

**Macmod, a macroeconomic
model for the Tanzanian
economy**

Hildegunn Kyvik Nordås
with Arild Angelsen

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Summary

This report outlines the structure of a macroeconomic model for the Tanzanian economy. It consists of a core IS-LM/ Mundell-Fleming model, an SS-DD framework for estimating the consumer price inflation and other price indices, and finally a sectoral supply block. The latter is at an early stage of development, due to inadequate data. The report starts with a discussion of some key features of the Tanzanian economy, emphasizing structural weaknesses and recent gains in terms of stabilizing the economy. It continues with the presentation of the model. The workings of the model are demonstrated by a set of scenarios where various policy measures in the face of an exogenous shock are explored. Finally the report presents a study of the agricultural sector.

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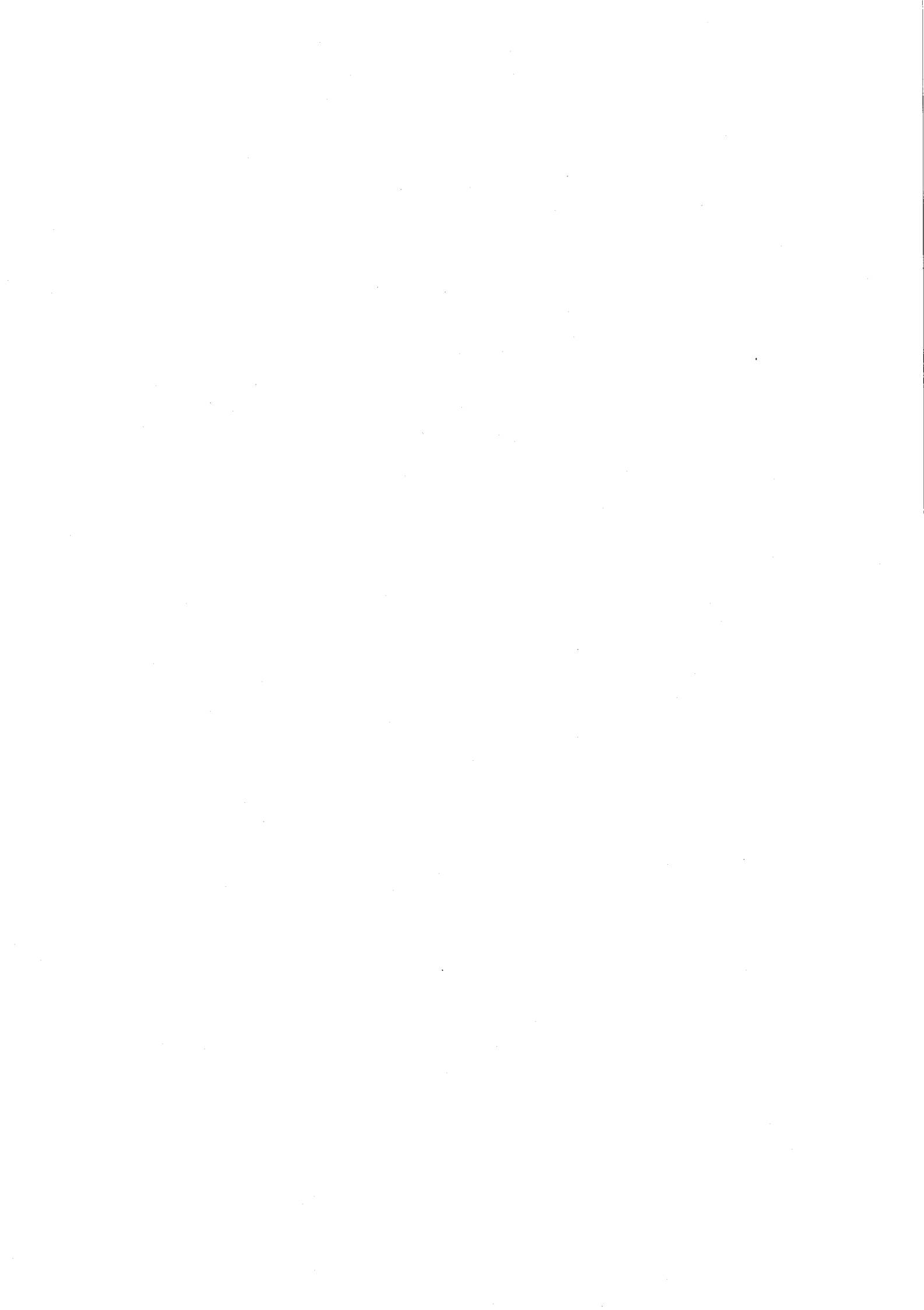
Indexing terms

Macroeconomic model

Tanzania

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1 Introduction

Macmod was first introduced in 1992/93 as an analysis tool for the development of the economic frame for the Rolling Plan and Forward Budget (RPFb). The model is therefore specially designed for analyzing the impact of fiscal and monetary policy on the economy. This document presents the third version of Macmod, but we start with a brief description of the two previous versions.

The first version focused on the supply side and was mainly an accounting framework without any behavioral equations. The development of the first version involved computerization of some of the sectors in the National Accounts and, thus, computing value added from data on quantities, prices and intermediate inputs. The model had 9 sectors corresponding to the sector composition of the National Accounts. Agriculture and manufacturing was further disaggregated into subsectors. Indirect taxes were added to GDP at factor cost estimated from the supply side. The resulting GDP at market prices was then distributed on expenditure categories. International trade was determined by applying fixed shares of GDP for intermediate imports, a fixed share of investment for investment goods and a fixed share of consumption for consumer goods. Traditional exports were estimated as fixed shares of output of the traditional export crops and mining, while the "non-traditional" exports were assumed to grow in line with world demand. Private consumption was the residual which balanced supply and demand (private consumption was also estimated residually in the National Accounts, in spite of the fact that it constituted close to 100 percent of GDP on average). Government revenue was estimated from effective tax rates and the tax base; GDP for income taxes, other taxes and non-tax revenue, sectoral output for local indirect taxes and imports for import taxes.

