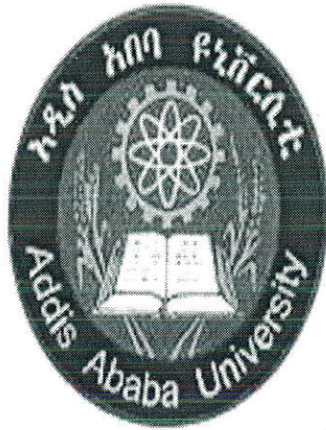


**ADDIS ABABA UNIVERSITY**  
**SCHOOL OF GRADUATE STUDIES**



**THE DYNAMICS OF FOOD PRICE INFLATION IN**  
**ETHIOPIA**

**BY: TADDESSE EMIRU**



**October, 2008**  
**Addis Ababa**



**Addis Ababa University**  
Department of Economics



**FACULTY OF BUSINESS AND ECONOMICS**  
**SCHOOL OF GRADUATE STUDIES**  
**ADDIS ABABA UNIVERSITY**

**THE DYNAMICS OF FOOD PRICE INFLATION IN**  
**ETHIOPIA**

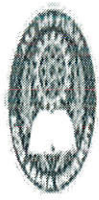
A Thesis Submitted to the School of Graduate Studies of the Addis Ababa University in  
Partial Fulfillment of the Requirements for the Degree of Masters of Science in Economic  
Policy Analysis

**BY: Taddesse Emiru**

**ADVISOR: Gebrehiwot Ageba (Ph.D)**

**October, 2008**

**Addis Ababa**



Addis Ababa University  
Department of Economics



# The Dynamics of Food Price Inflation in Ethiopia

**By: Taddesse Emlru**

**Advisor: Gebrehiwot Ageba (Ph.D)**



October, 2008  
Addis Ababa

ADDIS ABABA UNIVERSITY  
SCHOOL OF GRADUATE STUDIES



# THE DYNAMICS OF FOOD PRICE INFLATION IN ETHIOPIA

BY: TADDESSE EMIRU ANLEY  
DEPARTMENT OF ECONOMICS  
FACULTY OF BUSINESS AND ECONOMICS

Approval by Board of Examiners:

Dr. Gebrehiwot Ageba

[Advisor]

Signature

Dr. Hussien Hamda

[Examiner]

Signature

Dr. Alemayehu Geda

[Examiner]

Signature

October 27, 2008

Addis Ababa, Ethiopia

## ACKNOWLEDGMENT

I would like to extend my heartfelt thanks to my advisor *Dr. Gebrehiwot Ageba* for his unreserved support and indispensable comments without which this paper would not have this shape. This study has also benefited a lot from discussions with *Dr. Alemayehu Geda*, *Dr. Mulat Demeke*, and *Ato Zewdu Belete* (Professors of Economics at the Addis Ababa University). Yet, all the remaining errors are my own!

Next, I earnestly thank the Department of Economics of Addis Ababa University for its financial assistance in this project and all the staff for their support and various services in every respect during my stay in the University.

I would also like to appreciate *Ato Zena & Ato Birhanu* (CSA), *W/o Konjit* (UNECA Library), *Ato Kabsay* (National Accounts Department, MOFED), & *Ato Sharew Erkihun* (General Budget Department, MOFED), *Ato Emerta Asaminew* (NBE), *Ato Belete & Ato Mesfin* (DPPA), *Ato Asfaw* (EPE), *Ato Yehualashbet* (MIT, Domestic Trade Expansion Department), *Ato Melese* (EMA) . . . for providing me with (or helping me get) the necessary data.

All friends, classmates and colleagues. . . *Endro, Kediro, Temestat, Liyuti, Dessu, Tesfalbo, Kibrome, Addise, Emerttaaa, Buzex, Ebule, Adex, Abe, Yeme, Japitu, Geni, Eddy, Jerry, Dere, Kok, Gabriel, Newlove, Tilish, Dave, Mamo, Tom, Keфеcho, Tsegitu, Mele, Mahi, Asru*, and others . . . THANK YOU INDEED. 'Who is going to pay for . . .?' Thank you *Afework!* Love and blessing to *Dr. John W. Paintin* for encouragement and support, especially during times of trouble.

*Jerrytaddy* and *Fikirtaddy* were/are and will always be the source of inspiration for my entire career. You deserve the dedication of this piece of work.

Finally, I thank Pneumonia for not coming again.

Taddesse Emiru Anley

## TABLE OF CONTENTS

Section	Item	Page
	ACRONYM.....	iv
	List of Tables and Figures.....	vi
	List of Appendices.....	vii
	<i>Abstract</i> .....	viii
CHAPTER ONE	INTRODUCTION.....	1
1.1	Background.....	1
1.2	Statement of the Problem.....	2
1.3	Objectives of the Study.....	5
1.4	Scope of the Study.....	6
1.5	Significance of the Study.....	6
1.6	Limitation of the Study.....	6
1.7	Organization of the Paper.....	7
CHAPTER TWO	LITERATURE REVIEW.....	8
2.1	Overview.....	8
2.2	Theoretical Literature.....	9
2.2.1	The Cobb-web Model.....	9
2.2.2	The Multi-Market Model.....	11
2.2.3	The Monetarist Theory.....	13
2.2.4	The Structuralist Theory.....	14
2.2.5	Keynesian Inflationary Gap Model.....	16
2.2.6	Cost-push Vs Demand-pull Theories.....	19
2.2.2.6.1	Cost-push Theories.....	19
2.2.2.6.2	Demand-pull Theories.....	20
2.3	Empirical Literature.....	21
2.3.1	The World Experience.....	21
2.3.2	The Ethiopian Case.....	26

Section	Item	Page
CHAPTER THREE	DATA SOURCE, MODEL SPECIFICATION AND ESTIMATION TECHNIQUES.....	30
3.1	Data Source and Description.....	30
3.2	Model Specification and Estimation Techniques.....	31
3.2.1	Model Specification.....	32
3.2.2	Estimation Techniques.....	34
3.2.2.1	Time Series Properties of Variables.....	35
3.2.2.2	Cointegration Test.....	39
3.2.2.3	Lag-order Selection and Diagnostic Tests.....	45
3.2.2.4	Tests of Model Stability, Impulse Response Analysis and Granger Causality Tests.....	48
CHAPTER FOUR	ESTIMATION OF RESULTS AND DISCUSSION...	53
4.1	Recent Trends in Food Price Inflation.....	53
4.1.1	Recent Trends in Global Food Prices.....	53
4.1.2	Recent Experience of Food Price Inflation in Ethiopia	54
4.2	Model Estimation and Discussion.....	56
4.2.1	Time Series Properties of Variables.....	57
4.2.2	Tests of Cointegration [The Johansen Procedure].....	59
4.2.2.1	Lag-order Selection Criteria.....	59
4.2.2.2	Lag-Exclusion Test.....	61
4.2.2.3	Johansen Cointegration Test.....	62
4.2.3	Vector Error-Correction Approach.....	64
4.2.3.1	Granger Causality Tests.....	66
4.2.3.2	Vector Error-Correction Models.....	70
4.2.3.3	Diagnostic Tests.....	74
4.2.4	Impulse Response Analysis.....	76
4.2.4.1	Model Stability Test.....	76
4.2.4.2	Impulse Response Analysis of Food Price Inflation...	77

Section	Item	Page
CHAPTER FIVE	CONCLUSION AND RECOMMENDATION.....	81
5.1	Conclusion.....	81
5.2	Recommendation.....	85
	REFERENCE.....	87
	APPENDICES.....	102



## ACRONYM

AD	Aggregate Demand
ADF	Augmented Dicky-Fuller Test
ADLI	Agricultural Development Led-Industrialization
AIC	Akaike Information Criteria
AR	Autoregressive
AS	Aggregate Supply
BLUE	Best Linear Unbiased Estimator
CI(b, d)	Cointegrated of order ...
CPI	Consumer Price Index
CSA	Central Statistical Agency
DDRGM	Dummy for economic system/regime shift
DF	Dicky-Fuller Test
DPPA	Disaster Prevention and Preparedness Agency
DW	Durbin Watson Test
ECM	Error-correction Model
EEA/EEPRI	Ethiopian Economic Association/Ethiopian Economic Policy Research Institute
EG	Engel Granger
EMA	Ethiopian Meteorological Agency
EPE	Ethiopian Petroleum Enterprise
ERHS	Ethiopian Rural Household Survey
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization
FDAID	In-kind Food Aid Inflow
FDCPI	Food Price Index
GAP	Agricultural output gap index
GDP	Gross Domestic Product
GDPPC	Gross Domestic Product Per Capita
GNI	Gross National Income
HICES	Household Income and Consumption Expenditure Survey
HQ	Hannan-Quinn Information Criteria
I(d)	Integrated of order $d$
IFPRI	International Food Policy Research Institute
IFS	International Financial Statistics

IID	Identically and Independently Distributed
IMF	International Monetary Fund
IMPACT	International Model for Policy Analysis of Agricultural Commodities & Trade
IS-LM	Investment-Saving and Liquidity-Money
JB	Jarque-Bera Test
L	Lag Operator
LM	Lagrange Multiplier
LR	Likelihood Ratio Test
M2	Money Supply
MDGs	Millennium Development Goals
MIT	Ministry of Industry and Trade
MoFED	Ministry of Finance and Economic Development
NBE	National Bank of Ethiopia
NEER	Nominal Effective Exchange Rate
NGDP	Nominal Gross Domestic Product
OLS	Ordinary Least Squares
P	General/Aggregate Prices
PP	Philips Perron Test
PSNPs	Productive Safety-Net Programs
RF	Rainfall
RGDP	Real Gross Domestic Product
SAP	Structural Adjustment Program
SC	Schwarz Criteria
SEM	Simultaneous Equations Model
SRAS	Short-run Aggregate Supply
SNNP	Southern Nations and Nationalities People
US	United States
USD	United States Dollar
VAR	Vector Autoregression
VEC	Vector Error-correction
WFDP	World/Global Average Food Price
WB	World Bank
Y	Aggregate Output

## LIST OF TABLES AND FIGURES

<b>List of Figures</b>		
<b>Table/Figure</b>	<b>Item</b>	<b>Page</b>
Figure 2.2.1.1	The Cobb-web Model	9
Figure 2.2.5.1	The Keynesian Inflationary Gap Model	16
Figure 2.2.6.1.1	Cost-push Inflation Model	20
Figure 2.2.6.2.1	Demand-pull Inflation Model	21
Figure 4.1.2.1	Recent Trends in Food Price Inflation in Ethiopia	55
Figure 4.2.1.1.1	Unit-root Tests: Graphical Inspection	57
Figure 4.2.4.2.1	Response of food price inflation (Model 1)	78
Figure 4.2.4.2.2	Response of food price inflation (Model 2)	80
<b>List of Tables</b>		
<b>Table/Figure</b>	<b>Item</b>	<b>Page</b>
Table 4.2.1.1.1	Unit-root Tests: Augmented Dicky Fuller and Philips Perron Tests	58
Table 4.2.2.1.1	VAR Lag-order Selection Criteria	60
Table 4.2.2.2.1	VAR Lag-exclusion Test	61
Table 4.2.2.3.1	Unrestricted Cointegration Rank Test [Johansen Procedure]	62
Table 4.2.3.1.1	VAR Granger Causality/Block Exogeneity Test	67
Table 4.2.3.2.1	Vector Error-correction Model (VECM) Coefficient Estimates	70
Table 4.2.1.2.1	VAR Residual Normality Jarque-Bera Test	74
Table 4.2.1.2.2	VAR Residual Heteroskedasticity White Test	75
Table 4.2.1.2.3	VAR Residual Serial Correlation LM Test	75
Table 4.2.4.1.1	Roots of Characteristics Polynomial: Tests of Model Stability	76

## LIST OF APPENDICES

Appendix/Annex	Item	Page
Annex A	Recent trend in general and food price inflation and its details in Ethiopia	102
Annex B	Essentials of Matrix Algebra: Characteristics Roots and Eigenvectors	103
Annex C	Trends in aggregate food consumption expenditure in Ethiopia	104
Annex D	Trends in Household Consumption Expenditure	105

## **ABSTRACT**

*Fortunate is the one who can understand the causes of things – Virgil*

*This thesis tries to identify the major causes of food price inflation in Ethiopia, because not only food takes the lion's share (60%, on average) of the Consumer Price Index (CPI) but also that food price inflation is higher than that of non-food items despite food security is the nation's priority agenda in the Millennium Development Goals (MDGs). The study aims at identifying the major determinants of food price inflation, testing their significance and suggesting policy options to help curb the problem. To this end, annual time-series data on food price index and other variables for the period 1965-2006 (for Model 1) and 1963-2006 (for Model 2) are used from various sources and a Vector Error-correction approach employed. The long-run estimates show a single cointegrating equation in both models and their results support the monetarist contention that money supply is the only significant source of inflation and the direction of causality flows from the money supply (proxied by broad money M2) to food price inflation and not vice versa; but the Keynesian output gap in agriculture doesn't matter to food price inflation. In the short-run, however, structural variables like rainfall and government control on domestic food markets are significant price drivers. As a small open economy, domestic food markets are also found to be significantly affected by world food price inflation indicating the relevance of theories of imported inflation in domestic food markets. Besides, food aid is found to cause dependency syndrome on food producer farmers and hence exacerbating food price inflation. The impulse response analyses in this study suggest agriculture-led sustained economic growth as one way for a lasting solution to curb the malady of food price inflation if combined with tight policies of money supply. Finally, active and selective interventions by the government in the food market is found to be a short-run remedy to curb, at least, 'artificial' inflation of food prices.*

**KEY TERMS:** *Food price inflation, money supply and agriculture*

# CHAPTER ONE

## INTRODUCTION

This chapter introduces the study: section 1.1 provides a background for the motivation of the study [section 1.2]; the objectives are stated in 1.3 and 1.4 defines the scope of the study, then 1.5 points out its potential significance. Finally, the limitations of the study are given in section 1.6.

### 1.1 Background of the Study

The Ethiopian economy was known for long for its low inflation. At present, however, it is experiencing high inflation particularly with foodstuffs. Not only does food price inflation exceed that of non-food items in the domestic economy (CSA, 2007 and 2008), but also that food price in Ethiopia is generally more than the world average and has been relatively more volatile – the import parity of Ethiopia is very large (FAO, 2007).<sup>1</sup>

Some officials admitted that food price inflation is running high, especially in the cities, which resulted in high general price level since food prices account for the lion's share (60%) of consumer price index (CPI) in Ethiopia. To be specific, annual inflation averages 15% over the last four years, with the figure slightly higher in Addis Ababa and other regional capitals. Particularly with food prices, as high as 39% inflation is reported (CSA, 2008).

Even some scholars hypothesized not less than 60% food price inflation in [urban] Ethiopia recently [For example, Abebe and Andinet, 2007; Alemayehu and Abebe, 2008 – forthcoming]. Seeing that inflation in food items is *not fun* agenda as it puts the life of rural net food buyers and the urban poor at stake and hence major source of welfare deterioration, the hunch by the public seems not only about the going [food price] inflation, but also that it may further escalate in the

---

<sup>1</sup> Mulat et al. (2008 - forthcoming) argues that high transportation cost due to high oil prices and poor infrastructure is a possible explanation for this differential.

future, unless sturdy policy measures are taken. In less grandiose terms, food price inflation is *galloping* – ‘a double-digit [food price] inflation and expected to accelerate’ (Zijstra, 1991).

For the urban population and net food buyers [in rural areas in particular] it is frustrating to see that the food price inflation is hardly curbed despite some measures taken by the Ethiopian government that include provision of subsidized wheat & edible oil to the urban poor, export ban on certain food items, removing/lifting value-added & turnover taxes on [imported] foodstuffs, huge and continued subsidy on oil, introduction of commodity exchange market, etc.

In general, for the government’s policy measure to be effective, it requires the identification of the root causes of the food price hike. The interest of the researcher, therefore, is to dig out the real causes of food price inflation and thereby indicate the possible policy options that help control the problem in the country.

Survey of the literature in this paper suggests that most of the related studies conducted so far not only focus on general inflation in Ethiopia as opposed to food price inflation but also do they hardly give a comprehensive explanation as to why food prices are soaring although there are attempts by few studies (see chapter two). Therefore, only little or nothing is known on the root causes of soaring food prices in Ethiopia. The motivation and objectives of the study emanates from the indicated gap in knowledge.

## **1.2 Statement of the Problem**

Throughout the world, inflation is a major source of political unrest (Friedman, 1974 in Richard et al., 1984). In Ethiopia, there are serious complaints against the existing inflation that critically challenged the Ethiopian population. On the other hand, it is argued that a moderately high rate of inflation is a necessary byproduct or even a spur to development since the cost of one could

be a gain to the other, as there is no 'win-win' situation under inflation. In this regard, H. E. Sufian (2007) argued, the inflation rate, which was 6.8% two years ago, stood at 14.7% in 2006/07 budget year due to the economic development the country had achieved in the recent years (The Sub-Saharan Informer - June 1, 2007).

The International Monetary Fund (May, 1990 in Ramachandran, 1995), on the contrary, remarked that high inflation in developing countries might be expected to be associated with weak economic performance for several reasons. The plight, however, is that the case in Ethiopia is food price inflation despite good performance of the agricultural sector, especially during the last four years. Why is there food price inflation in the face of agricultural growth, the main supplier of food items in Ethiopia?

More interestingly, the supposition taken up by different groups on the source of the inflation varies significantly. For instance, what the IMF & the World Bank (WB) view as the cause of (food price) inflation and what the Ethiopian government suspects as the root cause lie on the two extremes. IMF's position goes to increased government expenditure financed by an increased money supply – demand side. This testifies the monetarist proposition that 'inflation is always and everywhere a monetary phenomenon'. On the other hand, the Ethiopian government's position is that food price inflation is caused by *structural* factors; that is, even though production has increased, it has not reached the marketplace for 'various reasons'. This, therefore, indicates that the case under scrutiny is not only theoretical quagmire, but also practical.

The question remains whether food price inflation in Ethiopia is demand-pull, cost-push or both, or none. However, any unscientific attempt to answer whether food price inflation in Ethiopia is

demand-pull or cost-push is like providing too simple an answer for too complex a problem since this is very general and needs further investigation.

The concern of this study, therefore, is identification of the major demand-side and/or supply-side factors that determine food price inflation in Ethiopia. The focus on food price inflation is of interest for this study, at least, for three reasons:

First, food is a basic need of human beings; that is, ‘in this ever-changing world, there is one constant, we all need food to live’. This could be why food security is a priority target of the Millennium Development Goals (MDGs).<sup>2</sup> Cochrane et al. (1967: 211 – 7) also noted that even if food supply may be fabulous, inflation on foodstuffs denies the right to entitlement. Besides, for low-income population like ours not only a large proportion of total household income but also a major portion of additional income is disbursed on food (income elasticity of demand for food is relatively high; i.e. the *Engel curve* for food in Ethiopia is flatter). For instance, 72% of household income in Ethiopia went for food in the year 1996 (WB, 2002).

This is why food price inflation is agreed to be the major source of welfare deterioration for the urban poor and rural net food buyers. Hence, inflation in food prices as compared to other items should be more critical for low-income economies as it hits low-income households disproportionately adversely even if they ‘sweat hard’.<sup>3</sup> This should be why the Asian Development Bank (April, 2008: 1) put this as worrisome precisely because food price inflation is the most regressive of all taxes – it hurts the poor the most.

Second, as indicated above, food price dynamics account for 60% of the CPI in Ethiopia, on average, which is a huge share [without exaggeration] as compared to the 39% share of non-food

---

<sup>2</sup> MDG Goal 1, Target 2: Halve, between 1990 and 2015, the proportion of people who suffer from hunger.

<sup>3</sup> For details on the social & economic impacts of [food] inflation see Mankiw, 1992 and Dornbusch, 1997.

items in the year 2000, for example (CSA, December 2007). This entails that food price inflation necessitates general inflationary pressures in the economy both directly and indirectly.

Finally, food prices increased even higher than non-food items that made it the preponderant contributor to high general inflation.<sup>4</sup> For instance, the country-level overall inflation rate stood at 17.2% in December 2007. This rate is 4.9 percentage points higher than the corresponding annual average rate of 12.3% in December 2006. Similarly, the country-level food and non-food price inflation rates stood at 22% and 11% in December 2007, respectively. This food price inflation is 8.4 percentage points higher than from the previous year (CSA, 2007).

In a nutshell, general inflation in Ethiopia is primarily attributable to food price hikes. Why is the food component of inflation higher than that of non-food items? What causes food prices to inflate in Ethiopia? Is it demand or supply-driven? Is it caused by monetary or structural factors?

### **1.3 Objective of the Study**

The study examines the dynamics of food price inflation in Ethiopia and aims at identifying the main determinants. Specifically it tries to:

- ❖ examine the trend in food prices and review recent price developments;
- ❖ identify the most important determinants of food price inflation and evaluate the relative significance of demand and supply side factors;
- ❖ examine the direction of causal relation between food price inflation and other variables
- ❖ recommend policy options to curb the problem; and
- ❖ point out directions for future research.

---

<sup>4</sup> See Annex A for the recent trends in general & food price inflation and its details.

#### **1.4 Scope of the Study**

The focus of the study is to identify the [major] causes of food price inflation in Ethiopia using time series data over the last three regimes. It tries to investigate the long-run causal relationship different factors may have with national-level food price inflation. It treats food prices in aggregate using the food component of the CPI. The coverage of the study is largely influenced by the availability of data. As a result, the dataset of the models differ. The scope and structure of the study is also affected by availability and quality of data.

#### **1.5 Significance of the Study**

As noted above, food price inflation in Ethiopia is alarming especially for rural net food buyers and the urban poor. Despite this, there is no agreed explanation for its causes. Thus, this research is expected to contribute towards identifying the major causes of the existing inflation. Likewise, it is expected to serve as an input for policy-makers in the course of designing policies aiming at alleviating the prevailing worrisome condition.

#### **1.6 Limitation of the Study**

The prices of all food items may not inflate at the same time and by the same rate. Let alone the specific response of different food items, the response and dynamics of the crop and livestock sub-sectors may differ for various reasons. The study, however, does not attempt to distinguish between these sub-sectors and treats aggregate food prices at the national level only. Admittedly, poor quality of data (the data is discrepant, shaky and inconsistent among sources) and its availability have significantly affected the structure of the study.

With regard to the variable of interest, some researchers are skeptical about the effectiveness of [the food component of] the CPI in Ethiopia on the ground of low degree of monetization of the economy. However, not only one barely has alternative index for country-level general/average

food prices, but also the degree of monetization has been increasing over time, especially following the liberalization of the financial market and hence increased number & services of microfinance institutions in Ethiopia.

Last but not least, while it may have an important part to play in explaining food price inflation, the study did not use oil price data for two reasons: oil is highly subsidized in Ethiopia and retail price of oil is unavailable for the period under study.

### **1.7 Organization of the Study**

The paper is organized in five chapters: chapter one introduces and the second [critically] reviews the literature, the third chapter describes the type & source of data, specifies the models and discusses the estimation techniques. Then, chapter four discusses the findings of the study and chapter five concludes.

## CHAPTER TWO

### LITERATURE REVIEW

Agénor (1999) noted that food is a foremost component of the subject of inflation especially in developing economies. In Ethiopia, as mentioned in the last chapter, food comprises the lion's share of the total CPI (CSA, 2008). Consequently, most theories that explain inflation dynamics in the context of such economies would be relevant to explain the dynamics of food prices.

This chapter assesses the contemporary wisdom (both theory and evidence) on food price inflation and its drivers, especially in the context of developing economies like Ethiopia. It defines general inflation and food price inflation in section 2.1, attempts to review theories of and empirical findings on food price inflation in section [2.2] and [2.3], respectively.

#### 2.1 Overview

Jackman et al. (1984: 1) defined *inflation* as a persistent tendency for the general level of prices to rise. Inflation in an economy, following Flemming (1976: 5) and CSA (2008), therefore, is the rate at which the general price level is changing. In the Ethiopian case, the rate of inflation is the country-level overall inflation rate calculated by the annual change based on twelve months moving average (CSA, 2008: 9). In a similar fashion, food price inflation (the subject of interest in this study) can be calculated by the rate of change in the food component of country-level CPI.<sup>5</sup>

It is customary to use CPI as a proxy to general price level and the calculation of inflation. Hiroyuki (1994: 127) asserts CPI-based inflation measures in market economies with the assumption that the commodity market is in equilibrium and that CPI is unbiased representation of transaction prices. What's important for this study, nevertheless, is not the measure but the

---

<sup>5</sup> This price is retail level price as this best indicates welfare of consumers as compared to farm-gate and wholesale prices.

causes of food price inflation. Besides, survey of the literature indicates the only index for average food prices in Ethiopia is the one computed by the Central Statistical Authority (CSA).

## 2.2 Theoretical Literature

There is no consensus on the causes of food price inflation in Ethiopia. In the Economics literature, we find quite vast theories that may correspond or contradict one another. To this end, this section makes a review of the prominent (relevant) theories and the contemporary wisdom on food price inflation including the Cobb-web model, the multi-market model, the Keynesian output gap model, the monetarist theory, and the structuralist theory. These are believed to have relevance in most literature in general inflation (for example, Zewdu, 1997; Aksoy, 1982; Albert et al., 1978; Andrew, 1985; Frisch, 1990; Mohsin et al., 2006; etc) and few attempts on food price inflation (like Yohannes, 2007; Mulat, 2007; and Alemayehu & Abebe, 2008 – forthcoming).

