

**ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES**

**Spatial Integration of White Wheat Markets in Ethiopia: Along with
Improvements in Transport Infrastructure**

**By
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**A Master's Thesis Submitted to the School of Graduate Studies of Addis Ababa University in
Partial Fulfillment of the Requirements for the Degree of Master of Science in Economics
(Economic Policy Analysis)**

**July, 2006
Addis Ababa, Ethiopia**

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Acknowledgments

Thank God,

First and foremost I would like to extend my heart felt gratitude to my advisor, Dr. Dejene Aredo, for his continual comments and tireless advice through out the year.

I am also very much grateful to Awash International Bank (AIB), for sponsoring my study and giving me the opportunity to participate in the program ; and all the staffs of AIB in general and the staffs of Business Development Department in particular for their contribution, in one way or another, towards the realization of the paper.

Special thanks to Dr. Eleni Gabre-Madhin, who have given me the chance to be attached to IFPRI and be able to share all those very useful experiences , access to various materials and for her insightful lead in to and advise on the topic, I really appreciate.

I am also highly indebted to Dr. Kinde Getenet who has devoted much of his time and has been very much supportive through out the year. I also thank Dr. Shaidur Rashid and Dr. Alemayehu Seyoum, for their encouragement and assistance.

Many thanks to Prof. Walter Enders for the technical assistance he gave me through our e-mail exchanges devoting his precious time.

I owe much to Ato Fantu Gutu, who has been very much cooperative and willing to devote his time to advice and help me on much of the technical difficulties of the paper.

Many thanks and high appreciation to Ato Kiflu, Ato Nigussie, Ato Gemechu, Ato Liyousew and W/t Hiwot for their free-inter mate flow of information through out the year.

I owe profound thanks to my class mates who have been so informative and helpful and for their charming attitude through out the year and this includes: Kassesh, Toli, Miki, Andu, Ashu, Z, Abdu, Rebeka and Abresh.

I am also highly indebted to W/rt Ethiopia, Ato Hashim, Beza, Senedi, Mahi, Bini and Zeki who have been so much cooperative in providing various materials and support so generously.

I am also sincerely grateful to Denbi and Teddisha for their continuous help and encouragement through out the program; besides many thanks and special appreciation to Azeb Semu (Azi) for typing this paper meticulously.

I would like to extend my deepest gratitude to my beloved sisters, Merry, Chilly, Helli and Kube, with out whom this paper wouldn't have been easy to complete, besides I would also want to thank Kukuberri and Wodere for their support and caring through out the program.

Last but not least, I would also want to extend my deepest gratitude to Ato Essayas Tefera for his help and Dr. Samuel Gebreselasie for the useful materials and very nice lead to the topic.

Thank you all.

Seneshaw Tamru

July, 2006

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Abstract

This paper attempts to analyze the impact road infrastructure may have on the level and degree of grain market integration on selected Ethiopian markets. Using wholesale price series of six markets and based on monthly data from January 1996 to December 2005, which is disaggregated in the pre and post construction periods, one of the major staple food crops of the country, white wheat is analyzed. The other two major crops, teff and maize were also considered in the descriptive analysis.

A threshold autoregressive (TAR) Model in the form of Error Correction Model is used to evaluate the level of integration and speed of adjustment towards equilibrium. The findings of the paper show that there is enough evidence to conclude that the deficit areas are isolated from Addis while the surplus areas were found to be well integrated in both periods. Some of the markets under consideration are found to be inefficient as smaller deviations than the threshold level from the long term equilibrium tend to be cleared (arbitraged) away; the results also show that the markets under consideration, could be clustered in to three market groups, that is the surplus areas including Addis, in one group and the two deficit areas each in other groups independently, isolated from Addis. The findings imply that any agricultural grain marketing policy should realize and be aimed at these three segregated groups, separately. The results suggest that geographic differences and distance are important factors affecting spatial markets integration between Addis and the regional markets. The results also propose, the requirement of government intervention mechanisms, such as availability of information (access to local media and telecommunications facilities), as key factors to improve spatial market integration between the markets. Moreover, as construction of roads alone hasn't as such improved and produced a significant impact on the level of market integration, the results indicate the need for a coordinated effort of the other market enhancing instruments; market information and institutions and put forward a system of commodity exchange as a mechanism that can incorporate these instruments.

Key words: Market integration, threshold level, Monte Carlo simulations, wheat, and construction of roads.

Chapter One

1. Introduction

1.1 Background

Accounting for about 46.9% of the GDP, employing 85% of the labor force, constituting about 90% of the exports and supplying most domestic food requirements, agriculture remains very central for Ethiopia's economy (www.ento.csiro.au). In spite of the sector's significant potential, structural food shortage has hampered the country's economic development for the past several years. Hence, ensuring sustained levels of agricultural marketed surplus of food both in terms of sufficient quantities and reasonable prices would be of crucial importance in the attempt of achieving development goals in a poor country like Ethiopia.

Even though grains are the most important field crops and the chief elements in the diet of the majority of the population, Ethiopia's major staple crops include a variety of cereals, pulses, oilseeds, and coffee. The most important grains are teff, wheat, corn, barley and millet; however, the first three grains constitute the staple foods of a good part of the population.

The demand for grains has shown a continual rise though on the other hand, supply has remained short, largely because of drought and market access, which harmfully affected crop production (www.us.library.org).

It is well known that, there is a time lag between planting and harvesting of agricultural production and even though producers do not have the power of controlling prices individually, they can be in charge of deciding the timing of supplying their product in

relation to this a given producer faces substantial probability of either a rise or fall of price in sometime after the harvest. A price rise is typically considered as a good fortune while the decline is viewed as a risk or bad fortune. The main reason of grain price differences across the world could be the result of surplus or deficit production of various regions in that grain prices are generally higher in grain-deficit, densely populated and port regions and lower in the inland producing regions (Penn state university, 2003).

Like other agricultural commodities, grain producers are prone to a great deal of uncertainties caused by the forces of supply and demand like changes in: weather and resulting yields, in foreign and domestic policies, in government and trade policies (Alabama Agriculture & Mechanical University, 2005).

Grain prices are prone to fluctuations because of the short-run inelasticity of supply and demand for them. Specifically, price fluctuations are created mostly from the supply side for the demand side is more sensitive to changes in income and taste than to price. Besides, the supply side is seasonal in nature in that grains are in excess supply at harvest and fall short during the remainder of the market year. This would lead to seasonal cycles of low prices during harvests followed by rising prices as stocks are drawn down (Commodity Futures Trading Commission, 1997).

If agricultural growth is to be realized, developing countries have to make sure and pave the way through which effective marketing and distribution systems are realized. This is expected to upgrade the performance of agricultural trade where by agricultural inputs are timely and efficiently delivered and small farmers are able to sell their produce easily and satisfactorily, and intern buy what they need (UNDP).

It has been stated in many literatures that trade enhances people's welfare by allowing them to specialize and capture the producer and consumer surplus. Nevertheless, a significant number of households in the developing countries still live largely in subsistence farming and the puzzle of rational decision makers withdrawing from the markets has been part of the development debate for years (Eskola, 2000).

The modern days are characterized as an era of increased development and economic integration. Improvements in transmission and communication mechanisms have made it easier for buyers and sellers to contact each other, resulting in a high level of market integration. Economic integration resulted in a more efficient use of resources, an increase in trade and an increase in productivity and overall production (Mohammed Ismet et.al., 1998). Efficiency of markets depends among other things on the number of traders, the level of competition among them and on the amount and costs of information at their disposal (Federico, 2004).

Market integration can be interpreted as the extent to which price shocks are transmitted between spatially separate markets (Goodwin and Piggott, 2001). The law of one price (LOP) and Purchasing Power Parity (PPP) have been used in many literatures of international trade as an aggregate method of evaluating market integration. While some analysis of the LOP have assessed the relationship between domestic and foreign prices, others have also studied price transmission issues across regions of the same country (Serra et al., 2004).

1.2 Statement of the Problem

Road transport contributes towards access to such facilities as, schools, health centers and water apart from the obvious importance of physical access to resources and markets, and its importance as social, economic and political integration (ERA, 2006). Moreover, expansion

of road network can add to economic diversification. It enables the exploitation of economies of scale and reducing a country's vulnerability to shocks. Besides, an efficient road transport service by raising the volume and efficiency of trade widens the market (ERA, 2006).

Government can affect the living standards of those people in agriculture sector in general and those in grain production and marketing sector in specific, through its policy by identifying policy changes that may induce technological innovation and productivity growth (GMRP, 1997).

