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SCHOOL OF GRADUATE STUDIES

MACROECONOMETRIC POLICY MODELLING FOR ETHIOPIA

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MACROECONOMETRIC POLICY MODELLING FOR ETHIOPIA

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Abstract

A small macroeconometric model for Ethiopia is specified, estimated and tested using time series data for the period 1965/66 –1998/99 with the objective of examining the effect of an increase in import prices and the impact of AIDS. The model is set up in general equilibrium framework and individual equations in the model are estimated in an ECM format using the Johansen approach in view of the time series properties of the macro-time series variables. In terms of the individual equations and dynamic with-in-sample simulation, the performance of the model is quite well.

Two dynamic counterfactual simulations are carried out. The result of the simulation demonstrates that an increase in import price has diverse impact on the economy including increase in the overall price level, real exchange rate depreciation, reduction in imports, deterioration in terms of trade and slowing down of the economic growth. This result is consistent with the import compression argument raised in Ndulu (1991) and Rattsø (1994).

In addition, it can be discerned that the prevalence of HIV/AIDS has a negative impact on the overall economy through lowering the active labour force. The decline in the labour force has a direct negative impact on both the output of the agricultural and non-agricultural sectors that would lead to the fall in private consumption, investment, exports and government tax revenue. The slow down of the economy would also be strengthened with the fall in imports due to the decline in exports and hence the shrinking down of the importing capacity.

Section I

INTRODUCTION

Ethiopia has passed through different policy regimes. In the 1960s and until the mid 1970s, economic policy and planning was guided by five-year plans. This was further strengthened when the military came into power in 1974 with the socialist ideology that presuppose central planning. The military government was following an ad-hoc planning strategy until the early 1980s. In 1983, it came up with a Ten-Year Perspective Plan that sets targets and gives guideline for implementation within the plan period. However, in the 1990s when the country moved from centrally planned economic system to market oriented one, together with measures to liberalize the economy, cutting across the various sector of the economy, there was no elaborated framework in government bodies for facilitating macroeconomic policy analysis. In particular the problem was severe when the effects of proposed policies are not tractable by simple reasoning alone (Alemayehu, 1999a).

Although some type of macroeconometric models, as a tool for policy analysis, are faced with so many criticisms- notably Lucas' (1976) critique which argued that the models are not likely to be useful for policy purpose (Fair, 1993), they are still useful in applied policy analysis. According to Fair (1994) even if the logic of the Lucas critique is correct, what matters is its qualitative importance. And mostly solving the problems by estimating structural parameters exacerbate the effects of a number of other problems. Furthermore, the relevance of the Lucas critique in the case of developing countries is negligible.

In the 1990's some excellent attempts are made to build a macroeconometric model for developing countries to analyse the issues of stabilization policies and structural adjustment (for instance see Haque et. al, 1991 and Soludo, 1995). In the spirit of stabilization policies and structural adjustment, policymakers need to have information on the orders of magnitude of the relevant parameters in addition to the qualitative nature of the relationship between variables (Khan et. al. 1991). Nevertheless, in the case of Ethiopia there are only few macroeconometric models (for instance Kidane and Kocklaeuner, 1985 and Mered, 1993) which are constructed to address the issues of stabilization and structural adjustment though their practical relevance is questionable. Thus, it is the intention of this paper to build a small-sized general equilibrium macroeconometric model which can be used to analyse the impact of either endogenous policy shock or exogenous shocks in the economy. The specific objective of this study also includes measuring the impact of import price increase and a decline in labour force due to the prevalence of HIV AIDS using the macro model. The use of the model can also be extended to analyse other policy shocks.

The organization of the paper is as follows. In section II the macroeconomic performance of the Ethiopian economy is examined. Section III investigates the related literatures. Section IV presents the stochastic equation to be estimated, the methodology and the empirical results. Section V contains policy experiments using the model. Finally, concluding remarks are provided in section VI.

Section II

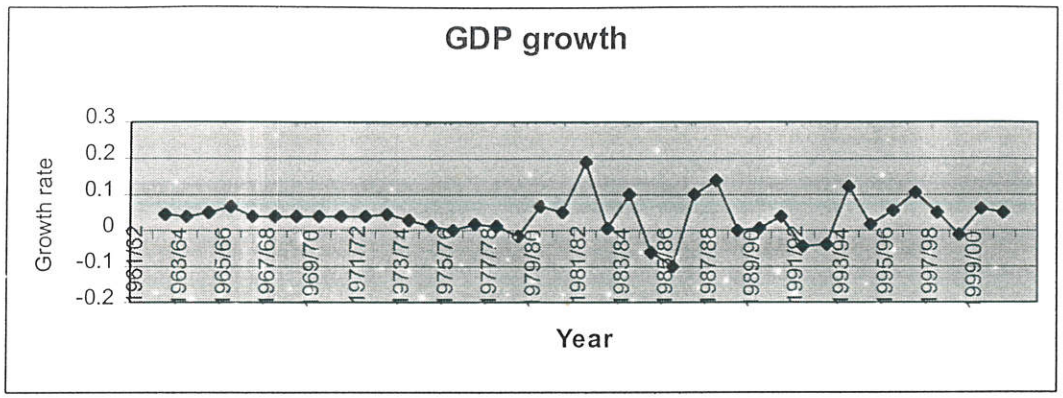
The Ethiopian Economy: A Survey

2.1 Macroeconomic Growth

The Ethiopian economy has passed through different growth episodes. According to the survey of Bethelemy and Söderling (2001), the Ethiopian economic history had recorded a sustained and strong growth experience starting at 1960 to end as shortly as 1972. In these twelve years the economy was growing by an annual average of 4.5%. Nevertheless, this trend is reversed after then. Starting the mid 1970s to the beginning of the 1990s, the growth performance of the economy became gloomy to the extent that negative growth rates started to be apparent. In the 1990s, a relatively good economic performance is achieved, however. This erratic path of the economy can be partly attributed to the state of political and economic policies that had been adopted in addition to the exogenous shocks that the country had experienced.

The evolution of the Ethiopian economy and its growth performance can be considered as taking place in three phases following the political swinging of the country (see Alemayehu, 2000 for a detailed discussion). Figure 1 shows the growth rate of the economy during the period 1961/62 to 1999/00.

Figure 2.1



During the pre- 1974 period, the ruling government had a predominantly feudalistic ideology with some capitalist touch. In the 1960s until the mid 1970s the capitalist structure, which is basically market oriented, had been further strengthened. However, this structure could not go any further. The 1974 revolution came up with its "brand new" socialist ideology (which is latter backed up by the former USSR and other East European countries) emphasizing government control and central planning of the economy. After having a centralized economy for nearly two decades with a decimal macroeconomic performance and high degree of macroeconomic distortion, the socialist government is overthrown in 1991. After the downfall of the *Military government,* the present government adopted market oriented system. The growth performance of the economy, as shown in table 1, closely follows the switching of regimes.

Table 2.1

Growth rate of real GDP (linear growth rate)

Period	***Growth rate***
1960/61 – 1973/74	*4.1%*
1974/75 – 1990/91	*2.1%*
1991/92 – 1999/00	*5.2%*
1960/61 – 1999/00	***2.6%***

In the first phase, pre-1974, the economy had been growing at a linear growth rate of 4.1% per annum. With a population growth rate of 2.3% per annum, per capita income was growing by around 1.8% per annum. In this period, with a good export performance and lower trade deficit, domestic absorption, on average, was only 1.1% higher than GDP. In the second phase, 1974/75-1990/91, the growth performance of the economy was disappointing. In this period the growth rate of 2.1% per annum was not even capable of maintaining the level of per capita income constant. Rather, with a population growth rate of 2.8% per annum, per capita income was going down by 0.7% every year. In this period, aggregate expenditure exceeded GDP by 6%, which is higher than the pre-1974 period average by 5-percentage point. This is mainly due to the expansion of the public sector following the socialist ideology.

A relatively good economic performance is recorded in the post- 1991 period, the third phase, however. In this period, 1991/92 – 1999/00, the economy was growing by about 5.2% per annum. This makes the country "one of the seven 'fast' growing economies of Africa for the decade" (Seid, 2000: 14). However, the domestic absorption was significantly higher than GDP having a share of 111.3% out of GDP, on average. In general, except two years, excess demand was a prevalent feature of the economy through out the entire period considered.

2.2 Saving and Investment

2.2.1 Trends in Investment

In the 1960s total investment was growing at an annual compound growth rate of 5.3% and it declined to 3.2% in the 1970s. The growth rate of investment revived again and reached 7% in the 1980s. In the last days of the military government it registered a

negative growth rate due to the misguided policy and the devastating war that took much of the country's resources. After the downfall of the military government the growth rate of investment showed an increasing trend due to the relatively good investment environment and stability. During the period 1992/93-1999/00 the total investment was growing at a linear growth rate of 15%.

The disaggregated figures of total investment give us different picture about the trend of investment. The private investment was growing by about 6% in the 1960s while government investment was growing by only 0.04% in the same period. However, this trend was reversed in the 1970s following the socialist ideology of the military government. In the 1970s private investment was growing by –1.36% while public investment grew by an annual compound rate of 20.8%. These growth rates are inline with the then ideology that deliberately discourages private investment through government policies such as maximum capital ceiling. This trend exhibited a slight change in the 1980s. In this period private investment was growing at an annual average rate of 1% while the growth rate of public investment was as high as 14%. The low or sometimes negative growth rate of the private investment continued until the downfall of the military government in 1991. After the military government is overthrown, the present government adopted a market led economy that emphasizes the importance of the private sector.

Following this change and the good investment atmosphere created for the private investment, its growth rate accelerated to 11.6% in the period 1991/92-99/00. The growth rate of the public investment was also high especially investment in

infrastructure showed an annual compound growth rate of about 46%. In general for the period 1965/66-1998/99 the linear growth rates (from the regression equation) of private investment, public investment and total investment were 7.5%, 12.1% and 8.9%, respectively.

The share of private investment out of the total GDP also follows the same trend as its growth rate. In the 1960s the share of private investment in the GDP was around 11.1% while the share of public investment was only 1.8%. However, the share of public investment started to grow steadily following the 1974 revolution, which introduced the socialist ideology that gives much credit to the public sector. In the 1980s the share of the public investment reached 9.6% of GDP while the share of the private investment was only 5% in the same period. In recent years the dominance of the public sector is diminishing. For instance in 1999/00 the share of the public sector investment was 6.3% of GDP while the private investment share was around 8% of GDP.

2.2.2 Trends in Saving

The Ethiopian average ratio of gross domestic saving (GDS) to GDP has been lower than that of the Sub- Saharan Africa average. The average rate of Sub Saharan Africa had been 16% in the 1970's and 14% in 1991 [World Bank, 1993]. In Ethiopia the average share of GDS to GDP had been around 11% in the 1960's and 7% in the 1970's reaching a minimum level of 2% in 1977/78. However, in the 1980's and 90's an increase in the ratio of GDS to GDP is observed i.e. 9.7% and 12.6%, respectively though it is still less than the average for SSA.

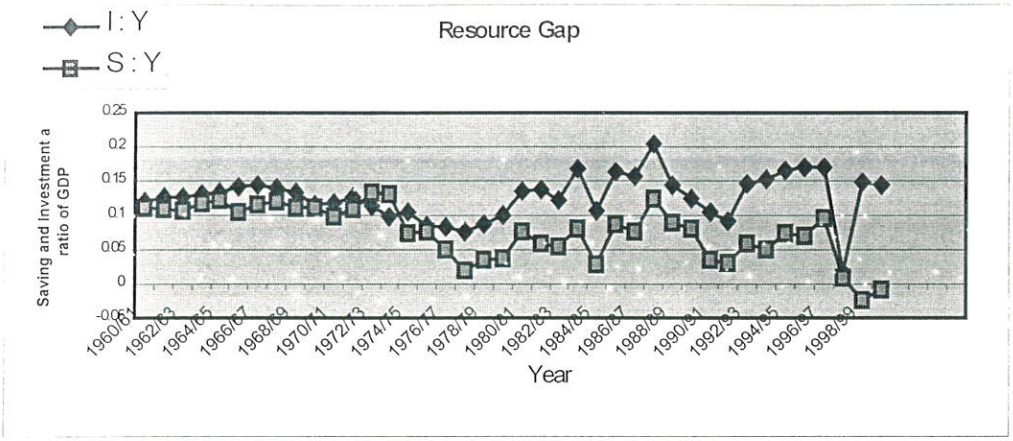
In the 1960's GDS had been growing at an average rate of 6% per annum and increased to 7.6% in the 1970's. However, this growth rate started to decelerate in the 1980's having an average growth rate of around 6%. By 1988-92 this growth rate appeared to be negative amounting to –14.5%. This negative growth rate is basically a result of a negative contribution of the government sector saving to the gross domestic saving.

Regarding the composition of saving much of the saving was contributed by the private saving. Until recently the private saving contributes above 80% of total saving. But in recent years the share of private saving declined reaching 40%of the total saving in 1997/98.

2.2.3. Saving and Investment

Throughout the period 1960/61-1999/00, the ratio of investment to GDP was higher than the saving to GDP ratio with the exception of 1972/73 and 1973/74 (see figure one below). This implies that the country was facing a serious resource gap to finance the investment expenditure. To bridge this resource gap external financing had been used extensively.

Figure 2.2



As the resource gap expanded, the external debt was also accumulating reaching a maximum level of 169.4% of GDP in 1998[1](World Development Indicators, 2000). The financing of this high level of debt was also high and ever increasing. In 1991/92 the debt-servicing ratio reached a maximum level of 82.5%[2] (see Alemayehu and Daniel, 1999) leaving a very small amount of foreign exchange from the export earning for the domestic investment purpose. To the extent that the nature of investment is import constrained, the decline in the private investment can be the result of the foreign exchange constraint, among other things.

2.3 Prices, Monetary Growth and the Financial Sector

2.3.1 Prices and Monetary Growth

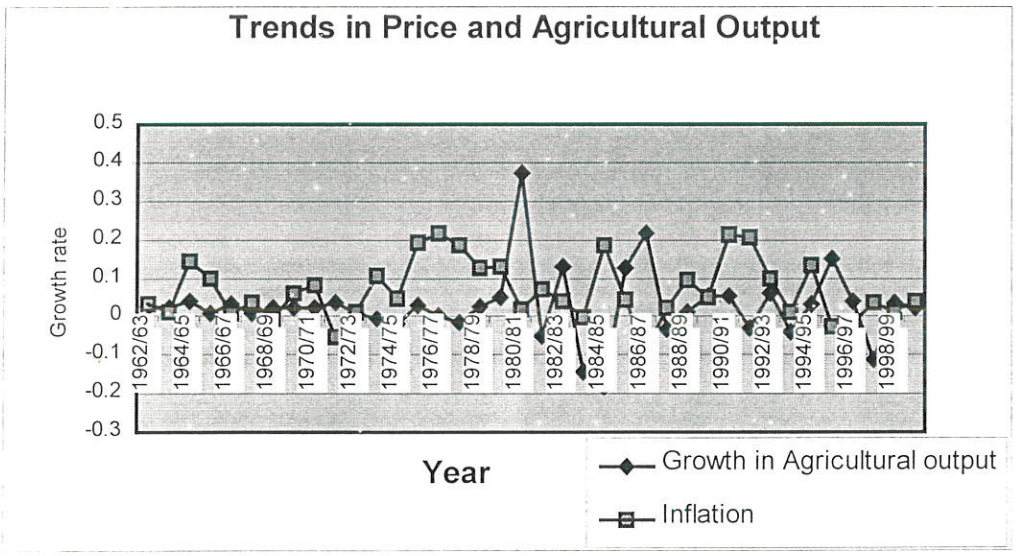
In Ethiopia, the price level, as compared to other African countries, is relatively stable in the last four decades. With the exception of the early and the last days of the military government, and some abnormal years inflation rate had been a one-digit figure. This

[1] The total debt includes the debt from the former USSR.
[2] The figure is taken from NBE annual report. 1997/98.

stable inflation rate is a result of conservative monetary policy in the pre-1974 and post-1974 period while it is due to the price control exercised during the 1974 –1991 period.

The growth in the price level can be attributed mainly to what is happening in the agricultural sector following the structuralist argument. As shown in the figure below, the growth rate of price is inversely related with the agricultural output growth. For instance, in 1984/85, the severe drought year, agricultural output has gone down by 16.4% while inflation rate has gone up to 18.5%; and in 1995/96 and 1996/97 where there was bumper harvest, inflation rate has gone down to -2.6% and -1.4%, respectively.

Figure 2.3.1.1



Following the monetarist argument, the other driving force of prices is monetary growth. As shown in figure 2.3.2, inflation and the growth of money supply have a strong co-movement, notwithstanding the price control, for a considerable period of time. The Granger non-Causality test also rejects the hypothesis of non-causality between money

supply (M2) and price level (CPI) (see table 2.3.1.1). This test shows that money supply can Granger cause higher price level and vice versa. The first relationship, from M2→ CPI, can be explained through the impact of money supply in creating excess demand and finally inflation. The Granger causality test also shows that higher price level can Granger cause higher money supply. This may be a case where agents want to maintain their real money balance constant – i.e. through the proportionality of money demand and price relationship.

