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DETERMINANTS OF ECONOMIC GROWTH IN ETHIOPIA

**By :
Seid Nuru Ali**

**A Thesis submitted to the School of Graduate Studies of
the Addis Ababa University in Partial Fulfillment of the
Requirements for the Degree of Masters of Science in
Economic Policy Analysis**

June, 2000



ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

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IN ETHIOPIA



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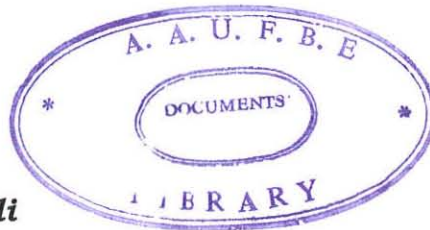


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DEDICATION

THIS
THESIS
IS DEDICATED TO
THE LATE MEKONNEN TADDESSE
WHO REALLY INFLUENCED ME TO LOVE ECONOMETRICS

Acknowledgement

It has become the willingness of Allah, the merciful, the almighty, and the most passionate, to successfully complete the program for my Masters Degree. I, therefore, praise Him.

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Seid Nuru
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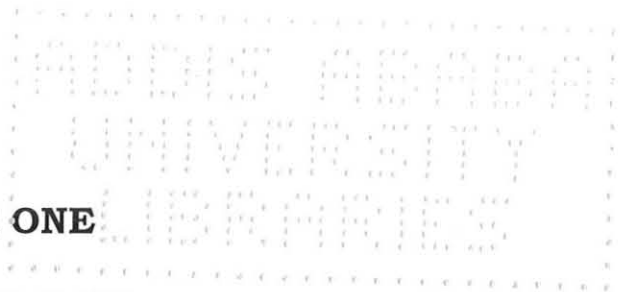
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ABSTRACT

Following the argument that growth models in developing countries should be treated in different way from that of the developing countries, I tried to model economic growth in Ethiopia using data from 1960/61-1998/99. The dependent variable is real GDP (in logs). The explanatory variables (factors) used are gross fixed capital formation, labor (population adjusted for activity rate), human capital index (calculated using gross enrollment ratio, years of schooling adjusted for return, world technology frontier and rate of adoption of technology), export, and mean annual rainfall (all in logs). The analysis makes use of the Johansen maximum likelihood estimation procedure. The main finding is that growth model in Ethiopia is best specified by inclusion of non-traditional factors, in this case rainfall and export. In this co-integration analysis, all the explanatory variables used with the exception of fixed capital formation are statistically significant with expected sign. Applying the Vector Error Correction Model (VECM), it has been found that only rainfall and export among the variables used for this study are significant in the short-run.

Along with this, a total factor productivity type of method has been used to determine the contribution of sectors to growth. It has been found that agriculture has been contributing to growth only half times its share in the GDP while other sectors have been contributing almost twice their share in the GDP.



CHAPTER ONE

INTRODUCTION

1.1 Background

Societies in general aspire for development. As it is believed that economic growth explain much of the development aspect, countries spend much of their resources and time in an effort to ensure sustained economic growth even by compromising equity issues at the initial stage believing that it would be compensated by future gains from economic growth.

However, level of economic development is not uniform across countries. Rather, there are disparities among countries. Jones (1998) has inferred from a data of inter-country comparison of income that the per capita incomes of the poorest countries in the world are less than 5 per cent of the per capita incomes of the richest countries in 1990.

The differences in economic growth and in income are not only across countries but also over time. The level of per capita income of some countries is much higher than it was thirty years ago while that of others is the same as what it was then. Japan and latter the South East Asian countries managed to register high economic growth rates and became

economic giants just in less than half a century. South Korea, Taiwan, Hong Kong and Singapore had the highest growth rates (5.3 to 6%) per annum compared to 1.4% to 2.7% growth rates of the economy of the industrialized countries (excluding Japan with 5% growth rate) for the period 1960-90 [Jones, 1998:4]. One important implication is that given the low level of income they have, there is a hope that there is a way for poor countries to grow and catch up with the rich ones. That is, at least in history, we observed countries, which had almost the same level of per capita income as Ethiopia, have managed to be richer than Ethiopia in about three decades. South Korea for example increased her per capita income six fold to about \$1,600 in 1984 from its low level of income in 1960s [Park, 1993:336].

The basic questions that follow are that: what are the factors that explain such disparities? That is, what are the sources of economic growth? Are these factors replicable?

In the literature, resource, population, physical and human capital, technology, culture, policy issues and others, besides historical incidences such as the legacy of colonization, are considered to be sources of economic growth. However, these factors do not explain growth of countries unequivocally. For example, the resource endowment shaped the direction of the technological innovations of USA. Her first

specialization in lumbering (wood working) and labor saving type of mechanization of her agriculture was due to the abundance of forest and land, respectively, in the face of scarce labor [Rosenberg, 1977:21-23]. For Japan and other South East Asian countries, learning and labor-intensive techniques explain more the growth of their economies than natural resources. Labor participation rate in 1990 for Hong Kong, Japan, China (main land) is the highest. On the other hand, India with the second largest population did not manage to sustain high level of economic growth [Jones, 1998:4].

Empirical works have been conducted to determine as to which factors are relevant in explaining growth across countries. Many of these research works for developing countries are done in different way as that of the developed countries believing that growth in developing countries are characterized by non-traditional factors.

1.2 Specification of the Problem

In modeling growth in the case of developed countries, technology, labor, capital, etc can be considered as the source of growth. In the developing countries, however, the conventional determinants of growth by themselves are rudimentary and as a result, the economy is not moving. One challenge is that these factors that are supposed to determine the acceleration of an economy are in turn determined by initial endowments

of a country. These initial endowments are very low in developing countries and much explained by uncertainties and vagaries of nature.

Ethiopia as one of the least developed nations shares this same problem. The growth-rate in GDP being more than offset by the population growth rate, the Ethiopian economy has almost been stagnant in the past four decades. The economy has been growing at an average of 2.6% annually for the period 1960/61-98/99. As the population was growing at a rate of 2.6% per annum for the respective period,¹ the per capita income remained stagnant.

The Ethiopian economy is a subsistent economy in the sense that it is highly dependent on agriculture, which is in turn dependent on nature, particularly rainfall. Being very susceptible to the fragility of nature, this sector on which above 85% of the population make living and which accounts for 52% of GDP cannot even feed the nation. The industrial sector on the other hand accounts for about 12% of GDP. The balance is the share of the service sector. This is in contrast to the case in the US where the agricultural sector in which less than 3% of the population engaged could in fact feed the world! [Gills, et al, 1992]. With highest share of agriculture in the GDP, such a poor performance in the economy

¹ Growth rates for real GDP, population and real per capita GDP are determined by regressing these variables on time. That is : $\ln \text{GDP} = 8.57 + 0.026t$; $\ln N = 7.67 + 0.0261t$ and $\ln \text{PCGDP} = 0.898 - 0.0008066t$.

is the reflection of the poor performance of the agricultural sector. Every time the nature turns bad, the agricultural output declines tremendously and the GDP follows the fate of agriculture.

What is more important in relation to drought is not the one-time famine that the peasants face. Rather, it has a continuous impact on their level of production. That is, the shock in one period forces the peasants to sell some of their assets and capital more importantly their oxen to bridge their consumption or even they can lose them. This makes peasants to remain with less factors of production for the next period to work with. This leads to lower output—"shock breeds shock". Even worse, the drought is now becoming more frequent than ever and this has a further implication on the dynamics of poverty.

In such a case, modelling growth in developing countries and hence in Ethiopia by including non-conventional factors such as rainfall would be appropriate.

So far, just little has been done on the determinants of growth in Ethiopia. One of these papers is the work by Netsanet (1997) which emphasized the role of human capital in determining economic growth. He used enrollment ratios at different levels (primary, secondary, tertiary and both primary and secondary levels and all levels combined), daily per

capita calorie intake, besides capital and working age population for his analysis. He used the Engle-Granger two step procedure for his estimation and got results that human capital as represented by enrollment ratios significantly contribute to economic growth while others have insignificant coefficients. The labor force is reported to have a negative sign. Moreover, primary education is reported to affect growth more strongly than other levels.

But, it may be difficult to give such strong conclusions with the given methodology used. For one thing, the Engle-Granger two step procedure is currently criticized for its weakness when there are more than one co-integrating vectors, in which case the Johansen procedure is superior. Secondly, even in the estimation procedure as it is, it would make sense if appropriate lags in at least enrollment ratios were made as this period enrollment ratio has less to do with this period's economic growth in the same period. Moreover, introducing enrollment ratios by level gives the same weight for different years of schooling.

✓ More importantly, the Ethiopian economy is believed to be constrained by the incapability of the agricultural sector to feed the growing population (to follow the Kaleckian argument) and as a result failing to enable the peasants to be the possible sources of demand and investable surplus. Such limited supply of the agricultural output which falls short

of demand is in turn a result of natural aspects particularly rainfall, uncertainties and static land size under cultivation. Factors such as rainfall constrained the peasants to produce enough to feed themselves and be a source of demand for industrial sector. Moreover, the limited supply of foreign exchange due to primary agricultural export is another constraint for growth. Hence, modeling growth in Ethiopia without addressing these issues would be incomplete.

1.3 The Theme of the Study

Given the background discussed so far, I stick to the belief that the growth function of developing countries differs from that of the developed countries because uncertainties are more relevant to developing countries than the developed countries. *Hence, the purpose of this paper is to show empirically that the agricultural sector which has naturally (and probably institutionally) been constrained has not been significantly contributing to long-term growth and rainfall, which is probably irrelevant to developed countries, can serve as proxy for supply (hence demand of peasants) in explaining low growth in Ethiopia.*

First, rainfall by itself incapacitates the peasants to produce at their full capacity, and it affects them not only by reducing their output but also by forcing them to sell some or all of their factors of production, more importantly oxen, which would be used for production after survival from

famine. This has important implication for the long-run growth in that the poverty dynamics reduces possible demand accordingly. Secondly, when rainfall is favorable, there is bumper harvest (better supply) and hence demand. When there is little rainfall below average, the supply of agricultural yield declines with adverse implication on demand. Hence, rainfall can serve as proxy for supply -demand gap to explain economic growth. The aim here is to show empirically that the Ethiopian economy is dependent on something that is not dependable.

The other aspect of the theme of this paper is that the human capital as a determinant of growth has to be properly approximated instead of using simple enrolment ratios.

In general, this paper, besides using a more advanced econometric techniques which are already on the frontier of the literature (Johansen maximum likelihood procedure, in this case), tries to incorporate factors which are more relevant in explaining economic growth in developing countries, in this case rainfall and strategic factor, export. Moreover, the human capital aspect enters the model being measured in more proper way than the previous work. This is represented by an index which accounts for gross enrollment, years of schooling, return to schooling, and degree of technological adoption.

1.4 Significance of the Study

Modeling and explaining growth is becoming interestingly a growing realm of research in economics. In Ethiopia, little has been done in this particular but very relevant area. Because I believe that a continuous and multi-disciplinary rigorous study is required to take the policy implications seriously as relevant to Ethiopia, the significance of this paper is to provoke and lead a path for further studies in the field. But, its immediate outcomes may be taken relevant to have a hint on some policy decisions.

1.5 Organization of the Paper

The remaining part of this paper has four sections. Brief summary of the performance of the Ethiopian economy is dealt as a background in Chapter Two. Sector contributions to growth are also considered. This is followed by a chapter in which theoretical and empirical literatures are surveyed. Chapter Four is devoted to the empirical (econometric) analysis. For the analysis, the Johansen maximum likelihood estimation procedure is employed using data for 1960/61 to 1998/99. A micro case study on the dynamics of land size and level of income has been presented in the Appendix section (Appendix B). Finally, conclusions and policy implications are presented in Chapter Five.

CHAPTER TWO

MACROECONOMIC PERFORMANCE OF THE ETHIOPIAN ECONOMY

2.1. Trends in Real GDP

The Ethiopian economy has been growing at an average annual rate of 2.6 per cent for the last four decades (1960/61-1998/99). In the same period, the population has been growing by almost the same rate at which the GDP has been growing nullifying the growth rate in per capita income. The agricultural sector has been the least performing in the period under consideration (see Tables 2-1a-b and Figures 2-4 and 2-5).

Table*2.1a: Growth Rates of Real GDP and its Sector Components

PERIOD	GROWTH RATE OF			GROWTH RATES IN VALUE-ADDED IN THE VARIOUS SECTORS			
	GDP	Population	PCGDP	Agriculture	Industry	Distributive Service	Other Service
1960/61-73/74	4.1	2.3	1.8	2.1	7.0	7.8	6.8
1974/75-90/91	2.1	2.8	-0.7	0.6	3.0	2.9	5.1
1991/92-98/99	5.4	2.8	2.6	2.6	8.1	7.8	8.5
1960/61-98/99	2.6	2.6	-0.006	1.2	3.0	3.7	5.7

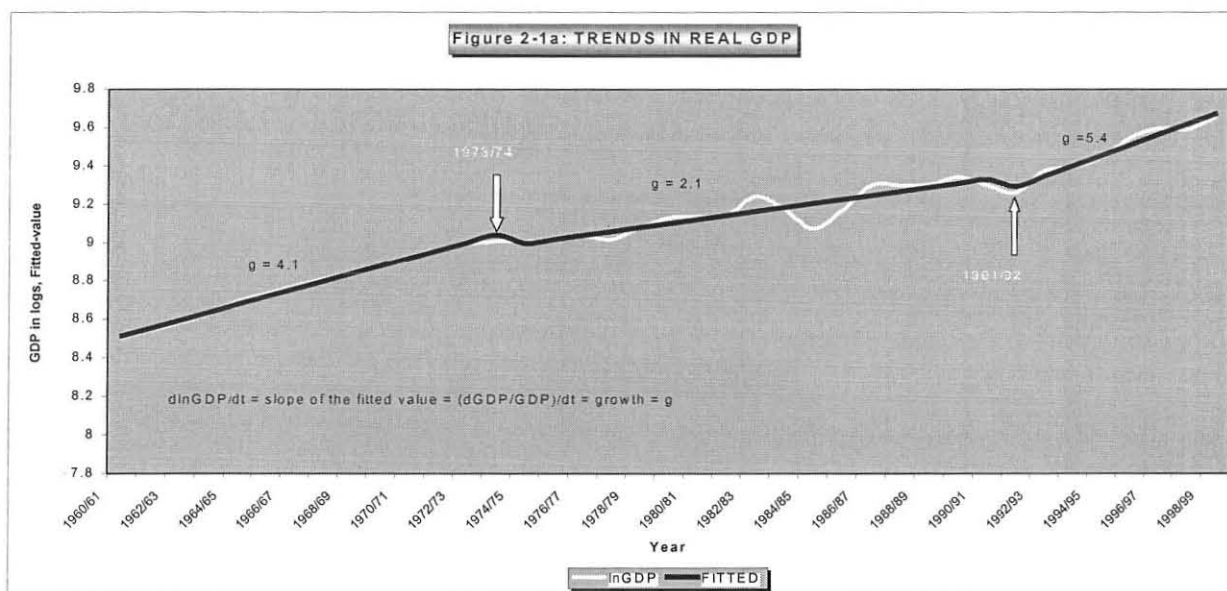
Source: Author's calculations using the data from MEDaC, National Accounts, 1999.

**Growth rates are estimated by regressing each variable on time using Ordinary Least Squares.*

Table 2.1b: Growth Rates of Real GDP and its Sector Components After Accounting for Availability of Rainfall

PERIOD	GROWTH RATE OF			GROWTH RATES IN VALUE-ADDED IN THE VARIOUS SECTORS			
	GDP	Population	PCGDP	Agriculture	Industry	Distributive Service	Other Service
1960/61-73/74	4.3	2.3	2	2.2	7.1	8.4	6.8
1974/75-90/91	2.1	2.8	-0.7	0.7	2.9	3.0	5.1
1991/92-98/99	5.7	2.8	2.8	3.1	8.2	7.8	8.4
1960/61-98/99	2.6	2.6	-0.006	1.3	2.9	3.6	5.5

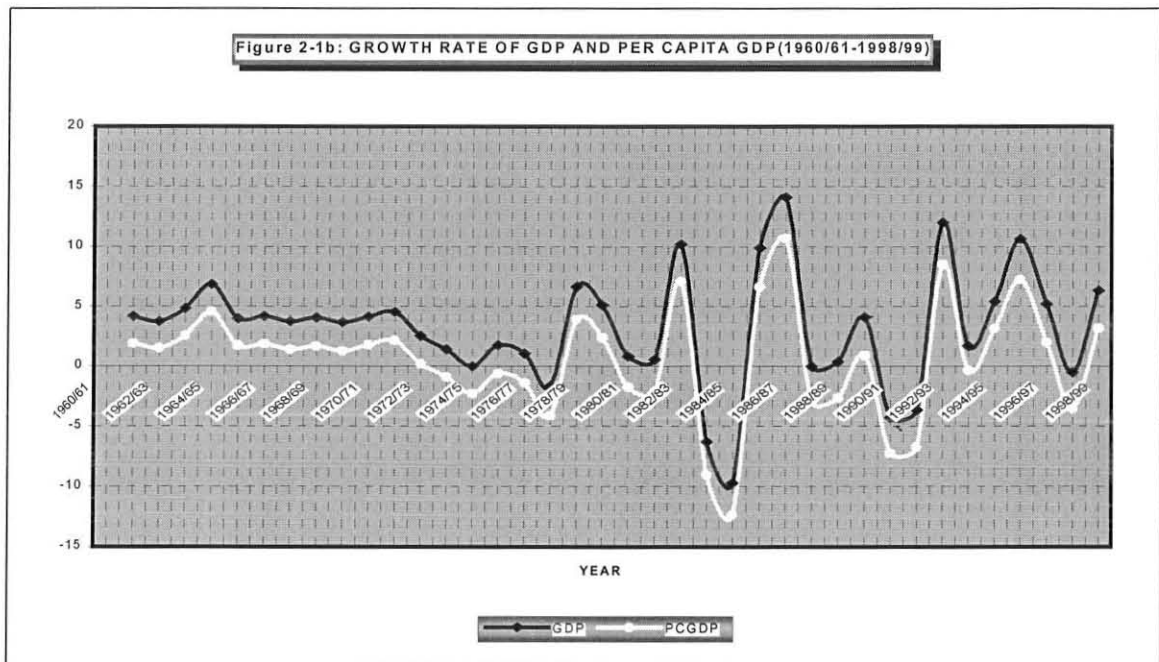
Source: Author's calculations using the data from MEDaC, National Accounts, 1999.



During the imperial era, the economy had been growing at a fairly sustainable rate of 4.1 per cent per annum. As the population was growing at about 2.3 per cent per annum, the per capita GDP had been growing at 1.8 per cent.

During the imperial period, while value-added in the agricultural sector was growing by 2.1 per cent (almost half of the growth rate of GDP), the other sectors were growing by more than 6.8 per cent per annum.

Since the year 1971/72, the growth rate of the economy started to decline but remained positive. Post 1973/74, it experienced tremendous fluctuations. The crusts were usually recoveries from recessions rather than actual booms. Hence the crests and deep troughs offset giving a resultant of a mere 2.6 per cent economic growth for the entire Derg period. This rate was not capable of catching with the population growth as a result of which the per capita GDP declined by about 0.7 per cent per annum for the period.



During the Derg regime too, the agricultural sector had been the least performing where value-added grew by less than 1 per cent. The "other" service sector for which the administrative and defence sub-sectors account the major share had the highest growth rate, that is 5.1 per cent. The industrial and distributive service sectors grew by about 3 per cent.