If markets are integrated, individual markets are no more only based on their local demand and supply but also on the situations happening in the other markets, and this mechanism of price transmission would be relatively easy to alleviate food shortages of the deficit areas. Moreover, in integrated markets, any shock would immediately be transmitted and arbitrated away, which would make prices to be more stable (Getnet, et.al., 2006)

There has been a lot of emphasis and support given for increased grain production through the package of agricultural technologies and inputs. It is only recently that market integration has emerged as an important issue in Ethiopia (Negassa, 1997; Negassa et.al., 2004; Sinkie, 1995; Tschirley et.al., 2003; Gabre-Madhin, 2003 and Dessalegn, 1998) in fact there are few articles which have focused on spatial market integration in Ethiopia (e.g. Negassa, 1997). However, fewer literatures (e.g. Negassa, 2003) have focused on the market integration of local regions and the role of the current improvement in transport infrastructure in the level of spatial market integration. In this paper, however, is intended to concentrate on spatial integration of regional markets along with the improvements in transport infrastructure and assess their integration and also give attention to the major staple foods of the country: teff (mixed teff), maize (white maize) and wheat (white wheat). Besides, the paper tries to use the

recently developed econometric model, Threshold Autoregressive (TAR) model, which will be expected to help reveal a better picture of the purpose.

1.3. Objectives and Research Questions of the Study

The main objective of the study is to evaluate the degree of integration of wheat grain markets along with the recent development of road infrastructure. The specific objectives of the study are:

- To analyze how road infrastructure affects the extent of market integration.
- To investigate differences in the extent of market integration between Addis Ababa and the food deficit and surplus areas in Ethiopia.

Being driven by the abovesly stated objectives, the study posses the following research questions:

- What are the impacts of infrastructure, especially that of construction of roads, on the direction of regional market integration?
- Which markets: those in surplus areas or those in deficit areas, are more integrated to Addis Ababa market and important in determining grain prices?

1.4. Hypotheses of the study

1. Construction of roads by lowering transaction costs would increase the degree of market integration
2. Level of integration of the regional markets with Addis Ababa market is higher for the deficit markets than the surplus markets

1.5. Significance of the study

As producer-marketing decisions are based on information about the markets, poorly integrated markets may reveal inaccurate price information, which leads to inefficient product movements (Goodwin and Schroeder, 1991). In developing countries well-integrated markets have been found to contribute significantly towards improvement of the lives of poor rural households. The degree and magnitude of a price shock transmission from one market into another entirely depends on how well the regions are connected by arbitrage (Ravallion, 1986). Government policies may perform the task of insuring food security and price stability, in the short run; and promote market integration and reduce high policy cost of segmented markets, in the long run (Negassa, 1997). Hence, knowledge of the extent of spatial market integration does have a significant importance for designing successful agricultural price stabilization policy.

There are many reasons for the need to assess the Ethiopian grain market price transmission across spatially linked markets, where grain takes the major share of poor farmers' income. Undertaking such analysis would help to assess the nature of price relationship, the direction of causal relationship, and the major determinants of grain prices. Moreover, examining the degree of market integration may be helpful in contributing towards the appropriate design of agricultural price policy making. These issues would help in designing and guiding efficient and cost effective government market interventions such as price stabilization and food aid distribution policies (Negassa, 1997).

Hence, this paper is believed to contribute towards identification of the degree and level of spatial market integration in relation to the road sector development and by then contributes towards agricultural development and rural households' way out of poverty.

1.6. Scope of the study

The study relies on price data of selected varieties of the main staple grains of the country: mixed teff, white wheat and maize. It is based on monthly data for the period from January 1996 to December 2005. Based on availability of data the study covers eight markets for each mixed teff and maize; where as it only covers six white wheat markets. Besides, while the descriptive analysis covers all the three cereals, the empirical analysis only discusses the case of white wheat. Moreover, the study concentrates on whether or not the construction of roads has affected the degree of market integration and not on the nature and/or state of road construction in Ethiopia.

1.7. Data Collection and Methodology

Markets are said to be integrated if a process of arbitrage connects them. This will be reflected in the price series of commodities in spatially separated markets (Campenhout 2005). Thus, the analysis of this paper is entirely based on secondary price data collected from Ethiopian Grain Trade Enterprise (EGTE), Central Statistical Authority (CSA), Ethiopian Transport Authority (ETA) and Ethiopian Road Authority (ERA)

The data is in a monthly basis and covers periods from January 1996 to December 2005. For all the three cereals under discussion, i.e. teff (mixed teff), wheat (white wheat) and maize (white maize), the wholesale price level is considered; besides, the before after approach is based on, except for Nekemte where the starting date is considered due to the fact that there is no any completed road between Addis and Nekemte, the final completion date of the roads constructed between Addis and the respective towns, here construction could refer to: upgrading, new construction or rehabilitation.

Since, the roads from Addis Ababa to the towns under consideration could be constructed on discontinued phases and/or lengths and obviously at different times; and significant number of construction phases have been going on, the completion date of the phase with the longest distance is considered as the demarcation date of the before after approach.

In addition, based on data availability, road construction route and importance as a major terminal market, eight markets are chosen for the descriptive analysis: Addis Ababa (ADD), Nazareth (NAZ), Shashemene (SHA), Nekemte (NEK), Dire Dawa (DD), Mekelle (MEK), Jimma (JMM) and Bahir Dar (BDR). While all the eight markets are considered in the analysis of mixed teff and maize, Nekemte and Bahir dar are withdrawn from the empirical analysis due to incomplete data. On the other hand, for the econometric analysis, only white wheat is considered, as the main purpose of the paper is to analysis the market integration of white wheat markets.

Furthermore, Addis Ababa is considered as the central market based on its size and locational advantage. Given that the Ethiopian road sector development is going on the basis of a radial configuration, Addis Ababa, a market considered central to the country, is granted the opportunity to enjoy a natural advantage to be a national clearinghouse for grains. This phenomenon does have an implication that the regional markets cannot trade directly with each other and as a result regional sellers have to bring grain to the central market and buyers would come to the same market to purchase the grains. (Gabre-Madhin, 2001)

The descriptive statistic tools used are mean, coefficient of variation, price differential and correlation coefficient. These analytical tools are believed to highlight the level of market integration, direction of flow of trade and degree of transmission of shocks.

Regarding the econometric analysis, the data is going to be analyzed using time series econometrics in the form of advanced co-integration analysis with Threshold Auto Regressive (TAR) model. In the intention of incorporating the potentially serious problem with the distributional assumptions of the Parity Bound Model (PBM), this paper reverts towards TAR model. With all its shortcomings, the TAR model is better suited to capture the dynamic nature of market linkages (Campenhout, 2005).

In this paper the impact of construction of roads on the degree of market integration is analyzed using a bivariate cointegration model -Threshold Autoregressive model (TAR). This will be done by adopting before-after approach i.e. before and after the construction of the roads and the null hypotheses that construction of roads by lowering transaction costs increase both the speed and level of wheat market integration is going to be tested. Besides, whether construction of roads by lowering transaction costs¹ will reduce the threshold levels will also be tested. Hence the test would be conducted in both periods (i.e. after the construction and before the construction) and compare the two parameters.

To address the stated objectives and analyze how the constructions of roads affect the level of market integration and direction of causality we rely on TAR model. Our aim here is to measure the level of transmission of shocks of carefully selected locations to Addis Ababa market. Because of its locational advantage and size of the market, Addis Ababa is regarded as a central market. Hence, the analysis is based on consideration of Addis Ababa as a central market and tries to assess the level of market integration before and after the construction of the roads. Besides, as constant transaction cost is the implicit assumption of TAR model it is relatively be sensible to differentiate the two road conditions and analyze the level of

¹ Transaction cost refers to the cost traders would face in moving the goods from one town to another and it includes costs of: loading, freight tariff (transportation), unloading, warehouse (storage), sacking etc...

integration for each period. Thus, the need of assessing the level of market integration between the selected locations and the central market, Addis Ababa, in the two periods of road construction is evident.

Even though, transaction costs and trade flows would contribute a lot in the analysis of spatial market integration, the inaccessibility and difficulty of gathering their data would force researchers to find other ways of assessing spatial market integration. As is mentioned in Campenhout (2005), studies relying on price data alone to evaluate market interrelation have been labeled level I methods. Here, also, since we are almost totally relying on price data, this paper can be classified as level I method.

The paper is organized in such a way that the next chapter reviews the literatures related to the issue while Chapter III presents the descriptive analysis. In Chapter IV, the methodology and specification of the model is presented, the next chapter, chapter five, follows with empirical (econometric) analysis while the last chapter concludes.