The second version put a stronger emphasis on the demand side. It was built on the Keynesian IS-LM/SS-DD framework. The core structure was an IS-LM model for an open economy with fixed exchange rates. The SS equation represented a marginal cost function and supply and demand were balanced by applying a mark-up rate on marginal costs.

The present, third version extends the second version by adding a balance of payment equation and thus endogenizing the exchange rate. This extension was motivated by the need to adopt the model to the new economic policy environment following recent liberalization measures. Of particular significance is liberalization of internal and external trade, a floating exchange rate regime, liberalization on the current account of the balance of payment and even some steps towards liberalization on the capital account of the balance of payments. These features are captured by extending the IS-LM model with a Mundell-Fleming type balance of payments (BP) framework.

The present version of Macmod contains a core model, the IS-LM-BP framework, which is a fixed price model of flexible exchange rates and an intermediate degree of capital mobility. In addition, the model contains an SS-DD block which determines the inflation rate and other price indices. The SS-DD block thus provides a framework for analyzing stabilization policies. Finally, the model contains a supply side block where real GDP at factor cost is determined by the sum of sectoral output. This block is provided in order to incorporate the most important structural features of

the economy. Moreover, it is possible to undertake broad industrial policy analysis within this framework. However, data on interlinkages among sectors are not yet available, a fact that limits the scope for industrial policy analysis and also the possibility to analyze how changes in demand affect each sector.

This third version of Macmod incorporates new information from the revised National Accounts and the 1991/92 household budget survey. In order to improve user friendliness, the model has been extended to include a base-line scenario and an alternative scenario such that a benchmark can be maintained and the impact of shocks or changes in policy can be evaluated against this benchmark.

Macmod is developed in Excel spreadsheets. This, together with the modeling framework impose some constraints on the model. First, we are confined to linear equations. Second, the core model must be entered into the spreadsheets in a reduced form because Excel can not solve simultaneous equations directly. However, the widespread use of Excel and the ease at which it can be incorporated into the planning system by far outweighs these limitations. Besides, there is for the time being nothing in the data suggesting that non-linear equations are better at capturing economic development than linear equations, particularly when we are dealing with a relatively short time horizon. The limitations of the software have therefore not been a binding constraint so far.

The rest of this paper is organized as follows: Chapter 2 provides a brief overview of macro-economic developments over the past decade. Chapter 3 presents the modeling framework. It starts by discussing the choice of theoretical framework on which Macmod is built. The discussion concludes that the Keynesian IS-LM framework is the most appropriate. The discussion is followed by a presentation of the basic structure of the model. Chapters 4-6 present the equations of the core model, the SS-DD extension and the supply side block respectively. Chapter 7 gives an example of how Macmod can be used for policy analysis. It presents the graphs and tables of a base line "business as usual" scenario compared to a severe drought scenario. Finally, the manual contains technical annexes.

2 The economy

The economy is dominated by agriculture and the level of income per capita is among the lowest in the world. Moreover, GDP per capita has been rather stagnant over the past decade. Figure 2.1 shows development in GDP at constant 1992 prices and its sectoral composition over the past decade. Clearly, little structural change has taken place during this decade, and agriculture has actually increased its share of total GDP.

