 1964 and 1991 benefitted the import-competing goods sector at the expense of the agricultural sectors. The pegged exchange rate policy created relative price change between domestic

and foreign currencies. The counter-factual experiment provides evidence that the relative price change induced higher imports and, therefore, lower net exports.

The results of the counter-factual experiment reveal that the pegged exchange rate policy that produced an over-valued domestic currency induced resources to shift to the non-traded goods sector. Resources moved away from relatively more productive uses in other sectors. The counter-factual experiment did not demonstrate that resources moved from relatively more productive agricultural production toward relatively less productive, but relatively more profitable, import-competing industries. This result is due to the difficulty of describing a supply system for Kenyan production. This result is disappointing, but the primary conclusion that Kenya's pegged exchange rate policy negatively affected aggregate output holds. Kenyan aggregate output would likely have been higher if the government had pursued a floating exchange rate policy instead of the set of policies that led to an overvalued exchange rate.

Chapter 5: Endnotes

1. Central Bureau of Statistics, Kenya Statistical Abstract, (Various Years). Office of the Vice President and Ministry of Planning and National Development and the Central Bureau of Statistics, Economic Survey, (Various Years).

2. United Nations, National Accounts, various years; and, International Monetary Fund, International Financial Statistics Yearbook, various years.

3. Robert J. Barro and Xavier Sala-i-Martin, Economic Growth, McGraw-Hill (Toronto, 1995), pp.84-86.

4. N. Gregory Mankiw, David Romer, and David N. Weil, "A Contribution to the Empirics of Economic Growth," NBER Working Paper 3541 (December, 1990), p.10.

5. N. Gregory Mankiw, David Romer, and David N. Weil, "A Contribution to the Empirics of Economic Growth," NBER Working Paper 3541 (December, 1990), p.13.

6. World Bank, World Development Report, statistical appendices.

7. F.W. Mwega and Tony Killick, "Monetary Policy in Kenya, 1967-88," Eastern Africa Economic Review, Vol.6, No.2 (Spring, 1990), p.124.

8. James A. Chalfant, Richard S. Gray, and Kenneth J. White, "Evaluating Prior Beliefs in a Demand System: The Case of Meat Demand in Canada," American Journal of Agricultural Economics, May 1991, p.476-490.

9. Giancarlo Moschini, "A Note on Using the 'Stone Index" in Demand System Estimation," Journal Paper No. J-15635, Iowa Agriculture and Home Economics Experiment Station, February, 1994.

Bibliography

Adams, Charles and Bankim Chadha, "On Interpreting the Random Walk and Unit Root in Nominal and Real Exchange Rates," IMF Staff Papers, Vol.38, No.4 (December, 1991).

American Economic Association, Readings in the Theory of International Trade, The Blakiston Company (Toronto, 1950).

Bardhan, P.K., and T.N. Srinivasan, "Cropsharing Tenancy in Agriculture: A Theoretical and Empirical Analysis," American Economic Review 61:1 (March, 1971).

Barro, Robert J., and R.F. Lucas, Macroeconomics (Canadian Edition), Irwin (Boston, 1994).

Barro, Robert J., and Xavier Sala-i-Martin, Economic Growth, McGraw-Hill (Toronto, 1995).

Bautista, Romeo M., and Alberto Valdes (eds.), The Bias Against Agriculture: Trade and Macroeconomic Policies in Developing Countries, ICS Press (San Francisco, 1993).

Binswanger, Hans P., and Vernon W. Ruttan (eds.) Induced Innovation: Technology, Institutions, and Development, Johns Hopkins University Press (Baltimore, 1978).

Blanchard, Oliver, and Stanley Fischer, Lectures on Macroeconomics, MIT Press (Cambridge, Mass; 1989).

Central Bureau of Statistics, Kenya Statistical Abstract, (Various Years).

Chalfant, James A., Richard S. Gray, and Kenneth J. White, "Evaluating Prior Beliefs in a Demand System: The Case of Meat Demand in Canada," American Journal of Agricultural Economics, May 1991, p.476-490.

Cheung, Steven N.S., "Private Property Rights and Sharecropping," Journal of Political Economy, 76 (December, 1968).

Christensen, L.R., D.W. Jorgenson, and L.J. Lau, "Transcendental Logarithmic Production Frontiers." Review of Economics and Statistics, Vol. 55, No. 1, 1973.

Cowitt, Philip P., World Currency Yearbook, 1988-89, International Currency Analysis (Brooklyn, N.Y.; 1991).

Deaton, Angus, and John Muellbauer, "An Almost Ideal Demand System," American Economic Review, 70(1980), pp.312-26.

Edwards, Sebastian, Real Exchange Rates, Devaluation, and Adjustment: Exchange Rate Policy in Developing Countries, MIT Press (Cambridge, 1989).

Edwards, Sebastian, and Sweder van Wijnbergen, "Disequilibrium and Structural Adjustment," Handbook of Development Economics Vol.II, Edited by H. Chenery and T.N. Srinivasan, Elsevier Science Publishers (New York, 1989).

Gandolfo, Giancarlo, International Economics II: International Monetary Theory and Open-Economy Macroeconomics (Second Edition), Springer-Verlag (New York, 1995).

Gerrard. C.D., Promoting Third World Agriculture: Lessons of Recent Experience, North-South Institute (Ottawa, 1983).

Greene, David G., Kenya, Growth and Structural Change, The World Bank (Washington, D.C.; 1983).

Grosh, Barbara, Public Enterprises in Kenya, L.Rienner (Boulder, Co.; 1991).

Hayami, Yujiro, and Vernon W. Ruttan, Agricultural Development: An International Perspective (Second Edition), Johns Hopkins University Press (Baltimore, 1985).

Herrick, Bruce, and Charles P. Kindleberger, Economic Development (Fourth Edition), McGraw-Hill Book Company (Toronto, 1983).

Hirshman, Albert O., Strategy of Economic Development, Yale University Press (New Haven, Conn.; 1958).

International Bank for Reconstruction and Development, The Economic Development of Kenya, Johns Hopkins Press (Baltimore, 1964).

International Monetary Fund, International Financial Statistics Yearbook, (Various Years).

Jones, Ronald W., and Peter B. Kenen (eds.), Handbook of International Economics, Vol.II, North-Holland (New York, 1985).

Kahn, Moshin S., and Jonathan D. Ostry, "Response of the Equilibrium Real Exchange Rate to Real Disturbances in Developing Countries," World Development, Vol.20, No.9 (1992).

Laidler, David, The Demand for Money: Theories and Evidence (4th Ed.) Harper and Row (New York, 1993).

Little, Ian M.D., Economic Development: Theory, Policies and International Relations, Basic Books (New York, 1982).

Majd, Mohammad G., "Land Reform Policies in Iran," American Journal of Agricultural Economics, 69:4 (November, 1987).

Mankiw, Gregory N., David Romer, and David N. Weil, "A Contribution to the Empirics of Economic Growth," NBER Working Paper 3541 (December, 1990).

Meier, Gerald M., Leading Issues in Economic Development: Studies in International Poverty, Oxford University Press (1970).

Miller, Norman N., Kenya: the Quest for Prosperity, Westview Press (Boulder, 1984).

Moschini, Giancarlo, "A Note on Using the 'Stone Index" in Demand System Estimation," Journal Paper No. J-15635, Iowa Agriculture and Home Economics Experiment Station, February, 1994.

Mwega, F.M., and Tony Killick, "Monetary Policy in Kenya, 1967-88," Eastern Africa Economic Review, Vol.6, No.2 (Sring, 1990).

Office of the Vice President and Ministry of Planning and National Development and the Central Bureau of Statistics, Economic Survey, (Various Years).

Rybczynski, T.B., "Factor Endowments and Relative Commodity Prices," Econometrica 22(4), December 1954, pp.336-341.

Schultz, T.W., Transforming Traditional Agriculture, Chicago University Press (Chicago, 1964).

United Nations, United Nations International Trade Statistics (Various Years), United Nations.

United Nations, United Nations National Accounts (Various Years), United Nations.

Varian, Hal R., Microeconomics (Second Edition), W.W. Norton & Co. (New York, 1984).

World Bank, Kenya: Agricultural Sector Report, Report 4629-KE, World Bank (Washington, D.C.; January 7, 1986).

World Bank, Kenya: Into the Second Decade, Johns Hopkins University Press (Baltimore, 1975).

World Bank, Kenya: Reinvesting in Stabilization and Growth Through Public Sector Adjustment (Vol. I), World Bank (Washington, D.C.; January 10, 1992).

Appendix A: Captial Growth Model

A.1 Base Growth Model

Total Capital Stock:

$$\hat{K}_t = \hat{K}_{pp,t} + \hat{K}_{pf,t} + \hat{K}_{gp,t} + \hat{K}_{gm,t} + \hat{K}_{gf,t} \qquad \text{A.1}$$

Private Capital Stock financed by the Private Sector

$$\hat{K}_{pp,t} = (\hat{K}_{pp,t-1} + \hat{K}_{pf,o} + \hat{K}_{gp,o} + \hat{K}_{gf,o})\, e^{-x_1} * \hat{K}_{pp,*}^{1-e^{-x_1}} - \hat{K}_{pf,o} - \hat{K}_{gp,o} - \hat{K}_{gf,o} \qquad \text{A.2}$$

Private capital Stock financed by Non-Residents

$$\hat{K}_{pf,t} = \frac{1}{\gamma_t}\left[\gamma_{t-1}\hat{K}_{pf,t-1} + \hat{I}_{p,t} - (\gamma_t \hat{K}_{pp,t} - \gamma_{t-1}\hat{K}_{pp,t-1}) - \gamma_t (e^{n+\delta} - 1)\,(\hat{K}_{pp,t-1} + \hat{K}_{pf,t-1})\right] \qquad \text{A.3}$$

Government Capital Stock financed by the Private Sector

$$\hat{K}_{gp,t} = \hat{K}'_{gp,t} - \hat{K}_{gf,t} \qquad \text{A.4}$$

Government Capital Stock financed by Central Bank

$$\hat{K}_{gm,t} = e^{-\pi_{d,t}} \frac{\hat{b}^m_{g,t-1}}{P_{d,t-1}} + \frac{\Delta \hat{b}^m_{g,t}}{P_{d,t}} \qquad \text{A.5}$$

Government Capital Stock financed by Non-Residents

$$\hat{K}_{gf,t} = \frac{1}{\gamma_t}\left[\gamma_{t-1}\hat{K}_{gf,t-1} + \hat{I}_{g,t} - (\gamma_t \hat{K}'_{gp,t} - \gamma_{t-1}\hat{K}'_{gp,t-1}) - \gamma_t (e^{n+\delta} - 1)\,(\hat{K}'_{gp,t-1} + \hat{K}_{gf,t-1})\right] \qquad \text{A.6}$$

A.2 Parameters and Variables

k_o = initial capital stock (1964)
k_* = steady-state capital stock (US 1964)
k' = trend capital stock
i_t = current investment (government or private)
Δb_t = new borrowing in the current period
x_1 = capital adjustment rate
n = population growth
δ = capital depreciation
γ = trade bias on capital

A.3 Trend Capital Adjustment Equations

Trend Capital Stock

$$\hat{K}_t = \hat{k}_{pp,t} + \hat{K}_{pf,t} + \hat{K}_{gp,t} + \hat{K}_{gf,t} \qquad \text{A.7}$$

Trend Private Capital Stock financed by Non-Residents

$$\hat{K}_{pf,t} = (\hat{k}_{pp,t-1} + \hat{K}_{pf,t-1} + \hat{K}_{gp,o} + \hat{K}_{gf,o})\, e^{-x_2} * \hat{k}_{pf,*}^{(1-e^{-x_2})} - \hat{k}_{pp,t} - \hat{K}_{gp,o} - \hat{K}_{gf,o} \qquad \text{A.8}$$

$$x_2 = \left[\zeta_2^2 + 4(1-\alpha)\, s(\delta + r_{pf}^*)\left(\frac{\delta + r_{pf}^*}{\alpha} - (n+g+\delta)\right)\right]^{\frac{1}{2}} - \zeta_2 \qquad \text{A.9}$$

$$\hat{k}_{pf,*} = \left[\frac{(1-\nu)A\alpha}{\delta + r_{pf}^*}\right]^{\frac{1}{1-\alpha}} \qquad r_{pf}^* = \rho_{pf} + \frac{g}{s} \qquad \zeta_2 = \rho_{pf} - n - \left(1 - \frac{1}{s}\right)g \qquad \text{A.10}$$

Trend Government Capital Stock financed by Private Sector

$$\hat{K}_{gp,t} = (\hat{K}_{t-1} - \hat{K}_{gf,t-1} + \hat{K}_{gf,o})\, e^{-x_3} * \hat{k}_{gp,*}^{(1-e^{-x_3})} - \hat{k}_{pp,t} - \hat{K}_{pf,t} - \hat{K}_{gf,o} \qquad \text{A.11}$$

$$x_3 = \left[\zeta_3^2 + 4(1-\alpha)\, s(\delta + r_{gp}^*)\left(\frac{\delta + r_{gp}^*}{\alpha} - (n+g+\delta)\right)\right]^{\frac{1}{2}} - \zeta_3 \qquad \text{A.12}$$

$$\hat{k}_{gp,*} = \left[\frac{(1-\nu)A\alpha}{\delta + r_{gp}^*}\right]^{\frac{1}{1-\alpha}} \qquad r_{gp}^* = \rho_{gp} + \frac{g}{s} \qquad \zeta_3 = \rho_{gp} - n - \left(1 - \frac{1}{s}\right)g \qquad \text{A.13}$$