Figure 2.3.1.2

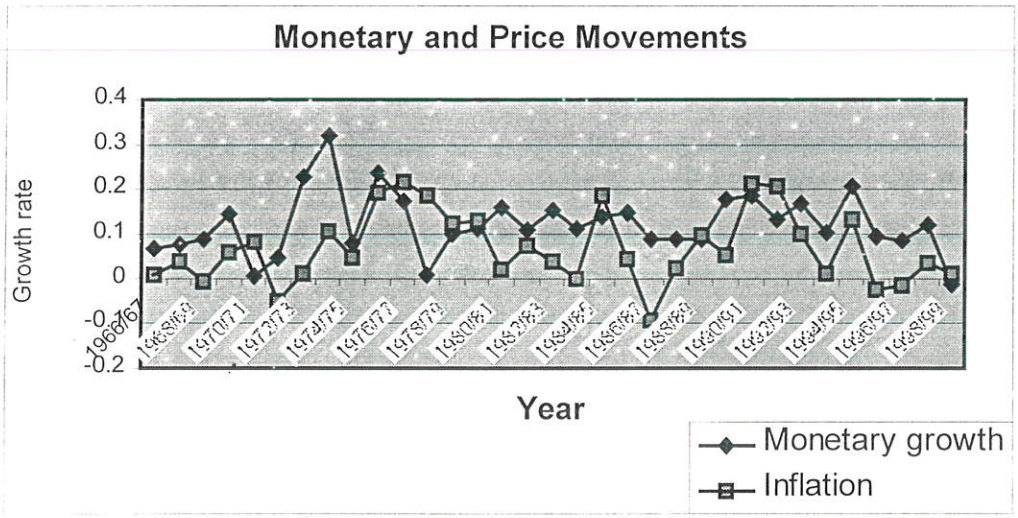


Table 2.3.1.1.1 Granger non-Causality test

Test	*Null*	*Result*
Granger-Causality test for adding M2 to CPI	*M2 does not GC CPI*	*F(3,24)=8.5702 (0.0005)***
Granger-Causality test for adding CPI to M2	*CPI does not GC M2*	*F(3,24) = 9.4084 (0.0003)***
Granger-Causality test for adding Deficit to M2	*Deficit does not GC M2*	*F(3,24) = 4.0778 (0.0179)**
Granger-Causality test for adding M2 to Deficit	*M2does not GC Deficit*	*F(3,24) = 3.7201 (0.0250)**

Figures in parenthesis are probabilities.
** and ** imply reject the null at 5% and 1% level of significance, respectively.*

The growth of money supply was at a manageable range during the pre- 1974 period. During the period 1966/67 – 1972/73, the average growth rate of M2 was around 9.3%;

and excluding the abnormal year of 1972/73 it was only 7.1%. In the following two decades, the average growth of the money supply surged to double-digit figure. For instance, during the period 1974/75 – 79/80 and 1980/81 – 90/91, it went up to 11.8% and 13.2%, respectively. In the post- 1991 period, the monetary growth has declined due to monetary restraints, however. Excluding 1994/95, in which M2 growth was about 20.7%, the average growth rate in the period 199192 – 98/99 was 9.8%.

The high monetary expansion in the 1974 --91 period is mainly due to the increasing level of deficit that had been an apparent feature of the fiscal system in Ethiopia. The Granger-Causality test for adding deficit as an explanatory variable in driving M2 rejects the null hypothesis of non-causality (see table 2.3.1.1). This result suggested that fiscal deficit is one of the main factors behind the higher growth of money supply. On the other hand, the result also implies that higher money supply can also cause deficit in the Granger sense. This can be explained through Keynes-Oliver –Tanzi effect in which monetary growth fuels inflation (as shown in table 2.3.1.1) that increases the government expenditure and erode the tax base; hence causes higher fiscal deficit.

2.3.2 The Financial Sector

As in most other developing countries, the financial sector of the Ethiopian economy is characterized by its dual nature. While the relatively organized money markets are concentrated in the urban area, the rural area has only access to the curb market and other local form of money market. On top of this, the development of the organized financial market is at its rudimentary stage. For instance, the population per bank ratio in

Ethiopia is 222,000 whereas the Sub Saharan average is 120,000, which is almost half of the Ethiopian ratio.

The development of the financial sector closely follows the change in regime and the resultant shift in the way of managing the economy. In the pre- 1974 period, the financial market was operating under the market economy system in which competition is the rule of the game. Privately owned banks were operating along with the state owned commercial bank. In addition to the privately owned banks, other specialized financial institutions (such as Ethiopian Saving and Mortgage Share Co. and Ethiopian Investment Corporation Share Co.) had also been operating to facilitate mortgage and development finance.[3]

In the socialist reign, 1974-1991, all the privately owned banks, specialized financial institutions and insurance companies were nationalized following the socialist ideology that demonise private ownership. Following this, the government adopted restrictive financial policies such as "fixed and compartmentalized interest rate on deposits and loans" (Assefa, 2000:14). In addition to this, there was also a serious credit rationing based on the priorities set by the central planning organ implying that the financial institutions were serving as passive policy instrument of the government.

The market-oriented system of the post-1991 period came up with its new financial sector reform that allows the private sector participation. The major policy shifts in this period are the liberalization of the financial sector and a greater autonomy given to the central bank. Following the reform, private banks and insurance companies started

operating along with the state owned banks and insurance company. In addition, the determination of interest rate also followed the market principle with some administrative element in the process.

2.4 External Debt[4]

In Ethiopia both the debt stock and the debt to GNP ratio increased steadily since the 1980s. This makes Ethiopia one of the SSA, which have a total debt that exceed their GNP, having a debt to GNP and debt to export ratios of 108.2% and 642.4%, respectively (see table 1) while the comparable figure of debt to GNP ratio for East and South Africa and North Africa is 129.5% and 77.8%, respectively [Alemayehu,1997]. This causes the country to have severe debt servicing difficulties. Despite efforts at rescheduling, the country has not been able to meet its debt service obligations, arrears have accumulated, thereby raising the stock of external debt.

Nowadays, arrears are considered as the key indicators of the intensity of debt-burden since they clearly signal the ability of a country to honour its debt obligation. In Ethiopia the accumulation of arrears on debt emerged in the 1980s. Prior to this period there had been no interest arrear and almost negligible principal arrear. The interest arrear which had been 0.1% of export or 0.01% of GNP in 1981 reached a peak of 53.3% of export or 8.4% of GNP in the year 1998. The principal arrear also escalated from a low level of 0.12% of export or 0.013% of GNP in 1981 to 71% of GNP or 449.7% of total export in 1998 (see table 2.4.1). In sum, by the year 1998 the total arrears (principal and interest) reached 79.5% of GNP, 50.3% of total external debt and 503% of export (Calculated from table 2.4.1). This rising level of arrears is because of the fact that resources are limited for debt-

[3] See Alemayehu, 1999b for detailed discussion on this issue.

service payments, i.e. meeting the debt - service obligation on schedule could only be accomplished by further debt rescheduling. This has worsened the situation as it resulted in even larger arrears accumulation in recent years.

Table 2.4.1 Indicators of Debt Burden for some selected years (All are in percentage)

Year	*1972*	*1981*	*1989*	*1992*	*1994*	*1996*	*1998*
*Debt to GNP ratio**	*11.1*	*35.6*	*98.6*	*173.2*	*208.9*	*169.4*	*158.2*
Debt to Export ratio	*91.5*	*332*	*1034.8*	*2036.9*	*1781.7*	*1224.3*	*1001*
Arrears to GNP ratio	--	*0.025*	*0.87*	*33*	*66.5*	*80.4*	*79.5*
Arrears to Export ratio	--	*0.23*	*9.1*	*388.1*	*567.05*	*581.2*	*503*
Interest arrears to total arrears	--	*46.2*	*23.2*	*14.5*	*12.3*	*10.1*	*10.6*
Principal arrears to total arrears	--	*53.8*	*76.8*	*85.5*	*87.7*	*89.9*	*89.4*

**including the debt to the former USSR*

Source: Calculated from World Development Indicators CD ROM, 2000.

Generally the increasing debt to GNP and debt to export ratios in addition to interest and principal arrears showed an unprecedented increase in the level of the country's debt. And those indicators listed above revealed that the total debt is well above the nation's GNP and around 10 fold of total export in 1998 implying that the debt burden, as compared to the country's capacity, is too heavy to take care of itself.

Regarding net resource flows on debt, there was an increasing and positive trend until very recently. However, since 1994/95 Ethiopia has started to record a negative inflow as shown in table 2.4.2. In general the figure computed for the whole of Africa shows that there is a net resource outflow starting from 1980s. For instance the net inflow was -1.71 billion, -4.41 billion and -4.68 billion in 1985, 1990 and 1992, respectively [Alemayehu, 1997]. The aggregate net resource flows on debt (which is a sum of Net resource flows on debt plus Foreign Direct Investment (FDI), portfolio equity flows, and official grants excluding

[4] Some part of this section is extracted from my BA thesis, Fiscal Response to Foreign Financial Flows in Ethiopia, 1998, Addis Ababa University.

technical cooperation) has exhibited an increasing trend, even if there was almost no FDI and portfolio equity flow, because of the rising level of financial grants (See table 2.4.2).

TABLE 2.4.2

Net Resource Flows on Debt and Aggregate Net Resource Flows (in million ETB)

	1976/77	*1980/81*	*1986/87*	*1989/90*	*1994/95*	*1997/98*
Net resource flows on debt (NRFD)*	109.1	366	395.5	951.8	425.8	278.9
Net transfer on debt (NTD)**	97.3	350.2	284.3	844.6	-74.8	-77.8
Aggregate Net Resource flows (ANRF)**	141.5	369.2	475.3	1018.6	1094.5	1195.5

*NRFD = loan disbursed minus principal repayments

**NTD = NRFD minus interest payments

***ANRF = NRFD plus FDI, portfolio equity flows, and financial grants

Source: Own calculation from Annual Reports (various years) of the National Bank of Ethiopia

In addition to looking at the structure and the extent of the external debt, it is worthwhile to assess the terms and conditions of these loans. Some terms and conditions are more stringent from the other. As the source of finance differs so do the terms and conditions. The interest rate, the maturity period and the grace period are listed in the following table.

Table 2.4.3 Average Terms and Conditions of all Creditors

	1970	*1980*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Interest (%)	4.4	3.6	6.6	4.7	1	1.7	1.1	1.0	2.2	2.4	0.6
Maturity Period (years)	31.8	18.5	21.8	20.3	40.1	40.7	40.4	36.3	30.4	33.5	40.6
Grace Period (years)	6.6	3.6	2.9	6	9.8	9.2	9.3	9.3	7.6	7.4	10.1
Grant element (%)	43.3	38.8	23.7	36	73.7	72.5	71.6	76.1	62.1	60.7	81.3

Source Global Development Finance, 1998 & 2000

As shown in the table above, the average interest rate on debt outstanding declined from 4.4% in 1970 to 3.6% in 1980, with some fluctuation in the meantime. But it increased to 6.6% and 4.7% in 1990 and 1991, respectively. Afterwards, because of a good relationship between the government and the lenders, the interest rate decelerated significantly to reach

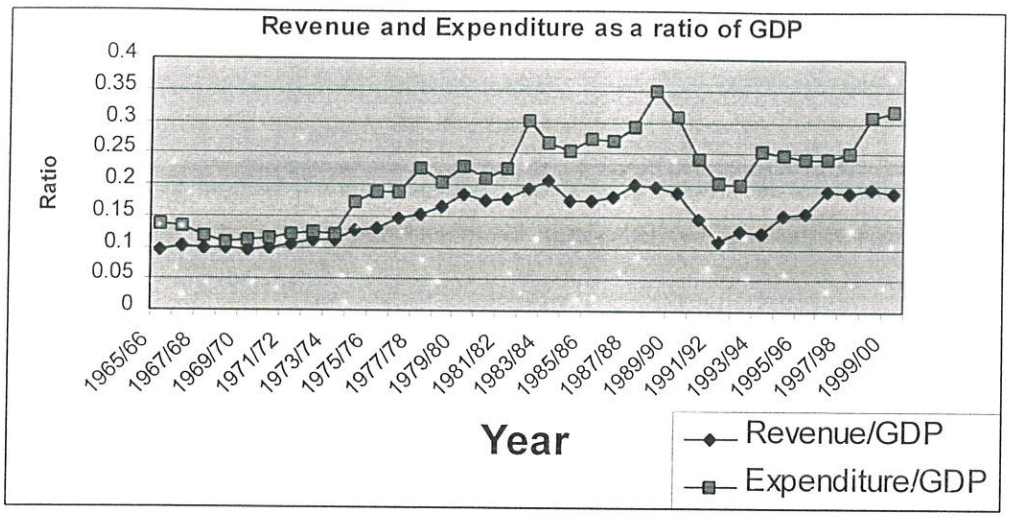
0.6% in the year 1998. Thus, the average interest rate declined by about 3.8 percentage point in 1998 as compared to 1970.

The repayment period also followed the same trend as that of the interest rate. The maturity period which was 31.8 years in 1970 appeared to be 20.3 years in 1991. The general trend of this term in the interim was harder. But starting from 1992 the repayment period is extended. For instance, the maturity period was 33.5 years and 40.6 years in 1997and 1998, respectively. The grace period did not vary much in the period 1970-1991. But after this period, the grace period is also extended to 10.1 years in 1998 as opposed to 2.9 years in 1990. Therefore, the terms and conditions for loans during the period prior to 1991 was unfavourable as compared to the post 1991 period.

2.5 Public Finance

In the year 1999/00 government expenditure was around 32% of the GDP while total government revenue accounts 18.7% of GDP. This clearly indicates that there is an excess government expenditure over its revenue which is referred as fiscal deficit. This had been a notable feature of the Ethiopian fiscal development since the 1970s. As Teshome (1992: 55) put it "During the period 1950-55 budgetary surpluses were recorded. During the period 1955-65 balanced budget where more or less maintained, after this until 1974 the deficit was kept small due to 'fiscal conservatism'. Afterwards a large and persistently rising fiscal deficits were sustained." This was the result of the 1974 revolution which introduced the socialist management system with expanded public sector without adequately expanding government revenue in addition to the extended war with Eritrea.

Figure 2.5.1



In the post- 1991 period, the fiscal deficit was kept well below 10% of GDP until 1997/98. However, with the broke out of the war with the neighbouring Eritrea in 1998 and due to the natural disaster in the same year, the fiscal deficit increased to 11.3 % and 13.1% of GDP in 1998/99 and 1999/00, respectively. The general trend of the increasing deficit is shown in the figure 2.5.2 and table 2.5.1 below

Figure 2.5.2

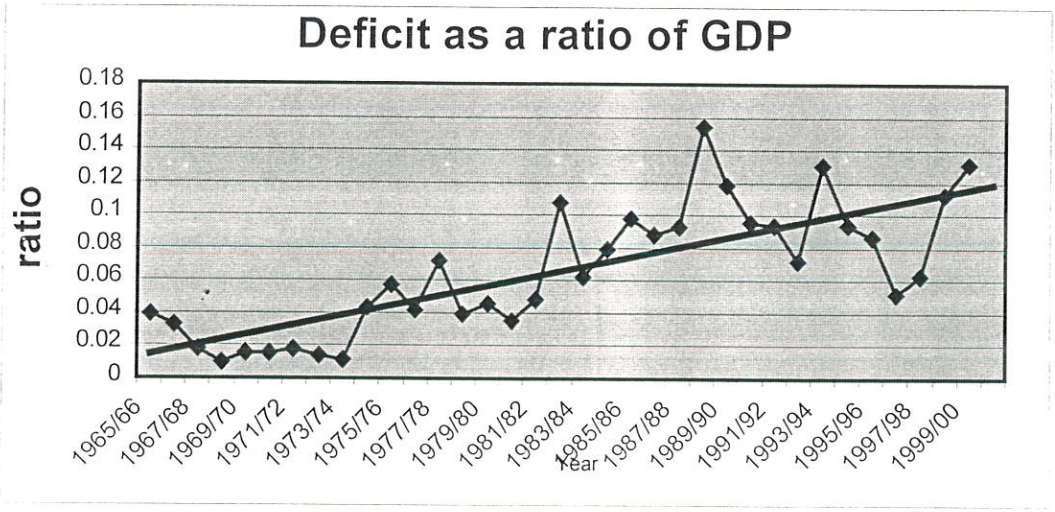


Table 2.5.1

Total government expenditure as a percentage of Revenue and GDP

Period	*Expenditure/Revenue*	*Expenditure/GDP*
1965/66-1973/74	118.8	10.5
1974/75-79/80	133.4	17.4
1980/81-1985/86	139.1	25.5
1986/87-90/91	160.3	29.2
1991/92-99/00	158.4	25.5

Source: *Ministry of Finance*

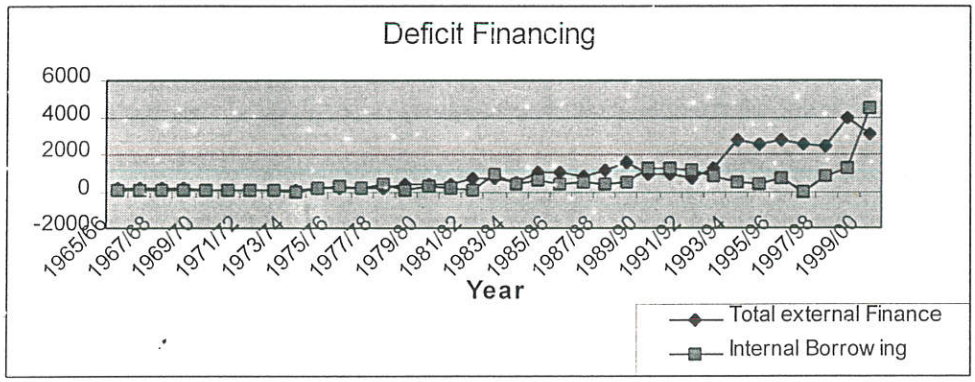
As shown in the table above the escalating expenditure over revenue was a major cause of the deficit. This may be because of the fact that prudent fiscal policies were not followed and the government expenditures may not be planned always and may reflect the need to cover "emergency costs" (World Bank, 1988).

The major factor behind a steadily increasing fiscal deficit had been the ever increasing government expenditure. In monetary terms the total government expenditure increased from ETB 1.65 billion i.e 20.7% of GDP in 1978/79 to ETB 6.05 billion i.e 23.3% of GDP in 1992/93 and it finally reached ETB 17.2 billion in 1999/00, which is 32 % of GDP. In terms of growth rate it had a nominal compound growth rate of about 10.5% per annum in the period 1974/75 -90/91. "The sharp increase in the government expenditure and the associated high growth rate in the period 1974-91 can be explained by the great expansion in the government bureaucracy, the launching of a series of expensive campaigns, the literacy and villagization campaigns, and most importantly wars in Ogaden and Eritrea." (Mohammed and Suleiman, 1994:29). The comparable figure for the period 1991/92 -99/00 is about 16.7% per annum. This high growth rate of the government expenditure is partly due to the effect of devaluation that can possibly

escalate the government expenditures in terms of domestic currency. In addition, the rehabilitation process in the after war period also contributes for the high growth of total expenditure. During this period government revenue was growing by 14.6% per annum.