Chapter Two

2. Review of Related Literatures

2.1 Theoretical Perspectives

Many of the specialized literatures have tried to define spatial market integration in various ways. On the one hand, markets are said to be integrated if there are enough agents who intervene in the markets and act in such a way that prices reflect all the available information and no abnormal profit exists in any of those markets. On the other hand, markets are said to be integrated if the price difference between two markets is small (D' Angelo, 2001).

Alternatively, spatial market integration could be defined as a co-movement of prices, and, more generally, as a smooth transmission of price signals and information across spatially separated markets. It could also be the opening and development of trade between markets and their integration in to a single operative entity (flow) and trade is the central part of market integration. But market integration alone does not guarantee or imply the markets are competitive (Baulch, 1997).

In a more formal approach, following Barret and Li (2000), spatial market integration could be stated as tradability or contestability between markets. This definition would indicate the movement of the respective commodity from the excess supply to the lower supply, in a Walrathian sense, the transmission of price shocks between the markets, or both. This approach emphasizes that an actual transfer of goods need not be observed to guarantee that markets are spatially integrated (D' Angelo, 2001).

Market integration is concerned with the free flow of goods and information and by then involves prices over form, space, and time and can be related with market efficiency. While vertical integration involves marketing channels (or stages), spatial integration, on the other

hand, is concerned with markets separated in space where as inter temporal integration refers to arbitrage across periods (Barret, 1995).

Among many factors that can influence prices of agricultural commodities, the major ones are: cost of production and marketing, government marketing policies and supply and demand situations, structure and concentration of marketing channels. It is important to see not only why the prices change but also how these changes are felt by different participants at the different levels of the agricultural marketing system. The latter issue is concerned with price transmission across the vertical marketing channels, in other words, the vertical integration of the marketing system. Regarding the analysis of vertical price transmission, it is concerned with the determination of the causal price linkages among different marketing levels (producer-wholesale-retail), the extent and the speed at which the price change occurring at a given marketing level is also reflected on other marketing level. The same approach of price transmission analysis could be used for both vertical marketing system and horizontal (across spaces) marketing system (Negassa 1997).

Price relationships among spatial markets may be affected by such factors as: the flow of information through the marketing system and individual market participants' access to market information, transportation cost and type of the product. On the other hand, the price linkages would negatively be affected by the lack of sufficient information and high transportation cost (Negassa 1997).

Even though spatial integration and efficiency between markets is restricted and distorted by distance between them as well as geographical differences, government intervention could also significantly affect spatial integration. Government intervention elements could be:

telecommunication facilities, road density or access to wholesale markets and these are capable of improving efficiency and integration between markets (D' Angelo, 2001).

The benefits of well-integrated market systems are widely accepted and are commonly acknowledged. As producer-marketing decisions are based on information about the markets, poorly integrated markets may reveal inaccurate price information, which leads to inefficient product movements (Eskola, 2000). Furthermore, developing countries should also take, some additional cases, into consideration for the realization of well integrated market systems. In these countries, well-integrated markets have been found to contribute significantly towards improvement of the lives of poor rural households (Campenhout, 2005). Besides, the prevalence, level and persistence of famines in market economies are also closely linked to market integration. The degree and magnitude of a price shock transmission from one market into another entirely depends on how well the regions are connected by arbitrage (Ravallion, 1986). The knowledge of the extent of spatial market integration does also have a significant importance for designing successful agricultural price stabilization policy (D'Angelo and Cordano, 2001).

Studying market integration could be initiated by several factors, the main being identifying the major or important markets for government intervention.

Since the last two decades, apart from the importance of the field, research on the field of market integration has been required for two additional factors. Primarily, many developing countries are undergoing economic reform and market liberalization, and hence, studying market integration is needed to evaluate policy (Dercon 1995). Secondly, the availability of time series data on price at higher frequencies than ever before for various locations has also initiated researches to engage in research in the field; in relation to the second point, however,

data on the other important factor affecting market integration, transaction cost data, is rarely available. Accordingly, researchers have been challenged to reveal the degree of market integration relying on price data of a particular commodity in different markets (Javier and Arturo, 2001).

If markets are well integrated, the government can either withdraw itself from or at least reduce level of intervention, its effort of influencing the price process of those markets. A scarcity in one market would immediately be transmitted to the other markets hence; the government can easily affect all the integrated markets by intervening in only few important markets without intervening in every market. Knowledge of market integration, by giving important information about the process of transmission of incentives across marketing chain, helps the government towards the success of policies such as market liberalization and price stabilization. A well-integrated and efficient market ensures regional balances occur between food-deficit and food-surplus locations. If price do not be transmitted properly, the localized scarcities and surpluses would cause excessive strain on the society (Goletti et.al., 1995).

Establishing the relevant spatial markets would help analyze the competitiveness of a market and sectoral or macroeconomic conditions. This is because if markets are not spatially integrated, cross-sectional aggregation of demand and supply losses its logical foundation-for a segmented market requires a more costly disaggregated analysis (B. Barret, 1995).

Well functioning markets, by matching demands and supplies across actors, play a fundamental role of ensuring economic policies attain their desired targets (Barret 2005).

In an analysis of spatial market integration, the starting point would be the existence of separate regions each with their own supply and demand conditions for a range of commodities. Hence, because of the fact that each product has its own supply and demand

functions, autarkic prices of each region can easily be identified from these functions at each point in time (say P_t^{1A} and P_t^{2A}) for each homogeneous commodity (Ravalion, 1986).

But, with an introduction of free trade across the regions, the actual price could deviate from the autarky prices. Subsequently, if the price differential between the two regions (P_t^{1A} and P_t^{2A}) exceeds the transaction cost at time $t(T_t)$ required to move a unit of good from one region to another, agents can make profit by shipping the good from the region with the lower price to the one with higher price. This process would eventually increase supply of the good, by then decrease price in the market with higher autarky price while in the other market, the one with lower autarky price, by increasing demand by then increase price. This process continues until the price differential equals transaction cost, T_t (Meyers, 2004).

Hence, markets are said to be spatially integrated if they are connected through such a process of arbitrage². However, if the price differential is lower than the transaction cost to ship a unit of a commodity, rational agents do not wish to engage themselves in any form of arbitrage, since any arbitrage would result in loss. Since, in this case, the actual prices are the autarky prices, prices will move independently, although it would be wrong to conclude from this that these markets are segmented (Ismet, 1998).

As the main purpose of studying market integration is characterization of the degree of co-movement of prices across spatially separated markets and as prices are the most readily available and most reliable information in the studies of markets of developing nations, market integration studies do almost solely rely on price patterns. More specifically, market integration studies of these countries are restricted to the inter dependence of price patterns across different locations (Goleti et. al. 1995).

The Law of one price (LOP) is used to be considered as a general approach of testing market integration and it assumes if markets are integrated, a price change in one market would be transmitted to other market on a one-for-one basis to the other market. It tests for a perfect co-movement of prices between markets under consideration. This approach is criticized for in that trade flows must occur in every period, the model rejects an actual spatial integration if non-random changes occur in transfer costs. This approach also assumes that prices in one market are exogenously set (Ismet et.al., 1998).

Moreover, most theories of market integration involves (or are based on) the Law of One Price (LOP). That is, as trade takes between two markets, in the assumption that any abnormal shocks to the system and existence of rational agents capable and willing to engage in arbitrage, any price difference of the commodities and services would become lesser and lesser and eventually disappears. But the problem with the LOP is that it assumes transaction costs are either considered constant or rejected (Jacks, 2000).

At the global level, in the assumption of the Law of One Price (LOP) and Purchasing Power Parity (PPP), price adjustments across countries determine monetary policies, exchange rate policies and the distribution of the gains from trade. At the national level, well-integrated markets ensure that macro-level policies affect the incentives and constraints faced by micro-level decision makers. This is because macroeconomic policies are usually ineffective in the absence of well functioning markets. Markets do also play an important role of managing risks associated with demand and supply shocks (Barret, 2005).

According to Federico, the concept of market integration was envisaged by late 18th century economists and was formally defined, for the first time, by Cournot. In Cournot's way of

² Arbitrage is a process of moving a commodity from an area of a lower price to an area of relatively higher

expression, market is said to be integrated when an entire territory of which the parts are so united by the relations of unrestricted commerce that prices take the same level throughout with ease and rapidity. Even though its current interpretation is much less requiring, taken literally, the LOP is a fairly strong standard which can seldomly attained (Federico, 2004).