Trend Government Capital Stock financed by Non-Residents

$$\hat{K}_{gf,t} = \hat{K}_{t-1}\, e^{-x_4} * \hat{k}_{gf,*}^{(1-e^{-x_4})} - \hat{k}_{pp,t} - \hat{K}_{pf,t} - \hat{K}_{gf,t} \qquad \text{A.14}$$

$$x_4 = \left[\zeta_4^2 + 4(1-\alpha)\, s(\delta + r_{gf}^*)\left(\frac{\delta + r_{gf}^*}{\alpha} - (n+g+\delta)\right)\right]^{\frac{1}{2}} - \zeta_4 \qquad \text{A.15}$$

$$\hat{k}_{gf,*} = \left[\frac{(1-\nu)A\alpha}{\delta + r_{gf}^*}\right]^{\frac{1}{1-\alpha}} \qquad r_{gf}^* = \rho_{gf} + \frac{g}{s} \qquad \zeta_4 = \rho_{gf} - n - \left(1 - \frac{1}{s}\right)g \qquad \text{A.16}$$

Appendix B: System of National Accounts

I. Production Account

Uses of Funds

+ Gross Domestic Product at Factor Prices

$$g\hat{d}p_t = \left[A\gamma_t K^{p}_{t-1}\beta_t\left(\frac{e^{I}_{t-1}}{e_{t-1}}\right)^{\eta_{r,e}}\left(\frac{TOT}{100}\right)^{\eta_{r,tot}}\left(\frac{r_{w,t}}{r^{I}_{w,t}}\right)^{\eta_{r,r_w}}\right]^{\lambda}\left[g\hat{d}p_{t-1}\frac{g\hat{d}p^{I}_{t}}{g\hat{d}p^{I}_{t-1}}\right]^{1-\lambda} - \hat{t}^{I}_{t} \qquad \text{B.1}$$

+ Indirect Taxes

$$\hat{t}^{I}_{t} = \hat{t}^{LR}_{t} + \hat{t}^{\tau}_{t} \qquad \text{B.2}$$

where:

License Revenue

$$\hat{t}^{LR}_{t} = -(\varepsilon^{I}_{t} - \varepsilon_{t})\frac{(\overline{P}_{f,t}n\hat{x}_{f,t} + \overline{P}_{m,t}n\hat{x}_{m,t})}{P_{d,t}} \qquad \text{B.3}$$

Tariff Revenue

$$\hat{t}^{\tau}_{t} = \varepsilon^{I}_{t}\sum_{i=2}^{3}\tau_{i,t}\frac{\overline{P}_{i,t}\hat{q}^{s}_{i,t}}{P_{d,t}} + \sum_{j=2}^{4}t^{x}_{j,t}\frac{P_{j,t}\hat{q}^{s}_{j,t}}{P_{d,t}} \qquad \text{B.4}$$

= Gross Domestic Product at Market Prices

Sources of Funds

+ Private Consumption

$$\hat{c}_t = \left[\hat{c}^{I}_{t}\left(\frac{e^{I}_{t-1}}{e_{t-1}}\right)^{\eta_{c,e}}\left(\frac{TOT}{100}\right)^{\eta_{c,tot}}\left(\frac{r_{w,t}}{r^{I}_{w,t}}\right)^{\eta_{c,r_w}}\right]^{\lambda}\left[\hat{c}_{t-1}\frac{\hat{c}^{I}_{t}}{\hat{c}^{I}_{t-1}}\right]^{1-\lambda}(1+FA_t)^{\eta_{c,FA}} \qquad \text{B.5}$$

+ Government Consumption

$$\hat{g}_t = \left[\hat{g}^{I}_{t}\left(\frac{e^{I}_{t-1}}{e_{t-1}}\right)^{\eta_{g,e}}\left(\frac{TOT}{100}\right)^{\eta_{g,tot}}\left(\frac{r_{w,t}}{r^{I}_{w,t}}\right)^{\eta_{g,r_w}}\right]^{\lambda}\left[\hat{g}_{t-1}\frac{\hat{g}^{I}_{t}}{\hat{g}^{I}_{t-1}}\right]^{1-\lambda}(1+FA_t)^{\eta_{g,FA}} \qquad \text{B.6}$$

+ Private Investment

$$\hat{i}_{p,t} = \left[\hat{i}^{I}_{p,t}\left(\frac{e^{I}_{t-1}}{e_{t-1}}\right)^{\eta_{i_p,e}}\left(\frac{TOT}{100}\right)^{\eta_{i_p,tot}}\left(\frac{r_{w,t}}{r^{I}_{w,t}}\right)^{\eta_{i_p,r_w}}\right]^{\lambda}\left[\hat{i}_{p,t-1}\frac{\hat{i}^{I}_{p,t}}{\hat{i}^{I}_{p,t-1}}\right]^{1-\lambda}(1+FA_t)^{\eta_{i_p,FA}} \qquad \text{B.7}$$

+ Government Investment

$$\hat{i}_{g,t} = \left[\hat{i}^{I}_{g,t}\left(\frac{e^{I}_{t-1}}{e_{t-1}}\right)^{\eta_{i_g,e}}\left(\frac{TOT}{100}\right)^{\eta_{i_g,tot}}\left(\frac{r_{w,t}}{r^{I}_{w,t}}\right)^{\eta_{i_g,r_w}}\right]^{\lambda}\left[\hat{i}_{g,t-1}\frac{\hat{i}^{I}_{g,t}}{\hat{i}^{I}_{g,t-1}}\right]^{1-\lambda}(1+FA_t)^{\eta_{i_g,FA}} \qquad \text{B.8}$$

+ Net Exports

$$n\hat{x}_t = g\hat{d}p_t - \hat{c}_t - \hat{g}_t - \hat{i}_{p,t} - \hat{i}_{g,t} \qquad \text{B.9}$$

= Gross Domestic Product at Market Prices

II. Non-Resident Sector Account

Uses of Funds

+ Net Exports
  balances in Production Account

+ Net Borrowing from Non-Residents
  i. by the Private Sector

$$\frac{\varepsilon_t \Delta \hat{b}^f_{p,t}}{\overline{P}_t} = \hat{c}_t + \hat{i}^p_t + \hat{i}_{p,t} + \hat{g}_t + \frac{\varepsilon_t r_{w,t} \hat{b}^f_{p,t-1}}{\overline{P}_{t-1}} - g\hat{d}p_t - \frac{r_{d,t} \hat{b}^p_{g,t-1}}{P_{d,t-1}} \qquad \text{B.10}$$

ii. by Government

$$\frac{\varepsilon_t \Delta \hat{b}^f_{g,t}}{\overline{P}_t} = \frac{\varepsilon_t \Delta \hat{b}^f_t}{\overline{P}_t} + \frac{\varepsilon_t \Delta \hat{b}^f_{p,t}}{\overline{P}_t} \qquad \text{B.11}$$

where

$$\frac{\varepsilon_t \Delta \hat{b}^f_t}{\overline{P}_t} = \frac{\varepsilon_t r_{w,t} \hat{b}^f_{t-1}}{\overline{P}_{t-1}} - n\hat{x}_t + \frac{\varepsilon_t \Delta \hat{h}_t}{P_{d,t}} \qquad \text{B.12}$$

= Total Uses

Sources of Funds

+ Net Factor Payments to Non-Residents
  i. from the Private Sector

$$\frac{\varepsilon_t r_{w,t} \hat{b}^f_{p,t-1}}{\overline{P}_{t-1}} = \left(e^{r_{d,t}} - 1\right) \frac{\hat{b}^f_{p,t-1}}{P_{d,t-1}} \qquad \text{B.13}$$

ii. from Government

$$\frac{\varepsilon_t r_{w,t} \hat{b}^f_{g,t-1}}{\overline{P}_{t-1}} = \frac{\varepsilon_t \overline{P}_t}{P_{d,t}} \left(e^{r_{w,t}} - 1\right) \frac{\hat{b}^f_{g,t-1}}{\overline{P}_{t-1}} \qquad \text{B.14}$$

iii. Change in Foreign Reserve Holdings
  balances in the Central Bank Account

= Total Sources

III. Private Sector Account

Uses of Funds

+ Private Consumption
  balances in Production Account

+ Private Investment
  balances in Production Account

+ Direct Taxes

$$\hat{t}^p_t = \hat{g}_t + \hat{f}_{g,t} + (e^{r_{w,t}}-1)\left(\frac{\hat{b}^p_{g,t-1}}{P_{d,t-1}} + \frac{\varepsilon_t \bar{P}_t}{P_{d,t}} \cdot \frac{\hat{b}^f_{g,t-1}}{P_{t-1}}\right) + \gamma_t (e^{\delta+n}-1)(\hat{k}^{p'}_{g,t-1} + \hat{k}^{m'}_{g,t-1}) \qquad \text{B.15}$$

+ Change in Money Balances

$$\hat{s}_t = \frac{\Delta \hat{m}_t}{P_{d,t}} + \gamma_t \hat{k}^{p'}_{g,t} + \gamma_{t-1} \hat{k}^{p'}_{g,t-1} \qquad \text{B.16}$$

+ Net Factor Payments to Non-Residents
  balances in Non-Resident Account

+ Net Lending to Government

$$\frac{\Delta \hat{b}^p_{g,t}}{P_{d,t}} = \frac{\Delta \hat{b}^{p,f}_{g,t}}{P_{d,t}} - \frac{\varepsilon_t \Delta \hat{b}^f_{g,t}}{\bar{P}_t} \qquad \text{B.17}$$

where

$$\frac{\Delta \hat{b}^{p,f}_{g,t}}{P_{d,t}} = \hat{g}_t + \hat{f}_{g,t} + \frac{r_{d,t} \hat{b}^p_{g,t-1}}{P_{d,t-1}} + \frac{\varepsilon_t r_{w,t} \hat{b}^f_{g,t-1}}{\bar{P}_{t-1}} - \hat{t}^p_t - \hat{t}^f_t - \frac{\Delta \hat{b}^m_{g,t}}{P_{d,t}} \qquad \text{B.18}$$

= Private Expenditures

Sources of Funds

+ GDP at Factor Cost
  balances in Production Account

+ Net Borrowing from Non-Residents
  balances in Non-Resident Account

+ Government Interest Payments to the
  Private Sector

$$\frac{r_{d,t} \hat{b}^p_{g,t-1}}{P_{d,t-1}} = (e^{r_{d,t}}-1)\frac{\hat{b}^p_{g,t-1}}{P_{d,t-1}} \qquad \text{B.19}$$

= Private Income

IV. Government Account

Uses of Funds

+ Government Consumption
  balances in Production Account

+ Government Investment
  balances in Production Account

+ Interest Payments on the Public Debt
  i. to Non-Resident Sector
  balances in Non-Resident Account

  ii. to the Private Sector
  balances in the Private Account

  iii. to the Central Bank
  balances within the Government Account

= Current Expenditures

Sources of Funds

+ Direct Taxes
  balances in the Private Account

+ Indirect Taxes
  balances in the Production Account

+ Remittances from the Central Bank
  balances within the Government Account

= Current Revenues

+ Net Borrowing
  i. from Non-Residents
  balances in the Non-Resident Account

  ii. from the Private Sector
  balances in the Private Account

  iii. from the Central Bank

$$\frac{\Delta \hat{b}^{m}_{g,t}}{P_{d,t}} = (e^{\mu_t}-1)\frac{\hat{m}_{t-1}}{P_{d,t}} \qquad \text{B.20}$$

= Current Revenues

V. Monetary Authority

Uses of Funds

+ Doestic Credit Expansion
  balances in the Government Account

+ Change in Foreign Reserve Holdings

$$\frac{\Delta \hat{m}_t}{P_{d,t}} = \frac{\varepsilon_t \Delta \hat{m}_{\varepsilon,t}}{P_{d,t}} + \frac{\varepsilon_t \Delta \hat{m}_{y,t}}{P_{d,t}} \qquad \text{B.21}$$

where

Unanticipated Changes in Output

$$\frac{\varepsilon_t \Delta \hat{m}_{\varepsilon,t}}{P_{d,t}} = \frac{(\hat{m}_t - \hat{mm}_t)}{P_{d,t}} \qquad \text{B.22}$$

Increase due to Trend Output Growth

$$\frac{\varepsilon_t \Delta \hat{m}_{y,t}}{P_{d,t}} = e^{\mu_t}\left[\left(\frac{g\hat{d}p'_t}{g\hat{d}p'_{t-1}}\right)^{1_y} - 1\right]\frac{\hat{mm}_{t-1}}{P_{d,t}} \qquad \text{B.23}$$

= Change in Assets

Sources of Funds

+ Change in the Monetary Base

$$\frac{\Delta \hat{mm}_t}{P_{d,t}} = \left(1_a R_{d,t}^{1_R} g\hat{d}p_t^{1_y}\right)^{\lambda}\left(\hat{mm}_{t-1}/P_{d,t-1}\frac{\hat{mm}'_t/P_{d,t}}{\hat{mm}'_{t-1}/P_{d,t-1}}\right)^{1-\lambda} \qquad \text{B.24}$$

where

$$\frac{\hat{mm}'_t}{P_{d,t}} = 1_a R^{*}_{d,t}{}^{1_R} g\hat{d}p'^{1_y}_t \qquad \text{B.25}$$