Figure 2.1

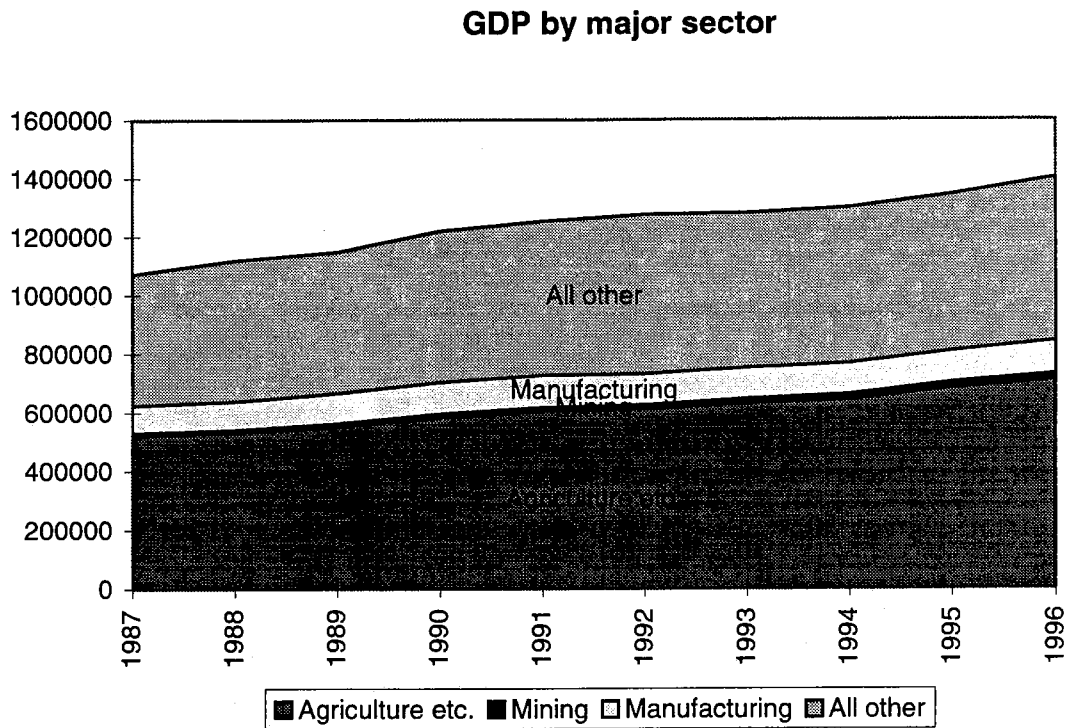


Figure 2.2

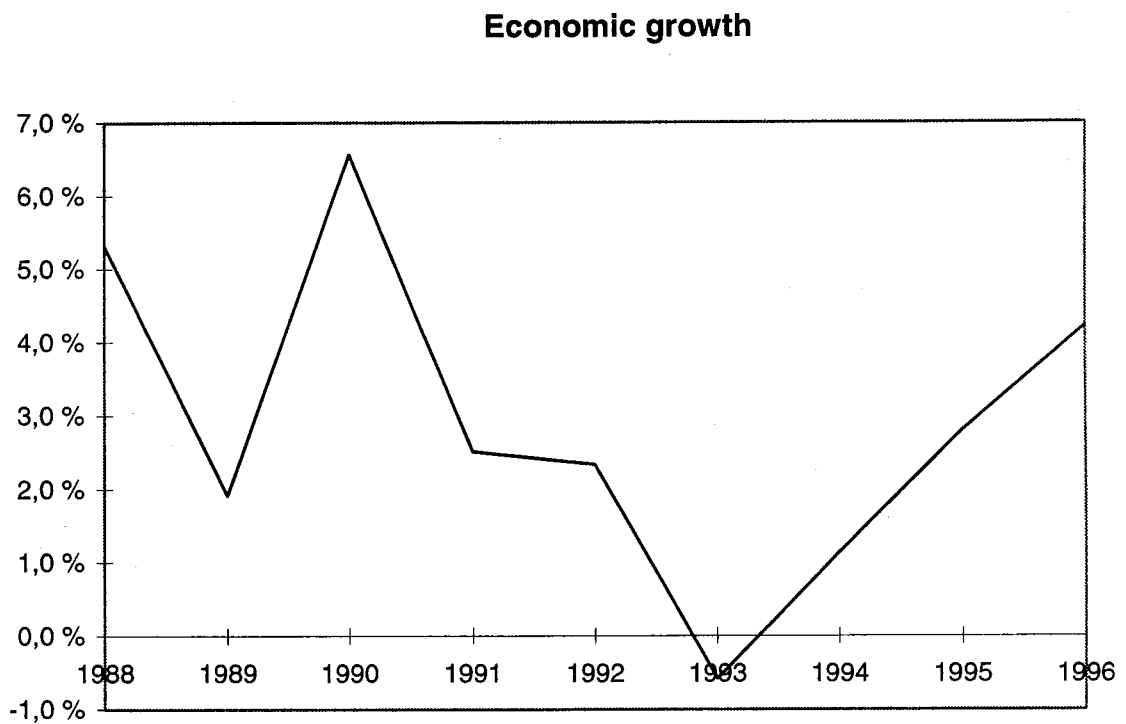


Figure 2.2 shows real GDP growth. It fluctuates widely due to the dominant position of rainfed agriculture. Thus, output can be seen more as fluctuating around a fairly flat trend, where fluctuations are induced by weather conditions, than as being on a

sustained growth path. This is particularly the case if we look at GDP per capita. There has been some discussion as to which the level of GDP per capita is underestimated in Tanzania. GDP estimates were recently revised for the period 1985-1996, where the new estimates were between 60 and 100 percent above previous estimates (Planning Commission 1996). However, although the income level has been revised, growth rates were not found to be on a rising trend as figure 2.2 suggests.