### 2.2.1 The Cobb-Web Model

Enders (1995: 20–25) presented the Cobb-web model to explain the volatility in agricultural prices. The model considers a single market for agricultural commodity, say, wheat, but can be generalized to all agricultural food items that presents the demand ( $d_t$ ) and supply ( $s_t$ ) in period  $t$  as in [2.1] and [2.2], respectively.

$$d_t = a - \gamma p_t, \gamma > 0 \dots\dots\dots [2.1]$$

$$s_t = b + \beta p_{(s)t}^e + \varepsilon_t, \beta > 0 \dots\dots\dots [2.2]$$

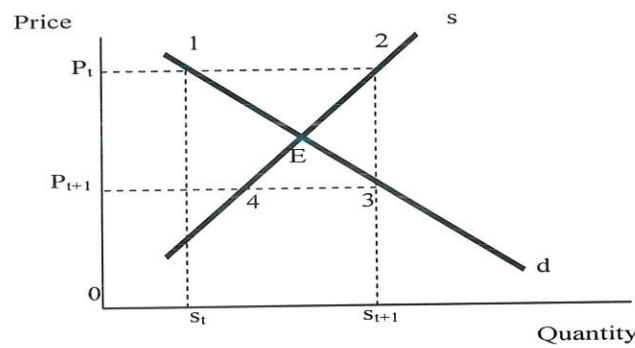
Where  $d_t$  and  $s_t$  are the demand for and supply of wheat in period  $t$ ;  $p_t$  is the market price of wheat in period  $t$ ;  $p_t^e$  is the price that farmers expected to prevail in period  $t$ , and  $\varepsilon_t$  a zero mean stochastic supply shock. All parameters  $a$ ,  $b$ ,  $\gamma$  and  $\beta$  are positive such that  $a > b$ . Why? It is a condition for scarcity! Then, it equates demand and supply, assuming food markets generally clear as in [2.3]:

$$s_t = d_t \dots\dots\dots [2.3]$$

The nature of the model is such that consumers buy as much as they desired at the market-clearing price  $p_t$ . At planning time, farmers do not know the price prevailing at harvest period; they base their 'supply decision' on the expected price ( $p_{(s)t}^e$ ). The actual quantity produced depends on the *planned quantity*  $b + \beta p_{(s)t}^e$ , plus a random *supply shock*,  $\varepsilon_t$ . Once the product is harvested, market equilibrium requires that the quantity supplied equals the quantity demanded. Unlike the actual market for most agricultural commodities, the model ignores the possibility of storage. The essence of the model is that farmers form their expectations in a *naïve* fashion; let farmers use last year's price as the expected market price so that:

$$p_{(s)t}^e = p_{t-1} \dots\dots\dots [2.4]$$

Figure 2.2.1.1 The Cob-web Model



Point E in Figure 2.2.1.1 represents the long-run equilibrium price & quantity combination. If the system is stable, successive prices will tend to converge to point E. However, the nature of the stochastic equilibrium is such that the ever-present supply shocks prevent the system from remaining at E. If we set all values of the  $\{\varepsilon_t\}$  sequence equal to zero,  $p_t = p_{t-1} = \dots = p$  and equate supply & demand, the long-run equilibrium price is given by  $p = \frac{(a - b)}{(\gamma + \beta)}$ . Similarly, the

equilibrium quantity ( $s$ ) is given by  $s = \frac{(a\beta + \gamma b)}{(\gamma + \beta)}$ .



To understand the dynamics of the system, suppose that farmers in period  $t$  plan to produce the equilibrium quantity ( $s$ ). Let there be a negative supply shock (say, due to the vagaries of nature) such that the actual quantity produced turns out to be  $s_t$ . As shown by point 1 in the above figure, consumers are *willing & able to pay*  $p_t$  for the quantity  $s_t$ ; hence, market equilibrium in  $t$  occurs at *point 1*. Updating one period allows us to see the main result of the model. For simplicity, assume that all subsequent values of the supply shock are zero (i.e.  $\varepsilon_{t+1} = \varepsilon_{t+2} = \dots = 0$ ). At the beginning of period  $t+1$ , farmers expect the price at harvest time to be the same as that of the previous period; thus,  $p_{(s),t+1}^e = p_t$ . Accordingly, they produce and supply quantity  $s_{t+1}$  (point 2 in the figure); consumers, however, are *willing & able* to buy quantity  $s_{t+1}$  only if the price falls to  $p_{t+1}$  (point 3).

The next period begins with farmers expecting to be at point 4. The process continually repeats itself until the equilibrium point is attained. As the above graph suggests, the market will always converge to the long-run equilibrium point. This result, nonetheless, does not hold for all demand and supply curves. It holds only for those that converge but does not hold for non-converging ones.<sup>6</sup>

### 2.2.2 The Multi-Market Model

The use of multi-market models in the economic development context can probably be traced to the estimation of agricultural household models in the 1980s. These models have proven particularly popular for work on agricultural sector analyses. André, et al. (2006) noted that:

*Multi-market models are intended to include only direct and indirect effects in a small number of related markets. Put differently, whether they are called 'limited general equilibrium' (as in Mosley, 1999) or 'multi-market partial equilibrium' (as in Arulpragasam, 1994), they focus*

---

<sup>6</sup> For conditions on convergence see Chiang (1984) – Chapter Nine

*the analysis on the combination of direct effects and indirect effects through price and quantity changes in a small group of commodities or factors with strong interlinked supply and demand.*

In spite of this limitation, these models allow to trace more clearly the channels through which a given policy change produces its effects. They typically consist of a core set of relationships describing producer and consumer behavior in the markets for key tradable and non-tradable crops.

Nevertheless, there is no theoretical limit on the number of interlinked goods or factors that can be considered in a multi-market model. However, the practical data requirements in terms of accurate supply and demand conditions for each interlinked good place an upper bound on the number of simultaneously estimated functions (Arulpragasam and Conway, 1994).

Traditionally, they have been used to measure the impact of price policies, the impact of technical and other economic changes on growth & equity, and the impact of trade liberalization in key staple food markets. The model allows analyzing the impact of price and non-price policies on production, factor use, prices, incomes, consumption, government revenues & expenditures and balance-of-trade. They are typically more reliable in measuring welfare impacts when the reforms being analyzed affect commodities or factors for which the set of close substitutes and complements are well defined (Arulpragasam and Conway, 2003 in André et al., 2006). The early analyses focused upon the substitution effects among a small number of agricultural products in household demand in response to relative price changes, using demand and supply elasticities (Arulpragasam and Conway, 1994).

Since the study is not interested in the price of specific food items, it is not worth to see the multi-market model in detail. Rather, we are concerned about food price inflation. Hence, it

doesn't make sense to talk about substitution relationships when food is treated in aggregate (and that food is a basic need with no substitutes). Instead, more relevant theories are given in the subsequent sections. Some of these theories, nonetheless, may overlap in their conjecture on the main sources of (food price) inflation.

### 2.2.3 The Monetarist Theory

The monetarist theory of inflation ascribes (food price) inflation to changes in the money supply. Several scholars wrote on money supply as the sole cause of any inflation. Friedman<sup>7</sup> (1970: 24) stated the famous monetarist view on inflation that *'inflation is everywhere & always a monetary phenomenon'* and concluded that inflation can be produced only by a more rapid increase in the quantity of money than output.

According to this theory, it is a behavioral 'fact' proven by empirical evidence that demand for money is stable (Ghatak, 1981: 23) and rate of inflation is cost of holding real balances. It follows, therefore, that the rate of increase of the nominal stock of money determines the inflation rate (Banerjee, 1975: 15–16). This is made possible based on the assumption that agents do not change the relationship among their wealth, volume of transactions & their income level and constant velocity of money in the short-run.

Frisch (1990: 221), then, derived growth rate of money supply to equate the growth of general prices as in [2.5]. That is, the monetarists formulated that the elasticity of the general price level to the change in the supply of money as unity.<sup>8</sup>

$$\frac{\partial M}{M} = \frac{\partial P}{P} \dots\dots\dots [2.5]$$

---

<sup>7</sup> Friedman and other economists in the Chicago School are known monetarists.

<sup>8</sup> Details of the *Equation of Exchange* and the derivation of the elasticity are found in Frisch (1990).

A number of their research, Kotwal (1987) mentioned, indicated that 'the long and large price movements are traceable to monetary factors'. The relationship between changes in the stock of money per unit of output and changes in the general price level is an outstanding specimen of empirical regularity in Economics.

However, they noted,

*. . . it should not be inferred that the relationship between money and price is straight, rigid and mechanical; but there are long and variable time-lags with regard to the effects of changes in the rate of growth of money supply on price and output. In other words, the monetary impulses that consist of changes in the rate of growth of money stock constitute a major force behind cyclical changes in the level of prices, output and employment (Ibid).*

#### **2.2.4 Structuralist Theory of Inflation**

Structuralists argue that there are equally important structural & institutional factors for food price inflation especially in developing countries. Thirlwall (1989) wrote that

*. . . the basic forces of (food price) inflation are supply phenomena – that is, structural limitations or bottlenecks inherent in the socio-economic system and cumulative inflationary processes. They, however, do not deny the fact that financial factors can propagate it. In view of this School, structural constraints in developing countries are very powerful.*

They also argue that not only are there equally important structural & institutional factors but also that money supply is explained by these factors outside the control of central banks. Moreover, Kirkpatrick (1981) explained that information asymmetry among agents and rigidities & disequilibria between supply and demand in different sectors are the characteristics of developing economies. As a result, we may find a simultaneous underutilization of resources in one sector and significant scarcity of commodities in the others.



The Structuralists note that 'nominal wage contract and a decline in real wages owing to inflation; restricted agricultural supplies as prime causes of inflation as witnessed in most Latin American countries (E.g. Brazil 1986–87); jumps in price of non-traded goods following a foreign exchange bonanza (E.g. Mexico) as possible episodes of conflict and price formation inspired inflation' (Taylor, 1992).

Similarly, Flemming (1976: 39–40), in view of the structuralist theory, stressed two basic causes of inflation (especially in Latin American countries); namely, the rigidity of food supply and the inadequacy & instability of the purchasing power of exports. Adding, he argues that in dual economies food supply is inelastic and hence prices are very flexible in response to changing demand.

Taslim (1982: 26–27) emphasized 'agricultural factors, foreign trade, social overheads and the tax system as important structural bottlenecks observed in developing countries'. Agricultural bottleneck is often regarded as a consequence of institutional defects. In most developing economies, a rapidly growing demand for food, due to high population growth rate, has not been accompanied by a corresponding rise in food production. This is more often attached to the agricultural sector (as the major supplier of foodstuffs especially in developing countries), which is dominated by subsistence farmers who do not respond to market signals. Pressure of increased demand is then manifested not in production increase but increasing price of foodstuffs.

In short, Burungi (1997) wrote;

*. . . structuralists attribute inflation to the structural rigidities of an economy; that is, inelastic food supply, foreign exchange constraints, budget constraints, lack of skilled labor power, etc that prevail in developing countries. The increase in money supply is a permissive factor for the inflationary spiral to manifest itself and becomes cumulative. It is a symptom of the structural*

*rigidities that give rise to inflation itself. Therefore, an increase in money supply is a necessary but not sufficient condition for rise in the general price level (p. 3).*

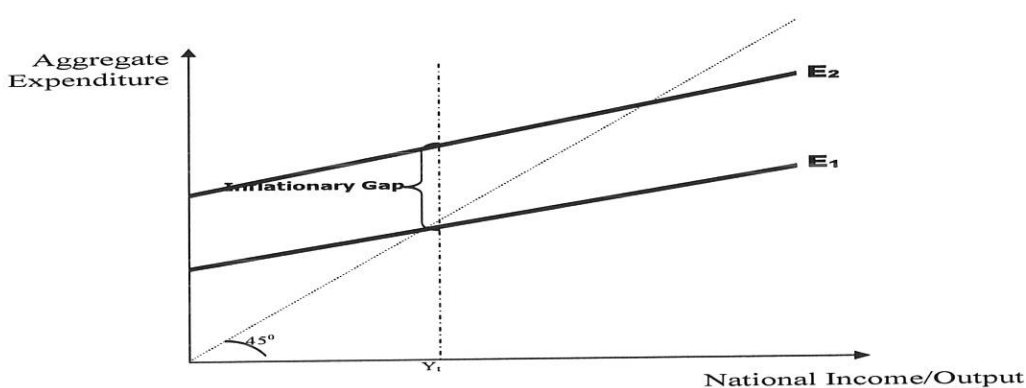
Flemming (1976) puts the difference between these theories in a nutshell as:

*While for Monetarists, excess demand [for food] resulting from excess supply of money [as a major portion of it goes for food consumption] is regarded as the only cause of inflation, the Structuralists ascribe inflation to the composition of demand for commodities accompanied by inflexibilities in the productive structure (pp. 39)*

### 2.2.5 Keynesian Inflationary Gap Model

For Keynes and opponents of the *quantity theory*, the description of inflation as *too much money chasing too few goods* regard as a characterization, albeit a slightly inaccurate one, of an inflation gap with the reason of the inaccuracy that the excess demand may not be due to an increase in the money supply. The inflation gap model is best illustrated by Fender (1990) with the help of the famous *Keynesian Cross* as in figure 2.2.5.1.

Figure 2.2.5.1 The Keynesian Inflationary Gap Model



In this model, the national income equilibrium condition is that aggregate expenditure equals the aggregate output or income. The equilibrium level of income is, therefore, given by the point at

which the aggregate expenditure curve cuts the  $45^{\circ}$  line. Aggregate expenditure is an increasing function of income in the Keynesian consumption function.

Full employment output ( $Y_f$ ) is defined as the level of output produced by the *fully employed labor force*, with the inevitable frictional & structural unemployment ('Keynesian' unemployment). If downward price rigidity is assumed, then, in the presence of (Keynesian) unemployment, changes in the aggregate expenditure schedule (brought about, say, due to changes in government expenditure or in the money supply) generate corresponding changes in output and employment. 'Once *full employment* is reached, however, increments in demand cannot increase employment or output; the so called *inflationary gap* emerges'. This may be defined as the difference between aggregate expenditure and aggregate output at full employment. In the above graph, if the actual expenditure schedule is  $E_2$  and the one which would (just) ensure full employment is  $E_1$ , then the vertical distance between the two at  $Y_f$  is the inflationary gap. This tells us 'when prices must rise; but not by how much' (Fender, 1990: 2–5).

In his own words, Harris; (1985) compared the quantity theory and that of Keynesians as follows:

*When an increase in money is regarded as a net addition to income, [food] prices will rise (if employment [in agriculture] is already full), but when it is regarded as a means to add to one's liquid assets, the rate of interest will fall. It is the former case which commands attention in the quantity theory. The latter holds the center of the stage in Keynesian theory* (pp. 13).

In passing, the reader may also note the following points of difference between the two theories: First, 'the *quantity theory* assumed a tendency towards full employment while Keynes indicated the possibility of equilibrium at a level below full employment'; second, 'the former focused on the long-run and the latter the short-run'; and finally, the former relates to the effect of changes in

the supply of money – a particular aspect of this medium of exchange, but the latter developed a kind of *general theory* of employment as well as interest and money. Thus, Banerjee (1975) concludes that ‘the classical *quantity theory* may be regarded as a special case of Keynesian theory applicable to conditions of full employment.’

Consequently, the recent debate on the relative merit on policy effectiveness, Ghatak (1981: 25) puts, centers on the question of changing aggregate demand by monetary or fiscal policies. Keynesians point out that only fiscal policies can change the level of income by changing aggregate demand, where as monetarists argue that aggregate demand can be changed only by monetary policies. It seems that the latter case rests on the working of a vertical or near-vertical LM curve<sup>9</sup> (which implies that the demand for money is very inelastic to changes in the interest rate) where as the former rests on the working of a vertical or near-vertical IS schedule with normal LM curve (that implies a very low elasticity of the investment function with respect to changes in interest rate).

Moreover, many writers argue over the relevance of these theories to different economies. For instance, Fender (1990) indicated,

*Although inflationary gap theory may be regarded as relevant in explaining many wartime inflations when there is considerable pressure of demand on resources, it is less appropriate in the case of many other inflations when prices often rise in the presence of excess capacity & unemployment (p. 4–5).*

---

<sup>9</sup> This is part of the famous IS-LM model. The two parts of the IS-LM model are, not surprisingly, the *IS curve* and the *LM curve*. *IS* stands for ‘investment’ and ‘saving’, and the *IS* curve represents what is going on in the market for goods & services. *LM* stands for ‘liquidity’ and ‘money’, and the *LM* curve represents what is happening to the supply and demand for money (Mankiw et al., 1994: 258).

## 2.2.6 Cost-push Vs Demand-pull Theories

Classical economic thought proposes that there are two major types of inflation – *demand-pull* and *cost-push*. The former occurs when there is an increase in the amount of money available to buy a fixed supply of goods. ‘This situation was very much in evidence when U.S. food prices raced dramatically upward in 1973 after nearly two decades of relative stability.’ *Cost-push* inflation, on the other hand, is largely ‘the result of rise in costs (especially labor) not offset by increases in productivity, as a result of which the general price level is forced upward’ (Duft, 1999).

Therefore, inflation as a general increase in the price level could be demand-pull, which is due to a shift in the economy's demand curve, or cost-push, which is escalated by an upward shift of the supply curve (Branson, 1989). Let us consider each of these theories next.

### 2.2.6.1 Cost-Push Theories of Inflation

The cost-based theories of inflation, also called *mark-up* inflation or *sellers' inflation*, or *supply-shock* inflation, Banerjee (1975) wrote,

*... originate from the sequence that prices rise due to increase in the cost of production. To be more specific, if there is an increase in the costs of firms then they will pass this on to consumers by marking their prices up as there will be a shift to the left in the aggregate supply. Cost-push inflation can be caused by many factors; including, rise in price of labor and other inputs, import price hikes, push on profits by entrepreneurs, and declining productivity.*

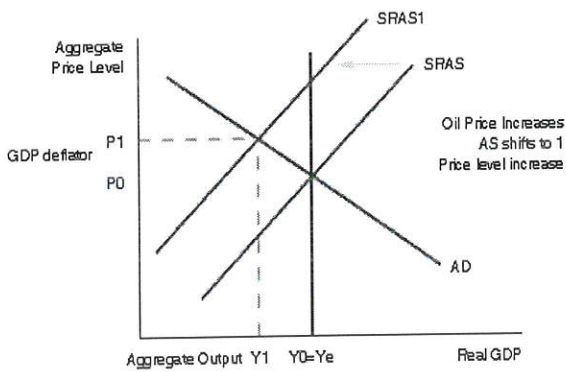
Figure 2.2.6.1.1 illustrates cost-push inflation using aggregate demand-aggregate supply model. Ghosh (2000) emphasized the imported inflation aspect of cost-push inflation seeing that many developing economies have been implementing structural adjustment and market reform programs;<sup>10</sup> an important component of which is the liberalization of food markets. This may

---

<sup>10</sup> Ethiopia has also adopted the Structural Adjustment Program (SAP) since 1991.

result in imported inflation through different channels. Itagaki (1979: 344–5) stated higher export & import prices as the major transmitting channels of international inflation. Higher import prices will not only increase domestic prices directly (indirectly) where imports are for final (intermediate) consumption, but also induce producers of import substitutes to raise their prices without jeopardizing competitive position.

Figure 2.2.6.1.1 Cost-push Inflation Model



From Figure 2.2.6.1.1, rise in general prices from  $P_0$  to  $P_1$  is caused by decrease in supply, say from SRAS to SRAS<sub>1</sub>, with demand remaining stable. Such inflation is known as cost-push. It may be caused by rise in cost of inputs (imported and/or domestic), like oil, labor, fertilizer, etc.

SRAS = short-run aggregate supply

AD = aggregate demand

Y = aggregate output and P = general prices

### 2.2.6.2 Demand Pull Theories of Inflation

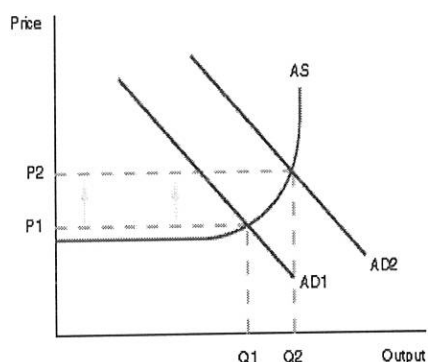
Demand-pull inflation is inflation caused by increases in aggregate demand due to increased spending by private, government and/or external sector. This theory speculates that inflation is caused when *'too much money chases too few commodities'*.

Fender (1990) noted, we would generally expect a positive relationship between growth rates and inflation. There is some empirical support for this relationship (For example, Balassa, 1964). The same argument can be used to explain the observation that countries



with higher per-capita income tend to have higher absolute price levels than low-income countries.

Figure 2.2.6.2.1 Demand-pull Inflation Model



In Figure 2.2.6.2.1, even if aggregate demand increased from  $AD_1$  to  $AD_2$ , supply cannot respond proportionately, resulting in a general price rise from  $P_1$  to  $P_2$ . Demand-pull inflation happens when output gap is very small. This is why it usually happens with a booming economy.

## 2.3 Empirical Literature

This section assesses the evidence from findings of various studies from the literature in general [2.3.1] and those with particular emphasis on the Ethiopian food markets [2.3.2].

### 2.3.1 The World Experience

Food price hikes are becoming increasingly sensitive across the world once again after the early 1970s. There are some studies dealing about food price drivers in different economies. But, the literature on general inflation is more affluent than that of food price inflation. Some of these studies on food markets are discussed below.

Mohsin and Axel (2006), using monthly series for the period during January 1998 - June 2005, 'examined the relative importance of monetary & structuralist supply-side factors for (food price) inflation in Pakistan.' They specified a stylized inflation model that includes standard monetary variables (money supply, credit to the private sector), exchange rate, as well as wheat-support price as a supply-side factor that has received

considerable attention in Pakistan and include 12 lags of all variables. 'The results indicate that monetary factors have played a dominant role in recent inflation, affecting inflation with a lag of about one year in Pakistan food markets. Changes in the wheat-support price influence inflation in the short-run, but not in the long-run. Furthermore, the wheat-support price matters only over the medium term if accommodated by monetary policy'. Khan and Qasim (1996), on their part, found food price inflation in Pakistan to be driven by money supply, value-added in manufacturing and wheat-support price.

Similarly, Xuehua et al. (2004: 1-15) investigated the impacts of monetary variables (such as money supply and interest rates) on food prices in China using vector error-correction (VEC) model on annual data covering 1980-2002. The study indicated that monetary variables and the food price index have a long-run equilibrium relationship. Furthermore, the direction of Granger-causality moved from money supply to the food price index and then to interest rates, rather than the reverse. And, monetary impacts on food prices mainly stem from the money supply rather than interest rates.

In relation to the potential of the exchange rate market dynamics on domestic food markets, Milan and Luc (May 2008: 4) studied the impact of exchange rate on food prices and found *dollar weakness* to increase dollar-commodity prices with price elasticity between 0.5 and 1. However, since food price changes are not closely correlated with dollar weakness, it is likely that the impact was at the lower end of this range. They added that the impact of bio-fuel use on rice prices is less direct than for other grains or oilseeds, since rice is not used for bio-fuel production and rice land is not easily switched to other bio-fuel crops. However the surge in wheat prices is being reflected in rice prices because wheat and rice are substitutes in consumption and imports

In line with this study, FAO (2003 and 2007b) suggested, a breakdown of cereal demand by type of use gives insights into the factors that have contributed to the greater increase in consumption and their contribution to food price hikes. While cereal use for food and feed increased by 4% and 7% since 2000, respectively, the use of cereals for industrial purposes (such as bio-fuel production) increased by more than 25%. This, therefore, entails that the role of bio-fuels as a source of demand for grain has also been a significant element of recent food prices.

More specifically, Braun (2007) cited in Alex (2008) estimated 30% of the picture on bio-fuels as a driver of food price hikes. Recent World Bank studies, according to Mitchell (2008), also suggest that rising energy and fertilizer prices and the falling dollar have contributed about 35% of the rise in world food prices.

Moreover, population growth is also believed to be among the major sources of increased food demand. In light of this, the world's urban population has grown more than the rural population; within the next three decades, 61% of the world's populace is expected to live in urban areas (Cohen, 2006). This is particularly true when population growth is backed up by increase in income to make additional food demand effective.

With regard to the supply-side, Braun (2007: 5) using International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) on global data from different regions of the world suggested that changes on the supply-side (including droughts and other shortfalls and the diversion of food for fuel) are powerful forces affecting the price surge at a time when demand is strong due to high income growth in developing countries. Under a scenario of continued high income growth (but no further



supply shocks), the preliminary model results indicate that food prices would remain at high levels for quite some time.

On the other hand, it is argued that supply & demand changes do not *fully* explain the price increases. Financial investors are becoming increasingly interested in rising commodity prices, and speculative transactions are adding to increased commodity-price volatility. In 2006, the volume of traded global agricultural commodities rose by almost 30% (Ibid: 5).

Agricultural commodity price rises are also argued to be affected by natural factors. In line with this argument, Easterling et al. (2007) estimated that agricultural prices will be affected by climate variability and change. Thus, temperature increases of more than 3°C may cause prices to increase by up to 40%.

While few studies focused on total food price inflation as reviewed above, others focus on the price dynamics of selected food items. For instance, Fredy (2006) used cointegration and Granger causality techniques to test for price linkages. For the commodities they analyzed (sugar, cotton, wheat, and rice – note that three of the four commodities are food items), prices in Tanzania were not well integrated with commodity prices in the world market. However, Granger-causality tests revealed the existence of a unidirectional causal relationship, whereby commodity prices in the world market Granger-cause prices in Tanzania. The methodologies taken together imply that commodity prices in international and local markets drifted apart from each other, but some shocks from the world market passed through to Tanzania, but not vice-versa. Thorough analysis of trade networks indicated that Tanzania responded simultaneously to price shocks from the world market & from neighborhood markets (pp. 16).