Two spatially separated markets, in the existence of trade, usually considered integrated if:

$$|p_i - p_j| \leq T_{ij} \quad \dots\dots\dots (1)$$

where T_{ij} ("commodity points") is the total transaction cost between the two markets (i & j). If the price differentials, by any reason, exceed the transaction costs (T_{ij}), traders are expected to arbitrage them away (i.e. would take part in trading activity and benefit from the opportunity). The failures of this approach are: First, it neglects the existence of other markets and second, the LOP is one specific condition of a more general problem of efficiency in the spot market for commodities. It is commonly understood, in a semi-strong sense, that markets are considered efficient when prices take in to account all the available information-or, in a parallel saying, when there are no exploitable opportunities towards maximizing profit. Accordingly, violation of the LOP is an occasion of inefficiency in that traders may neglect profit opportunities from the exploitation of Knowledge about prices in another market and on transaction costs. Furthermore, in an efficient market, traders should also take into account the information about shocks which are going to affect prices. In a perfectly efficient market, all the markets under consideration should immediately react to relevant news and their prices should commonly determined by aggregate demand and supply (Fackler and Goodwin, 2001). The issue of efficiency is important in itself because it speed up specialization according to the comparative advantage and by then raises economic welfare (Federico, 2004).

price in order to benefit out of it and, obviously, a rational trader engages in arbitrage whenever the price

In the intention of overcoming some of the problems of the LOP, co-integration tests are used to test for more general equilibrium. This approach, besides allowing price comovements to be less than perfect and permits seasonal variations in transfer costs, it also allows prices to be determined endogenously. This approach is also criticized for it ignores transfer costs and its assumption of linear relationship between market prices. Moreover, the test does not distinguish whether markets are independent or integrated when both are subject to a common exogenous inflationary process (Ismet et. al 1998).

In integrated markets, a shock in one market can easily be transmitted in to the other markets; on the other hand, if the markets are segmented, the markets would be independent of each other in that no shock would be transmitted from one market to another. Subsequently, co-movement of prices of spatially separated markets may indicate the existence of market integration (Ravallion, 1986).

Though the importance of well-functioning markets is inevitable, the existing condition of almost all of the developing countries is typified by poor communications and transport infrastructure, limited rule of law, and restricted access to commercial finance (Barret, 2005).

Many literatures on market integration of developing countries show that there exists considerable commodity price variability across space and various empirical tests suggest that there is a significant and puzzling forgone arbitrage opportunities. In fact, in many the international trade literatures, deviations from the LOP and from PPP, even in advanced market economies, have been observed (Barret, 2005).

According to sexton, et al. (1991) and Lutz, et al. (1995), cited in D' Angelo (2001), two factors that explain the lack of efficient spatial integration could be first, either physical

difference exceeds the transaction cost of the process.

barriers for trading, incomplete information or risk-averse agents, or all. The second is that the existence of imperfect competition structure in the markets under analysis, which would lead to a significant entry barrier, which in turn prevent price arbitrage in the markets. A large amount of transaction cost than the price differential between the markets under consideration, would also block the arbitrage process of rational agents for an arbitrage, in this case, leaves the agents in a loss (D' Angelo, 2001).

The structure of Ethiopian grain market has significantly altered after the liberalization in that in the post-liberalization period, contrary to the pre-liberalization period, the activities of private grain traders have increased tremendously (Negassa 1997).

As part of the continued market reform process, the government of Ethiopia amalgamated, in October 1999, the Ethiopian Grain Trade Enterprise (EGTE) with the Ethiopian Oil Seeds and Pulses Export Corporation (EOPEC) and re-established it, as a public enterprise. The major function of the united EGTE has shifted towards raising commercial profitability by engaging (concentrating) on exportable grains and hence, it doesn't need to intervene directly to stabilize grain price (Bekele, 2002).

In Ethiopia, when producers' prices depressed, the government implemented producers' price support intervention to purchase grains from farmers (such as the 1995/96 purchase of maize and wheat through Ethiopian Grain Trade Enterprise, EGTE). Besides, at times of bumper harvest the EU contemplated the local purchase of food aid grains from local traders and other trading companies instead of import (Negassa 1997).

Regarding the road condition of the country, as part of Ethiopian government's 10-year road sector Development program (RSDP, 1997-2007), and intent of addressing the constraints in

the road sector related to restricted road network coverage and low standards, there has been a significant improvement on the size and quality of the road network.

Though much of the country's road network dates back to 1930s and 1940s, it was in 1955 that the Ethiopian Roads Authority (ERA) was established. In 1955, the road network was about 6400Km, of which 3400Km were paved. Currently, in 2005, the country's road network consists of a classified road network of 37,018 Km of which 4,972 Km are paved (RSDP, 2006).

However, Ethiopia compared to its both geographic and /or population size is still with a very limited road network which adversely affects economic developments of its society especially those in rural areas. There is only about 37,000 Km of roads available for motorized vehicles that leaves about 70 percent of the population to travel for about six hours to reach a road (ERA, 2006).

2.2 Models of spatial market integration

Various attempts of measuring market integration have been made, in the past, including correlation coefficients, Ravallion's short-term and long-term tests of integration, long-term multiplies and times to adjust; cointegration coefficients, causality , error correction, vector autoregressive, parity bounds and threshold autoregressive tests .

Until two decades or so ago, researchers focused on the use of bivariate correlation coefficients between spatially separated markets and the price differences between the markets under consideration.

Price correlation coefficients of different markets were considered as a very simple way of analyzing market integration. This model was used as an attempt to measure the degree of

market integration, in the absence of simultaneous information about prices and trade flows (Fatchamps and Gavian, 1996). This technique is motivated by the intuition that integrated markets exhibit a co-movement of prices and it is the easiest way to measure the pattern. Accordingly, a higher (lower) correlation was used to be understood as a higher (lower) degree of spatial integration and the sign of the correlation is considered as an indication of the direction of the effect. But, economists immediately identified serious methodological flaws in the study. The major problems with the simple bivariate correlation coefficients are that it requires filtering in order to eliminate bias due to problem of non-stationarity probably caused by common exogenous trends (e.g. general inflation), common periodicity (e.g., agricultural seasonality), or autocorrelation. Further, it did not consider the existence of transaction costs and considered price co-movement as an indication of market integration.

On the other hand, contemporaneous correlation tests may overestimate segmentation, if a lag price effect exists between markets. In addition, these simple statistics do not recognize the problem of heteroscedasticity commonly exists in price data of reasonably high frequency (Barret, 1995). Moreover, the method failed to incorporate the effects of synchronous factors such as general price inflation, seasonality, population growth, procurement policy, etc.

To ease some of the failures, it was suggested to consider the correlation of price differences, which leads to interpretation of market integration as interdependence of price changes of different markets. Besides, these changes would absorb the common trends that would have created spurious correlation (Goletti et. al., 1995).

This approach is also criticized in that it doesn't indicate, or impossible to locate, which market among those being analyzed, is the main central market (if there exists). Moreover, if the price transmission is not contemporary but lagged, the correlation analysis hides a real

integration, that is, it shows a lower degree of integration even if there is an actual integration, though it is not instantaneous (D' Angelo, 2001).

As a further refinement, co-integration analysis has been suggested. The main concern of co-integration analysis is that prices of different localities have a stable relationship. Though across time, the price margins are subject to various shocks, if long run relationship is observed among different price series, they can be considered as to be co-integrated. Subsequently, this co-integration may indicate the existence of interdependence between two series (markets) and its absence, on the other hand, indicates market integration. Specifically, if co-integration is rejected in both directions-markets are said to be segmented, where as, if the test is accepted in both directions, markets can be considered as integrated (Gonzalez et.al., 2004).

The problem here is that, it is not enough to say that markets are integrated; the extent of integration has an importance. Perfect integration and segmentation are extreme cases of market mechanisms, in that perfect integration occurs when a price of one market is entirely affected by the shock in another market, while segmentation occurs when there is no co-integration; most of the time, the level of integration ranges between the two extremes. Hence, the concern of analysts has diverted towards finding ways of precisely measuring the different degrees and magnitude of price transmission (Golletti et.al, 1995).

However, the co-integration test by itself was considered as a weak test and researchers precede adopting an error correction model, and testing for short-run market integration. It was noted that two price series have to be co-integrated before an error correction model can be used and when co-integration is observed it is taken as an indication of long run market integration. This model, however, is based on two key assumptions: first, one market should

be exogenous and second, the more problematic one, there should be continuous, unidirectional trade flow (Prabhat Vase, 2003).

In this formation, if there is an indication of long-run market integration, the model could be reformulated as an error-correction model. Alongside, Ravillion's technique, the non-stationary nature of most price series led to the use of co-integration techniques to analyze long-run market integration. If existence of long-run market integration is found, then the short-run dynamics that are consistent with this long-run dynamics are tested using error-correction techniques (e.g., Goodwin and Schroeder, 1991).