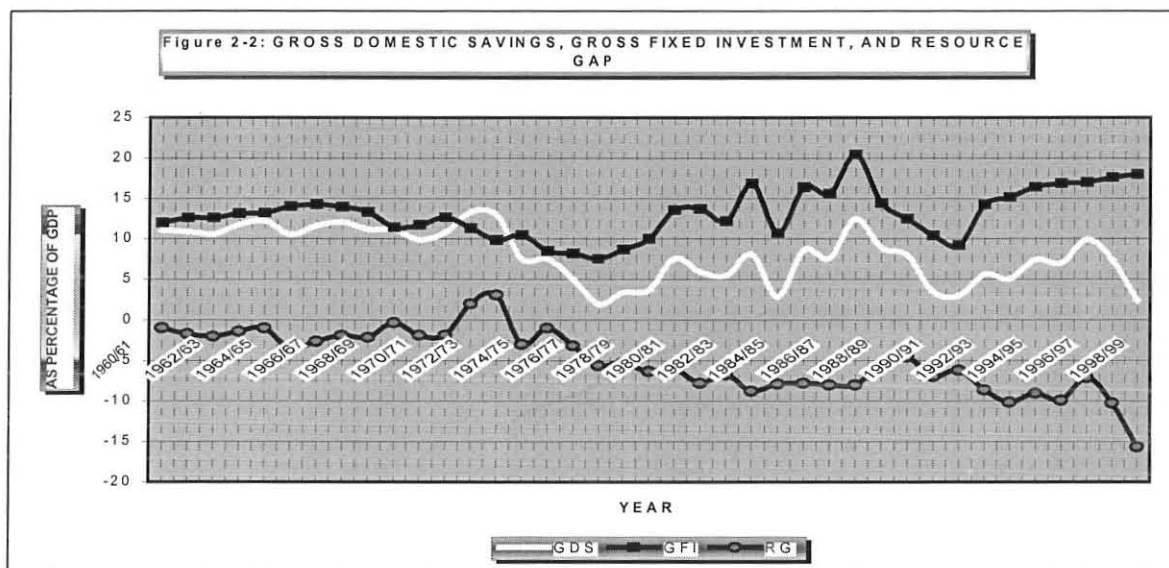
Under the period of Ethiopian Peoples' Revolutionary Democratic Front (EPRDF), that is 1991/92-1998/99, the growth rate in GDP has been positive but experienced fluctuations. After the abnormal year 1991/92 (there was political instability), it is only in the year 1997/98 that a mere negative growth (-0.5%) is recorded. On average the economy has been growing at about 5.4 per cent for the period 1991/92-1998/99. This is in fact one of the seven "fast" growing economies (above 4%) of Africa for the decade. If there had not been frequent drought, the growth rate of GDP would have been 5.7 per cent.

The value-added in the agricultural sector has grown by about 2.6 per cent for the period 1991/92-1998/99. This rate would have risen to 3.1 per cent if there had not been drought.

2.2 Savings and Investment

Savings and investment are considered to be the essential components of the capital accumulation process. Though developing countries are required to mobilise a saving rate of 15% in achieving sustainable economic growth, the 13% percent saving rate recorded in 1974/75 remained to be the highest in four decades. The highest record since 1992 is 9.9%, which is registered in 1996/97. The average for Sub-Saharan Africa is about 12%.

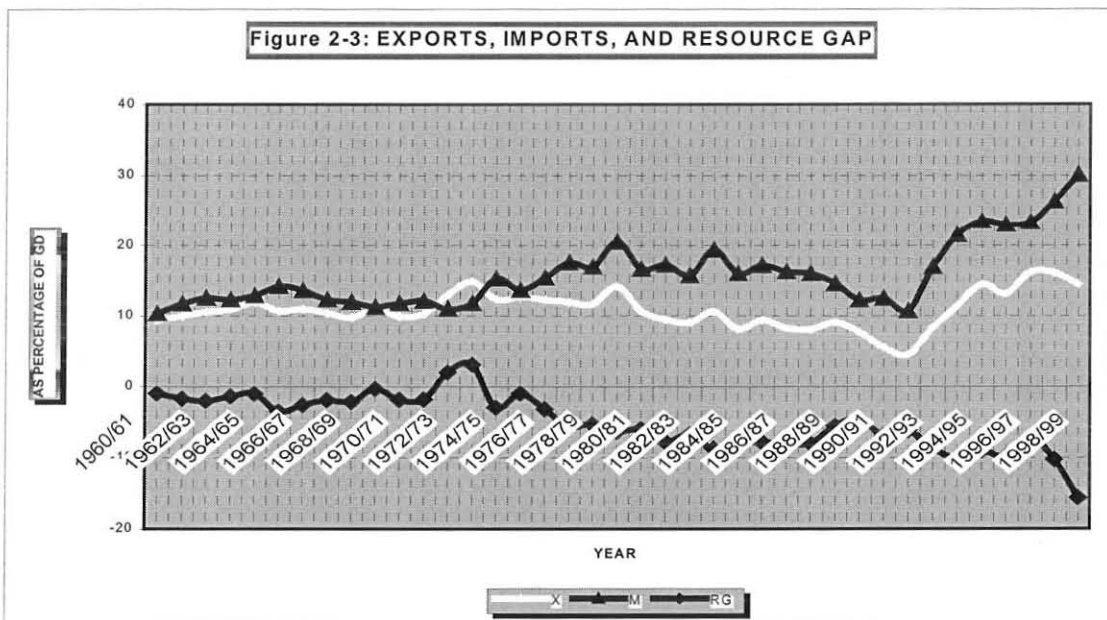
Though the investment rate is not that much big, it is not in divergence with the average for Sub-Saharan Africa which is 18%. But the rise in gross fixed capital formation is not paralleled by savings. This results in widening resource gap.



2.3 Exports and Imports

The major export earnings come from the agricultural sector. This sector accounts for about 90 percent of the total foreign exchange earnings and coffee alone accounts for 60-70 per cent.

Values of goods and services exported have shown an increasing trend post 1993 but the imports have been significantly increasing thereby widening the resource gap.



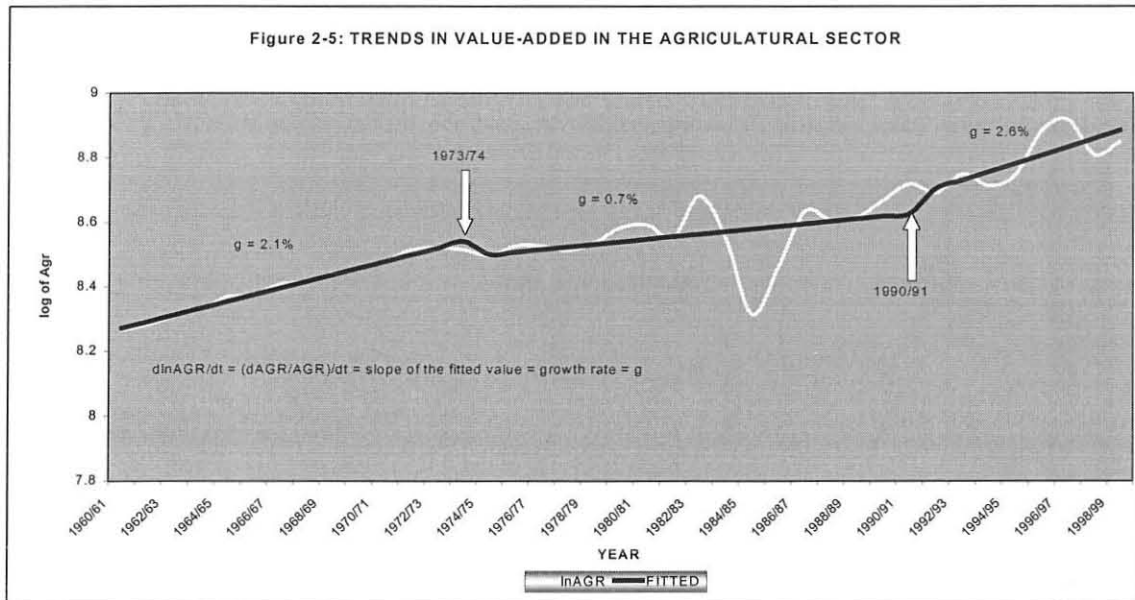
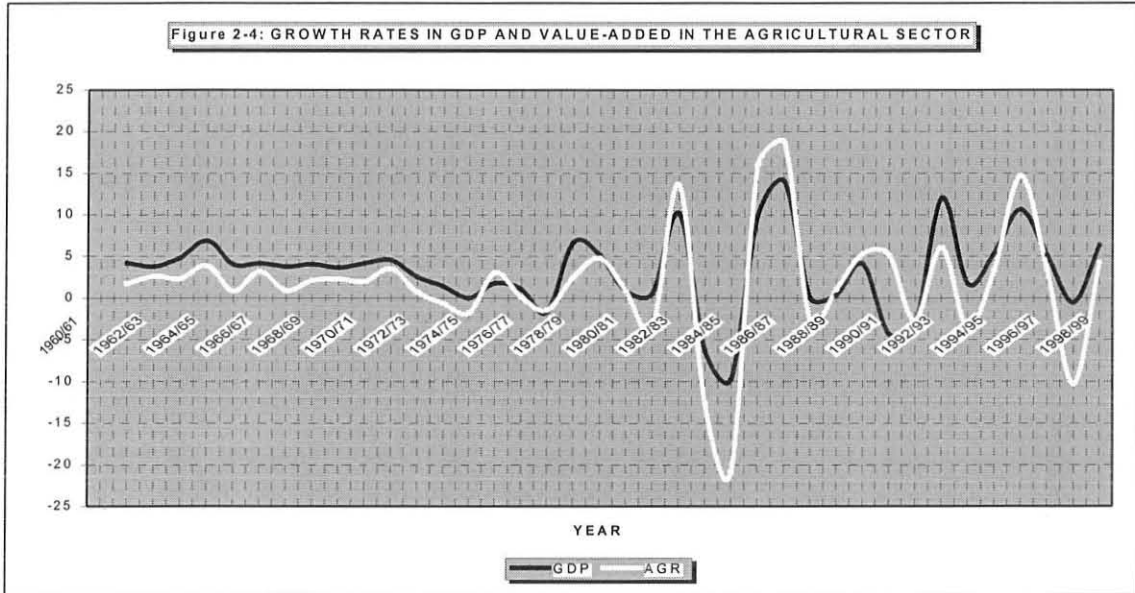
2.4. Possible Causes of the Poor Performance of the Economy

2.4.1 High dependency on the Agricultural Sector

Agriculture accounts for about 50 per cent of GDP and about 90 per cent of the total foreign exchange earnings. Moreover, about 85 percent of the population make their living on this sector. Such large share in GDP and export earnings and it being the mainstay of the major segment of the society has an important implication on the overall economy. Basically, the growth of an economy depends on what happens to a sector with the largest share. The important factor that should be emphasised is the high dependency of the agricultural activities on rainfall. The depression in 1984/85 with the decline of real value-added in the agricultural sector by more than 20% and real GDP by more than 9% (the deepest in four decade time) are explained by the serious drought that year. On the other hand, the high growth rates in GDP in 1986/87 and 1997/98 are achieved due to bumper harvest which in turn are results of good and timely rainfall. In 1999, for a mere reason that the “*Belg*”² rain ceased in “*Belg*” growing areas (about 10% of the total harvest), the Ethiopian Disaster Prevention and Preparedness Commission announced that some 5 million Ethiopians were in urgent need of food aid due to the “*Belg*” failure. Even this year (2000), some 8 million people are in desperately urgent need of food aid due to drought in the country. As it is evident

² In Ethiopia, there are two crop seasons. The main season is “*Meher*” when crops are harvested during November to January and the second season is “*Belg*” when crops are harvested from April to June.

from Figure 2-4, the growth rate of GDP systematically follows the trends of the growth rates of the value-added in the agricultural sector.



Relying on the share of a sector to GDP alone to judge on the role of the sector for overall performance of GDP is misleading. It is rather required to consider its contribution to the growth of GDP. In this connection, I tried to compute the contribution of each sector to the growth rate of GDP using the method discussed in Appendix A.

As shown in Tables 2.2a and 2.2b, the agricultural sector accounted for 60.8, 52.4, 50.4, and 55 percent of GDP in the periods 1960/61-73/74, 1974/75-90/91, 1991/92-98/99, and 1960/61-1998/99, respectively. As a rule, as an economy grows, the share of the agricultural sector should decline while that of the industrial sector overtaking the major share. In this particular case, although the share of the agricultural sector declined by about 17 percent over the periods 1960/61-73/74 to 1991/92-98/99, it can be considered insignificant when one looks at the length of time over which such transformation is achieved. Here, I am comparing performances in two periods nearly two decades apart. The other evidence for the fact that the structure of the economy is not following the normally expected pattern is that the share of the industrial sector has declined by about 19 percent (more than the rate that of agriculture has declined!) over the same period. It is the share of the "other" service sector that showed a significant leap, growing by about 96 percent for the period under consideration. The administrative and the defense sub-sectors accounted for the major (36.3%) part of this sector.



The share of the distributive sector which includes the sub-sectors trade, hotels and restaurants, and transport and communications has increased by only 5 percent over the period under consideration.

Table 2.2a: Sector Contribution to GDP and Growth

		1960/61-73/74	1974/75-90/91	1991/92-98/99	1960/61-98/99	
Sector Contribution to GDP	Agriculture	60.8	52.4	50.4	55.0	
	Industry	13.3	13.0	10.8	12.7	
	Distributive Service	13.1	14.8	13.8	14.0	
	Other Service	12.8	19.8	25.1	18.4	
Growth Rate in GDP		4.1	2.1	5.4	2.6	
Sector Contribution to Growth in GDP	Agriculture	Value	1.28	0.32	1.31	0.66
		Percentage	31.2	14.9	24.3	25.4
		Contr. Factor	0.51	0.29	0.48	0.46
	Industry	Value	0.93	0.39	0.88	0.39
		Percentage	22.7	18.1	16.3	14.7
		Contr. Factor	1.71	1.43	1.50	1.15
	Distributive Service	Value	1.02	0.43	1.08	0.52
		Percentage	24.9	20.5	20.0	19.9
		Contr. Factor	1.90	1.35	1.45	1.42
	Other Service	Value	0.87	1.01	2.13	1.05
		Percentage	21.2	47.0	39.4	40.3
		Contr. Factor	1.66	2.37	1.57	2.19

Source: Author's calculations using data from MEDaC, National Accounts, 1999.

Table 2.2b: Sectoral Contribution to GDP and Growth after Adjusting for the Availability of Rainfall

		1960/61-73/74	1974/75-90/91	1991/92-98/99	1960/61-98/99	
Sector Contribution to GDP	Agriculture	60.8	52.4	50.4	55.0	
	Industry	13.3	13.0	10.8	12.7	
	Distributive Service	13.1	14.8	13.8	14.0	
	Other Service	12.8	19.8	25.1	18.4	
Growth Rate in GDP		4.3	2.2	5.6	2.6	
Sector Contribution to Growth in GDP	Agriculture	Value	1.34	0.37	1.56	0.72
		Percentage	31.5	16.8	27.7	27.7
		Contr. Factor	0.52	0.32	0.55	0.50
	Industry	Value	0.94	0.38	0.89	0.37
		Percentage	22.1	17.3	15.8	14.2
		Contr. Factor	1.66	1.33	1.46	1.12
	Distributive Service	Value	1.1	0.44	1.08	0.5
		Percentage	25.9	20	19.2	19.2
		Contr. Factor	1.98	1.35	1.39	1.37
	Other Service	Value	0.87	1.01	2.11	1.01
		Percentage	20.5	45.9	37.4	38.9
		Contr. Factor	1.60	2.32	1.49	2.11

Source: Author's calculations using data from MEDaC, National Accounts, 1999.

More interesting and worth investigating is the contribution of each sectors to growth rate of GDP. In this case, the agricultural sector grew

by 2.1 percent- half of the rate at which the GDP grew-and it accounted for 31.2 percent of the growth of GDP for the period 1960/61-73/74. The fact that this sector is contributing to growth much less than its share to GDP is witnessed by the low relative contribution factor, which is 0.51. The other sectors have a relative contribution factor greater than unity for the imperial period implying that they contribute to growth more than their contribution to GDP. As it can be shown in Table 2-2b, the results are not that much altered when intensity of drought (availability of rainfall) is taken into account.

During the Derg regime, the agricultural sector grew by only 0.6 percent on average annually. The contribution of this sector to growth in GDP has significantly declined to a mere 15 percent (contribution factor = 0.48) being overtaken by the "other" service sector whose contribution increased from 21 percent during the imperial era to 47 percent to the Derg period. The relative contribution factor for the "other" service sector by then was 2.37. The share of the growth rates of the industrial and distributive service sectors in the growth rate of GDP have declined in that period as compared to that of the imperial era. The conclusions still hold even under the scenario when the intensity of drought is considered.

The last decade in consideration (1991/92-98/99) is the period of the Ethiopian Peoples Revolutionary Democratic Front (EPRDF) regime. During this period, the value-added in the agricultural, industrial, "other" service, and the distributive service sectors grew by 2.6, 8.1, 7.8, and 8.5, respectively. However, the industrial sector, although it grew faster than ever partly due to the increase in efficiency of the most government-owned enterprises following the liberalisation, its share in the GDP has significantly fallen by about 17 percent over the previous regime. It is however still contributing to growth significantly despite its small share in GDP. The contribution of agriculture to growth has increased significantly over that of the Derg regime but did not catch up with what had been during the imperial period. Unlike in the other regimes, the growth rates in both in GDP and value-added in the agricultural sector would have increased if not for the prevalence of frequent drought. This is witnessed by the increase in the growth rates of GDP, and value-added in the agricultural sector, and even in the contribution of the sector to growth when intensity of drought is taken into account.

Surprisingly, such dependency on rain-fed agriculture and the suffering from hunger is in the presence of the water resource the country is blessed with. The surface water resource of the country is estimated to be 110.72 billion m³ per year and the ground water resource is estimated

to be 2.6 billion m³. Out of the potential irrigable land area of 3.7 million hectare by the major rivers, only 4.3% is currently irrigated.[Ministry of Water Resources, Water resources Sector Profile].

☛ The other factor associated with poor performance in the agricultural sector is static and unproductive land under cultivation. Out of the total land area of 1.12 million km² the country has, only 12% is under cultivation. The other 53% of the total area is under pasture while only 10% is covered by lakes and rivers. The balance is under forest, swamp or barren.[MoWR, Water Resources Sector Profile]. Regardless of such background, however, the land in the northern part of the country has been over-populated, over-utilized, eroded and is not capable of supporting the population any more. During the Derg, there was a possibility of re-settlement program from the northern part to the southern and southwestern parts of the country though the implementation was not well planned. The current political arrangement however does not seem to allow such possibilities particularly among regional states. In fact, the EPRDF is currently supporting voluntary resettlement option within a state. But, the question is how self-sufficient are regional states in terms of arable land and other resources. Low productivity of the land is another problem. Land productivity is very low. The national average for the major crops is 11.67 quintal per hectare.[Central Statistical Authority, Land Utilization Survey, 1994/95].

The important conclusion that comes out of the discussion made so far is that the agricultural sector which accounts for the major part of GDP contributes less to the growth rate of GDP. The implication is that since this sector is highly static, it made the overall economy static. On the other hand, the industrial sector with significant growth rate is limited to contribute what it should have contributed to growth due to its low share in GDP.

2.4.2 Uncertainties

The Ethiopian history is a history of war. Both the civil and external wars retarded economic activities. The economy is therefore a 'war-torn' economy. In some years when the war reached climax, the major crop producing areas were war fields. Even worse, productive workers have been recruited for the war. The declines in real GDP in 1990/91 and 1991/92 for example, are best explained by war and political instability than other factors. Above all, economic agents were uncertain about their investment decisions. During the Derg era, government was responsible for expansion of investment (industries). But, the defense budget alone was above 40% of the total recurrent expenditure which in turn was 26.1% of GDP in the late 80s (from its level of 15% of GDP in mid 70s). The government was busy of conducting war. Even during the imperial era, the *coup de tat* trials and the students' movement of "Land to the

Tiller” have been making unrest. Once more, Ethiopia has been confronting another round of war since 1998.