Eckstein and Heien (1978) analyzed the major causes of the food price inflation of 1973. They used log-linear econometric model on data over 1950–1970 across food & feed items to decompose the overall price rise into its proximate causes. They found, in the approximate order of their importance, domestic monetary policy, government acreage restrictions, the Soviet grain deal, world economic conditions, devaluation of the dollar, and price freeze as major determinants of food price inflation

Lamm (1980) offered a supply-shift concept of food price inflation as an explanation of why food prices have increased. This view is consistent with cost-push theories of inflation under oligopolistic market set up. The effects of higher farm product prices on food prices are analyzed using Pascal distributed lag models of the price adjustment process. Estimates are presented for 23 selected food products. The results indicate that higher farm prices are passed through to the retail level most quickly for food products which are not highly processed.

Expectations are gaining an increasing importance in theories of food price inflation. In this regard, Benkovskis (2007) attempted to see the impact of consumer expectation on inflation using consumer survey with a sample of 1,000 respondents in Latvia on a monthly basis for the period 2001–2007. His Vector Autoregressive (VAR) model indicated that inflation has positive and statistically significant reaction to the expectations shock and output gap shocks. There is inertia in inflation expectations. It further compared the inertia before and after accession to European Union and concluded that the contribution of expectations shocks to inflation is rather small (0.4–0.5% points prior to the accession, 0.2–0.3% points at the end of 2006/after accession). For Moser (1995), however, rainfall had a significant effect on the rate of food price increases, in addition to money growth and exchange rate changes in Nigeria.

Xuehua et al. (2004: 12–3) also found that food prices in China have a long-run equilibrium relationship with monetary variables, such as the money supply and interest rates. Their Granger-causality tests reveal that there exist bi-causality relationship between food price and monetary variables. Specifically, a change in the money supply Granger-causes a change in food prices and a change in food prices Granger-cause a change in interest rates. The opposite direction of this Granger causality relationship does not exist. A possible reason is that interest rates in China are not determined by financial market forces. Impulse response functions demonstrate that the money supply is not neutral in determining China's food prices. Thus, they recommended that the dominant monetary policy instrument which can be used by the Chinese government to control food price fluctuations is the money supply instead of interest rates – monetary policy matters in the determination of food prices in China.

### **2.3.2 The Ethiopian Case**

Inflation is measured using consumer price index (CPI) that measures the average change in the price paid by consumers for a fixed market basket of goods & services. In Ethiopia, CPI is computed based on household expenditure weights of the goods & services in the basket and their current market prices.

The country level CPI aggregates the regional group indices. The contribution of the five relatively big regions (Oromiya, Amhara, SNNP, Addis Ababa and Tigray) in terms of the magnitude of the expenditure account for more than 95%. Hence, the contribution of the remaining regions to the same is only about 5% (CSA, 2008: 12).

This index has two major components, namely food and non-food. The food index, which is the subject of interest in this study, has 13 sub-groups: cereals; pulses; bread & other prepared food; meat; milk, cheese & eggs; vegetables & fruits; spices, oil & fats; potatoes, other tubers & stems; coffee (whole) beans & tea leaves; other food items; milling charges; and food taken away from home (Ibid).

Studies on the causes of food price inflation in Ethiopia are scarce. The survey of literature in this study suggests that there are only few attempts done so far in relation to the Ethiopian food markets. To mention, Hoddinott (2003) on the impact of food aid on food production and food price inflation, Hashim (2007) did a structural analysis of price drivers, Xinshen (2007) utilized a multi-market model of food price inflation, Paul (2007) studied food markets and food prices, Mulat et al. (2007 – forthcoming) analyzed food price developments based on surveys in selected markets Alemayehu and Abebe (2008 – forthcoming) on the causes of recent inflation in Ethiopia.

The development of a general equilibrium macroeconometric model by Yohannes (2007) gave a relative focus to the issue of identifying the causes of food price inflation. He dynamically simulated the time path of response of key variables including food and non-food price inflation to changes in some selected policy instruments & exogenous variables using annual time-series data for the 1970/71 up to 2005/06 and found food price statistically significantly explained by real GDP, money supply, nominal effective exchange rate and price indices of major world trading partners. Specifically, he found that

*A 10% increase in money supply increases average food price inflation by 8% in the first year and accelerates slightly to 8.7% in the second year before it starts to decelerate (pp. 18).*

He added that a 5% increase in the price indices of major trading partners increases food prices by 4.5%, which makes it the most important determinant of food prices with elasticity of 0.9 (pp. 28). However, the study does not consider the potential effects of lagged variables though it attempts to see one-period lag effects of few variables. However, the study does not include adequate relevant variables that may explain food market in Ethiopia, such as rainfall and food aid.

As indicated above, Mulat et al. (2007 - forthcoming) conducted the first phase of their wider survey on the determinants of food price inflation with the objective of looking at supply and demand factors as well as other influences that have a direct and indirect bearing on food prices. They focused on identifying key issues and hypotheses using secondary data & a review of the relevant literature, including survey or consultant reports, a Rapid Trader Survey in Addis Ababa, Shashemene, Bahir Dar, Mekelle and Dire Dawa to get traders' view about recent developments through a focus group discussion. Then, they suggested that "the evidence does not suggest that marketing factors are behind the recent food price inflation". Doing a cursory look of the recent trends in public expenditure, credit disbursement, money supply, remittances, productive safety net programs (PSNPs) and export earnings, this study suggests that demand factors could be relevant in explaining the recent rise in price levels in Ethiopia. This, however, is no more than a hypothesis and calls for further & detailed investigation.

Hoddinott (2003) studied the impact of food aid on production and prices in Ethiopia based on simple model isolating the behavior of interest from a household-level panel data in three rounds of the Ethiopian Rural Household Survey (ERHS) collected in 1994, 1995 and 1996. The study focused on food aid flows and several dimensions of

household and inter-household behavior in selected areas of rural Ethiopia, examined whether access to food aid has disincentive effects on income generation and reported:

*Simple descriptive statistics, such as comparison of means or proportions, suggest strong disincentive effects across a variety of behaviors. On average, households not receiving food aid worked five times as many days in these activities than did households that received food aid. Conversely, children in households receiving food aid spent more time in wage work than children in households not receiving food aid.*

This study, however, did not explicitly look into the impact of aid on price of food even though a statistically significant disincentive effect on the side of the beneficiaries may be inferred from the findings.

Even these attempts are not focused to the identification of the *true* causes of food price inflation and/or the direction of causality relations food price inflation may have with potential monetary and/or structural variables. Therefore, little is known on the causes of food price inflation. This study, therefore, tries to fill the gap in knowledge about the Ethiopian food markets in terms of identifying major food price drivers and the direction of causality relations.

## CHAPTER THREE

### DATA SOURCE, MODEL SPECIFICATION AND ESTIMATION TECHNIQUES

This chapter describes the type & source of data used in the study [3.1], specifies the models, discusses estimation techniques and explains the type & importance of diagnostic tests to be conducted [3.2].

#### 3.1 Data Source and Description

The study is interested in the dynamics of food price inflation in Ethiopia. To explore the dynamics, country-level annual series are utilized. The dataset (differ between the models based on data availability) comprise of country-level retail food price index (FDCPI), and other structural & monetary variables including rainfall (RF), world food price (WFDP), real gross national income (GNI), nominal effective exchange rate (NEER), in-kind food aid (FDAID), money supply (M2), dummy for regime shift (DDRGM)<sup>11</sup> and agricultural output gap (GAP)<sup>12</sup> for the period 1965–2006 and 1963–2006 for the two models, respectively. The data comes from various sources and goes through the necessary adjustment for consistency and have its shape to fit the models.<sup>13</sup>

Retail food price indices are obtained from different issues on Household Income, Consumption and Expenditure Survey (HICES) of the Central Statistical Agency (CSA). After the necessary adjustment (rebasing, referencing & linking) is done, an index is calculated for the period under

---

<sup>11</sup> DDRGM is 1 for relatively liberalized food markets (pre-1974 and Post-1991 periods) and 0 otherwise (during 1974–1990). That is, during the *Derg* regime, food markets were highly centralized.

<sup>12</sup> Agricultural output gap is proxied by the ratio of actual agricultural output to the potential. Therefore, the higher is the ratio; the lower is the output gap in the sector, and vice versa.

<sup>13</sup> Average food price indices for different period based on different base period are linked having December 2000 as a common base. Row station-wise monthly data is aggregated to national average. The potential agricultural output is derived from the trend in the sector's GDP approximated by a linear function. These adjustments are important to capture the true picture of country level food price inflation in Ethiopia because CSA started to collect price data for Addis Ababa since 1963 and country-level data since 1995/6 with the base period changed thrice (1995/6, Dec 2000 and Dec 2006). (CSA, October, 2008 Volume 7, No 1:16 – Amharic Version and unstructured interview with Ato Zena, Household Budget and Prices Statistics Head).

study. Macroeconomic data including average world food price, money supply and nominal effective exchange rate are obtained from various publications and unpublished documents of the National Bank of Ethiopia (NBE) and International Financial Statistics (IFS) database of the International Monetary Fund (IMF). Annual real GNI data is taken from the National Accounts Department of the Ministry of Finance & Economic Development (MoFED) and IFS's database. Food aid series is obtained from Disaster Prevention & Preparedness Agency (DPPA) and the Ethiopian Economic Association (EEA/EEPRI) database. Average rainfall series is computed from the raw monthly data of the Ethiopian Meteorological Agency (EMA), which covers all areas over the country in 18 different stations. The reason for using cumulated rainfall in a given season is that rainfall is useful not only for crop production & feed for livestock but also for preparation of the land for cultivation & grazing. That is, rainfall in a production season has direct or indirect potential contributions towards production.

### **3.2 Model Specification and Estimation Techniques**

Economic theory argues price is a cause as well as an effect variable. Food price is not different. This necessitates the motivation to see the true causality relation food price inflation has with what competing theories state as major drivers. It must be noted that whilst prior studies examined the determinants of inflation it may be argued that they do not fully explore the causal relationship between the variables.<sup>14</sup> Besides, most studies focused on general inflation as opposed to food price inflation. This study uses structural vector autoregression (VAR)<sup>15</sup> modelling approach (that fall in the class of *dynamic models* since they introduce lags to approximate the data generating process) to examine the true causes of food price inflation in Ethiopia and scrutinize the direction of causality.

---

<sup>14</sup> See chapter 2, section 2.3.2 for a survey of relevant studies in Ethiopia

<sup>15</sup> VAR models were first developed by Sims (1980), *Macroeconomics and Reality*, Econometrica, vol.48

### 3.2.1 Model Specification

Enders (1995: 294) noted that when one is not confident that a variable is actually exogenous, VAR models better capture the variables symmetrically. Badawi (2007: 1-2) also noted that there is no prior endo-exogenous division of the series in VAR modelling proper.<sup>16</sup> However, they are criticized of lacking economic theory (atheoretical since they use only the observed time-series properties of data to forecast economic variables) (Terry et al., 1999). Moreover, Cooley and Leroy (1985) and Leamer (1983) pointed out that identifying restrictions are required to give economically interpretable meaning to the results of any simultaneous equation model (SEM) including VAR models.

Structural VAR modelling approach, on the other hand, is based on (economic) theory and seeks to identify potentially relevant variables (from competing theories), explores movements that appear to have been causing & highly correlated with the variable of interest (food price inflation) in the past; and this may, then, be useful in forecasting future food price inflation. This approach, therefore, provides a convenient means of testing causality as it relies on the causal & feedback relations amongst variables. Moreover, it provides an important framework for analyzing both short & long-run relationships among different variables through error-correction models (Johansen and Juselius, 1992)<sup>17</sup> and facilitates dynamic simulation of variables, which is gaining importance in normative economics (Lutkepohl and Reimers, 1992).

Hence, this study utilizes an eclectic structural VAR approach with exogenous series (*VAREX/VECM – Model 1*) and without exogenous series (*VAR/VECM – Model 2*) in order to capture food price drivers from contemporary competing theories (monetarists, Keynesian and structuralists). Model 1 treats few series (rainfall, world food price, food aid and dummy for

---

<sup>16</sup> Sims (1980) methodology is referred to by Cooley and LeRoy (1985) as atheoretical macroeconometrics

<sup>17</sup> The recent multivariate methods developed by Johansen (1998), Johansen and Juselius (1992) uses the VAR for testing and estimating the (long-run) co-integrating relationships among non-stationary variables.

regime shift) as exogenous because: rainfall is a natural phenomenon; small economies like Ethiopia are price-takers in the international (food) market,<sup>18</sup> food aid is a political or humanitarian decision and the dummy variable for regime shift is naturally a phenomenon outside our model.

*Model-1* aims at examining the relative significance and causality relations potential food price drivers have (particularly from monetary and structuralist theories). Where as *model-2* seeks to evaluate the [ir] relevance of the *Keynesian inflationary gap* theory in the context of food sub-sector, with the presumption that expenditure on food is increasing – hence, in the face of ever increasing expenditure (on food), whether *output gap* in agricultural sector determines food price inflation.

Before we specify our models the *notations* should be clear: *Z* is matrix of endogenous series, and *X* for exogenous series,  $\beta$  &  $\gamma$  are coefficient matrices and  $\varepsilon$  is a vector of innovations that may be contemporaneously correlated but are expected to be uncorrelated with their own lagged values and with all of the right-hand side variables. The subscript *t* stands for time period of observation, the superscripts (1, 2) for endogenous series imply the relevant model so as to maintain notational consistency between the models, and  $\Delta^i$  for *i*<sup>th</sup> difference of a series. In addition, the variables in UPPER CASE are in levels and *lower case* in logarithms.

Then, **Model 1** examining the relative importance of monetary and structural variables in the Ethiopian food market specifies the data generating process as:

$$Z_t^1 = \beta_0^1 + \beta_1^1 Z_{t-1}^1 + \dots + \beta_{k-1}^1 Z_{t-k}^1 + \gamma_1 X_{t-1} + \dots + \gamma_k X_{t-k} + \varepsilon_t^1; k = \text{lags} \dots \dots \dots [3.1]$$

Where  $Z_t^1$  and  $X_t$  are (*n* × *1*) matrices of endogenous and exogenous series, respectively. Each of

---

<sup>18</sup> This is known to be the small *open economy argument* in standard literature.

the  $\beta_i^1$ 's and  $\gamma_i$ 's ( $n \times n$ ) matrices of parameters, and  $n$  is the number of endogenous (FDCPI, GNI, M2 and REER) & exogenous (RF, DDRGM, WFDP, and FDAID) series each. The error-term  $\varepsilon_i^1$  is an iid  $(0, \delta_1^2)$  (iid = identically and independently distributed with mean 0 and constant variance,  $\delta_1^2$ ).

**Model 2**, which seeks to evaluate the [ir] relevance of the Keynesian inflationary gap model in the context of the Ethiopian food markets, does not have exogenous series – it is a VAR model with food price inflation (FDCPI) and agricultural output gap (GAP) variables. The model specifies the data generating process as:

$$Z_t^2 = \beta_0^2 + \beta_1^2 Z_{t-1}^2 + \dots + \beta_j^2 Z_{t-j}^2 + \varepsilon_t^2; j = \text{lags} \dots \dots \dots [3.2]$$

Where  $Z_t^2$  is ( $h \times 1$ ) matrix of endogenous series and each of the  $\beta_i^2$  ( $h \times h$ ) matrix of parameters; where  $h$  is the number of endogenous series in the model. The error-terms  $\varepsilon_t^2$  are iid  $(0, \delta_2^2)$ .

### 3.2.2 Estimation Techniques <sup>19</sup>

Estimating the models should be accompanied by investigation of the (time-series) properties of the data generating process against a *battery-of-tests*: for [in] existence of unit-root in the variables and autocorrelation, heteroskedasticity, and normality of the error-terms. For the validity of normative analysis in certain variables for relevant impulse/experiments, model stability shall be tested and the direction of causal relations checked via tests of Granger causality.

This section discusses the need to examine the time-series properties of the variables [3.2.2.1], checking cointegrating relations in the variables [3.2.2.2], determine lag-order and importance of diagnostic tests [3.2.2.3], and tests of stability & impulse response analysis and granger causality tests [3.2.2.4].

---

<sup>19</sup> *Eviews 5* is the econometric package utilized for this study.

### 3.2.2.1 Time-series Properties of the Data

Checking the time-series properties of the variables is important since it matters to the validity of our model estimates. For this objective, stationarity tests shall be conducted. If the series contemplated in our models are found to be stationary, we can estimate them using ordinary least squares (OLS) technique. If they are not, which characterizes most economic time-series, OLS may result in *spurious* results. Yet, it is possible to have valid estimates with non-stationary series if they are cointegrated. Therefore, if the series in our models are found to be non-stationary, cointegration test shall be conducted using the *Johansen Procedure*.

#### Unit-root Tests

As stated above, for OLS regression results to be valid on time-series, all the series have to be stationary; that is, whether they will come back to their long-run trend after a certain shock at a point in time. On the contrary, if a series follows a random-walk<sup>20</sup> (non-stationary), OLS regression may result in spurious results and estimates will be inconsistent since the series do not have constant mean and finite variance. Besides, the effect of temporary shocks on a series may have a short-term (long-term) memory based on stationarity (non-stationarity) of the series, which determines policy implication in normative economic analysis (Pindyck and Rubinfeld, 1991: 460–70).

The easiest way that gives initial clue about the likely nature of the series and [in] existence of unit-root is visual inspection of their graph plotted against time. If the graph has a trending nature (an indicator of changing/time-dependent mean) or has varying deviations from the average (an indicator of infinite variance), then we will suspect the series for unit-root; otherwise, the series may be stationary (Gujarati, 2004).

---

<sup>20</sup> A series is a random-walk when its mean and variance are time-dependent and there is no long-run mean to which it converges



On top of this, Econometrics literature is affluent in methods of unit-root tests (hence, order of integration)<sup>21</sup>. Alemayehu et al., (2007) noted that the most widely used in applied research are Augmented Dicky-Fuller (ADF) and Philips-Perron (PP) tests. The older version of the ADF test was initiated by Dicky and Fuller in 1979<sup>22</sup> but with risky assumptions: the series should have neither a drift-term nor time trend, and the error-terms are statistically independent and have a constant variance (Enders, 1995: 239). The reason why these are risky assumptions is that if violated, the test is no more valid (Holden and Herman, 1994: 75). As we shall see soon, however, ADF does not share these problems.

Following Alemayehu et al., (2007: 22–3) and Greene (2003: 637–46), the simplest version of the DF test is illustrated below and later expanded to show the relative merits of ADF test. Consider an AR (1) process like [3.3],

$$z_t = \phi z_{t-1} + u_t \dots\dots\dots [3.3a]$$

$$\text{Or } \Delta z_t = (\phi - 1)z_{t-1} + u_t \dots\dots\dots [3.3b]$$

It, then, tests for  $H_0: \phi = 1 (\equiv (\phi - 1) = 0)$  against  $\phi < 1$ . When  $\phi = 1$ , [3.3] will become

$$z_t - z_{t-1} = \Delta z_t = u_t \dots\dots\dots [3.4]$$

This entails that [3.4] is a random-walk, which is an I (1) series. A unit-root process is said to be integrated of order one [I (1)] if it becomes stationary with first difference. More generally, a series is integrated of order  $d$ , I ( $d$ ) if it becomes stationary by differencing the series  $d$  times. On the other hand, if  $|\phi| < 1$ , then the series is I (0) or stationary.

Rewriting [3.3] with the *lag operator* ( $L$ ) gives

$$(1 - \phi_1 L)z_t = u_t \dots\dots\dots [3.5]$$

Divide the term  $[1 - \phi_1 L]$  by  $\phi_1$  to get  $[(1/\phi_1) - L]$ . The root of this equation, is the value of  $L$ ,

---

<sup>21</sup> Order of integration is the number of times a series has to be differenced to get it stationary  
<sup>22</sup> It was called Dicky Fuller test when first formulated by Dicky and Fuller (1979).

denoted  $L^*$ , which satisfies  $[(1/\phi_1) - L^* = 0]$ . Then, the solution for this condition is  $[L^* = (1/\phi_1)]$ . This value is called the *root* of the equation. If  $\phi_1 = 1$ , then  $L^* = 1$  and the equation has a *unit-root*. In this case, the first difference of  $z_t$  is stationary since substituting for  $\phi_1 = 1$  gives  $z_t - z_{t-1} = u_t$  (that is, stationary). Therefore, an I (1) series has one unit-root; whereas an I (0) series has no unit-root.

The ADF test augments the formulation in [3.3] by adding *generous* lagged levels of the change in a (dependent) variable to produce a better white-noise error-term (Alemayehu et al., 2007: 23).

An extension of this formulation for  $p$  process is given by [3.6].

$$z_t = \phi_1 z_{t-1} + \phi_2 z_{t-2} + \dots + \phi_p z_{t-p} + u_t, \dots \dots \dots [3.6a]$$

$$\text{Or, } \Delta z_t = \phi_1^* z_{t-1} + \phi_2^* \Delta z_{t-1} + \phi_3^* \Delta z_{t-2} + \dots + \phi_p^* \Delta z_{t-p+1} + u_t; u_t \sim \text{iid}(0, \sigma^2) \dots \dots \dots [3.6b]$$

Where  $\phi_1^* = \phi_1 + \phi_2 + \dots + \phi_p - 1$  and  $\phi_i^* = -(\phi_{i+1} + \dots + \phi_p)$ .<sup>23</sup>

It should be noted that  $z_t$  may be tested for stationarity under the null hypothesis of existence of unit-root,  $H_0: \phi^* = 0$  against the alternative of stationarity,  $\phi^* < 0$ . In order to test the null hypothesis, the ADF test statistic is calculated as  $\frac{\phi_1^*}{SE \phi_1^*}$  (This statistic does not mimic the standard t-distribution for non-stationary series even in large samples),<sup>24</sup> which shall be, then, compared against the Dickey-Fuller's  $\tau$  (*tau*) test statistic. We reject the *null hypothesis* if the calculated test statistic exceeds the tabulated at the desired level of significance; otherwise, we cannot reject it.

This test adjusts the DF test to take care of possible serial correlation in the error-terms by adding higher order lagged terms to account for the fact that the underlining data generating

---

<sup>23</sup>  $\phi^* = (\phi - 1)$  and  $\phi_i^* = -\phi_2$  for the case of [3.5] where  $p = 1$ ; that is AR(1)  
<sup>24</sup> D. A. Dickey and W. A. Fuller (1979:427-431). Note also that the *tau* test statistics depends on whether the series has (or not) a drift term, time trend or both.

process may be more complicated than a simple AR(1) process and this *augmentation* will ‘whiten’ the error-term (Alemayehu et al., 2007: 22). This proves ADF test is superior to the DF test.

Nevertheless, care must be taken to test for unit-roots in the presence of structural breaks in the series as the test is biased towards non-rejection of unit-roots if there is (are) structural break(s) in the series. This may be a sound concern for most series in our models as they could possibly have structural breaks. For instance, food price inflation may have a break following the start and end of the centralized system (1974–1991). The agricultural output gap may have such breaks following years of draught, and so on.

Philips-Perron tests account for the possibility of *structural breaks*. The formal procedure of testing for unit-root at time period  $t = \tau + 1$  with the null hypothesis of a one-time jump in the level of a unit-root process against the alternative of a one-time change in the intercept of a trend stationary process is developed by Philips & Perron (1989). Following Enders (1995: 243 – 251), the PP test procedure is given as:

$$H_0 : z_t = \phi_0 + z_{t-1} + \mu_1 D_p + u_t; \dots\dots\dots [3.7a]$$

$$H_1 : z_t = \phi_0 + \phi_2 t + \mu_2 D_L + u_t; \dots\dots\dots [3.7b]$$

$D_p$  is a pulse dummy such that  $D_p = 1$  if  $t = \tau + 1$  and 0 otherwise; and  $D_L$  represents a level/intercept dummy such that  $D_L = 1$  if  $t > \tau$  and 0 otherwise.

This test uses non-parametric statistical methods to take care of the serial correlation in the error-terms. The econometric problem, therefore, is to determine whether an observed series is best modeled by [3.7a] or [3.7b]. This involves: detrending the series by estimating [3.7b] (call the residuals  $\hat{z}_t$ ), estimating the regression of the residuals on their lagged values as in [3.8a]

$$\hat{z}_t = a_1 \hat{z}_{t-1} + v_t, \dots\dots\dots [3.8a]$$

Under the null hypothesis of existence of unit-root, the theoretical value of  $a_1$  is unity. When  $\nu_t$  is an iid, the distribution of  $a_1$  depends on the proportion of observations occurring prior to the break denoted  $\lambda=1/t$  ( $t$ =total number of observations). Now, perform diagnostic tests on  $\nu_t$  for serial correlation because if they are serially correlated, we should use the augmented form of the regression as in [3.8b].

$$\hat{z}_t = a_1 \hat{z}_{t-1} + \sum_{i=1}^k \theta_i \Delta \hat{z}_{t-i} + \nu_t \dots\dots\dots [3.8b]$$

Where  $\hat{z}_t$  is the detrended series.

Then, we calculate the  $t$ -statistic under the null  $a_1 = 1$  and compare to the PP critical values, which is naturally identical to DF statistics when  $\lambda=0$  and  $\lambda=1$ . In effect, there is no structural break unless  $0 < \lambda < 1$ . The maximum difference between the two statistics occurs when  $\lambda=0.5$ ; even this is marginal (Gujarati, 2004: 818). This test is more general in that it can also allow for one-time change in the drift or one-time change in both the mean and drift.