The ever growing fiscal deficit had been financed from both the external sources (such as external borrowing and grants) and domestic sources which include borrowing from banking system and non-bank sources. But as the government runs a large deficit, it has to resort to external source in view of the limited alternative from domestic sources.

Figure 2.5.2



As shown in the figure above, external finance constituted an important element in government expenditure finance. Over the years, the level of external financial flow that was devoted for that budgetary purpose has been increasing though the share from government finance did not vary significantly.

On average the total external finance was covering about 60.4% of the deficit finance during the period 1983/84 - 90/91 and increased to 75% in the period 1991/92 - 99/90. The external assistance, which is one part of external finance and mostly referred as grants in the records, contributes about 28% of total deficit finance annually in the years 1983/84 - 94/95. But in recent years the annual share of grants in the deficit finance

showed an increasing tendency. For instance in the years 1995/96 - 99/00 it has an annual share of 41% of the total deficit finance.

Regarding external borrowing, it accounts on average about 54.8% and 43.7% of the external finance during the period 1983/84 - 94/95 and 1995/96 – 99/00, respectively; and it financed about 36% and 29.8% of the fiscal deficit annually in the same periods. On the other hand, unlike grants, external loan is the most important source of financing capital expenditure.

The domestic financing of the fiscal deficit constitutes on average about 39.6%, out of this the banking system contributes more than 90% in the period 1983/84 - 90/91. But in the 1990s, the contribution of the domestic financing has gone down. For instance, during the period 1994/95 – 98/99 its average share out of the total deficit finance was only 17.3%. However, in recent year its share has shown an increasing trend having a share of 36.5% and 63.4% in 1998/99 and 1999/00, respectively. This increasing trend is not surprising since access to foreign loan was freezed due to the war with Eritrea.

2.6. External Trade

Ethiopia, being a small and open economy, is highly dependent on external trade. Openness, as measured by the share of external trade from GDP, increased significantly from around 20% in 1960/61 to 45% in 1999/00. Following this trend, the trade balance has expanded remarkably. For instance, the trade balance that had been 6% of GDP in 1980/81 went to 15.2% of GDP in 1999/00.

The Ethiopian external sector can be characterized as a net importer in the last four decades, with the exception of 1972/73 and 1973/74 in which trade surplus is recorded. As a result of this, the trade balance was expanding continuously. Apart from being dependent on the export of few primary products, the secular TOT deterioration, and the overvalued and continuously appreciating (until 1991) real exchange rate can be stated as the main factors behind the ever-growing trade balance.

Figure 2.6.1

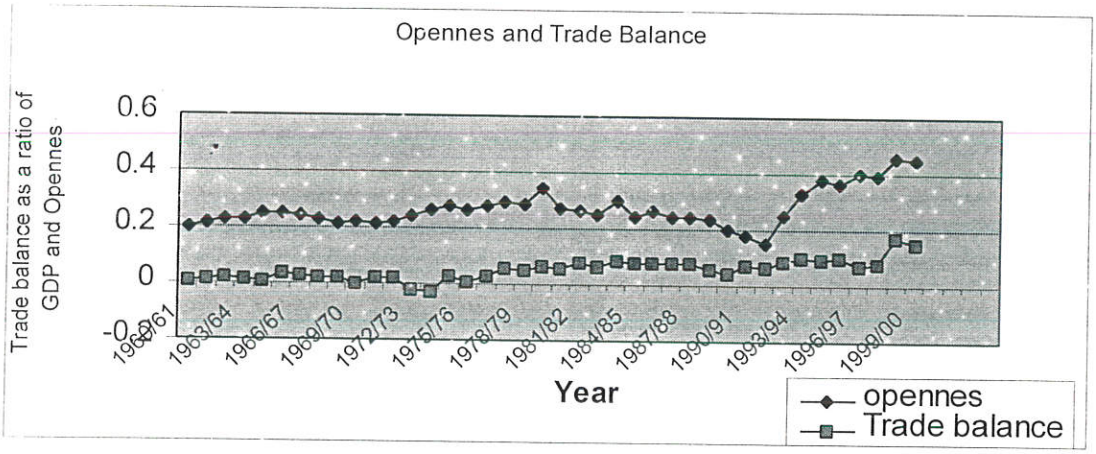
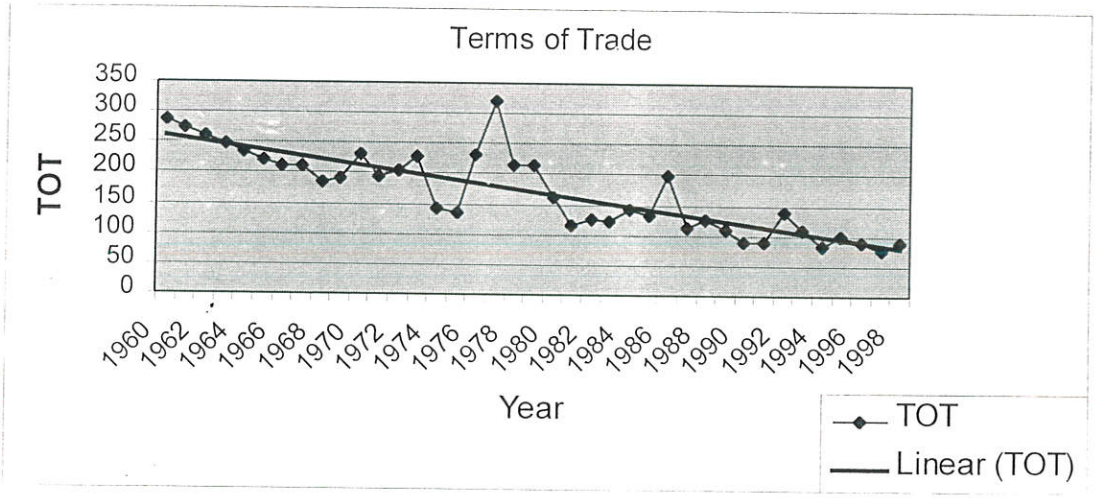


Figure 2.6.2



In the 1960s, exports were growing on average by 9.1% while imports were growing by 8.2%. As a result trade balance and its growth rate were kept low being 1.7% of

GDP and 12.3% per annum, respectively. Even if exports were growing relatively better in the 1970s, 10.5% per annum, trade balance rose to 2.3% of GDP as a result of high growth rate of imports. The positive growth rate of exports disappeared in the 1980s until the beginning of the 1990s, however. In the eighties the annual average growth rate of exports was about –0.5% while imports were growing by 3.2% per annum, thereby driving the trade balance to 7% of GDP in the same period. The deceleration of export growth in this period can be attributed to the policies that had been adopted which include controlling and restricting the private sector from participating in external trade, monitoring prices and quantities; and other distorted anti-market rules (see Alemayehu, 1999c).

In the 1990s a good export performance is achieved. During the period 1991/92 – 99/00 exports were growing by a linear growth rate of 23.2% while imports were growing by 21.5%. This high growth rate of imports and exports is in line with the trade liberalization policy adopted in this period. However, even if the growth rate of exports is remarkable and higher than that of imports, trade balance had rather expanded to reach to an average of 10.2% of GDP in the same period. Especially, in recent years, the trade balance is expanding even more. For instance, in 1998/99 and 1999/2000 it had been 17.1% and 15.2% of GDP, respectively.

The increase in trade balance also shows the declining share of exports in covering import bill. Export earnings were covering about 86% of the import bill in the 1960s and it goes down to 55.2% and 54.8 % in the eighties and the nineties, respectively. This indicates that the domestic capacity to import is eroded continuously, which in effect leads the country to run down its reserve and to be dependent on foreign financial flows to cover its import requirement.

Section III

Literature Review and the Modelling Framework

3.1. Introduction

Several macroeconomic models are built for Africa. Harris (1985) surveyed most of the macro models constructed (until the mid 1980s) in the case of Africa. In his survey of 184 studies, 54% are constructed by university-based professionals, 29% as Ph.D. dissertation, 15% by international agencies and only 2% by African government agencies. The models are classified as supply driven, demand driven, reduced form monetary driven, general equilibrium price clearing and those based on consistency checking without formal closure. The key observation of the survey (Harris, 1985:3) is that the greatest number and most sophisticated of the models have been undertaken as academic efforts; and there is little evidence of these models being used in any systematic way by African policy makers or policy-making organizations. Harris further noted that a few models have been generated within government agencies; however, while none of these models are particularly sophisticated in conception or execution, they do seem to have been used, particularly in the formulation of National Development Plans. In addition to this, only few of the models address issues that have been central to international discussions of IMF and World Bank proposals for stabilization and structural adjustment (Harris, 1985:4). This shows that macro modelling is at its infancy in Africa.

Harris (1985) also implied some of the challenges facing African macroeconomists. Most importantly, the need to develop appropriate theory that reflect on the understanding of how particular economies actually work to guide specification of models that are designed to shed light on the effects of alternative policy actions is given

paramount importance. In light of these observations, some of the macroeconomic models built in the context of Africa and other developing countries are reviewed in the last section in order to draw some lesson in building a macroeconomic model for Ethiopia.

In the next section a brief theoretical background in macroeconomic modelling is presented. The final section reviews different macro economic models constructed in the case of developing countries. Both macroeconometric models and the CGE type models are considered. Emphasis is given to the models built in the context of Africa since most of the economies have similar characteristics and face almost common external shocks. It is believed that this section helps in formulating a relevant macro model for Ethiopia.

3.2. Theoretical Considerations

The knowledge about the operation of the economy is one of the key aspects in designing policy or evaluating alternative policies. In the history of macroeconomics, there are different ways of viewing how the macro economy operates. Hence, it is a natural consequence that the modelling strategy depends on the assumption made about the working of the economy. Following Harris (1985), we can classify the types of macro models into Keynesian/demand driven, supply driven, general equilibrium class of models, and reduced form monetary model. Apart from this classification, we can also have a VAR approach pioneered by Sims (1980) in which the objective is just to fit the data at the expense of theoretical consistency. The theoretical underpinning of such types of models and their variants, such as cointegrating VAR approach, will not be discussed in this section and the detailed discussion can be found in Sims (1980) and

Garratt et al. (1999). However, some empirical models constructed in this framework are discussed in the final section.

3.2.1 Demand Driven Models

Demand driven models are essentially based on the Keynesian framework in which supply does not play any significant role. In this class of models, supply passively adapts itself to demand and that prices are frequently taken as given or changed parametrically (Backhouse, 1995). Thus, the main issue is finding the equilibrium values of interest rate and of output demanded by the economic agents, given the price level (Branson, 1989). The ISLM models are classic examples of demand driven models.

The ISLM model offers a standard theoretical and underpinning of monetary and fiscal policy in the context of demand driven models. The model variants normally considered include a closed or open economy, perfect or imperfect capital mobility, and fixed or flexible exchange rate regimes. Usually a combination of scenarios is assumed and policy analysis is accordingly pursued (Murinde, 1993). The ISLM framework is mostly extended to derive the aggregate demand schedule.

In practical modelling exercise, aggregate demand is disaggregated into its components –i.e. consumption function, investment function (both depends on the level of income), and exogenously given government expenditure. The external sector and the money market are specified usually. Input-output models can also be interlinked into such formulation in order to determine the level of sectoral output requirement such that the final demands disaggregated by commodities can be fulfilled. In this class of models, the closure rule equates output to aggregate demand. In such a case, since supply and prices

do not play any role in the model, the only avenue in which policies can have any impact is through the management of aggregate demand.

3.2.2 Supply Driven Models

In the supply driven models, productive capacity is the main determinant of output. "The key analytical equations are production functions that relate outputs to factor availability and technology, and factor accumulation rules such as saving determined investment level" (Harris, 1985:20). The Harrold Domar and Solow type neoclassical growth models; and consistency check models such as gap models and RMSM are some of the supply driven models.

The closure rule depends on the specific model considered. For instance, in the classical growth models Says' Law is assumed to hold. In the neoclassical models of small open economies, assuming perfectly elastic supplies of import and demands for exports, output composition problems can always be overcome through trade (Harris, 1985). In the context of gap models, the closure rule depends on the assumption made about which gap prevails.

3.2.3 Reduced Form Monetary Models

Such models are basically based on the pioneer work of Polak (1957), and they are popularised, with some extension, as monetary approach to the balance of payment by Whitman (1975) and Frenkel and Johnson (1976). They are further popularised by the IMF research department and came as the financial programming model. Its fundamental basis is that the balance of payments is essentially a monetary phenomenon. As Pilbeam (1998:105) put it "Not only is the balance of payments a measure of

monetary flows, but such flows can only be explained by a disequilibrium in the stock, demand for and supply of money".

The IMF financial programming model is designed to determine the magnitude of domestic creation/expansion required to achieve a desired balance of payments target under a predetermined exchange rate (Agènor and Montiel, 1996). In the words of Frenkel (1991: v) "[financial programming models] start from the proposition that in an open economy with a fixed exchange rate, the money supply is an endogenous variable reacting to surpluses and deficits in balance of payments and not an exogenous policy instrument, as is customarily assumed in a closed economy. ... these models derive a formal relationship between changes in the domestic component of the money stock and changes in international reserve, which can then be employed for setting policy. Specifically, the models allow one to obtain a value for the policy variable – domestic credit- that is consistent with a desired balance of payments position".

The closure rule for such models can either be classical or Keynesian. In the classical case it can be solved for the domestic price level, taking real output as exogenous; and it can be solved for the changes in real output taking the price level as given in the Keynesian case (Agènor and Montiel, 1996).

3.2.4 General Equilibrium Class of Models

3.2.4.1 Computable General Equilibrium Models (CGE)

The main task of CGE models is to analyse the complex linkages among economic agents that characterize a general equilibrium system (Robinson and Roland-Holst, 1988). CGE models are mostly constructed based on SAM. The model works by

simulating various economic actors across markets (Robinson, 1989). As the name indicates, the model incorporates a complete specification of both the demand and supply sides of all markets. CGE models can be classified into neoclassical and structural CGE.

In the neoclassical CGE models, optimising behaviour of agents is assumed and incorporated in equations describing their behaviour, which essentially describe various first order conditions for profit and utility maximization (Robinson, 1989). In addition, the assumption of full employment is maintained through out the neoclassical CGE. As any other neoclassical models, product and factor prices are the major equilibriating variables.

The other type of CGE is structuralist CGE model. According to Taylor (1990:1) "[s]tructuralist thought considers that structural characteristics of the economy are fundamental to its behaviour. Among the structural factors are distribution of income and wealth, tenancy relationships on the land, the type and degree of specialization in foreign trade, the density of chains of production, the degree of concentration in markets, control of the means of production by distinct types of actors, functioning of financial intermediaries, and penetration of technical advance, as well as socio-political factors associated with the extent of organization of the working class and other influential sectors and classes, the geographical and sectoral distribution of the population, and its level of skills". Thus, in the structuralist tradition, disequilibria are explained as being caused by political and social conflicts. The CGE model is, therefore, constructed to reflect such peculiar feature of the economy unlike that of the neoclassical CGE that is essentially based on only the first-principle.

3.2.4.2 Econometric General Equilibrium Models

The econometric general equilibrium models are based on the specification of aggregate demand and aggregate supply along with the money market and exchange rate determination equation/s. The standard neoclassical general equilibrium models, such as the RMSM-XX, fall under such category. The neoclassical general equilibrium model specification contains the money market, goods market and the labour market, all being the function of set of prices such as real wage and interest rate. As a closure, equilibrium condition in each of the markets is also specified to maintain the general equilibrium condition.

Different types of such general equilibrium models can arise depending on the specific closure rule. For instance, using the neoclassical general equilibrium model with out instantaneous market clearing, we can reach to some form of disequilibrium model in which equilibrium may be restored through an adjusting variable. Prices can serve as equilibrating variable in a case where excess demand prevails while the adjustment may come through capacity under utilization if excess supply prevails. In the context of general equilibrium model, inconsistencies may also be let to be absorbed through passive accumulation or de-accumulation of stocks, fiscal deficits or balance of payment deficit or surplus (Harris, 1985).

These types of models have a desirable characteristic that both side of the economy are emphasized and modelled explicitly. This limits the occurrence of outrageous assumptions such as supply created its own demand in the case of supply driven models or supply adapts itself to demand. Thus, in section four the model is specified in a

general equilibrium context in which price acts as an adjusting variable whenever there are inconsistencies between demand and supply.

3.3. Survey of Empirical Literature

As discussed in the previous section we can have different theoretical formulation in building macroeconomic model. In this section, attempt is made to show the specific features of some of the models that fall under the category of demand driven, supply driven, general equilibrium class of models and VAR based models. The classification is mainly based on the dominant closure rule assumed in the models.

Demand Driven Models

Oshikoya (1990) built a demand driven macro model for Nigeria combining macro econometric and input output approaches. The model is composed of 7 major blocks (domestic expenditure block, public finance and money supply block, foreign trade and balance of payment block, input-output production sector, national income block, factor of production block, and wage and prices block) with 25 stochastic equations, 5 input output relationships and 38 identities and definitions. The macro model of the final demand is complemented by the inter industry supply flows through the input-output model. The residuals in the sectoral value added from the input-output model are also modelled as stochastic equations with the inclusion of capital stock, inter alia, as a proxy for supply constraints in production.

In the domestic expenditure block, private consumption expenditure is related with disposable income, price and bank credit to the private sector while the government consumption expenditure is assumed to be a function of total government revenue. The private investment expenditure is specified in a simple form to be dependent on lagged level

of income and the average discount rate. The government investment is assumed to be exogenous policy variable.

The second block i.e. public finance and money supply specifies the disaggregated government revenue functions, interest payments and amortization on external debt and money supply function. The interesting aspect of this block is that it makes external debt servicing and money supply endogenous to the model considering a rising level of external debt and debt servicing payment and low level of the asset and financial markets. In the foreign trade and balance of payments block two export equations and four import equations are identified. In all of the import equations foreign exchange reserve is included as a proxy for policies relating to the rationing of foreign exchange. The balance of payment sector is linked with the rest of the economy through the final demand that is linked to the sectoral value added via the input-output relationship. This sector is also linked to the public finance and money supply sector through the government oil export revenue, which in turn affects government spending.