2.4.3 Unmonetaized Sector

The Ethiopian economy is a subsistent economy. Most of the products of the farmers is produced and at the same time consumed in the peasant sector. It has therefore been difficult to extract surplus from the sector. That is why it was planned as policy priority in the Third Five Year Development Plan of the imperial government to monetize the rural sector, to decrease the non-monetary consumption from 50% to 40% and increase monetary consumption from 40% to 45%[The Third-Five-Year Development Plan, 1968:54-6]. This has long run implication on growth since savings are low in this sector. Financial intermediaries, particularly banks are not penetrating to the rural area; marketing services are missing or are not sufficiently and efficiently organized and there are few or no credit facilities. Even in the urban areas, banks demand big collateral, which most investors cannot afford.

2.4.4 Poor Infrastructure

Availability of infrastructure is considered to be the important prerequisite for investment. However, such factor, which is supposed to play a permissive role in the economy, is missing or very rudimentary. That is why even currently, private investment projects with a capital of

52% of the total investment capital of the country licensed since 1992 are concentrated in Addis Ababa for the relative existent of infrastructure.

2.4.5. Institutional Factors and Policy Issues

To comment on the policy issue, during the imperial era, the system resisted the demand of the people for changing the land tenure. The land was under the ownership of few feudal lords and one-third of it belonged to the church while the majority poor was tenant. This situation retarded growth partly due to lack of incentive (the land the tenants work on is not theirs) and latter arose unrest to the extent that the monarch was overthrown by the popular revolution in 1974/75.

During the Derg regime, in the agricultural sector, collectivization and villagization were implemented without the will of the peasants. Moreover, the compulsory and deliveries of produces to the then Agricultural Marketing Corporation (AMC) and the quota deliveries were disincentives to the peasant sector.

Currently, the Agricultural Development Led industrialization strategy (ADLI) is in place. This strategy is launched because it is believed that the peasant sector is both a potential buyer and a source of surplus for industrialization. Hence, the argument is that increasing the purchasing power of 85% of the people-the peasant- by increasing its standard of life

is an important step that should not be missed in gearing the economy to industrialization.

The problem is that with small fragmented and unproductive land in the hands of the peasant, it is hardly possible to transform the agricultural sector particularly in the face of unpredictable rain. Moreover, the land lease policy and other institutional factors add to the current problems in the economic activities.

In the Second Five Years Development Program of EPRDF, it seems that the front implicitly admitted that the policy biased towards the agricultural sector was threatened by natural constraints (there are in fact institutional and technical constraints as well) and emphasis would be given to the industrial sector for the coming five years [EPRDF's Five Year Development Program, 2000].

The other problem worth mentioning is the existence of inefficient and incompetent bureaucracy.

CHAPTER THREE

LITERATURE SURVEY

THEORETICAL LITERATURE

3.1 Introduction

Economic growth can be defined as the growth rate of real per capita GDP over some period. The trend of growth of real GDP can be considered as sustainable economic growth while the short-run fluctuations of growth over the trend can be thought of as business cycles. Economic development on the other hand includes economic growth, distribution of income, unemployment and poverty. Nowadays, development is being defined as transformation of societies. Joseph Stiglitz (1998) has defined development as follows:

Development represents a transformation of society, a movement from traditional relations, traditional ways of thinking, traditional ways of dealing with health and education, traditional methods of production, to more 'modern' ways. For instance, a characteristic of traditional societies is the acceptance of the world as it is; the modern perspective recognises change, it recognises that we, as individuals and societies, can take actions that, for instance, reduce infant mortality, extend life spans, and increase productivity. Key to the changes is the movement to 'scientific' ways of thinking, identifying critical variables that affect outcomes, attempting to make inferences based on available data, recognising what we know and what we do not know [Stiglitz, 1998:2].

There is a recent concept called human development. According to this concept, human beings should be at the very center of economic decisions. Economic growth should not be an end by itself but a means to another end- the welfare of society. Hence, the motto is growth with human face. The United Nations Development Program uses an index called human development index (HDI) to measure the human development performance of countries. Per capita GNP (measured at the purchasing power parity-PPP), life expectancy and education (mean years of schooling and adult literacy rate) are used to calculate the HDI [See the various issues of the Human Development report of UNDP].

3.2 Theories of Growth

In history, early accumulations of capital have helped countries to sustain economic growth. The industrial revolution has its root in the early capital accumulations. In fact, the sources of these accumulations may vary from country to country. One such means of acquiring capital was colonization [Sacks and Warner, 1997]. It would be incomplete, for example, to talk about the development of England without mentioning the underdevelopment of India. Partly due to such historical facts and partly due to the empirical findings that capital explained 30 to 55% of

the growth of the economies of many countries, capital fundamentalism has been advocated for many years.³

Since the time when industrialization was considered synonymous to growth after Britain's success of expanding industrial output by 400% during the industrial revolution, the other factor that has been found to play essential role in economic growth is technology [Gills, et al, 1992]. England used inventions for her growth. Countries such as Germany managed to industrialize through innovations. In recent times, the South East Asian countries achieved growth through learning-incremental changes at shop-floor level [Amsden, 1989].

Such historical patterns of growth are being represented by growth models. Following is a brief discussion of these models.

3.2.1 Early Growth Theories

As can be read from history of economic thought, mercantilists emphasized external commerce while the cameralists focused on taxation and state regulation of the internal economy.

³Thirlwall, Pensmazoglu and Maddison found that 30 to 55% of the growth of more than twenty countries is explained by capital formation in 1970s[Thirlwall, 1974:6].

In latter days, phisiocrats emphasized agriculture since they believed it has the capacity to create investible surplus. This was essentially a question of ensuring spontaneous growth [See Lombardini, 1996].

In Adam Smith's analysis, too, the central problem was economic development. For him, development was considered to be progress and the latter was not a mere growth. For him, economic development is quantified in terms of expanding consumption which in turn is a function of innovation and growing population. Central in Smith's argument was the division of labor. The acceleration of economic growth is fostered by division of labor. Accumulation enables entrepreneurs to expand the latter [See Lombardini, 1996].

3.2.2 The Keynesian Growth Models

Unlike the Adam Smith's conception of saving (frugality) as an important prerequisite of growth, Keynesian approach gives emphasis to the demand aspect. For Keynes, demand is prerequisite for growth. It can be generated from consumers and the state. Saving on the other hand is considered to be the product of growth; that is, it is a residual variable [Lombardini, 1996:33,178].

Growth models in the Keynesian framework ranges from the one sector Harrod-Domar growth model to the Hirishman import substitution models of the unbalanced growth theory [Grabowski and Shields, 1996].

To start with the Harrod-Domar model,⁴ it assumed that the output of an economic unit is determined by the level of capital invested in that unit. To produce Y units of output, α units of labor and κ units of capital are required; that is, the economy has a fixed-coefficients technology. The associated production function is given by:

$$Y_t = \min \left[\frac{K_t}{\kappa}, \frac{L_t}{\alpha} \right] \quad [3-1]$$

Investment is assumed to be equal to net savings (which is in turn a constant function of output). Increments in output equals to increments in investment divided by saving rate. This is from the demand side. From the supply side, increment in output equals investment divided by capital-output ratio.

Since investment and output have a constant relation, (I_t/Y_t is constant (= s)), then the growth rate of I_t and Y_t should be the same. At full-employment level of capital stock, the required rate of growth is equal to the ratio of saving rate to the capital-output ratio:

⁴ See Branson(1989), Gills, et. Al (1993).

$$\frac{\left(\frac{dY_t}{dt}\right)}{Y_t} = \frac{\left(\frac{dI_t}{dt}\right)}{I_t} = \frac{s}{\kappa}$$

$$\Rightarrow g = \frac{s}{\kappa} \quad [3-2]$$

The ratio s/κ gives the “warranted” rate of growth of full-employment level of capital stock [Branson,1989].

For full employment of labor, output need to grow by the growth rate of the labor force. If we assume that the output grows at the growth rate of labor n and if λ represents the rate of growth of average labor productivity, growth rate in output equals $(n+\lambda)$ where $(n+\lambda)$ is referred to as natural rate of growth of effective labor force, and the Harrod-Domar condition for equilibrium growth (where both capital and labor are fully employed) is that:

$$(n + \lambda) = \frac{s}{\kappa} \quad [3-3]$$

The validity of the Harrod-Domar condition is assured only if $(n+\lambda)$ just happens to equal s/κ . Under other cases, the model deviates from full-employment equilibrium.

One of the weaknesses of the model is the assumption of fixed-coefficients production function (does not allow for factor substitution) and the other is that the saving ratio is assumed to be fixed.

The other growth theory under the Keynesian framework is the theory of balanced growth. The term “balanced growth” has been given different notion by different authors.⁵ In this case, I stick to the meaning given by Rosenstein-Rodan and Ragnar Nurkse. Nurkse has elaborated and substantiated the Rosenstein-Rodan’s theory on balanced growth

According to Nurkse, capital formation “lies at the very centre of the problem of development in economically backward countries.” Such countries as compared to developed countries are equipped with meager capital in relation to their population and natural resource [Nurkse, 1955:1].

Nurkse reintroduced a concept called “vicious circle of poverty” which he explained as “circular constellation of forces tending to act and react upon one another in such a way as to keep a poor country in a state of poverty.” According to him, a poor country is trapped in such deadlock.

⁵ Some argue that balanced growth means “investing in a laggard sector or industry so as to bring it abreast of others”. Some believe that it implies investment in all sectors simultaneously. Still others think that it is a balanced development of agriculture and manufacturing [Jhingan, 1986:180].

Perhaps such countries are trapped in such type of circles that afflict the accumulation of capital [Nurkse, 1955:4].

The circle operates both on the supply and demand sides. On the supply side, there is a small capacity to save, which in turn is a result of low level of real income. The latter in turn is a reflection of low productivity. The low productivity is mainly due to the lack of capital, which is in turn the result of low capacity to save. On the demand side, investment motive is low due to low purchasing power (effective demand) of the people resulted from low level of real income. The low level of real income is due to low productivity, which is a result of the meager amount of capital used, which in turn is a result of low inducement to invest. Productivity is the common factor of the two sides [Nurkse, 1955:4-5]. The determinant of investment decision is the market size and the ultimate determinant of market size (purchasing power) is productivity.

The question here is: is it possible to break the deadlock? If it is possible, what is the way out of the impasse? Nurkse argued that, at least in history, we have seen nations developed. So there should be way out. He drew the solution as:

The difficulty caused by small size of the market relates to individual investment incentives in any single line of production taken by itself. At least in principle, the difficulty vanishes in the case of more or less synchronized application of capital in a wide range of different industries. Here is an escape from the deadlock; here, the result is an over all

enlargement of the market. People working with more and better tools in a number of complementary projects become each others customers [Nurkse, 1955:11].

Nurkse called such application of a wide range of industries 'balanced growth.' For him, investment in one or two industries does not enlarge market; and the result would be a snail's pace growth. Hence the way out is a sort of 'frontal attack.' The doctrine of balanced growth requires a balance between the various sectors of the economy both in the domestic sector and the foreign sectors[Nurkse, 1955].

The doctrine of the balanced growth is criticized on many grounds. First, the simultaneous establishment of industries raises cost. Moreover, it does not account for the shortage of resource [Jhingan, 1986:189].

The theory against the balanced growth theory is the unbalanced growth theory. Unlike the doctrine of the balanced growth theory, it argues that developing countries have no enough resource to finance investments on many sectors simultaneously and as a result it is important to invest on selected priorities so as to achieve ultimately a balanced growth[Jhingan, 1986].

The unbalanced growth theory is popularized by Albert Hirshman. According to Hirischman, development follows a series of disequilibria. In order to get the economy moving, the policy should target on creating

“tensions” and “disproportions”. It requires to deliberately unbalance the economy by investing in strategically selected industries.

It is possible to unbalance the economy from two angles. The first one is unbalancing the economy through social overhead investments. This implies excess infrastructure facilities over directly productive investment and hence encourages private investment to follow suit. For example abundance of power with cheap price induces entrepreneurs to invest seeing both the availability and low price of power. The second option is unbalancing the economy through investment in directly productive activities. But such a move is equivalent to shortage in infrastructures and hence is “disorderly” and “compulsive” while unbalancing via excess social overhead costs is “permissive”. [Jhingan, 1986:192].

According to Hirschman (cited in Jhingan), any investment may have backward and forward linkages. A country may choose to establish industries that have the larger linkage effects. Since it may be costly for a developing country to establish large industries, it may be advisable to set up “last industries first”. In such cases, countries may adopt export promotion and import substitution instead of infant industry protection [Jhingan, 1986:194-5].

The limitations of this theory, among others, are inadequate attention to the timing, composition and direction of unbalanced growth and too much emphasis on investment decisions [Jhingan, 1986].

So far, one-sector models are considered. There are also dualistic models, the most important ones being the Lewis theory of unlimited supplies of labor and the Fei-Ranis theory, which is an extension of the Lewis theory. Following is a brief discussion of the Lewis model [Jhingan, 1986].

Lewis assumes that there is unlimited supply of labor at subsistence wage in many underdeveloped countries. For Lewis, capital accumulation is essential and plays central role in economic development. Hence, the theme of his theory lies on the strategy of ensuring capital formation [Jhingan, 1986].

Lewis divided the economy into “subsistence” sector and “capitalist” sector. Underdeveloped countries are over-populated in relation to their capital and natural resources. Hence, the marginal productivity of labor in such countries is negligible, zero or even negative. Since there is unlimited supply of labor at the subsistence wage, it is possible to draw labor from the “subsistence” sector and employ in the “capitalist” sector at current wage. By doing so, it is possible to expand or establish

industries regardless of their skill as skilled-labor is a “quasi-bottleneck” as it could be alleviated through training [Jhingan, 1986].

Since marginal productivity is higher than the capitalist wage, surplus is created in the capitalist sector. The profit motive induces the capitalist to re-invest. The process continues until the subsistent sector becomes competitive both in labor productivity and factor costs [Jhingan, 1986].

Some of the critiques of the model are: wage rate in the capitalist sector is not constant; the theory is not applicable if capital accumulation technique is labor saving; skilled labor is not in fact a temporary bottleneck and marginal productivity of labor is not zero [Jhingan, 1986:152].

3.2.3 The Kalecki Model

This model is similar to those models under the Keynesian framework but it differs in its consideration of the institutional factors constraining the agrarian sector and it would be worth discussing separately for its relevance to this paper.

Kalecki (1972) showed how growth of national income is affected by the decline in consumption demand in the agrarian economy, which is a result of the limited supply of necessities. The growth in national income

is constrained by the shortage of food supply in the agrarian sector in less developed mixed economies.

Kalecki considered that productive investment and increase in inventories (production accumulation) are prerequisite for output growth.

In defining economic growth, he started with the basic identity:

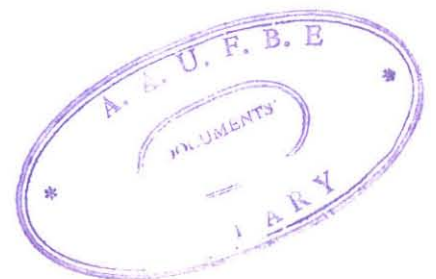
$$Y = I + S + C \quad [3-4]$$

Where Y = national income, I = investment, S = savings (and hence $I+S$ = productive accumulation), and C = consumption.

The national income is assumed to rise between this and the following year due to a rise in investment I at a rate of $1/\theta$ where θ is the capital-output ratio. As there is continuous obsolescence and wear and tear in equipment, part of the increase in output is an allowance for such depreciation and can be represented by δY where δ is the depreciation parameter. On the other hand, output can grow due to organization of labor, efficient use of raw materials, elimination of faulty products, etc and yet still by using the existing plant. Let this increase in output which accrue to improvements in utilization of equipment be represented by νY .

The associated increase in output, therefore, is given by:

$$\Delta Y = \frac{1}{\theta} I - \delta Y + \nu Y \quad [3-5]$$



Dividing Equation [3-5] by Y, we get⁶:

$$\begin{aligned}\frac{\Delta Y}{Y} &= \frac{1}{\theta} \left(\frac{I}{Y} \right) - \delta + \nu \\ \Rightarrow g &= \frac{1}{\theta} \left(\frac{I}{Y} \right) - \delta + \nu\end{aligned}\quad [3-6]$$

Where **g** is growth rate of national income. The constancy of I/Y implies that investment grows proportional to income. That is, if investment is increased by the same rate as national income, then the national income grows at its constant rate. It follows that for accelerated growth in national income, investment should grow at higher rate than national income.

Kalecki further assumed that the volume of inventories increases proportional to national income:

$$S = \mu \Delta Y \quad [3-7]$$

Where S = increase in inventory, and μ 'average period of turnover.'

Re-arranging Equation [3-6] and [3-7], we have:

$$\frac{I}{Y} = (g + \delta - \nu)\theta \quad [3-8]$$

and

$$\frac{S}{Y} = \mu \left(\frac{\Delta Y}{Y} \right) = \mu g \quad [3-9]$$

⁶ Kalecki is pessimistic on the application of this model for capitalist economy particularly in the interpretation of ν . He assumed full utilization of productive capacity in the socialist system while full utilization in capitalist system depends on the effective demand and volume of productive capacity [Kalecki, 1972:12].

Adding Equations [3-8] and [3-9] and re-arranging it can be written as:

$$g = \frac{1}{\theta + \mu} \left(\frac{I + S}{Y} \right) - \frac{\theta}{\theta + \mu} (\delta - \nu) \quad [3 - 10]$$

$(I+S)/Y$ which we may denote by \mathbf{i} represents the relative share of productive accumulation in the national income and Kalecki termed it as "*rate of productive accumulation*".

The relative share of consumption, hence, is:

$$\frac{C}{Y} = 1 - i \quad [3 - 11]$$

Denoting $(\theta+\mu)$ by \mathbf{k} (capital- output ratio for total capital), we can re-write Equation [3-10] as:

$$g = \frac{i}{k} - \frac{\theta}{k} (\delta - \nu) \quad 3 - 12]$$

The implication of Equation [3-12] is that for constant rate of growth of national income \mathbf{g} , productive accumulation also grows at rate \mathbf{g} . The same is true for the increase in inventories. The immediate implication is that the share of consumption $(\mathbf{1-i})$ also remains constant and consumption increases proportional to national income. If the national income is to accelerate, the relative share of productive accumulation in the national income \mathbf{i} must rise and by implication, the share of consumption $(\mathbf{1-i})$ declines steadily (because \mathbf{i} increases more rapidly than national income). Hence, a rise in the rate of growth of national income

reduces consumption adversely in the short-run with further implication that attention should be given to such effect when a particular rate of growth is chosen. The other factors Kalecki emphasized to be taken into account in the determination of the rate of growth of national income are balance of manpower and balance of trade [Kalecki, 1972:12].

Kalecki discussed the mechanics of growth with the basic growth model developed so far under separate conditions of unlimited supply of labor, foreign trade balances, increase in labor productivity, increasing capital-output ratio, and full employment [Kalecki, 1972]. But more relevant to the theme of this paper is his discussion on the necessity supply constrained growth of national income in developing countries.

We have seen in the discussion above that accelerated growth in the national income has implication on consumption which has also in turn implication on output (at least from the Keynesian macroeconomics point of view). Kalecki extended further the argument on this issue. He assumed that there are two types of consumer goods namely *necessities*- which are consumed by the majority of the population ('broad mass')- and *non-essentials*- which are consumed by the richest strata of the population. He further assumed that there is no inflation pressure for necessities particularly staple foods and low-income groups are not taxed. The aim is to show that for a given target growth in national

income (g) for some five or ten years plan, the rate of increase in supply of necessities required to ensure the planned growth rate g is an increasing function of g .

For a given growth rate of national income g , there corresponds a given rate of increase in demand for necessities c_n . For the rate of increase in demand for necessities to remain constant, the growth rate of national income and that of consumption should be the same and equal to the rate of growth of population n thereby keeping the per capita consumption unchanged. If, however, $g > n$, then per capita consumption will increase at a rate $g-n$ and the corresponding rate of increase in per capita demand for necessities is c_n-n . In general it holds that $(c_n-n) < (g-n)$. Denoting the average income elasticity of demand for necessities by η_{Id} we can write:

$$c_n - n = \eta_{Id}(g - n) \quad [3-13]$$

where $\eta_{Id} < 1$.

By re-arranging Equation [3-13], we have:

$$c_n = n + \eta_{Id}(g - n) \quad [3-14]$$

Though it may be thought that η_{Id} depends on g , as it is low percentage and as the period in consideration is short, its impact on the elasticity can be considered to be negligible.