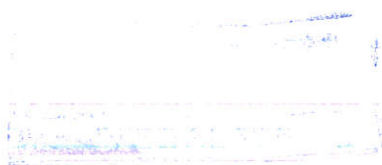
Nevertheless, Gujarati, (2004: 820) and Enders (1995: 251-2) noted that not only all tests for unit-root have less power to distinguish between a unit-root and near unit-root process, but also that there is no uniformly powerful test for unit-root.<sup>25</sup> We, therefore, shall use ADF and PP tests to establish whether or not the series in our models are stationary.

### 3.2.2.2 Cointegration Tests

We cautioned that regressing non-stationary series using OLS may result in spurious outcomes. If the series are found to have unit-root, it is possible to make them stationary by differencing. But, this may ‘throw away’ information concerning the co-movements in the data generating process.

---

<sup>25</sup> Power of a test is the probability of rejecting false null hypothesis; or  $1 -$  probability of type II error (Enders, 1995: 251)



For the reason that if a linear combination of non-stationary series is stationary, 'it may *cancel out* the stochastic trend the series have.' In this case, we say the series are *cointegrated* and the regression may give meaningful relationship among them. Economically speaking, the series are cointegrated if they have a long-term (equilibrium) relationship as most economic theories are often expressed in equilibrium terms (Green, 2003: 856 and Gujarati, 2004: 824). But, if the series are stationary, we can estimate our models by OLS and no cointegration relation is expected.

There are two ways of testing the existence of cointegration between variables of interest and estimating the co-integrating vector, viz The Engel-Granger (EG) Approach and the Johansen Approach. Next, we will go briefly through the EG Approach and then appreciate the Johansen Procedure.

### **Engle-Granger Two Stage Approach**

The variables in our models are cointegrated of order  $d, b$ ; denoted CI ( $d, b$ ) if they are each integrated of order  $d$ , but their linear combination exists that is integrated of order  $b$ , where  $b < d$  (Engel and Granger, 1987). In this case, food price inflation is expected to have equilibrium relationship with the variables pondered.

The *Engle-Granger two-stage approach* begins by testing whether the variables of interest are stationary. If variables contemplated in the models follow an I (1) process, then (in the *first stage*), estimates of the long-run equilibrium equation are made using OLS. Then, an ADF test on the residual of the long-run equation (which is equal to the linear combination of the variables of interest) is conducted to determine if the variables in question are cointegrated – that is, whether the error-term follows a stationary process. Stationarity of the error-term is taken as proof of cointegration.

If the error-term is stationary, (in the *second stage*) we could combine the error-term with the first difference of the variables (short-run indicators) to estimate the final model. This final model which consists of the first difference of the variables and stationary error-term is called an error-correction model (ECM). This model helps to show the deviation from the equilibrium food price position and how an adjustment towards the equilibrium is made by combining both the long-run and short-run versions of the model in one regression (Alemayehu et al., 2007: 30-1; Enders, 1995: 374). The Engle-Granger methodology, though it tests [in] existence of cointegration among time-series, is inferior to the Johansen Procedure due to the following shortcomings.

When we have more than two variables in an equation (model 1, for example), the residual-based technique (EG Two Stage Approach) no longer has a unique vector. It should be understood that with  $k$  variables in the system, there must be at most  $k-1$  possible vectors (Engel and Granger, 1991; Banerjee et al., 1993 in Ibid). Secondly, unless one has a clear theory that specifies the direction & magnitude of the coefficients, the interpretation of the outcome vector in this residual-based method is problematic. Thirdly, one has to make a strong assumption about a unique cointegration vector in the analysis (Alemayehu et al., 2007: 30; Enders, 1995: 375 and 385-6). Fourth, the large sample properties on which this approach is derived may not, unfortunately, be applicable to the sample size for actual practical research. That is, the EG methodology suffers from dependence on the choice of the series for normalization – changing the right and left-hand side variables may affect our conclusion on cointegration relationship between them, especially when we have finite sample. This problem is compounded when we have multivariate series since there may be more than one cointegrating vector, which the EG Approach hardly identifies (Enders, 1995: 385-6). These factors, thus, have led to the popularity of the *Johansen Approach* (Johansen, 1988; Johansen and Juselius, 1992) since it handles multivariate systems in a better way as discussed below.

## The Johansen Procedure

The Johansen Procedure uses the VAR for testing & estimating the long-run relationships among non-stationary series (Hamilton, 1994). It relies heavily on relationships between the rank of a matrix and its characteristic roots.<sup>26</sup> The concept of *rank* and *eigenvalue* or vector is central to the cointegration test using this approach. This is because testing for the existence of a non-zero eigenvalue is tantamount to testing for the rank of a matrix. The latter, in turn, indicates the number of linearly independent rows. This follows from the fact that the rank of a matrix is equal to the number of non-zero eigenvalues. Nonetheless, as we shall establish soon, this procedure is nothing more than a multivariate generalization of the DF test discussed in section 3.2.2 (Enders, 1995: 386). Accordingly, if the variables are cointegrated, the *error-correction* variants of the models in [3.1] and [3.2] shall be represented by [3.9] and [3.10], respectively:<sup>27</sup>

$$\Delta Z_t^1 = \Gamma_1^1 \Delta Z_{t-1}^1 + \dots + \Gamma_{k-1}^1 \Delta Z_{t-k+1}^1 + \Phi_1 X_{t-1} + \dots + \Phi_k X_{t-k} + \Pi^1 Z_{t-k} + e_t^1; \dots \dots \dots [3.9a]$$

More compactly,

$$\Delta Z_t^1 = \sum_{i=1}^{k-1} \Gamma_i^1 \Delta Z_{t-i}^1 + \sum_{i=1}^k \Phi_i X_{t-k+i} + \Pi^1 Z_{t-k} + e_t^1 \dots \dots \dots [3.9b]$$

Where  $\Gamma_i^1 = (I - \beta_1^1 - \dots - \beta_i^1) = [I - (\sum_{i=1}^{k-1} \beta_i^1)]$ ; and  $\Pi^1 = -(I - \beta_1^1 - \dots - \beta_k^1) = -(I - \sum_{i=1}^k \beta_i^1)$  is the *error-correction* term of Model 1

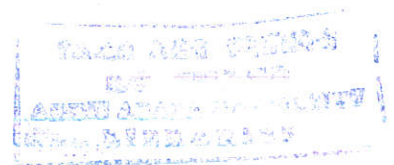
$$\Delta Z_t^2 = \Gamma_1^2 \Delta Z_{t-1}^2 + \dots + \Gamma_{j-1}^2 \Delta Z_{t-j+1}^2 + \Pi^2 Z_{t-j} + e_t^2 \dots \dots \dots [3.10]$$

Where  $\Gamma_i^2 = (I - \beta_1^2 - \dots - \beta_i^2) = [I - (\sum_{i=1}^{j-1} \beta_i^2)]$  and  $\Pi^2 = -(I - \beta_1^2 - \dots - \beta_j^2) = -[I - (\sum_{i=1}^j \beta_i^2)]$  is the *error-correction* term of Model 2.

The VEC specifications in [3.9] and [3.10] contain information on both short-run and long-run adjustments to changes in the series via the estimates of  $\hat{\Gamma}$ ,  $\hat{\Phi}$  and  $\hat{\Pi}$ , respectively. Such models

<sup>26</sup> For essentials of matrix algebra see Alpha C. Chiang, 1984 (3<sup>rd</sup> Edition) or Annex B (Borrowed from Enders, 1995:412-415)

<sup>27</sup> If the constants in [3.1] and [3.2],  $\beta_0$ 's, are restricted such that the rows of  $\Gamma$  can differ only by a scalar, it is possible to write each  $\Delta Z_t$  in terms of  $\Gamma_i Z_{t-i}$



exploit this property of cointegrated series and allow estimating how quickly, when disturbed, the series return to their long-run equilibrium. Besides, if it so happens that the non-stationary series are cointegrated and the error-correction term omitted, the model is going to be misspecified (Kapinos, 2006: 3–4).

The key feature to note in [3.8] and [3.9] above is the rank of  $\Pi$ ; which is equal to the number of independent cointegrating vectors. Clearly, if  $\text{rank}(\Pi) = 0$ , the matrix is null and [3.8] and [3.9] are the usual VAR models in first differences. Instead, if  $\Pi$  is of rank  $n$ , the vector process is stationary. In intermediate cases, if  $\text{rank}(\Pi) = 1$ , there is a single cointegrating vector and the expression  $\Pi^\ell Z_{t-\theta}$ ;  $\ell = 1, 2$ ;  $\theta = j, k$  is the error-correction factor. For the remaining cases in which  $1 < \text{rank}(\Pi) < n$ , there are multiple cointegrating vectors (Enders, 1995: 389–90; Greene, 2003: 655-8 and Alemayehu et al., 2007: 33–5).

The number of distinct cointegrating vectors can be obtained by checking the significance of the characteristic roots of  $\Pi$ . Recall that the rank of a matrix is equal to the number of its characteristic roots that differ from zero. If we obtain  $\Pi$  and order  $n$  characteristic roots such that  $\lambda_1 > \lambda_2 > \dots > \lambda_n$ ,  $\text{rank}(\Pi) = 0$  and all these characteristic roots will equal zero if the variables in  $Z_t$  are not cointegrated.<sup>28</sup> In terms of the formula for test statistic of the number of characteristic roots that are insignificantly different from unity, given by [3.11] and [3.12], each of the expressions  $\ln(1-\lambda_i)$  will be zero since  $\ln(1) = 0$ . Similarly, if  $\text{rank}(\Pi) = 1$ ,  $0 < \lambda_1 < 1$  so that the first expression  $\ln(1-\lambda_1)$  will be negative and all the other  $\lambda_i = 0$  so that  $\ln(1-\lambda_2) = \dots = \ln(1-\lambda_n) = 0$ . Note that, in practice, we obtain only estimates of  $\Pi$  and the characteristic roots,  $\hat{\lambda}$ .

---

<sup>28</sup> In the context of model 1, this refers to the cointegration relationship both endogenous and exogenous series might have.

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i) \dots\dots\dots [3.11]$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \dots\dots\dots [3.12]$$

Where  $\hat{\lambda}$  is the estimated values of the characteristic roots (also called eigenvalues) obtained from the estimated  $\Pi$  matrix; and T is the number of usable observations.

The first statistic,  $\lambda_{trace}(r)$ , tests the *null hypothesis* that the number of distinct cointegrating vectors is less than or equal to  $r$  against a *general alternative*. The further the estimated characteristic roots are from zero, the more negative is  $\ln(1 - \lambda_i)$  and the larger this statistic. On the other hand,  $\lambda_{max}(r, r+1)$  tests the *null hypothesis* that the number of cointegrating vectors is  $r$  against the *alternative* of  $r+1$  cointegrating vectors. Once more, if the estimated value of the characteristic root is close to zero,  $\lambda_{max}$  will be small (Enders, 1995: 391 and Hansen (2007: 114 – 5)).<sup>29</sup> The  $\lambda_{max}$  test has the sharper alternative hypothesis. It is usually preferred for trying to pin down the number of cointegrating vectors especially when the two statistics do not come up with similar results (Enders, 1995: 392-3; Alemayehu et al., 2007: 34 and Greene, 2003: 657). Alternatively, one may choose either of the statistics based on the interpretability of cointegrating relations when they yield conflicting results (Johansen and Juselius, 1990).

Generally speaking, the critical values of these test statistics are smallest with a drift term and largest with an intercept term included in the cointegrating vector. Instead of carelessly positing the forms of  $\beta_0$ , it is possible to test restricted forms of the vector. The Johansen procedure also allows for testing restricted forms of the cointegrating vector(s). The key insight to all such hypothesis tests is that if there are  $r$  cointegrating vectors, only these  $r$  linear combinations of the

---

<sup>29</sup> Johansen and Juselius (1990) provided the critical values for both statistics. Their distribution depends on the number of non-stationary components ( $n-r$ ) and the form of vector  $\beta_0$

variables are stationary. All other linear combinations are non-stationary.<sup>30</sup> In order to test restrictions on the cointegrating vector, Johansen (1991) defines the two matrices of dimension  $n \times r$  (where  $r$  is the rank of  $\Pi$ ) such that  $\Pi = \alpha\pi'$ ;  $\pi$  is matrix of cointegrating parameters and  $\alpha$  the matrix of weights with which each cointegrating vector enters the  $n$  equations of the VAR. In this sense,  $\alpha$  can be viewed as the matrix of the *speed-of-adjustment parameters*.

### 3.2.2.3 Lag-order Selection and Diagnostic Tests

Gaussian error-terms are the basic building blocks for the Johansen cointegration test. Thus, diagnostic tests on the error-terms of our models are indispensable as it determines the [in] validity of the cointegration results. Put differently, it is notorious to the regression results for the error-terms to be autocorrelated, heteroskedastic or skewed. Instead, they are expected to be serially uncorrelated, homoskedastic and normally distributed for the cointegration results to be accepted.

#### Lag-order Selection

We should mention a concern that the results of the Johansen test can be quite sensitive to the lag length included in the models. This is why determination of appropriate variables to include (basically from relevant theories) and the determination of the appropriate lag-order are fundamental in VAR approach. In terms of model 1, for instance, this is stating how important it is to decide which monetary and structural variables to include and how far way behind each variable affects food price inflation.

The appropriate lag-order ( $k$  for model 1 and  $j$  for model 2) of the VAR is determined using standard model selection criteria, such as *sequential modified LR test statistic* (LR test), *final prediction error* (FPE), *Akaike Information Criteria* (AIC), *Schwarz Criteria* (SC) and *Hannan-Quinn information*

---

<sup>30</sup> For details on testing restrictions, see Enders (1995: 393-6)

critera (HQ) test statistics. Allowing data-dependent rules to pick the lag length in our models, information criteria approaches may be used in this study. The two known information criteria AIC and SC are given as [3.13a, and 3.13b]:

$$AIC = \frac{2\ell}{T} + \frac{2k}{T}; \quad \dots \dots \dots [3.13a]$$

Where  $\ell$  is the log likelihood given as  $\ell = -\frac{T}{2}[1 + \log(2\pi) + \log(\frac{\hat{\varepsilon}'\hat{\varepsilon}}{T})]$  and

$$SC = -\frac{2\ell}{T} + \frac{k(\log T)}{T} \dots \dots \dots [3.13b]$$

Schwarz Criteria in [3.13b] imposes greater penalty for additional coefficients

This paper along with using *AIC* and *SC* will employ a likelihood ratio (LR) test which tests the appropriateness of one lag-order over another. But, when the selection criteria indicate different lag-orders to incorporate, it shall be selected based on the general considerations of signs of autocorrelation in the case of shorter lags and over-parameterization of the model which erodes degrees of freedom (hence, multicollinearity between the different lagged variables and poor out of sample forecasts although the within sample fit may be good) in the case of longer lags. This is why one should optimize on the trade-off between possibility of autocorrelation and over-parameterization to arrive at a parsimonious lag (Gujarati, 2004; Alemayehu et al., 2007; and Hamilton, 1994).

**Test of Autocorrelation**

Often, serial correlation in the errors of a dynamic model simply indicates that the model has not been completely specified (Wooldridge, 2003: 379). The most widely used tests are *Lagrange Multiplier* (LM) test and *Durbin & Watson* (DW) test. The *DW* statistic is given by

$$DW = \frac{\sum_{t=2}^T (\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^T \hat{u}_t^2} \approx 2(1 - \hat{\rho}) \dots \dots \dots [3.14]$$

in regression of the error-term as in [3.15] below:

---

<sup>31</sup> The lowest AIC is the most preferred

$$u_t = \theta_1 u_{t-1} + \dots + \theta_i u_{t-i} + e_t; t = 2, \dots, T; i = 1, \dots, q \dots \dots \dots [3.15]$$

under the null  $H_0: \theta_1, \dots, \theta_q = 0$  with the classical assumptions, including *normality* and *homoskedasticity* of error-terms. Though, this distribution depends on the values and number of the right-hand-side variables, the sample size, and whether the regression contains an intercept, it is conceptually the same as the *t*-test.<sup>32</sup>

A better test for [3.14] is the Lagrange multiplier form of the *F*-test given by

$$LM = (T - q) R_u^2 \sim \chi^2 \dots \dots \dots [3.16]$$

with *q* degrees of freedom;  $R_u^2$  is obtained from the regression of the error-term in period *t* on lagged values of the errors and current and lagged values of other series.<sup>33</sup>

**Test of Heteroskedasticity**

Regression estimates are no longer best linear unbiased estimators (BLUE) in the existence of heteroskedastic error-terms. *White test* helps to check the homoskedasticity [or heteroskedasticity] of the error-terms. It involves regressing the *squared* OLS residuals on the fitted and squared fitted values as in [3.17]. Then, an *F*-test is asymptotically valid. This test is the *LM* statistic for testing all  $\vartheta_i$  (*i* = 1, ..., *q*) are zero in [3.17].

$$\hat{u}_t^2 = \vartheta_0 + \vartheta_i Z_{it} + \vartheta_{i+i} Z_{it}^2 + \vartheta_{2i+i} Z_{it} Z_{jt}; i, j = 1, \dots, q \dots \dots \dots [3.17]$$

This is regression of the error-term on each series, its square and covariance among them.

**Tests of Normality**

The normality of the error-terms is tested using *Jarque-Bera test* and measures of *skewness & kurtosis* (Graphical inspection may also give insight on the distribution of the error-terms). Jarque-Bera

---

<sup>32</sup> As a rule of thumb if the calculated DW is less than 2, there is evidence of positive serial correlation  
<sup>33</sup> As usual, if the calculated *LM* statistic exceeds the tabulated, the null hypothesis of no autocorrelation is rejected and vice versa.

(JB) test is an asymptotic (large sample) test based on residual regression on kurtosis and skewness of the distribution and is given by

$$JB = T \left[ \frac{S^2}{6} + \frac{(K - 3)^2}{24} \right] \sim \chi^2 \dots\dots\dots [3.18]$$

Where  $T$  = the number of observations,  $K$  = measure of kurtosis and  $S$  = skewness coefficient, respectively (for normally distributed variables  $S = 0$  and  $K = 3$ ).

Under the null hypothesis of normal distribution of the errors, this test is a joint test of  $S = 0$  and  $K = 3$ . Hence, the test statistic works such that it presumes normal distribution and asks the data to sufficiently prove it is not! The calculated statistic is significantly different from zero only when the distribution is not normal (Wooldridge, 2003; Gujarati, 2003: 148).

### 3.2.2.4 Test of Stability, Impulse Response Analysis and Granger Causality

Finally, the study is interested in the direction of causal relations the variables might have and the response of effect variables to changes in cause variables. The impact of other variables on food price inflation is of particular interest to this study. Therefore, tests of causality and impulse response analyses shall be conducted.

#### Granger Causality and Exogeneity Tests

A test of causality involves whether or not the lags of one series enter in to the equation for another. Correlation does not necessarily imply causation in any meaningful sense of that word. The econometric graveyard is full of magnificent correlations, which are simply spurious or meaningless. The Granger (1969) approach to the question of whether the monetary and structural variables contemplated in the models cause food price inflation is to see how much of the current food price inflation can be explained by its past values and then to see whether adding lagged values of those variables of interest (like money supply, nominal effective exchange rate, gross national income, etc) can improve the explanation. Accordingly, food price inflation is

said to be Granger-caused by these variables if they individually help in the prediction of food price inflation. Equivalently, if the coefficients on the lagged variables of interest are statistically significant, then they are Granger causing food price inflation. It is important to note that two-way causation is common especially with economic behaviors like [food] price. However, it is important to note that the statement “ $x$  Granger causes  $y$ ” does not imply that  $y$  is the effect/result of  $x$ .

In terms of our VECM models ([3.9] and [3.10]), the absence of Granger causality requires both the coefficient on the error-correction term  $\Pi$  and the coefficients on the individual explanatory variables  $\Gamma$ 's &  $\Phi$ 's (for endogenous and exogenous series, respectively) to be insignificant (Enders, 1995: 315). Watson (2000: 2848–9) cautioned that Granger causality test statistic often have non-standard asymptotic distribution so that conducting inference using critical values from  $\chi^2$  table is incorrect. This is because estimated coefficients in VAR models with integrated components can behave differently than estimators in covariance stationary VAR models. That is, when  $(Z_{1t}, Z_{2t})$  are covariance stationary, the resulting Wald, LR or LM test statistics for the null hypothesis of Granger non-causality will have a large sample  $\chi_j^2$  distribution and when they are integrated, the distribution of the test statistic depends on the location of unit-roots in the system. In our case, if the series are found to be cointegrated, we can safely refer to the  $\chi_j^2$  table to make inference on causality among variables of interest.

Enders (1995: 315–6) noted that Granger causality is a weaker condition than the condition for *exogeneity*. Exogeneity would imply that values of, say, nominal effective exchange rate that are additionally present in the model would also not affect food price inflation. A necessary condition for the exogeneity of the former is for current and past values of the latter not to affect the former. The *Hausman test* can be utilized to answer the question of exogeneity. In terms of



our VECM (model 1, for example), suppose the endogenous series  $Z_1, Z_2, Z_3,$  &  $Z_4$  and exogenous series  $X_1, X_2, X_3$  &  $X_4$ . Further suppose that the first equation of the model is

$$Z_{1t} = b_0 + b_2 Z_{2t} + b_3 Z_{3t} + b_4 Z_{4t} + a_1 X_{1t} + \dots + e_{1t} \dots \dots \dots [3.19]$$

If  $Z_2, Z_3$  and  $Z_4$  are truly endogenous, we cannot estimate [3.19] by OLS. But how do we find that out? First, we obtain the reduced-form equations for  $Z_2, Z_3$  and  $Z_4$  (Note: the reduced-form equations will have only predetermined variables on the right-hand side). From these reduced-form equations, we obtain  $\hat{Z}_{2t}, \hat{Z}_{3t}$  and  $\hat{Z}_{4t}$  (predicted values of  $Z_{2t}, Z_{3t}$  and  $Z_{4t}$ , respectively). Then, in the spirit of the *Hausman test*, we can estimate [3.20] by OLS:

$$Z_{1t} = b_0 + b_2 Z_{2t} + b_3 Z_{3t} + b_4 Z_{4t} + a_1 X_{1t} + \dots + \lambda_2 \hat{Z}_{2t} + \lambda_3 \hat{Z}_{3t} + \lambda_4 \hat{Z}_{4t} + e_{1t} \dots \dots \dots [3.20]$$

Using the *F*-test, we test the hypothesis that  $\lambda_2 = \lambda_3 = \lambda_4 = 0$ . If this hypothesis is rejected,  $Z_2, Z_3$  and  $Z_4$  can be deemed endogenous; if it is not rejected, they can be treated as exogenous (Gujarati, 2003: 756–7).

Finally, a *block exogeneity* test is useful for detecting whether to incorporate a variable in to a VAR model. It is a multivariate generalization of the *Granger causality* test which determines whether lags of one variable say, money supply, Granger cause any one of the variables in the system. In our four (two) endogenous variables system for model 1 (model 2), the test is whether lags of one variable Granger cause any of the remaining variables. In essence, block exogeneity restricts all lags of a variable (say  $Z_{1t}$ ) in the equations for the other variables ( $Z_{2t}, Z_{3t}$  and  $Z_{4t}$ ) to be equal to zero. This cross-equation restriction is properly tested using the likelihood ratio test given by [3.21]:

$$(T - c)(\log|\Sigma_r| - \log|\Sigma_u|) \sim \chi^2 \dots \dots \dots [3.21]$$

with degrees of freedom equal to  $3k$  since  $k$  lagged values of  $Z_{1t}$  are excluded from each equation;

Where  $|\Sigma|$  is the determinant of the variance/covariance matrix of the residuals,  $c = nk + 1$ ;  $n$  = number of variables.

What we do is, we estimate the equations for the other variables,  $Z_{2t}$ ,  $Z_{3t}$  and  $Z_{4t}$  using  $k$  lagged values of all the series,  $Z_{it}$  and calculate  $|\Sigma_u|$ . Then, we re-estimate the three equations for the other variables excluding the lagged values of food price inflation,  $Z_{1t}$  and calculate  $|\Sigma_r|$ . Then, we find the LR statistic using [3.20]. Here,  $c = 4k + 1$  since the three unrestricted equations contain  $k$  lags of all the variables plus a constant.

### **Impulse Response Analysis**

The coefficients in our error-correction models indicate the direct ceteris paribus impact of one variable (say, money supply) on the other (as a matter of interest, food price inflation), ruling out the possible interrelations and hence indirect effects among them. If this happens to be so, impulse response analyses help capture both the direct and indirect impacts of change in relevant monetary and structural variables particularly on food price inflation because impulse response functions represent the time profile of the effect of a shock to one variable on the future values of all endogenous variables. This is particularly indispensable in normative Economics. It also provides an important framework to facilitate dynamic simulation of variables (Lutkepohl and Reimers, 1992).

But, for this inference analysis to be compelling, the VAR models in [3.1] and [3.2] must be stable. To this end, the stability of the VAR should be tested looking at the *roots of characteristic polynomial* and by checking whether all the roots are lying within a unit circle. For a VAR to be stable and have orthogonal error-terms it must have a modulus of less than one for all of its roots of polynomials. This, in turn, ensures all roots to lie within a unit circle and hence inferences

drawn from the impulse response analysis would generally be valid (Lutkepohl and Reimers, 1992; Enders, 1995: 305).

If our model(s) are stable, we can make experiments on the direct and indirect impacts of policy related relevant variables in our models, like money supply, exchange rate, rainfall, etc on food price inflation and the potential policy implications for the sake of normative analysis.