Block four represents the input-output production sector. In this section, value added in agriculture, mining, industry, utilities and transport, and commerce and service and their residuals are included. Value added in each sector is generated by transformation of an input-output type production process linking final demand with value added by sector. In the sectoral residual equations, capital stock and a time trend are included to endogenize supply constraints, changes in technology and tastes. The national income and the factors of production blocks-i.e. block 5 and 6 are basically definitional relationships. The final block relates wages and prices. The major innovation of the model is that it incorporates the input-output model into the macroeconometric model to capture the

intersectoral linkage. Moreover, both the demand and the supply aspects are emphasized.

El-Sheikh (1992) has also constructed a demand driven macro-sectoral model of Egypt to capture the interaction between financial sector, balance of payment, producing sector and prices. The model is composed of 31 behavioural equations and 9 identities with four major blocks: the demand components block, production sector block, public finance and the financial sector. On the demand side, private consumption function (disaggregated into food and non-food consumption with bank credit as an additional argument), export functions (disaggregated into cotton and manufacturing export) and import function for intermediate inputs and foods are specified. Public consumption and investment are assumed to be exogenous policy instruments. The interesting aspect of this block is the way manufacturing export function is specified. The manufacturing export is dependent, inter alia, on the manufacturing capacity output level that is used as a proxy to importing capacity of Egypt's trade partner[5]. In addition, it may also account for supply constraints on export.

The other important block is that of the production block that is disaggregated into agricultural and urban supply subsystem. The agricultural supply subsystem, which sectors agricultural products into cotton and foods, is essentially formulated in a neoclassical fashion in which a Cobb-Douglas production function is set for both of the agricultural products. The income derived from the sector, which is an accounting identity approximated by econometrics, is given by the agricultural value added function. The urban supply and income subsystem is formulated based on a Leontief

view of urban production by identifying the urban value added equations. The urban economy is divided into construction, manufacturing, distributive services and residual sector (which is extraneous due to its nature). The value-added equations for the above three sectors are formulated based on the input-output coefficients by linking the sectoral final demand components with the aggregate demand components, which is essentially a Keynesian formulation. This formulation assumes a highly elastic urban supply with the bounds of the existing production capacity. However, a supply dummy is introduced to allow for input shortage and hence the resultant under-capacity utilization.

Another important block is the financial asset holding block. The asset holding equations are formulated based on the stock adjustment version of the rational portfolio selection hypothesis and all the relevant yields are set exogenously. The final block is the public finance block. In this block different types of government revenue functions are specified and the government expenditure is assumed to be exogenous.

Generally, the model is a detailed model and it tries to capture the institutional regularities of the Egyptian economy. Its attempt to relate the input-output formulation with the macroeconometric structure and the degree of disaggregation of the model are its positive sides. However, the exogeneity assumptions on investment (both private and public) and the government expenditure are questionable.

[5] It is implicitly assumed that capacity manufacturing output is predominantly determined by the availability of international market. Hence, the growth in manufacturing capacity output can be partly attributed to the importing capacity of the trading partners, among other things.

Egwaikhide (1997) also constructed a small demand driven macroeconometric model for Nigeria with the objective of analysing the effect of budget deficit on the current account. The model has 8 behavioural equations with 9 definitions and identities. In the model price is endogenously determined depending on the money supply and the parallel market exchange rate, among others. Domestic absorption is divided into private consumption (modelled using consumption function), gross investment (a simple accelerator model) and government expenditure (divided into transfer expenditure - assumed to be exogenous- and other government expenditure). The government sector determined the government budget deficit depending on the government revenue and the government expenditure. The external sector determines the current account balance depending on the total export, disaggregated into oil (exogenous) and non-oil (endogenous) exports, and total imports modelled to be a function of the (endogenous) aggregate demand, terms of trade and its lag level. Finally, the monetary sector is specified in a quite simple way containing only the definitional money supply equation and thus the money demand is implicitly assumed to be passive that adapt to the money supply.

In general the model is fairly good for its objective though it is small. Nevertheless, the estimation suffers from simultaneity bias since the equations in the model are estimated by OLS that does not take care of the contemporaneous correlation between the endogenous variable and the disturbance term in the system. Moreover, the results may also be spurious as there is no test for the time series properties of the variables.

Supply Driven Models

Lipumba et al. (1988)[6] built a supply driven macroeconometric model of Tanzania. The model has 90 equations, of which 37 are behavioural. The model disaggregates GDP into eight sectors (agriculture, manufacturing, construction, commerce, transport, utilities, public administration, and mining-exogenous). Employment is determined exogenously for six sectors; for manufacturing and construction, it is determined simultaneously with sectoral output. Real absorption is divided into real private consumption, real fixed capital formation (a supply constrained accelerator model) and exogenous real government expenditure. The government sector determined the nominal government deficit, depending on endogenous government revenue and exogenous government expenditures. The nominal government deficit then feeds into the money supply, which in turn affects prices.

In the monetary sector, money demand is let to adjust to the money supply, and hence there is no role for the rate of interest. The price sector is composed of six endogenous sectoral deflators and three economy wide deflators. The economy wide deflators depend on import prices, overall productivity, and the money supply. Finally, the external sector is modelled in detail (having 32 of the 90 equations) since it is argued that this is the main route by which supply constraints operate. Export is disaggregated into five based on the type of crops exported and imports are also disaggregated by the type of imports. In the model foreign exchange availability is considered as the most important constraint to imports. Moreover, the supply-constrained nature of the economy is also reflected in the way GDP is constructed.

[6] The review of this model is based on the shorter version of the model presented in Horton and McLaren (1989).

Perera (1994) constructed a macroeconometric model of Sri Lanka to assess the impact of exogenous shocks and macroeconomic policies. The model looks a supply-constrained model from the way it is constructed. The model has five blocks: GDP by sector of production, expenditure on GDP (demand side), the government sector, monetary sector and the external sector. The agricultural sector is disaggregated into five major crops and for crops which have a long gestation period, their production functions are derived from the first principle that captures the decision making process. The manufacturing sector is disaggregated into three sub-sectors: export processing, industrial sector and construction (demand determined). The service sector value added is also disaggregated into four sectors: trade, transport, public administration and other services: and all re determined by both demand and supply conditions.

The demand side of the model is specified under each production sector of the model. The domestic consumption function for each of the agricultural produces (i.e. tea, rubber, coconut and minor food crops) is specified in the respective sub-sectors. The consumption functions of industrial goods and investment in industries are explained under the industrial sector of the model.

The government sector contains the government revenue and the government expenditure functions (both are exogenous) and they determine the government deficit, which has a feed back effect to the money supply. The monetary sector specified an endogenous money supply function with government fiscal deficit and external assets as an argument, among others. Finally, the external sector specified disaggregated import and export functions, and it is linked to the rest of the economy through the money supply function.

Van Frausum and Sahn (1993) have also constructed a supply driven macroeconometric model for Malawi with the objective of measuring the effects of external shocks and policies. The model is composed of 60 equations (of which 20 are behavioural) with 5 blocks: production block, balance of payment block, government finance block, price block and monetary block. The production block disaggregates GDP by sector of production: agriculture, industry, and construction. The service sector is extraneous assuming that services are a mark-up over production in the other sectors. For the agricultural sector three supply response functions (for maize, cash crop and estate crop production) are specified. The industrial sector is specified by letting industrial production index to be a function of imports of intermediate goods, capital stock of equipment, capital stock of infrastructure and an interaction term. Finally, value-added of the construction sector is specified as a function of gross fixed capital formation of government and of the private sector.

The balance of payment block is one of the interesting blocks of the model. It shows how the current account balance is ultimately transformed into external debt. The export equation is identified to be dependent on cash crop production level and relative prices, among others. The import function is basically a foreign exchange constrained function where foreign exchange availability (i.e. value of total exports plus long term borrowing net of factor payments) and credit worthiness indicator are the arguments. Total external debt (identity) is modelled as a sum of one-year lagged debt and the balance of the current account. The next block is the government finance block that is entirely made up of non-stochastic equations. Current revenue is determined by imports and GDP.

Official transfers are assumed to be exogenous. Government external debt service and interest payments on domestic debt are given as a function one-year lag external and domestic debt outstanding. The government expenditure is determined as an identity by the financial constraints- i.e. total revenues plus net borrowing. The price block includes six prices: retail price index, GDP deflator, real wage rate in the private sector, black market exchange rate, gross fixed capital formation deflator and deflator for government expenditure on wage, goods and grants. And finally, the monetary sector block specifies total advances from commercial banks as a function of foreign exchange availability and of the real interest rate.

In general the model is a good representation of a typical developing economy. However, some of the assumptions are stringent. For instance, as noted by Alemayehu (1998), the assumption of government expenditure determination by financial constraints alone ignores the inelastic nature of government spending and the inflation that can be possibly generated in this process in developing countries.

Lemma (1993) constructed a macroeconometric model for Ethiopia. The model has 53 equations (of which 14 are behavioural and the rest 39 are identities) with four major blocks: production sector and investment block, foreign trade block, public finance block and the price block. The model is essentially supply driven and has two productive sectors- agriculture and non-agriculture. The agricultural sector is related to the real relative price the farmers receives, the supply of manufactured goods to the farming sector and other exogenous variables like rainfall. The value added in the non-

agricultural sector is specified as a function of the level of monetary investment. The aggregate level of investment, in turn, is a function of major source of funding such as government savings, credit from banking system and foreign capital inflow.

The foreign trade block contains three export supply functions (private export functions for pulse and hide; and public coffee export function) and two import demand functions (capital goods import and raw material imports, and consumers good import is assumed exogenous). The government sector consists of two behavioural government revenue functions (direct and indirect taxes revenue function and import tax function) and an identity export tax revenue function. The government current expenditure and export tax rates are treated as policy instruments. Finally, the price block identifies two price equations based on consumer price index (CPI) and industrial sector price deflator. The change in CPI is related to excess domestic demand (a pure monetarist formulation) and rate of inflation for imported goods. Price in the industrial sector follows a mark-up rule and is indexed to the CPI in the structuralist tradition.

The model, by and large, describes the structural and institutional peculiarities of the Ethiopian economy and its policy-making institutions of the socialist era (post 1974/75). However, a significant part of the data (10 observations out of 18) used is for the period of pre-1974/75 which cannot be described by the above explained model due to a clear institutional and structural differences between the two periods. In addition to this, some of the assumptions in which the model rests constrained the wider use of the model. For instance, the exogeniety assumption on government current expenditure and agricultural price is questionable. In the case where the economy is open for external shocks such as

war, drought and terms of trade fluctuations, the exogeneity assumption on government recurrent expenditure will not be a fair assumption. Moreover, to the extent that peasants in Ethiopia had been marketing a considerable part of their produce (after fulfilling the levied quota by Agricultural Marketing Corporation) in the flexible price market, treating agricultural price as purely exogenous is not acceptable. The exclusion of the monetary sector and the formulation of CPI equation can also stand in the negative side of the model. Above all, the result of the model suffers from simultaneity bias as each equation in the model is estimated by OLS.

Asemerom and Kocklaeuner (1985)[7] also constructed a supply side macroeconometric model for Ethiopia. The supply side of the model disaggregates GDP by the production sectors: agriculture, other commodities, construction and distributive service and other services. From the expenditure side, the consumption function (for both private and public), sectoral investment functions, export and import functions are specified. The export function is disaggregated into coffee and non-coffee and imports are also disaggregated into capital goods, intermediate goods, consumption goods, fuel, and service imports. Savings are disaggregated into private and public and specified accordingly. Finally, the saving and the trade gap equations, assuming the trade gap is binding, close the model.

The model is fairly disaggregated. But, as Lemma (1993) noted, the sectoral equations are not interconnected to capture the simultaneity in the system and hence an exogenous shock in one variable would fail to have any impact on the rest of the system. Moreover,

[7] Asemerom (1991) has also constructed a macroeconomic demographic model for Ethiopia. Nevertheless, it is not reviewed here since it deviates from the objective of this study.

because of the absence of price equation, the effect of any disequilibrium between aggregate demand and supply would completely spills-over to the foreign balance and hence it over or under estimates the foreign exchange gap.

General Equilibrium Models

CGE Models

Davies et al. (1994) constructed a CGE model for Zimbabwe to analyse the impact of state regulation and interventions and hence the resultant import compression argument. For this end the regulations are analysed within a macroeconomic framework that is build around a social accounting matrix for 1985. The model consists of 113 equations, of these 112 are independent and hence there are 112 endogenous variables. However, the basic feature of the model is comprised of 25 equations of which 24 are supply side equations and the remaining one is the closure of the model that equates the demand side with the supply side.

Basically the model is comprised of three sectors: food agriculture, non-tradable and tradable. The non-tradable sector is further disaggregated into consumer and capital goods; and the tradable sector is disaggregated into exportable and importable in order to include the terms of trade effects and differences in import rationing. The policy rule for allocating foreign exchange is also introduced to link import capacity to capacity utilization in import dependent manufacturing industries. Finally, the model is used to identify driving forces in the growth pattern and for counterfactual investigations of the consequences of drought, exchange rate policy and a change in public expenditure patterns. But some of the stringent assumptions of the model, such as the exogeneity assumption on the agricultural sector and on investment, may constrain the wider use of the model.

Decaluwé et al. (1994) built a CGE model for Rwanda to analyse the policy impact under credit rationing. The model has a total of 70 equations: 4 price equations, 11 equations relating output and employment, 4 equations which describe the operating surplus in the economy, 12 equations describing households behaviour, 6 equations that depict firms behaviour, 22 equations which define the public sector, the central bank accounting and the operation of commercial banks, and 7 equations describing demand for products and the external sector. Finally, 3 equations are set as a closure of the model.

In the supply side the production activities are divided into three sectors: export crop production, manufacturing and export of crop production, and other production activities. From the demand side final demand is equated with total investment expenditure and consumption. Finally the income of firms and commercial banks is derived from the SAM. One of the interesting aspects of the model is that it tries to depict the financial constraints on the supply side and hence it represents a typical repressed economy.

Go (1994) has also constructed a macro model for Philippines using a dynamic CGE model with the objective of analysing the effect of external shocks and adjustment policies on investment and growth. The model is constructed in a dynamic context to incorporate inter-temporal and forward-looking behaviour in investment and consumption decisions. Saving and investment decisions are assumed to be separate and simultaneous. At each point in time, consumption is and increasing function of wealth and investment is also an increasing function of Tobin's q. The equality of savings and

investment is assumed to be brought by an adjustment in the level of foreign borrowing supplied at a given world interest rate.

In the production block three producing sectors (primary sector, manufacturing sector and service sector) with two labour types- urban and rural- and one representative household are identified. Production is formulated as a nested function of inputs. Output in each sector is a CES combination of value added and material input. Material input is a fixed-coefficient aggregation of inputs. Value added is also a CES composite of labour and installed capital. Labour in each sector is a Cobb-Douglas combination of urban and rural type. The other blocks of the model are the public finance and the external sector. The public finance block of the model is composed of government revenue and government current expenditure, and assumes government capital expenditure to be exogenous. The external sector is characterized by the imperfect substitutability of domestic and imported goods.

The working of the model follows the general equilibrium condition. It assumes that demand for each labour type equals its supply, the demand for each category of goods equals its supply, the balance in the external current account must be offset by flows in the capital account, government revenue is allocated between public expenditure and savings, and total savings must cover total investment expenditures. The model is interesting in its attempt to introduce dynamics in the CGE model.

Storm (1994) constructed a dynamic CGE model for India to assess the macroeconomic impact of agricultural policies. The model is a nine-sector dynamic model constructed for a mixed economy. The production side of the model is disaggregated into two sectors- agricultural and non-agricultural (which includes services and manufacturing).

Agricultural prices are assumed to fluctuate to clear the market. But in the case of rice and wheat the price adjustment is subjected to lower bound procurement prices. The non-agricultural sectors display a mark-up pricing scheme due to its oligopolistic structure and capacity under-utilization. Production in the agricultural sector is assumed to be determined by a two-stage procedure in which, first, the land allocated to it is determined; and next, its yield level per unit of land is established. In non-agricultural sector output is determined by sector wise demand, presupposing under-utilization of production capacities.

On the demand side, private consumption, private investment and public investment functions are specified for both agricultural and non-agricultural sectors. In the external sector exports and competitive imports are assumed to be exogenous. The public finance block specifies the government revenue and current expenditure equations, which are both definitional. Finally, the model is closed by national income identity that equates GDP to its sectoral components, and maintains saving investment balance. The determination of the agricultural production and the attempt made to capture the institutional aspects of the model (such as the pricing schemes for some of agricultural products) are the interesting aspects of the model.

Econometric General Equilibrium Models

Haque et al. (1991) have constructed a prototype general equilibrium macro economic model for developing countries. The model is constructed in a flexible price Mundell-Fleming framework (with 7 behavioural equations and 15 identities and definitional equations). From the aggregate demand side consumption is specified as a function of real interest rate and disposable income. The investment function is basically an

accelerator model where real interest rate differential is included as an additional argument. Another aspect of the aggregate demand is the trade balance in which the export and the import functions are specified. Exports are assumed to be a function of the real exchange rate and foreign income while imports are related to real domestic output and the real exchange rate. Finally, the government sector is assumed to be exogenous.

On the supply side, the economy's aggregate supply function is specified as a Cobb-Douglas production function with the assumption of complete wage-price flexibility. In the money market, the money supply and domestic interest equations are specified. The money supply equation is given as a sum of domestic credit and foreign exchange reserve where the latter is determined endogenously through the balance of payment. The domestic nominal interest rate is specified to depend on foreign interest rate, expected change in exchange rate and degree of capital mobility.

The prototype model explained above is estimated for 31 developing countries. The inclusion of degree of capital mobility into the model and endogenizing the foreign exchange reserve accumulation are the positive sides of the model. However, the basic assumptions of the model are questionable and at most unrealistic in the case of developing countries. For instance, the assumption of complete wage-price flexibility and some monopoly power of the developing countries over the price of its output in the world market do not seem realistic. In addition to this, even if the authors claim that they used an efficient estimation technique and control for country heterogeneity, using fixed effects model for distinctly different groups of countries (such as Brazil, Chile, S.Africa, Ethiopia, Kenya, etc) does not give reasonable estimates. Moreover, their result may not

be robust in the face of the recent estimation techniques that consider unit root and cointegration in panel data.[8]

Bodart and Le Dem (1996) have also constructed a macroeconometric model in a general equilibrium framework for Cote d' Ivoire with the objective of analysing the labour market. The model is constructed on the assumption of small, open developing country with a pegged exchange rate regime and perfect capital mobility. The economy is divided into three production sectors: agricultural sector (producing for both export and domestic consumption), urban formal sector (essentially producing manufacturing good for both domestic and export) and urban informal sector which basically produces non-tradable or petty-trade goods and non-traded services. The demand side of the economy is represented by the usual Keynesian way that is comprised of private consumption, public consumption (exogenous), investment, and trade balance. The allocation of the labour force is disaggregated and related to each of the production sectors and the public sector.