The rate c_n can be considered as the approximate value of the rate of growth of supply of necessities. Let us assume that the rate of growth of total consumption is c . Then, given one of the rates g , c_n , and c , it is possible to solve for the other two. Kalecki considered the rate of supply of necessities c_n to be the one which is given. The increase in production of necessities, particularly staple food, is limited by institutional factors. These factors keep the supply of necessities low over the given time horizon.⁷ The implication is that the growth rate of supply of necessities which is constrained by institutional factors in the development of agriculture, determines the growth rate of national income. To this end, Kalecki concluded:

The resulting agrarian situation [the fact that poor peasants hold small land while the rich get major share, etc] is one of the factors limiting agricultural output within the general economic development, as under the prevailing agrarian relations the small farmers are unable to expand their production. ...The lagging of agriculture behind general economic growth leads to an inadequate supply of foodstuffs and an increase in their prices, which is again to the disadvantage of the 'stepsons' of the system. Even if the aggregate real income of those strata do not decline as a result of the rise in employment, they do not show any appreciable growth [Kalecki, 1972:166].

⁷ For Kalecki, the institutional factors are feudal land ownership (a problem during his time), and domination of peasants by merchants and money lenders. Moreover, the production of necessities is not equal to its supply as there are imports with further implications on the constraints to growth. [Kalecki, 1972:151].

3.2.4 The Neo-Classical Growth Models

One of the major criticisms of the Harod-Domar model is the assumption of fixed coefficient of production, that is, it does not allow for factor substitution. This assumption is relaxed under neo-classical growth models.

Robert Solow introduced a neo-classical growth model to the literature in 1956. His model was based on two fundamental equations namely the (Cobb-Douglas) production function and a capital accumulation equation.

This model does not account for technological progress and the prediction is that level of per capita income is determined by population growth rate and investment rate. Accordingly, economic growth can happen only temporarily and lasts only until capital per capita reached its steady-state level.

The second model Solow introduced in 1957 incorporates an exogenous technology (labor augmenting technology). In this case, the production function is written as:

$$Y(t)=K(t)^\alpha(A(t)L(t))^{1-\alpha} \quad [3-15]$$

Dividing this function by $A(t)L(t)$, one gets output per unit of effective labor as a function of capital per unit of effective labor.

$$\tilde{y}(t) = \tilde{k}(t)^\alpha \tag{3-16}$$

The capital accumulation equation is re-written in terms of capital – technology ratio as:

$$\frac{d\tilde{k}}{dt} = s\tilde{y} - (n + \delta + g)\tilde{k} \tag{3-17}$$

Here, $g = (dA/dt)/A =$ the rate at which technology grows.

Solving the above equations, one gets the steady-state value of per capita income:

$$y^*(t) = A(t) \left(\frac{s}{\delta + n + g} \right)^{\frac{\alpha}{1-\alpha}} \dots\dots\dots [3-18]$$

The important implications of these results are level of per capita output is determined by technological level, investment rate and population growth rate. While sustained growth rate of per capita output over time is determined by technological changes. Other temporary shocks such as policy changes can affect growth only temporarily just until a new steady-state level is reached. Hence, according to Solow’s model, per capita output differences across countries and over time are

explained by population growth rate, investment rate and technological levels of countries [Jones, 1998: 21-39; Romer, 1996:7-25].

The other implication of the dynamic analysis of the model is that if initial capital stock is far below the steady-state, rate of accumulation (until the new steady-state is restored) is fast and accordingly output grows fast but at a slower rate later as it approaches steady-state level, where growth ceases. This implies that poor economies with lower value of capital and output tend to catch up with the initially rich ones. The prediction hence is that poor economies grow faster than rich ones [Barro, 1997a:397]

3.2.5 Endogenous Economic Growth Theories

The Solow growth model considers the role of technology as source of growth. However, the models fail to endogenously incorporate technology and hence sources of technological differences across countries remained unexplained. The basic improvement of the new growth theory or endogenous growth theory over these models is that it explicitly tries to model technology rather than assuming it to be exogenous. In essence, it looks for determinants of technological progress, that is, factors that push the technology frontier upward continuously. In this theory, the central motive of profit maximization of business firms is considered to

determine technological progress as these firms involve in research and development (R&D) seeking new and better 'mousetraps'[Jones, 1998:89]

According to Paul Romer, the productivity term **A(t)** in the previous models which was assumed to be exogenous this time represents the “stock of knowledge or the number of ideas that have been invented over the course of history up until [a] time....” The new ideas produced can then be represented by the growth rate of **A(t)**. This in turn is a function of the number of researchers engaged in finding new ideas with a parameter characterizing degrees of finding new ideas [Jones, 1998:71-101].

Letting **L_A(t)** to be the number of people engaged in an effort of discovering new ideas and ψ the rate of their success in discovering new ideas, then we can write:

$$\frac{dA(t)}{dt} = \psi L_A(t) \quad [3-19]$$

If the total labor force is L, then the labor force engaged in output production is (L-L_A). Denoting the difference L_Y, the production function can be written as:

$$Y(t) = K(t)^\alpha (A(t)L_Y(t))^{1-\alpha} \quad [3-20]$$

As to the rate of new ideas discovered by researchers, we can make three assumptions [see Jones, 1998]. First the rate can be constant. Second, it

may increasingly be dependent on the already discovered stock of knowledge, $A(t)$, that is, "*standing on shoulders*" effect. Finally, it could be the case that the most obvious ideas can be first discovered in which case the rate is a decreasing function of $A(t)$. We can capture these possibilities by modeling the rate of new ideas discovered as:

$$\psi = \delta A(t)^\phi \quad [3-21]$$

It is also logical to assume that the rate of discovering new ideas depends on the number of people engaged in research at a point in time, that is, ϕ is equal to $\lambda L_A(t)^\lambda$. To account for possibilities of externality associated with duplication, λ is assumed to be less than one. Combining this with Equations [3-19] and [3-21], we can have:

$$\frac{dA(t)}{dt} = \delta L_A(t)^\lambda A(t)^\phi \quad [3-22]$$

Here, it is assumed that $\phi < 1$. If $\phi > 0$, it reflects a positive knowledge spillover in research that is the "*standing on shoulder*" effect while the condition that $\lambda < 1$ is associated with the "*stepping on toes*" effect.

Dividing Equation [3-22] by $A(t)$, we can write:

$$\left(\frac{dA(t)}{dt} \right) \frac{1}{A(t)} = \delta \frac{L_A(t)^\lambda}{A(t)^{1-\phi}} \quad [3-23]$$

The left hand side of Equation [3-23] is a constant growth rate g_A and the denominator and numerator should grow at equal rate to maintain the constancy of g_A along the balanced growth path. Taking logs and

derivatives of both sides and representing the growth rate of $L_A(t)$ by the population growth rate n , we have:

$$g_A = \frac{\lambda n}{1 - \phi} \quad [3-24]$$

The implication is that the growth rate of researchers and the parameters of production function for ideas determine the long-run growth. Intuitively, it is highly likely to get people with brilliant mind in large population than small one [Jones, 1998].

The extension of the above model in the Romer's framework is a case where avenue for technological transfer is considered. The model starts with the basic assumption that countries produce output using labor and capital as inputs and the number of capital goods is limited by the level of skill, h , of the workers. A small country far from the world technology frontier uses the advanced capital goods by learning how to use these new techniques. Individuals in such countries accumulate skill at a rate of accumulation: ⁸

$$\frac{dh_t}{dt} = \mu e^{\nu t} A_t^\gamma h_t^{1-\gamma} \quad [3-25]$$

where $\mu > 0$ and is openness to world technology, u = amount of time spent on accumulating new skills, A = world technology frontier, and $0 < \gamma \leq 1$ [Jones, 1998:117].

By re-arranging Equation [3-25] and letting the 'growth rate' of skill accumulation equal to the growth rate of output, g , at steady-state, we can write:

$$\left(\frac{h_t}{A_t}\right)^* = \left(\frac{\mu e^{y_t}}{g}\right)^{\frac{1}{\gamma}} \quad [3-26]$$

Recalling the equation for steady-state per capita output in the previous discussions and introducing $h^*(t)$, we have:

$$y_t^* = \left(\frac{s_k}{n + g + \delta}\right)^{\frac{\alpha}{1-\alpha}} \left(\frac{\mu}{g} e^{y_t}\right)^{\frac{1}{\gamma}} A_t^* \quad [3-27]$$

Thus, an economy grows as workers in the economy learn to use ideas developed in the world.

3.2.6. Non-Conventional Determinants of Economic Growth

In developing countries, uncertainties such as war, drought, macroeconomic instabilities (such as high inflation), excessive government involvement in the economy and dictatorship are considered to retard growth. According to Collier and Gunning (1999a, 1999b), at aggregate level and in general case, lack of openness to international

⁸ Jones justified the application of this specification by relating to the fact that it is widely supported by the literature in labor economics. It is argued that "additional years of schooling increases the wage earned by an individual by something like 10 percent"[Jones, 1998].

trade, lack of social capital, geography and risk, lack of infrastructure, lack of financial depth, and high aid dependence characterize the poor performance of the African economies.

For Sachs and Warner(1997) economic policies, initial conditions, demography and physical geography explain the poor economic performance of Africa. The authors did not discredit the colonial legacy, ethnic divisions and particular geographic difficulties in affecting the African economic performance. More important determinants, according to them, are economic policies such as lack of openness to international trade, low government saving and lack of market -supporting institutions. They argued that "...Africa could have grown at over 4% per year in per capita terms with appropriate policies." The other factors that explain African growth are land-lockedness, natural resource dependence, disease and lower life expectancy [Sachs and Warner, 1997].

There are also factors that explain the performance of the economy at micro level. Collier and Gunning (1999a, 1999b) identified high risk and volatility, lack of rural social capital, government intervention in forms of regulation and taxation, credit constraints, and lack of financial depth as factors constraining the peasant households. In the case of risk and uncertainty, in about 15 countries the agricultural activity depends on short period of time- usually less than 150 days- and is highly

susceptible to climatic change. In some areas of Ethiopia, Tanzania and Zimbabwe, the probability of total crop failure is 10% [Collier and Gunning, 1999b].

From the firm side, their economic activities are constrained by high risk environment, regulation and taxation, lack of social capital, poor public service, and lack of financial depth [Collier and Gunning, 1999b].

The other factor, which is not usually considered in the traditional models of economic growth, is the role of state, which constitutes the political economy of growth. The traditional economic theory argues that the role of the government in the economy should be minimal. In reality, however, governments do involve in the market though the extent and way of intervention vary. Governments may play pivotal role in achieving economic growth through policy instruments usually by enabling the private sector to play the role what it should play in the economy. At initial stages, it may even require the active involvement of government in strategic investment activities. South Korea is once more a case in this respect. In 1970s, almost two-thirds of the investment resources were directly or indirectly controlled by the state. That is, 60% of the total investment was financed by government savings and foreign savings- which was under the control of government [Park, 1993].

Today, new ideas have been seen to play an essential role in economic growth of countries. For instance, in a case study made on Mauritius and Taiwan, Romer (1993) argued, "*...it was the knowledge...brought by the foreigners that caused both investment and growth.*" In the process government had an important role in introducing new ideas. The direction of government policy also matters. For example in Mauritius, the government made export processing zone to attract foreign investors with their new techniques of production, i.e. new ideas. The government launched policies such as unrestricted and tariff free imports of machinery, avoiding restrictions on ownership or repatriation of profits, centralized wage setting and a ten year income tax holiday for foreigners, banning of unions, devaluation, etc [Romer, 1993:77].

In Taiwan, the government has indeed played a major role in bringing new ideas. As an initial policy, it imposed "tariffs and quantitative limits on imports of yarn and finished products," restrictions for new entry of firms. It encouraged and assisted in finding foreign investors "with technology to share." It also encouraged the establishment of electronics industry besides textile (unlike Mauritius with no diversification). It established Industrial Technology research Institute. It encouraged exports so that investors bring new techniques to compete in the world market. Moreover, the government controls quality [Romer, 1993:83-4].

Depending on the directions of government policies, the directions of approaches to the economy are different and the economic status they achieved are different. Mauritius depended on textile and there was no production of ideas but using ideas. In Taiwan, however, the government helped in both using ideas and producing ideas.

The other candidate in affecting economic growth from the political economy perspective is democracy. According to Collier and Gunning (1999a), governments' damaging behavior due to the fact that they are serving narrow constituencies, ethnic diversity in the face of low level of political rights, high incidence of corruption, and high aid dependence are the other important problems.

Przeworski and Limongi (1996) seem to be pessimistic about the validity of the standard regression models on 'growth-democracy' relation. They, however, suggested as a hunch that "Politics does matter but 'regimes' do not capture the relevant differences." For them, it is not democracy or authoritarianism per se that matters. They believe that it would be a solution if it were possible to find "...institutions that enable the state to do what it should do but disable it from doing what it should not." In general, their basic conclusion is that the impact of democracy on growth is not unequivocal.

EMPIRICAL LITERATURE

There are many empirical works conducted on growth. Some of them are conducted to test the validity of the traditional growth models. Others are extensions of the basic models. The various empirical works mostly focus on cross-country basis rather than on a single country.

Empirically, Mankiw, Romer and Weil (1992) conducted a research on large set of countries and found that saving rate and population growth rate determine income; and more than half of the cross-country income variations can be solely explained by these factors. This result, according to Mankiw, Romer and Weil, validates the predictions of the Solow model. The magnitudes of these factors were not however intuitive-they were too large [Mankiw, Romer and Weil, 1992:407-8].

They extended the basic Solow model by introducing human capital. They proxied rate of accumulation of human capital by the percentage of the working-age population that are in high school. In their cross-country study, they used average values for the period 1960-1985 across countries and came up with a result that the per capita income variations across countries are best explained by the inclusion of the human capital aspect [Mankiw, Romer and Weil, 1992:424-33].

*The other empirical work on growth is the one conducted by Calamitsis, et al (1999). They used private and government investment ratios, indices of life expectancy at birth and infant survival rate (to proxy human capital), population growth adjusted for technical progress and capital depreciation, inflation, budget deficit, terms of trade, volume of exports, effective exchange rate, and dummy for war as explanatory variables where the dependent variable was growth rate in real per capita GDP. They used a panel data for 32 Sub-Saharan Africa countries for the period 1981-97. Their results showed that private investment contributes to growth while government investment was not robust. The policy-related variables were significant with expected sign. The indices for human capital had positive sign but were not robust. Dummy for war had negative and significant coefficient implying negative impact on growth. Finally, the dummy for IMF-supported program had positive and significant coefficient [Calamitsis, et.al, 1999:10].

*The other work is by Robert J. Barro (1997a). He used panel data for about 100 countries for the period 1960-1990. The dependent variables are the growth rates of real per capita GDP for the periods 1965-1975, 1975-1985, and 1985-1990. The explanatory variables include initial value of GDP (to account for convergence), male secondary and higher schooling, life expectancy, fertility rate, government consumption ratio, terms of trade, democracy index (and its square), inflation rate, and

dummies for Sub-Saharan Africa, Latin America, and East Asia. He found that initial value of GDP has negative and significant coefficient supporting the case of convergence theory. Male secondary and higher education and terms of trade have positive and significant coefficients. While inflation, government consumption ratio, fertility rate, and the square of democracy index have negative and significant coefficients. For Barro(1997a), the overall relation between growth and democracy is not perfect. One explanation he made (by re-specifying the linear model to a quadratic one) is that "...in the worst dictatorships, an increase in political rights tends to increase growth and investment because the benefits from limitations on governmental power is the key matter." On the other hand, in countries, which have a moderate democracy already, a further democratization impairs growth and investment through intensified concern with income redistribution. He has conducted a cross-country study and found a mixed result implying that there is non-linear relation. According to Barro, this implies that democracy is not critical for economic growth [Barro, 1997b: 60-61]. Lastly, dummy for Sub-Saharan Africa and Latin America had negative coefficients though not significant.

* Jeffrey Sachs and Andrew Warner (1997) on their part conducted a research on growth. They used data for Sub-Saharan Africa countries for the period 1960-90. They showed that land-lockedness, geographical

conditions, high natural-resource-dependence (represented by dummy for land-locked countries, dummy for tropical climate, and share of natural resource exports, respectively) have significant negative impact on growth while openness to international trade has significant positive impact [Sachs and Warner, 1997:359-366]

Though there is rich literature on the theory of economic growth, little has been done in Ethiopia. Some papers have been written on the macroeconomic performance of the Ethiopian economy. A recent work in this regard is the paper by Berhanu and Seid (1999). The paper made an evaluative assessment of the Ethiopian economy particularly the macroeconomic performance for the period 1992-1998. It makes comparison to the economic performance under the previous regimes. It observes that the trend in the growth of the economy has been highly associated with the patterns of the growth rate in the value-added in the agricultural sector. The authors tried to show the high dependency of the agricultural output on weather. They used a simple error correction model in modeling yields in major crops as a function of land, agrarian labor force, mean annual rainfall and dummy for war. Rainfall has been found significantly affecting yields in major crops.

One important gap (besides the methodology of analysis used) is that these factors that are shown to affect agricultural yield could have been

directly modeled as a determinant of economic growth, along with other relevant factors, rather than assuming they affect growth via the agricultural yield.

However, in the realm of formal modeling of the economic growth per se, little has been done in Ethiopia. One of the few attempts related to growth is a paper by Netsanet (1997). The theme of the paper was that human capital significantly contributes to economic growth in Ethiopia. The author used enrollment ratios at various level of education to capture the role of human capital to growth. The enrollment ratios were introduced into the model along with physical capital, working age population and per capita calorie intake. As an estimation procedure, Engle-Granger two-step procedure of error correction model has been used. The results were that enrollment ratios were positive and significant while calorie intake was not significant. Physical capital was significant only in the short-run model. Particularly, enrollment ratio of the primary school level has been emphasized to be highly significant in contributing to growth. Moreover, the sign of the labor force was negative which the author interpreted as that increase in labor force had an adverse effect on growth.

CHAPTER FOUR

ECONOMETRIC ANALYSIS

I understand that the problem of economic growth is much complicated and does not give a hand to easy explanation as such. The problem of the explanation arises not only because it calls for interdisciplinary analysis but also because the economic variables per se are many and difficult to model. Statistical complications associated with economic data particularly in the analysis of time series data add to the problem. The attempt here, therefore, is to model what I think are the most relevant factors in determining economic growth in Ethiopia. This Chapter is devoted to the modeling and econometric analysis of the determinants of economic growth in Ethiopia.

4.1 The Model

The basic model starts with the Cobb-Douglas Production function:

$$Y_t = F(A_t, K_t, L_t) \quad [4-1]$$

where Y_t = level of output, A_t = level of technology, K_t = capital, and L_t = labor.

To endogenize the technology, A_t , let it be represented by level of skill of an individual, h_t , and Equation [4-1] can be written as:

$$Y_t = F(K_t, L_t, h_t) \quad [4-2]$$

h_t entering in the same manner as labor-augmenting technology. Following Paul Romer, the human capital accumulation equation can be represented by:

$$\frac{dh_t}{dt} = \mu e^{\psi v} A_{wt}^\gamma h_t^{(1-\gamma)} \quad [4-3]$$

where μ = degree of openness to world technology to account for degree of technology transfer; v = number of years spent in learning new techniques; A_{wt} = world technology frontier; ψ and γ are parameters.

Assume that the human capital grows at a constant rate, g_h . Hence, Equation [4-3] can be re-arranged to give:

$$h_t = \left(\frac{\mu e^{\psi v}}{g_h} \right)^{\frac{1}{\gamma}} A_{wt} \quad [4-4]$$

For empirical purpose, Equation [4-4] can be weighted across the number of individuals. Moreover, as g_h is constant, one can write:

$$h_t = \left(\mu \sum_{i=1}^v (E_{it} e^{\psi i v}) \right)^{\frac{1}{\gamma}} A_{wt} \quad [4-5]$$

where E_{it} is number of individuals with a particular level of education in year t .