Figure 2.3

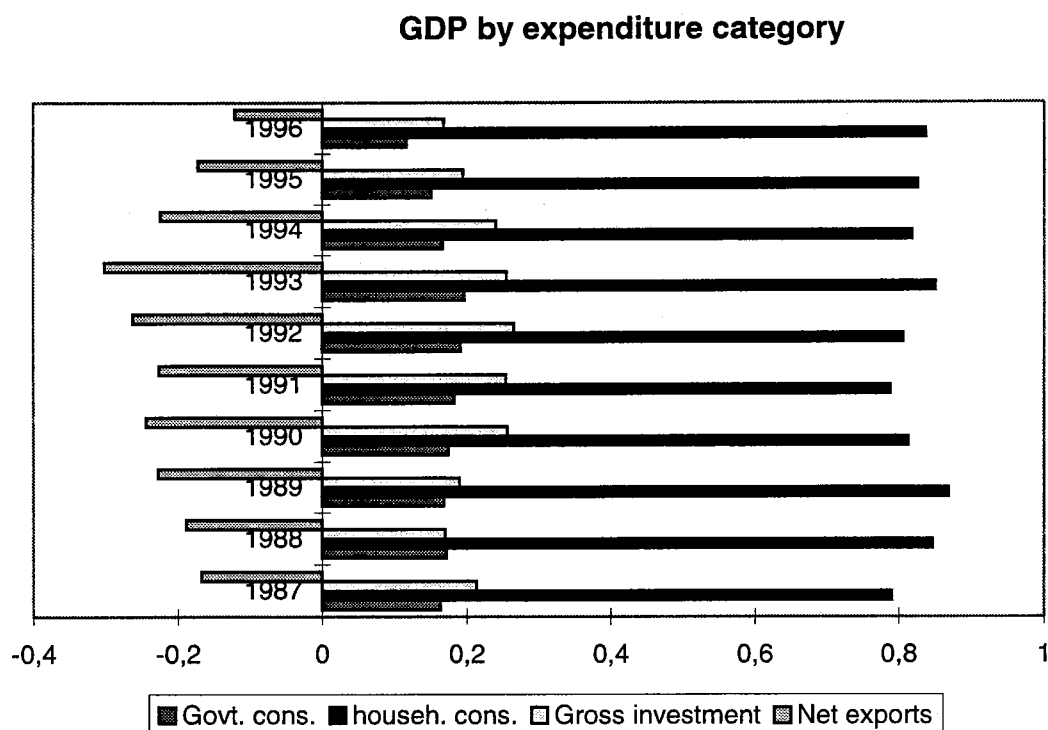
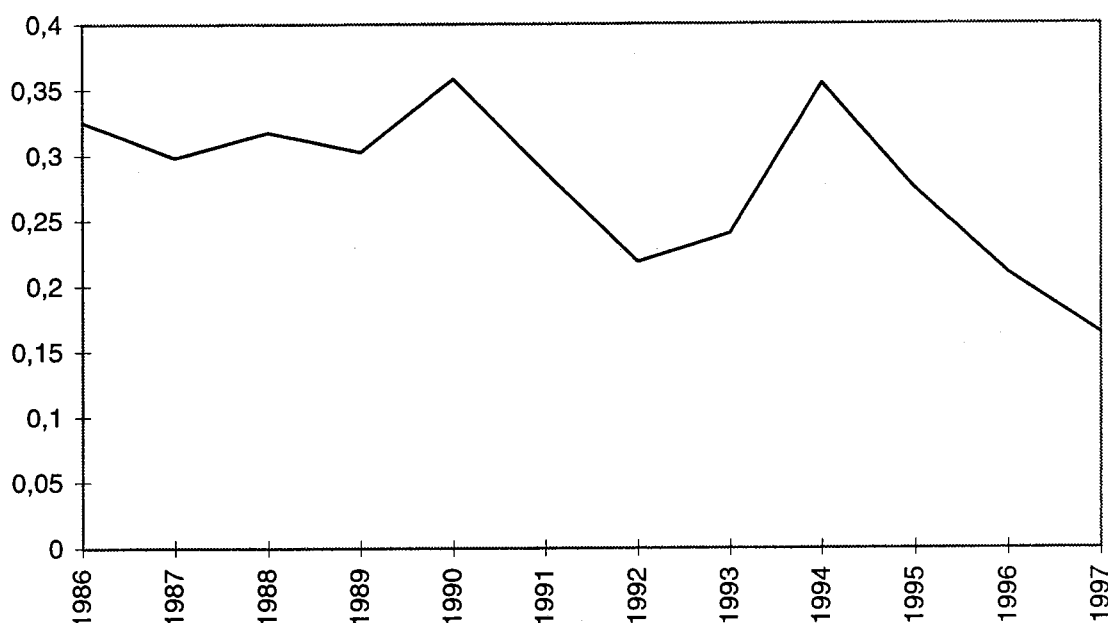


Figure 2.3 illustrates some of the structural problems of the Tanzanian economy. Private consumption is about 80 percent of GDP, and if government consumption is added to that, close to a 100 percent of GDP at market prices is spent on consumption. Thus, investment is almost entirely financed from abroad. This is reflected in a substantial deficit on the current account of the balance of payments, and even more so on the trade balance, shown in figure 2.3. Net exports of goods and services was negative to the tune of 30 percent of GDP in 1993, but have since declined to about 12 percent of GDP in 1996. This is a substantial improvement in the external balance during a relatively short period of time, and it has taken place in spite of real appreciation of the exchange rate, as is further discussed in annex 4. However, the improvement has taken place during a period of economic reforms which have improved incentives and opened some bottlenecks (see Mans 1994 for a discussion).

Curbing inflation is another area where substantial gains have been achieved during the last 5 years. As figure 2.4 shows, the rate of inflation has declined from above 30 percent in 1994 to close to 15 percent in early 1998.

Figure 2.4

Consumer price inflation



From this brief presentation of the key macro-economic indicators, it is clear that there has been significant gains as far as stabilization is concerned, but the economy is not yet on a sustained growth path. Therefore, we will argue in the next chapter, it is not unreasonable to build a model which is largely demand-driven.

3 The modeling framework

3.1 The choice of theoretical framework

In spite of recent developments in macroeconomic theory comprising i) sophisticated models of economic growth, ii) models analyzing the interrelationship between the financial and the real economy and iii) models analyzing the channels through which economic reforms affect the economy, the Keynesian IS-LM framework is still the most commonly adopted framework for analyzing fiscal and monetary policy.

The Keynesian IS-LM framework is concerned with business cycle fluctuations and how fiscal and monetary policy can be used to smooth such fluctuations. The framework was developed following the world-wide depression during the 1930s and gained further ground during the stagflation period of the 1970s.¹ Thus, the framework was developed in order to analyze how the government's fiscal and monetary policy can be designed such that the economy avoids deep recessions.

¹ Stagflation is a combination of high inflation and slow growth.

In developing countries fluctuations in income and production are usually not seen as a business cycle phenomenon. Nevertheless, fluctuations in developing countries have much of the same characteristics as business cycles: They are often caused by fluctuations in commodity prices, which are indeed a business cycle phenomenon. Another cause of fluctuations, particularly in economies dominated by the agricultural sector, is weather conditions. Changes in weather conditions are often cyclical, and are therefore quite easily incorporated into a business cycle-type model.

An alternative to the Keynesian framework is the neoclassical framework. In the "purist" neoclassical model it is assumed that all markets clear at any point in time. However, there is a large body of research incorporating distortions and market imperfections into the neoclassical model in order to adopt it to developing country conditions. An applied research area in this field is the development of computable general equilibrium models (CGE). These models compute aggregate output, sector allocation of resources and income distribution. They usually apply a social accounting matrix for parameter estimations through a method of calibration (see for example Bergman et. al. (1990)).