In the model labour demand is represented well in all of the production sectors. Labour demand is derived by the first principle from the constrained maximization problem of each production sector while the demand for labour in the public sector is assumed to be exogenous. Different wage rate determinations are also defined for each sector. The wage rate is assumed to be determined based on the average production in the agricultural and informal sector while in the formal urban sector wages are assumed to be fixed by institutional factors and are fully indexed to the public wages. The public

[8] See Pesaran, 2000 and Lm, et al. 1997 for a detailed discussion of this method.

wages are determined by some form of exogenously given mark-up rate based on one period lag of wage rate.

In general the disaggregation of the model (especially the labour market) is quite satisfactory. Its attempt to derive the labour demand of each production sector from the first principle and to explicitly introduce the informal urban sector is its strong aspects. However, the use of the model is constrained by its limiting assumptions such as perfect capital mobility and non-existence of rural unemployment. These assumptions have serious implication in the model. For instance the assumption of perfect capital mobility is manifested in the closure of the model in which external financing gaps are closed automatically. The assumption of the non-existence of rural unemployment is also manifested in the wage determination of the agricultural sector, which is based on the agricultural average productivity.

VAR Based Models

Chishti et al. (1992) have tried to construct a macroeconometric model of Pakistan using a VAR approach. The VAR model contains ten 'key' macroeconomic variables that are involved with stabilization policies. The model is estimated based on unrestricted VAR and employs an F-test and impulse response function to analyze the anticipated and unanticipated shocks. The results of the model have some interesting features. For instance, the F-test shows that real GDP, price and the external resource are affected by anticipated policy shocks while the other variables are invariant with such shock. The impulse response exercise also shows the effect of conventional stabilization policies such as monetary and fiscal policy shocks. However, their approach- i.e. Sims type unrestricted VAR approach- has been subjected to a number of criticisms. As discussed

by Garrat et al. (1999) first, the approach requires care in the initial stage of transformation of the data to achieve stationarity (even if the authors argued that the transformation does not matter). For example, a VAR model of the first-differences of I(1) variables is misspecified if there exists a cointegration relationship between two or more of the I(1) variables. Second, the variables included in such a VAR model are arbitrary and it is difficult to imagine how this choice could be made without reference to some underlying economic theory.[9] The model could rather be more appealing from both theoretical and empirical aspects if it were constructed in a structural (cointegrating) VAR framework.

Kouassi (1997) also constructed a structural cointegrating VAR based macro model for Cote d' Ivoire to analyse the impact of external shock on the domestic economy. The model is classified into three blocks: public finance block, balance of payment block and the money market block. The public finance block is composed of two government revenue equations, one expenditure equation and a fiscal closure that determines the budget deficit. The government revenue is disaggregated into fiscal and non-fiscal revenue where the first one is specified as a function of real GDP, level of import, terms of trade and prices while the later is a function of total export and terms of trade. The government current expenditure is also modelled to be a function of current and lagged level of real GDP and price. In modelling the government expenditure, only the current expenditure is specified assuming, implicitly, capital expenditure to be exogenous.

The balance of payments block is composed of two equations: the foreign exchange reserve equation and the current account balance equation. The foreign exchange reserve

[9] Also see Pagan (1987) for detailed discussion about the pitfall of using such method.

accumulation equation is given as a definition while the current account balance is a behavioural equation that relates the current account balance with the level of import, export, terms of trade, debt and the real exchange rate. The last block- money market block- specifies an exogenous money supply equation and behavioural money demand and price equations. The money demand function is a standard money demand function with income and expected inflation rate, among others, as arguments. The price equation relates the domestic price level with local goods and imported goods prices. The model is estimated using unrestricted VAR approach after identifying the cointegrating relationships and attempt is also made to address the problems related to time series econometrics. Moreover, the attempt made to relate and hence to show the effect of external shocks (mainly terms of trade shock) on government budget is the interesting feature of the model.

Section IV

4.1 The Modelling Framework

The issues that confront a model-builder include the choice of appropriate theoretical framework for modelling the economy; the extent of institutional and structural details to be incorporated in such a model, and what should be the 'correct' use of macro models in such economies (Soludo, 1995). The size and structure of a macro model reflect the different purposes for which they are built. Thus, in this paper a small macroeconometric model will be formulated that can be used for policy analysis and/or evaluation purpose.

The mainstream models of the early 1970s were emphasizing the effective demand ignoring the supply side of the economy. These models were based on the Keynesian IS-LM framework which is basically demand-driven and assumes that whatever is demanded is supplied, and, in a way, the supply side does not play any role in the model. According to Wallis (1989 and 1995) this approach was rudely shocked by commodity price fluctuations and the 1974-75 recessions. In addition, the models were not able to cope up with the coexistence, not previously experienced, of rapid inflation and high unemployment (Wallis, 1995). These factors coupled with Lucas (1976) and Lucas and Sargent (1978) critics called for a modification or a complete change in the modelling framework. Following these developments internally consistent and articulated macroeconomic framework that captures both the demand and the supply side started to come into the modelling arena. Nowadays the change is stimulated, especially in the case of developing countries, due to the shift in emphasis on stabilization policies.

In the cases of developing countries, the structuralist school has great influence in macroeconomic modelling. The structuralist school argues that every economy is unique and hence models must take the unique features of the economy in question into consideration. Thus, models must be tailor-made for the particular economy that they are used in (see Taylor, 1983 and 1991 and Alemayehu, 1998). However, there is no consensus to-date on the appropriate analytical framework for the study of developing country macroeconomic issues (Haque, et al, 1991).

Some emphasize the economic theory while others emphasize the structural features of the economy as a guide for macroeconomic modelling. According to Soludo (1995:3) "the view by some analyst is that economic theory is economy-specific, and thus the structural and institutional characteristic should be taken as a given, and economic theory and policy making (must also be) designed to be consistent with the given features". Nevertheless, what is more important is to formulate a model that shows the structural features of the economy without compromising the economic theory and the analytical rigor of the model. As Wallis and Whitley (1991:284) put it "given the indispensability of macroeconometric models- there is no alternative- the task of economists and econometricians is to ensure that policy makers have available to them the best possible models". In view of this, the model is set up in a general equilibrium framework and the individual equations are specified based on the economic rationale and the characteristics of the economy.

4.2 Model Specification

The behavioral model developed in this section tries to capture the peculiar structure of the Ethiopian economy. The model is developed considering the supply-constrained nature of the economy. On the supply side, total output in the economy is disaggregated into agricultural sector and non-agricultural sector which basically includes industry, services and other distributional activities. In addition, since the economy is characterized by a general capacity under utilization, the capacity utilization rate of the economy is also specified. On the demand side, the private and public consumption expenditures and private investment expenditure functions are specified. The government investment is assumed to be exogenous. In addition to the public and private expenditure components, the domestic demand for imports (disaggregated into consumption goods import and intermediate and raw material import) and foreign demand for export is included on the demand side. The monetary sector contains a behavioral money demand and definitional money supply equations. The money supply equation is endogenous to the model to capture the monetization of the deficit. The price and the real exchange equations are also specified and hence they are determined endogenously.

Aggregate Demand

Aggregate demand for domestic output is the sum of domestic absorption and the trade balance.

$$Y = A + (X-Z)$$

Where A is domestic absorption and X and Z are export and import, respectively. Domestic absorption is in turn the sum of private consumption (C), investment (I) and government expenditure on domestic goods (G).

Private Consumption

The consumption function is specified in the traditional way in which consumption level is a function of income and price level. The function is given as

$$\text{Log } RC_{pt} = \beta_{10} + \beta_{11} P_t + \beta_{12} \text{log} RC_{t-1} + \beta_{13} \text{log} RY_t + \beta_{14} \text{log } RY_{t-1} \quad \ldots\ldots\ldots(!)$$

where RC_{pt} is real private consumption, P_t is the price level and RY is real income.

Private Investment

The private investment function is specified based on FitzGerald et. al (1992). The model is basically an accelerator model but it is extended to capture the external constraints to private investment.

The private investment (Ip) function is defined in the simple accelerator model to show the adjustment of capital stock (K*) to its desired level (K_{pt-1}).

$$I_{pt} = \lambda(K^*_{pt} - K_{pt-1}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.1)$$

Where λ is the adjustment coefficient.

The desired capital stock for the current year (K^*_{pt}) is given as

$$K^*_{pt} = b_1 RY_t + b_2 kg_{t-1} + b_3 DG_t + b_4 Z_t + b_5 J \ldots\ldots\ldots\ldots\ldots (2.2)$$

$b_1 > 0$; $b_2 > 0$; $b_3 < 0$; $b_4 > 0$; $b_5 < 0$

where DG_t is level of public debt

Z_t is the level of imports; and J is capital flight

Substituting (2.2) into (2.1) and first differencing to circumvent the capital stock problem we yield

$$I_{pt} = \beta_{20} \Delta RY_t + \beta_{21} I_{gt} + \beta_{22} Z_t + \beta_{23} \Delta J_t + \beta_{24} PB_t \quad \ldots\ldots\ldots(2.3)$$

Where PB is first difference of DG and implies public current borrowing; and I_{gt} is the first difference of government capital stock implying the government investment expenditure. Since the measurement of capital flight is controversial, ΔJ will not be used in the estimation process.

Government Sector

The government sector is modelled from both the revenue and expenditure sides. From the government revenue side, tax revenue is modelled to be a function of total output and foreign financial flows and the non-tax revenue is assumed to be exogenous. The expenditure function is also explicitly specified rather than being assumed to be exogenous policy variable[10]. Assuming expenditure as exogenous is not realistic so long as the economy is open for external shocks such as increase in foreign inflation rate and/or foreign interest rate, and an increase or decrease in foreign financial flows.

The specification of the government sector is basically based on Alemayehu (1998) with some extensions to allow for the effects of foreign inflation on the government expenditure.

Tax Revenue

Tax revenue is defined to be a function of economic activity proxied by GDP (Y), level of foreign trade and foreign capital flow (F). This is given as

$$\text{Log } TR = \beta_{30} + \beta_{31} \log RY_t + \beta_{32} \log (x+Z) + \beta_{33} \log F_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where $\beta_{3i} > 0$ and $i = 1...3$

[10] For instance, Feltensten (1985) treated expenditure as exogenous policy variabe.

Government Expenditure

The government current expenditure (G) is assumed to be positively related to total revenue (T) and foreign inflow (F). Foreign inflation rate proxied by import price (p^m) is also included in the specification and expected to be related positively with G. the lagged value of G is also introduced to show the persistence of previous patterns of expenditure

$$\text{Log } G_t = \beta_{50} + \beta_{51}\text{logTR}_t + \beta_{52}\text{logF}_t + \beta_{53}\text{logP}^m + \beta_{54}\text{logG}_{t-1} \quad \text{.....(4)}$$

where $\beta_{5i} > 0$ for $i = 1...4$

Foreign capital inflow is included in the above specifications to allow for the possible effect of foreign capital inflow on revenue and expenditure following the 'fiscal response to foreign financial flow' literature which argues that foreign financial inflows reduce government effort in collecting tax (see Heller, 1975, Mosely et. al, 1987, White, 1993 and 1994, and Gang and Khan, 1991).

Fiscal Closure

The fiscal stance of the government is closed by the public deficit and its given as

Total government revenue (TGR) = TR + other government revenue (OGR)

Total government expenditure (TGE) = G + Capital expenditure (CE)

Fiscal deficit (FD) = TGR - TGE

External Sector

Export

A single export supply function is estimated without desegregating the total exports into coffee and non-coffee like Asmerom and Kocklaeuner (1985) and Lemma (1993). This

is fairly acceptable since the natures of the commodities exported are almost similar. The equation is, therefore, given as

$$\text{Log } X_t = \beta_{60} + \beta_{61} \text{logTOT}_t + \beta_{62}\text{logRER}_t + \beta_{63} \text{logCUR}_t + \beta_{64}\text{logRY}_t$$

Where $\beta_{61} > 0$ $\beta_{63} > 0$ $\beta_{64} > 0$; β_{62} is indeterminate. .....(5)

Imports

The import function is disaggregated into two parts: consumers' good import and intermediate import. The specification is similar to that of Soludo, 1995.

Consumers' Good Import

$$\log \text{Zcons}_t = \beta_{70} + \beta_{71} \log\text{RY}_t + \beta_{72}\log\text{RER}_t + \beta_{73} \log R_{t-1} + \beta_{74}\log\text{Zcons}_{t-1} \quad .....(6)$$

where Zcons is import of consumers' good, RY_t is real income, RER is real exchange rate and R is total foreign exchange reserves.

Intermediate import

$$\log \text{ZRac}_t = \beta_{80} + \beta_{81} \log\text{RY}_t + \beta_{82}\log\text{RER}_t + \beta_{83} \log R_{t-1} + \beta_{84}\log\text{ZRac}_{t-1} \text{.....(7)}$$

where ZRac is intermediate import, RY is real income , RER is real exchange rate and R is total foreign exchange reserves.

In both import equations lagged dependent variables appeared to show partial stock adjustment behaviour.

Total import (Z) will then be the summation of consumers' good import, intermediate import; and other imports.

$$Z = \text{Zcons} + \text{Zrac} + \text{Zother}$$

External Sector Closure

The external sector is closed by the reserve flows identity in which the accumulation or de-accumulation of reserves take place. Except the trade balance, the other components of the external sector are exogenous in the model

BOP = CA + Transfer payments + capital account balance + net errors and omissions

Change in Reserve = BOP + change in arrears + debt relief

Reserve $_{(t)}$ = Reserve $_{(t-1)}$ + Change in reserve $_{(t)}$

Where CA (current account) is given as trade balance + net services + private transfer payments.

Aggregate Supply

Production

In modelling the production side, the production sectors are disaggregated into agricultural and non-agricultural. The agricultural and the non-agricultural production functions are distinguished and specified on the basis of the economic structure of the country.

Agricultural Production Function

The agricultural production function is assumed to be positively related with labour in the agricultural sector, rainfall, and relative price of agricultural products. The function is given as:

$$\text{Log Yagr} = \beta_{90} + \beta_{91}\,\text{logLagr}_t + \beta_{92}\text{logRF}_{t-1} + \beta_{93}\log\left(\frac{P_{agr}}{P_{nagr}}\right)_t + \beta_{94}\text{logYagr}_{t-1} + \beta_{95}\,T \quad \ldots.(8)$$

Where Yagr is agricultural GDP, Lagr is labour force in agricultural sector, RF is rainfall, T is a time trend , and P_{agr}/P_{nagr} is the ratio of agricultural GDP deflator to non agricultural GDP deflator. The data for labour force is adjusted using the capacity

utilization rate in the agricultural sector to proxy employed labour force in the sector since the data for employed labour force is not available.

Non-Agricultural Production Function

The non-agricultural sector contains both manufacturing and service sectors. The non-agricultural production sector is determined by labour force in the sector, change in capital stock, intermediate import and capacity utilization in the economy. This production function is given as

$$\text{Log } Ynagr = \beta_{100} + \beta_{101} \log Lnagr_t + \beta_{102} \log \Delta K_t + \beta_{103} \log Zrac_t + \beta_{104} \log CUR \quad \ldots\ldots\ldots(9)$$

Where Lnagr is labour force in non-agricultural sector, K_t is change in capital stock, Zrac is intermediate imports, and CUR is capacity utilization rate in the economy. The data for labour force is adjusted using the capacity utilization rate in the non-agricultural sector since the data for employed labour force is not readily available.

The total production will be given as

RY= Yagr + Ynagr

Capacity Utilization Rate

Capacity under utilization in the economy may come from both the agricultural sector and the non-agricultural sector. Under utilization of capacity in the agricultural sector can be mainly attributed to shortage of rainfall, among other things. In the non-agricultural sector the main cause of under utilization of capacity is shortage of imported inputs. Thus, capacity utilization in the economy is assumed to be dependent on the level of capital imports, total export earnings and rainfall.

$$\text{Log } CUR_t = \beta_{110} + \beta_{111}\log RF_{t-1} + \beta_{112}\log Zcap + \beta_{113}\log X_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$\beta_i > 0$ where i = 1…3; RF is rain fall, Zcap is intermediate imports, and X is exports.

Prices

The domestic price level is expected to be determined by the excess demand over the supply in the domestic economy (RED) excess money supply over the money demand (EMs) and import prices ($P^{m)}$. In addition to this, capacity utilization rate (CUR) is also related with the rate of inflation because it shows the nature of mark-up pricing. The mark-up (the profit margin) is assumed to be an increasing function of the capacity utilization rate (Soludo, 1995). Thus, the inflation equation is given as

$$P_t = \beta_{120} + \beta_{121}\,EMs + \beta_{122}\log RED_t + \beta_{123}\log CUR_t + \beta_{124}\log P^m \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Money Market

Money Supply

The money supply equation is specified in such a way that it is partly endogenous from the side of the balance of payments and the fiscal deficit. Following the flow of funds approach, the domestic money supply (Ms) in the economy can be given as

$$Ms = (TGR\text{-}TGE) - G^s_p + DC_p + \Delta R \quad \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Where (TGR – TGE) is the budget deficit, G^s_p is net sales of government interest bearing assets to the non-bank private sector, DC_p is domestic credit to the private sector, F is change in foreign financial flows, and ΔR is change in foreign exchange reserve.

Money Demand

The demand for real money balance (M/P) is positively related to income (RY) and negatively related with the opportunity cost of holding money. The demand for the real money is given as:

$$\text{Log } (M/P)_t = \beta_{140} + \beta_{141} \log RY_t - \beta_{142} r_t + \beta_{143} \pi_t + \beta_{144} \log(M/P)_{t-1} \ldots\ldots\ldots (13)$$

Where r and π are interest rate and inflation rate, respectively. And they are used to proxy opportunity cost of holding money.