As part of the several attempts made to improve the inherent problem exists in correlation coefficient techniques. Delgado disaggregated analysis by season, and controlled for some hetroscedasticity, and found a seasonally dependent integration (segmentation of grain markets in North Nigeria). The most notable improvement of analytical method came from Ravalion, who through error- correction model of commodity pricing allowed for autocorrelation, different short run and long run dynamics, and common inflationary and seasonal components.

As the earlier technique of testing for market integration used the simple correlation analysis which with non-stationary price data failed to address the problem and in an attempt of upgrading the mentioned limitations, several researchers have tried to reveal a better picture of degree of spatial market integration. Accordingly, as stated above, being motivated by filling the gap of the imprecision and inferential dangers of static measures Ravallion (1986) tried to incorporate both the contemporaneous and lagged effects and developed a dynamic distributed lags model, which is also known as Radial model (Gonzalez et.al, 2004).

The Ravallion model searches for a dynamic representation of market integration. Ravallion, in his model tried to develop a technique that differentiates between the short run and long run dynamics of market integration for trade may not adjust instantaneously and arbitrage could take time (Jacks, 2000).

The basic notion of Ravallion's model relies on the assumption that in the spatial markets analysis, among the markets under consideration, one is a central (dominant) market and the others are regional markets and that price shocks emanate from one dominant (urban) market that faces a Weakley exogenous price from those of the other markets. Secondly, even though trade takes place among the localized markets, it is trade with the central market that determines local price formation. Ravallion also assumed that, although market demand shocks originate from cities, agricultural supply shocks originate from regional (rural) markets (B.Barret, 1995).

The structural form of Ravallion's model could be presented as:

$$P_{1t} = \sum_{j=1}^n a_{1t} P_{1t-j} + \sum_{k=2}^N \sum_{j=0}^n b_{k1j} P_{kt-j} + X_{1tc1} + e_{1t} \dots \dots \dots (2)$$

for the central market

$$P_{it} = \sum_{j=1}^n a_{it} P_{it-j} + \sum_{j=0}^n b_{ij} P_{it-j} + X_{itci} + e_{it} \dots \dots \dots (3)$$

for the localized markets

where P_{1t} - the price in the central market at time t,

P_{it-j} -the price in the central market in time t-j,

P_{kt-j} (or P_{it-j} in 2) – The price in localized market k (or i) in time t-j.

X_1 - a vector of other influences on the central market

P_{it} - the price in localized market i in time t , and

X_i - a vector of other influences on localized market i .

In this way of representation, Ravallion's model states that prices in the central market are determined by its past values and all localized markets and concurrent values in the localized markets where as prices in the localized markets are determined by movements in the central markets, concurrent values in the central markets and by respective localized markets

Since, the concern here is on the transmission mechanisms between markets, not with the structure of price formation with in the central markets, the first equation can safely be disregarded. The possible hypothesis that can be made, using the second equation, could be existence of short-run market integration (where by $b_{ij} = 1$ and a price rise in the central market will immediately be transmitted on to the localized markets) and existence of long-run market integration (whereby $\sum \alpha_{ji} + \sum b_{ji} = 1$ and the short-run price adjustment process is consistent with an equilibrium in which a unit increase in the central price is passed on fully in localized prices) (Jacks, 2000). Alongside the assumption of specific structure of integration relationship, the model also imposes, a priori, a restriction that there exists a central market (D' Angelo, 2001).

As indicated by Silvapulle and Jauasuriya (1994), the Radial model's assumption of existence of a dominant central market (i.e., the assumption that any link cities should be established through a central market) is the main limitation of the model. They argued that this might not be an accurate way of modeling the dynamics of spatial integration of markets. They also added that, even if there exists a central market, rather than imposing it in a priori, it is better testing the hypothesis of existence (D' Angelo, 2001).

Moreover, the Radial model failed to take in to account the effect of international flow reversals and direct links between regional markets which can easily violate the assumptions

of the model. Moreover, the model is also criticized for its assumption of constant inter-market transfer costs that are either additive or proportional. The Radial model may wrongly conclude that markets are segmented (unintegrated) if transfer costs are time-varying or actually more complex (B. Barret, 2005).

So as to resolve the problems with the radial model, the vector auto regressive (VAR) technique has been developed as an extension to the radial model, which allows for testing the existence of a central market. Despite the enhancement, two problems become clear. First, as most price series are typically non stationary, there is a possibility that spurious correlations arise. Second, the degree of spatial integration between markets has been studied from a one-way directional perspective, that is, the radial model hypothesis has been verified under the assumption of existence of a central market.

To solve the two problems, a couple of methods are developed. For the first problem, non-stationarity, the co-integration analysis enhances the study of long run behavior of the series, even when the series are non-stationary. For the second problem, the multivariate co-integration methodology is proposed to solve it. Still, testing the hypothesis established by Ravallion's model remains the main target; though here, the priori restriction is relaxed (Jacks, 2000).

The second assumption, which makes the methodology difficult to generalize across a wide range of countries, is relaxed in Baulch's parity bounds model (Baulch, 1997). Baulch hypothesized, because of either impediments to trade increasing transfer costs or modest price spread between markets, that periodic market segmentation could occur. In an event of irregular breaks in trade, the error correction models reject short-run integration and unable to

identify the brakes, while Baulch's model differentiates between different types of breaks of trade (Prabhat Vase, 2003).

The model developed by Sexton et.al. (1991) was the first model to explicitly acknowledge the existence of transaction costs, and they tried to incorporate it through an estimate, based up on their model, a switching regression model. Baulch (1997), made it popular for measuring food market integration in developing countries and several studies relied on this model known as the Parity Bounds Model (PBM) (e.g, Fafchamps and Gavian, 1996; Negassa et.al., 2004).

Although the PBM has brought a significant improvement for the analysis of spatial market integration over the pervious model that disregard transaction costs, it has its shortcomings too. The first criticism is its underlying distributional assumption. Based on the price differentials between two markets, the original model identifies three exhaustive regimes. That is, the price difference is either equal to the transaction cost (regime 1) above the transaction cost (regime 2), or below the transaction cost (regime 3). In this switching regime regression model, the first regime is modeled as a constant plus a normally distributed error-term; here the constant stands for the transaction cost. The second regime adds an additional error term on the first regime's equation, while the third regime subtracts an additional error-term from the first regime's equation. These additional error terms are assumed to be half-normal truncated from below at zero. After formulating each regime's respective density functions, probabilities are assigned to each regime, and the likelihood function can be specified. The probabilities of being in one of the three regimes, the transaction cost, and the standard error terms can be computed by maximizing the lag of the likelihood function (Javier and Arturo, 2001).

To view the problem with the distributional assumption of PBM, let's assume that the price difference between two markets lies in regime 2, where it is larger than the transaction cost. In this case there are profitable arbitrage opportunities that could be exploited. Here, it seems logical to assume a half-normal distribution, because the probability of observing large deviations from the transaction cost is lower than the probability of observing smaller deviations. Obviously, it can easily be understood from economic reasoning that in this region there are limits as to how big the difference between the price differentials and transaction costs would be (Campenhout, 2005).

But, the above condition may not hold for regime 3 in that, if trade does not take place between two regions due to the lower amount of the price differential between them than the transaction cost, there is no reason to assume that smaller deviation from the parity bounds should occur at a higher probability than a large deviation, as is indicated by the assumption of a half-normal distribution underlying the model. The main failure of the PBM would be here, the half-normal distributional assumption for regime three, while one expects any price difference has the same probability of occurrence. The success of the PBM relies on the believability of the distributional assumptions (D'Angelo and Cordano, 2001).

The other problem of the PBM is that it is static in nature, in that it may indicate the probabilities of, for example, deviation from the parity bounds, but it fails to show the change these deviations have from the equilibrium overtime. As is indicated by many researchers, trade may not adjust instantaneously and may show delays due to such factors as: sluggishness in price adjustment, delays in transportation and expectation formation under price uncertainty. Subsequently, using a static model like the parity bounds model, might lead to observation of a high frequency of inefficient arbitrage (i.e., too little or too much trade), and hence may lead to wrongly conclude the market under consideration are poorly

integrated. However, if instead of the static PBM, a dynamic model would be used, by assessing (incorporating) the time it takes for prices to adjust to one another, a different conclusion than the PBM, would be reached (Campenhout, 2005).

2.3. Empirical literature

Negassa (1997), in his paper "Vertical and Spatial integration of Grain Markets in Ethiopia: Implications for grain markets and food security policies", using weekly price data collected from August 1996 to July 1997 deflated by CPI (1995=100), for Addis Ababa market, he tried to analyze the vertical and spatial integration of grain markets in Ethiopia. He used Granger Causality tests and found that the grain markets in Ethiopia exhibit a high degree of vertical and spatial market integration.