In developing countries, the structuralist school has had great influence. The idea here is that every economy is unique, and consequently models need to take the unique features of the economy in question into consideration. Thus, models are tailor-made for the particular economy they are used in, based on empirical research identifying bottlenecks and constraints which block or narrow the channels through which fiscal, monetary, trade, and industrial policy are supposed to work. Structuralist models nevertheless are often based on a core of the IS-LM framework. Hence, they extend the IS-LM model with supply side equations in which the constraints are incorporated. The result is a framework where what is demanded is not necessarily supplied, even if high prices could be charged for the goods and services produced (for an early contribution, see Taylor (1981)).²

When deciding on theoretical framework and the model structure, we need to take into consideration that the Tanzanian economy is relatively open to international trade, and trade constitutes a large share of GDP. In addition, international transactions related to debt servicing and development assistance are large compared to the size of the economy. Therefore, the Tanzanian economy is influenced by the global economy to a significant extent and Macmod should consequently be a model for an open economy. In addition the following considerations were taken when the choice of a theoretical framework for Macmod was made:

1. The time horizon of the projections is 3-4 years.
2. The purpose of the model is to analyze fiscal and monetary policy in relation to the preparation of the RPFB.
3. The economy is dominated by agriculture.
4. Lack of infrastructure, both physical and economical, results in under-utilization of productive resources and inhibits economic agents from responding fully to market signals.

² Recall that the IS-LM model is demand-driven and assumes that whatever is demanded is supplied, and the supply side does not play a role in the model.

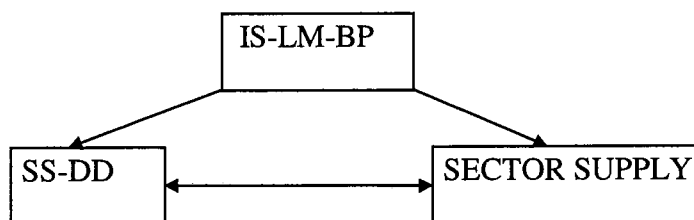
5. The financial markets are thin.
6. Only a 10 year data series of the National Accounts exists. No input-output table has been prepared since 1978 (although an input-output table is now under construction) and no social accounting matrix has ever been prepared for the economy.

Points 1, 4 and 6 rule out a CGE model. Points 1-5 point in the direction of a structuralist model. However, point 6 limits the scope for a structuralist approach and suggests that the model should be simple and built on sound economic principles rather than attempting to capture the unique features of the Tanzanian economy. On the background of these considerations, the IS-LM-BP framework has been chosen as the framework for the core model. The balance of payments part is based on the Mundell-Fleming model. Nevertheless, an attempt is made to capture points 1-5 by extending Macmod by a supply-side submodel. Here the realism of the assumption that whatever is demanded is being supplied can be explored.

3.2 Model structure

Macmod contains 3 blocks which are interlinked as follows:

Figure 3.1



The IS-LM-BP framework constitutes the core model. It is solved at constant 1992 prices for the three key macroeconomic variables: **Real income (GDP), the real interest rate, and the real exchange rate.** Aggregate demand ($GDP=DD$) is then linked into the SS-DD block where it is combined with aggregate supply (SS) in order to find the **rate of inflation** compatible with the equilibrium condition that supply equals demand. Aggregate demand and its components are finally linked into the sector supply block. Here it is assumed that some sectors are “followers,” and output is mainly determined by demand. All the service sectors and construction belong to this category. Structural constraints and exogenous shocks are assumed to affect goods producing sectors and electricity and water the most. Electricity and water shortages in turn affect output in manufacturing. For these sectors structural features such as rainfall, world market prices and industrial policy measures are incorporated into the supply function.

Note that the linkages between the blocks run one way; from the core model to the other two blocks. This reflects the physical linkages found in the computerized

model. However, if comparison of the sectoral supply model and the core model reveals that there is a significant excess supply or excess demand in the economy, this calls for rethinking the scenario for the exogenous variables in the core model. The linkage from the sector model back to the core model thus goes through the judgment of the user of the model.

3.3 The core model

The IS-LM-BP model consists of three markets:

1. The market for goods and services
2. The money market
3. The market for foreign exchange

Solving the model is defined as the process of finding the combination of real GDP (representing the value of goods and services produced in the economy), the real interest rate and the real exchange rate which ensure balance in all three markets at the same time.

A market is defined as a meeting-place where people, or agents, engage in economic transactions. Macmod classifies these agents into four categories:

1. Households
2. Government
3. The financial sector
4. The rest of the world.

These agents engage in trade and transfer financial resources among themselves on all three markets listed above. The government, for example, collects taxes from households, it borrows from the financial sector and from the rest of the world and pays interest and principal on these loans.

The IS-LM-BP framework does not make the flow of funds between economic agents explicitly. Therefore, and in order to be sure that there are no loose ends in the model, a flow of funds accounting framework is incorporated into the model. This framework does not have any bearings on the solution to the model, but is put there as a consistency check. It shows that demand from each agent adds up to total demand and that sources of funds equal uses of funds (including savings) for each agent. Finally it shows the changes in stocks owned by each agent as a result of the flow of funds. The flow of funds consistency framework is similar to the one applied in the World Bank's RSM-X model.

Households are assumed to own the productive resources of the economy. Thus, households own the stock of physical capital and land in the economy. They also supply the labor which is needed to produce final output.

It is, however, the case that the government owns both land and capital and participates in the production of goods and services through its parastatals. In the

model the government's productive activities are treated in the same way as private productive activities. Hence, the parastatals are classified under the private sector (e.g. households). This accords well with accounting practices in the country. Thus, the parastatals' income is not recorded as government revenue, and parastatals pay taxes in the same way as private enterprises. Flow of funds between the four agents is shown in table 3.1.