Exchange Rate

Since the nominal exchange rate had been fixed for long period of time, the specification of the exchange rate will be based on the real exchange rate. The real exchange rate equation follows similar formulation as that of Ghura and Grennes (1993).

$$\text{Log RER} = \beta_{150} + \beta_{151} \log TOT_t - \beta_{152} \log(OPEN)_t + \beta_{153} \log F_t + \beta_{154} EMs \ldots\ldots\ldots (14)$$

Where RER is the real exchange rate, TOT is terms of trade,

OPEN = [(X+Z)/ Y] is the ratio of GDP over the sum of imports (Z) and exports (X); F is foreign financial flows, and EMs is excess money supply, measured as the difference between money supply and money demand.

Summary of the model

Private Consumption

$$\text{Log } RC_{pt} = \beta_{10} + \beta_{11} P_t + \beta_{12} \log C_{t-1} + \beta_{13} \log RY_t + \beta_{14} \log RY_{t-1}$$

Private Investment

$$\log RI_{pt} = \beta_{20} \Delta \log RY_t + \beta_{21} \log I_{gt} + \beta_{22} \log Z_t + \beta_{24} \log PB_t$$

Government Tax Revenue

$$\text{Log } TR = \beta_{30} + \beta_{31} \log RY_t + \beta_{32} \log (x+Z) + \beta_{33} \log F_t$$

Government Expenditure

$$\text{Log } G_t = \beta_{50} + \beta_{51} \log TR_t + \beta_{52} \log F_t + \beta_{53} \log P^m + \beta_{54} \log G_{t-1}$$

Fiscal Closure

The fiscal stance of the government is closed by the public deficit and its given as

Total government revenue (TGR) = TR + other government revenue (OGR)

Total government expenditure (TGE) = G + Capital expenditure (CE)

Fiscal deficit (FD) = TGR - TGE

External Sector

Export

$$\text{Log } X_t = \beta_{60} + \beta_{61} \text{logTOT}_t + \beta_{62}\text{logRER}_t + \beta_{63} \text{logCUR}_t + \beta_{64}\text{logRY}_t$$

Imports

Consumers' Good Import

$$\text{log Zcons}_t = \beta_{70} + \beta_{71} \text{logRY}_t + \beta_{72}\text{logRER}_t + \beta_{73} \text{logx}_{t-1} + \beta_{74}\text{logZcons}_{t-1}$$

Intermediate import

$$\text{log ZRac}_t = \beta_{80} + \beta_{81} \text{logRY}_t + \beta_{82}\text{logRER}_t + \beta_{83} \text{logX}_{t-1} + \beta_{84}\text{logZRac}_{t-1}$$

Z = Zcons + Zrac +Zother

External Sector Closure

CA = X - Z + net services + private transfer payments

BOP = CA + Transfer payments + capital account balance + net errors and omissions

Change in Reserve = BOP + change in arrears + debt relief

Reserve $_{(t)}$ = Reserve $_{(t-1)}$ + Change in reserve $_{(t)}$

Aggregate Supply

Agricultural Production Function

$$\text{Log Yagr} = \beta_{90} + \beta_{91} \text{logLagr}_t + \beta_{92}\text{logRF}_{t-1} + \beta_{93} \log\left(\frac{P_{agr}}{P_{nagr}}\right)_t + \beta_{94}\text{logYagr}_{t-1} + \beta_{95} T$$

Non-Agricultural Production Function

$$\text{Log } Ynagr = \beta_{100} + \beta_{101} \log Lnagr_t + \beta_{102} \log \Delta K_t + \beta_{103} \log Zrac_t + \beta_{104} \log CUR$$

The total production will be given as

$$RY = Yagr + Ynagr$$

Capacity Utilization Rate

$$\text{Log } CUR_t = \beta_{110} + \beta_{111} \log RF_{t-1} + \beta_{112} \log Zcap + \beta_{113} \log X_t$$

Prices

$$P_t = \beta_{120} + \beta_{121} EMs_t + \beta_{122} \log RED_t + \beta_{123} \log CUR_t + \beta_{123} \log P^m$$

Money Market

Money Supply

$$Ms = (TGR\text{-}TGE) - G^s_p + DC_p + \Delta R$$

Money Demand

$$\text{Log } (M/P)_t = \beta_{140} + \beta_{141} \log RY_t - \beta_{142} r_t + \beta_{143} \pi_t + \beta_{144} \log (M/P)_{t-1}$$

Exchange Rate

$$\text{Log } RER = \beta_{150} + \beta_{151} \log TOT_t - \beta_{152} \log (OPEN)_t + \beta_{153} \log F_t + \beta_{154} EMs$$

Identities and Definitions

$$\Delta LogRY = LogRY - LogRY(-1)$$

$$RY = YAGR + YNAGR$$

$$RAD = RCp + RCONSg + RIp + RIg$$

$$RED = RAD - RY$$

$$FD = G + Ig - TR - NTR$$

$$Z = Zcons + Zcap + Zothers$$

$$TB = X - Z$$

$$CA = X - Z + \text{net services} + \text{private transfer payments}$$

BOP = CA + Transfer payments + capital account balance + net errors and omissions

Change in Reserve = BOP + change in arrears + debt relief

Reserve $_{(t)}$ = Reserve $_{(t-1)}$ + Change in reserve $_{(t)}$

INFLATION = LogP - LogP(-1)

$$TOT = \frac{P_X}{P_Z} \times 100$$

Definition of variables

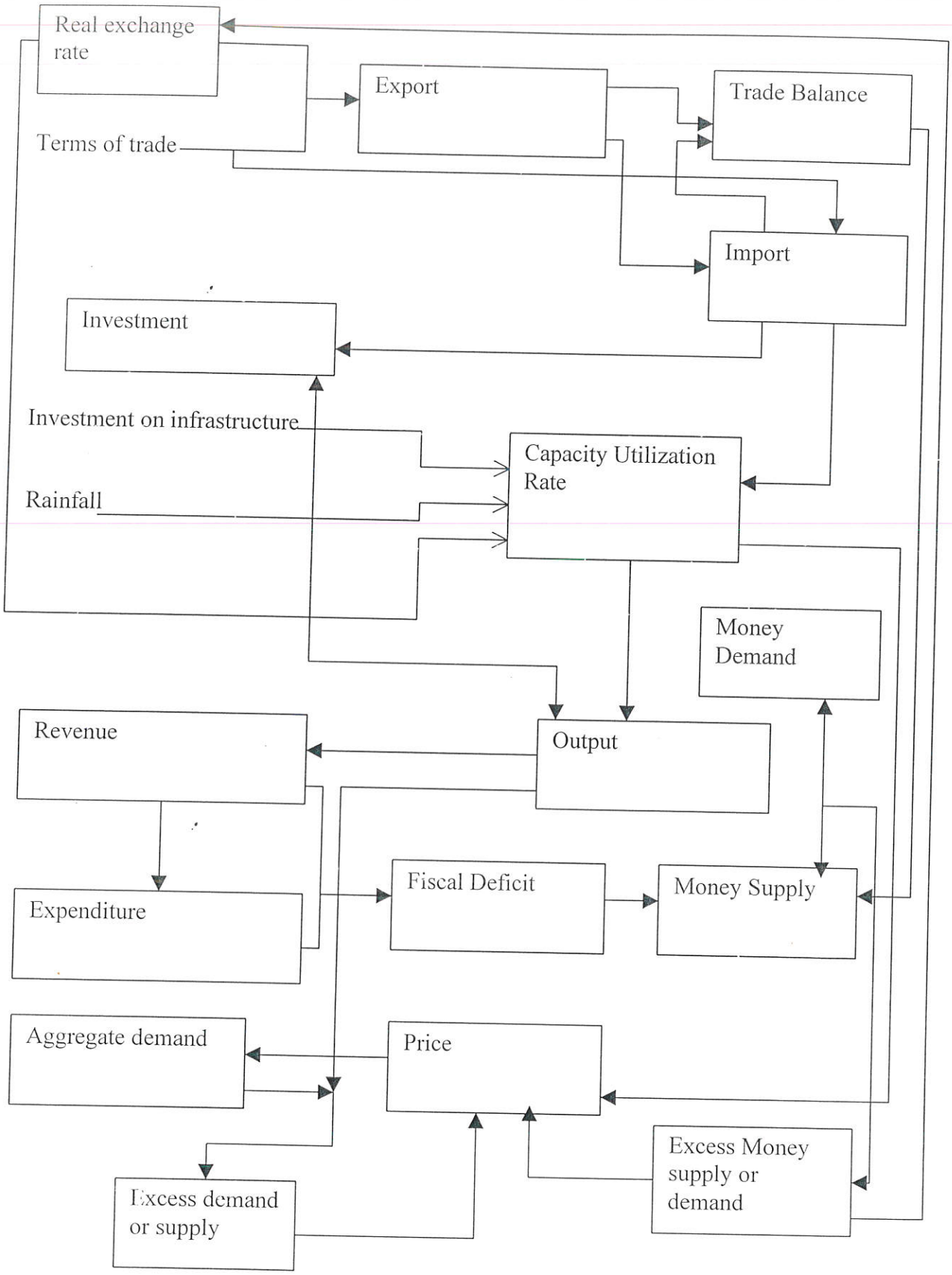
CE	Capital expenditure
CUR	Capacity utilization rate
Δ	Change
EMs	Excess money supply over money demand, measured as the difference between money supply and the estimated money supply.
F	Foreign financial flows (grants + loan and credits)
FD	Fiscal deficit
G	Government expenditure
G^s_p	net sales of government interest bearing assets to the non-bank private sector
Ig	Nominal government investment
K	Change in capital stock –i.e gross fixed capital formation
Lagr	Labour force in agriculture
Lnagr	Labour in non-agricultural sector
Ms	Money supply
NS	Net service export
NTR	Government non-tax revenue
OGR	other government revenue

OPEN	Openness measured as export and imports as a ratio of GDP
PB	Public borrowing (domestic)
P^{m}	Import price
P_t	Price level measured by the CPI
$\frac{P_{agr}}{P_{nagr}}$	Price ratio of agricultural and non-agricultural products
π	Inflation rate
r	Real deposit interest rate
RAD	Real aggregate demand
RCONSg	Real government consumption
RC_{pt}	Real private consumption expenditure
RED	Real excess demand
RER	Real exchange rate
RF	Rainfall
RI_g	Real government investment expenditure
RI_{pt}	Real private investment
RY_t	Real output
TB	Trade balance
TGE	Total government expenditure
TGR	Total government revenue
TOT	Terms of trade
TR	Government tax revenue
X	Exports
Yagr	Agricultural output
Ynagr	Non-agricultural output

Z	Total imports
Zcons	Import of consumers' good
Zothers	Other imports (i.e. Z- Zcons –Zrac)
Zrac	Import raw material and capital goods (intermediate imports)

4.3 Working of the Model

The operation of the model is as follows (also see the chart below). The value of export together with foreign financial inflows (i.e. foreign exchange availability), terms of trade and real exchange rate determine the level of imports. Imports, in turn, affect the level of private investment and determine the capacity utilization rate of the economy along with the exogenously given weather condition and availability of infrastructure. The capacity utilization rate is assumed to have a direct impact on output which in turn affects government revenue and expenditure and hence the fiscal deficit. The fiscal deficit has a feed back effect on prices through its effect on money supply. The level of output also determined the aggregate demand. The excess demand over the total output is assumed to be financed by foreign financial flows. However, for a given level of foreign financial flows, the disequilibrium between aggregate demand and aggregate supply is assumed to spillover to the domestic price (note that the price equation includes excess demand as an argument) and market clearing will be achieved through adjustment in price.


Real exchange rate
Export
Trade Balance
Terms of trade
Import
Investment
Investment on infrastructure
Capacity Utilization Rate
Rainfall
Money Demand
Revenue
Output
Fiscal Deficit
Money Supply
Expenditure
Aggregate demand
Price
Excess Money supply or demand
Excess demand or supply

4.4. Estimation Techniques

Basically there are three methods of estimating the parameters of a macroeconometric model –i.e. single equation information estimation technique (SEIE), limited information relating to the whole system (LISE), and full information estimation relating to the whole system technique (FISE) (Challen and Hagger, 1983). OLS, distributive lag class of models and ARIMA models can be classified as the single equation information technique, while 2SLS, instrumental variable estimation and limited information maximum likelihood (LIML) methods are classified as limited information relating to the whole system; and 3SLS and full information maximum likelihood (FIML) estimation techniques can be categorized as full information relating to the whole system. As their name indicates, the main difference of these techniques is on the information content of the estimator. The other important distinction of these methods is that single equation and limited information estimation techniques involve estimation of the stochastic equations one at a time[11] while in the full information estimation all the stochastic equations are estimated simultaneously.

The main challenges in estimating the parameters of a macroeconometric model are the problems of endogeniety and non-stationarity in the time series. In the presence of endogeneity, OLS is no longer unbiased. But, provided that the residuals are white noise, it can be consistent and asymptotically efficient. However, "an essential feature of systems of stochastic equations is that, in general, each endogenous variable is contemporaneously correlated with every disturbance." (Challen and Hagger, 1983: 82).

[11] Among the LISE estimation methods, fixed point class of estimation techniques such as iterative instrumental variable estimation, restricted reduced-form instrumental estimation, limited information

As a result, the OLS estimates may loss their desirable property of consistency and asymptotic efficiency. In addition to this, even if there is no endogeniety problem, the prevalence of non-stationarity in almost all macroeconomic variables may limit the usefulness of OLS. In the presence of a unit-root in the time series, the result of OLS may lead to spurious result. However, if the variables are cointegrated then the result is not spurious –i.e. the OLS estimates are consistent. But the usual t-tests do not apply (and hence inference is not possible) because the estimates are not only consistent but also super-consistent (Mukherjee, et al, 1998).

The problem of endogeniety can be taken care of by using the LISE or FISE methods stated above. But still the problem of non-stationarity limits the methods to be used in estimating the long run parameters of the model. If some or all of the variables are non-stationary, the asymptotic distribution of the usual statistics may not be appropriate for the same reason given in the case of OLS.[12] In the presence of stochastic trend in the time series, stationarity can be achieved by taking difference of the series and hence the estimation will be based on the transformed series. In doing so, however, the long run equilibrium relationship is sacrificed. In addition, using such a dynamic model has a practical difficulty in using it for dynamic simulation because of its long simulation data base requirement especially when its dynamic adjustment is slow (Wallis, 1987). This calls for the use of the concept of cointegration and error correction model in which both the short run and the long run consistent parameters can be derived. This approach is

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iterated instrumental variables, and restricted reduced-form 2SLS are exceptions since they involve entire system estimation in deriving a fixed-point estimator.

[12] In the context of 2SLS, Fair (1994) derived the accurate distribution in using 2SLS with the existence of non-stationariy.

suggested by Elbadawi and Schmidt-Hebbel (1991); and used by Mason et al. (1990) and Soludo (1995).

In using the error correction model (ECM), we resort to the Johansen (1988, 1996) procedure that is basically based on multivariate autoregressive model (i.e. VAR) and maximum likelihood estimation technique. The ECM can be derived from the p^{th} order VAR –i.e. VAR(p)[13] of the form

$$\mathbf{x}_t = A_1\mathbf{x}_{t-1} + A_2\mathbf{x}_{t-2} + \ldots + A_p\,\mathbf{x}_{t-p} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where $\mathbf{x}_t$ is n x 1 vector of endogenous variables, A_i is n x n matrix of parameters, and

$\varepsilon_t \sim IN(0, \Omega)$

Upon repeated reparameterization, equation (1) can be written as

$$\Delta\mathbf{x}_t = \sum_{i=1}^{p-1}\Gamma\Delta\mathbf{x}_{t-i} + \Pi\mathbf{x}_{t-p} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where $\Gamma = -[I - \sum_{j=1}^{i} A_j]$ and $\Pi = -[I - \sum_{i=1}^{p} A_i]$

Equation (1) can be viewed as a simple multivariate generalization of DF test while equation (2) is a multivariate generalization of the original Sargan (1964) error correction model.

Johansen factorised the π matrix in to α and β matrices, both of dimension (n x r), where r is the rank of π which is the same as the cointegration rank, such that $\pi = \alpha\beta'$. Thus, equation (2) can be written as

[13] The VAR can also be specified to include constant, linear term or other deterministic elements such as dummy variable (see Johansen, 1996: 167-176).

$$\Delta \mathbf{x}_t = \sum_{i=1}^{p-1} \Gamma \Delta \mathbf{x}_{t-i} + \alpha\beta' \mathbf{x}_{t-p} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The matrix α is the matrix of weights with which each cointegrating vector enters the n equations of the VAR (Enders, 1995), and it represents the speed of adjustment to disequilibrium (Harris, 1995). The matrix β is a matrix of long run coefficients or cointegrating parameters.

In factorising π into α and β matrices, it is not possible to use OLS due to the cross equation restrictions. As a result Johansen (1988) used maximum likelihood estimation technique to derive the α and β matrices. The procedure is

i. Estimate the multivariate ECM (VECM) as that of equation (2) using maximum likelihood method of estimation;

ii. Determine the rank of π (r);

iii. Use the r most significant cointegrating vectors to form β'; and

iv. Select α such that $\pi = \alpha\beta$' (Enders, 1995).[14]

As described above, the long run coefficients –i.e. the β matrix is derived using the maximum likelihood estimation technique, which has the desirable properties of unbiasedness, consistency, efficiency and asymptotic normality in a single equation; and it has the properties of consistency, efficiency and asymptotic normality in a system of equations (Iyoha, 1996). Thus, this procedure can be applied to each equation in the macroeconometric model so as to achieve unbiased, consistent and efficient long run estimates. Moreover, in this procedure unnecessary restrictions on the dynamic of the

[14] For a detailed technical discussion about the maximum likelihood estimation of the β matrix, see Johansen (1996: 93 – 95).

system can be avoided. In this case, the VECM is estimated in a dynamic context and the term $\beta'\mathbf{x}_{t-p}$ in equation (3) represents up to n – 1 cointegrating relationship in the multivariate model which ensure that $\mathbf{x}_t$ converge to their long run steady state solutions. This, in effect, implies that the dynamics of the individual equations are collapsed to give a corresponding steady state solution. Therefore, the stationary cointegrating vectors/vector normalized with respect to the variable of interest give/s the structural long run relationships/relationship among the variables in the model.