Marcel Fatchamps and Sarah Gavian (1995), in their paper "the Spatial integration of Livestock Markets in Niger", assessed the Niger's degree of livestock market spatial integration. They have used data from 35 districts and 3 urban cantons, from January 1968 to December 1988 by applying four different methods of analysis. They adopted four different techniques, in the intention of partially compensating for the weakness of their data. The methods used were: co-integration; Granger causality; Ravallion's (1986) model of market integration and Baulch's (1994) parity bounds model. In their analysis, they found Niger's geographical market integration of livestock is low, that is prices in different districts frequently exceed their parity bounds and often fail to co-move.

Mohammad Ismet et.al., (1998), in their paper "Government intervention and market integration in Indonesian rice markets" evaluated the long-run spatial price relationships and factors affecting the degree of integration of Indonesian rice markets using multivariate co-integration tests. They relied on weekly price data of the periods from 1982 to 1993. In their

analysis, they used a before-after approach of self sufficiency periods as well as for the entire period. The co-integration test they have used for entire Indonesian rice market, represented by nine most relevant price series, produced a result that the pre-self sufficiency period has shown a relatively higher degree of market integration. The decline in the degree of market integration overtime indicates that rationalizing of the Indonesian rice price policy post 1984 rice self-sufficiency has resulted in low market integration.

Serra et.al (2004), on the other hand, in their article "Non parametric modeling of spatial price Relationships", argued that nonparametric modeling is better suited than the TAR model and they tried to reveal their argument by analyzing degree of market integration of U.S. egg markets at the turn of the nineteenth century. They compared the results found from TAR and nonparametric model using monthly price data from October 1881 to October 1911. In their analysis, they found that in the majority of the cases studied, non parametric regression supports the TAR results. But, their results indicate that non-parametric methods indicate a higher level of market integration than the one found by TAR model (method).

Negassa et. al (2004), in their paper "Grain Marketing policy changes and spatial efficiency of Maize and Wheat markets in Ethiopia", have applied the extended version of the standard parity bounds model (EPBM) to analyze the impact grain marketing policy changes have on the efficiency of maize and wheat markets in Ethiopia. They based their analysis on data from August 1996 to August 2002 and ten, considered important, markets. Accordingly they found that policy changes do not have a significant impact on spatial market efficiency. Their results also show that there is higher level of spatial market inefficiency in Maize and Wheat markets both before and after the policy changes.

D' Angelo and Cordano (2001), in their paper "Market integration for agricultural output markets in Peru: the role of public infrastructure", have showed the impact public investment on infrastructure may have on the level and efficiency of agricultural product of the Peruvian markets. They based their analysis on the most important agricultural crop of the country, Potato, using daily price series of 10 cities from 1995 to 2001 and stated that there is enough evidence to conclude that the Peruvian agricultural markets are spatially integrated. Nevertheless, they also found that there is short term disequilibria through which the efficiency with which price information is transmitted across markets is affected. The analysis relied on Threshold Co-integration model to assess the speed of adjustment towards the equilibrium, the presence of transaction costs and probabilities of successful and failed arbitrage between spatially distributed markets. In their paper, it was shown that distance and geographic differences are important factors affecting spatial integration and efficiency between markets. In addition government intervention in the form of availability of information (access to local media and telecommunications facilities), road density or access to wholesale markets were found in the paper as key elements capable of reducing transaction costs and enhance the improvement of spatial integration between markets.

In his article "Modeling Trends in Food Market integration: Methods and an Application to Tanzanian Maize Markets", Bjorn Van Campenhout (2005) has also used TAR model. In his analysis, he argued TAR model better explains spatial market integration than the competitive PBM. In the analysis he analyzed how transaction costs and speed of adjustment of maize market in seven selected Tanzanian markets have changed during the nineties; the data cover a period from 1989 to 2000.

Chapter Three

3. Descriptive Analysis

In this analysis, Addis Ababa market is taken as a central market both for consumption and terminal market because of its size and locational advantage. The descriptive statistic tools used are mean, standard deviation, coefficient of variation, price differential and correlation coefficient. These analytical tools are expected to help reveal the level of market integration, direction of flow of trade and degree of transmission of shocks.

In the analysis three major staple food grains: teff (mixed teff), wheat (white wheat) and maize (white maize) are chosen. The terminal markets are included (chosen) by their importance upon the production, consumption or distribution purposes and availability of data over periods under discussion; from January 1996 to December 2005, besides wholesale price level is considered for all the grains.

3.1. Overview of the Ethiopian Grain Marketing System

In Ethiopia, grain marketing can arguably considered as the largest of all the markets due to the volume of output it involves, the size of the geographical area it covers in its operation, and the number of participants in the process. It involves a number of participants: in the form of production, selling, transportation, storing and buying (Dessalegn et.al., 1998).

Since, grain production of Ethiopia fluctuates from year to year based on weather and rainfall conditions, the annual grain marketed does also take that trend. As a result, in a relatively good crop year, the proportion of output marketed is estimated, by farmers, to be about 27% of their produce. Moreover, regarding the seasonality of grain supply by farmers, they usually sell their produce between January and March, they sell about 79% of their grain produce in

this period where as the remaining 21% is sold during June-December (Dessalegn et.al, 1998).

Before 1991, private grain marketing had been suppressed by the government policy. In the stated period, since 1974, the then socialist regime was directly engaging in wholesale and retail trade. As a result, in the process, with the help of the World Bank, the agricultural marketing corporation (AMC) was introduced in 1976 in order to buy grain from farmers and sell them to urban consumers and state organizations. Government policy, was forcing traders to sell at least 50% of their supplies to the AMC at a specified price. Farmers also had to deliver a significance portion of their produce, to AMC, in the form of quota (Molla et.al 1995).

The March 1990's policy has brought a radical change in grain marketing activity, in that quotas and fixed prices were abolished and all controls on interregional movements were eliminated. Besides, the policy has permitted the private sector participation in the area. In 1992, the Ethiopian Grain Trading Enterprise (EGTE) was formed as a replacement for AMC (Negassa and Jayne, 1995).

As part of the continued market reform process, the government of Ethiopia amalgamated, in October 1999, the Ethiopian Grain Trade Enterprise (EGTE) with the Ethiopian Oil Seeds and pulses Export Corporation (EOPEC) and re-established it, as a public enterprise. The major function of the united EGTE has shifted towards raising commercial profitability by engaging (concentrating) on exportable grains and hence, it doesn't need to intervene directly to stabilize grain price (Bekele, 2002).

EGTE collects price data from around 100 market centers, spread widely around the country and in which EGTE engages in buying and selling activity. The data is collected in a weekly basis and conducted on market days of each market (Tschirley, et,al 1995).

The structure of Ethiopian grain market has significantly altered after the liberalization in that in the post- liberalization period, contrary to the pre-liberalization period, the activities of private grain traders have increased tremendously (Negassa 1997).

In Ethiopia, when producers' prices depressed, the government implemented producers' price support intervention to purchase grains from farmers (such as the 1995/96 purchase of maize and wheat through Ethiopian Grain Trade Enterprise, EGTE). Besides, at times of bumper harvest the EU considered the local purchase of food aid grains from local traders and other trading companies instead of import (Negassa 1997).

3.2. Road Infrastructure of Ethiopia

In Ethiopia, on purely physical grounds (linear units of route per unit area), only about 32 percent of the areas are connected with all weather roads. This is based on the assumption that all the existing poor roads of the country are accessible throughout the year (in reality 60% of the roads are presently found in fair to poor condition). The major centers of the country are also poorly connected. If not for financial constraints, most of the population centers need to be connected and available tracks developed to suitable engineering standards (ERA, 2006).