= Change in Liabilities

Appendix C: National Accounts Data, 1964-1990

I. Production Sector

	Uses of Funds								National Product		
	Value Added		GDP at Factor Cost	Indirect Taxes				less Subsidies	GDP at Market Prices	Net Factor Payments to Non-Residents	
	Agriculture	Non-Agriculture		Excise Taxes	Domestic Tariff	Export Taxes	Foreign Exchange Licenses			from Private Sector	from Government	Net Labour Income
1964	142.62	154.81	297.42	4.31	17.17	2.72	31.45	0.40	352.67	6.56	3.27	-
1965	128.24	166.39	294.63	5.11	19.88	3.41	35.10	0.50	357.63	5.60	3.36	-
1966	158.30	182.63	340.93	5.54	24.49	3.97	41.06	0.70	415.29	8.87	3.60	-
1967	163.53	200.68	364.21	6.62	22.54	3.74	41.40	1.50	437.01	10.11	3.64	-
1968	171.98	226.76	398.74	7.38	26.73	3.69	44.21	2.60	478.15	10.58	3.56	-
1969	182.97	249.95	432.92	9.16	28.70	4.54	43.39	2.10	516.61	6.07	3.39	-
1970	196.31	277.96	474.27	11.93	34.72	5.94	44.67	1.16	570.36	4.92	3.26	-
1971	207.09	309.06	516.15	13.97	43.31	6.73	53.91	1.04	633.03	5.19	3.60	-
1972	279.55	353.59	633.15	17.67	37.27	7.51	55.64	1.30	749.95	7.48	4.67	-
1973	314.93	387.82	702.75	27.01	47.61	11.98	86.73	2.26	873.81	30.49	5.25	-
1974	380.77	490.29	871.06	32.77	69.20	18.03	67.78	1.83	1,057.01	30.74	5.33	-
1975	420.11	564.12	984.23	43.83	73.21	21.82	70.55	0.81	1,192.83	27.80	6.31	-
1976	560.69	671.45	1,232.15	50.69	95.21	28.83	45.95	0.77	1,452.06	51.82	7.59	-
1977	790.33	831.72	1,622.05	59.28	117.09	42.32	18.60	0.55	1,858.78	55.80	9.71	-
1978	759.60	981.29	1,740.89	73.68	154.89	40.74	47.52	0.47	2,057.25	60.26	12.20	-
1979	787.86	1,123.36	1,911.21	103.18	144.85	48.34	68.41	0.60	2,275.39	52.73	17.46	-
1980	844.65	1,310.04	2,154.69	112.87	221.94	61.58	77.72	0.70	2,628.09	45.58	26.50	-
1981	972.69	1,462.99	2,435.68	140.54	232.64	66.95	146.37	1.22	3,020.96	48.60	41.19	1.17
1982	1,169.35	1,673.50	2,842.85	160.85	234.13	71.17	204.82	1.58	3,512.24	42.68	53.96	1.39
1983	1,355.66	1,969.35	3,325.01	191.93	230.30	85.42	153.69	1.67	3,984.68	60.60	60.74	1.46
1984	1,501.90	2,238.39	3,740.29	200.78	280.96	105.97	118.20	1.81	4,444.40	74.43	69.35	1.66
1985	1,662.98	2,694.64	4,357.62	226.65	264.38	126.64	61.05	0.99	5,035.35	115.72	82.53	1.89
1986	1,986.79	3,156.53	5,143.32	271.33	336.54	150.76	(28.36)	0.58	5,873.01	96.63	96.54	2.27
1987	2,067.94	3,255.86	5,323.80	364.08	399.31	147.13	226.78	0.67	6,460.43	112.58	111.45	3.13
1988	2,352.47	3,735.46	6,087.93	430.45	475.80	172.64	303.18	0.15	7,469.85	163.98	138.70	3.82
1989	2,648.85	4,497.03	7,145.88	491.66	550.54	193.74	184.62	0.07	8,566.38	168.79	158.72	-
1990	2,877.51	5,701.92	8,579.43	537.83	635.27	224.90	54.23	0.00	10,031.66	233.11	186.12	4.47

Sources:

Agriculture: 1972-1989, NA:1.10.1; 1964-1971, NA:4.Industries.1

Non Agriculture: 1972-1989, NA:1.10.GDP-1-Other Adj-Import duties; 1964-1971, NA:4.Summation.1 Other Producers-Industries.1

Sources of Funds

GNP at Market Prices	GDP at Market Prices	Private Consumption	Gross Investment		Changes in Inventories	Government Consumption	Net Exports		Errors & Omissions	Errors Attributed to Personal Consumption
			Private	Government			Exports	Imports		
342.85	352.67	242.90	40.00	4.30	2.30	49.30	120.29	104.89	(5.64)	4.12
348.67	357.60	253.60	38.70	7.00	5.50	52.30	118.40	114.97	(5.89)	2.96
402.83	415.29	280.70	52.30	8.90	11.50	57.10	138.54	135.86	4.50	(2.39)
423.26	437.11	293.20	69.40	12.80	6.80	63.70	127.57	136.36	4.00	(4.00)
464.01	478.05	312.40	74.20	15.40	7.40	73.50	137.15	146.29	9.00	(4.71)
507.15	517.26	326.90	75.70	18.00	7.20	85.50	148.82	150.36	4.04	1.46
562.18	570.47	344.69	90.80	21.90	26.96	93.10	163.68	182.15	1.82	9.66
624.24	632.77	410.49	116.20	28.00	7.72	114.23	176.61	228.54	(3.82)	11.88
737.81	749.48	467.91	130.67	33.10	4.20	132.73	194.50	220.25	(2.86)	9.48
838.07	873.77	518.35	144.18	35.43	47.09	144.48	237.72	256.59	2.42	0.69
1,020.94	1,057.01	683.40	164.06	38.73	70.39	180.68	333.24	418.33	(1.82)	6.68
1,158.72	1,192.89	816.40	200.44	41.45	(24.81)	219.30	350.52	415.14	(6.09)	10.82
1,392.65	1,451.95	895.44	241.97	48.46	3.84	253.79	463.36	461.98	0.25	6.82
1,793.27	1,858.93	1,034.00	331.17	58.84	51.22	322.05	642.75	593.34	1.24	10.99
1,984.79	2,057.24	1,248.86	443.44	70.56	96.62	398.60	578.25	796.16	2.63	14.45
2,205.20	2,275.35	1,469.14	446.74	93.70	(24.20)	447.31	586.38	736.59	1.79	(8.92)
2,556.00	2,628.09	1,605.93	493.89	128.64	166.66	533.77	744.71	1,056.01	3.49	7.02
2,929.99	3,020.97	1,836.86	580.18	148.31	133.40	576.42	796.86	1,057.14	30.94	(24.86)
3,414.22	3,512.35	2,232.06	541.55	126.65	99.49	647.44	878.18	1,019.08	24.68	(18.63)
3,861.88	3,984.68	2,443.43	615.44	102.03	111.85	733.11	995.87	1,024.62	9.98	(2.41)
4,298.96	4,444.44	2,808.13	654.05	153.11	118.59	775.60	1,170.49	1,243.35	6.20	1.62
4,835.21	5,035.32	2,924.46	688.02	192.36	405.94	880.10	1,288.60	1,338.63	32.54	(38.06)
5,677.57	5,873.04	3,509.57	933.27	219.95	125.22	1,075.91	1,513.32	1,516.97	35.05	(22.28)
6,233.28	6,460.47	4,050.93	1,056.63	230.11	305.81	1,214.46	1,392.83	1,748.65	88.77	(130.42)
7,163.36	7,469.81	4,679.07	1,159.57	362.63	370.87	1,287.46	1,660.85	2,069.48	30.79	(11.96)
8,238.87	8,566.23	5,206.97	1,362.35	349.77	460.43	1,636.11	1,965.35	2,635.58	69.53	151.30
9,607.96	10,031.95	6,083.00	1,584.00	447.00	345.00	1,831.00	2,542.53	3,094.90	80.20	214.11

II. Private Sector

Uses of Funds

	Personal Consumption	Direct Taxes	Non-Tax Government Revenue	Factor Payments Abroad		Personal Savings					
				Investment Income	Labour Income	Gross Investment	Inventory Changes	Net Lending to Govt	Net Lending to Non-Residents	Increase in Money Base	Increase in Foreign Exchange
1964	242.90	14.50	8.00	6.56		40.00	2.30	8.86	13.29		(1.89)
1965	253.60	15.68	8.59	5.60		38.70	5.50	7.20	(0.43)		0.89
1966	280.70	18.44	9.05	8.87		52.30	11.50	2.81	1.25		7.18
1967	293.20	22.12	10.31	10.11		69.40	6.80	5.84	(18.82)	6.70	(0.75)
1968	312.40	24.97	12.41	10.58		74.20	7.40	1.91	(6.39)	8.05	0.54
1969	326.90	29.09	15.05	6.07		75.70	7.20	8.23	(14.00)	16.80	0.24
1970	344.69	36.85	19.47	4.92		90.80	26.96	13.63	(22.93)	6.35	1.56
1971	410.49	44.55	25.00	5.19		116.20	7.72	11.14	(19.75)	(5.25)	(8.08)
1972	467.91	51.28	27.56	7.48		130.67	4.20	20.84	(19.07)	6.05	2.20
1973	518.35	56.40	25.83	30.49		144.18	47.09	18.71	(34.97)	6.55	5.25
1974	683.40	67.70	23.32	30.74		164.06	70.39	(3.76)	(62.46)	19.70	(21.81)
1975	816.40	83.70	26.31	27.80		200.44	(24.81)	9.89	(38.18)	(8.80)	20.26
1976	895.44	99.15	37.05	51.82		241.97	3.84	67.10	(59.11)	19.40	(3.76)
1977	1,034.00	125.52	48.19	55.80		331.17	51.22	78.63	(63.48)	61.60	9.04
1978	1,248.86	147.39	63.95	60.26		443.44	96.62	(75.59)	(60.29)	11.65	(12.85)
1979	1,469.14	162.69	79.15	52.73		446.74	(24.20)	57.41	(140.94)	42.95	(8.79)
1980	1,605.93	185.95	71.35	45.58		493.89	166.66	35.36	(107.03)	4.85	(98.53)
1981	1,836.86	199.68	68.68	48.60	1.17	580.18	133.40	67.46	(24.43)	9.15	(37.90)
1982	2,232.06	216.45	86.20	42.68	1.39	541.55	99.49	12.06	(27.58)	59.10	47.29
1983	2,443.43	241.78	96.13	60.60	1.46	615.44	111.85	226.72	(25.89)	(6.40)	(13.29)
1984	2,808.13	276.50	105.70	74.43	1.66	654.05	118.59	170.63	(39.71)	32.25	15.20
1985	2,924.46	328.23	124.43	115.72	1.89	688.02	405.94	199.46	(21.94)	47.65	(0.56)
1986	3,509.57	370.43	131.50	96.63	2.27	933.27	125.22	206.80	(96.30)	143.75	86.62
1987	4,050.93	420.13	137.58	112.58	3.13	1,056.63	305.81	45.34	(140.27)	98.05	42.90
1988	4,679.07	483.25	188.65	163.98	3.82	1,159.57	370.87	150.08	(82.79)	12.45	(21.66)
1989	5,206.97	555.58	224.88	168.79	0.00	1,362.35	460.43	221.89	(270.62)	104.60	(125.46)
1990	6,083.00	656.12	177.74	233.11	4.47	1,584.00	345.00	(28.30)	(255.62)	157.55	(11.28)

Sources:

Personal Consumption: 1972-1989, NA:1.1.2; 1964-1971, NA:1.2

Direct Taxes: 1964-1989, GFS:A.1, also SA:175a.Government Revenue.Income Taxes

Non-Tax Revenue: 1980-1989, GFS:C.V; 1964-1979, SA:Compulsory Fees less Airport Tax plus Property Income plus Sales of Goods and Services

Net Investment Income: 1964-1989, IFS:-[77ajd+77akd] less Net Labour Income and Interest Paid on Public Debt to Non-Residents

Net Labour Income: 1981-1989, BP:-[27+28]; 1964-1980, Not Available

Gross Private Investment: 1972-1989, NA:2.11.Total Industries; 1964-1971, NA:8.Industries.subtotal

Changes in Inventories: 1972-1989, NA:1.1.3.a; 1964-1971, NA:1.3

Net Lending to Non Residents: 1964-1989, IFS: [77bad+77bbd+77gbd+77gcd]

Increase in Monetary Base: 1967-1989, IFS:/\14

Increase in Foreign Exchange: 1964-1989, IFS: 79..d [k-money]b10

Error Attributed to Personal Consumption: Balancing Entry believed to represent unaccounted personal consumption

Sources of Funds								
Errors Attributed to		Total Personal Outlays	Total Personal Income	Value Added:		Interest Income on Govt Debt	Net Transfers	
Personal Consumptio	Non-Tax Revenue			Agriculture	Non-Agriculture		Government	Non-Residents
4.12	(29.61)	309.02	309.02	142.62	154.81	1.14	13.56	(3.11)
2.96	(38.51)	299.79	299.79	128.24	166.39	1.21	5.49	(1.54)
(2.39)	(34.27)	355.43	355.43	158.30	182.63	1.39	13.04	0.07
(4.00)	(26.29)	374.61	374.61	163.53	200.68	1.69	12.78	(4.07)
(4.71)	(30.37)	410.99	410.99	171.98	226.76	2.13	13.70	(3.57)
1.46	(25.39)	447.35	447.35	182.97	249.95	2.90	14.78	(3.25)
9.66	(44.56)	487.40	487.40	196.31	277.96	3.77	13.36	(4.00)
11.88	(68.61)	530.48	530.48	207.09	309.06	4.49	14.46	(4.61)
9.48	(56.61)	651.98	651.98	279.55	353.59	5.01	14.32	(0.50)
0.69	(96.86)	721.70	721.70	314.93	387.82	6.06	15.94	(3.05)
6.68	(81.95)	896.00	896.00	380.77	490.29	7.92	21.92	(4.89)
10.82	(106.14)	1,017.69	1,017.69	420.11	564.12	10.72	27.32	(4.59)
6.82	(69.09)	1,290.63	1,290.63	560.69	671.45	14.16	52.53	(8.20)
10.99	(14.88)	1,727.80	1,727.80	790.33	831.72	18.67	85.67	1.41
14.45	(62.27)	1,875.63	1,875.63	759.60	981.29	25.45	102.99	6.30
(8.92)	(68.31)	2,059.64	2,059.64	787.86	1,123.36	27.82	116.61	4.00
7.02	(112.25)	2,298.78	2,298.78	844.65	1,310.04	31.55	102.45	10.09
(24.86)	(184.45)	2,673.54	2,673.54	972.69	1,462.99	52.10	141.16	44.60
(18.63)	(183.59)	3,108.46	3,108.46	1,169.35	1,673.50	78.27	141.85	45.49
(2.41)	(139.95)	3,609.47	3,609.47	1,355.66	1,969.35	99.02	143.23	42.20
1.62	(136.22)	4,082.82	4,082.82	1,501.90	2,238.39	115.34	183.87	43.31
(38.06)	(6.88)	4,768.36	4,768.36	1,662.98	2,694.64	148.40	195.39	66.96
(22.28)	99.30	5,586.77	5,586.77	1,986.79	3,156.53	186.59	209.65	47.22
(130.42)	(138.02)	5,864.35	5,864.35	2,067.94	3,255.86	223.83	257.48	59.23
(11.96)	(280.56)	6,814.76	6,814.76	2,352.47	3,735.46	278.18	369.68	78.97
151.30	(131.48)	7,929.21	7,929.21	2,648.85	4,497.03	323.10	355.83	104.40
214.11	261.98	9,421.87	9,421.87	2,877.51	5,701.92	392.52	257.65	192.26