In this procedure the significance of the long run coefficients can also be tested in a more reliable way upon making a rank restriction and restrictions on the β matrix. The test statistics is based on the likelihood ratio that has asymptotic ^{2} distribution with degrees of freedom equal to the number of restrictions placed on β. Specifically the test statistics is given as

$$LR = T\sum_{i=1}^{r}[\ln(1-\lambda_i^*) - \ln(1-\lambda_i\wedge)]$$

Where $\lambda_i\wedge$ and λ_i^* denote the ordered eigen values of the unrestricted and restricted models, respectively (see Enders, 1995: 393 –396 and Johansen, 1996: 104 – 120). The stability of the coefficients can also be examined by making use of the recursively estimated eigen values plot.

4.5 Estimation Results

4.5.1 Individual Equations

Estimation of the equations of section 4.1 is presented in this sub-section. Insignificant and multicollinear variables are dropped in the estimation process. The result suggests that most of the equations performed well. In terms of tracking performance, significance and ex-post forecasting ability of the individual behavioural equations, the model has desirable properties. With the exception of the real exchange rate equation, the accuracy of the forecasts is not rejected.

Summary of final results

Consumption function

$$LReal\_Cp = 2.175 + 0.6787LogrY - 0.1647LogPrice + 0.03211strDmy$$

LR- Prob values (0.0007) (0.0227) (0.0170)

Investment function

$$Log\ Ip = 6.536 - 0.2094logPBr + 7.780\ logrY + 0.63591logZcap - 0.5667LogIg$$

LR prob. (0.0786) (0.0000) (0.0012) (0.0130)

Tax revenue function

$$LTR = -28.02 + 1.016Lyreal - 0.2514LF_{t-1}$$

(0.0436) (0.0160)

Expenditure function

$$LG = -0.2309 + 0.8666\ LTR + 0.3941\ LPf$$

LR prob (0.0412) (0.0990)

Export function

$$Log\ X = -8.488 + 0.4035\ logTOT + 1.248Log\ Y + 1.378log\ RER$$

(0.0494) (0.0000) (0.0001)

Consumers import

$$LogZcons = -0.3761 + 0.981 Log X - 1.222 Log RER$$
$$(0.0108) \quad (0.0023)$$

Capital and raw material intermediate imports function

$$LogZcap = 4.366 - 1.584 LogRER + 0.7521 Log X + 1.719 s1992$$
$$(0.0005) \quad (0.0529) \quad (0.0000)$$

Agricultural Production function (2SLS estimates)

$$LYagr = 5.756 + 0.2996 LYagr_{t-1} + 0.08686 LPa/Pna_{t-1} + 0.7589 LLFagr + 0.1879 LRF_{t-1} - 0.0329 Dmy$$
$$Prob \quad (0.0322) \quad (0.0120) \quad (0.0000) \quad (0.0010) \quad (0.1317)$$

Non agricultural production function

$$LYnagr = 5.411 + 0.8728 LLFnagr + 0.07497 LMcap - 0.2018 s1991$$
$$\textbf{Prob} \quad \textbf{(0.0000)} \quad \textbf{(0.1984)} \quad \textbf{(0.0007)}$$

Price equation

$$LCPI = -3.450 + 0.3558 EM_s + 0.3875 LED + 0.08635 LPm + 0.2637 Dmyotlier$$
$$(0.0002) \quad (0.0000) \quad (0.1165) \quad (0.0000)$$

Capacity utilization rate equation

$$LCUR = 2.550 + 0.1929 LRF_{t-1} + 0.07606 Lzcap - 0.07861 Dmyoutlier$$
$$(0.0316) \quad (0.0000) \quad (0.0003)$$

Money demand equation

$$LM/P = -5.735 + 0.9961 LrY + 14.67 INF + 0.1465 RIR - 0.478 Dmy$$
$$(0.0305) \quad (0.0000) \quad (0.0000) \quad (0.2294)$$

Real exchange rate equation

$$LRER = 9.592 - 1.066 LTOT + 0.8301 LOPEN - 0.3467 LFF - 0.2727 LEXCR - 0.0928 Dmy$$
$$(0.0026) \quad (0.0186) \quad (0.0016) \quad (0.0061) \quad (0.0735)$$

The tests for the accuracy of the forecast, and hence the stability of the coefficients, is reported under three scenarios denoted as

a. Using (variance of the VAR): This is an index of numerical parameter constancy, ignoring both parameter uncertainty and intercorrelation between forecasts errors at different time periods.

b. Using V(e): This test is similar to (a), but takes parameter uncertainty into account.

c. Using V(E) (the full variance matrix of all forecast errors E): This takes both parameter uncertainty and inter-correlations between forecast errors into account (see Doornik and Hendry, 1997:267-268).

Table 4.5.1

Parameter Consistency Forecast Test (^{2} Test)

Equation	***Ignoring parameter uncertainty and intercorrelation between the forecast errors at different time period***	***With parameter uncertainty but ignoring intercorrelation between the forecast errors at different time period***	***With both parameter uncertainty and intercorrelation between the forecast errors at different time period***
Consumption	*2.2097 (0.6973)*	*1.666(0.7969)*	*2.0187(0.7323)*
Investment	*17. 326(0.0675)*	*9.94(0.4458)*	*8.7408(0.5569)*
Tax Revenue	*1.6218(0.08049)*	*1.1011(0.8941)*	*1.0297(0.9053)*
Government Exp.	*6.7966(0.1470)*	*4.1666(0.3839)*	*4.086(0.3945)*
Export	*21.94(0.0250)**	*12.397(0.1344)*	*14.245(0.756)*
Consumers' Import	*4.6981(0.7893)*	*2.4373(0.9646)*	*2.9505(0.9374)*
Intermediate import	*6.7669(0.5620)*	*2.9848(0.9353)*	*2.943(0.9379)*
Agricultural Production fn.	*5.1864(0.2687)*	*3.1032(0.5407)*	*2.8145(0.5893)*
Non agricultural production fn.	*19.577(0.0033)***	*12.249(0.0566)*	*10.474(0.1060)*
Price	*8.2268(0.4116)*	*5.9334(0.6547)*	*5.8914(0.6594)*
Capacity Utilization	*8.331(0.2148)*	*4.2635(0.6411)*	*4.3009(0.6360)*
Money Demand	*12.084(0.0601)*	*8.7336(0.1891)*	*8.8466(0.1824)*
Real exchange rate	*36.341(0.0001)*** *F- test version 3.6341(0.0084)***	*19.253(0.0372)** *F- test version 1.9253(0.1088)*	*19.297(0.366)** *F- test version 1.9297(0.1080)*

Values in parenthesis are probability values.

**and ** imply reject the null at 5% and 1% level of significance, respectively.*

The null hypothesis: the forecast is accurate.

The full estimation results of the individual equations are given in appendix one; and the summary of the result is given below. The results in appendix I include: diagnostic tests based on the VAR, one-step ex-post forecast analysis, actual and fitted values and the recursive eigen values plot. The diagnostic tests suggest that there is some problem of vector non-normality in the private investment equation, tax revenue equation, agricultural production function, and non-agricultural production function. In the presence of non-normality in the residual, the main problem is that inference based on the standard distributions is not possible because the underlying distribution for such test statistics is normal distribution. However, in the Johansen procedure the problem of non-normal vector residuals is not a problem due to the fact that inference is based on likelihood ratio in which the underlying distribution takes some form of likelihood function that doesn't require normality.

4.5.2 Properties of the Full Model

Once the individual equations are estimated, the next step is to solve the model- i.e solving for the values of the endogenous variables given the values of exogenous variables. This enables us to examine the fit of the model to the historical data since the fit of the individual equations does not guarantee a good fit in the system or in the complete model. According to Challen and Hagger (1983:164) "It is possible that every stochastic equation of the system performs adequately on the basis of the individual equation evaluation procedures but that the system as a whole gives a poor representation of the real economy in which the historical time paths of the endogenous variables were generated." This may be the result of a more complex dynamic structure in the model as a whole than any of the individual equation it is composed (Oshikoya,

1990). Thus, in this section, with-in-sample tracking performance of the whole system is examined based on the standard statistical tools available.

The model is simulated in a dynamic context. This involves using the simulated values of the endogenous variables at time t-1 to predict the values of the dependent variable at time t. To do so, Gauss-Seidel iterative method is used. The Gauss-Seidel technique starts by guessing a set of values (starting values) for the endogenous variable. Most of the time, the guess for a particular endogenous variable will be its observed values in period t. Then using this set of values, it starts iterating until convergence is achieved with a predetermined level of tolerance (see Challen and Hagger, 1983: 33-37).

The examination of the model is carried out in the context of with-in-sample tracking performance of the model. In principle, both with in and outside sample (ex-post) forecasts must be used. However, "(for ex-post forecast) to be worth while, the time paths must be of reasonable length, about ten sample points as a minimum" (Challen and Hagger, 1983: 171). As a result of this long forecast period requirement, the ex-post forecast is not performed to save some degrees of freedom.[15] On the other hand, in the calibration process, the maximum likelihood estimates of the non-agricultural production function are substituted by the 2SLS estimates because of poor tracking performance of the maximum likelihood estimates in the system.

There are different summary statistics to evaluate the forecasting ability of a model. Root mean squared error, mean absolute error, mean absolute percentage error and

[15] The maximum likelihood estimation technique employed in this study also requires higher degrees of freedom to get a robust result.

Theil's inequality coefficient are among the most commonly used statistics. The first two forecast error statistics depend on the scale of the dependent variables; and the remaining two statistics are scale invariant (i.e. unit free). In most instances unit-free measures are preferable (Challen and Hagger, 1983). As a result, Theil's inequality coefficient is used in this study.

Theil's inequality coefficient is given as

$$T=\frac{\sqrt{\frac{1}{h+1}\sum_{t=s}^{s+h}(\hat{Y}_t-Y_t)^2}}{\sqrt{\frac{1}{h+1}\sum\hat{Y}_t^2}+\sqrt{\frac{1}{h+1}\sum_{t=s}^{s+h}Y_t^2}}$$

Where Y and $\hat{Y}$ are actual and forecasted values, respectively. S is forecast sample and h is the length of forecast sample.

Theil's inequality coefficient can be decomposed into bias, variance and covariance proportions.

$$\text{Bias proportion}=\frac{(\bar{\hat{Y}}-\bar{Y})^2}{\frac{\sum(\hat{Y}_t-Y_t)^2}{h}}$$

$$\text{Variance proportion}=\frac{(S_{\hat{Y}}-S_Y)^2}{\sum(\hat{Y}_t-Y_t)/h}$$

$$\text{Covariance proportion}=\frac{2(1-r)S_{\hat{Y}}S_y}{\sum(\hat{Y}_t-Y_t)^2/h}$$

Where $\bar{\hat{Y}},\bar{Y},S_{\hat{Y}},S_Y$ are means and standard deviations of $\hat{Y}$ and Y, respectively; and r is correlation between $\hat{Y}$ and Y.

The bias and variance proportion show how far the mean of the forecast is from the mean of the actual series and how far the variation of the forecast is from the variation of the actual series. The covariance proportion measures the remaining unsystematic forecast errors. The sum of these three measures would be unity. If the forecast is good, the bias and variance proportions should be small so that most of the bias would be unsystematic.

Table 4.5.1 shows Theil's inequality coefficient (TIC), and its decomposions. Except for investment and real exchange rate equations, the TIC is below 0.2. These figures are in the acceptable range since "TIC less than 0.3 or 0.4 are considered not to be unduly large"(Oshikoya, 1990:101). The bias proportion is less than 10% for all cases and it is less than 5% for 73% of the cases. The variance proportions indicate that the model replicates the variability in the data series in most of the cases. Except for the consumers' import function, the variance proportion is well below 10% and it is less than 5% for 80% of the cases. The result also shows that more than 85% of the forecast error is unsystematic and hence captured by the covariance proportion.

Table 4.5.2.1. Forecast Evaluation

	TIC	Bias	Variance	Covariance
Consumption	0.10	0.031	0.013	0.956
Private investment	0.19	0.094	0.055	0.852
Tax revenue	0.09	0.002	0.032	0.966
Government expenditure	0.01	0.000	0.008	0.992
Exports	0.15	0.047	0.094	0.859
Consumers' Import	0.16	0.040	0.108	0.852
Intermediate imports	0.08	0.003	0.034	0.963
Agricultural Output	0.06	0.018	0.025	0.958
Non Agricultural output	0.11	0.062	0.027	0.910
Price	0.06	0.011	0.048	0.942
Capacity utilization rate	0.02	0.000	0.022	0.978
Money demand	0.1	0.030	0.050	0.920
Real exchange rate	0.21	0.093	0.048	0.859
Money supply	0.075	0.022	0.013	0.966
Real output	0.08	0.032	0.017	0.951

Higher forecast error is observed in real investment function, export function, consumers' import function and real exchange rate equation. This is a common feature for most macroeconometric models in the case of developing countries. According to Salvatore (1989), real investment spending is often a source of large forecast errors in macroeconometric models because of its erratic nature. In addition, a large forecast error in exports can be attributed to the fluctuation in demand in the international market due to cyclical variations in developed countries. Consumers' imports function also shows a relatively higher TIC due to its fluctuation that may be the result of government policies on consumers' imports and fluctuations in foreign exchange availability (Salvatore, 1989).

Section V

Dynamic Counter Factual Simulation

In this section, two counter factual simulations are carried out using the model presented in the previous section. The probable impact of the shocks in the overall economy is also discussed. The results of the alternative scenarios are given as percentage deviation from the base run (or control run) in table 5.1 and 5.2.

5.1 Increase in Import Price

Since the 1960s, terms of trade had been deteriorating continuously as shown in section II. This is mainly the result of increasing import prices relative to export price. Increases in import prices have diverse impact on the overall economy. It affects the domestic price level, government expenditure, real exchange rate, imports and exports directly; and those variables also transmit the shock to the different sectors of the economy. For instance, an increase in price affects the level of consumption, and hence aggregate demand while an increase in government expenditure affects the fiscal deficit, money supply and prices. In view of this, a permanent and maintained 10% increase in import prices is introduced in 1980/81 and thus the simulation is in the period 1980/81 –98/99.

The result of 10% import price increase scenario and the control run are contained in table 5.1. According to this simulation, had there been a 10% increase in import price since 1980, there would have been 9.3% decline in terms of trade during the simulation period, on average. This in turn would lead to 39% depreciation in the real exchange rate. Real exchange rate depreciation would encourage exports while deteriorating terms of trade do the other way round. As a result exports, on average, would have been higher in the first twelve years of the simulation period by about 5.3%. However, the positive impact of real exchange rate on exports would be dominated by the negative pressure of the terms of trade deterioration. Thus, exports would be lower than the base run in the rest of the period by about 2.3%.

Table 5.1 Deviation from the base run (in percentage)

Year	Price	TOT	RER	Consumers' Import	Intermediate imports	Export
1980/81	3.3	-8.	39.9	2.9	-5.0	10.6
1981/82	2.3	-9.	37.5	1.3	-5.8	9.4
1982/83	1.9	-9.	37.3	-0.2	-6.4	8.2
1983/84	1.3	-8.	37.2	-1.4	-6.9	7.2
1984/85	1.0	-8.	84.1	-3.2	-7.2	7.3
1985/86	1.1	-8.	42.0	-3.6	-7.8	5.6
1986/87	1.0	-8.	50.4	-4.7	-8.0	4.8
1987/88	1.0	-9.	43.2	-5.8	-8.9	4.3
1988/89	0.9	-9.	54.6	-6.7	-9.1	3.8
1989/90	1.2	-9.	47.9	-7.6	-9.7	3.1
1990/91	1.4	-9.	49.2	-8.2	-9.7	2.6
1991/92	1.6	-8.	43.0	-8.0	-9.3	1.8
1992/93	1.5	-8.	45.8	-8.6	-9.5	0.9
1993/94	1.8	-9.	45.1	-13.3	-12.3	-1.2
1994/95	1.9	-10.	35.6	-6.6	-9.4	2.6
1995/96	1.7	-10.	34.7	-11.2	-9.8	-0.6
1996/97	1.7	-10.	31.6	-12.6	-10.6	-2.0
1997/98	3.1	-10.	32.5	-13.9	-11.2	-3.3
1998/99	5.1	-10.	25.1	-14.6	-12.1	-4.3
Average	*1.8*	*-9.*	*43.0*	*-6.6*	*-6.6*	*-8.9*

Table 5.1 (Continued)

Year	CUR	Non agricultural output	Gov't EXP	Tax Rev	Consn	INVT	Output
1980/81	-1.5	2.8	9.	8.4	3.9	-15.9	1.6
1981/82	-1.8	1.4	6.	3.6	2.4	-12.1	0.7
1982/83	-1.9	0.1	3.	-0.6	1.3	-13.5	0.0
1983/84	-2.1	-1.0	0.	-4.3	0.3	-11.8	-0.7
1984/85	-2.3	-2.1	-2.	-9.4	-0.5	-16.0	-1.5
1985/86	-2.4	-3.0	-4.	-10.7	-1.1	-8.1	-1.9
1986/87	-2.5	-3.9	-6.	-14.0	-1.7	-13.0	-2.5
1987/88	-2.7	-4.7	-8.	-16.5	-2.3	-12.1	-3.0
1988/89	-2.8	-5.4	-9.	-18.8	-2.8	-12.7	-3.5
1989/90	-3.0	-6.1	-11.	-21.2	-3.3	-12.9	-3.9
1990/91	-3.0	-6.7	-12.	-21.7	-3.6	-10.5	-4.2
1991/92	-2.9	-7.1	-12.	-20.6	-3.8	-7.4	-4.3
1992/93	-3.0	-7.4	-13.	-22.3	-4.2	-11.6	-4.8
1993/94	-3.7	-8.2	-23.	-37.4	-5.3	-25.7	-6.3
1994/95	-3.0	-8.4	-9.	-15.8	-4.5	12.0	-4.2
1995/96	-3.5	-8.6	-17.	-27.2	-5.3	-13.5	-6.2
1996/97	-3.8	-8.9	-19.	-28.4	-6.2	-15.4	-6.9
1997/98	-4.1	-9.3	-20.	-29.2	-7.1	-16.2	-7.5
1998/99	-4.5	-9.8	-21.	-30.3	-8.0	-18.2	-8.2
Average	*-2.9*	*-5.1*	*-9.*	*-16.7*	*-2.7*	*-12.3*	*-3.5*

The increase in import price would also affect both consumers' import and capital and raw material imports. As compared to the control run, consumers' import and capital and raw material imports would be lower by 6.3% and 8.5%, respectively, in the alternative scenario. The fall in capital and raw material imports could be transmitted to capacity utilization rate and non-agricultural production sector. Capacity utilization rate and non-agricultural output would, therefore, decline by 2.9% and 5.1%, respectively. As a result total output would have been lower by 3.5 %. Following this consumption and investment would fall by 2.7% and 16%, respectively.