Table 3.1 Flow of funds

	Households	Government	Financial sector	Rest of world	Production Account	Total sources
Households		Transfers	Interest on deposits	Exports of factor services, transfers	GDP _f	
Government	Income taxes and other taxes		Interest on deposits	Transfers	Indirect taxes less subsidies	
Financial sector	Interest on loans	Interest on loans		Interest on foreign assets		
Rest of the world	Interest on loans, Tanzanian import of factor services	Interest on loans	Interest on loans		Imports less exports (to/from Tanzania)	
Consumption and savings	Government consumption government savings	private consumption private savings	Change in net worth	foreign savings		
Total uses						

The rows show each agent's sources of funds while the columns show each agent's uses of funds. For example the first column shows that households spend their income on consumer goods and services, they pay taxes to the government and interest on loans from the financial sector. Finally they save. The first row shows that GDP in the first instance accrues on households as earnings on the labor they supply and as return on their capital and land assets. Other sources of income are transfers from government and abroad, payment for factor services sold abroad, and interest on deposits in banks.

Changes in stocks are shown in table 3.2 below. Again rows represent sources of funds while columns show uses of funds. All entries are *changes* in stocks.

Table 3.2 Changes in stocks

	Households	Government	Banks	Rest of world	Savings account	Total sources
Households		Capital transfers	borrowing	borrowing	private savings	
Government	Borrowing (bonds and bills)		borrowing	borrowing	government savings	
Banks	Deposits	Deposits		borrowing, reserves		
Rest of the world	amortization	amortization	amortization		foreign savings	
Investment account	Private investment	Government investment				
Total uses						

In the absence of capital controls financial assets are usually much more internationally mobile than goods and services. Thus, capital flows respond to market signals such as differences in interest rates and productivity levels much more quickly and vigorously than trade flows. Moreover, even if strict capital controls are in place, they are increasingly difficult to enforce due to improvements in communication technology and lower transaction costs.

Tanzania does regulate international capital flows on the capital account of the balance of payment. However, capital controls are not synonymous with prohibition of capital flows. Moreover it is an objective to gradually liberalize capital flows, particularly those related to foreign direct investment. On this background the core model assumes an intermediate degree of capital mobility. However, the parameter which represents the degree of capital mobility may be re-estimated as further liberalization takes place.

These assumptions, reflecting the policy stance in the country, have crucial bearings on the way the economy responds to changes in the exogenous variables, or the policy variables. The implications are the following:

1. Monetary authorities control money supply. Monetary policy is therefore a powerful tool in controlling aggregate demand.³ The transmission mechanism is as follows: An increase in the money supply leads to a decline in the rate of interest, an increase in investment and consequently an increase in aggregate demand.
2. The IS-curve moves endogenously as a response to movements in the exchange rate. Fiscal policy through expenditure is therefore a less effective tool in controlling aggregate demand, although it does affect the composition of demand.
3. The BP curve moves endogenously as a response to changes in government expenditure. Again the effect is to make fiscal policy less effective in controlling aggregate demand, but more effective in influencing the composition of demand.

³ This as opposed to the case of fixed exchange rates where the money supply required to maintain the exchange rate fixed would take precedence over all other considerations.

Figure 3.2

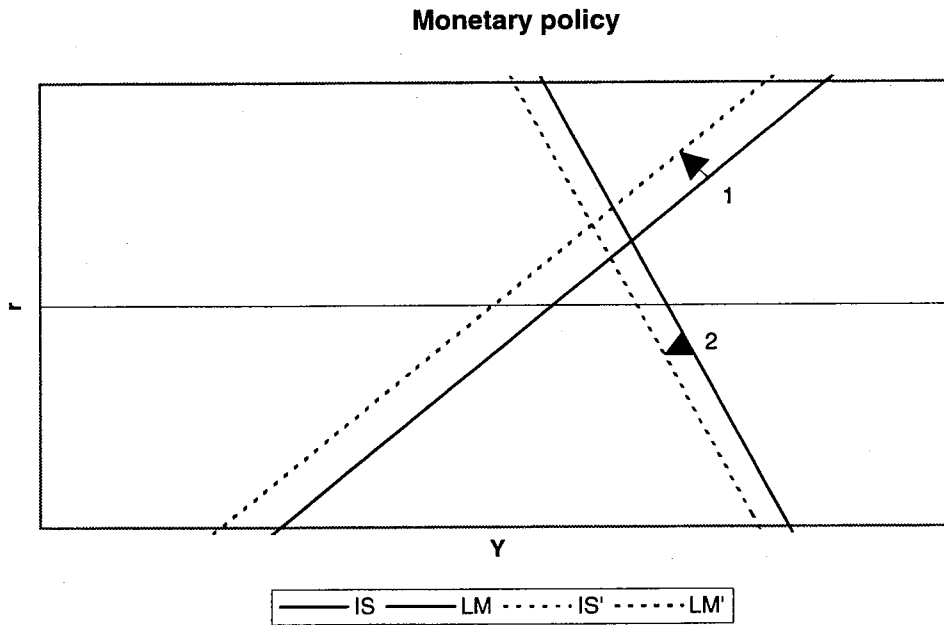


Figure 3.2 illustrates the impact of a contractionary monetary policy on the economy. A reduction in the money supply shifts the LM curve to the left (arrow 1). In the first instance this leads to a higher interest rate. This is, however, not compatible with equilibrium in the market for foreign exchange, and the shilling appreciates in real terms. During this adjustment, we are on the excess supply side of the IS curve (the goods and services market), and the IS curve will endogenously shift to the left as a response to the appreciation of the exchange rate (arrow 2). How far it shifts depends on the degree of capital mobility. The new equilibrium is on the BP curve (omitted for convenience of presentation) to the left of the initial equilibrium. A tightening of monetary policy has consequently led to a lower level of aggregate demand.