III. Government Sector

	Uses of Funds							Sources of Funds		
	Government Consumption	Gross Government Investment	Transfers to Private Secto		Interest Paid on Public D		Total Uses	Total Revenues & Financing	Direct Taxes	Non-Tax Government Revenue
			Direct Transfers	Subsidies	to Private Sector	to Non-Residents				
1964	49.30	4.30	13.56	0.40	1.14	3.27	71.97	71.97	14.50	8.00
1965	52.30	7.00	5.49	0.50	1.21	3.36	69.86	69.89	15.68	8.59
1966	57.10	8.90	13.04	0.70	1.39	3.60	84.73	84.73	18.44	9.05
1967	63.70	12.80	12.78	1.50	1.69	3.64	96.11	96.11	22.12	10.31
1968	73.50	15.40	13.70	2.60	2.13	3.56	110.89	110.89	24.97	12.41
1969	85.50	18.00	14.78	2.10	2.90	3.39	126.67	126.67	29.09	15.05
1970	93.10	21.90	13.36	1.16	3.77	3.26	136.55	136.55	36.85	19.47
1971	114.23	28.00	14.46	1.04	4.49	3.60	165.81	165.81	44.55	25.00
1972	132.73	33.10	14.32	1.30	5.01	4.67	191.13	191.14	51.28	27.56
1973	144.48	35.43	15.94	2.26	6.06	5.25	209.42	209.42	56.40	25.83
1974	180.68	38.73	21.92	1.83	7.92	5.33	256.41	256.41	67.70	23.32
1975	219.30	41.45	27.32	0.81	10.72	6.31	305.92	305.92	83.70	26.31
1976	253.79	48.46	52.53	0.77	14.16	7.59	377.29	377.29	99.15	37.05
1977	322.05	58.84	85.67	0.55	18.67	9.71	495.49	495.49	125.52	48.19
1978	398.60	70.56	102.99	0.47	25.45	12.20	610.27	610.27	147.39	63.95
1979	447.31	93.70	116.61	0.60	27.82	17.46	703.50	703.50	162.69	79.15
1980	533.77	128.64	102.45	0.70	31.55	26.50	823.61	823.61	185.95	71.35
1981	576.42	148.31	141.16	1.22	52.10	41.19	960.40	960.40	199.68	68.68
1982	647.44	126.65	141.85	1.58	78.27	53.96	1,049.75	1,049.75	216.45	86.20
1983	733.11	102.03	143.23	1.67	99.02	60.74	1,139.80	1,139.80	241.78	96.13
1984	775.60	153.11	183.87	1.81	115.34	69.35	1,299.08	1,299.08	276.50	105.70
1985	880.10	192.36	195.39	0.99	148.40	82.53	1,499.76	1,499.76	328.23	124.43
1986	1,075.91	219.95	209.65	0.58	186.59	96.54	1,789.21	1,789.21	370.43	131.50
1987	1,214.46	230.11	257.48	0.67	223.83	111.45	2,038.00	2,038.00	420.13	137.58
1988	1,287.46	362.63	369.68	0.15	278.18	138.70	2,436.80	2,436.80	483.25	188.65
1989	1,636.11	349.77	355.83	0.07	323.10	158.72	2,823.60	2,823.60	555.58	224.88
1990	1,831.00	447.00	257.65	0.00	392.52	186.12	3,114.29	3,114.29	656.12	177.74

Source:

Government Consumption: 1972-1989, NA:1.1.1; 1964 1971, NA:1.1

Gross Government Investment; 1972-1989, NA:2.11.Producers of Government Services;
1964-1971, NA:8. Producers of Government Services - Sub-Total

Direct Transfers: 1980 1989, GFS:C.3 3.5 Other Subsidies; 1966-1979, SA:Current Transfers-Rest of World Other Subsidies

Other Subsidies: 1972 1989, NA:1.3.1.b; 1964-1971, NA:1.Cost-Structure of GDP.5

Interest Paid to Private Sector: 1964-1989, SA:Interest Paid to Private Sector

Interest Paid to Non Residents: 1964-1989, SA:Interest on External Debt

Error Attributed to Non Tax Revenue: 1964 1989, Balancing Entry representing unaccounted non tax revenue

Private Sector Deficit Financing: 1972 1989, IFS:82 81; 1964-1971, SA:Recurrent Expenditure plus Development Expenditure less Recurrent Revnue

Indirect Taxes				Net Transfers from Non-Residents	Errors Attributed to Non-Tax Revenue	Deficit/(Surplus) Financed by			
Excise Taxes	Domestic Tariffs	Export Taxes	Foreign Exchange Licenses			Total Financing	Private Sector	Non-Residents	Central Bank
4.31	17.17	2.72	31.45	15.61	(29.61)	7.83	8.86	(1.04)	-
5.11	19.88	3.41	35.10	7.25	(38.51)	13.38	7.20	6.18	-
5.54	24.49	3.97	41.06	3.07	(34.27)	13.38	2.81	10.57	-
6.62	22.54	3.74	41.40	5.11	(26.29)	10.57	5.84	2.93	1.80
7.38	26.73	3.69	44.21	12.50	(30.37)	9.36	1.91	6.25	1.20
9.16	28.70	4.54	43.39	11.36	(25.39)	10.78	8.23	7.50	(4.95)
11.93	34.72	5.94	44.67	13.14	(44.56)	14.40	13.63	8.96	(8.20)
13.97	43.31	6.73	53.91	25.43	(68.61)	21.52	11.14	(1.21)	11.60
17.67	37.27	7.51	55.64	14.11	(56.61)	36.70	20.84	16.61	(0.75)
27.01	47.61	11.98	86.73	13.51	(96.86)	37.23	18.71	14.32	4.20
32.77	69.20	18.03	67.78	16.11	(81.95)	43.45	(3.76)	17.86	29.35
43.83	73.21	21.82	70.55	21.15	(106.14)	71.50	9.89	34.26	27.35
50.69	95.21	28.83	45.95	13.60	(69.09)	75.90	67.10	28.45	(19.65)
59.28	117.09	42.32	18.60	25.53	(14.88)	73.85	78.63	35.92	(40.70)
73.68	154.89	40.74	47.52	28.33	(62.27)	116.05	(75.59)	107.94	83.70
103.18	144.85	48.34	68.41	29.60	(68.31)	135.60	57.41	70.94	7.25
112.87	221.94	61.58	77.72	44.19	(112.25)	160.28	35.36	80.92	44.00
140.54	232.64	66.95	146.37	53.38	(184.45)	236.63	67.46	59.71	109.45
160.85	234.13	71.17	204.82	27.20	(183.59)	232.53	12.06	26.81	193.65
191.93	230.30	85.42	153.69	77.54	(139.95)	202.98	226.72	61.10	(84.85)
200.78	280.96	105.97	118.20	84.03	(136.22)	263.15	170.63	89.37	3.15
226.65	264.38	126.64	61.05	90.54	(6.88)	284.73	199.46	(4.44)	89.70
271.33	336.54	150.76	(28.36)	120.88	99.30	336.83	206.80	11.28	118.75
364.08	399.31	147.13	226.78	116.74	(138.02)	364.28	45.34	157.38	161.55
430.45	475.80	172.64	303.18	227.52	(280.56)	435.88	150.08	256.44	29.35
491.66	550.54	193.74	184.62	288.93	(131.48)	465.13	221.89	389.63	(146.40)
537.83	635.27	224.90	54.23	237.06	261.98	329.18	(28.30)	105.18	252.30

IV. Non-Resident Sector

	Uses of Funds (by Non-Residents)					Deficit/(Surplus) Financed By				
	Exports of Goods & Services	Errors & Omissions	Net Transfer Payments		Total Receipts on the Current Account	Net Borrowing By		Decrease in Exchange		Total Uses
			Government	Private		Private	Government	Private	Central Bank	
1964	120.29	(5.64)	15.61	(3.11)	127.15	(13.29)	(1.04)	1.89	-	114.72
1965	118.40	(5.89)	7.25	(1.54)	118.22	0.43	6.18	(0.89)	-	123.93
1966	138.54	4.50	3.07	0.07	146.18	(1.25)	10.57	(7.18)	-	148.32
1967	127.57	4.00	5.11	(4.07)	132.61	18.82	2.93	0.75	(5.00)	150.11
1968	137.15	9.00	12.50	(3.57)	155.07	6.39	6.25	(0.54)	(6.75)	160.43
1969	148.82	4.04	11.36	(3.25)	160.97	14.00	7.50	(0.24)	(22.40)	159.82
1970	163.68	1.82	13.14	(4.00)	174.65	22.93	8.96	(1.56)	(14.65)	190.32
1971	176.61	(3.82)	25.43	(4.61)	193.61	19.75	(1.21)	8.08	17.10	237.33
1972	194.50	(2.86)	14.11	(0.50)	205.25	19.07	16.61	(2.20)	(6.30)	232.43
1973	237.72	2.42	13.51	(3.05)	250.60	34.97	14.32	(5.25)	(2.35)	292.29
1974	333.22	(1.82)	16.11	(4.89)	342.61	62.46	17.86	21.81	9.65	454.40
1975	350.52	(6.09)	21.15	(4.59)	360.98	38.18	34.26	(20.26)	36.05	449.21
1976	463.36	0.25	13.60	(8.20)	469.01	59.11	28.45	3.76	(38.90)	521.43
1977	642.75	1.24	25.53	1.41	670.93	63.48	35.92	(9.04)	(102.40)	658.90
1978	578.25	2.63	28.33	6.30	615.50	60.29	107.94	12.85	72.10	868.67
1979	586.38	1.79	29.60	4.00	621.77	140.94	70.94	8.79	(35.70)	806.74
1980	744.71	3.49	44.19	10.09	802.47	107.03	80.92	98.53	39.15	1,128.10
1981	796.86	30.94	53.38	44.60	925.78	24.43	59.71	37.90	100.35	1,148.17
1982	878.18	24.68	27.20	45.49	975.55	27.58	26.81	(47.29)	134.50	1,117.16
1983	995.87	9.98	77.54	42.20	1,125.60	25.89	61.10	13.29	(78.45)	1,147.43
1984	1,170.49	6.20	84.03	43.31	1,304.03	39.71	89.37	(15.20)	(29.20)	1,388.72
1985	1,288.60	32.54	90.54	66.96	1,478.63	21.94	(4.44)	0.56	42.25	1,538.94
1986	1,513.32	35.05	120.88	47.22	1,716.47	96.30	11.28	(86.62)	(25.10)	1,712.33
1987	1,392.83	88.77	116.74	59.23	1,657.58	140.27	157.38	(42.90)	63.55	1,975.88
1988	1,660.85	30.79	227.52	78.97	1,998.13	82.79	256.44	21.66	16.85	2,375.88
1989	1,965.35	69.53	288.93	104.40	2,428.22	270.62	389.63	125.46	(250.95)	2,962.99
1990	2,542.53	80.20	237.06	192.26	3,052.05	255.62	105.18	11.28	94.70	3,518.83

Sources:

Exports: 1964-1989, IFS:77aad:77ahd

Errors & Omissions: 1964 1989, IFS:77e.d

Net Transfers from Non-Residents to Government: 1964-1989, IFS:77agd

Net Transfers from Non-Residents to Private Sector: 1964-1989, IFS:77afd

Net Borrowing from Non-Residents by Government: 1964-1989, IFS:77gad

Imports: 1964-1989, IFS: [77abd:77aid]

Sources of Funds (of Non-Residents)

Total Payments on the Current Account	Imports of Goods & Services	Net Factor Income Paid to Non-Residents		
		Net Investment Income		Net Labour Income
		Private	Government	
114.72	104.89	6.56	3.27	0.00
123.93	114.97	5.60	3.36	0.00
148.32	135.86	8.87	3.60	0.00
150.11	136.36	10.11	3.64	0.00
160.43	146.29	10.58	3.56	0.00
159.82	150.36	6.07	3.39	0.00
190.33	182.15	4.92	3.26	0.00
237.33	228.54	5.19	3.60	0.00
232.40	220.25	7.48	4.67	0.00
292.33	256.59	30.49	5.25	0.00
454.40	418.33	30.74	5.33	0.00
449.24	415.14	27.80	6.31	0.00
521.39	461.98	51.82	7.59	0.00
658.85	593.34	55.80	9.71	0.00
868.62	796.16	60.26	12.20	0.00
806.78	736.59	52.73	17.46	0.00
1,128.10	1,056.01	45.58	26.50	0.00
1,148.11	1,057.14	48.60	41.19	1.17
1,117.10	1,019.08	42.68	53.96	1.39
1,147.43	1,024.62	60.60	60.74	1.46
1,388.79	1,243.35	74.43	69.35	1.66
1,538.77	1,338.63	115.72	82.53	1.89
1,712.41	1,516.97	96.63	96.54	2.27
1,975.80	1,748.65	112.58	111.45	3.13
2,375.97	2,069.48	163.98	138.70	3.82
2,963.09	2,635.58	168.79	158.72	0.00
3,518.60	3,094.90	233.11	186.12	4.47