## CHAPTER FOUR

### ESTIMATION OF RESULTS AND DISCUSSION

In this chapter we will briefly see the recent trends in food price inflation, which is the source of motivation for this study [4.1], estimate the econometric models specified in the last chapter and discuss the results [4.2].

#### 4.1 Recent Trends in Food Price Inflation

The world economy suffers from many problems but none more critical than what is happening to food prices in view of the fact that even small price rises can hit hard, especially the poor.<sup>34</sup> The recent experience in Ethiopia is not different. This, mainly, is why identifying sources of food price inflation is indispensable and hence interesting area of research. This section, therefore, evaluates the recent trends in food price inflation at a global as well as national level.

##### 4.1.1 Trends in Global Food Price Inflation

Sharp food price hikes have again, after three decades (after the 1973 food price inflation), become the major global concerns particularly in the recent past.<sup>35</sup> In the year 2006, world food price index revealed an annual average rise of 9%. A year after, the figure increased to 23% and even 37% if December 2007 is compared with the same month of the preceding year (FAO, 2008). Average food prices more than doubled by early 2008 compared to 2000. Over the last 12 months (June 2007 – June 2008) the average food price inflated by 56%, with wheat rising by 92% and rice, the staple of

---

<sup>34</sup> In 2006, with a population of about 80 million, 81% of the Ethiopian populations live below the poverty line of USD 2 a day and 44% below the national poverty line (WB, 2007). Globally, close to 3 billion people currently earn less than USD 2.00 a day, of which USD 1.00 is spent on food (World Resource Institute, 2008).

<sup>35</sup> Global food price inflation is viewed to be a new source of famine and global food crisis.

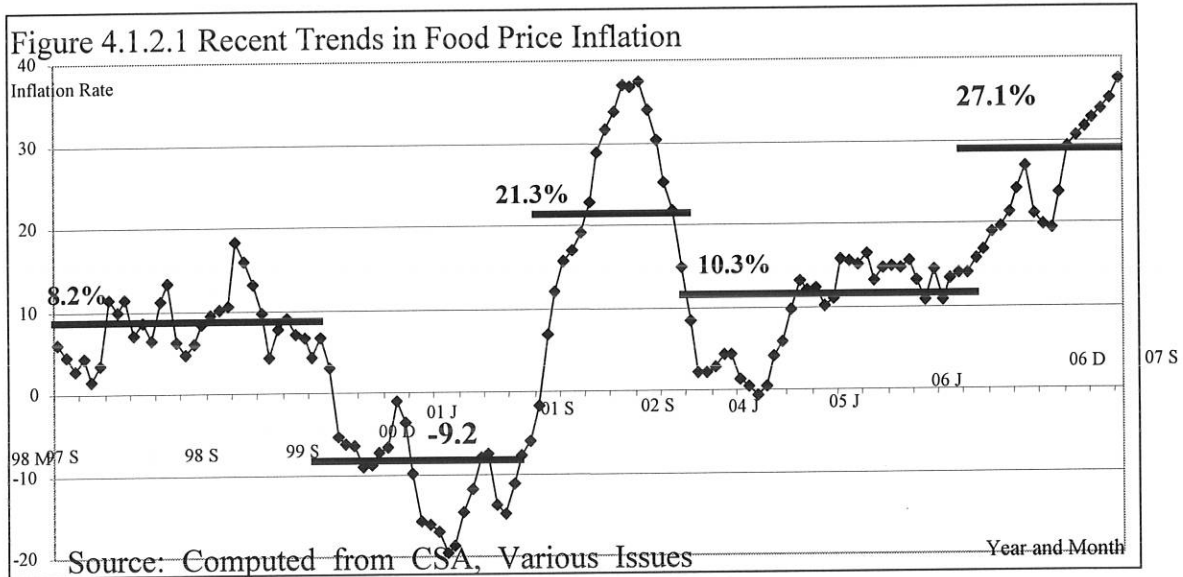
half the world, by 96% (www.bbc.com/africa retrieved on June 22, 2008). While high price events are not unusual in most agricultural markets what is unusual in the current situation is that the price spike applies to almost all major food and feed commodities, rather than just a few of them (FAO, 2008).

It has been argued, recent food price inflation may be attributed to short-term agricultural production shortfalls. On the other hand, many scholars disagree on the ground that many of the current food price drivers have lasting effects and hence the future is gloomy. Some of these drivers, according to Joachim (2007), are dramatic increase in demand for cereals (80% between 2000 and 2006) following income growth in developing countries, the lion's share of this growth goes to food purchase; sluggish increase in aggregate agricultural supply; increased demand for bio-fuel due to shocks in global oil prices; agricultural subsidy in developed countries; speculation in agricultural output markets; and the likes. The scope of this study, however, is the case in Ethiopia.

#### **4.1.2 Recent Experience of Food Price Inflation in Ethiopia**

It has become apparent recently that the increasing inflation rate in Ethiopia is largely the result of increase in food price inflation as food not only takes the lion's share of the CPI but also its price increase faster than non-food items. This entails policies targeting food security and food prices do affect inflation targeting in the country. Policy-makers target on inflation because relative price fluctuations are unavoidable parts of any economy. This becomes frustrating when many people are so poor that a (small) rise in food prices becomes the question of survival, like the present condition of the urban poor and rural net buyers in Ethiopia.

The recent experience in domestic food markets is irritating because food prices blow up as high as 39% in real terms, based on December 2000 prices. Worse is, the price hike is higher & consistent for cereals (generally regarded as staple), especially teff, wheat, maize and barley with their share in the cereals market given by 30%, 22%, 27% and 12%, respectively. Cereal prices have inflated higher in the recent few years than what was experienced in a decade during 1996-2005 (28.5%).



Roughly, the average inflation during the Imperial and the Derg regimes was less than what the economy experiences in the current regime (CSA, Various Issues). The above figure suffices in indicating how quickly recent food price is rising (27.1%) as compared to that during Nov 1997 – Mar 2000 (8.2%), Apr 2000 – Mar 2002 (-9.2%), and Dec 2003 – Dec 2006 (10.3%), on average. This rate is recently sustainably increasing despite efforts and policy measures by the government. Why?

Policies aimed at food prices are closely related to food security as undesired food price inflation compromises the (food security) efforts of the government. One of the components of Ethiopia's food security policy is economic growth where the focus is on agricultural income growth (Broeck

and Dercon, 2001: 4). Does this help in alleviating the long-term problem in the food market? Answering this partly requires identifying the determinants of food price inflation in the country.

## 4.2 Model Estimation and Discussion

This section estimates two separate econometric models to identify the true causes and lay a ground to suggest possible solutions for the problem of food price inflation in Ethiopia. The models aim at testing the [ir] relevance of competing theories of food price inflation particularly in developing countries. The first model incorporates monetary and structural variables and the second examines whether or not agricultural output gap matters to food price inflation.

The rationale for using two separate models is that merging the agricultural output gap in the first model may cause a 'series' problem of multicollinearity since the Ethiopian economy is predominantly agrarian.<sup>36</sup> Besides, estimating two independent models saves degrees of freedom, which otherwise could have made a combined model easily over-parameterized.

The study utilizes a multivariate cointegration and vector error-correction modelling approach (VECM). In this approach, what we are going to do, in a nutshell, is testing the time-series properties of the variables contemplated in the models, determining the lag-order of vector autoregression using different criteria, checking for the [in] existence of cointegrating relationships & number of cointegrating vectors using the Johansen procedure, assessing the long-run coefficients & the adjustment coefficients diagnosing the residuals for the validity of estimation results and checking for model stability for innovations analysis.

---

<sup>36</sup> A separate exercise revealed a 0.6 of correlation coefficient between rainfall and agricultural output gap index

Logarithmic transformations of the series are used to exploit its advantage of correcting skewed distribution and tackling possible heteroskedasticity (Alemayehu et al, 2007). Only rainfall variable is used in levels for its transformation is found to be *near* stationary and hence disturbs the cointegration relation *model 1* is scrutinizing. Accordingly, the coefficients of the transformed series will have the interpretation of *elasticity*.

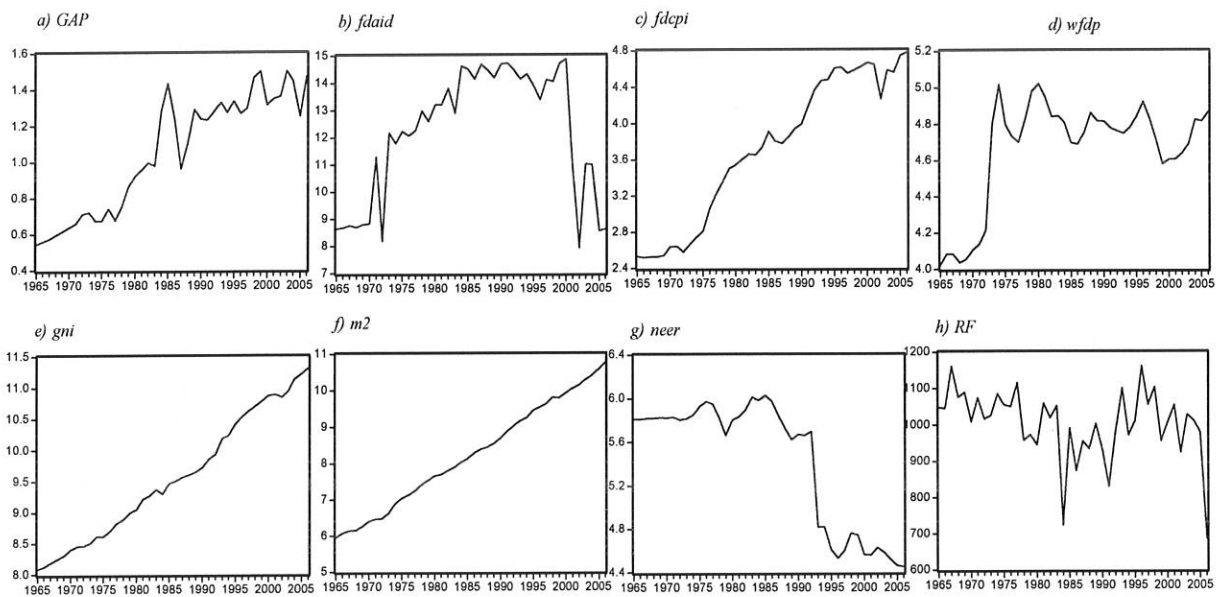
#### 4.2.1 Time-series Properties of Variables

Here, the time-series properties of each variable are examined. Visual inspection of the graphs of the variables and formal tests of stationarity of the variables are conducted.

##### Stationarity Tests <sup>37</sup>

Graphical inspections and formal tests revealed consistent results. The graphical inspection of all the variables in both models is given in figure 4.2.1.1.1 below.

Figure 4.2.1.1.1 Unit Root Test: Graphical Inspection



<sup>37</sup> If the variables contemplated in our models are stationary, we shall estimate the models using OLS. If not, we shall expect the variables to have possible cointegrating relation.

A glance at the figures may deduce ‘none of the series mimic a stationary nature’ because it has a trending nature, hence a time-dependent mean (*fdlpi*, *GAP*, *gni*, *m2*, *neer*, and *wfdp*), or it has uneven deviations from its average, indicator of infinite variance (*fdaid*, and *RF*), or both. Therefore, visual inspections suspect all the series for unit-root. However, this does not say on the order of integration of the series that is tested formally soon.

Table 4.2.1.1.1 Unit-root Tests: Augmented Dicky-Fuller and Philips Perron Tests

Variable	P-value	Test Statistics	Critical Value	Inference
<b>Augmented Dicky-Fuller Test</b>				
<i>fdlpi</i> (Logarithm of Food Price Index)	0.7196	-1.73004	-3.52362	<i>I(1)</i>
<i>m2</i> (Logarithm of Money Supply)	0.1533	-2.96803	-3.52362	<i>I(1)</i>
<i>Gni</i> (Logarithm of Gross National Income)	0.4596	-2.23287	-3.52362	<i>I(1)</i>
<i>neer</i> (Logarithm of Nominal Effective Exchange Rate)	0.1592	-1.35763	-1.9491	<i>I(1)</i>
RF (Rainfall)	0.3845	-0.7515	-1.94932	<i>I(1)</i>
DDRGM (Dummy for Regime Shift)	0.1159	-1.53393	-1.9491	<i>I(1)</i>
<i>fdaid</i> (Logarithm of Food Aid)	0.5571	-0.33844	-1.9491	<i>I(1)</i>
<i>wfdp</i> (Logarithm of World Food Price)	0.3069	-2.54351	-3.52661	<i>I(1)</i>
<i>GAP</i> (Agricultural Output Gap Index)	0.8195	-0.76054	-2.935	<i>I(1)</i>
<b>Philips-Perron Test</b>				
<i>fdlpi</i> (Logarithm of Food Price Index)	0.6294	-1.9136	-3.52362	<i>I(1)</i>
<i>m2</i> (Logarithm of Money Supply)	0.1555	-2.95992	-3.52362	<i>I(1)</i>
<i>Gni</i> (Logarithm of Gross National Income)	0.4596	-2.23287	-3.52362	<i>I(1)</i>
<i>neer</i> (Logarithm of Nominal Effective Exchange Rate)	0.1587	-1.35978	-1.9491	<i>I(1)</i>
RF (Rainfall)	0.2536	-1.06745	-1.9491	<i>I(1)</i>
DDRGM (Dummy for Regime Shift)	0.1142	-1.54211	-1.9491	<i>I(1)</i>
<i>fdaid</i> (Logarithm of Food Aid)	0.5939	-0.23918	-1.9491	<i>I(1)</i>
<i>wfdp</i> (Logarithm of World Food Price)	0.6726	-1.82836	-3.52362	<i>I(1)</i>
<i>GAP</i> (Agricultural Output Gap Index)	0.8246	-0.74367	-2.9314	<i>I(1)</i>
The critical values are based on the 95% confidence interval				

The [in] existence of unit-root and order of integration of the variables are formally checked by ADF and PP tests using general-to-specific modelling approach. As summarized in table 4.2.1.1.1, all the series are found to be integrated of order one (I (1)) at the 5% level since the (absolute value of) calculated test statistics are less than that of the critical values (and hence high p-values) indicate failure to reject the null hypotheses of non-stationarity; but, the same hypotheses are rejected when the variables are first differenced (not reported). These indicate that the series are integrated of order 1, and hence the possibility for cointegration. But, ordinary least squares (OLS) regression with these variables is invalid for its results are *spurious* and mis-specifies the models. Therefore, section 4.2.2 explores the cointegration relations the series might have using the Johansen procedure in order to maintain the validity of the models estimates.

#### 4.2.2 Tests of Cointegration: The Johansen Procedure

In order to see whether the series are cointegrated and determine the number of cointegrating vectors, we shall first determine the lag-order, and check the importance of each lag in both models.

##### 4.2.2.1 Lag-Order Selection Criteria

The models are first estimated using VAR modelling approach at the maximum lag-order possible in order to determine the appropriate lag length. The table below summarizes the lag-order selection criteria and the lag length selected by the respective criterion as indicated by an asterisk (\*). The lag-order selection criteria choose the lag that minimizes the value of each statistic reported in the table. In the first model, all the criteria point to the appropriateness of one lag; but two different lag-orders [1 and 3] in model 2. Therefore, choice is made based on general consideration of possible signs of autocorrelation in case of shorter lags and easily over-parameterization of the model that erodes degrees of freedom in the case of longer lags.



Table 4.2.2.1.1 Vector Autoregression Lag-order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
<b>Model 1</b>						
Endogenous variables: <i>fdcpi</i> , <i>gni</i> , <i>m2</i> and <i>neer</i> ; Exogenous variables: <i>DDRGM</i> , <i>flaid</i> , <i>RF</i> , and <i>wfdp</i>						
Sample: 1965 2006; Included observations: 37						
0	47.689570000	NA	0.000002650	-1.496734000	-0.625967000	-1.189748000
<b>1</b>	196.891900000	<b>225.819800*</b>	<b>0.0000000204*</b>	<b>-8.69686000*</b>	<b>-7.12948100*</b>	<b>-8.14428600*</b>
2	207.172500000	13.337010000	0.000000003	-8.387704000	-6.123712000	-7.589541000
3	225.482200000	19.794250000	0.000000003	-8.512552000	-5.551946000	-7.468800000
4	239.230000000	11.889990000	0.000000005	-8.390812000	-4.733592000	-7.101470000
5	253.900800000	9.516190000	0.000000009	-8.318962000	-3.965130000	-6.784033000
<b>Model 2</b>						
Endogenous variables: <i>fdcpi</i> and <i>GAP</i> ; Exogenous variable: C						
Sample: 1963 2006; Included observations: 39						
0	-14.053380	NA	0.008164	0.867750	0.954827	0.898449
<b>1</b>	60.515300	137.045100	0.000180	-2.946773	<b>-2.685543*</b>	<b>-2.854677*</b>
2	63.636610	5.399028	0.000189	-2.899276	-2.463893	-2.745783
<b>3</b>	69.702430	<b>9.836464*</b>	<b>0.000170*</b>	<b>-3.010942*</b>	-2.401406	-2.796052
4	73.594670	5.890958	0.000173	-3.005117	-2.221428	-2.728830
5	76.885580	4.625056	0.000183	-2.966788	-2.008945	-2.629103
6	79.188520	2.987598	0.000206	-2.875055	-1.743059	-2.475973
7	83.869550	5.566629	0.000206	-2.911867	-1.605718	-2.451388
* indicates lag-order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						
NA=Not Available						

Adoption of general-to-specific approach, by starting from the general (theory) possible and letting *the data speak* via the [in] significance of each lag jointly and separately, the selection criteria point to lag-orders of 1 and 3 as adequate representation of the data in the two models, respectively. This is stating current food price inflation may be caused by last period changes in monetary and structural

variables (like money supply, gross national income and nominal effective exchange rate) but degree of agricultural output utilization may have relatively persistent impact up to three periods. But, is it *really* important to include each lag indicated by the criteria in explaining food price inflation in Ethiopia?

#### 4.2.2.2 Lag-exclusion Test

Lag-exclusion test answers the above question by evaluating the significance of all endogenous variables at each lag separately and jointly. It is evident from the results in table 4.2.2.2.1 that each lag has a significant contribution to explain current food price inflation and hence legitimate to include them in the models because the joint  $\chi^2$  test statistics, with probability value in brackets [...], reported for the first model (14685.44 [0.000] for one lag) and the second model (51.27164 [0.000000000196], 18.30223 [0.001077] and 13.0942 [0.010825] for three lags, respectively) show the individual & joint significance of each lag in our models. Alternatively, the low probability values indicate the null hypothesis that “the lags included in each model can be individually and jointly excluded from the model” is rejected. In less grandiose terms, it is found to be appropriate to include one lag for the first and three lags for the second model.

Table 4.2.2.2.1 Lag-exclusion Test (chi-squared test statistics, p-values in parenthesis)

Lag	Model 1					Model 2		
	<i>fdcpi</i>	<i>m2</i>	<i>gni</i>	<i>neer</i>	<b><i>Joint</i></b>	<i>fdcpi</i>	<i>GAP</i>	<b><i>Joint</i></b>
1	997.2083 [0.00000]	10903.55 [0.00000]	6096.143 [0.00000]	173.217 [0.00000]	<b>14685.44</b> <b>[0.00000]</b>	23.176540000 [0.00000927]	25.68461 [0.00000265]	<b>51.27164</b> <b>[0.000000000196]</b>
2	Not included in the model					2.028867000 [0.362608]	14.805360000 [0.00061]	<b>18.302230000</b> <b>[0.001077]</b>
3	Not included in the model					1.848164 [0.396896]	9.767467 [0.007569]	<b>13.0942</b> <b>[0.010825]</b>
D.f.	4	4	4	4	<b>16</b>	2	2	4

### 4.2.2.3 Johansen Cointegration Test

Even at the cost of repetition, it should be noted that ignoring the possible cointegration relation the series might have and hence the error-correction element results in misspecification of the models. The study, thus, tested this using the Johansen procedure and the values for both the maximum eigenvalue test ( $\lambda_{max}$ ) & the trace test ( $\lambda_{trace}$ ) are used to determine the number of cointegrating vectors in the models as summarized in table 4.2.2.3.1. As discussed in the last chapter, these tests start with the null of at most  $r$  distinct cointegrating vectors against the alternative of  $r+1$  and at most  $r$  cointegrating vectors against a general alternative, respectively.

Table 4.2.2.3.1 Unrestricted Cointegration Rank Test (Johansen Procedure)

Trace Test					
Model	Hypothesized Number of Cointegrating Equations	Eigenvalue	Trace Statistic	0.05 Critical Values	Probability (P-Value)**
1	None *	0.595056	73.4677	63.8761	0.0063
	At most 1	0.415631	37.30748	42.91525	0.1625
	At most 2	0.222901	15.81856	25.87211	0.5072
	At most 3	0.133486	5.731069	12.51798	0.4952
2	None *	0.294863	15.83803	12.3209	0.0124
	At most 1	0.04552	1.86353	4.129906	0.2027
Maximum Eigenvalue Test					
Model	Hypothesized Number of Cointegrating Equations	Eigenvalue	Maximum Eigen Statistic	0.05 Critical Value	Probability (P-Value)**
1	None *	0.595056	36.16022	32.11832	0.0151
	At most 1	0.415631	21.48892	25.82321	0.1687
	At most 2	0.222901	10.08749	19.38704	0.6095
	At most 3	0.133486	5.731069	12.51798	0.4952
2	None *	0.294863	13.9745	11.2248	0.016
	At most 1	0.04552	1.86353	4.129906	0.2027
* Denotes rejection of the null hypothesis at the 0.05 level					
**MacKinnon-Haug-Michelis (1999) p-values					
Trace Test and Maximum Eigenvalue Test indicate 1 cointegrating equation for each model at the 0.05 level					

As it is apparent from columns three & four of the lower block of the table, the maximum eigenvalue test rejects the null hypothesis of no cointegrating vector ( $r = 0$ ) against the alternative of ( $r = 1$ ) at 5% level of significance for both models since the test statistics for each model (36.16022 and 13.9745) are greater than the respective critical values (32.11832 and 11.2248). On the other hand, the null of at most one cointegrating equation ( $r \leq 1$ ) against the alternative of 2 cointegrating equations ( $r=2$ ) cannot be rejected because the test statistics (21.48892 and 1.86353) are less than the 5% level critical values (25.82321 & 4.129906) for model 1 and 2, respectively. And, the same is true for successive tests (of model 1 in particular). This culminates in implying a unique cointegrating vector for each model.

By the same token, the upper block of the same table reports the results of the trace test for number of cointegrating relations. This block ensures that there is a unique cointegrating vector for each model as the test statistic rejects the null hypothesis of no cointegrating vector (since calculated trace statistics (73.4677 and 15.83803) are greater than the 5% level critical values (63.8761 and 12.3209) for the two models, respectively). Successive rows in the same block, nevertheless, indicate that we fail to reject the respective null hypotheses. Hence, these ensure the existence of only one cointegrating vector for each model.

Having seen that both models have cointegration relation among the (endogenous) variables, ignoring the error-correction element in estimation would result in misspecification problems. Hence, the next section presents the vector error-correction estimates that take in to account the cointegration relations.

### 4.2.3 Vector Error-Correction Approach

From the model estimates (in table 4.2.3.2.1 on page 71), the equations containing the unrestricted *beta* coefficients ( $\beta$ ) and speed of adjustment coefficients (*alpha*,  $\alpha$ ) are given by [4.1] and [4.2]:

$$7.0254 \text{ fdcpi} + 1.816983 \text{ gni} - 23.06772 \text{ m2} - 3.713177 \text{ neer} + 2.03418 = 0 \dots\dots\dots [4.1a]$$

$$1.880474 \text{ fdcpi} - 5.453442 \text{ GAP} = 0 \dots\dots\dots [4.2a]$$

After ad-hoc normalization<sup>38</sup> on the logarithm of the food price index variable, with standard-errors in parentheses, the models would appear as in [4.1b] and [4.2b]:

$$\text{fdcpi} + \underset{(0.54)}{0.25863} \text{ gni} - \underset{(-0.46765)}{3.283468} \text{ m2} - \underset{(-0.19358)}{0.528535} \text{ neer} + \underset{(0.06037)}{0.289546} = 0 \dots\dots\dots [4.1b]$$

$$\text{fdcpi} - \underset{(-0.1794)}{2.900036} \text{ GAP} = 0 \dots\dots\dots [4.2b]$$

Eliminating insignificant<sup>39</sup> endogenous variables from model 1, we have [4.1c] as the final equation estimating the long-run relationship among the endogenous series. For model 2, however, there is no insignificant variable to be dropped; and hence [4.2b] remains as the final model estimating the long-run relationship between the degree of utilization of agricultural potential<sup>40</sup> and food price inflation.

$$\text{fdcpi} - \underset{(-0.46765)}{3.283468} \text{ m2} - \underset{(-0.19358)}{0.528535} \text{ neer} + \underset{(0.06037)}{0.289546} = 0 \dots\dots\dots [4.1c]$$

Therefore, we can make our long-run relationship analyses based on [4.1c] and [4.2b]. These long-run estimates imply that, *ceteris paribus*, there exist a significant positive relation between food price inflation & money supply and nominal effective exchange rate in the first model. This seems to

<sup>38</sup> This ad-hoc normalization involves dividing both sides of the equation by the coefficient of the variable of interest; in our case the logarithm of food price index.

<sup>39</sup> As a rule of thumb, a variable is insignificant if the t-value (ratio of the coefficient to the standard error) is less than 2.