Moreover, a major part of accumulation of capital depends on factors affecting the production in the agricultural sector, more importantly rainfall. First, farmers' capital acquisition depends on the frequency of drought. A drought in a particular year forces agricultural households to sell out their capital stock to bridge their consumption and even they may lose some of them, usually their oxen and other livestock. This leaves them with meager or no capital to work with after recovery from famine. Second, the capital accumulation process in the non-agricultural sectors is by and large a function of profit. Profits depend on the agricultural sector via input and demand linkages. These linkages in turn depend on the level of production of necessities in the agricultural sector. Obviously, production in this sector is highly dictated by the availability of rainfall. Hence, rainfall has both a direct effect (by reducing level of output in the agriculture) and indirect effect (via level of capital accumulated)⁹. Accumulation of capital is also determined by capacity to import capital goods. As a result, Equation [4-1] can be written as:

⁹ By differentiating Equation [4-6], we have:

$$dY_t = \frac{\partial Y_t}{\partial H_t} dH_t + \frac{\partial Y_t}{\partial K_t} dK_t + \frac{\partial Y_t}{\partial \rho_t} d\rho_t + \frac{\partial Y_t}{\partial X_t} dX_t + \frac{\partial Y_t}{\partial L_t} dL_t$$

$$\Rightarrow \frac{dY_t}{d\rho_t} = \frac{\partial Y_t}{\partial K_t} \frac{dK_t}{d\rho_t} + \frac{\partial Y_t}{\partial \rho_t}$$

$$Y_t = F(H_t, K_t(\rho_t, X_t), L_t) \quad [4-6]$$

where H_t = human capital, ρ_t = rainfall, and X_t = foreign exchange earnings.

Let accumulation of capital be written as:

$$K_t = K_t^* \rho_t^\theta X_t^\tau \quad [4-7]$$

where K_t^* is level of capital independent of rainfall and foreign exchange earnings, X_t is foreign exchange earnings, θ and τ are parameters.

Combining Equations [4-5] through [4-7], one can write as:

$$Y_t = \left(K_t^* \rho_t^\theta X_t^\tau \right)^\alpha L_t^{1-\alpha} \left(\left(\mu \sum_{i=1}^v (e^{\psi_i \nu} E_{it}) \right)^{\frac{1}{\gamma}} A_{wt} \right)^\beta \quad [4-8]$$

Assume that technological transfer is constrained by foreign exchange earnings, which can be determined by the values of export, X_t :

$$\mu_t = \bar{\mu} X_t^\delta \quad [4-9]$$

Hence, Equation [4-8] becomes:

$$Y_t = \left(K_t^* \rho_t^\theta X_t^\tau \right)^\alpha L_t^{1-\alpha} \left(\left(\bar{\mu} X_t^\delta \sum_{i=1}^v (e^{\psi_i \nu} E_{it}) \right)^{\frac{1}{\gamma}} A_{wt} \right)^\beta \quad [4-10]$$

Transforming Equation [4-10], we have an estimable model:

$$\ln Y_t = \phi + \alpha \ln K_t^* + \lambda L_t + \beta \ln H_t + \eta \ln X + \xi \ln \rho_t \quad [4-11]$$

where $\phi = \frac{\beta}{\gamma} \ln \bar{\mu}$, $\lambda = 1-\alpha$, $H_t = \left(\sum_{i=1}^v (E_{it} e^{\psi_i \nu}) \right)^{\frac{1}{\gamma}} A_{wt}$, $\eta = \frac{\beta}{\gamma} \delta + \alpha \tau$, and $\xi = \alpha \theta$.

Here, the task remaining before the estimation procedure is determining ψ , A_{wt} and γ . The parameter ψ can be determined as a share of the labor force, which gets training in the total labor force. For this analysis, it is determined as follows.

$$\ln E_t = \sigma + \psi \ln L_t + \varepsilon_t \quad [4-12]$$

A_{wt} is proxied by the potential output achieved so far by the best technology in the world, in this case USA. The "potential" GDP can be approximated by regressing the logarithm of the GDP on time and adding the highest positive residual on the fitted values.¹⁰

The parameter γ is determined as a ratio of the logarithm of the Ethiopian "potential" GDP to the logarithm of that of USA:

$$\ln Y_{PETHt} = \varphi + \gamma \ln Y_{PUSAt} \quad [4-13]$$

Sometimes, rainfall has a "twin hazard" effect in that excessive rainfall may have an adverse impact on output. Although it can be ignored as the probability of the occurrence of excessive rainfall is low, the estimable model represented by Equation [4-11] may be re-written to account for the severity of excessive rainfall:

$$\ln Y_t = \phi + \alpha \ln K_t^* + \lambda L_t + \beta \ln H_t + \eta \ln X_t + \xi \ln \rho_t + \varpi \ln \rho_t^2 \quad [4-14]$$

where $\varpi < 0$.

¹⁰ Yohannes Ayalew has used this method of approximating a potential GDP in his attempt of estimating the minimum level of unemployment to determine a Philips curve for Ethiopia for his Masters thesis in the same batch. I am very grateful for his kind permission to use the method here.

Equation [4-11] and [4-14] are the estimable models in the co-integration analysis.

Here, $\frac{\partial \ln Y_t}{\partial \ln \rho_t} = \xi + 2\varpi \ln \rho_t = 0$ at maximum level of the output-

rainfall "function". This implies: $\ln \rho_t = \frac{-\xi}{2\varpi} \Leftrightarrow \rho_t^* = e^{\left(\frac{-\xi}{2\varpi}\right)}$.

Hence, there is 'optimal' mean annual rainfall, $e^{\left(\frac{-\xi}{2\varpi}\right)}$, beyond which output declines.

4.2 Estimation Procedures and Results

In handling time series economic data, particularly in regression analysis it is nowadays becoming almost mandatory to test variables for stationarity¹¹. If variables entering a regression are not stationary, then, results that are obtained using ordinary least squares (OLS) techniques would be spurious in the sense that variables would seem to have causation just because they merely have common trends over time rather than true causation [See Maddala (1992), Harris (1995)].

However, most economic time series variables are not stationary. A variable may be stationary by differencing. Such a variable is said to

¹¹ A given variable (a stochastic process) is said to be stationary if it has a zero or at least constant mean, constant variance over time, and if the covariance between observations in two time periods depends only on the distance of the lag between the two time period rather than on the actual time the covariance is computed [See Gujarati (1995), Harris (1995)].

have difference stationary process (DSP). However, some variables may trend upward but along a deterministic line. Such variables are in the category of trend stationary process (TSP), which requires to be detrended in a regression analysis. Most economic variables are, however, in the category of difference stationary process [Maddala, 1992].

One possibility is to estimate using differences of variables (if these differences are stationary). But, such a procedure gives only the short-run dynamics while one's interest may be in determining the long-run parameters. Thus, there would be a loss of considerable long-run information. In such cases, one has to appeal to a notion of co-integration. Time series variables may be non-stationary but their linear combination may be stationary. If this holds, we say there is co-integration (long-run relationship) between the variables involved.

So far, there are two major procedures to test for the existence of co-integration, namely, the Engle-Granger two-step procedure and the Johansen maximum likelihood estimation procedure. In the Engle-Granger two-step procedure, variables entering the co-integrating vector are tested for integration of the same order, in fact order one-I(1). The first step is to estimate the long-run static model of the I(1) variables and obtain the residual. If this residual, which is the linear combination of the variables or the disequilibrium, is stationary, then the variables are

said to be co-integrated, that is, they do have long-run relationship. The second step in this procedure is to estimate the error correction model (ECM). That is, the first difference of the dependent variable is regressed on the first differences of the explanatory variables with their appropriate lags, and the first lag of the residual obtained in the first step. However, this procedure has its own weaknesses. In the first place, the residual that is used as error-correcting term in the second procedure is obtained from the static regression in the first step which is already suspected to be spurious. It also categorizes variables as endogenous and exogenous with an implication of simultaneity problem. Although this problem can be minimized using the three-stage procedure,¹² there still remains a major problem, that is, the uniqueness of the co-integrating vector. This procedure assumes that there is one co-integrating vector even for more than two variables involved in the analysis. When there are more than two variables in the system, there can be more than one co-integrating vector threatening the validity of the coefficients when the Engle-Granger procedure is used because this procedure does not give consistent estimates of any of the co-integrating vectors [Thomas, 1997:440]. The

¹²The three-step procedure, which is developed by Engle and Yoo (1989), is a continuation of the Engle – granger two-step procedure. In this approach, the residual obtained in the regression of the ECM (the second step) is regressed on the product of the negative of the coefficient of the error correcting term and the various conditioning variables. In this case, the corrected parameter for each independent variable is the new coefficient in the third stage plus the coefficient of the respective conditioning variable in (first step) static model and the corrected standard error is the one obtained in the third step [Cuthbertson, et.al. 1992:140-1].

coefficients could merely be combinations of the various co-integrating vectors [Harris, 1995].

To this effect, the Johansen maximum likelihood estimation procedure is superior. Hence, the proper econometric analysis of this paper follows this procedure.

Before the formal analysis, it would be important to discuss the behavior of the data used and the technical manipulations made to transform them.

The Data

The data sources of this analysis are the national income accounts of Ethiopia as prepared and compiled by the Ministry of Economic Development and Co-operation (MEDaC), the database of the Ministry of Finance, summaries of the weather forecasts of the Ethiopian Meteorological Agency, the annual statistical bulletins of the Ministry of Education, quarterly and annual bulletins of the National Bank of Ethiopia, various survey reports and statistical abstracts of the Central Statistical Authority, the database of the Ethiopian Investment Authority, and the International Financial Statistics (IFS) of the International Monetary Fund (IMF).

Data Transformation:

The national income accounts of Ethiopia has two series. The 'old' series runs from 1960/61 to 1992/93 while the 'new' revised series runs from 1980/81 to 1998/99. There is a major structural break between these two series. Hence, to make consistent series, I adjusted the series for the period 1960/61 to 1979/80 using the growth rates of the 'old' series and the value of the year 1980/81 as:

$$X_{t-1} = \frac{X_t}{(1 + g_t)}$$

where X_t is a given series (variable) in year t , and g_t is the growth rate of the variable. Gross domestic product (GDP), gross fixed capital formation or gross fixed investment (GFI), and net exports of goods and services are adjusted by this method.

For this analysis, capital stock would be relevant. But, there is no readily available data for this variable in Ethiopia. I tried to generate my own series. I regressed investment on GDP and considered the coefficient of output as the saving rate, s . I calculated the capital-output ratio, κ , as a ratio of the saving rate to growth rate of real GDP, and it is found to be 2.2. I calculated the capital stock of Ethiopia for the year 1960/61 as the product of κ (≈ 2.2) and the GDP in that year. The series is generated as

the sum of the previous year capital stock and net gross fixed investment. Another problem is determining the net capital formation (investment) because the rate of depreciation is not known for the entire period. One very crude means is to approximate it to be, say, 5% per annum. But this does not help in the regression analysis as both “gross” capital stock and capital stock proper have the same trend (the depreciation rate is constant). Calculated this way, though the series gives a fairly rough estimate on the level of capital stock, it could not be used for the co-integration analysis for its unique statistical behavior- it is integrated of order 2 ($K_t \sim I(2)$) unlike the others which are $I(1)$ (see below).

The labor is represented by population adjusted for activity rate. Population above the age of ten that had been involved in economic activity is considered labor for the given census or survey period while the gaps are filled by projections. The population data projected by CSA and used by MEDaC assumes almost constant growth rate. The other population data is the one projected by the IMF and it has more or less a varying rate of growth over time. For these reasons, the population projected by the IMF is used in this analysis.

The other variable used in the analysis is human capital formation, which is usually difficult to measure. Detailed explanations are given in

section 4.1 above as to how it is calculated. In general, gross school enrollments of the primary, secondary, and tertiary levels with the associated years of schooling, relative share of the individuals with certain level of education in the total labor force, and potential GDP of the US (to proxy world technology frontier) and the share of level of Ethiopian technology in the world level of technology (which in this case is approximated by the ratio of “local” potential GDP of Ethiopia to that of USA.

Lastly, the mean annual rainfall data (in milli meter) is calculated as an average for nine meteorological stations in the country.

Order of Integration:

One important attribute of a (time series) variable is order of integration. For this particular analysis, variables are required to be integrated of order one for reasons that the variables are not expected to be stationary (I(0)), and other orders of integration particularly when they are mixed are difficult to analyze.



For the order of integration of the various variables, a test of unit root is conducted using the Dicky-Fuller (DF) and Augmented Dicky-Fuller (ADF) tests¹³. Using these tests, variables entering the co-integration analysis in this paper are tested for their order of integration and all variables except capital stock generated are integrated of order one. The results are summarized in Table 4-1 except for capital stock.

¹³ Consider a stochastic process (a variable) Y_t that can be written as: $Y_t = \rho Y_{t-1} + \varepsilon_t$, where ε_t is a 'white noise' error term. It follows that it is possible to write: $Y_{t-1} = \rho Y_{t-2} + \varepsilon_{t-1} \Rightarrow Y_t = \rho^2 Y_{t-2} + \varepsilon_t$. Proceeding this way, it possible to write for n observations as: $Y_t = \rho^n Y_{t-n} + \varepsilon_t$. Here, if $\rho < 1$, then Y_t converges to a certain initial value and said to be stationary. In fact, if $\rho = 0$, Y_t is a random white-noise process ($= \varepsilon_t$) which is by definition stationary. If $\rho = 1$, then, Y_t does not converge to a certain initial value in which case we say it has a 'unit root', that is it is non-stationary. Of course, if $\rho > 1$, Y_t explodes. [See Gijaratti, 1995; Harris, 1995; Cuthbertson, et al, 1992]

But testing a null that " $\rho = 1$ " is statistically problematic [see Harris, 1995]. Hence, $Y_t = \rho Y_{t-1} + \varepsilon_t$ can be re-written: $\Delta Y_t = \alpha Y_{t-1} + \varepsilon_t$ where $\alpha = (1-\rho)$. Hence, the null that $\rho = 1$ is equivalent to $H_0: \alpha = 0$. The 't-statistic' calculated is read against a statistic called τ -statistic calculated by Dicky and Fuller. This test for unit root is called Dicky-Fuller (DF) test after D. A. Dicky and W. A. Fuller (1979).

To account for possible autoregression problem, the test can be augmented as:

$\Delta Y_t = \phi + \alpha Y_{t-1} + \sum_{i=2}^k \gamma_i \Delta Y_{t-i} + \varepsilon_t$. It is called the Augmented Dicky-Fuller (ADF) test for unit root. The

intercept ϕ is introduced to capture drifts in the series and this equally works in the DF test discussed above. To account for existence of deterministic trends, it is possible to introduce time trend as:

$$\Delta Y_t = \phi + \alpha Y_{t-1} + \beta t + \sum_{i=2}^k \gamma_i \Delta Y_{t-i} + \varepsilon_t.$$

Table 4-1: Results of Unit Root Tests for Order of Integration of Variables

VARIABLE	DF			ADF						
	Without drift and trend	With drift	With drift and trend	Without drift and trend with lag of		With drift with lag of		With drift and trend with lag of		
				1	2	1	2	1	2	
lnY _t	3.53	-0.53	-2.82	2.93	4.27	-0.52	-0.35	-3.18	-2.04	
lnK* _t	1.04	-0.83	-2.15	1.33	1.07	-0.26	-0.71	-1.55	-2.32	
lnL _t	6.98	-0.64	-1.73	4.08	3.21	-0.64	-0.63	-1.70	-1.54	
lnH _t	2.24	-1.47	-2.68	2.48	2.18	-1.57	-1.55	-2.34	-2.37	
lnX _t	1.32	-0.56	-1.52	1.15	1.20	-0.81	-0.69	-1.88	-1.86	
lnρ _t	0.40	-2.85	-1.63	0.61	0.90	-1.87	-0.72	-0.43	-2.82	
ΔlnY _t	-4.33	-5.63	-5.54	-4.02	-1.68	-6.57	-3.00	-6.46	-2.93	
ΔlnK _t	-7.13	-7.34	-7.40	-3.58	-5.14	-3.75	-3.77	-3.84	-3.88	
ΔlnL _t	-2.82	-6.04	-5.99	-1.73	-1.09	-4.59	-3.34	-4.56	-3.32	
ΔlnH _t	-6.12	-7.07	-4.43	-3.54	-2.86	-4.37	-3.82	-3.95	-2.68	
ΔlnX _t	-5.14	-5.31	-4.17	-3.91	-3.34	-4.13	-3.63	-4.17	-3.68	
Δlnρ _t	-8.40	-8.33	-8.32	-6.88	-4.35	-6.90	-4.42	-7.05	-4.62	
Critical Values	1%	-2.63	-3.629	-4.241	-2.63	-3.629	-4.241	-2.63	-3.629	-4.241
	5%	-1.951	-2.947	-3.543	-1.951	-2.947	-3.543	-1.951	-2.947	-3.543

*Fixed gross capital formation is used instead of capital stock.

Co-integration Analysis Using the Johansen Approach

As it has been pointed out earlier, in the Johansen procedure, there is no a priori categorization of variables as exogenous and endogenous. Hence, given the variables lnY_t , lnK_t , lnL_t , lnH_t , lnX_t , and $ln\rho_t$ in Equation [4-11], it is possible to represent these variables by a vector Z_t and model as an unrestricted autoregression (VAR) with k lags:

$$Z_t = B_1 Z_{t-1} + B_2 Z_{t-2} + B_3 Z_{t-3} + \dots + B_k Z_{t-k} + U_t \quad [4-15]$$

where Z_t is an $(n \times 1)$ matrix, B_i is an $(n \times n)$ matrix of parameters, and U_t is independently and normally distributed with mean of null vector 0 and vector of variances Ω , that is, $U_t \sim IN(0, \Omega)$.

The vector error correction model (VECM) counterpart of Equation [4-15] can be specified as:

$$\Delta Z_t = \Gamma_i \Delta Z_t + \dots + \Gamma_k \Delta Z_t + \Gamma_{k-1} \Delta Z_{t-k+1} + \Phi D_t + \Pi Z_{t-k} + U_t \quad [4-16]$$

The estimates $\hat{\Gamma}_i$ represent short-run adjustments while $\hat{\Pi}$ contains long-run information. D_t represents vectors of dummies, intercepts and predetermined exogenous variables.

In determining the rank, r , of a matrix, if there is full rank, that is if $r = n$ where n is the number of variables entering the co-integration space, it implies that each variable is 'co-integrated' to itself, and hence each variable is $I(0)$ (stationary), which is in contradiction with the fact that the variables are $I(1)$ - the very case that leads us to appeal to the case of co-integration. If there is reduced rank, that is, if r is less than n , it is possible to represent Π as $\alpha\beta'$ where β is $(n \times r)$ vector of long-run parameters and the $(n \times r)$ α -matrix represents speed of adjustment to disequilibrium. Hence, ΠZ_{t-k} in Equation [4-16] is equivalent to $\alpha\beta' \mathbf{Z}_{t-k}$ and $\beta' \mathbf{Z}_{t-k}$ represents up to $(n-1)$ linear combinations (co-integrating vectors) that ensure the convergence of the vector \mathbf{Z}_t to their long-run steady-state path [See Harris, 1995; Charemza and Deadman, 1997].