According to the eight years Road Sector Development Program (RSDP) of Ethiopian Road Authority (ERA), over the eight year periods of 1997-2004, the total average vehicle kilometer traveled has increased by about 6% per annum. The considerable change is observed mainly on the heavy vehicles, Trucks & Trucks & Trailers followed by buses, which are influenced by the economic activity of the country and passenger mobility. This

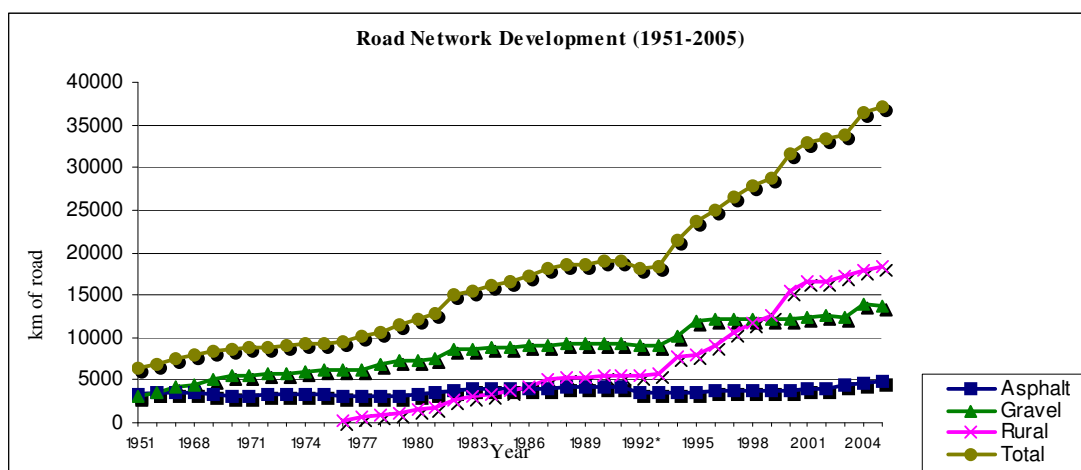
phenomenon can be linked to an improvement in the quality of the road network, increase in vehicle fleet and greater utilization of trucks, truck and trailers and buses (ERA, 2006)

Due to shortage of resources for maintenance during the 1970's and 1980's up until recently, civil works have been concentrated on upgrading and rehabilitating of the existing road network,; as a result, most of the roads were at the verge of total deterioration and there hasn't been much change on the road density of Ethiopia, which is still by far below most sub-Saharan Africa countries (RSDP, 2006).

Hence, in the intention of incorporating the road infrastructure in the development endeavor of the country, future investments would focus on expansion of the network.

The graph, below, shows the network development by the type of road from the year 1951-2005, and it can be seen that the trend of road network increases over the years from 1953-2005. During the three regimes: the Imperial (1951-1973), the Derg (1974-1991) and the current government (since 1992), the road network has increased on average by 2.1%, 6.2% and 8.1%, per annum respectively. However, the growth rate is still well under the estimated required average growth rate of 16% of the network that Ethiopia would need to reach the 100,000 km target by 2015 (ERA, 2006).

Figure 3.1: Road network development (1951-2005)



Source: ERA, 2006

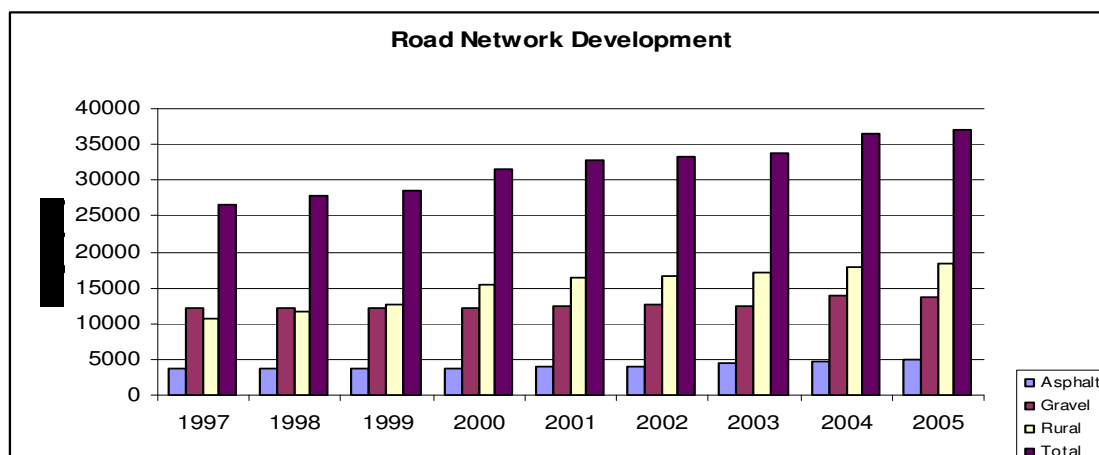
The total road network of the country at the beginning of 1997 was about 26,550 km with a road density of 0.46 and 24.14 per thousands population and per thousand square km respectively (see annex, 4.b). The total road network has increased to 37,018km in the year 2005 with an average annual growth of 4.9% per annum. This is due to the construction of new gravel and regional roads with a total land area of 1.1 million sq. km and a road network of 37,018km, the current road density is 33.6km per 1000 sq. km and 0.51 km per 1000 population, indicating an increment of about 9.5 km and 0.05km with respect to area and population respectively (ERA, 2005).

It can be seen, from fig. 3.2. below, that all the three types of road network expansions: asphalt, gravel and rural, are increasing over the nine years, 1997-2005. A larger emphasis has been given for rural road network expansion being followed by gravel and asphalt.

Similarly, annex 4.c, shows the condition of road improvement across periods from 1997-2005 and it can be seen from the figure that larger emphasis is being given for the improvement of the roads in good state while roads in poor state have been relatively

neglected (or decreasing over time), roads in fair states are somewhat in a steady state (ERA RSDP).

Figure 3.2: The road network development (1997-2005)



Source: ERA, 2006

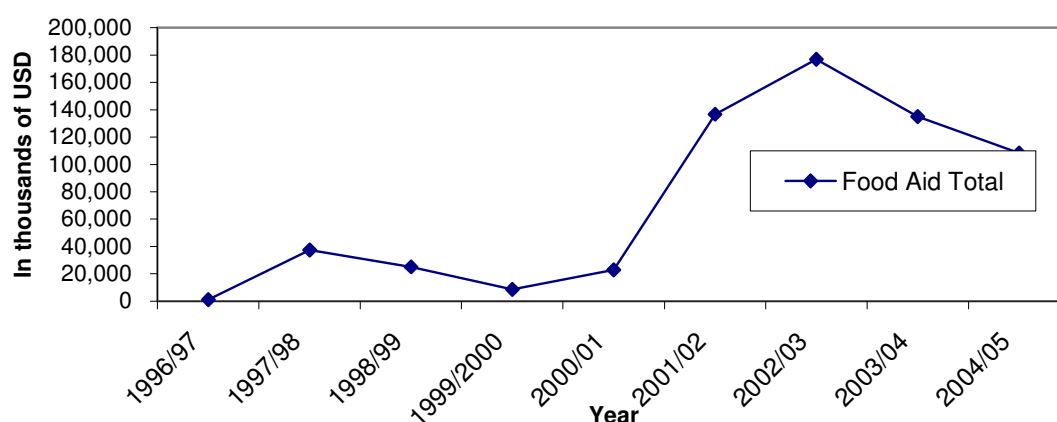
3.3. Food Aid

It is commonly understood that food aid is beneficial, in various ways, for a poor self-insufficient country like Ethiopia. However, food aid, in kind, if not properly and cautiously monitored might have a negative consequence on the demand for market surplus and storage by, directly increasing the supply of the grain and decrease the price the suppliers would have got and hence may adversely affect farmers incentives in the long run and could endanger the success of the food security policy implemented by the government (Negassa, 1997). Besides, it may have a depressing effect on the food aid recipient producers by reducing their motivation to engage in production activity.

Looking at the trend of total food aid in kind from fig.3.3, below, the figure reveals peculiar characteristics over the past 9 years. In the figure it can be seen that it maintained a steady low amount up until 2000/01 where it shoots up and reached its peak in 2002/03, a year quite well

known for the drought that put the lives of around 15 million people at risk. Although it has declined significantly in 2003/04 it still remained a substantial amount compared to the pre 2000/01 period. A case in point here is that even during 2000/01 and 2001/02 where there was a boom in production there was a significant amount of food aid that may have added to the deflationary pressure during that period.