<sup>40</sup> Recall that this is proxied by the index, defined in chapter 3, as the ratio of actual agricultural GDP to the potential/trend output in the sector. This implies that the higher the index the lower the gap, and vice versa.

confirm the Monetarist view that inflation is a monetary phenomenon, though may not be 'always and everywhere'.

This conjecture sounds in the perspective of expanding role of microfinance institutions and farmers cooperatives especially in the rural areas. Not only the number of microfinance institutions in Ethiopia reached more than 28, mobilizing a total deposit of more than a billion birr, with outstanding loans of approximately 3 billion birr, serving more than one and half a million households, owning assets valued approximately at 4 billion birr, etc (NBE, 2008), but also that their role is increasing over time (Andinet et al., 2007 Chapter 5: 9).

Some researchers including Andinet et al. (2007) indicated that the role of cooperatives has been significantly increasing both in the input and output market through improved access to storage facilities and market information. They added that emergence of farmers' cooperatives and access to credit channeled through microfinance institutions and the Ministry of Agriculture & Rural Development (MoARD) has also greatly contributed to the change in production and marketing behavior of farmers. 'The availability of [cheap] credit may, therefore, help farmers reduce/avoid *distress selling*' (Getachew, 2007) and enabling farmers maintain liquidity (WB, 2007). This may, in turn, contribute to food price inflation through its impact on food supply.

It is not surprising to see nominal effective exchange rate having a positive long-run (*ceteris paribus*) relationship with food price inflation because Ethiopia is a net importer of food. Besides, it may give the impression that the imported component of food price inflation is a significant determinant of domestic food price inflation. This particularly makes sense when we observe the fact that global

food cost hikes have been moving parallelly with that of the domestic, especially in the recent past (see section 4.1).

The second model estimates revealed a direct long-run relationship between food price inflation and degree of utilization of agricultural sector potential. This seems to be in line with the Keynesian view on *inflationary gap* theory.

Yet, it should be noted that those coefficients shall not be interpreted as they appear unless we are sure on the direction of causal relations among the variables. And, this is too early a time to deduce on the direction of causality. For instance, one may ask whether it is higher food prices encouraging (at least, net seller) farmers and food suppliers to utilize more of the sector's capacity or the other way around. In the context of the first model, does food price inflation bring about changes in gross national income (of, at least, the rural population who constitute the majority) or growth in national income results in food price inflation via its effect on food demand? Therefore, it is vital to know the direction of causality in order to give economically meaningful interpretation to the coefficients. This shall be verified with Granger causality tests as presented next.

#### **4.2.3.1 Granger Causality Test**

Granger causality tests given in table 4.2.3.1.1 below may help us identify the direction of causal relationship among significant endogenous variables, with the center of interest for this study being the causal relation of food price inflation with other variables.<sup>41</sup>

---

<sup>41</sup> Recall that the higher is the chi-square statistics calculated as in equation 3.21 (the lower the probability), the null hypothesis that the (excluded) variable does not Granger cause the dependent variable can be rejected, and vice versa.

Accordingly, the statistics in the table prove that food price inflation does not have a two-way causal relation with any of the variables, which makes analyses on causal relations with regard to this variable of interest more reliable than otherwise. The above block (panel a) of the table testifies that food price inflation is strongly Granger caused by money supply, and weakly by gross national income (but insignificant), but not by effective exchange rate.

Table 4.2.3.1.1 VAR Granger Causality/Block Exogeneity Wald Tests (for model 1 [a] and 2[b])

Panel a)

Excluded	Dependent Variable											
	<i>fdcpi</i>			<i>m2</i>			<i>gni</i>			<i>nee</i>		
	Chi-sq	df	Prob	Chi-sq	df	Prob	Chi-sq	df	Prob	Chi-sq	df	Prob
<i>fdc</i>				0.836498	1	0.3604	0.074619	1	0.7847	0.591072	1	0.442
<i>m2</i>	12.03168	1	0.0005				8.622477	1	0.0033	0.404739	1	0.5247
<i>gni</i>	4.465567	1	0.0346	0.811411	1	0.3677				0.120245	1	0.7288
<i>nee</i>	0.026346	1	0.8711	0.743715	1	0.3885	0.240106	1	0.6241			
<b>All</b>	<b>20.71705</b>	<b>3</b>	<b>0.0001</b>	<b>1.700226</b>	<b>3</b>	<b>0.6369</b>	<b>15.63141</b>	<b>3</b>	<b>0.0013</b>	<b>1.97483</b>	<b>3</b>	<b>0.119</b>

Panel b)

Excluded	Dependent Variable					
	<i>fdcpi</i>			<i>GAP</i>		
	Chi-sq.	d.f.	Prob.	Chi-sq.	d.f.	Prob.
<i>fdcpi</i>				10.72108	3	0.0133
<i>GAP</i>	1.129752	3	0.7699			
<b>All</b>	<b>1.129752</b>	<b>3</b>	<b>0.7699</b>	<b>10.72108</b>	<b>3</b>	<b>0.0133</b>

To be specific, other things being the same, a 1% increase (decrease) in money supply results in a direct increase (decrease) of average food prices by 3.283468%. This shows that average food price is highly responsive (elastic) to changes in money supply in the economy since changes in money holding especially by households are mainly for food consumption. The link between the money stock and food price inflation (especially in economies where a larger proportion of household income is spent on food) occurs through a monetary transmission process whereby the amount of

money economic agents desire to hold is less than the available money stock. Assuming a stable demand for money, this serves to reduce the value of money (in terms of goods & services) thus increasing the price level including food items.

On the other hand, changes in effective exchange rate do not Granger cause food market price inflation for the combined reason of fixed (managed-floating) exchange rate regime during 1974-91 (pre 1974 and 1991 – present) and minor share of food import in the domestic supply.

It is interesting to see in the lower block of the table that the degree of utilization of the potential of the agricultural sector does not Granger cause food price changes since the p-value is very high (0.7699). This may be due to the enormous underutilization of agricultural sector potential and hence room for further utilization without spurring food price hikes even in the face of increased expenditure on food. For instance, despite 66% of land in Ethiopia is known to have potential for agriculture (arable), only less than two-fifth (37.3%) of this potential has been so far utilized (only 27.9 million hectares of land is either intensively or moderately cultivated, on average). Besides, there exists a bulk potential to expand the area of land under cultivation through the use of irrigation; but less than 5% of the over 3 million hectares of irrigable land is currently under use. In addition, there are various agro-ecological zones that entail the possibility of enormous production potential in terms of crop and livestock variety (CSA, Various issues).

The degree of under-utilization in the other sub-sectors, with their share to the sectoral GDP in parenthesis (livestock [30%], bee-hive keeping [negligible], fishing [less than 1%], etc) is even worse than the crop sub-sector. For instance, the livestock sub-sector is highly underutilized though the nation stands first in Africa and 9<sup>th</sup> in the World in terms of the number of live animals (Ibid).

On the other hand, food price changes weakly Granger cause the degree of utilization of agricultural sector potential with a p-value of 0.0133. This may convey the message that food price changes may offer (at least, part of) the incentive to exert efforts to utilize more or less of the sector's potential. Higher food prices, so to speak, may enable (net seller) farmers buy agricultural inputs that help better exploit the sector's potential. On the contrary, food price falls may not only disable farmers purchase modern agricultural inputs (settle their agricultural input bill/loan), but may also push part of the labor force out of the sector – they may be forced to look for alternative means of livelihood in the urban areas and hence increased rural-urban migration. This argument, nonetheless, assumes flexibility of farmers in shifting between economic activities and that purchase of inputs on the part of the farmers is determined by the ability of their food product to fetch higher prices in the market.

Yet, this could be challenged on the ground that the Ethiopian agriculture is dominated by small-holder farming system with subsistent production mainly for home consumption. Almost 97% of cultivated land belongs to and 95% of agricultural output comes from small-holder farmers. These could necessitate the reservation that subsistent farmers may not bother much about prices of agricultural output.

This argument may be strengthened by the inference from the same table that neither food price changes (p-value of 0.7847) nor effective exchange rate (p-value of 0.6241) Granger cause gross national income in real terms, the lion's share of which comes from the agricultural sector as the sector is the backbone of the Ethiopian economy. This is likely for the reason that small-holder subsistent farmers have very low exportable surplus. However, this is not adequate to deduce as a conjecture, but indication of a gap for further studies in the area. Even so, the study argues, prices

may not only motivate/discourage some surplus producers but also affect farmers' and food suppliers' decisions of what to produce and where to supply.

Moreover, whereas money supply is found to be exogenous (p-value of 0.6369), nominal effective exchange rate is weakly exogenous (p-value of 0.119) since the former is a decision variable by the National Bank of Ethiopia and the latter is determined mainly by the relative appreciation or depreciation of the currencies of (major) trading partners. Having known the direction of causality relationships among the variables, we may proceed to examining their short-run and long-run dynamics using vector error-correction models.

#### 4.2.3.2 Vector Error-Correction Models

In this representation, the short-run dynamics of the series in the system are influenced by the deviation from their long-run equilibrium. In the interest of economizing space, the error-correction components of both models are summarized in table 4.2.3.2.1.

Before we proceed to the dynamics of the endogenous series, we shall see the findings on the predetermined exogenous variables. Focusing on food price inflation (second column), all predetermined exogenous series, like rainfall, regime shift, average world food price and food aid are statistically significantly affecting food price changes and hence its inflation even at 1% level.

To be more specific, when government actively intervenes in the food market, average food price tend to decline by 10.76%, and vice versa. This is because, in the absence of active price controls by the government, food retailers are in an (unfair) advantage in setting market prices at least for two reasons:



Table 4.2.3.2.1 Vector Error-Correction Model Coefficient Estimates [with t-values]

Error-correction:	Dependent Variables [Model 1]			
	$\Delta fdpi_t$	$\Delta m2_t$	$\Delta gni_t$	$\Delta neer_t$
<i>Coint. Eq1</i>	-0.433779 [- 4.1899]** *	0.061724 [1.0791]	- 0.108701[- 2.20612]** *	0.303444 [ 1.69799]** *
$\Delta fdpi_{t-1}$	- 0.095634 [- 0.60985]	0.012444 [0.14363]	0.271279 [ 3.63485]** *	- 0.3796 [- 1.40236]*
$\Delta m2_{t-1}$	- 0.622075 [- 1.69864]** *	- 0.00742 [- 0.03667]	- 0.211164 [- 1.21154]	0.649044 [ 1.02673]
$\Delta gni_{t-1}$	- 0.128793 [- 0.40884]	0.002271 [0.01305]	- 0.369481 [- 2.46443]** *	0.272432 [ 0.50101]
$\Delta neer_{t-1}$	- 0.070904 [- 0.62772]	0.065821 [1.05471]	0.011363 [ 0.21137]	0.039737 [ 0.2038]
C	- 1.179846 [- 2.70664]** *	- 0.26625 [- 1.10553]	- 0.846755 [- 4.08151]** *	1.050832 [ 1.39656]*
$DDRGM_t$	0.107633 [ 2.38475]** *	0.001801 [0.07223]	0.08664 [ 4.03342]** *	- 0.183874 [- 2.36015]** *
$RF_t$	- 0.000141 [- 8.8919]** *	- 4.0000092 [- 0.56103]	0.000249 [ 3.29941]** *	- 0.000142 [- 0.5179]
$fdaid_t$	0.018645 [ 2.1975]** *	- 0.005301 [- 1.13092]	0.008195 [ 2.02933]** *	- 0.024254 [- 1.65601]*
$wfdp_t$	0.189126 [ 2.25578]** *	0.106475 [2.29862]** *	0.120316 [ 3.01528]** *	- 0.130186 [- 0.89956]
R-squared	0.461059	0.289811	0.591011	0.215558
Adj. R-squared	0.299376	0.076754	0.468315	0.019774
F-statistic	2.85163	1.360253	4.816853	0.915973
Log likelihood	43.91582	67.6485	73.61531	22.08012
Akaike AIC	- 1.695791	- 2.882425	- 3.180765	- 0.604006
Schwarz SC	- 1.273571	- 2.460205	- 2.758546	- 0.181786
Error-correction:	Dependent Variables [Model 2]			
	$\Delta fdpi_t$	$\Delta GAP_t$		
<i>Coint. Eq1</i>	0.080339 [ 2.14082]** *	0.058074 [ 2.24146]** *		
$\Delta fdpi_{t-1}$	- 0.247195 [- 1.25284]	- 0.050518 [- 0.37085]		
$\Delta fdpi_{t-2}$	0.097331 [ 0.47998]	0.156739 [ 1.11955]		
$\Delta fdpi_{t-3}$	0.051579 [ 0.25049]	- 0.143084 [- 1.00650]		
$\Delta GAP_{t-1}$	- 0.128232 [- 0.51455]	0.080106 [ 0.46558]		
$\Delta GAP_{t-2}$	0.071589 [ 0.35731]	- 0.603511 [- 4.36301]** *		
$\Delta GAP_{t-3}$	- 0.289513 [- 1.13272]	- 0.071139 [- 0.40315]		
R-Squared	0.04946	0.493902		
Adj. R-squared	0.01234	0.401884		
F-statistic	0.286186	5.367454		
Log likelihood	29.88067	44.7		
Akaike AIC	- 1.144034	- 1.885		
Schwarz SC	- 0.84848	- 1.589446		

\*\*\*, \*\* and \* imply that the variable is significant at 1%, 5% and 10% levels, respectively. The critical values for these levels

First, its demand is relatively price inelastic since food is necessary for survival. Second, there are no (strong) consumers' associations to bargain on retail food prices. This perhaps justifies the need for strategic government intervention in the food market to curb soaring food costs. For example, Elleni (2006) argues 'the introduction of *commodity exchange* helps to make food markets more transparent & efficient'. Inefficient food markets, if left alone, tend to work at the expense of food buyers.

Given Ethiopian agriculture is rain-fed; a statistically significant inverse impact of rainfall on food price inflation is not unexpected. The results indicate that an evenly distributed 'favorable' increase in 100 mm rainfall at the national level (but with the biological limit to the amount desired for crop production, grazing land, and fish production) results in average food prices to decline at the rate of 0.0141% as favorable rainfall brings about bumper harvest and hence increased supply of food, which seems economically insignificant to curb the problem. Yet, in a nut shell, good harvest periods due to favorable rainfall may reduce food price inflation via its impact on food supply, *ceteris paribus*. One may have a hunch on price-disincentive on the part of the farmers following good harvest season. However, the output effect is likely to outweigh the possible price disincentive effect and hence bumper harvest due to efficient utilization of the sector's potential rather increases farmers' income.

On the other hand, food aid and world average food price are found to have a strong positive impact on domestic food price inflation. This could be because food aid has a 'disincentive effect' on the part of the farmers – the more the food aid the farmers are 'enjoying', the less the effort they put in their farming activities and hence less market supply of food. Put differently, food aid may cause

dependency syndrome on the farmers.<sup>42</sup> To give a flavor of this to the reader, Ethiopia has been food aid recipient for several decades and the model estimates confirm doubling food aid inflow would rather aggravate food price inflation by nearly 2%, *ceteris paribus*.

As pointed out in the same column domestic food price inflation is more elastic to global food price inflation (0.189) than even food aid, other things being the same. This finding is appealing since Ethiopia is a net importer of food. Domestic food price inflation fetches nearly 19% of global food price hikes (*ceteris paribus*), which is in line with theories of imported inflation/cost-push theories. Nonetheless, global food price inflation is not totally reflected in domestic food price inflation because the share of food import in domestic food supply may be minimal.<sup>43</sup>

With regard to the short-term dynamics of endogenous variables, a variable reacts to deviations from long-run equilibrium relation occurring in the previous period if the coefficient of the lagged error-correction term (*Coint. Eq1*) in table 4.2.3.2.1 (on page 71) is significant. It is evident from the summary report that average current food prices adjust to previous period's error at the rate of 43.37% and 8% in the two models, respectively. Put differently, these rates show how fast short-run deviations in average food price changes adjust to its long-run values.

The third and last columns of the upper block in the table combine both coefficients of short-run dynamics and adjustment parameters to prove the tendency of money supply to be strictly exogenous and effective exchange rate weakly exogenous (see Abdulaziz, 2008 for discussions in the context of general inflation).

---

<sup>42</sup> For a comprehensive argument of aid dependency in Africa with particular emphasis to Ethiopia, see Alemayehu et al (1998)

<sup>43</sup> The share of food import in Ethiopia in total merchandise import averages at 11.3% during 1993-2003 (IFS, 2007 Database Researchers computation)

Finally, the third (*m2*) column of the table appears to argue for the *long-run neutrality of money* because money supply is found to have statistically insignificant impact on national output (income). This study, nevertheless, does not take this as adequate representation to conclude about the hypothesis.

### 4.2.3.3 Diagnostic Tests

For the cointegration analyses so far examined to be valid, diagnostic tests on normality, autocorrelation, and heteroskedasticity of the error-terms shall be conducted (Alemayehu et al, 2007 and Greene, 2004). The results for these tests are summarized below and results establish a legitimate basis for the validity of cointegration analyses since residuals not notorious.

The fact that (most of) the series are transformed in to natural logarithms must have ‘whiten’ the errors. Specifically, table 4.2.1.2.1 reports the results of Jarque-Bera test of normality as in equation 3.18 for each model and shows that we fail to reject the null hypothesis (of residual multivariate normality) for the variables individually & jointly since the probability values are reasonably high (joint p-values of 0.4014 and 0.2715 for the two models, respectively) – the calculated JB statistics are not statistically significantly different from zero. Therefore, (all) the residuals are statistically normally distributed.

Table 4.2.1.2.1 VAR Residual Normality Jarque-Bera Test

Component	Model 1					Model 2		
	<i>fdcpi</i>	<i>m2</i>	<i>gni</i>	<i>near</i>	Joint	<i>fdcpi</i>	<i>GAP</i>	Joint
JB Statistics	2.215924	2.429419	2.909072	0.780616	8.335031	3.750616	1.406669	5.157285
D.f.	2	2	2	2	8	2	2	4
Prob.	0.3302	0.2968	0.2335	0.6768	0.4014	0.1533	0.4949	0.2715
Included observations are 41								

Similarly, table 4.2.1.2.2 provides the White test as in equation 3.17. The p-values (0.1330 and 0.4654, respectively for the two models) entail our failure to reject the null hypotheses of homoskedasticity of the residuals in both models. <sup>44</sup>

Table 4.2.1.2.2 VAR Residual Heteroskedasticity White Test

	Chi-square Stat.	Degrees of Freedom (D. f.)	Probability Value
<b>Model 1</b>	169.38050	150	0.1330
<b>Model 2</b>	81.43946	81	0.4654

Finally, table 4.2.1.2.3 below reports the results showing whether the errors are autocorrelated up to lag  $k$  using the Lagrangian Multiplier test as in equation 3.16. Accordingly, we failed to reject the null hypotheses (of no residual autocorrelation) since p-values are high (the lowest values are 0.2132 and 0.1234 for the first and second model, respectively). Hence, the residuals in both models are not autocorrelated.

Table 4.2.1.2.3 VAR Residual Serial Correlation LM Tests

<b>Model 1</b>									
Lags	1	2	3	4	5	6	7	8	9
LM Stat.	20.1588	14.6060	18.9569	13.7901	14.3003	15.1666	15.6187	27.5465	26.4866
Prob.	0.2132	0.5537	0.2709	0.6143	0.5764	0.5125	0.4799	0.3580	0.4760
<b>Model 2</b>									
Lags	1	2	3	4	5	6	7	8	9
LM Stat.	5.39393	4.59307	5.03433	3.44855	7.24674	4.53483	2.65181	4.79961	6.42436
Prob.	0.2492	0.3317	0.2838	0.4857	0.1234	0.3384	0.6177	0.3085	0.1696
Probabilities are calculated from $\chi^2$ with 16 and 4 degrees of freedom for model 1 and model 2, respectively									

Economic variables are interrelated. So far, we saw only the direct effects by way of vector error-correction modelling approach. This, however, does not show the indirect effects of variables with

<sup>44</sup> This test is also described as a general test for model misspecifications since the null hypothesis underlying the test assumes that the errors are both homoskedastic and independent of the regressors and that the [linear] specification of the model is correct. Accordingly, the test results prove not only that the VAR residuals are homoskedastic but also that the models are not misspecified.

long-run equilibrium relationship and hence cannot conclude about total effects. This shall be made based on the impulse response analysis in section 4.2.5 as it captures both direct and indirect effects.

#### 4.2.4 Impulse Response Analyses

Price stability, of which food price inflation is a core element, is a major macroeconomic objective in most economies including Ethiopia. Given this objective, the ability to predict the process of food price adjustments is essential. In understanding and predicting food price inflation in Ethiopia, it is necessary to understand the impact of shocks and the underlying process. From normative economics perspective, an understanding of such interactions and transmission process between (the main) macroeconomic variables and food price inflation serves to guide the process of policy formulation and implementation. Critical elements of our analysis are food price inflation, money supply, gross national income, nominal effective exchange rate and degree of utilization of agricultural sector potential. Before we embark on actual impulse response analysis, the stability of the vector autoregression models shall be checked using the roots of characteristic polynomial.<sup>45</sup>

##### 4.2.4.1 Model Stability Test<sup>46</sup>

Accordingly, the results in table 4.2.4.1.1 indicate that no root lies outside the unit circle. The roots of characteristic polynomial for both models are all less than unity and hence they satisfy the stability condition. This guarantees a dependable forecast about the future values of food price inflation in response to changes in other variables in both models (the study did up to 30 periods).

---

<sup>45</sup> This measures the ability of the model to track changes of variables of interest outside the sample. If the models are not stable, innovations analysis would generally be invalid as the model would have poor forecast ability about the future values of a series following a change in an endogenous variable, while all the above analyses remaining valid. Only if a model is stable, inference using impulse response analyses would be valid.

<sup>46</sup> The stability test involves checking whether all the roots of characteristic polynomial lie within a unit-circle or not. For the models to be stable and have orthogonal error-terms each needs to have a modulus of less than one for all of its roots. If this is the case, impulse response analyses would generally be valid; otherwise not.

Table 4.2.4.1.1 Roots of Characteristic Polynomial: Tests of Model Stability

Model 1						
Root	0.9931	0.58732 - 0.15924i	0.58732 + 0.15924i			0.58386
Modulus	0.9931	0.60853	0.60853			0.58386
Model 2						
Root	0.9829	0.03733 - 0.78857i	0.03733 + 0.78857i	0.54468 - 0.08703i	0.54468 + 0.08703i	-0.53627
Modulus	0.9829	0.78945	0.78945	0.55159	0.55159	0.53626
No root lies outside the unit circle – The VAR models satisfy the stability condition						

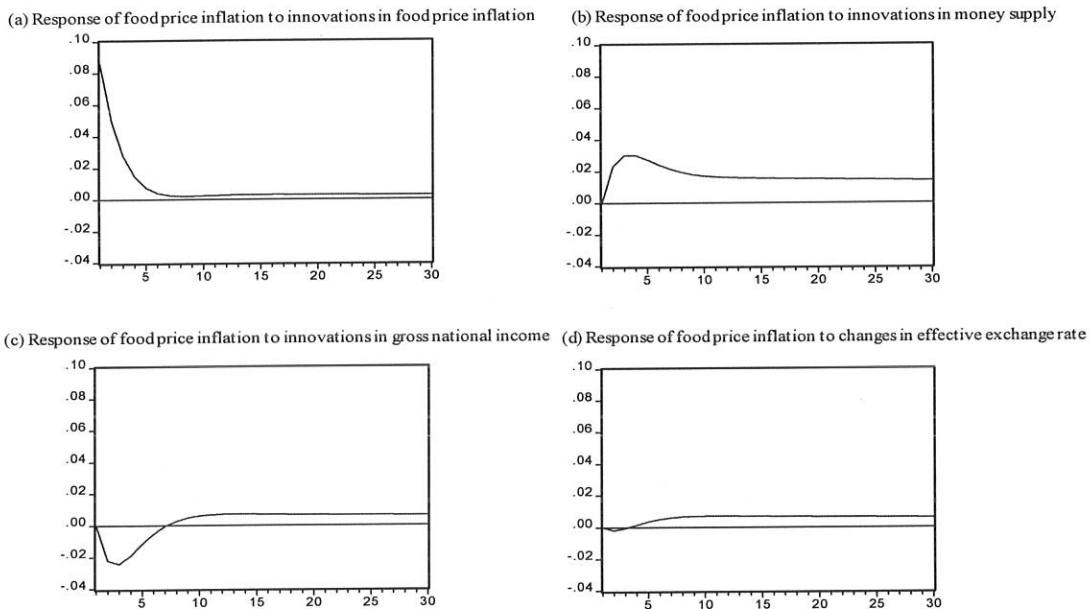
#### 4.2.4.2 Impulse Response of Food Price Inflation

A shock to one variable not only directly affects itself and other variables but is also transmitted to all of the other endogenous variables through the dynamic structure of the VAR. For instance, a shock in money supply may not only directly affect food price inflation but also is transmitted to other endogenous variables like gross national income via the dynamic structure of the first model. The same goes for the second model. In order to trace this effect of a one-time shock in an endogenous variable on current and future values endogenous variables with particular focus on food price inflation, impulse response functions for this variable are estimated and the results presented in figure 4.2.4.2.1.