Figure 3.3

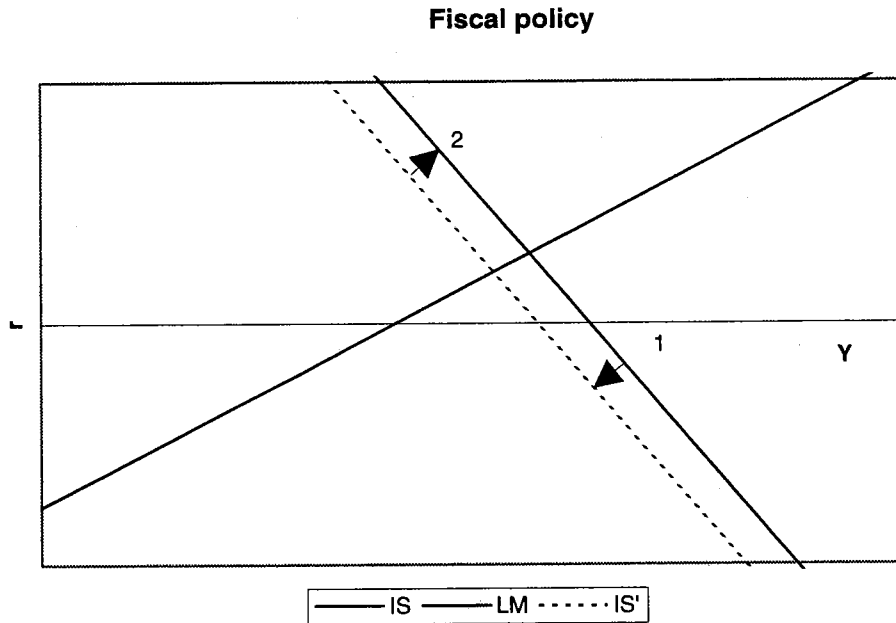


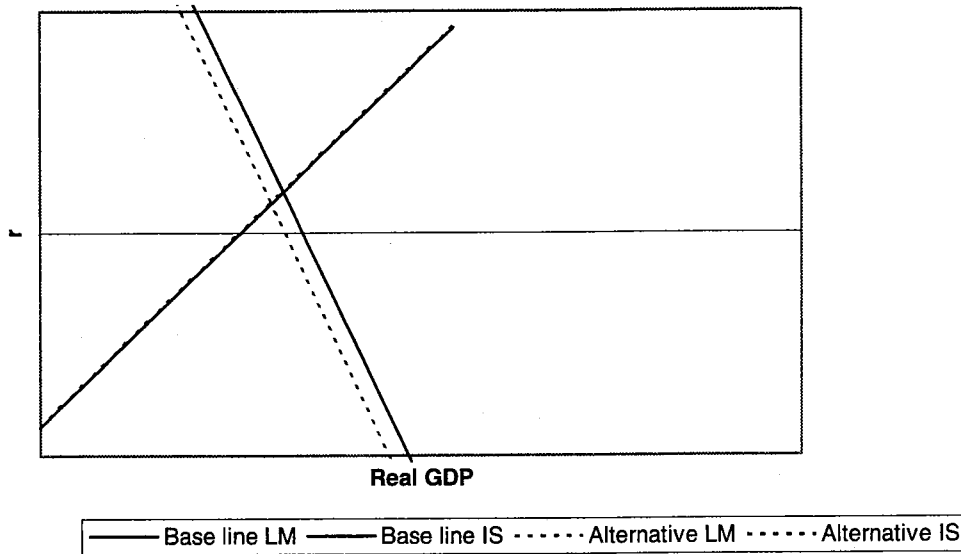
Figure 3.3 illustrates the impact of tightening fiscal policy from the expenditure side. The IS-curve will first move to the left as a result of reduced government expenditure (arrow 1). Since some government expenditure is spent on imports, the BP curve (omitted) will also move to the left, but the shift is much smaller than for the IS curve. This first step in the adjustment process leads to a situation with lower interest rates which are incompatible with balance in the market for foreign exchange, causing an outflow of capital and a depreciation of the exchange rate. As a result, both the IS and the BP-curves will start moving back to their initial position (arrow 2). Depending on the real exchange rate elasticity of the two curves, and the degree of capital mobility. Both may move all the way back to the initial position or somewhere between the initial and the first round adjustment position. Thus, fiscal policy will have little effect on aggregate demand. However, in the extreme case presented in figure 3.3, demand is shifted, shilling for shilling, from government expenditure to reduced net imports. Hence, in the open economy with flexible exchange rates government expenditure is more likely to crowd out net exports than local investment.

The adjustment process just described takes place in a world of fixed prices. An alternative adjustment process is, however, one of stagflation. That happens when excess supply of money instead of leading to lower interest rates and an outflow of capital, leads to increases in prices such that the real money supply declines and the LM curve shifts to the left. The end result in that case will be lower aggregate demand and higher prices. This does, however only happen when the exchange rate is floating and there is strict control of the capital account on the balance of payment, which is an unlikely policy combination.

Tightening fiscal policy from the revenue side is more powerful in affecting aggregate demand than government expenditure as illustrated in figure 3.4. It shows an increase in the effective tax rate on income.

Figure 3.4

The impact of increased income taxes



Increased taxes will reduce disposable household income, and thereby reduce private consumption and also aggregate demand if it is not followed by an offsetting expansion in expenditure. Since the tax rate affects the fiscal multiplier, the slope of the IS curve becomes steeper as a result of an increase in taxes. This also implies that the higher the tax level, the steeper the IS curve and by implication the less effective is monetary policy in affecting demand.

Before closing this section, it is useful to look at how monetary and fiscal policy have influenced aggregate demand in the past. To get a very rough idea, we have computed the correlation coefficients between the various components of total expenditure and money supply and government final consumption respectively for the period 1987-1996. The results are presented in table 3.3.

Table 3.3 Correlation between money supply and GDP and its expenditure categories.