For this particular analysis, Equation [4-16] can be written out in full as:

$$\begin{bmatrix} \Delta \ln Y_t \\ \Delta \ln K_t \\ \Delta \ln L_t \\ \Delta \ln \rho_t \\ \Delta \ln H_t \\ \Delta \ln X_t \end{bmatrix} = \Gamma_i \begin{bmatrix} \Delta \ln Y_{t-i} \\ \Delta \ln K_{t-i} \\ \Delta \ln L_{t-i} \\ \Delta \ln \rho_{t-i} \\ \Delta \ln H_{t-i} \\ \Delta \ln X_{t-i} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} & \alpha_{15} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} & \alpha_{25} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} & \alpha_{35} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} & \alpha_{45} \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & \alpha_{55} \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & \alpha_{65} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} & \beta_{41} & \beta_{51} & \beta_{61} \\ \beta_{12} & \beta_{22} & \beta_{32} & \beta_{42} & \beta_{52} & \beta_{62} \\ \beta_{13} & \beta_{23} & \beta_{33} & \beta_{43} & \beta_{53} & \beta_{63} \\ \beta_{14} & \beta_{24} & \beta_{34} & \beta_{44} & \beta_{54} & \beta_{64} \\ \beta_{15} & \beta_{25} & \beta_{35} & \beta_{45} & \beta_{55} & \beta_{65} \end{bmatrix} \begin{bmatrix} \ln Y_{t-1} \\ \ln K_{t-1} \\ \ln L_{t-1} \\ \ln \rho_{t-1} \\ \ln H_{t-1} \\ \ln X_{t-1} \end{bmatrix} \quad [4-17]$$

Once the model assumes the form in Equation [4-17], the first task is to determine the number of co-integrating vector and get estimates of α and β ¹⁴. If there is a rank of 0, then there is no co-integration, that is, Π is $(n \times n)$ null matrix and it would imply that there is no long-run relationship among the variables involved and estimation by differences would be appropriate. Hence, the interesting case is when there is a reduced rank, that is when there are $r \leq (n-1)$ co-integrating vectors in β . In this case, $\Pi Z_{t-k} (= \alpha \beta' Z_{t-k})$ should be stationary $I(0)$ so that U_t becomes white noise.

Testing that there is $n-1$ co-integrating vectors is equivalent to testing that the first $r (= n-1)$ eigenvalues are non-zero while the remaining $(n-r)$

¹⁴ In the Johansen maximum likelihood estimation procedure, the existence of $n-1$ number of co-integrating vectors is determined by testing the significance of the first $n-1$ eigenvalues, $\hat{\lambda}_i$, estimated by solving the equation $|\lambda S_{kk} - S_{k0} S_{00}^{-1} S_{0k}| = 0$ where S_{ij} is the second moments and cross-products of the residuals R_{0t} and R_{kt} obtained from separate regression of the vectors ΔZ_t and Z_{t-k} on ΔZ_{t-k} ($i = 1, \dots, k+1$), respectively. The r elements in the corresponding eigenvector \hat{V} , are the co-integrating vectors, $\hat{\beta} = (\hat{v}_1, \dots, \hat{v}_r)$. The α -matrix can be estimated as $\hat{\alpha} = S_{0k} \hat{\beta}$ [See Johansen, 1997:91-5; Charemza and Deadman, 1997:176-7; Harris, 1995:78].

eigenvalues are zero¹⁵. This is the same as testing that the last $(n-r)$ columns of the α -matrix are effectively zero¹⁶ [See Harris, 1995].

In estimating the model represented by Equation [4-11] using the Johansen maximum likelihood procedure, data for 1960/61-1998/99 are used and the results are summarised in Tables [4-2] and [4-3]. Here, the dummy for war entered the estimation unrestricted.

As it is evident from Table [4-2], the null for no co-integration is rejected while a case of one co-integrating vector is supported by both the maximal- λ (λ_{\max}) and the λ_{trace} statistics.

TABLE 4-2: Tests for Number of Co-integrating Vectors

$H_0: \text{Rank} = r$	$n - r$	$\hat{\lambda}_i$	$-T \ln(1 - \hat{\lambda}_{r+1})$	$\lambda_{\max}(95\%)$	$-T \sum \ln(1 - \hat{\lambda}_i)$	$\lambda_{\text{trace}}(95\%)$
$r = 0$	6	0.79332	58.34**	39.4	115.1**	94.2
$r \leq 1$	5	0.525451	27.58	33.5	56.75	68.5
$r \leq 2$	4	0.291179	12.73	27.1	29.17	47.2
$r \leq 3$	3	0.243436	10.32	21.0	16.44	29.7
$r \leq 4$	2	0.144746	5.79	14.1	6.12	15.4
$r \leq 5$	1	0.008976	0.33	3.8	0.33	3.8

**Rejection at 1% level of significance.

¹⁵ The test for the significance of the $\hat{\lambda}_i$ eigenvalues makes use of the likelihood-ratio test:

$LR = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i)$, ($r = 0, 1, \dots, n-1$ and $T =$ number of observations), which is read against a test statistic with asymptotic distribution tabulated by Johansen (1988) and Osterwald-Lenum (1992) called trace statistic, λ_{trace} , under the null $H_0: \lambda_i = 0$ (equivalent to $r = s$, $s = 0, 1, \dots, n-1$) against the unrestricted alternative that $r = n$.

The other LR-test statistic is the maximal-eigenvalue or λ -max statistic given by $LR = -T \ln(1 - \hat{\lambda}_{r+1})$, $r = 0, 1, \dots, n-1$. The null is that there are r co-integrating vectors against the alternative that there are $r+1$ co-integrating vectors [Harris, 1995:87-8].

¹⁶ As Johansen (1992b) (as quoted in Harris) showed that $\hat{\lambda}_i = \hat{\alpha}'_i S_{00}^{-1} \alpha_i$, ($i = r+1, \dots, n$), testing for the significance of $\hat{\lambda}_i$ is tantamount to testing the significance of α_i [Harris, 1995:78].

Table 4-3: Results of Co-integration Analysis (PCFIML output)

(a) Standardized β' Eigenvectors						
$\ln Y_t$	$\ln K_t$	$\ln L_t$	$\ln H_t$	$\ln X_t$	$\ln p_t$	
1.000	-0.02422	-0.1612	-0.1070	-0.1149	-0.3100	
-2.031	1.000	-0.1689	0.2125	0.09746	-1.036	
-1.545	0.8164	1.000	-0.3033	-0.6266	2.504	
-0.9855	0.5526	-1.216	1.000	-0.6044	3.152	
4.507	-2.133	-1.982	-0.05986	1.000	0.557	
-0.2918	0.4011	-0.06552	-0.00552	0.3777	1.000	
(b) Standardized α-coefficients						
$\ln Y_t$						
$\ln K_t$	-0.6171	-0.02896	0.02486	-0.0006928	-0.008688	0.01764
$\ln L_t$	-2.080	-0.4717	-0.007964	-0.1126	-0.03670	0.02196
$\ln H_t$	0.07994	-0.03229	0.01354	-0.01890	0.01625	0.01011
$\ln X_t$	-0.9931	0.06445	0.3149	-0.2173	0.07652	-0.02875
$\ln p_t$	1.782	-0.5010	0.1253	-0.02283	-0.03592	0.04142
	1.001	0.1511	-0.02962	-0.06671	-0.03042	0.0005160
Diagnostic Tests						
Vector AR 1-2F(72, 38) = 1.0717 [0.4157]						
Vector Normality $\chi^2(12) = 21.02[0.0530]$						
Number of lags used: 2						
Variables entering unrestricted: <i>Constant, Dummy for War (DWAR)</i>						

Tests for vector serial correlation and normality are conducted and these tests do not detect serial correlation and normality problems at 5% level. But, the degree of freedom did not allow to test for vector heteroscedasticity and autoregressive conditional heteroscedasticity. However, tests after dropping a variable or decreasing the number of lags by one showed the absence of such problems.

Once it is statistically supported that there is one co-integrating vector, then, what is relevant is the first column of the α -matrix (and hence the first row of the β' -matrix).

For this particular co-integrating vector, given that there are six rows of the α -matrix and the six columns of the β '-matrix, one can write six equations for the six variables involved. As the relevant equation here is the one in which $\ln Y_t$ is written as a function of the other five variables, there is a requirement for the latter five entries of the first row of the α -matrix to be statistically zero. This is essentially a test for weak exogeneity and if it holds true, it is possible to write from Equation [4-17]:

$$\Pi_1 Z_{t-1} = \alpha_{11} [\beta_{11} \quad \beta_{21} \quad \beta_{31} \quad \beta_{41} \quad \beta_{51} \quad \beta_{61}] \begin{bmatrix} \ln Y_{t-1} \\ \ln K_{t-1} \\ \ln L_{t-1} \\ \ln \rho_{t-1} \\ \ln H_{t-1} \\ \ln X_{t-1} \end{bmatrix} \quad [4-18]$$

Here, α_{11} represents speed of adjustment of the first co-integrating vector. For this particular analysis, a test for weak exogeneity is conducted by imposing a zero-restriction on the α -coefficients of the first column using LR-test¹⁷ and the results are summarised in Table 4-4.

¹⁷ The LR-test statistic used for the restrictions is given by $-2 \log(Q) = T \sum_{i=1}^r \log \left(\frac{(1 - \hat{\lambda}_i^*)}{(1 - \hat{\lambda}_i)} \right)$ where $Q =$ (Restricted maximized Likelihood)/(Unrestricted Maximized Likelihood), $T =$ number of observations, $r =$ rank, and $\hat{\lambda}_i$ and $\hat{\lambda}_i^*$ are eigenvalues for unrestricted and restricted model, respectively [Harris, 1995].

Table 4-4: Test for Zero Restrictions on α - Coefficients

	$\ln Y_t$	$\ln K_t$	$\ln L_t$	$\ln H_t$	$\ln X_t$	$\ln p_t$
α -coefficient	-0.6171	-0.02896	0.02486	-0.000693	-0.008688	0.01764
LR-test: $\chi^2(\approx 1)$	6.9743	3.7744	0.1739	0.5099	2.4003	3.6553
p-value	0.0083**	0.0520	0.6767	0.4752	0.1213	0.0528

*Rejection at 5% level of significance.

The zero-restriction on α -coefficient is rejected for $\ln Y_t$ but cannot be so for the rest variables [See Table [4-4]]. Hence, it is possible to normalise with $\ln Y_t$ by conditioning on the remaining variables. Thus, the single equation model with the estimates of the long-run coefficients (elasticities) can be written as:

$$\ln Y_t = 0.02422 \ln K_t + 0.1612 \ln L_t + 0.107 \ln H_t + 0.1149 \ln X_t + 0.31 \ln p_t \quad [4-19]$$

Given this co-integrating vector, the sign and significance of estimate of α_{11} ($=-0.6171$) are worth discussing. It is statistically significant and its sign is as expected. It indicates adjustment towards the long-run steady-state path. If it were positive, it would indicate that $\ln Y_t$ would be deviating from the long-run steady-state path after a certain shock. The magnitude (about 62%) is fairly reasonable as full adjustment is not expected. This implies that economic agents adjust for about 62% of the shock in the system.

The long-run coefficients of the respective variables should be tested for 'significance' to determine which variables are uniquely constituting the co-integrating vector. Here again, a zero-restriction is imposed on each

coefficient and the results for the LR-statistics are summarised in Table [4-5].

Table 4-5: Tests for Zero Restrictions on the Long-run Parameters

	lnYt	lnKt	lnLt	lnHt	lnXt	lnρ _t
β-coefficient	1.000	-0.02422	-0.1612	-0.1070	-0.1149	-0.3100
LR-test:χ ² (≈1)	28.828	0.7772	25.968	26.43	28.866	19.243
p-value	0.0000**	0.3780	0.0000**	0.0000**	0.0000**	0.0000**

**Rejection at 1% level of significance.

According to the results, capital is found to be statistically insignificant. One possible reason is that it may be due to the fact that capital is represented by gross fixed capital formation as there is no data for capital stock proper for Ethiopia. The capital stock I generated using the method discussed under the data transformation section is excluded for its unique statistical behaviour (it is I(2))¹⁸. With this caution, however, it is possible to argue that capital had less to explain the GDP growth in Ethiopia probably because the economy is highly dependent on the agricultural sector. Moreover, government investment particularly during the Derg regime has a major share in gross capital formation. It has been empirically shown that government investment is not robust in explaining growth in Sub-Saharan Africa (See the empirical literature section). In Ethiopia, most of the government enterprises have been performing much below their capacity. The other related explanation

¹⁸ It is possible to get co-integrating vectors even in the presence of I(2) variables as they may co-integrate down to lower orders particularly when there are I(0) variables to ultimately give stationary linear combinations [Harris, 1995]. But, the estimation process is a bit complex and I am constrained by the absence of ready-made computer software to handle it though Johansen has a theoretical discussion on this issue.

could be that there is a minimum threshold level of capital that is required to trigger growth.

The other variables, namely, labor, human capital, export, and availability of rainfall (proxy for agrarian demand) are statistically significant. Rainfall is significant in the long-run model because the impact of drought has long-term effect by reducing the income and the factors of production of peasants. A micro-case study in the Amhara region shows that the number of oxen per household has decreased by 47% and 14.5% in North Wollo and East Gojam Zones, respectively, between the 1970s and 1990s due to drought. Per capita income for the same period has declined by 69% in North Wollo and 36% in East Gojam [See Appendix B for the details]. Hence, any shock or structural problem associated with these variables is manifested in the economy. Inefficient, unskilled labour force, low and structurally constrained export, and low demand constitute poor performance in the economy.

So far, the existence of long-run relationship is statistically assured and the associated long-run parameters are determined. To complete the analysis at least in the Johansen framework, one extension remains. The coefficients of the short-run dynamics, the Γ_i 's in Equation [4-17] have yet to be estimated. Once the co-integrated vector(s) is/are determined, the parsimonious vector error correction model (PVECM) using the

general to specific modelling approach of David Hendry can be estimated as:

$$\Delta \ln Y_t = \sum_{i=1}^k \gamma_i \Delta \ln Y_{t-i} + \sum_{i=0}^k \Gamma_i \Delta Z_{t-i}^* + \Phi D_t + \alpha (\hat{\beta}_1' \tilde{X}_{t-1} + \hat{\beta}_2' \tilde{X}_{t-1} + \dots) + U_t \quad [4-20]$$

where $\Delta \ln Y_t$ = change in the log of real GDP, $i = 1, \dots, k$ is the number of lags, ΔZ_{t-i}^* is a vector of differences of variables other than GDP, and $(\hat{\beta}_1' \tilde{X}_{t-1} + \hat{\beta}_2' \tilde{X}_{t-1} + \dots)$ contains the error correcting term(s)-co-integrating vector(s)¹⁹.

In this particular analysis, a case of one co-integrating vector is supported and the variables other than GDP are weakly exogenous.

Thus, the ultimate PVECM to be estimated is:

$$\begin{bmatrix} \Delta \ln Y_t \\ \Delta \ln K_t \\ \Delta \ln L_t \\ \Delta \ln \rho_t \\ \Delta \ln H_t \\ \Delta \ln X_t \end{bmatrix} = \Gamma_i \begin{bmatrix} \Delta \ln Y_{t-i} \\ \Delta \ln K_{t-i} \\ \Delta \ln L_{t-i} \\ \Delta \ln \rho_{t-i} \\ \Delta \ln H_{t-i} \\ \Delta \ln X_{t-i} \end{bmatrix} + \alpha \hat{\beta}' \begin{bmatrix} \ln Y_{t-1} \\ \ln K_{t-1} \\ \ln L_{t-1} \\ \ln \rho_{t-1} \\ \ln H_{t-1} \\ \ln X_{t-1} \end{bmatrix} + \varepsilon_t \quad [4-21]$$

That is, there is no need to use a simultaneous equation model in estimating the structural parameters.

¹⁹ The residual shows a disequilibrium in the system and the logic behind including its lag as explanatory variable (error correction term) is that the disturbance (disequilibrium) of this period determines the direction of the dependent variable next period [Banerjee, et al, 1993].

Equation [5-21] has been estimated using ordinary least squares (OLS) technique and the results are summarised in Table [4-6].

Table 4-6: Results for the VECM

Dependent Variable is $\Delta \ln Y_t$			
Variable	Coefficient	t-ratio	Diagnostic Tests
Constant	1.267	3.906**	AR 1- 2F(2, 27) = 0.10641 [0.899]
$\Delta \ln Y_{t-2}$	-0.347	-3.131**	ARCH 1 F(1, 27) = 1.4328 [0.2413]
$\Delta \ln X_t$	0.126	5.097**	Normality $\chi^2(2)$ = 3.2069 [0.2012]
$\Delta \ln X_{t-3}$	0.074	3.099**	X_i^2 F(10, 18) = 0.5757 [0.8355]
$\Delta \ln \rho_t$	0.087	2.512*	$X_i * X_j$ F(19, 10) = 0.6358 [0.8046]
$\hat{\beta}' \tilde{Z}_{t-1}$	-0.435	-3.807**	RESET F(1, 29) = 0.00082[0.9774]
$R^2 = 0.69$ $F(5, 29) = 12.848$ $T = 35$ (1964/65-98/99) $DW^* = 1.84$			
<p>*Rejection at 5% level of significance. **Rejection at 1% level of significance. ♣Not applicable when there is lag in the dependent variable.</p>			

The various diagnostic tests (the Breush-Pagan test of higher order serial correlation up to two lags, the aoutoregressive conditional heteroscedastic test, the test for normality based on skiwness and kurtosis, the White test of heteroscedasticity, the specification/heteroscedasticity test, and the Ramsey's RESET test of functional form, in the order they are reported in table 4-6) did not detect statistical problems to which they are assigned.

The coefficient of the vector error correction term is significant with expected sign and reasonable magnitude (-0.44), which approximates the coefficient in the first row of the α -matrix.

As to the coefficients of the short run dynamics, only that of export and rainfall are found to be significant while labor, human capital, and gross fixed capital formation are not significantly different from zero. It is recalled that labor and human capital are significant in the case of long-run model. Hence, it may be possible to infer that labor is not productive in the short-run. This is expected for an economy where about 85% of the labor force make their living on agriculture in the face of static land size. Moreover, human capital formation has long-term effect on growth rather than to explain short-run fluctuations.

CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

Conclusions

Economic development can be described as a transformation of societies. Economic growth, which can be defined as a sustainable growth in real GDP or per capita GDP, explains much of economic development. This is because it is believed that other issues that economic development encompasses are directly or indirectly explained by economic growth. For this reason, countries spend much of their resource and time in an effort to ensure sustainable economic growth.

However, there are disparities among countries and over time in terms of economic growth. There are different factors that explain such differences in income and growth. These include capital, resource (both natural and human resources), among others.

Different theories have been proposed in an attempt to explain the disparities in income and proposing means of achieving sustainable economic growth. The theory of growth dates back to the times of merchantalism and latter emphasized by Adam Smith. Recent theories include the Keynesian, neoclassical, and endogenous growth theories.

Factors that are relevant to developed countries may not be so in explaining growth in developing countries. These factors such as capital and labor are structurally constrained to contribute what they should have contributed. Hence, it would be appropriate to model growth in developing countries separately from the developed ones by accounting for structural aspects.

In this respect, there is a reason to believe that the growth model for Ethiopia should be treated in different way from that of developed countries. The economy is highly dependent on a static sector-agriculture (as high as 50%) which in turn is susceptible to the fragility of nature, particularly rainfall. The export earnings, which are the major determinants of the country's capital and skill accumulation through technological transfer, depend on this sector-this sector accounts for 90% of the foreign exchange earnings. Such high dependency on the agriculture sector made the economy to grow at only an average rate of 2.6% per annum for the last four decades. We recognize that we are not better off in terms of per capita income as population has been growing at a rate of 2.6% nullifying the growth in per capita GDP.

Few research works have been conducted in explaining growth in Ethiopia. However, they focused on only some dimensions of the

determinants of growth in the country and some of these factors considered by the researches lack proper measurement. With such background, the theme of this paper is to model economic growth in Ethiopia by considering the relevant structural factor, in this case rainfall, and other factors, in this case export and human development, which I think are not properly addressed in the past research works.

The study uses both descriptive and econometric techniques to determine and discriminate the determinants of economic growth in Ethiopia.

To determine the contribution of each sector to the growth of GDP given their share in the over all GDP, a total factor productivity (TFP) type of method is employed. The results show that agricultural sector which has been growing at an average rate of 1.2% has contributed to growth only about half times its share in the GDP while the industrial and service sectors contribute about twice their share in the GDP for the last four decades. The analysis was repeated after accounting for availability of rainfall and yet the result was not that much altered in the long-run. In fact, the growth rate of agriculture shows a high growth when rainfall is considered but only for the last decade.

The econometric analysis part makes use of the Johansen maximum likelihood estimation procedure. Particularly, as growth analysis is a long-run (trend) analysis, co-integration analysis is relevant. In this case, the Johansen procedure is superior.