Impulse response functions represent the time profile of the effect of a shock to one variable on the future values of all endogenous variables. If the innovations  $\varepsilon_t$  are contemporaneously uncorrelated, interpretation of the impulse response is straightforward: the  $i^{th}$  innovation,  $\varepsilon_{i,t}$  is simply a shock to the  $i^{th}$  endogenous variable,  $y_{i,t}$ . Innovations, however, are usually correlated, and may be viewed as having a common component which cannot be associated with a specific variable. In order to interpret the impulses, it is common to apply a transformation to the innovations so that they become uncorrelated. The analyses are given separately for the sake of clarity in viewing the total

effect of each endogenous variable on food price inflation. The graph below shows how food price inflation as the variable of interest in this study responds to impulse/shocks to all endogenous variables.

Figure 4.2.4.2.1 Response of Food Price Inflation to Cholesky 1 SD Innovations in Endogenous Variables



To start with, panel (a) of the figure supports the Keynesian contention of downward price rigidity, at least in the food market. One standard deviation food price hike is followed by a persistent increase in the same for decades. Specifically, a unit standard deviation shock in food price inflation causes further inflation of as high as 0.08 standard deviations, especially immediately after the shock both directly & indirectly. This could be why it is not uncommon to see food price surges are difficult to bring back to normal. Besides, expectations could play a vital role in explaining this downward rigidity because current food price inflation may signal further inflation and hence buyers may tend to demand more today. This could instigate additional food price hikes if not supported by a proportional increase in food supply. Besides, if the mass-media is exceptionally broadcasting about on going food price inflation, it might aggravate food costs through the *announcement effect*.

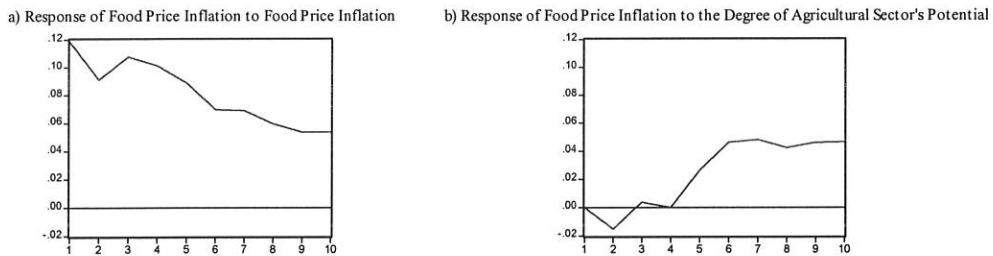
In the second panel (b), the monetarist argument is supported by high elasticity of food price inflation to shocks in money supply explained by as high as 0.03 standard deviations positive response of the latter to a unit standard deviation shock in the former. On top of this, it is important to note that food price inflation has a sustained high elasticity to shocks in money supply, approximately 0.02 standard deviations for decades. On the other hand, in the third panel (c), a shock in gross national income brings about food price deflation for some 7-8 years, followed by sustained but very low (0.01 SD) food price inflation. One may draw a lesson that sustained economic growth could be a lasting solution for the problem of food price inflation. Because one standard deviation increase in gross national income initially holds food price changes down by as high as 0.025 standard deviations. Besides, food price inflation after nearly a decade of economic growth is not harmful even to final consumers, at least for two reasons: the resulting food price inflation is less than 0.01 standard deviations and sustained economic growth may enable buyers to carry such food price inflations as far as there is equitable income distribution.

Finally, one standard deviation increase in nominal effective exchange rate is followed by an immediate brief deflation for about 3-4 years, followed by a persistent inflation in average food prices. This culminates in indicating that food price inflation is less elastic to effective exchange rate – one standard deviation depreciation of our currency (as compared to the currencies of our trading partners) fetches only about less than 0.01 standard deviation price inflation directly and indirectly in the domestic food market.

Before we conclude, let us do impulse response analyses of the second model. In panel (a) of figure 4.2.4.2.2, we could see a similar result to the first model. A unit standard deviation shock in food price inflation is followed initially by as high as 0.12 and later a sustained food price inflation of

between 0.08 and 0.05 standard deviations. The combined result of the two models strengthens the argument of downward price rigidity in the food market in the context discussed above.

Figure 4.2.4.2.2 Response of Food Price Inflation to Cholesky 1 SD Innovations in the Endogenous Variables (Model 2)



Similarly, an increased utilization of agricultural potential by one standard deviation would initially result directly and indirectly in slight deflation of approximately 0.0175 standard deviations. This may be due to the outweighing effect food supply following increased utilization of the sector's potential at early stages of the sector's growth. Later, however, an increased utilization would result in economic growth as the sector plays vital direct & indirect roles and hence more than proportionate increase in demand for food. This, in turn, may lead to (a manageable) food price inflation of 0.02 standard deviations. This implies that increasing agricultural sector growth brings neither price disincentive for the (net food seller) farmers nor does it aggravate food price inflation in the economy.

Therefore, this culminates in indicating agriculture development (led industrialization) as a sound direction for the economy since fast & sustained growth of the economy led by agricultural sector helps rectify the malady of food price inflation in the economy and meet the long-term objective of industrialization via its linkages with other sectors.

## CHAPTER FIVE

### CONCLUSION AND RECOMMENDATION

This chapter concludes on the major findings of the study [5.1] and suggests policy options to curb the malady of food price inflation in Ethiopia [5.2].

#### 5.1 Conclusion

This paper examined the dynamics of food price inflation in Ethiopia during the period 1963–2006 covering the last three regimes. It focused on average food price inflation in the context of contemporary theories using two separate vector error-correction models.

The first model examined the relative importance of monetarist and structuralist theories of (food price) inflation and the second model tested the Keynesian inflationary gap model in the context of the food market in Ethiopia. The time-series properties of the variables is checked and found to be econometrically plausible for cointegration and error-correction analyses.

As a time-series analysis, it is legitimate to cast how far behind current food price inflation is affected by past monetary and structural variables. According to the first model estimates, these variables are related only at one lag implying current food price inflation may be affected by only last year's variables including money supply, rainfall, nominal effective exchange rate, shocks in the global food market, food aid and gross national income. Whereas, the degree of utilization of the agricultural potential in the second model has a more persistent relation with food price inflation for about three lags. Besides, lag exclusion tests confirmed that each of these lags is found to be important in explaining the relationship among the variables.

Since tests on the time-series properties of the variables disclosed that each series is integrated of order one (I (1)) and that its residuals are normal, not serially autocorrelated and homoskedastic both individually and jointly, cointegration test using the Johansen procedure is conducted and come up with a unique cointegrating vector for each model at 5% level. This proves the existence of long-run equilibrium relationship between food price inflation and other variables.

Accordingly, food price inflation is found to have a statistically significant long-run (*ceteris paribus*) positive relation with money supply (3.283468) and effective exchange rate (0.528535) in the first model and output gap index (2.900036) in the second model, respectively (elasticities are in brackets). But gross national income has insignificant long-run relation with food price inflation. This may not, however, mean that these significant variables are true causes of food price inflation in Ethiopia unless checked for Granger causality among them.

Granger causality test results found food price inflation to have a bi-directional relationship with none of the variables. Specifically, nominal effective exchange rate does not Granger cause food price inflation for not only the foreign exchange market in Ethiopia operates under a managed-floating regime but also food import has a shallow share in domestic food supply. Similarly, agricultural sector output gap does not Granger cause food price inflation since the agricultural sector potential is highly underutilized, respectively. Therefore, the only relevant endogenous variable that Granger causes food price inflation in the first model is money supply. This appears to suggest food price inflation in Ethiopia is *a monetary phenomenon* at least in the long-run.

Nevertheless, model 1 also revealed that food price inflation in Ethiopia is the result of the interplay of monetary & structural variables and domestic & non-domestic factors because the exogenous

structural variables like rainfall, regime shifts, world food price inflation and food aid are found to be statistically significantly affecting food price inflation.

Rainfall in Ethiopia inversely affects food price inflation since agricultural sector (the major supplier of foodstuffs) is rain-fed. Given the potential for irrigation and huge arable land, there is a scope for increasing agricultural production. In the effort to solve this malady, more efficient water management through irrigation in an environmentally sustainable way and better agronomics may help as doubling water use (cognizant of the biological limit of what is necessary for production) would tend to deflate food price by 0.0141% on average.

An active intervention by the government is found to help deflate food prices by 0.107633%, on average, at least, through control over speculation in food markets. This indicates that it is worse than futile for the government to expect the inefficient market system to resolve the malady of food price inflation in Ethiopia.

The above factors are the major significant domestic factors affecting food price inflation in Ethiopia. However, food price inflation in Ethiopia is not only caused by domestic factors. It is also caused by factors outside the domestic economy as the country interacts with the rest of the world via trade, aid and the likes. Specifically, global food price hikes contribute for domestic food market ailment through food imports. Domestic food price inflation responds to changes in price of the same global market with elasticity of 0.189126 – about 19 per cent of global food price shocks are transferred to the domestic market.



Besides, food aid to the country is clearly found to be harmful at least in aggravating food price inflation. The elasticity of domestic food price inflation to food aid inflow is 0.018645. This indicates doubling existing food aid inflow would exacerbate domestic food price inflation by nearly 1.86%, *ceteris paribus*.

The above analyses, nonetheless, takes in to account only the direct effect of a variable on food price inflation despite these domestic & foreign variables may be interrelated. This dictates the need to see the total effects of an impulse/change in these variables on food price inflation. For such analyses, the VAR models satisfied the condition of stability.

These analyses suggest that expectations in the food market are important because food prices are downward rigid and any triggered inflation on food prices would tend to come up with a spiral of the same. But, more importantly, money supply is found to have a strong positive total effect on food price inflation in Ethiopia confirming again the monetarist conjecture that (food price) inflation is *a monetary phenomenon*.

On the other hand, the demand-pull inflationary pressure of increased (gross national) income is more than offset (in the short-run and medium-term) by the increased domestic food production as agricultural sector is the backbone of the economy. Even in the long-run (after 7-8 years), the inflationary pressure triggered by the direct and indirect effect of sustained growth (increase in gross national income) is manageable as this will boost the per capita income enabling food buyers shoulder such an inflation on food items as cheap food is no more expected even at the global level. This culminates in pointing out that an efficient utilization of the potential of agricultural sector may help solve the problem of food price inflation in Ethiopia.

## 5.2 Recommendation

Based on the findings of the study, the following (policy) interventions are suggested:

- (a) The monetary authority shall carefully monitor the money supply through selective money market operations in order to control over food price inflation as this malady is found to be a monetary phenomenon at least in the long-run.<sup>46</sup>
- (b) The Ethiopian economy is predominantly agrarian and the agricultural sector is predominantly rain-fed. Decreasing dependence on rain-fed agriculture through effective water management, like irrigation<sup>47</sup> and conservation, should be a priority agenda for the Agricultural Development Led Industrialization (ADLI) strategy to thwart the problem.<sup>48</sup>
- (c) Ethiopia is a net importer in the international food market; and imported inflation has been significantly contributing for domestic food price hikes. The study, therefore, suggests for efforts to substitute food imports by domestic production so that dependence on food import is reduced through encouraging domestic food processing firms since the lion's share of food import constitutes processed food items. Without adequate substitution efforts, lifting/removing taxes on imported food items could be a way out only in the short-run as increasing international food prices push domestic prices up and continue to do so.
- (d) Similarly, Ethiopia needs to minimize its dependence on food aid as it exacerbates domestic food price inflation through its potential to cause dependency syndrome on the part of recipients both at the household as well as national level. Rather, the study suggests for short-

---

<sup>46</sup> See Samuel M. (2005) for the demand of monetary policy in Ethiopia

<sup>47</sup> see International Water Resources Management (2004) for detail treatment on experience and opportunities for promoting small-scale micro-irrigation and rainwater harvesting for in Ethiopia

<sup>48</sup> Grey, David and Claudia Sadoff (2002) has an Africa-size argument on water resources and poverty

term emergency food aid scheme for unforeseen vagaries of nature combined with efforts to support and teach recipients not to fall in to dependency syndrome.

- (e) On top of these, active and careful monitoring of food markets by the government through organizing & supporting consumer associations as well as farmer cooperatives, introduction & strengthening of commodity exchange markets in different parts of the country and designing specific policy tools to control creation of artificial shortages and unfair speculation, etc is essential.
  
- (f) Finally, the study treated food prices in aggregate while the exact causes of food price hikes may be better identified through a careful analysis of specific food item prices. Hence, it may give a better insight for future studies to focus on major cereals and livestock individually. More importantly, I would suggest for oil price changes to be considered in future studies. In line with this, an interesting question particularly in Ethiopia would be to try to see food price inflation if all world oil price shocks were totally transferred to final consumers as oil has a direct or indirect linkage to transportation of agricultural inputs & outputs and hence their prices. In addition, a kind of panel study considering other rain-fed agriculture dominant African economies may shed light on the issue as well.

## REFERENCE

- 1 Abdulaziz Behiru Shifa, 2008, The Short-run and Long-run Dynamics of Money Supply, Output and the Price Level in Ethiopia: A paper presented to the 6th International Conference on the Ethiopian Economy, Ethiopian Economic Association, 6th International Conference on the Ethiopian Economy. Ethiopian Economic Association, UN Conference Center.
- 2 A, Ocampo J., 1990. Import Controls, Prices and Economic Activity in Columbia. *Journal of Development Economics*, Elsevier Science Publishers, North Holland., 32(2).
- 3 A., Lulseged, 1996. Money Demand and monetization in Ethiopia. MSc Thesis, Addis Ababa University, Addis Ababa.
- 4 Adam, C. S, 1993. Time Series Econometrics For Africa - Mimeographed.
- 5 Agenor, P., P. Montiel, 1999, Development Macroeconomics. Princeton University Press, Princeton, New Jersey.
- 6 Agenor, P., P. Montiel, 2006, Development Macroeconomics. Macmillan Publishers Ltd., London.
- 7 Aksoy, A. M., April 1982. Structural Aspects of Turkish Inflation: 1950-1979. *World Bank Staff Working Papers*(54).
- 8 Alemayehu Geda, Befekadu Digafe, 1998, Transiting from Aid Dependency in Sub-Saharan Africa: the case of Ethiopia, AERC workshop on 'Transiting from Aid Dependency in Africa', Nairobi, Kenya.
- 9 Alemayehu Geda, N.Ndung'u and Daniel Zerfu, 2007, Applied Time Series Econometrics: A Practical Guide for Macroeconomic Researchers with a focus on Africa. AAU, AERC and Central Bank of Kenya (memo), Addis Ababa.

- 10 Alemayehu Geda and Frederik Hrizinga, 2006, Theoretical Framework of the MOFED Macroeconomic Model, MOFED -SOAS-MMS Collaborative Project.
- 11 Alemayhu Geda, 1999, A Consistent Macro Database of Ethiopia: Background paper prepared for Ethiopian Economic Association, Addis Ababa.
- 12 \_\_\_\_\_, 2001, Macroeconomic Performance in Post-Derg Ethiopia, Northeast African Studies, pp. 159-204.
- 13 André Croppenstedt, Lorenzo Bellu, Fabrizio Bresciani, August 2006, Multi-Market Models in Policy Analysis: How Do They Work? Roles of Agriculture Project: Newsletter.
- 14 Andrew S., Downes (Ed.), April, 1985. Inflation in Barbados: An Econometric Investigation, Economic Development and Cultural Change, 33.
- 15 Ayalew, Yohannes, 2007, Explaining the Current Sources of Inflation in Ethiopia: A Macroeconometric Approach [Second Draft], NBE Staff Paper, Addis Ababa.
- 16 Badawi, Ahmad, 2007, Time Series Macroeconometrics, Nairobi, pp. 1-12.
- 17 Banerjee, A., J. Dolado, J.W. Galbraith, and D. Hendry, 1993, Co-Integration, Error Correction, and the Econometric Analysis of Non-stationary Data. Oxford University Press, Oxford, United Kingdom.
- 18 Banerjee, Mrityunjoy, 1975, Inflation: Causes and Cures, With Special Reference to Developing Countries. The World Press Private Limited, Calcutta, India.
- 19 Barrett, Christopher B., 2002. Food Security and Food Assistance Programs, Cornell University, Warren Hall Ithaca. New York.
- 20 Barro, Robert, 1997, Macroeconomics. The MIT press, Cambridge Massachusetts.
- 21 Belete, Zewdu, 1997. The Dynamics of Inflationary Process in Ethiopia, Addis Ababa University - Unpublished, Addis Ababa.



- 22 Benkovskis, Konstantins, 2007. Inflation Expectations in Latvia: Consumer Survey Based Results, Bank of Latvia.
- 23 Bowen, William G., 1960. 'Cost Inflation' versus 'Demand Inflation': A Useful Distinction. *Southern Economic Journal*, 26(3), 199-206.
- 24 Branson, W, 1989, *Macroeconomic Theory and Policy*. Harper and Row, Publishers, New York San Francisco.
- 25 Braun, Joachim von, December, 2007, *The World Food Situation: New Driving Forces and Required Actions*, Policy Brief, Washington D. C.
- 26 Brunner, Karl (Ed), 1983, *Inflation, The Quantity Theory, and Rational Expectations*, vol. 5. North Holland Pub House, Amsterdam.
- 27 CBL, 2007. Central Bank of Lesotho: June, 2007 Economic Review. 82.
- 28 Chiang, Alpha C., 1984, *Fundamental Methods of Mathematical Economics*. McGraw Hill, New York.
- 29 Christiaensen, Milan Brahmhatt and Luc, May, 2008. *Poverty Reduction and Sustainable Development*, Poverty Reduction & Economic Management Department and Sustainable Development Department of the East Asia & Pacific region of the World Bank., Washington D.C.
- 30 Cochrane, E. W. Bunkers; Willard W., *Financial Sector Policy for Developing Countries*. *The Review of Economics and Statistics* in R. E. Hall, ed., *Inflation: Causes and Effects*. University of Chicago Press for the NBER., 39(2), 211-217.
- 31 Cochrane, P. and G. H. Orcutt, 1949. Application of least squares regression to Relationships containing autocorrelated error terms. *Journal of the American Statistical Association* (44), 32-61.

- 32 Cohen, B., 2006. Urbanization in developing countries: Current trends, future projections, and key challenges for sustainability. *Technology in Society*, 28, 63-80.
- 33 Conway, Jehan Arulpragasam and Patrick, 1994, *Partial Equilibrium Multi-Market Analysis*, pp. Chapter 12 Accessed on May 20, 2008.
- 34 Cooley, T. F., and S. F. LeRoy, 1985. Atheoretical Macroeconometrics, A Critique. *Journal of Monetary Economics* (16), 283-308.
- 35 Cooley, T. F and G.D. Hansen, 1989. The Inflation Tax in a Real Business Cycle Model. *American Economic Review*, 79, 733-748.
- 36 CSA, 2008. *Ethiopian Consumer Price Index: Methodology and Data Collection*, Central Statistical Agency, Addis Ababa.
- 37 \_\_\_\_\_, 2008. *Zena Masia*, Central Statistical Authority, Addis Ababa.
- 38 \_\_\_\_\_, February, 2008, *Statistical Bulletin*. Central Statistical Agency, Addis Ababa.
- 39 De Gregorio, J, 1995. *The Effects of Inflation on Economic Growth: Lessons from Latin America*. IMF Working Paper; WP/91.
- 40 Denboba, Habtamu, 2000. *The Causes of Low Inflation in Ethiopia*. MSc. Thesis, Addis Ababa University, Addis Ababa – Unpublished.
- 41 Dercon, Katleen Van den Broeck and Stefan, August, 2001. *Agricultural production changes in Ethiopia - Draft Paper*.
- 42 Dickey, D.A. and W.A. Fuller, 1979. Distribution of the Estimators for Autoregressive Time-Series with a Unit Root. *Journal of the American Statistical Association* (74), 427-431.
- 43 Domaç, Ilker, 1996. *The Main Determinants Of Inflation In Albania*, The World Bank, Washington, D.C. and Tirana, Albania.

- 44 \_\_\_\_\_, 1995. Poverty Reduction and Economic Management, World Bank, Washington, D.C.
- 45 Duft, Ken D., 1999. Extension Marketing Economist; Cooperative Extension, Washington State University, Pullman; Washington.
- 46 Eckstein, Dale Heien and Albert, May, 1978, The 1973 Food Price Inflation pp 186-196, American Journal of Agricultural Economics.
- 47 Enders, Walter, 1996, Applied Econometrics Time Series. John Wile and Sons Ltd, Chichester.
- 48 Engle, R.F. and B.S. Yoo, 1987. Forecasting and Testing in Cointegrated Systems. Journal of Econometrics Reprinted in: R.F. Engle and C.W.J., 35, 143-159.
- 49 Engle, R.F. and C.W.J. Granger, 1987. Cointegration and Error-correction: Representation, Estimation, and Testing. Econometrica Reprinted in: R.F.
- 50 Engle and C.W.J. Granger, eds., Long-Run Economic Relations: Readings in Cointegration. Oxford University Press: New York, 1991, 55, 251-227.
- 51 Evans, Alex, 2008. Rising Food Prices: Drivers and Implications for Development, IFPRI.
- 52 Fackler, David Orden and Paul L., May, 1989. Identifying Monetary Impacts on Agricultural Prices in VAR Models. American Journal of Agricultural Economics, 71(2), 495-502.
- 53 Fender, John, 1990, Inflation: A Contemporary Perspective. The University of Michigan Press, Michigan, U.S.A.
- 54 Fischer, Dornbusch R. and S., 1996. Moderate Inflation. The World Bank Economic Review, 7(1), 1-44.
- 55 Fischer, Stanley, 1981, Relative Shocks, Relative Price Variability, and Inflation, Brookings Papers on Economic Activity, pp. 381-441.
- 56 Flemming, John, 1976, Inflation. Oxford University Press, Great Britain.

- 57 FAO, 2003. Food Outlook (3), Food and Agriculture Organization of the United Nations (FAO), Rome.
- 58 Friedman, Milton, 1970, The Counter-Revolution in Monetary Theory (for Wincott Foundation), Occasional Paper, London, IEA.
- 59 \_\_\_\_\_, 1948. A Monetary and Fiscal Framework for Economic Stability. American Economic Review, 38(3), 245-264.
- 60 Frisch, H, 1990, Theory of Inflation. Cambridge University Press, Cambridge.
- 61 Fuller, D. A. Dickey and W. A., 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. Journal of the American Statistical Association, 74, 427-431.
- 62 Fuller, W. A., 1976, Introduction to Statistical Time Series. John Wiley & Sons, New York.
- 63 G, Moser, 1995. The main Determinants of Inflation in Nigeria.
- 64 Gabre-Madhin, Elleni, 2006, Does Ethiopia need a commodity exchange? An integrated approach to market development, the Ethiopia Strategy Support Program (ESSP) Policy Conference on Bridging, Balancing, and Scaling Up: Advancing the Rural Growth Agenda in Ethiopia. IFPRI, Addis Ababa.
- 65 Ghatak, Subrata, 1981, Monetary Economics in Developing Countries. The Macmillan Press Ltd., London.
- 66 Ghosh, A., 2000, Inflation and Growth, IMF Research Bulletin, pp. 1-3.
- 67 Ghosh, A and S. Phillips, 1998. Warning: Inflation may be Harmful to your Growth. IMF Staff Papers, 45(4).
- 68 Ghosh, Madhusudan, 2000. Cointegration Tests and Spatial Integration of Rice Markets in India, in V. M. Rao and N. A. Mujumdar. Indian Journal of Agricultural Economics, Mumbai. India, 55(4), 615-617.

- 69 Granger, C. W. J., 1969. Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. *Econometrica* (37), 424-438.
- 70 Granger, Eds., 1991, Long-Run Economic Relations: Readings in Cointegration. Oxford University Press, Oxford.
- 71 Greene William H., 2003, *Econometric Analysis*. Prentice Hall
- 72 Gregory Mankiw, Ball Laurence M., N., and David H. Romer, 1988. The New Keynesian Economics and the Output-Inflation Trade-off. *Brookings Papers on Economic Activity*, 1988(1), 1-65.
- 73 Gregory Mankiw N., 2000, *Macroeconomics*. Worth Publishers, New York.
- 74 Gregory Mankiw, et al, 1996. The Macroeconomics of Low Inflation. *Brookings Papers on Economic Activity*, 1996(1), 1-76.
- 75 Grey, David and Claudia Sadoff, 2002, Water Resources and Poverty in Africa: Essential Economic and Political Responses, African Ministerial Conference on Water, Abuja, Nigeria.
- 76 Gujarati D. N (Ed.), 2004. *Basic Econometrics*. McGraw-Hill Companies.
- 77 Gupta, S., 1982, *Monetary Economics, Institutions, Theory and Policies*. S. Chand and Company, New Delhi. India.
- 78 Hamilton, James D., 1994, *Time Series Analysis*. Princeton University Press.
- 79 Harris, Laurence, 1985, *Monetary Theory*, New York.
- 80 Harris, Richard, 1995, *Using Cointegration Analysis in Econometric Modelling*. Prentice Hall/Harvester Wheatsh University, Portsmouth.
- 81 \_\_\_\_\_, 1995, *Using Cointegration Analysis in Econometric Modelling*. Prentice Hall/Harvester Wheatsh, University of Portsmouth.
- 82 Harris, R.I.D, 1995, *Using Co-integration Analysis in Econometric Modeling*. Prentice Hall, Harvester Wheatsheaf, London.