V. Monetary Authority

	Uses of Funds			Sources of Funds	
	Increase in Foreign Reserves	Net Lending to Government	Total Uses	Total Sources	Increase in the Monetary Base
1964					
1965					
1966					
1967	5.00	1.80	6.80	6.70	6.70
1968	6.75	1.20	7.95	8.05	8.05
1969	22.40	(4.95)	17.45	16.80	16.80
1970	14.65	(8.20)	6.45	6.35	6.35
1971	(17.10)	11.60	(5.50)	(5.25)	(5.25)
1972	6.30	(0.75)	5.55	6.05	6.05
1973	2.35	4.20	6.55	6.55	6.55
1974	(9.65)	29.35	19.70	19.70	19.70
1975	(36.05)	27.35	(8.70)	(8.80)	(8.80)
1976	38.90	(19.65)	19.25	19.40	19.40
1977	102.40	(40.70)	61.70	61.60	61.60
1978	(72.10)	83.70	11.60	11.65	11.65
1979	35.70	7.25	42.95	42.95	42.95
1980	(39.15)	44.00	4.85	4.85	4.85
1981	(100.35)	109.45	9.10	9.15	9.15
1982	(134.50)	193.65	59.15	59.10	59.10
1983	78.45	(84.85)	(6.40)	(6.40)	(6.40)
1984	29.20	3.15	32.35	32.25	32.25
1985	(42.25)	89.70	47.45	47.65	47.65
1986	25.10	118.75	143.85	143.75	143.75
1987	(63.95)	161.55	98.00	98.05	98.05
1988	(16.85)	29.35	12.50	12.45	12.45
1989	250.95	(146.40)	104.55	104.60	104.60
1990	(94.70)	252.30	157.60	157.55	157.55

Sources:

Increase in Foreign Exchange: 1967-1989, IFS:/\[11-16b-16c-16cl-16e-17a-17r]

Net Lending to Government: 1967-1989, IFS:/\[12a-16d]

Appendix D

Results of Estimations

D.1 Absorption Elasticites

A seemingly-unrelated-regression (SUR) system of six equations was estimated using ordinary-least-squares method. The output for the regression is duplicated below.

```
UNIT  6 IS NOW ASSIGNED TO: c:\stiff\gbmfd\data\ABS.OUT
|_TITLE System 6 X&M, ruk, fao, ip, res no weight lag, d84*year
  System 6 X&M, ruk, fao, ip, res no weight lag, d84*year
|_System 6 / restrict dn list iter=1000 piter=500 conv=.0001
|_OLS Lypc LypcL LE Lxde lmde Lruk YEAR
|_OLS LIppc LIppcL LE Lxde lmde Lruk Lfaopc YEAR
|_OLS LIGpc LIGpcL LE Lxde lmde Lruk Lfaopc YEAR
|_OLS LGpc LGpcL LE Lxde lmde Lruk Lfaopc YEAR
|_OLS Lxpc LxpcL LE Lxde lmde Lruk Lfaopc YEAR
|_OLS lmpc lmpcl le Lxde lmde lruk lfaopc year
|_res lypcl:1=lippcl:2
|_res lypcl:1=ligpcl:3
|_res lypcl:1=lgpcl:4
|_res lypcl:1=lxpcl:5
|_res lypcl:1=lmpcl:6
|_end
DN OPTION IN EFFECT - DIVISOR IS N
IR OPTION IN EFFECT - ITERATIVE RESTRICTIONS

ITERATION   21 SIGMA INVERSE
  1985.0
 -466.63       426.51
  81.227      -66.858       119.41
  262.91      -364.74       120.36       965.38
 -436.86       96.599       22.444       59.917       351.79
  117.91      -101.48      -22.644      -79.674      -118.65       215.02
ITERATION   21 SIGMA
 0.93109E-03
 0.97010E-03  0.63123E-02
-0.31993E-03  0.12429E-02  0.10250E-01
 0.13198E-03  0.22439E-02 -0.57149E-03  0.20625E-02
 0.10753E-02  0.19647E-03 -0.91600E-03 -0.24185E-03  0.49064E-02
 0.55583E-03  0.35180E-02  0.11243E-02  0.15573E-02  0.20245E-02  0.78190E-02

SYSTEM R-SQUARE =  1.0000 ... CHI-SQUARE =   275.14     WITH  36 D.F.
LOG OF LIKELIHOOD FUNCTION =   230.081
LIKELIHOOD RATIO TEST OF DIAGONAL COVARIANCE MATRIX =   44.647     WITH  15 D.F.

 EQUATION  1 OF  6 EQUATIONS
DEPENDENT VARIABLE = LYPC                  26 OBSERVATIONS
 R-SQUARE =   0.9981

VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.93109E-03
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.30514E-01
SUM OF SQUARED ERRORS-SSE=  0.24208E-01
MEAN OF DEPENDENT VARIABLE =   4.8054
LOG OF THE LIKELIHOOD FUNCTION =  230.081
```

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	T-RATIO	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
LYPCL	0.34895	0.62214E-01	5.6088	0.0000	0.7532	0.34289	0.34282
LE	-0.16591	0.83136E-01	-1.9956	0.0460	-0.3772	-0.25448E-01	-0.64609E-02
LXDE	0.16078	0.62092E-01	2.5894	0.0096	0.4673	0.17723	0.13645
LMDE	0.62240E-01	0.55804E-01	1.1153	0.2647	0.2220	0.87964E-01	0.49761E-01
LRUK	0.18497E-01	0.32838E-01	0.56328	0.5732	0.1142	0.79250E-02	0.85114E-02
YEAR	0.34496E-01	0.55675E-02	6.1959	0.0000	0.7844	0.37099	14.196
CONSTANT	-65.962	10.773	-6.1228	0.0000	-0.7808	0.00000	-13.727

DURBIN-WATSON = 2.0584 VON NEUMANN RATIO = 2.1408 RHO = -0.06595
RESIDUAL SUM = -0.16209E-12 RESIDUAL VARIANCE = 0.93109E-03
SUM OF ABSOLUTE ERRORS= 0.61331
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9981
RUNS TEST: 10 RUNS, 16 POS, 0 ZERO, 10 NEG NORMAL STATISTIC = -1.4019

EQUATION 2 OF 6 EQUATIONS
DEPENDENT VARIABLE = LIPPC 26 OBSERVATIONS
R-SQUARE = 0.9897

VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.63123E-02
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.79450E-01
SUM OF SQUARED ERRORS-SSE= 0.16412
MEAN OF DEPENDENT VARIABLE = 2.9450
LOG OF THE LIKELIHOOD FUNCTION = 230.081

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	T-RATIO	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
LIPPCL	0.34895	0.62214E-01	5.6088	0.0000	0.7600	0.35477	0.33691
LE	-0.60466	0.21702	-2.7862	0.0053	-0.5023	-0.82677E-01	-0.38422E-01
LXDE	0.30887	0.16129	1.9150	0.0555	0.3708	0.30350	0.42771
LMDE	-0.31325	0.14579	-2.1486	0.0317	-0.4089	-0.39465	-0.40865
LRUK	-0.52937E-01	0.92212E-01	-0.57408	0.5659	-0.1189	-0.20217E-01	-0.39746E-01
LFAOPC	-0.19923	0.53631E-01	-3.7149	0.0002	-0.6124	-0.19180	-0.55802E-01
YEAR	0.89203E-01	0.14721E-01	6.0595	0.0000	0.7841	0.85518	59.898
CONSTANT	-174.11	28.738	-6.0584	0.0000	-0.7841	0.00000	-59.120

DURBIN-WATSON = 1.8787 VON NEUMANN RATIO = 1.9538 RHO = 0.02215
RESIDUAL SUM = 0.16120E-12 RESIDUAL VARIANCE = 0.63123E-02
SUM OF ABSOLUTE ERRORS= 1.7542
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9897
RUNS TEST: 15 RUNS, 14 POS, 0 ZERO, 12 NEG NORMAL STATISTIC = 0.4338

EQUATION 3 OF 6 EQUATIONS
DEPENDENT VARIABLE = LIGPC 26 OBSERVATIONS
R-SQUARE = 0.9862

VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.10250E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.10124
SUM OF SQUARED ERRORS-SSE= 0.26650
MEAN OF DEPENDENT VARIABLE = 1.4450
LOG OF THE LIKELIHOOD FUNCTION = 230.081

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	T-RATIO	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
LIGPCL	0.34895	0.62214E-01	5.6088	0.0000	0.7600	0.36980	0.31545
LE	-0.20999	0.27713	-0.75775	0.4486	-0.1561	-0.26027E-01	-0.27195E-01
LXDE	0.33425	0.20172	1.6570	0.0975	0.3266	0.29771	0.94332
LMDE	-0.60672	0.18784	-3.2300	0.0012	-0.5586	-0.69287	-1.6131
LRUK	0.23146	0.11961	1.9351	0.0530	0.3742	0.80129E-01	0.35418
LFAOPC	-0.43975E-01	0.72218E-01	-0.60892	0.5426	-0.1260	-0.38375E-01	-0.25102E-01
YEAR	0.11158	0.20940E-01	5.3284	0.0000	0.7433	0.96960	152.69
CONSTANT	-219.12	40.938	-5.3525	0.0000	-0.7448	0.00000	-151.64

DURBIN-WATSON = 2.2370 VON NEUMANN RATIO = 2.3265 RHO = -0.12054
RESIDUAL SUM = 0.17603E-12 RESIDUAL VARIANCE = 0.10250E-01
SUM OF ABSOLUTE ERRORS= 2.1703
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9862
RUNS TEST: 14 RUNS, 11 POS, 0 ZERO, 15 NEG NORMAL STATISTIC = 0.1263

```
 EQUATION  4 OF  6 EQUATIONS
DEPENDENT VARIABLE = LGPC                    26 OBSERVATIONS
 R-SQUARE =    0.9968
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.20625E-02
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.45415E-01
SUM OF SQUARED ERRORS-SSE=  0.53625E-01
MEAN OF DEPENDENT VARIABLE =   3.0257
LOG OF THE LIKELIHOOD FUNCTION =  230.081

                              ASYMPTOTIC
VARIABLE     ESTIMATED    STANDARD    T-RATIO          PARTIAL STANDARDIZED ELASTICITY
  NAME      COEFFICIENT     ERROR    --------     P-VALUE CORR.  COEFFICIENT  AT MEANS

LGPCL       0.34895      0.62214E-01   5.6088      0.0000 0.7600  0.34928      0.33751
LE         -0.40994      0.12398      -3.3064      0.0009-0.5676 -0.54259E-01 -0.25355E-01
LXDE        0.18013      0.92504E-01   1.9473      0.0515 0.3762  0.17134      0.24279
LMDE       -0.68746E-01  0.82421E-01  -0.83409     0.4042-0.1713 -0.83838E-01 -0.87292E-01
LRUK        0.55484E-01  0.53030E-01   1.0463      0.2954 0.2132  0.20512E-01  0.40547E-01
LFAOPC     -0.89932E-01  0.32669E-01  -2.7528      0.0059-0.4978 -0.83808E-01 -0.24517E-01
YEAR        0.62921E-01  0.88650E-02   7.0977      0.0000 0.8286  0.58391       41.123
CONSTANT   -122.86       17.310       -7.0981      0.0000-0.8286  0.00000      -40.607

DURBIN-WATSON = 1.7373     VON NEUMANN RATIO = 1.8068     RHO =  0.09045
RESIDUAL SUM = -0.87041E-13  RESIDUAL VARIANCE =  0.20625E-02
SUM OF ABSOLUTE ERRORS=  0.94730
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9968
RUNS TEST:     8 RUNS,    13 POS,     0 ZERO,    13 NEG  NORMAL STATISTIC = -2.4019

 EQUATION  5 OF  6 EQUATIONS
DEPENDENT VARIABLE = LXPC                    26 OBSERVATIONS
 R-SQUARE =    0.9888
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.49064E-02
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.70046E-01
SUM OF SQUARED ERRORS-SSE=  0.12757
MEAN OF DEPENDENT VARIABLE =   3.4787
LOG OF THE LIKELIHOOD FUNCTION =  230.081

                              ASYMPTOTIC
VARIABLE     ESTIMATED    STANDARD    T-RATIO          PARTIAL STANDARDIZED ELASTICITY
  NAME      COEFFICIENT     ERROR    --------     P-VALUE CORR.  COEFFICIENT  AT MEANS

LXPCL       0.34895      0.62214E-01   5.6088      0.0000 0.7600  0.34021      0.34118
LE         -0.64842      0.19370      -3.3475      0.0008-0.5724 -0.10473     -0.34882E-01
LXDE        0.17343      0.14117       1.2285      0.2193 0.2481  0.20130      0.20331
LMDE        0.10618      0.12815       0.82857     0.4073 0.1702  0.15802      0.11727
LRUK        0.12111      0.80608E-01   1.5025      0.1330 0.2990  0.54639E-01  0.76982E-01
LFAOPC     -0.42202E-01  0.43470E-01  -0.97083     0.3316-0.1984 -0.47993E-01 -0.10007E-01
YEAR        0.19864E-01  0.11216E-01   1.7711      0.0766 0.3464  0.22495       11.292
CONSTANT   -38.216       21.847       -1.7492      0.0803-0.3427  0.00000      -10.986

DURBIN-WATSON = 1.8681     VON NEUMANN RATIO = 1.9428     RHO =  0.05418
RESIDUAL SUM =  0.76827E-13  RESIDUAL VARIANCE =  0.49064E-02
SUM OF ABSOLUTE ERRORS=   1.5204
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9888
RUNS TEST:    10 RUNS,    11 POS,     0 ZERO,    15 NEG  NORMAL STATISTIC = -1.5155

 EQUATION  6 OF  6 EQUATIONS
DEPENDENT VARIABLE = LMPC                    26 OBSERVATIONS
 R-SQUARE =    0.9844
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.78190E-02
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.88425E-01
SUM OF SQUARED ERRORS-SSE=  0.20329
MEAN OF DEPENDENT VARIABLE =   3.6082
LOG OF THE LIKELIHOOD FUNCTION =  230.081

                              ASYMPTOTIC
VARIABLE     ESTIMATED    STANDARD    T-RATIO          PARTIAL STANDARDIZED ELASTICITY
  NAME      COEFFICIENT     ERROR    --------     P-VALUE CORR.  COEFFICIENT  AT MEANS

LMPCL       0.34895      0.62214E-01   5.6088      0.0000 0.7600  0.34599      0.34022
LE         -0.58827      0.24133      -2.4377      0.0148-0.4531 -0.88908E-01 -0.30511E-01
LXDE        0.34354      0.17673       1.9439      0.0519 0.3756  0.37311      0.38828
LMDE       -0.22558      0.16073      -1.4035      0.1605-0.2809 -0.31412     -0.24019
LRUK        0.26519      0.10293       2.5765      0.0100 0.4733  0.11195      0.16251
LFAOPC      0.36517E-02  0.61124E-01   0.59742E-01 0.9524 0.0125  0.38857E-02  0.83479E-03
YEAR        0.41243E-01  0.14611E-01   2.8228      0.0048 0.5072  0.43704       22.604
CONSTANT   -80.191       28.473       -2.8164      0.0049-0.5064  0.00000      -22.225
```

```
DURBIN-WATSON = 2.1639    VON NEUMANN RATIO = 2.2505    RHO = -0.08449
RESIDUAL SUM =  0.60396E-13  RESIDUAL VARIANCE =  0.78190E-02
SUM OF ABSOLUTE ERRORS=   1.7759
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9844
RUNS TEST:   14 RUNS,   14 POS,    0 ZERO,   12 NEG  NORMAL STATISTIC =  0.0310
```