	M2
GDPmp	0.92
Private consumption	0.93
Investment	-0.1

As can be seen from this table, the correlation coefficients between money supply and GDP and consumption are exceptionally high.⁴ The correlation between money

⁴ For comparison, the correlation between GDP and M2 and between private consumption and M2 are found to be negligible in South Africa, while the correlation between the same expenditure categories and narrow money (M0) was found to be about 0.8 (Sharp 1997).

supply and investment is, however, negligible and, if anything, slightly negative. This suggests that the transmission mechanism for monetary policy in the past has not been the Keynesian transmission via interest rates and investment. It appears that money supply has rather had a direct effect on private consumption and GDP through net wealth effects. This is probably because a large share of the money demand has been for working capital in parastatals and cooperatives and for credit to government, which in turn has increased the purchasing power in the economy. In future, however, the Keynesian transmission mechanism should be expected to be more prominent as capital markets are deregulated, and government monetize the budget deficit to a much lesser extent.

Turning to the correlation between government final consumption and other expenditure categories, the correlation coefficients are presented in table 3.4. The first column shows the correlation of government expenditure and other expenditure categories in the same year, the second column shows the correlation between government consumption and other expenditure categories with one year lag.

Table 3.4 Correlation between government final consumption and other expenditure categories

	Government consumption	Govt. cons -1
Private consumption	-0.48	-0.46
GDPmp	-0.46	-0.45
Investment	0.58	0.45

Although correlations say nothing about causation, it appears from these correlation coefficients that fiscal policy has the opposite effect as what the Keynesian framework predicts; government consumption appears to crowd out private consumption and crowd in investment. It is difficult to explain these correlations, but they do justify the feature that fiscal policy has little effect on aggregate demand in Macmod.

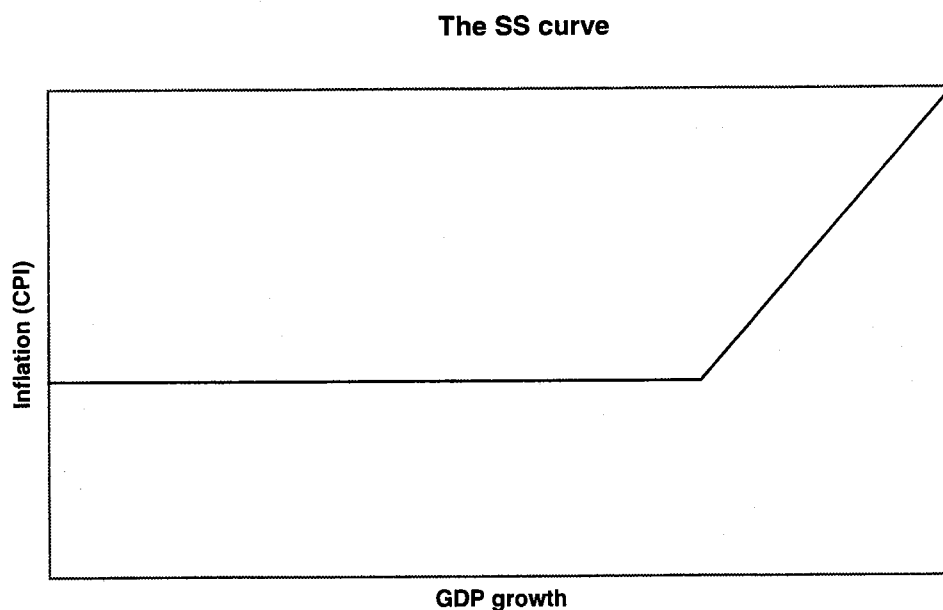
3.4 The SS-DD block

This sub-model balances total supply and demand. As opposed to the core model, it is written in log-linear form. In an open economy, there are two sources of consumer price inflation, i) local inflation and ii) imported inflation. The latter has a direct and an indirect impact on consumer prices. The direct impact is obviously changes in the price of imported consumer goods. The indirect impact works through increased costs of locally produced goods due to increased costs of intermediate imports.

There are three major factors driving the market price for locally produced goods. The first is the marginal cost of production. A constant returns to scale production technology is assumed such that marginal costs are constant for given input prices. The second source of inflation is excess demand. Thus, inflation grows faster than the increase in marginal costs if aggregate demand grows faster than capacity output. It is, however, assumed that prices are flexible upwards, but less so downwards. Consequently, excess demand has an inflationary effect, while excess supply does not

have a deflationary effect.⁵ The third factor which determines the CPI is changes in indirect taxes. The SS curve is illustrated in figure 3.5.

Figure 3.5



If the growth rate of aggregate demand (determined in the core model) in a particular year is lower than the growth rate of capacity output, the solution is on the horizontal part of the SS-curve. If aggregate demand grows faster than capacity output on the other hand, the solution is on the upward sloping part of the SS-curve.

3.5 The sector supply block

The sector supply block is at this stage a rough estimation of sectoral output. It entails the 9 sectors represented in the National Accounts. The most important sector, agriculture, is further subdivided into three subsectors; cash crops, food crops and other agriculture.

Sectoral output is not estimated from sectoral production functions as would have been the case in a CGE model. Instead the idea is to capture some of the structural features which may jeopardize the assumption that whatever is demanded is supplied, and that prices play the role of balancing supply and demand as demonstrated by the SS-DD framework. The sectoral supply block is thus added to the model in order to assess the realism of the results from the demand-driven model, and serves as another consistency check.

⁵ Capacity utilization in Tanzania is generally believed to be low. It therefore takes substantial growth over several years to reach the capacity limit. Nevertheless, there may be adjustment costs related to increasing the rate of capacity utilization, for example costs of hiring new workers and start-up costs for previously idle machinery. Thus, it is assumed that if actual output *grows* faster than capacity output, it has an inflationary effect.