The model incorporates labor, physical capital, human capital, export, and rainfall as determinants of growth in Ethiopia. The human capital aspect is represented by index incorporating the gross enrollment ratio, the number of years of schooling adjusted for return to schooling and world technology frontier following the Romer's equation of rate of accumulation of skill. The physical capital is represented by gross fixed capital formation as there is no a readily calculated data for the capital stock proper and the data I generated has no proper statistical behavior in the co-integration analysis.

Data from different sources covering the period 1960/61 to 1998/99 are used for the analysis. Pre-estimation tests of statistical behavior of the time series, particularly the Dicky-Fuller and Augmented Dicky-Fuller tests for unit root, showed that all variables entering the analysis are integrated of order 1 (I(1)).

In applying the Johansen technique, both the λ -max and λ -trace statistics of the likelihood ratio test supported a case of the existence of

one co-integrating vector. Further zero restriction tests on the long-run parameters and adjustment coefficients showed that all long-run parameters are significantly different from zero except that of capital while only the adjustment coefficient of the logarithm of GDP is statistically significant with expected negative sign witnessing the adjustment of the variable to shocks towards the steady-state path. The fact that only the first entry of the α -matrix is significant implies that the logarithm of GDP is weakly exogenous and we can condition on the other variables, in this case determinants of growth, that are, labor force, capital, human capital, export, and rainfall (proxy for supply of necessities in the agricultural sector).

The vector error correction counterpart of the long-run model is estimated using the general to specific modeling approach of David Hendry to determine the parsimonious vector error correction model (PVECM). In this case, only rainfall and export are statistically significant.

Given the various data and statistical problems, the above results may imply that labor, human capital, export, and agricultural demand (as proxied by rainfall) determines the (long-term) growth of GDP while capital had little contribution to long-term growth. This may be due to the fact that the Ethiopian economy is highly dependent on agriculture

in which about 85 % of the total labor force are employed. Moreover, government investment, which usually does not, except investment in infrastructure, contribute to growth, has larger share in the Ethiopian investment. The other related explanation could be that a minimum threshold level of capital is required to trigger growth. From the short-run dynamic analysis, it is found that only supply shocks in the agricultural sector and export earnings, among the factors considered in this model, seem to be the major determinants of the short-run fluctuations in output.

Policy Implications

One immediate implication of the analysis is that, for sustainable economic growth, one option is to free the agricultural activities from dependency on the generosity/frugality of nature, particularly rainfall, increase the productivity of agricultural sector, and as a result increase the effective demand of the peasant. The second option is to give priority to the industrial sector (which is historically and logically proved to be productive). The first option seems to be slow as it demands huge financial capacity in the face of static land size in the hands of peasants and technical capacity of constructing irrigational schemes. A growth strategy may give relatively due emphasis to a sector which can trigger growth with a relatively moderate financial requirement

The other implication of this paper is that the human capita aspect should be given emphasis. Here, training is not enough by itself to ensure sustainable economic growth. The point is on crafting citizens with developmental sentiment. Moreover, it requires for a government in power to win the hearts and minds of the people-get their support- in the process of ensuring growth and development. Mobilization is important. There is another route through which education fosters growth. The probability of the children of our farmers to make living out of the static sector, agriculture, is very low. To this effect, education, both persuasive and forced education, has important role for the transformation of the agricultural sector.

Lastly, diversification of the exports of the country is important. This calls for assisting entrepreneurs with endeavors of producing exportable industrial goods which can be competitive in the world market. This is in fact part of the effort of fostering industrialization.

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APPENDICES

Appendix A

Technical notes on the on the Calculation of Sector Contribution to Growth

A sector which accounts for a major part of GDP may not necessarily contribute to the growth of GDP significantly. Contributions of each sector to the growth of GDP can be determined using the following total factor productivity (TFP) accounting type of method. (This method is developed by Solow and latter Romer to determine total factor productivity). Letting $Y = \text{GDP}$, $Y_A = \text{value-added in the agricultural sector}$, $Y_I = \text{value-added in the industrial sector}$, $Y_{DS} = \text{value-added in the distributive sector}$, and $Y_{OS} = \text{value-added in the "other" service sector}$, we can write:

$$Y = Y_A + Y_I + Y_{DS} + Y_{OS} \quad [\text{A} - 1]$$

Noting that the change in GDP is the sum of the changes in the various sectors, and dividing each change by GDP, we have:

$$\frac{\Delta Y}{Y} = \frac{\Delta Y_A}{Y} + \frac{\Delta Y_I}{Y} + \frac{\Delta Y_{DS}}{Y} + \frac{Y_{OS}}{Y} \quad [\text{A} - 2]$$

Multiplying each of the quotients of the right-hand side of Equation [A-2] by the respective Y_i/Y_i where Y_i is value-added in the i^{th} sector, we can solve for the contribution of the i^{th} sector to the growth of GDP as:

$$\frac{\Delta Y}{Y} = \frac{\Delta Y_A}{Y} \cdot \frac{Y_A}{Y_A} + \frac{\Delta Y_I}{Y} \cdot \frac{Y_I}{Y_I} + \frac{\Delta Y_{DS}}{Y} \cdot \frac{Y_{DS}}{Y_{DS}} + \frac{Y_{OS}}{Y} \cdot \frac{Y_{OS}}{Y_{OS}} \quad [\text{A} - 3\text{a}]$$

$$\Rightarrow \frac{\Delta Y}{Y} = \left(\frac{\Delta Y_A}{Y_A} \right) \left(\frac{Y_A}{Y} \right) + \left(\frac{\Delta Y_I}{Y_I} \right) \left(\frac{Y_I}{Y} \right) + \left(\frac{\Delta Y_{DS}}{Y_{DS}} \right) \left(\frac{Y_{DS}}{Y} \right) + \left(\frac{\Delta Y_{OS}}{Y_{OS}} \right) \left(\frac{Y_{OS}}{Y} \right) \quad [\text{A} - 3\text{b}]$$

$$\Rightarrow g = g_A \left(\frac{Y_A}{Y} \right) + g_I \left(\frac{Y_I}{Y} \right) + g_{DS} \left(\frac{Y_{DS}}{Y} \right) + g_{OS} \left(\frac{Y_{OS}}{Y} \right) \quad [\text{A} - 3\text{c}]$$

where g = growth rate in GDP and g_i (i representing A , I , DS , and OS) is the growth rate of the value-added in the i^{th} sector while Y_i/Y is the share of the i^{th} sector in GDP. Hence the contribution of a sector to the growth of GDP is the product of the growth rate of value-added in the sector and its share to the GDP.

Equation [A-3c] can be written as:

$$g = g_A^* + g_I^* + g_{DS}^* + g_{OS}^* \quad [\text{A} - 3\text{d}]$$

The g^* 's represent the contribution of each sector to the growth of GDP.

In general, the contribution of the i^{th} sector to growth can be written as:

$$g_i^* = \frac{\Delta Y_i}{Y_i} \cdot \frac{Y_i}{Y} \quad [\text{A} - 4]$$

and by multiplying Equation [A-4] by Y_i/Y_i , we have:

$$g_i^* = \frac{\Delta Y_i}{Y} \cdot \frac{Y_i}{Y_i} \Rightarrow g_i^* = \left(\frac{\Delta Y_i}{Y} \right) \left(\frac{Y_i}{Y} \right) \Rightarrow g_i^* = g_i \cdot \left(\frac{Y_i}{Y} \right) \quad [\text{A} - 5]$$

$$\text{This implies: } g = \sum_{i=1}^n \left(\frac{\Delta Y_i}{Y} \right) \left(\frac{Y_i}{Y} \right) = \sum_{i=1}^n g_i \left(\frac{Y_i}{Y} \right) = \sum_{i=1}^n g_i^* \quad [\text{A} - 6]$$

where n is the number of sectors. That is, growth rate of GDP is the weighted-sum of the growth rates of the value-added in the various sectors where the weighting factors are the share of each sector in the GDP.

The other simple method to see the contribution of a sector to growth in GDP in relation to its contribution to GDP is to look at the ratio of the percentage contribution of a sector to its share in GDP. It is simple to show that this 'relative contribution factor' is the same as the ratio of growth rate in the value-added of a sector to growth rate in GDP. That is:

$$\phi = \frac{\left(\frac{g_i^*}{g} \right)}{\left(\frac{Y_i}{Y} \right)} = \frac{\left(\frac{g_i \cdot \frac{Y_i}{Y}}{g} \right)}{\left(\frac{Y_i}{Y} \right)} = \frac{g_i}{g} \quad [\text{A} - 7]$$

where ϕ may be called relative contribution factor, that is a sector contributes to growth rate of GDP ϕ times more than its share in GDP. If a sector contributes to growth as much as its share in GDP, ϕ equals 1, if a sector is contributing to growth less than its share in GDP, $\phi < 1$, and if the share of the growth rate of a sector in the growth rate of GDP is greater than its share in GDP, then $\phi > 1$.

Appendix B

A Micro Case Study on the Dynamics of Land Size and Level of Income

It will be recalled that the theme of this paper centered on the argument that uncertainties particularly those associated with nature have adverse impact on the income of the agricultural households in Ethiopia with implications on economic growth. I believe that it makes the work of modeling growth at a national level more complete if this assertion as a basis for modeling growth is supported by some way of micro-case evidence. Thus, this chapter is devoted to empirically show that there is a dynamics of poverty associated with insufficient rain, and declining land size per household with important implications on the macroeconomic growth.

For this study, one Kebele in the Habru Woreda of North Wollo Zone (Amhara Region) is selected. Three Kebeles are considered from East Gojam Zone of the same region for comparison purpose. Some hundred agricultural households in North Wollo and another hundred households in East Gojam are randomly interviewed on issues such as land holdings, livestock and income over decades since 1970s.

The intention is not to represent the situation in the country but to draw some features of the modes of economic activities of the agricultural

households in the face of constraints as a case study. Moreover, I believe that most of the crop growing areas of the Northern, North Eastern, and North Western part of the country share the same problem. Here, the focus of the study is the Kebele called Girana in North Wollo while the three Kebeles in Gojam are used for comparison purpose.

Land Holding

In the 1970s, the average land size per household in the Kebele was 1.5 hectare. With an average family size of 5 during the period; and therefore the per capita land holding was about 0.33 hectare. In the 1980s, the land size per household declined to 1 hectare, that is, there was an average decline of 33.3% relative to the 1970s. In the 1990s, the average land size per household is 0.6 hectare. That is, there is a decline in land size per household by about 60% on average in two decades. While in East Gojam, the size declines by about 19% (less than one-third of the decline in N. Wollo), the per capita land size further decreased to 0.09 hectare. This converts into a 73% decline relative to the 1970s as contrast to a 46% decline in East Gojam. Here, the decline in per capita land holding is by far greater than that of land per household in E. Gojam because there is more expansion of family size than in N. Wollo. Here, we can see that the per capita land holding is getting squeezed from two sides, that is, due to increase in peasant household and due to

expansion of family size. In this case, 13% of the decline in the per capita land holding is explained by the augmentation of family size.

Livestock

Livestock in mixed farming are important forms of capital acquisition. They are the peasants' means of savings. In particular, however, their acquisition of oxen has an important implication on their output because the oxen are the 'capital' they work with.

Table B-1: Trends in Land Holdings and livestock in Girana Area (N. Wollo)

	1970S	1980S	1990S	PERCENTAGE CHANGE 1990S OVER 1970S	PERCENTAGE CHANGE 1990S OVER 1970S FOR EAST GOJAM
Land Size per Household (ha.)	1.5	1	0.6	-60	-18.7
Per capita Land Holding	0.33	0.2	0.09	-73	-46
Oxen per hh	3	2	1.6	-47	-14.5
Per capita Oxen	0.55 (an ox for 2 people)	0.4(an ox for 3 people)	0.26 (an ox for 4 people)	-53	-71
Cows per hh	4	2	1	-75	-58
Per capita Cows	0.7 (a cow for an individual)	0.5 (a cow for 2 people)	0.17 (a cow for 6 people)	-76	-72
Goats and sheep per hh	4	2	0.15 (1 to 7 people)	-96	-56
Beehives per hh	1	0.3	0	-100	-43
Family Size	5		6	20	49

The average number of oxen per household has decreased from 3 in the 1970s to 1.6 in the 1990s (a decline of 47%). While in East Gojam, the decline is only 14.5%. There is a further decline in per capita holding due to the augmentation of the family size. In the 1970s, the ratio was an ox to two family members of a household. While in the 1990s, the ratio is an ox to four members of a household. Of course, the decline in per capita

oxen in Gojam is greater than in N. Wollo due to fast expansion of family size in Gojam.

The implication of the above figures is that the labor force in each household is equipped with meager capital and few and fragmented land to work with. Hence, land size and capital, most importantly oxen, are constraining, as a limiting factor, the output decisions of a peasant household.

To wind up the discussion on the decline of the level of wealth of households, the number of cows per household has decreased by about 75% within two decades in the Girana area and by 58% in Gojam.

At this point, it is important to mention the level of acquisition of beehives because it has important implication for the degree of deforestation. In North Wollo (Girana area), the beehives per household was 1 (ranging from owning zero to 9) in the 1970s. But, in the 1990s, almost nobody, among the interviewee, possesses beehives. On the other hand, there is only a decline of 43% in beehives per household over the two decades.

Level of Income

Obviously, land and oxen are among the major determinants of output in the peasant sector. Thus, it is natural to expect the decline in output (income) following the decline of these factors particularly in the absence of other substitutes or efficiency gain and increase in productivity due to new techniques.

In the area under study, a household used to earn a yearly income of 8,076 birr annually from crop production at 1999 constant price in the 1970s. The equivalent per capita income was 1,744 birr. Crop production was almost the only source of income until 1985. In late 1990s, the annual household income from crop production at 1999 constant price is 1,787 birr. In per capita terms, this is equivalent to 281 birr. This shows that there is a decline in income from crop production of households by 69% on average and a decline in per capita income by 83.9% within two decades.

However, the farmers managed to partially compensate for the decline in income following the small size of land and drought by shifting to the production of cash crops using irrigation schemes, which require less land, and no oxen, after the major drought that stroke the area in 1985, and only one interviewee reported for not possessing cash crops and vegetable. Almost all the households interviewed reported that they had

started producing cash crops since 1985. In late 1990s, the average annual income of a household from cash crops, fruits and vegetable is 1,584 birr, that is, 46.5% of the total income of the households. But, the land under cash crops, fruits and vegetable is about 15 to 20 per cent of the total land holding of a household. Hence, it increases the average income of a household to 3,402 birr which is equivalent to a per capita income of 535 birr. Thus, the actual decline in income of a household and per capita income are 58% and 69%, respectively. In contrast, the per capita income of a household in East Gojam has declined by 36%.

The fact that the fruits and vegetables each household produces are permanent gave the households a means of security against seasonal crop failure with a principle of “a stick of sugarcane for a child a day” or “a papaya for a child a day”. The vegetables and cash crops are also marketable where the major markets are Dessie, Woldiya, and Mekele. About 52.5% of the cash crops and vegetable are marketable while the balance is consumed by the household. This has an important implication for the monetization process.

The other source of income is wage from daily labor and hiring oxen to investors in the area. Some plots of land which were marshy area before are leased out to investors who produces vegetable and fruits. There are three such sites currently who employs some 30 casual workers with a

wage of 5 birr a day and some permanent ones. Moreover, some farmers hire out their oxen to the investors with a payment of 15 birr per pair of oxen per day.

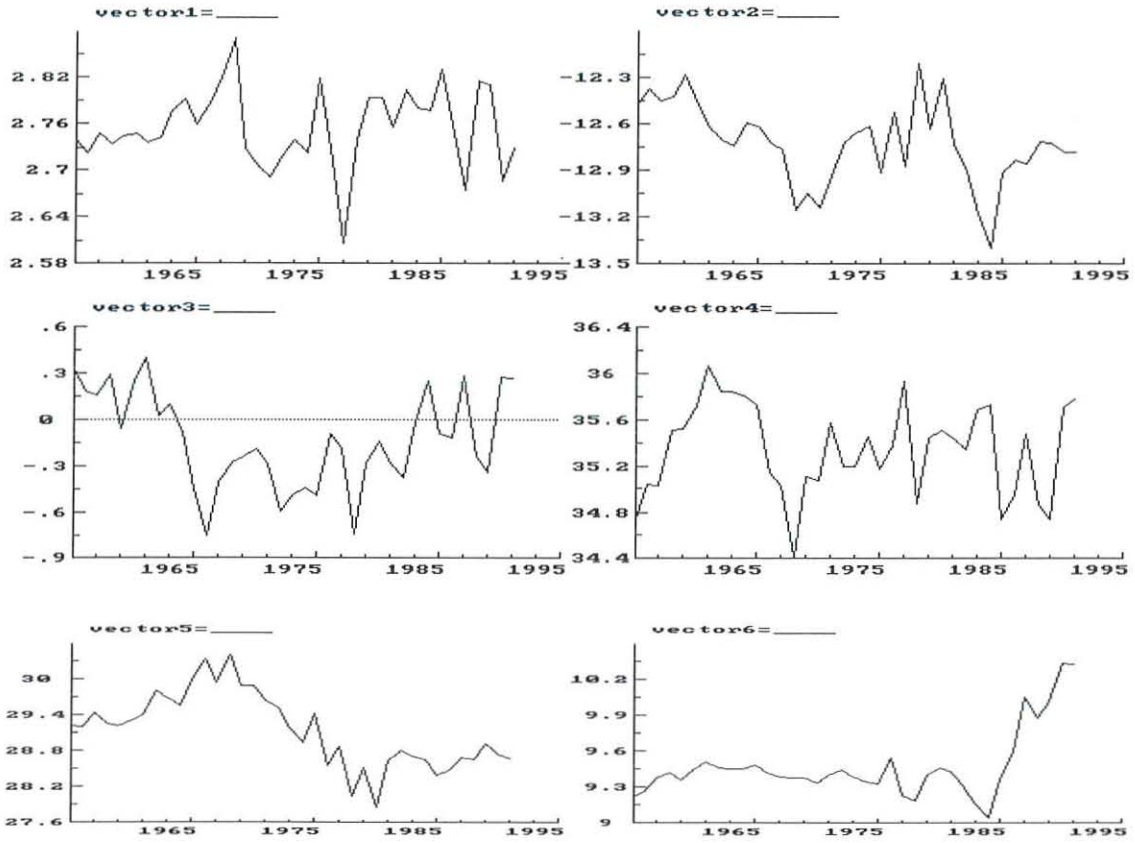
One important aspect worth mentioning is the share of the expenditure on industrial outputs in the total income of households. Though there is variation in demand for industrial outputs ranging from 8 to 20%, the average share is 13%. Most of the items which the households demand are salt, clothing, cast iron (for plough). Households who send their children to school have larger share of expenditure on industrial goods.

Regarding the use of modern inputs, the households are aware of the importance of the use of fertilizer particularly on maize. But they reported that they do not use much and most of the time due to financial constraints. There is a credit facility by the Amahara credit and savings association but most of the farmers reported that the debt is a burden. Some interviewee reported that they use fertilizer simply because priority is given to those who purchase fertilizer to get access to water to irrigate their land. Some farmers use a traditional method of maintaining the fertility of their land by letting their and their neighbors' cattle to stay in a wide temporary cattle-shed constructed on the plot of land using fences.

Though the farmers are experienced with irrigation techniques, there is a shortage of water to irrigate the whole land each household possesses. The currently available water from a river and some other streams is being utilized twenty-four hour a day. This makes even night storage of water difficult. Currently, the Amhara regional government has given attention to the area and as a result a Kobbo-Girana valley development is on the way to be undertaken in collaboration with the Tigray regional state.