D.2 The Demand for Money

The demand for money was estimated using the SHAZAM econometric package. The output for the regression is duplicated below.

```
|_OLS LMBP LMBPL LTBILL LGDP LPOP LPOPL / DLAG LIST RESTRICT

REQUIRED MEMORY IS PAR=    5 CURRENT PAR=  226
OLS ESTIMATION
      19 OBSERVATIONS     DEPENDENT VARIABLE = LMBP
...NOTE..SAMPLE RANGE SET TO:    3,   21
|_RESTRICT LPOP = 1 - LGDP
|_RESTRICT LPOPL = - LMBPL
|_END

 R-SQUARE =  0.9048     R-SQUARE ADJUSTED =  0.8858
VARIANCE OF THE ESTIMATE =  0.96373E-02
STANDARD ERROR OF THE ESTIMATE =  0.98170E-01
MEAN OF DEPENDENT VARIABLE =   8.8152
LOG OF THE LIKELIHOOD FUNCTION =  19.3860

MODEL SELECTION TESTS - SEE JUDGE ET.AL.(1985, P.242)
 AKAIKE (1969) FINAL PREDICTION ERROR- FPE =   0.11666E-01
   (FPE ALSO KNOWN AS AMEMIYA PREDICTION CRITERION -PC)
 AKAIKE (1973) INFORMATION CRITERION- AIC =  -4.4575
 SCHWARZ(1978) CRITERION-SC =  -4.2586

                    ANALYSIS OF VARIANCE - FROM MEAN
                      SS          DF            MS                F
REGRESSION        1.3739          3.       0.45797             47.521
ERROR            0.14456         15.       0.96373E-02
TOTAL             1.5185         18.       0.84360E-01

                    ANALYSIS OF VARIANCE - FROM ZERO
                      SS          DF            MS                F
REGRESSION        1477.8          4.        369.46          38336.059
ERROR            0.14456         15.       0.96373E-02
TOTAL             1478.0         19.        77.788


VARIABLE     ESTIMATED    STANDARD    T-RATIO     PARTIAL STANDARDIZED ELASTICITY
  NAME      COEFFICIENT     ERROR      15 DF       CORR.  COEFFICIENT  AT MEANS

LMBPL      0.28218      0.19022       1.4834      0.3577  0.26662       0.28096
LTBILL    -0.42039E-01 0.33620E-01  -1.2504      -0.3072 -0.10810      0.12989E-01
LGDP        1.2795      0.45173       2.8324      0.5903   1.1760        1.6446
LPOP       -0.27951     0.45173      -0.61875     -0.1578 -0.23120      -0.89108E-01
LPOPL      -0.28218     0.19022      -1.4834      -0.3577 -0.22858      -0.88618E-01
CONSTANT   -6.7066       3.7803      -1.7741      -0.4165  0.00000E+00 -0.76080

DURBIN-WATSON = 1.7334    VON NEUMAN RATIO = 1.8297    RHO =  0.11052
RESIDUAL SUM =  0.19096E-12  RESIDUAL VARIANCE =  0.96373E-02
SUM OF ABSOLUTE ERRORS=   1.4538
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9092
RUNS TEST:   11 RUNS,   10 POSITIVE,    9 NEGATIVE, NORMAL STATISTIC =    0.2492
DURBINS H STATISTIC (ASYMPTOTIC NORMAL) =  0.86173
COEFFICIENT OF SKEWNESS =  -0.0440 WITH STANDARD DEVIATION OF 0.5238
COEFFICIENT OF EXCESS KURTOSIS =  -0.8675 WITH STANDARD DEVIATION OF 1.0143
     GOODNESS OF FIT TEST FOR NORMALITY OF RESIDUALS - 10 GROUPS
OBSERVED  0.0  0.0  2.0  4.0  3.0  5.0  3.0  2.0  0.0  0.0
EXPECTED  0.2  0.5  1.5  3.0  4.3  4.3  3.0  1.5  0.5  0.2
CHI-SQUARE =    2.5099 WITH  2 DEGREES OF FREEDOM
```

D.3 Demand System

A seemingly-unrelated-regression (SUR) system of two equations was estimated using ordinary-least-squares method. The output for the regression is duplicated below.

```
UNIT  6 IS NOW ASSIGNED TO: c:\stiff\gbmfd\data\aids.out
|_title equations NT and M, stone expenditure, trend
  equations NT and M, stone expenditure, trend
|_system 2 / restrict dn iter=100 piter=50 list conv=.000001
|_ols sn lpf lpm lpn lestone year
|_ols sm lpf lpm lpn lestone year
|_res lpn:2=lpm:1
|_res lpf:1+lpm:1+lpn:1=0
|_res lpf:2+lpm:2+lpn:2=0
|_end
DN OPTION IN EFFECT - DIVISOR IS N
IR OPTION IN EFFECT - ITERATIVE RESTRICTIONS

ITERATION    5 SIGMA INVERSE
   71464.
  -1898.3        8424.0
ITERATION    5 SIGMA
  0.14077E-04
  0.31722E-05  0.11942E-03

SYSTEM R-SQUARE =  0.9879 ... CHI-SQUARE =   119.22     WITH   7 D.F.
LOG OF LIKELIHOOD FUNCTION =   196.209
LIKELIHOOD RATIO TEST OF DIAGONAL COVARIANCE MATRIX =  0.71298     WITH   1 D.F.

 EQUATION  1 OF  2 EQUATIONS
DEPENDENT VARIABLE = SN                    27 OBSERVATIONS
 R-SQUARE =   0.9725

VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.14077E-04
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.37520E-02
SUM OF SQUARED ERRORS-SSE=  0.38009E-03
MEAN OF DEPENDENT VARIABLE =  0.17320
LOG OF THE LIKELIHOOD FUNCTION =  196.209

                              ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    --------   P-VALUE CORR. COEFFICIENT  AT MEANS
LPF       -0.24089E-01 0.8539E-02  -2.821     0.005-0.499    -0.6585     0.0294
LPM       -0.58820E-02 0.8747E-02 -0.6725     0.501-0.136    -0.1595     0.0064
LPN        0.29971E-01 0.8865E-02   3.381     0.001 0.568     0.8891    -0.0386
LESTONE   -0.10435     0.9520E-02  -10.96     0.000-0.913    -0.8997    -3.0270
YEAR      -0.62609E-03 0.2081E-03  -3.009     0.003-0.523    -0.2156    -7.1464
CONSTANT   1.9358      0.3719       5.206     0.000 0.728     0.0000    11.1762

DURBIN-WATSON = 1.8333     VON NEUMANN RATIO = 1.9039     RHO =  0.05311
RESIDUAL SUM = -0.72164E-15  RESIDUAL VARIANCE =  0.14077E-04
SUM OF ABSOLUTE ERRORS=  0.81873E-01
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9725
RUNS TEST:   14 RUNS,   14 POS,    0 ZERO,   13 NEG  NORMAL STATISTIC = -0.1893

 EQUATION  2 OF  2 EQUATIONS
DEPENDENT VARIABLE = SM                    27 OBSERVATIONS
 R-SQUARE =   0.9582

VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.11942E-03
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.10928E-01
SUM OF SQUARED ERRORS-SSE=  0.32244E-02
MEAN OF DEPENDENT VARIABLE =  0.66993
LOG OF THE LIKELIHOOD FUNCTION =  196.209
```

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	T-RATIO	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
LPF	-0.40820E-01	0.2299E-01	-1.775	0.076	-0.341	-0.4794	0.0129
LPM	0.46702E-01	0.2276E-01	2.052	0.040	0.386	0.5360	-0.0132
LPN	-0.58820E-02	0.8747E-02	-0.6725	0.501	-0.136	-0.0738	0.0020
LESTONE	0.18760	0.2628E-01	7.139	0.000	0.825	0.6845	1.4070
YEAR	0.21141E-02	0.6129E-03	3.449	0.001	0.576	0.3080	6.2388
CONSTANT	-4.4533	1.096	-4.063	0.000	-0.638	0.0000	-6.6474

DURBIN-WATSON = 1.4109 VON NEUMANN RATIO = 1.4651 RHO = 0.25985
RESIDUAL SUM = 0.18874E-14 RESIDUAL VARIANCE = 0.11942E-03
SUM OF ABSOLUTE ERRORS= 0.22377
R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.9582
RUNS TEST: 13 RUNS, 11 POS, 0 ZERO, 16 NEG NORMAL STATISTIC = -0.4221

D.4 Completing the Model

Estimates for three data series needed to be found in order to complete the model: GDP shocks, phi, and eta. The first data was estimated by taking deviations of actual GDP from trend GDP. The last two data series are parameters on the KCB function that models exchange market intervention. These paramters are not observeable, so other methods were used to calibrate the model.

The paramter that represents the degree of management is inferred from KCB statements and currency history from annual editions of World's Currency Yearbook. The degree of overvaluation permitted by the KCB was then set according to whether the value solved the model. In several years, the overvaluation parameter was unreasonably high or low, and the GDP shock was adjusted instead.

In the last three or four years of the simulation period, the GDP shocks became unreasonably large. The absorption elasticities were modelled as constant elasticities, and given the rapid decline in Kenya's terms-of-trade this assumption could no longer capture shifts of the autonomous portions of GDP components.

Appendix E: Baseline Data

	WORLD PRICES (USD)					REST-OF-WORLD ECONOMIC DATA		
						Real		Nominal
	Food	Importable	Export	Price	Terms of	Interest	Inflation	Interest
Year	Crops		Crops	Level	Trade	Rate	Rate	Rate
1964	70.6	62.6	102.3	97.3	81.5	6.00%		
1965	57.0	59.8	120.1	100.0	100.0	6.00%	2.69%	8.86%
1966	55.5	57.8	130.4	103.3	108.6	5.94%	3.27%	9.41%
1967	58.6	58.3	124.8	106.6	104.5	5.51%	3.16%	8.85%
1968	65.8	60.8	109.7	111.6	88.9	5.13%	4.57%	9.93%
1969	65.6	63.9	104.5	117.3	80.9	6.05%	4.94%	11.29%
1970	72.8	67.1	100.7	123.6	74.2	5.52%	5.24%	11.05%
1971	68.3	66.2	116.3	130.2	87.8	3.53%	5.24%	8.95%
1972	71.8	72.3	125.7	136.5	86.9	3.75%	4.73%	8.66%
1973	64.7	66.0	149.5	145.2	92.5	5.23%	6.13%	11.68%
1974	88.9	103.0	174.8	158.1	88.3	3.76%	8.55%	12.63%
1975	101.5	113.7	166.1	173.1	77.8	1.44%	9.03%	10.60%
1976	111.8	125.8	222.6	184.1	111.5	3.30%	6.14%	9.64%
1977	118.1	140.8	318.1	196.7	148.5	3.10%	6.63%	9.94%
1978	131.9	145.4	291.1	212.3	115.5	3.99%	7.64%	11.94%
1979	130.3	153.9	315.4	230.9	110.1	5.89%	8.40%	14.79%
1980	140.0	154.6	314.1	252.5	108.9	6.84%	8.94%	16.39%
1981	161.8	156.0	270.9	277.7	104.4	8.54%	9.53%	18.88%
1982	161.0	171.5	246.6	295.0	99.3	8.80%	6.03%	15.37%
1983	184.2	203.8	237.2	307.0	106.0	8.85%	3.97%	13.18%
1984	158.7	224.3	272.2	320.6	126.3	9.39%	4.34%	14.14%
1985	266.5	291.6	227.6	332.2	102.6	8.17%	3.56%	12.03%
1986	337.8	326.8	257.2	341.2	107.5	7.60%	2.66%	10.47%
1987	325.4	257.5	237.3	352.2	98.9	6.97%	3.16%	10.35%
1988	346.1	300.2	238.6	365.8	90.6	7.15%	3.79%	11.22%
1989	419.7	381.9	217.1	381.7	86.3	8.07%	4.27%	12.68%
1990	453.2	501.3	206.9	397.3	78.1	7.75%	4.01%	12.07%
1991	462.3	511.4	211.0	412.0	75.0	6.12%	3.61%	9.95%