- 83 Harris, Seymour E., 1949, *Monetary Theory and Fiscal Policy*. McGraww-Hill, Kogakusha. Tokyo.
- 84 Heien, Dale M., February, 1980. Markup Pricing in a Dynamic Model of the Food Industry. *American Journal of Agricultural Economics*, 62(1), 10-18.
- 85 Hendrik S., Houthakker John, and A. Schnittker, 1974. Food Prices and Inflation. Dale E. Hathaway; *Brookings Papers on Economic Activity*, 1974(1), 63-116.
- 86 Hoddinott, John, 2003. Examining the Incentive Effects of Food Aid on Household Behavior in Rural Ethiopia, International Food Policy Research Institute (IFPRI) and World Food Program (WFP), Washington D. C.
- 87 Imai, Hiroyuki, 1994. Inflationary Pressure in China's Consumption Goods Markets: Estimation and Analysis, in Shigeto. *The Developing Economies: Institute of Developing Economies* (Eds. Kawano et al), 32(2), 127-134.
- 88 IMF, 2007. *The Rise and Fall of Inflation: Lessons From The post war Experience*. World Economic outlook. International Monetary Fund, Washington D.C.
- 89 \_\_\_\_\_, 2006. *The Federal Democratic Republic of Ethiopia: Selected Issues and Statistical Appendix*, International Monetary Fund, Washington D.C.
- 90 International Water Resources Management Institute, 2004. *Experiences and Opportunities for Promoting Small-Scale Micro-irrigation and Rainwater Harvesting for Food Security in Ethiopia*.
- 91 Itagaki Yoichi et. al., 1979. Imported Inflation in Popua, New Guinea: 1972-1976 in Shigeto Kawano et al. (Eds.). *The Developing Economies: Institute of Developing Economies* (Eds. Kawano et al), Tokyo, Japan, 17(3), 344-345.
- 92 J., Barro R., 1995. *Inflation and Economic Growth*. NBER Working Paper, 5326.
- 93 Jarque, C.M. and A.K. Bera, 1980. Tests for normality, homoskedasticity and serial independence of regression residuals. *Economic Letters*, 6, 255-259.

- 94 Johansen, S., 1988. Statistical analysis of cointegrating vectors. *Journal of Economic Dynamics and Control*, 12, 231-254.
- 95 \_\_\_\_\_, 1991. Estimation and hypothesis testing of cointegration vectors in the presence of linear trend. *Econometrica*, 59, 1551-1580.
- 96 \_\_\_\_\_, 1995, *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*. Oxford University Press, Oxford.
- 97 Johansen, S. and Juselius, K., 1992. Testing Structural Hypothesis in Multivariate Cointegration Analysis of the purchasing power parity and the UIP for UK. *Journal of Econometrics*, 53, 211-244.
- 98 \_\_\_\_\_, 1990, *Maximum Likelihood Estimation and Inferences on Co-integration with the Application to the Demand for Money*, *Oxford Bulletin of Economics*, pp. 169-210.
- 99 Kapinos, Pavel, 2006, *Inflation* - Accessed on June 1, 2008.
- 100 Kedir, Sherefedin, 2007. *Tracing the Impact of the Impacts of Food Aid on Agriculture and Consumers in Ethiopia: CGE Model Approach*, Addis Ababa University: Addis Ababa - Unpublished.
- 101 Kersting, Mark A. Wynne and Erasmus K., April, 2007, *Openness and Inflation*, Staff papers of the Federal Reserve Bank of Dallas - Working Paper, Dallas.
- 102 Khan, A. and M. Qasim, 1996. *Inflation in Pakistan Revisited Part II*. *Pakistan Development Review*, 35(4), 747-759.
- 103 Kifle, Semu, 1994. *The Interaction of Government Deficit, Money Supply and Inflation in Ethiopia: 1967 - 1992*, Addis Ababa University, Addis Ababa - Unpublished.
- 104 Kilima, Fredy T. M., *Are Price Changes in the World Market Transmitted to Markets in Less Developed Countries? A Case Study of Sugar, Cotton,*

Wheat and Rice in Tanzania. Discussion Paper Thesis, Sokoine University of Agriculture, Morogoro, Tanzania.

- 105 King, Mike Belongia; Richard A., February, 1983. A Monetary Analysis of Food Price Determination. *American Journal of Agricultural Economics*, 65(1), 131-135.
- 106 Kirkpatrick, C.H. and F.I. Nixon (Ed.), 1981. *Theories of Inflation in Less Developed Countries* in Livingston (Ed.). *Development Economics and Policy*.
- 107 Kotwal, O. P., 1987, *Theories of Inflation: A Critical Survey*. Chicago University Press, Chicago.
- 108 L.Rubinfeld, Robert S. Pindyck and Daniel, 1998, *Econometric Models and Economic Forecasts*. McGraw-Hill Co.
- 109 Lamm, R. McFall, 1980. *The Dynamics of Food Price Inflation*, National Economic Analysis Division, Economics, Statistics, and Cooperatives Service; United States Department of Agriculture., USA.
- 110 Leamer, E. E, 1983. Let's Take the Con Out of Econometrics. *American Economic Review* (73), 31-43.
- 111 Lougani, P. and P. Swagel, 2001, *Sources of Inflation in Developing Countries*, IMF Working Paper No: WP/01/198.
- 112 Lucas, Robert E., Jr., 1981, *Rules, Discretion, and the Role of the Economic Advisor in Studies in Business-Cycle Theory*, R.E. Lucas, Jr., ed., M.I.T. Press.
- 113 M., Samuel, 2005. *The Demand for monetary policy in Ethiopia*. MSc. Thesis, Addis Ababa University, Addis Ababa.
- 114 M. J, Laider D.E.W and Perkins, 1975. Inflation: A Survey. *Economics Journal*, 85(340).

- 115 Maddala, G.S., 2001, *Introduction to Econometrics*. Macmillan Publishing Co., New York.
- 116 \_\_\_\_\_, 1985, *Limited Dependent and Qualitative Variables in Economics*. New York, Macmillan Publishing Co.
- 117 Maddala, G.S., and I.-M. Kim, 1998, *Unit Roots, Cointegration, and Structural Change*. Cambridge University Press, Cambridge, U.K.
- 118 MOFED, June, 2008. *Annual Report, Various Issues*, Ministry of Finance and Economic Development, Addis Ababa.
- 119 MOFED, 2007. *Annual Report on Macroeconomic Developments: Ethiopian Fiscal Year 1999 E.C (2006/07)*. Ministry of Finance and Economic Development, Addis Ababa.
- 120 Lougani, P. and P. Swagel, 2001, *Sources of Inflation in Developing Countries*, IMF Working Paper No: WP/01/198.
- 121 Lucas, Robert E., Jr., 1981, *Rules, Discretion, and the Role of the Economic Advisor in Studies in Business-Cycle Theory*, R.E. Lucas, Jr., ed., M.I.T. Press.
- 122 M., Samuel, 2005. *The Demand for monetary policy in Ethiopia*. MSc. Thesis, Addis Ababa University, Addis Ababa.
- 123 M.J, Laider D.E.W and Perkins, 1975. *Inflation: A Survey*. *Economics Journal*, 85(340).
- 124 Maddala, G.S., 1985, *Limited Dependent and Qualitative Variables in Economics*. New York, Macmillan Publishing Co.
- 125 Maddala, G.S., 2001, *Introduction to Econometrics*. Macmillan Publishing Co., New York.
- 126 Maddala, G.S., and I.-M. Kim, 1998, *Unit Roots, Cointegration, and Structural Change*. Cambridge University Press, Cambridge, U.K.

- 127 MOFED, June, 2008. Annual Report, Various Issues, Ministry of Finance and Economic Development, Addis Ababa.
- 128 MOFED, 2005, Building on Progress: A Plan for Accelerated and Sustained Development to End Poverty (PASDEP), 2 volumes. Ministry of Finance and Economic Development, Addis Ababa.
- 129 Mitchell, Donald, 2008, A Note on Rising Food Prices, Memo, Washington D.C.
- 130 Mohanty, M.S. and M. Klau, 2001, What Determines Inflation in Emerging Market Countries? BIS Papers No 8 Modeling Aspects of the Inflation Process and Monetary Transmission Mechanism in Emerging Market Countries.
- 131 Mulat Demeke et al., 2007, Exploring Demand and Supply Factors Behind The New Developments in Grain Prices In Ethiopia: Key Issues and Hypotheses, Department of Economics, Addis Ababa University and DFID Joint Research Project - ETHIPIA, Addis Ababa.
- 132 Mullendore, W. C., August 1957, Are Wages Inflationary? Management Record, Vol. 2, pp 272-276.
- 133 Mundell, R, 1968, International Economics, New York.
- 134 National Bank of Ethiopia, (NBE), 2008. Quarterly and Annual Reports, Various Issues, National Bank of Ethiopia, Addis Ababa.
- 135 Paul De Grauwe and Magdalena Polan, 2005, Is Inflation Always and Everywhere a Monetary Phenomenon? Scandinavian Journal of Economics. Balckwell Publishing, Oxford - Accessed in Novermber, 2007.
- 136 Phillips, P.C.B. and P. Perron, 1988. Testing for a Unit Root in Time Series Regression. *Biometrika* (75), 335-346.
- 137 Pindyck, Robert S. and Daniel L. Rubinfeld, 1991, Econometric Models and Economic Forecasts. McGraw-Hill, New York.

- 138 Quah, D. and Vahey, S.P., 1995. Measuring Core Inflation. *The Economic Journal* (432), 1130 - 1144.
- 139 R., Barro, 1997, Determinants of Economic Growth - A Cross Country Empirical Study. *American Economic Review*, 79, 733-748.
- 140 R. McFall Lamm, and R. McFall Lamm, 1978. Food Price Dynamics, National Economic Analysis Division, Economics, Statistics, and Cooperatives Service, United States Department of Agriculture.
- 141 Ramachandran, K. S., 1995, Inflation: The Critical Issues. Vikas Publishing House Pvt Ltd.
- 142 Richard Jackman et al., 1984, The Economics of Inflation. Basil Blackwell, Oxford.
- 143 Richard Jackman, Charles Mulvey and James Trevithick, 1981, The Economics of Inflation. Basil Blackwell, Oxford.
- 144 Richard Jackman Richard Layard, and Stephen Nickell, 1994, The Unemployment Crisis. Oxford University Press, Oxford.
- 145 Roop, R. C. Kite; J. M., 1981. Changing Agricultural Prices and Their Impact on Food Prices under Inflation. *American Journal of Agricultural Economics*; Proceedings Issue <http://links.jstor.org/sici> Retrieved on January 16 2008, 63(5), 956-961.
- 146 S., Dornbusch R. and Fischer, 1994, Macroeconomics. McGraw-Hill incorporated, New York.
- 147 Sala-i-Martin, Barro R. J. and X., 1995, Economic Growth. McGraw Hill, New York.
- 148 Sarel, M., 1995. Non-Linear Effects of Inflation on Economic Growth, International Monetary Fund, IMF, Washington D.C.
- 149 Sargent, Thomas J, 1993, Rational Expectations and Inflation. Harper Collins College Publishers.

- 150 Sargent, Thomas J., 1982, The Ends of Four Big Inflations in R.E. Hall, ed.,  
Inflation: Causes and Effects for the NBER. University of Chicago Press,  
Chicago.
- 151 Schimmelpfennig, Mohsin S. Khan and Axel, 2006, Inflation in Pakistan: Money or  
Wheat? SBP-Research Bulletin.
- 152 Shively, Gerald E., 1996. Food Price Variability and Economic Reform: An ARCH  
Approach for Ghana. *American Journal of Agricultural Economics*, 78(1),  
126-136.
- 153 Sims, C., 1980. Macroeconomics and Reality. *Econometrica* (48), 1-48.
- 154 Taslim, M., 1982. Inflation in Bangladesh: A Re-examination of the Structuralist-  
Monetarist Controversy. *The Bangladesh Development Studies*, 10(1), 26-29.
- 155 Terry Quinn, Geoff Kenny and Aidan Meyler, 1999. Inflation Analysis: An  
Overview, Central Bank of Ireland, Ireland.
- 156 The Sub-Saharan Informer (Weekly, English), Vol. on The Debate on Current  
Inflation in Ethiopia, June 2007
- 157 Todaro, M., 1995, Economic Development. Longman Publishing Ltd, London and  
New York.
- 158 Watson, M. W., 1994, Vector autoregressions and cointegration: Chapter 47 Vol. 4.,  
In: R. F. Engle and D. L. McFadden (Ed.), *Handbook of Econometrics*.  
North Holland Elsevier, Amsterdam.
- 159 William G. Cochran and Snedecor, George W., 1967, *Statistical Methods*. The Iowa  
State University Press.
- 160 Woldemichael, Andinet D., 2008, Food Price Inflation and the Urban Poor, Annual  
Conference on the Ethiopian Economy. Ethiopian Economic Association,  
UN ECA Conference Room.

- 161 Wooldridge, Jeffrey M., 2000, *Introductory Econometrics: A Modern Approach*. South-Western College Publishing.
- 162 Wooldridge, Jeffrey M., 2002, *Econometrics Analysis of Cross-section and Panel Data*. The MIT Press, London.
- 163 Wooldridge, Jeffrey M., 2003, *Introductory Econometrics: A Modern Approach*, U.S.A.
- 164 World Bank, 2007, *Explaining Sources of Food Price Inflation in Ethiopia: Just-in-time*, Policy Note, Addis Ababa.
- 165 World Development Indicators, WDI, 2007, *World Development Indicators Data Base*. The World Bank, Washington DC, pp. CD-ROM.
- 166 Xuehua Peng, Mary A. Marchant and Michael R. Reed, 2004. *Identifying Monetary Impacts on Food Prices in China: A VEC Model Approach*, University of Kentucky, Lexington, KY.
- 167 Yücel, Ilker Domaç and Eray M., 2003, *Inflation in Turkey*, Central Bank of Turkey Bulletin, Ulus, Ankara Turkey.
- 168 Zijsra, J., 1991. *A Central Baner's View - Selected Speech and Articles: A Book Review* by Edward J. Bomhoff. *Journal of Monetary Economics*, 22(3).

Annex A: Recent Trends in general & food price inflation and its details.

Fiscal Year & Month	General Index	Country Level Inflation Rate										
		Food Total	Beverage	Cigaretts & Tobacco	Clothing & Footwear	House Rent, Construction, Material, Water, Fuel, & Electricity	Furniture, Furnishing, Household Eqpt. & Decoration	Medical Care & Health	Transport & Communication	Recreation, Entertainment & Education	Personal Care & Effects	Miscellaneous Goods
Weight	100	60.1	2.0	0.5	9.3	15.4	4.9	1.2	2.0	1.0	0.9	2.6
2001/02	-8.5	-6.7	12.7	5.6	0.3	-18.3	-18.2	15.2	-37.9	11.9	5.4	-45.7
2002/03	15.1	24.8	1.1	7.5	-2.4	7.2	-1.5	0.0	4.2	-24.0	-45.6	-46.7
2003/04	8.6	11.8	0.1	-2.8	0.6	6.3	-0.2	-1.4	1.9	-0.9	6.8	0.0
2004/05	6.8	7.7	1.1	-10.5	0.8	9.3	2.4	4.9	7.9	3.3	13.5	0.0
2005/06	12.3	14.0	6.9	38.1	3.3	12.8	-5.8	1.8	6.4	4.2	9.7	0.0
2006/07	17.8	18.9	10.9	-17.3	8.4	21.3	13.4	5.3	21.3	-7.0	16.8	0.0

Fiscal Year & Month	General Index	Addis Ababa Inflation Rate										
		Food Total	Beverage	Cigaretts & Tobacco	Clothing & Footwear	House Rent, Construc, Material, Water, Fuel, & Energy	Furniture, Furnishing, Household Eqpt. & Decoration	Medical Care & Health	Transport & Communication	Recreation, Entertainment & Education	Personal Care & Effects	Miscellaneous Goods
Weight	100	60.1	2.0	0.5	9.3	15.4	4.9	1.2	2.0	1.0	0.9	2.6
2001/02	-9.2	-6.7	-12.7	1.3	20.4	-25.9	-10.9	8.7	-25.9	-9.9	5.9	30.9
2002/03	-4.6	9.6	-2.7	3.9	-1.0	3.6	-0.6	0.1	-0.1	-1.3	4.5	3.6
2003/04	5.6	8.6	2.3	0.9	-2.9	7.3	1.4	-4.9	2.8	3.8	4.3	-7.6
2004/05	7.2	5.7	0.9	-0.9	-1.5	11.0	3.6	55.5	8.9	11.6	-1.4	0.0
2005/06	8.4	13.0	5.8	1.8	5.3	8.8	3.1	13.0	3.3	2.4	2.4	0.0
2006/07	18.6	25.2	17.8	-0.4	2.7	12.9	12.9	24.9	13.4	10.7	19.8	0.0

Source: IEA Database, 2005

## Annex B: Essentials of Matrix Algebra: Characteristic Roots and Rank

### Characteristic Roots

Let  $A$  be an  $(n \times n)$  square matrix with elements  $a_{ij}$  and  $x$  and  $(n \times 1)$  vector. The scalar  $\lambda$  is called the *characteristic root* of  $A$  if

$$[A.1] \quad Ax = \lambda x; \text{ Let } I \text{ be an } (n \times n) \text{ identity matrix, so that we can rewrite [A.1] as}$$

$$[A.2] \quad Ax - \lambda x = 0 \text{ or } (A - \lambda I)$$

Since  $x$  is a vector containing values not identically equal to zero, the above equation requires that the rows of  $(A - \lambda I)$  be linearly dependent. That is, it requires that the determinant  $|A - \lambda I| = 0$ .

Thus, we can find the characteristic root(s) of [A.1] by finding the values of  $\lambda$  that satisfy

$$[A.3] \quad |A - \lambda I| = 0$$

And, [A.3] is called the characteristic equation of the square matrix  $A$ .

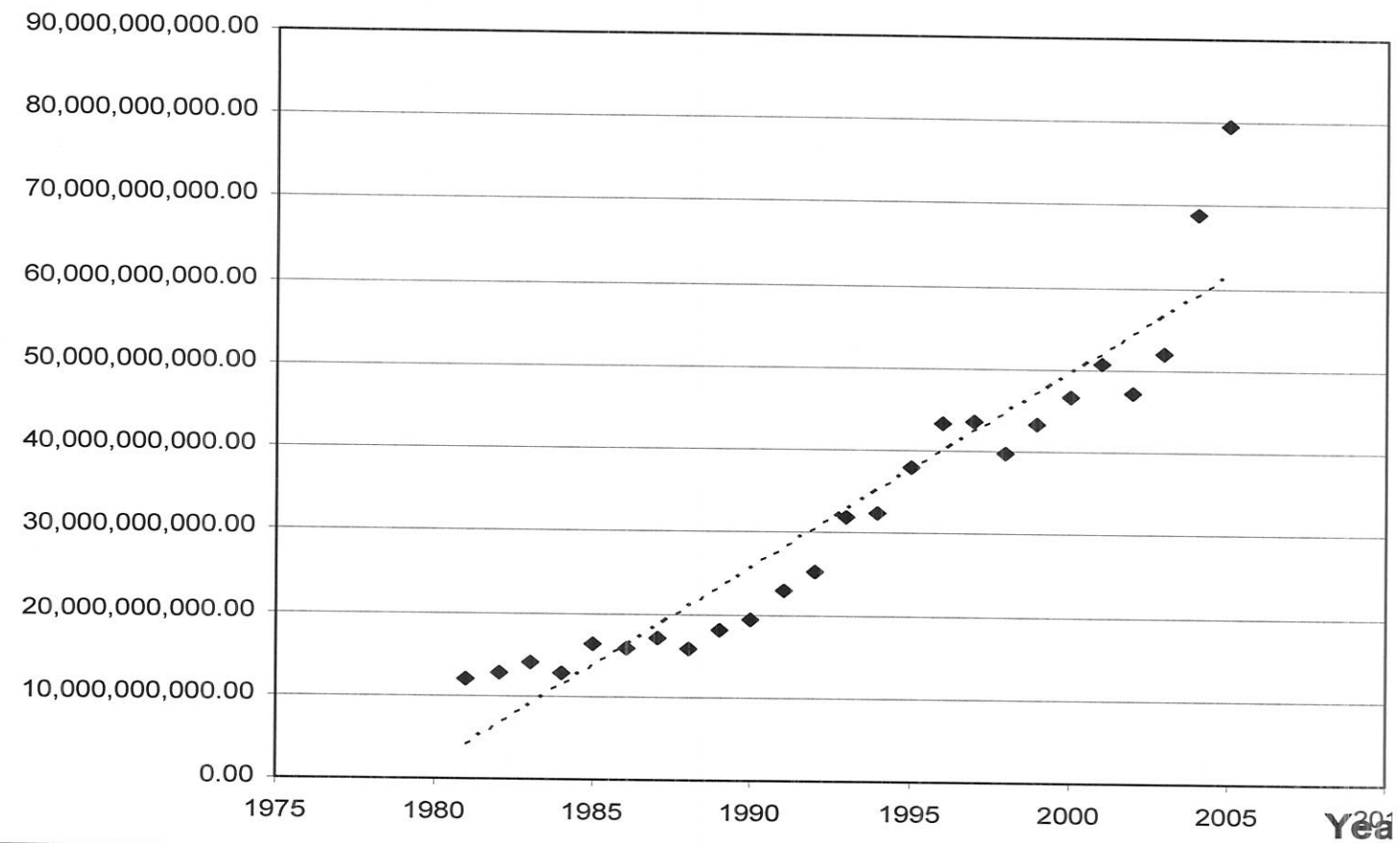
### Rank of a Matrix

The rank of a square  $(n \times n)$  matrix  $A$  is the number of linearly independent rows (columns) in the matrix. The notation  $\text{rank}(A) = r$  means that the rank of  $A$  is equal to  $r$ . The matrix  $A$  is said to be *full rank* if  $\text{rank}(A) = n$ . This entails that the rank of  $A$  is equal to the number of its non-zero *characteristic roots*. If all the rows of  $A$  are linearly independent, the determinant of  $A$  is not equal to zero. None of the characteristic roots can equal zero if  $|A| \neq 0$ . On the other extreme, if  $\text{rank}(A) = 0$ , each element of  $A$  must be zero and the characteristic equation degenerates in to  $\lambda^n = 0$  with the solutions  $\lambda_1 = \lambda_2 = \lambda_3 = \dots = 0$ . Therefore, the rank a matrix is equal to the number o its characteristic roots that differ from zero.



**Annex C: Household Final Consumption Expenditure, Current (Eth Birr)**

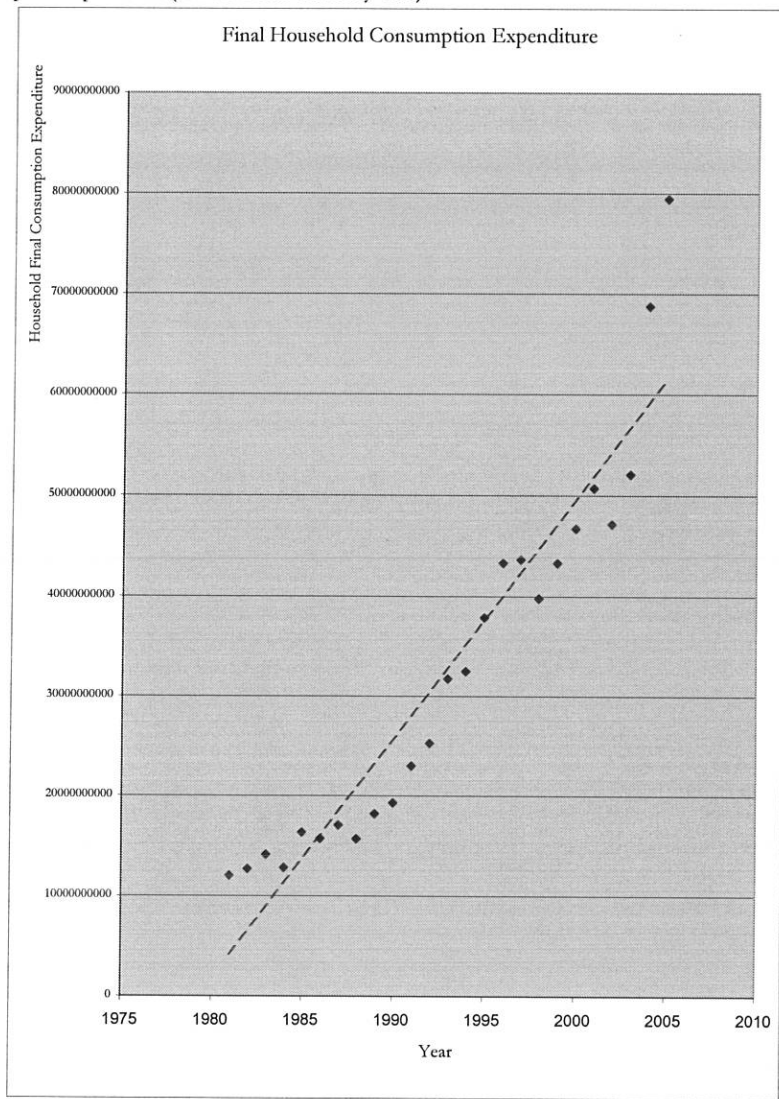
Household Final Consumption Expenditure  
(Eth Birr in Millions)



**Annex D Trends in Household Final Consumption Expenditure**

Year Household final consumption expenditure (current Local Currency Unit)

1981	12037252096
1982	12699890688
1983	14121351168
1984	12800325632
1985	16352251904
1986	15724964864
1987	17077748736
1988	15686849536
1989	18182799360
1990	19301808128
1991	22962808832
1992	25234427904
1993	31743934464
1994	32491028480
1995	37876862976
1996	43304747008
1997	43679092736
1998	39806185472
1999	43314057216
2000	46730985472
2001	50764005376
2002	47201005568
2003	52095746048
2004	68744953856
2005	79465644032



## DECLARATION

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

Taddesse Emiru Anley

[Name]



[Signature]

October 3, 2008

[Date]

Gebrehiwot Ageba (Ph. D)

[Advisor]



[Signature]

October 3, 2008

[Date]