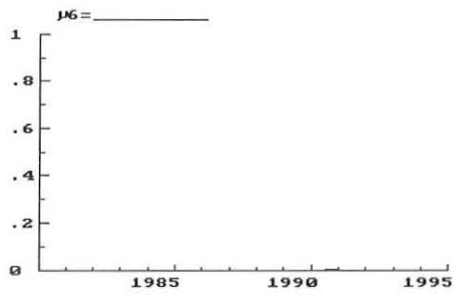
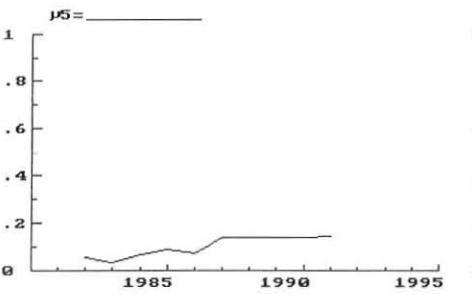
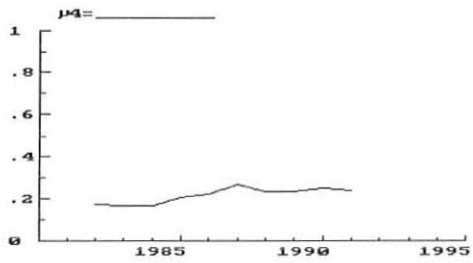
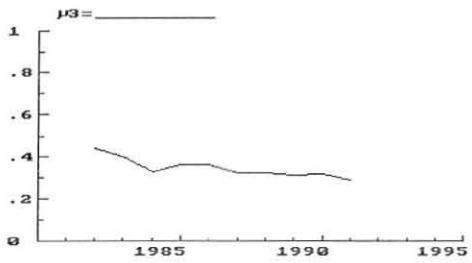
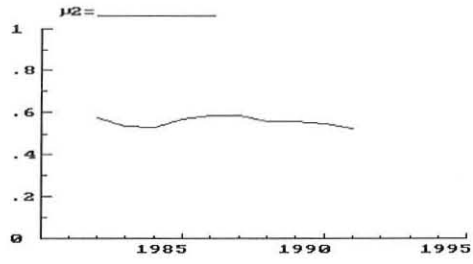
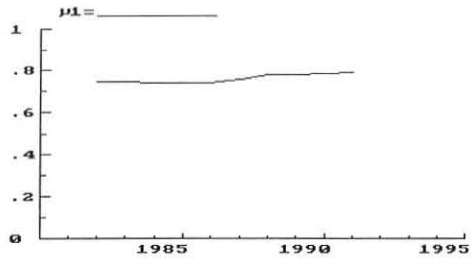
Appendix C: Recursive Graphics for the Co-integration Analysis

a) Co-integration Vectors

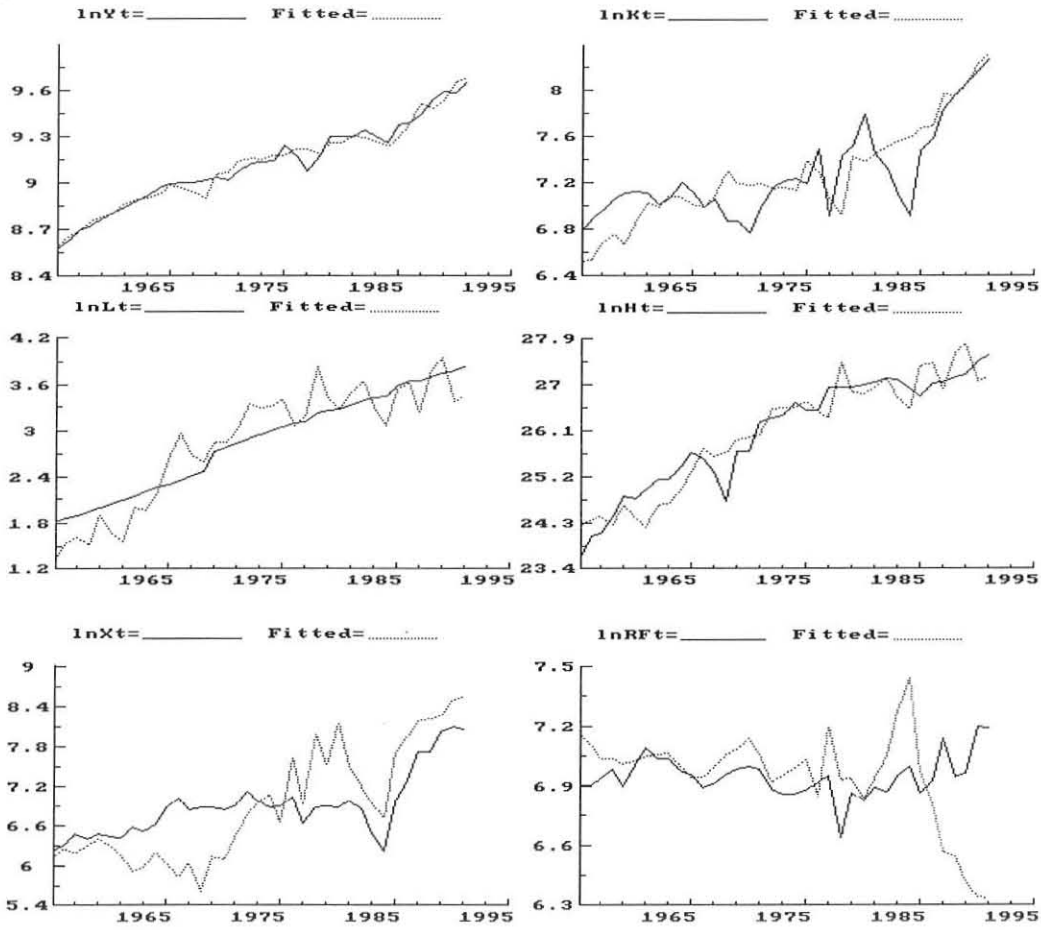


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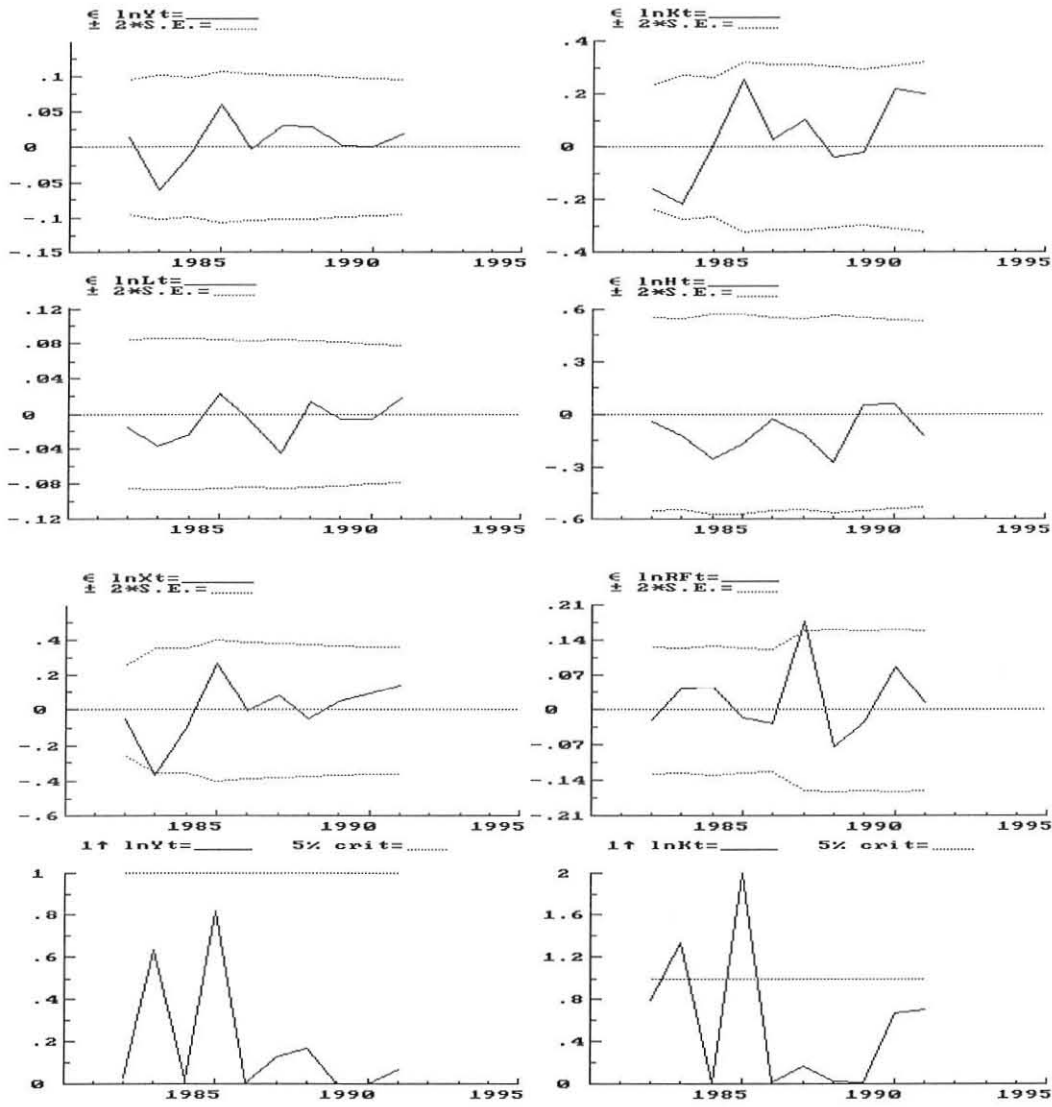
b) Recursive Eigenvalues

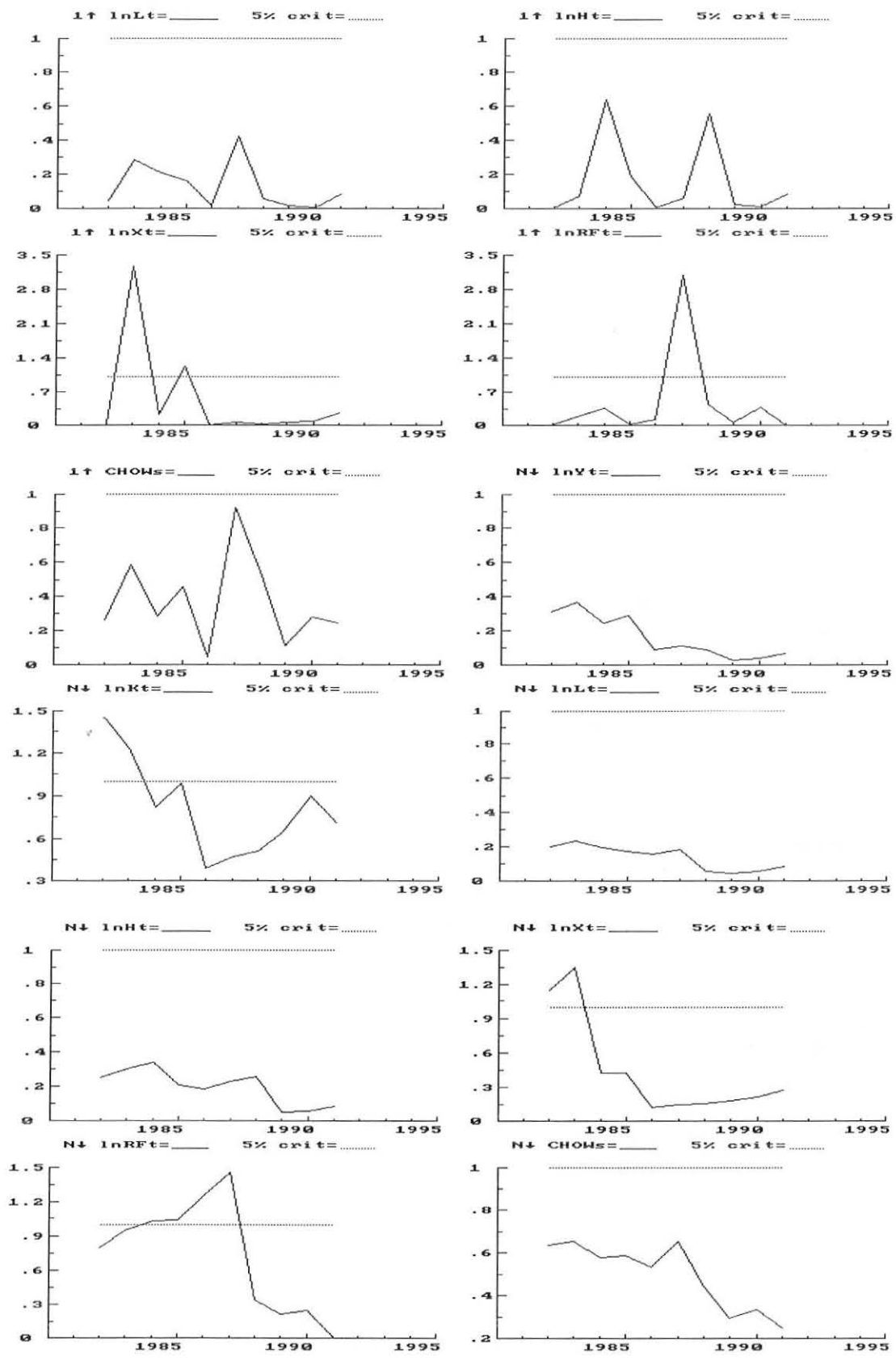


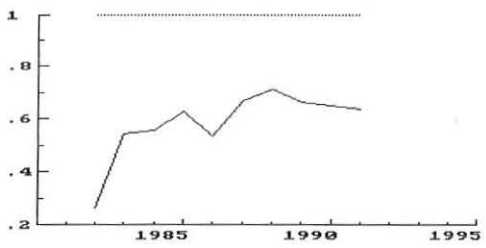
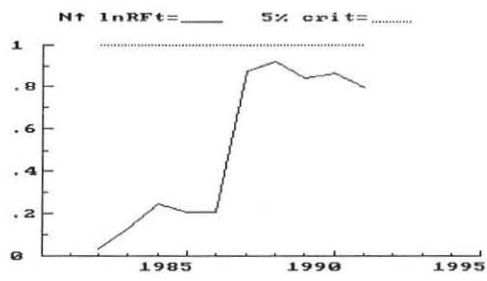
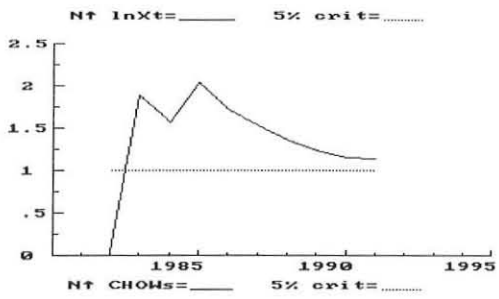
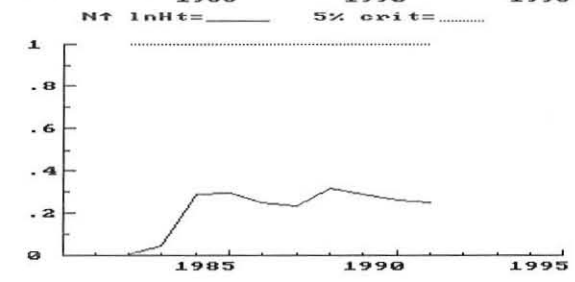
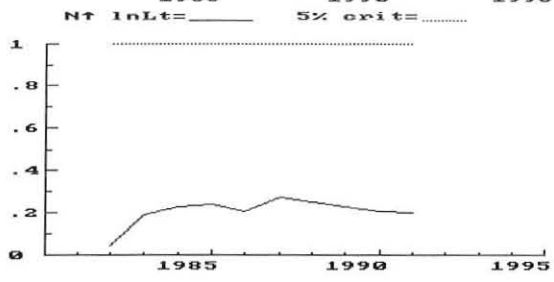
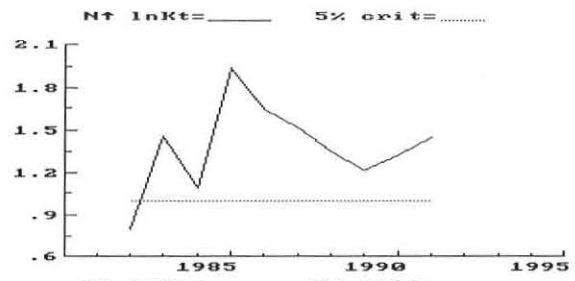
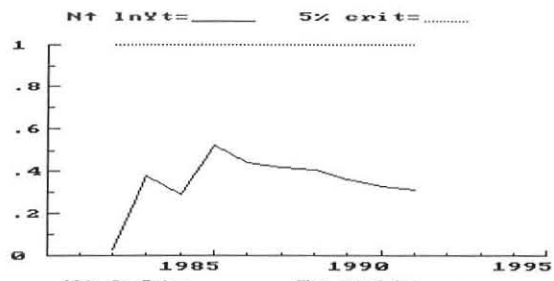
c) Actual and Fitted Values



d) 1-Step Residuals $\pm 2*S.E.$, 1-Step Chow-Tests, $N \downarrow$ -step and $N \uparrow$ -Step Chow Tests

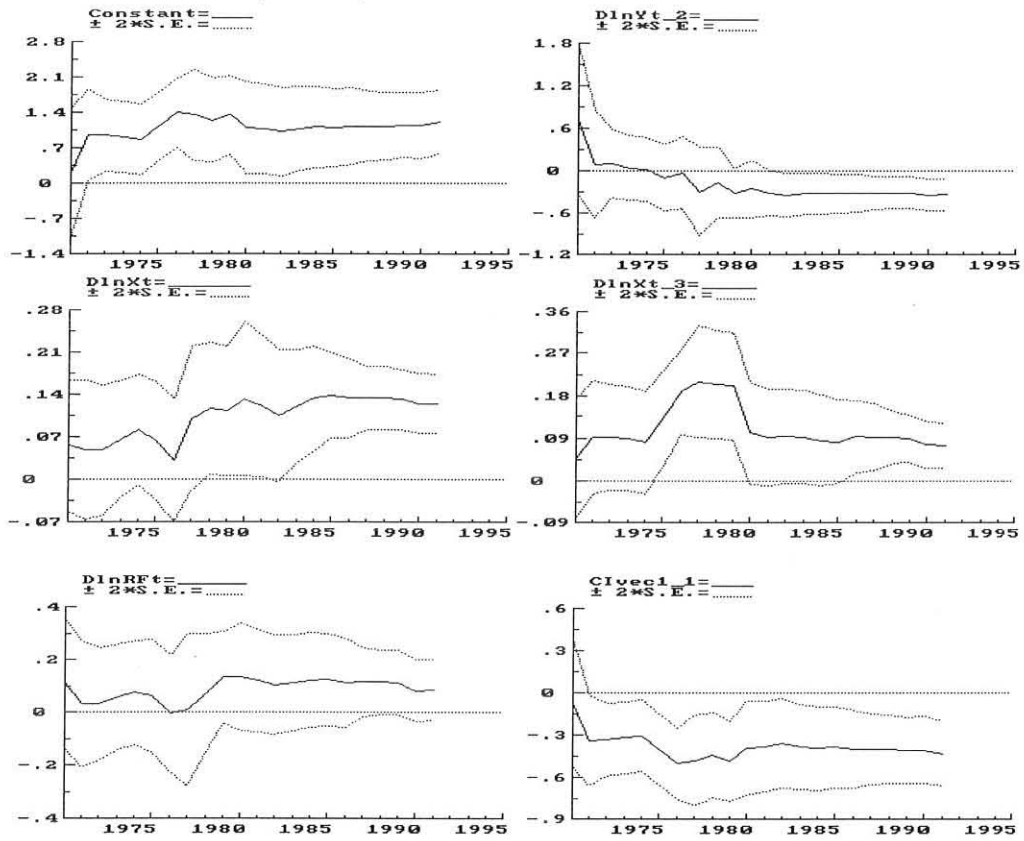






Appendix D: Recursrive Graphics for the VECM

Parameter Stability Test: $\beta \pm 2 * S.E.$



DECLARASION

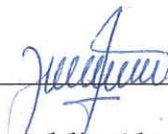
I, the undersigned, declared that this thesis is my original work and it has never been presented in any other university. All sources of materials used for this thesis have been duly acknowledged.

Name: Seid Nuru Ali

Signature  _____

Confirmed by adviser:

Name: Haile Kebret (PhD)

Signature  _____

Place and Date of Submission: Addis Ababa University, June 2000