Year	Foreign Aid (% gdp)	DOMESTIC TARIFFS		EXPORT TAXES		
		Food Crops	Importable	Food Crops	Importabl	Export Crops
1964	3.56%	6.07%	16.89%	0.48%	0.57%	2.26%
1965	1.62%	5.08%	14.86%	0.57%	0.87%	2.88%
1966	0.79%	4.64%	16.38%	0.50%	0.73%	2.87%
1967	0.24%	2.42%	14.18%	0.49%	0.59%	2.93%
1968	1.88%	2.37%	14.97%	0.44%	0.67%	2.69%
1969	1.60%	2.13%	15.12%	0.48%	0.70%	3.05%
1970	1.72%	3.18%	16.33%	0.57%	0.71%	3.63%
1971	3.37%	3.84%	17.30%	0.50%	0.96%	3.81%
1972	1.84%	2.58%	12.96%	0.51%	0.46%	3.86%
1973	1.27%	3.05%	14.83%	0.89%	0.48%	5.04%
1974	1.14%	3.17%	18.56%	0.76%	1.25%	5.41%
1975	1.37%	2.16%	17.83%	0.65%	1.72%	6.22%
1976	0.38%	3.14%	20.21%	0.82%	1.08%	6.22%
1977	1.51%	3.21%	21.11%	0.88%	0.17%	6.58%
1978	1.79%	3.88%	22.56%	0.75%	0.17%	7.05%
1979	1.47%	3.23%	18.08%	1.07%	-0.04%	8.24%
1980	2.21%	6.48%	23.03%	0.98%	0.96%	8.27%
1981	3.40%	3.56%	21.35%	0.94%	1.01%	8.40%
1982	2.13%	3.71%	17.22%	0.58%	0.56%	8.10%
1983	3.10%	4.17%	14.89%	0.96%	0.20%	8.58%
1984	2.95%	8.77%	16.14%	1.06%	-0.26%	9.05%
1985	3.40%	4.49%	12.94%	0.68%	0.49%	9.83%
1986	2.93%	4.41%	14.47%	0.95%	0.44%	9.96%
1987	2.84%	2.97%	16.21%	0.93%	0.10%	10.56%
1988	4.33%	2.88%	16.50%	0.89%	0.31%	10.39%
1989	4.99%	3.03%	16.10%	0.52%	0.87%	9.86%
1990	4.99%	4.62%	14.49%	1.06%	1.23%	8.85%
1991	4.99%	4.62%	14.49%	1.06%	1.23%	8.85%

Year	EXCHANGE RATES: Official Rate	EXCHANGE RATES: Parallel Market Rate	Trade Bias	Real Stock of Money	Inflation Rate	Rate of Growth of Money	Nominal Interest Rate	Real Interest Rate
1964	1.000	1.000	1.54	45.77		25.00%	23.22%	23.22%
1965	1.000	1.365	1.52	44.39	0.75%	25.00%	31.32%	30.34%
1966	1.000	1.393	1.56	40.70	8.08%	25.00%	31.28%	21.46%
1967	1.000	1.447	1.53	37.29	4.63%	27.35%	28.43%	22.75%
1968	1.000	1.653	1.50	38.31	-2.27%	25.80%	23.34%	26.20%
1969	1.000	2.461	1.49	43.55	-5.17%	42.80%	18.43%	24.89%
1970	1.000	2.404	1.47	50.85	-1.54%	11.33%	20.28%	22.16%
1971	1.000	1.649	1.47	57.44	-0.85%	-8.41%	18.99%	20.01%
1972	1.000	1.745	1.48	63.89	7.29%	10.59%	9.95%	2.48%
1973	1.000	2.316	1.74	68.48	7.30%	10.36%	13.14%	5.44%
1974	0.971	1.836	1.40	71.19	18.63%	28.24%	12.96%	-4.78%
1975	1.204	1.826	1.40	70.96	6.71%	-9.84%	15.02%	7.79%
1976	2.250	1.770	1.33	80.34	24.92%	24.05%	9.05%	-12.70%
1977	1.078	1.108	1.26	75.54	19.76%	61.57%	14.05%	-4.76%
1978	0.768	1.518	1.33	75.47	-4.48%	7.21%	23.28%	29.06%
1979	0.719	1.917	1.38	76.97	3.50%	24.78%	18.99%	14.97%
1980	1.012	1.922	1.37	78.20	1.48%	2.40%	22.10%	20.33%
1981	2.069	2.081	1.46	88.83	19.28%	4.14%	20.83%	1.30%
1982	2.520	2.479	1.57	97.33	24.40%	25.67%	16.88%	-6.04%
1983	2.848	1.940	1.46	119.67	20.01%	-2.21%	21.48%	1.23%
1984	2.492	1.580	1.42	132.97	9.62%	11.40%	16.00%	5.82%
1985	2.774	1.195	1.26	151.34	24.62%	15.12%	16.15%	-6.79%
1986	2.207	0.963	1.18	133.01	12.81%	39.62%	18.54%	5.08%
1987	2.445	1.836	1.45	129.38	3.45%	19.35%	21.93%	17.87%
1988	2.527	1.506	1.48	141.12	16.20%	2.06%	30.41%	12.23%
1989	2.976	1.138	1.31	155.02	21.12%	16.95%	20.98%	-0.12%
1990	3.286	1.038	1.21	151.38	21.01%	21.83%	22.96%	1.61%
1991	3.964	1.357	1.30	159.48	25.06%	15.67%	24.39%	-0.53%

Year	Price Level	Consumer Price Index	Non-Traded	Food Crops	Importable	Export Crops
1964	100.00	100.00	100.00	100.00	100.00	100.00
1965	100.75	101.20	128.44	80.02	91.46	116.77
1966	109.23	113.04	161.63	79.11	91.55	126.75
1967	114.41	125.36	191.74	81.81	90.58	121.23
1968	111.84	126.76	178.55	90.17	93.42	106.78
1969	106.20	115.66	150.94	88.95	97.51	101.36
1970	104.58	112.35	130.47	97.14	100.84	97.14
1971	103.69	104.91	121.97	90.57	98.70	112.07
1972	111.54	111.74	129.38	96.84	107.38	121.04
1973	119.99	117.45	139.92	98.91	112.87	139.89
1974	144.56	136.61	170.88	109.24	144.66	165.84
1975	154.59	148.96	175.08	126.84	162.17	160.72
1976	198.34	180.08	216.01	150.20	196.45	245.43
1977	241.67	215.05	315.59	145.88	205.60	345.81
1978	231.08	216.96	294.17	159.99	209.21	294.20
1979	239.32	222.60	311.79	158.59	216.75	304.91
1980	242.88	232.98	320.98	169.12	215.83	301.40
1981	294.52	294.23	343.89	252.57	285.03	316.55
1982	375.91	376.29	425.49	333.29	401.26	348.75
1983	459.19	433.85	434.18	432.05	531.35	407.12
1984	505.54	441.18	489.00	395.32	604.54	503.64
1985	646.68	611.75	552.60	671.36	795.35	476.61
1986	735.04	768.21	758.63	776.93	828.36	531.23
1987	760.81	829.22	745.10	917.60	826.34	494.50
1988	894.57	913.18	766.31	1075.93	1062.98	536.95
1989	1104.98	1103.15	887.24	1350.53	1379.77	569.21
1990	1363.30	1301.46	1087.32	1533.80	1853.55	609.75
1991	1751.49	1600.52	1239.54	2019.96	2441.07	746.60

GDP ACCOUNTS

Year	GDP at Market Prices	Indirect Taxes	Consumption	Government Consumption	Investment		Net Exports
					Private	Government	
1964	2477.4						
1965	2407.4	232.7	1665.9	185.2	636.2	80.7	-160.6
1966	2271.2	297.8	1925.6	174.7	531.5	79.5	-440.1
1967	2155.9	317.5	2056.2	174.0	506.2	79.5	-660.0
1968	2230.4	307.8	2152.7	174.7	482.7	75.0	-654.8
1969	2432.2	302.8	2240.1	181.3	470.7	75.8	-535.7
1970	2677.4	287.2	2300.8	186.8	465.8	73.9	-349.9
1971	2840.5	289.1	2260.3	195.1	514.9	74.0	-203.8
1972	2942.1	275.0	2273.3	205.7	544.9	77.3	-159.0
1973	3062.3	385.4	2369.7	218.5	556.3	89.2	-171.5
1974	3111.4	316.1	2539.1	210.2	510.6	83.0	-231.6
1975	3088.2	279.2	2281.7	219.4	611.2	68.2	-92.3
1976	3349.2	273.5	2290.1	250.8	703.4	93.3	11.6
1977	3150.5	199.8	2222.5	285.8	859.5	123.0	-340.3
1978	3243.9	246.9	2232.8	310.9	897.9	133.8	-331.5
1979	3274.7	284.2	2365.8	327.5	862.4	148.6	-429.7
1980	3318.8	307.7	2511.5	336.7	825.5	160.8	-515.8
1981	3647.1	368.7	2603.5	354.4	819.3	176.2	-306.2
1982	3784.2	403.3	2762.0	354.7	768.8	178.6	-279.9
1983	4396.2	352.9	2938.7	351.1	728.2	184.5	193.6
1984	4515.1	387.0	2899.2	377.7	809.5	216.2	212.4
1985	4882.2	303.4	2849.6	392.0	833.4	207.9	599.4
1986	4306.2	241.8	2705.7	421.3	931.3	217.8	30.2
1987	4358.4	283.4	2574.5	449.0	1011.5	217.9	105.6
1988	4750.6	297.7	2822.8	424.7	871.1	199.4	432.5
1989	4956.2	313.0	2934.5	420.1	812.2	198.4	591.0
1990	4775.9	326.2	2755.9	441.8	855.5	199.6	523.1
1991	5008.7	298.3	2518.5	463.5	924.9	193.4	908.5

	PRODUCTION							
	Supply by Sector				Output Shares			
Year	Non-Traded	Food Crops	Importable	Export Crops	Non-Traded	Food Crops	Importable	Export Crops
1965	324.4	453.0	541.3	367.4	24.5%	21.3%	29.1%	25.2%
1966	322.2	441.1	530.6	361.3	28.7%	19.2%	26.8%	25.3%
1967	307.7	415.4	500.4	340.9	32.8%	18.9%	25.2%	23.0%
1968	329.8	444.8	533.1	358.3	31.5%	21.4%	26.6%	20.4%
1969	372.0	502.9	602.8	400.5	28.0%	22.3%	29.4%	20.3%
1970	419.1	573.7	686.4	452.3	24.5%	24.9%	31.0%	19.7%
1971	434.7	606.3	724.1	482.5	22.7%	23.5%	30.6%	23.2%
1972	442.7	625.9	746.9	501.2	22.1%	23.4%	31.0%	23.4%
1973	457.8	651.5	778.5	526.2	22.1%	22.2%	30.3%	25.4%
1974	476.5	674.2	812.5	550.9	22.4%	20.2%	32.3%	25.1%
1975	453.9	646.6	778.1	527.1	21.3%	22.0%	33.9%	22.7%
1976	475.6	684.0	827.4	563.4	20.3%	20.3%	32.1%	27.3%
1977	413.7	562.1	706.4	480.4	24.9%	15.7%	27.7%	31.7%
1978	424.4	569.2	719.2	492.2	24.4%	17.8%	29.4%	28.3%
1979	437.6	573.8	736.6	507.1	25.2%	16.8%	29.5%	28.5%
1980	452.8	587.7	757.4	525.2	25.7%	17.5%	28.9%	27.9%
1981	509.2	676.9	859.8	599.7	22.4%	21.9%	31.4%	24.3%
1982	541.9	730.9	920.2	639.3	21.6%	22.8%	34.6%	20.9%
1983	645.0	911.0	1135.3	792.6	17.5%	24.6%	37.7%	20.2%
1984	635.3	911.8	1136.6	805.6	17.6%	20.4%	39.0%	23.0%
1985	683.6	1019.8	1261.8	876.6	15.2%	27.6%	40.4%	16.8%
1986	578.6	836.5	1039.7	697.6	18.9%	28.0%	37.1%	16.0%
1987	584.2	824.7	1040.3	665.2	18.3%	31.8%	36.1%	13.8%
1988	681.2	974.5	1235.1	760.9	15.9%	31.9%	39.9%	12.4%
1989	731.3	1057.6	1341.2	759.1	14.9%	32.8%	42.4%	9.9%
1990	707.5	1021.2	1272.8	619.9	15.2%	30.9%	46.5%	7.5%
1991	729.4	1089.3	1341.1	583.7	13.3%	32.3%	48.0%	6.4%