In the alternative scenario, domestic price level would increase by 2% while government tax revenue would have been lower by 16.7%. Government expenditure would also increase by 5%, on average, in the beginning of the shock period due to an increase in import price. However, this increase in government expenditure would not be maintained due to the serious revenue loss that would reduce the spending capacity of the government. As a result government expenditure would be lower by 9.1% in the rest of the simulation period.

5.2 The Impact of AIDS: A Decline in Labour Force

According to the UNAIDS (2000) report, 10% of African youths are infected by HIV; and in Ethiopia 280,000 working age population (14 –49years) died because of AIDS in 1999. AIDS deaths are mainly concentrated in the 20 – 50 age groups. This indicates that the economically active population- i.e. the labour force- is affected disproportionally more than the overall population. The effect of this labour force decline is discussed in this section.

Following Quattek (2000:9), the channels in which the impact of HIV AIDS is reflected in the economy are

1. Lower labour force
2. Lower labour productivity through absenteeism and illness
3. Cost pressure for companies through higher benefit payments and replacement costs
4. Lower labour income, as employees bear some of the AIDS- related costs
5. Lower population translating into lower expenditure
6. Increased private sector demand for health services
7. Higher government expenditure on health services.

In this study, however, only one aspect of HIV –i.e. its impact on reducing labour force- is considered. The scenario experimented hear is that what would have been the performance of the economy, had there been a 10% decline in the labour force since 1980/81 due to HIV. Thus, the result should be interpreted carefully with these caveats in mind.

Table 5.2 A 10% decrease in labour force due to AIDS: Deviation from the base run (in percentage)

Year	Agri outpu	non agr o	invt	Consn	price	consumer
1980/81	-1.9	-1.2	-12.5	-1.0	-3.6	-3.2
1981/82	-1.9	-1.3	-1.7	-1.3	-3.3	-3.4
1982/83	-1.9	-1.4	-2.0	-1.5	-4.0	-3.5
1983/84	-1.9	-1.5	-1.8	-1.6	-2.7	-3.6
1984/85	-2.0	-1.5	-1.6	-1.7	-2.2	-3.8
1985/86	-2.0	-1.6	-1.8	-1.8	-2.0	-3.7
1986/87	-2.0	-1.7	-1.8	-1.8	-2.9	-3.7
1987/88	-2.0	-1.7	-1.9	-1.9	-2.4	-3.9
1988/89	-2.0	-1.8	-2.0	-1.9	-2.4	-3.9
1989/90	-2.0	-1.9	-2.1	-2.0	-2.1	-4.0
1990/91	-2.0	-1.9	-2.0	-2.0	-1.5	-4.2
1991/92	-2.0	-2.0	-1.9	-2.0	-1.0	-4.2
1992/93	-2.1	-2.0	-2.0	-2.1	-1.8	-4.2
1993/94	-1.9	-2.1	-1.0	-2.1	-1.2	-4.1
1994/95	-2.1	-2.1	-2.9	-2.1	-1.2	-4.3
1995/96	-2.1	-2.1	-1.6	-2.2	0.8	-4.1
1996/97	-2.1	-2.1	-1.6	-2.2	2.6	-4.0
1997/98	-2.1	-2.1	-1.8	-2.2	5.5	-4.1
1998/99	-2.1	-2.1	-2.1	-2.2	7.0	-3.9
Average	***-2.0***	***-1.8***	***-2.4***	***-1.9***	***-1.0***	***-3.9***

Table 5.2 (continued)

Year	Intermedi	CUR	Tax Revnu	Govt Exp	Export	Output
1980/81	-1.6	-0.5	-7.3	-5.9	-2.5	-1.4
1981/82	-1.7	-0.5	-7.5	-6.1	-2.6	-1.5
1982/83	-1.7	-0.6	-7.9	-6.4	-2.6	-1.5
1983/84	-1.8	-0.6	-7.9	-6.5	-2.7	-1.6
1984/85	-1.7	-0.6	-8.3	-6.7	-3.2	-1.6
1985/86	-1.8	-0.6	-8.2	-6.7	-2.9	-1.6
1986/87	-1.8	-0.6	-8.0	-6.6	-3.0	-1.7
1987/88	-1.9	-0.6	-8.1	-6.7	-3.0	-1.7
1988/89	-1.9	-0.6	-8.2	-6.8	-3.2	-1.8
1989/90	-2.0	-0.7	-8.3	-6.9	-3.2	-1.8
1990/91	-2.0	-0.7	-8.2	-6.9	-3.3	-1.8
1991/92	-2.1	-0.7	-8.3	-7.0	-3.3	-1.9
1992/93	-2.1	-0.7	-8.3	-7.1	-3.4	-1.9
1993/94	-2.1	-0.7	-8.3	-6.9	-3.3	-1.9
1994/95	-2.3	-0.7	-8.9	-7.4	-3.3	-2.0
1995/96	-1.8	-0.7	-8.2	-6.9	-3.2	-2.0
1996/97	-1.9	-0.7	-7.6	-6.5	-3.1	-2.0
1997/98	-1.9	-0.7	-7.3	-6.3	-3.1	-2.0
1998/99	-2.0	-0.7	-7.2	-6.2	-2.9	-2.0
Average	***-1.9***	***-0.6***	***-8.0***	***-6.7***	***-3.0***	***-1.8***

As shown in table 5.2 the decline in the labour force would directly affect the production process in both the agricultural and non-agricultural sectors. According to the result, the agricultural and the non-agricultural output would decline by around 1.7% and 1.4% on average during the forecast period as compared to the base run. As a result of the fall in output, private consumption, investment, exports and government tax revenue would be lower by 1.6%, 2.4%, 3% and 7.4%, respectively. The decline in government revenue would in turn put a downward pressure on government expenditure and hence it would go down by 6.7% on average.

As described above, exports would decline by 3% in the simulation period. This would have a direct repercussion on imports through lowering the availability of foreign exchange. The result shows that consumers' imports and capital and raw material imports would on average fall by 3.9% and 2%, respectively, in the alternative scenario. The fall in capital and raw material imports would diminish the capacity utilization rate by 0.6%, on average.

Section VI. Conclusion

Using the Ethiopian time series data for the period 1965/66 – 1998/99, a small macroeconometric model is specified, estimated and tested with the objective of analysing the impact of either endogenous policy shock or exogenous shocks. In building this model, or a macro model in general, the main challenge was to choose appropriate theoretical framework and efficient estimation technique. To avoid outrageous assumptions about the working of the economy such as supply creates its own demand in the case of supply driven models or supply passively adapts itself to demand in the case of Keynesian models, general equilibrium framework is chosen as an appropriate way of viewing the operation of the economy.

The model developed in this study tries to capture the peculiar structure of the Ethiopian economy. The model is developed considering the supply-constrained nature of the economy. On the supply side, total output in the economy is disaggregated into agricultural sector and non-agricultural sector which basically includes industry, services and other distributional activities. In addition, since the economy is characterized by a general capacity under utilization, the capacity utilization rate of the economy is also specified. On the demand side, the private and public consumption expenditures and private investment expenditure functions are specified. The government investment is assumed to be exogenous. In addition to the public and private expenditure components, the domestic demand for imports (disaggregated into consumption goods import and intermediate goods import) and foreign demand for export is included on the demand side. The monetary sector contains a behavioral money demand and money supply equations. The money supply equation is endogenous to

the model to capture the monetization of the deficit. The price and the real exchange equations are also specified and hence they are determined endogenously.

The model's operation is consistent with the general equilibrium framework in which price serves as equilibriating variable. The value of export, terms of trade and real exchange rate determine the level of imports, which in turn affect the level of private investment and determine the capacity utilization rate of the economy. Imports and exports determine the trade balance that may spillover to the monetary sector and affects the money supply. The capacity utilization rate is assumed to have a direct impact on output that consecutively affects government revenue and expenditure and hence the fiscal deficit. The fiscal deficit has a feed back effect on prices through its effect on money supply. The level of output also determined the aggregate demand by affecting consumption level, investment and government expenditure. The excess demand over the total output is assumed to be financed by foreign financial flows. However, for a given level of foreign financial flows, the disequilibrium between aggregate demand and aggregate supply is assumed to spillover to the domestic price so as to achieve market clearing through adjustment in price.

The behavioral equations in the model are estimated individually recognizing the time series properties of the variables in the model. Error correction framework based on the Johansen (1988, 1996) approach is used to derive consistent long-run parameters of the macro model. This procedure takes care of simultaneity bias through maximum likelihood estimation technique and non-stationarity in the time series by making use of likelihood ratio test in the case of inference.

The result of the individual equation estimation shows a good fit in all of the equations; and the ex-post forecasting ability of the individual equations is not rejected. The recursive eigen value plot also shows that the parameters are fairly stable. The model as a whole also reveals a good feature. In terms of Theil's inequality coefficient and its decompositions, the model has a desirable property of low bias and variance proportion; and the bulk of the forecast error is unsystematic and hence captured by the covariance proportion. A low bias proportion shows that the mean of the forecast is not far apart from the actual mean while the low variance proportion shows that the variation in the actual data is captured by the forecast very well- i.e. the turning points are captured in most of the cases.

Two dynamic counter factual simulations are carried out using the model. The two scenarios experimented are a 10% maintained increase in import price and a 10% maintained decline in labour force due to HIV ADIS since 1980/81. The result of both scenarios is in line with the theoretical a priori expectation. In the case of the first scenario, there would be a fall in terms of trade, depreciation of real exchange rate, decline in imports, decline in capacity utilization rate and output. This result is in line with the import compression argument raised in Ndulu (1991) and Rattsø (1994). Real private investment and consumption level would also be lower than the base run. In the case of the second scenario, the decline in labour force would lead to lower level of output, private consumption, investment, exports, government tax revenue and government expenditure. The fall in output would be further propagated by the decline in capital and raw material imports and the resultant capacity under utilization.

In general, the model performs well. However, for specific and practical purposes, further disaggregation is necessary. Inclusion of the labour market, disaggregating government expenditures by activities, and disaggregating the production activity in detail would give a better shape for the model.

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Appendix

Individual equation estimation results and diagnostic tests

Summary of the individual equation estimation result

Equations	*Reduced form ß'*				
Consumption	***Constant***	***LReal_Y***	***LPRICE***	***strDmy***	
	LReal_Cp	***2.175***	***0.6787***	***-0.1647***	***0.03211***
	LR- Prob values		*(0.0007)*	*(0.0227)*	*(0.0170)*
Investment		***Constant***	***LPB_real***	***DLYfac***	***LZcap***	***LIgreal***
	LIpreal	***6.536***	***-0.2094***	***7.780***	***0.6359***	***-0.5667***
	LR- Prob values		*(0.0786)*	*(0.0000)*	*(0.0012)*	*(0.013)*
Tax Revenue		***Constant***	***LReal_Y***	***LF_1***	
	LTR	***-28.02***	***4.016***	***-0.2514***	
	LR-Prob		*(0.0436)*	*(0.0160)*	
Government Exp.		***Constant***	***LTR***	***LPf***	
	LG	***-0.2309***	***0.8666***	***0.3941***	
	LR prob		***(0.0412)***	***(0.0990)***	
Export		***Constant***	***LTOT80***	***LRER***	***LY***
	LX	***-8.488***	***0.4035***	***1.378***	***1.248***
	LR prob		***(0.0494)***	***(0.0001)***	***(0.0000)***
Consumers' Import		*Constant*	*LX*	*LRER*	
	LMcons	***-0.3761***	***1.171***	***1.222***	
	LR-Prob		***(0.109)***	***(0.0023)***	
Intermediate import		*Constant*	*LRER*	*LX*	*s1992*
	LMcap	*4.366*	*-1.584*	*0.6964*	*1.719*
	LR-prob		*(0.0005)*	*(0.0529)*	*(0.0000)*
Agricultural Production fn.		***Constant***	***LPa/Pna***	***LLagr***	***LRF***	***i1984***
	LYagr	***5.130***	***0.2035***	***0.4450***	***0.3222***	***-0.2720***
	LR-prob		*(0.0751)*	*(0.0000)*	*(0.0102)*	*(0.0001)*
Non agricultural production fn.		***Constant***	***LLFNagr***	***LMcap***	***Dummy***
	LYnagr	***7.314***	***1.929***	***0.1830***	***-1.454***
			(0.0004)	*(0.0925)*	*(0.0562)*
Price		*Constant*	*LMS*	*LED*	*LPm95*	*Dmyotlier*
	LCPI	***-3.450***	***0.4472***	***0.3875***	***0.08635***	***0.2637***
	LR-Prob		*(0.0002)*	*(0.0000)*	*(0.1165)*	*(0.0000)*
Capacity Utilization		***Constant***	***LRF***	***LMcap***	***DMY LCUR***
	2.550	***0.1929***	***0.07606***	***-0.07861***	
	LR-Prob		***(0.0316)***	***(0.0000)***	***(0.0003)***
Money Demand		***Constant***	***Lreal_Y***	***INF***	***RIR***	***imp***
	LM/P	***-5.735***	***0.9961***	***14.67***	***0.1465***	***-0.4780***
	LR- Prob		*(0.0305)*	*(0.0000)*	*(0.0000)*	*(0.2294)*
Real exchange rate		***Constant***	***LTOT95***	***LOPEN***	***LF***	***LEXCR***	***Dmy***
	LRER	***9.592***	***-1.066***	***0.8301***	***-0.3467***	***-0.2727***	***-0.09281***
	LR-Prob		*(0.0026)*	*(0.0186)*	*(0.0016)*	*(0.0061)*	*(0.0735)*

Note

In estimating the capacity utilization equation, there is a serious multicollinearity between import and export, import and investment on infrastructure, and export and investment on infrastructure. This implies that import, export and investment in infrastructure cannot appear in a single equation. This calls for the choice of variables to enter into a single equation. Thus, to circumvent this problem we have to take only one of the above variables along with other possible explanatory variables. As a result, intermediate imports is taken to be the best explanatory variable.

Diagnostic tests

Equations	***Vector Portmanteau based on 4 lags***	***Vector autocorrelation based on F-stat***	***Vector normality based on ^{2}***	***Vector heteroscedasticity based on ^{2}***
Consumption	30.809	1.7954 [0.0693]	12.495 [0.0518]	DA
Investment	73.293	1.2051 [0.2961	23.658 [0.018]	DA
Tax Revenue	12.423	0.7113 [0.680]	24.69 [0.0501]	0.41345 [0.9928]
Government Exp.	11.24	1.565 [0.1662]	2.3775 [0.666]	1.0503 [0.4341]
Export	***56.598***	***1.351 [0.1784]***	***8.7238 [0.366]***	***199.67 [0.0594]***
Consumers' Import	74.72	1.178 [0.2898]	12.687 [0.123]	0.29431 [0.9999]
Intermediate import				
Agricultural Production fn.	24.354	2.363 0.0359]*	12.163[0.016]*	0.63513 [0.8986]
Non agricultural production fn.	42.81	1.982 [0.0504]	28.16 [0.010] *	0.6517 [0.9357]
Price	55.511	1.591 [0.0787]	5.1844 [0.737]	191.53 [0.1235]
Capacity Utilization				
Money Demand	30.778	0.699 [0.7898]	23.78[0.0006]**	0.10227 [0.9999]
Real exchange rate	*97.01*	*1.2065 [0.295]*	*9.3297 [0.5011]*	DA

DA implies that the degree of freedom does not allow to calculate the specified statistics.
* and ** reject the null at 5% and 1% level of significance.

Parameter Consistency Forecast Test (^{2} Test)

Equation	*Ignoring parameter uncertainty and intercorrelation between the forecast errors at different time period*	*With parameter uncertainty but ignoring intercorrelation between the forecast errors at different time period*	*With both parameter uncertainty and intercorrelation between the forecast errors at different time period*
Consumption	*2.2097 (0.6973)*	*1.666(0.7969)*	*2.0187(0.7323)*
Investment	*17. 326(0.0675)*	*9.94(0.4458)*	*8.7408(0.5569)*
Tax Revenue	*1.6218(0.08049)*	*1.1011(0.8941)*	*1.0297(0.9053)*
Government Exp.	*6.7966(0.1470)*	*4.1666(0.3839)*	*4.086(0.3945)*
Export	*21.94(0.0250)**	*12.397(0.1344)*	*14.245(0.756)*
Consumers' Import	*4.6981(0.7893)*	*2.4373(0.9646)*	*2.9505(0.9374)*
Intermediate import	*6.7669(0.5620)*	*2.9848(0.9353)*	*2.943(0.9379)*
Agricultural Production fn.	*5.1864(0.2687)*	*3.1032(0.5407)*	*2.8145(0.5893)*
Non agricultural production fn.	*19.577(0.0033)***	*12.249(0.0566)*	*10.474(0.1060)*
Price	*8.2268(0.4116)*	*5.9334(0.6547)*	*5.8914(0.6594)*
Capacity Utilization	*8.331(0.2148)*	*4.2635(0.6411)*	*4.3009(0.6360)*
Money Demand	*12.084(0.0601)*	*8.7336(0.1891)*	*8.8466(0.1824)*
Real exchange rate	*36.341(0.0001)***	*19.253(0.0372)**	*19.297(0.366)**
	*F- test version 3.6341(0.0084)***	*F- test version 1.9253(0.1088)*	*F- test version 1.9297(0.1080)*

Values in parenthesis are probability values.

**and ** imply reject the null at 5% and 1% level of significance, respectively.*

The null hypothesis: the forecast is accurate.

DECLARATION

I, the undersigned, declare that this thesis is my own original work and has not been presented in any other university. All sources of materials used for this thesis have been duly acknowledged.

Name: Daniel Zerfu Gurara

Signature: 

Date: June 2001

Place: Addis Ababa.