	CONSUMPTION					
	Demand by Sector			Expenditure Shares		
Year	Non-Traded	Food Crops	Importable	Non-Traded	Food Crops	Importable
1965	324.4	496.5	1149.2	22.3%	21.3%	56.4%
1966	322.2	589.1	1428.0	22.7%	20.3%	57.0%
1967	307.7	628.6	1597.7	23.1%	20.2%	56.7%
1968	329.8	600.4	1576.3	22.6%	20.8%	56.6%
1969	372.0	596.9	1516.9	21.8%	20.6%	57.5%
1970	419.1	569.9	1488.7	21.0%	21.3%	57.7%
1971	434.7	587.6	1503.3	20.8%	20.9%	58.3%
1972	442.7	593.3	1506.4	20.7%	20.8%	58.5%
1973	457.8	636.7	1625.9	20.6%	20.3%	59.1%
1974	476.5	694.0	1660.5	20.5%	19.1%	60.4%
1975	453.9	607.9	1418.7	20.6%	19.9%	59.5%
1976	475.6	653.4	1542.9	20.4%	19.5%	60.1%
1977	413.7	754.5	1777.9	21.5%	18.2%	60.3%
1978	424.4	698.1	1678.9	21.2%	19.0%	59.8%
1979	437.6	748.4	1796.6	21.2%	18.4%	60.4%
1980	452.8	764.3	1932.8	21.0%	18.7%	60.3%
1981	509.2	689.8	1830.8	20.1%	20.0%	59.9%
1982	541.9	692.6	1769.8	19.7%	19.7%	60.6%
1983	645.0	691.6	1753.7	18.5%	19.8%	61.7%
1984	635.3	758.9	1730.1	18.8%	18.1%	63.1%
1985	683.6	639.2	1621.1	18.0%	20.5%	61.5%
1986	578.6	621.0	1662.3	19.1%	21.0%	59.9%
1987	584.2	561.7	1633.2	18.9%	22.4%	58.7%
1988	681.2	589.6	1645.1	18.0%	21.8%	60.2%
1989	731.3	595.4	1633.5	17.5%	21.7%	60.8%
1990	707.5	592.2	1446.9	17.6%	20.8%	61.5%
1991	729.4	550.2	1314.0	17.3%	21.3%	61.4%

Appendix F: Floating Exchange Rate Policy Dat

Year	EXCHANGE RATES		Trade Bias	Real Stock of Money	Inflation Rate	Rate of Growth of Money	Nominal Interest Rate	Real Interest Rate
	Official Rate	Parallel Market Rate						
1964	1.000	1.000	1.54	44.88		25.00%	32.50%	32.50%
1965	1.187	1.000	1.13	44.63	-3.76%	25.00%	32.50%	37.68%
1966	1.376	1.000	1.14	44.27	18.43%	25.00%	32.43%	11.82%
1967	1.626	1.000	1.11	42.90	19.03%	27.35%	31.89%	10.80%
1968	2.371	1.000	1.11	45.85	35.31%	25.80%	32.65%	-1.97%
1969	4.385	1.000	1.12	53.51	57.31%	42.80%	33.61%	-15.06%
1970	5.624	1.000	1.13	64.11	26.22%	11.33%	41.81%	12.36%
1971	5.286	1.000	1.14	75.34	-5.27%	-8.41%	27.20%	34.28%
1972	5.382	1.000	1.12	86.93	7.36%	10.59%	11.25%	3.62%
1973	6.020	1.000	1.14	96.45	10.87%	10.36%	14.60%	3.37%
1974	6.108	1.000	1.17	107.07	32.89%	28.24%	13.75%	-14.40%
1975	5.238	1.000	1.17	105.31	-9.60%	-9.84%	20.64%	33.46%
1976	5.583	1.000	1.19	120.97	23.01%	24.05%	8.00%	-12.20%
1977	7.041	1.000	1.21	111.11	45.93%	61.57%	17.85%	-19.24%
1978	7.904	1.000	1.22	105.97	12.75%	7.21%	43.44%	27.23%
1979	9.514	1.000	1.21	106.88	22.05%	24.78%	29.80%	6.35%
1980	9.327	1.000	1.25	109.02	2.07%	2.40%	32.14%	29.45%
1981	11.089	1.000	1.22	124.48	13.15%	4.14%	22.69%	8.43%
1982	14.821	1.000	1.20	138.81	28.36%	25.67%	18.15%	-7.95%
1983	16.655	1.000	1.19	175.34	18.43%	-2.21%	27.50%	7.66%
1984	16.625	1.000	1.24	197.68	5.99%	11.40%	17.55%	10.91%
1985	17.650	1.000	1.19	223.60	26.16%	15.12%	18.38%	-6.17%
1986	18.180	1.000	1.20	192.10	22.23%	39.62%	20.81%	-1.17%
1987	26.262	1.000	1.21	177.67	22.81%	19.35%	34.72%	9.70%
1988	29.329	1.000	1.21	200.39	18.20%	2.06%	31.42%	11.19%
1989	31.642	1.000	1.20	226.07	24.77%	16.95%	21.42%	-2.69%
1990	33.162	1.000	1.19	218.35	21.97%	21.83%	23.54%	1.29%
1991	41.711	1.000	1.19	224.02	23.87%	15.67%	25.47%	1.30%

Year	Price Level	Consumer Price Index	Non-Traded	Food Crops	Importable	Export Crops
1964	100.00	100.00	100.00	100.00	100.00	100.00
1965	96.31	95.14	128.40	70.67	80.77	138.60
1966	115.80	114.41	164.86	79.44	91.93	174.37
1967	140.08	145.12	216.56	97.18	107.61	197.16
1968	199.40	210.78	280.52	158.96	164.69	253.17
1969	353.68	354.29	430.99	292.41	320.56	444.50
1970	459.70	451.82	487.34	419.97	435.93	546.38
1971	436.08	405.12	441.19	372.86	406.32	592.40
1972	469.41	430.39	470.55	394.52	437.44	651.38
1973	523.29	455.00	521.53	398.08	454.27	856.92
1974	727.05	619.78	689.83	556.09	736.38	1013.01
1975	660.47	585.82	635.47	539.46	689.75	818.92
1976	831.33	706.28	780.21	638.59	835.25	1169.77
1977	1315.95	1122.70	1478.94	850.64	1198.90	2101.18
1978	1494.84	1336.01	1661.24	1075.12	1405.86	2148.93
1979	1863.55	1639.23	2121.16	1265.81	1729.98	2771.96
1980	1902.61	1730.35	2177.52	1376.73	1756.98	2706.24
1981	2169.90	2027.74	2237.95	1841.25	2077.85	2771.46
1982	2881.32	2649.90	2854.54	2460.38	2962.15	3380.37
1983	3464.40	3003.31	2830.71	3164.82	3892.22	3638.32
1984	3678.11	2992.54	3125.26	2839.49	4342.33	4149.31
1985	4777.94	4235.24	3627.00	4882.33	5784.03	3656.70
1986	5967.68	5880.12	5415.09	6351.26	6771.69	4251.50
1987	7496.95	7684.71	6722.89	8717.86	7850.83	5637.69
1988	8993.42	8499.38	6878.19	10351.36	10226.72	6338.50
1989	11521.48	10561.98	8023.45	13612.52	13907.30	6253.71
1990	14351.86	12587.50	9976.80	15559.52	18803.24	6303.09
1991	18220.84	15482.32	11706.88	19961.94	24123.45	8086.48

GDP ACCOUNTS

Year	GDP at Market Prices	Indirect Taxes	Consumption	Government Consumption	Investment		Net Exports
					Private	Government	
1964	2477.4						
1965	2430.8	101.6	1665.9	185.2	636.2	80.7	-137.1
1966	2420.9	97.4	1715.6	199.0	664.3	87.7	-245.7
1967	2365.4	75.7	1759.1	210.1	686.7	90.7	-381.3
1968	2510.9	90.4	1822.3	216.4	675.2	86.8	-289.9
1969	2795.2	116.3	1908.1	226.0	658.9	87.9	-85.8
1970	3134.8	160.2	1975.4	233.7	650.9	85.9	188.9
1971	3370.1	185.5	1970.5	242.8	708.0	85.7	363.1
1972	3533.8	153.6	2006.8	254.9	740.8	89.3	442.0
1973	3745.7	187.6	2082.1	274.8	772.3	104.4	512.0
1974	3965.9	258.8	2112.3	283.7	797.2	102.6	670.0
1975	3878.1	251.7	2059.0	275.4	827.2	79.1	637.5
1976	4205.3	286.5	2122.4	307.3	917.0	107.1	751.6
1977	3919.6	231.0	2138.1	338.2	1053.7	137.7	251.9
1978	3964.0	253.6	2240.6	352.5	1023.7	145.4	201.8
1979	3983.5	231.1	2365.6	372.6	994.1	162.8	88.4
1980	4048.4	293.5	2463.8	391.7	988.7	179.3	24.9
1981	4421.7	309.2	2575.3	410.3	969.5	195.4	271.2
1982	4641.7	292.6	2642.7	425.7	969.6	204.2	399.5
1983	5514.3	359.4	2682.4	444.6	1003.1	219.7	1164.6
1984	5668.1	424.1	2694.9	473.5	1085.3	254.2	1160.2
1985	6089.5	392.3	2734.2	478.0	1062.0	239.4	1575.9
1986	5284.1	327.9	2719.8	491.5	1098.6	242.8	731.4
1987	5228.7	314.0	2715.2	499.4	1102.3	234.9	676.8
1988	5825.7	388.9	2724.6	507.0	1083.0	229.0	1282.2
1989	6156.5	427.7	2728.6	520.0	1066.6	233.2	1608.0
1990	5853.0	425.9	2688.7	527.6	1046.7	227.0	1363.0
1991	6033.2	447.9	2569.6	531.2	1055.8	213.7	1662.9

PRODUCTION

	Supply by Sector				Output Shares			
Year	Non-Traded	Food Crops	Importable	Export Crops	Non-Traded	Food Crops	Importable	Export Crops
1964								
1965	314.4	497.1	594.0	300.0	24.5%	21.3%	29.1%	25.2%
1966	308.2	481.2	578.0	293.0	26.3%	19.8%	27.5%	26.4%
1967	295.9	455.7	548.6	279.2	28.8%	19.9%	26.5%	24.7%
1968	326.3	502.9	604.9	306.7	26.2%	22.9%	28.6%	22.3%
1969	377.8	590.9	712.5	361.0	22.5%	23.8%	31.5%	22.2%
1970	431.1	696.2	841.3	426.7	19.1%	26.5%	33.3%	21.1%
1971	448.5	751.6	909.0	465.9	17.6%	24.9%	32.9%	24.6%
1972	460.0	790.3	957.3	494.6	17.1%	24.6%	33.0%	25.4%
1973	480.2	839.2	1020.7	528.8	16.7%	22.3%	30.9%	30.2%
1974	503.0	896.9	1092.5	571.5	15.6%	22.4%	36.1%	26.0%
1975	485.9	869.3	1058.1	555.9	15.7%	23.9%	37.2%	23.2%
1976	513.0	929.3	1135.7	600.5	15.1%	22.4%	35.9%	26.6%
1977	457.7	778.6	976.0	514.4	18.9%	18.4%	32.6%	30.1%
1978	477.6	789.9	997.0	527.6	19.0%	20.3%	33.5%	27.1%
1979	491.3	787.8	1008.2	535.4	19.8%	18.9%	33.1%	28.2%
1980	505.5	798.1	1025.2	546.8	20.1%	20.0%	32.9%	27.0%
1981	563.8	908.2	1159.5	621.9	17.9%	23.7%	34.1%	24.4%
1982	592.8	972.5	1235.2	665.2	16.9%	23.9%	36.6%	22.5%
1983	691.1	1224.2	1539.7	836.7	13.2%	26.1%	40.3%	20.5%
1984	681.2	1239.8	1548.7	854.9	13.4%	22.1%	42.2%	22.3%
1985	740.8	1394.2	1734.9	915.8	11.7%	29.8%	43.9%	14.6%
1986	650.3	1145.8	1439.0	702.3	15.0%	30.9%	41.4%	12.7%
1987	656.6	1115.4	1429.3	676.7	15.1%	33.3%	38.5%	13.1%
1988	739.2	1299.3	1673.5	780.2	12.5%	33.1%	42.2%	12.2%
1989	792.3	1424.9	1835.3	748.1	11.4%	34.7%	45.6%	8.4%
1990	787.0	1390.7	1753.0	518.4	11.9%	32.9%	50.2%	5.0%
1991	808.91	1475.1	1834.22	449.5	10.9%	33.9%	51.0%	4.2%

	CONSUMPTION					
	Demand by Sector			Expenditure Shares		
Year	Non-Traded	Food Crops	Importable	Non-Traded	Food Crops	Importable
1964	314.4	528.3	1245.0	22.6%	20.9%	56.4%
1965	308.2	570.7	1365.9	22.9%	20.4%	56.6%
1966	295.9	582.7	1441.8	23.2%	20.5%	56.2%
1967	326.3	544.9	1386.7	22.5%	21.3%	56.2%
1968	377.8	545.8	1348.9	21.6%	21.1%	57.3%
1969	431.1	525.8	1341.0	20.7%	21.7%	57.6%
1970	448.5	550.9	1382.8	20.5%	21.3%	58.2%
1971	460.0	566.9	1421.0	20.4%	21.1%	58.5%
1972	480.2	631.2	1610.7	20.3%	20.4%	59.3%
1973	503.0	619.1	1427.0	19.9%	19.8%	60.3%
1974	485.9	579.4	1334.4	20.0%	20.3%	59.7%
1975	513.0	625.8	1460.6	19.8%	19.8%	60.4%
1976	457.7	711.6	1648.5	20.8%	18.6%	60.7%
1977	477.6	691.1	1664.5	20.5%	19.2%	60.4%
1978	491.3	747.0	1800.6	20.4%	18.5%	61.0%
1979	505.5	746.6	1880.8	20.3%	18.9%	60.8%
1980	563.8	703.3	1887.3	19.5%	20.0%	60.5%
1981	592.8	707.1	1826.1	19.1%	19.7%	61.2%
1982	691.1	682.2	1726.0	18.1%	19.9%	62.0%
1983	681.2	749.3	1703.5	18.3%	18.3%	63.5%
1984	740.8	644.8	1644.7	17.5%	20.5%	62.0%
1985	650.3	633.7	1715.7	18.4%	21.0%	60.6%
1986	656.6	610.3	1829.9	18.3%	22.1%	59.6%
1987	739.2	610.3	1726.9	17.5%	21.7%	60.8%
1988	792.3	598.2	1648.7	17.0%	21.8%	61.3%
1989	787.0	615.3	1528.1	17.0%	20.7%	62.2%
1990	808.9	593.6	1458.3	16.8%	21.0%	62.3%
1991						