Figure 3.3 Trends in Total Food aid

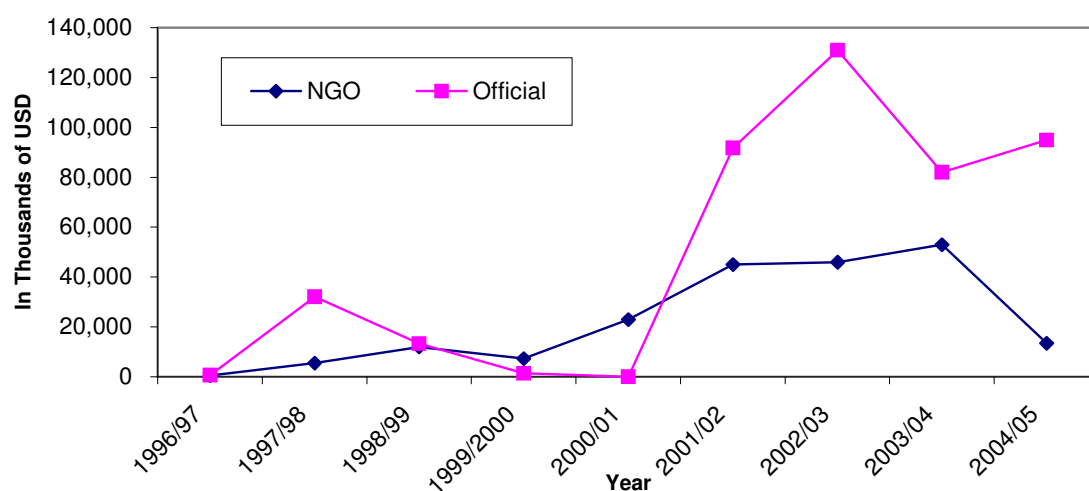


Source: DPPC

Similarly, fig. 3.4 below depicts a further disaggregated food aid by the channel through which the food aid was received. Principally the official food aid data dominates the one from NGOs in explaining the total food aid flows in that the latter follows the trend of the former primarily because of the former's magnitude and volatility. Surprisingly, the trend further shows an increase during 2004/05 where there was an increased production.

Food aid channeled through NGOs depicts a rather steady and low until the turn of 2000/01 where it surges up gently during 2000/01. It then maintains a relatively steady level until it sharply declines in 2004/05. This was because of the fact that there was a need to continue the support until the recovery period and then going back to its pre 2000/01 state.

Figure 3.4 Trends in Official and NGO Food Aid



Source: DPPC

The benefit of well-disseminated truck vehicles, as shipment mechanisms, is quite obvious. They can be considered as players of the major role in the entire process of market integration, especially in a country like Ethiopia where road transport dominates the other transport means, if there are any, transportation mechanisms. Table, below shows the trend of number of truck vehicles before and after 2001/02 periods. The table reveals that the total number of vehicles over a certain capacity, have been increasing though the rate of increment has been declining over the years.

Table 3.1: Trends of Number of Truck vehicles

Region	Before 2001/02	2001/02	2002/03	2003/04	2004/05	2005/06
Addis Abeba	80,515	86,725	92,162	97,253	102,463	105,078

Afar	316	350	367	378	418	419
Amhara	2,799	3,113	3,383	3,744	3,979	4,159
Aid Org.	3,537	3,755	3,795	3,955	4,144	4,210
African Union	205	210	212	228	240	252
Benish. G.	147	163	164	164	192	192
Core Dip.	831	929	936	997	1,084	1,103
Dire Dawa	1,721	1,797	1,895	1,947	2,005	2,005
Federal (ET)	35,382	36,389	36,705	37,391	38,252	38,456
Gambella	30	42	42	42	51	51
Harar	885	885	888	890	890	890
Oromyia	8,683	9,388	10,315	11,045	11,456	11,638
Somalie	776	871	1,011	1,256	1,343	1,386
SNNP	2,207	2,634	2,856	2,935	3,145	3,174
Tigray	1,914	2,019	2,180	2,228	2,358	2,389
UN	971	1,026	1,039	1,080	1,171	1,194
Total	140,919	150,296	157,950	165,533	173,191	176,596

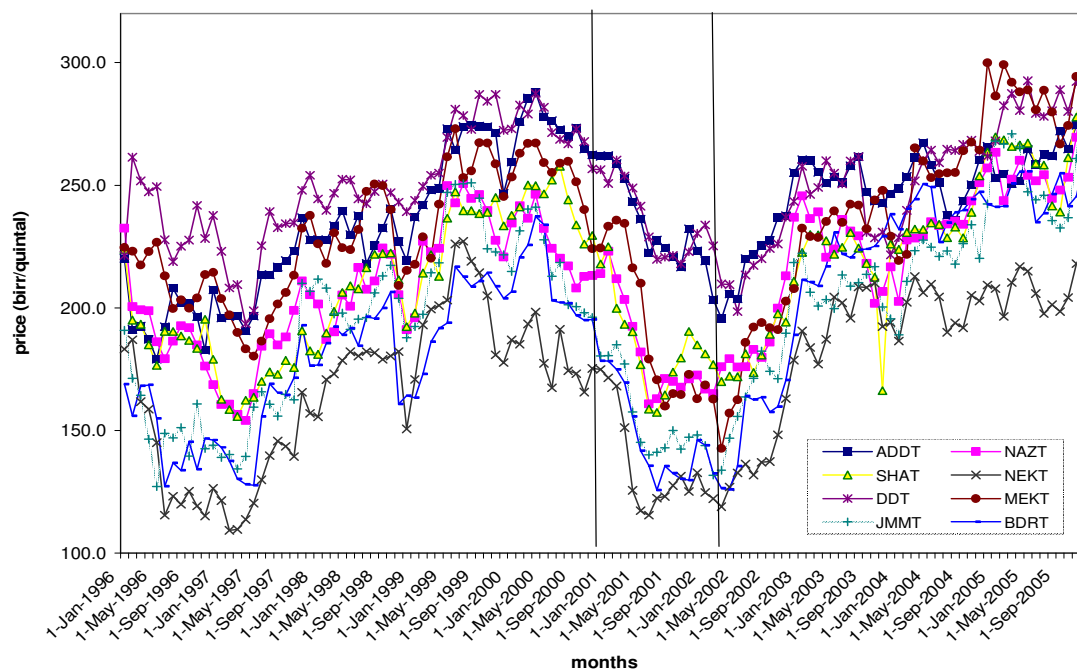
Source: ETA

3.4. Trends of Wholesale Price of Grains

Figures, 3.5.a-c, show the trends of the deseasonalized wholesale prices of the three cereals: mixed teff, maize and white wheat, of the selected markets in the two periods under discussion. As the road construction completion date of the regional markets, with Addis differs the two vertical lines in the middle of the graphs show the completion dates, except for Nekemte, of the construction of the roads between Addis and the markets; for Nekemte, the starting date was considered as there is no completed road between Addis and Nekemte. That is, the roads were constructed within the periods demarcated by the two vertical lines.

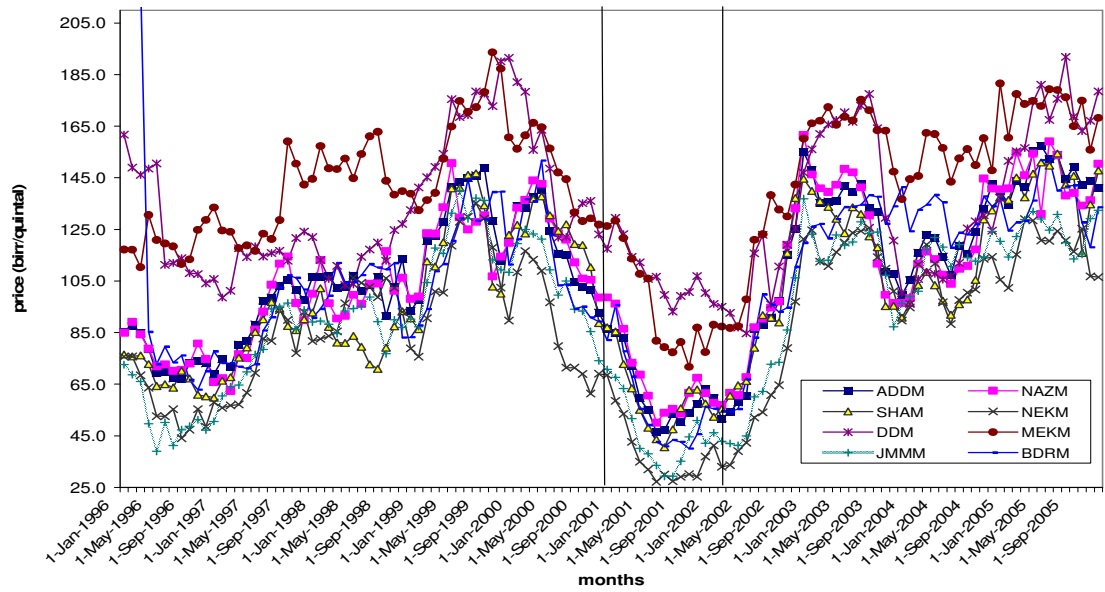
Accordingly, the figures depict that while the mixed teff and white wheat markets are typified by a rather similar trend and smaller dispersion in the post construction period, the maize markets reveal unclear trend and dispersion in the two periods.

Figure 3.5.a: Trends of deseasonalized wholesale price (birr/quintal) of mixed teff in the pre and post construction period



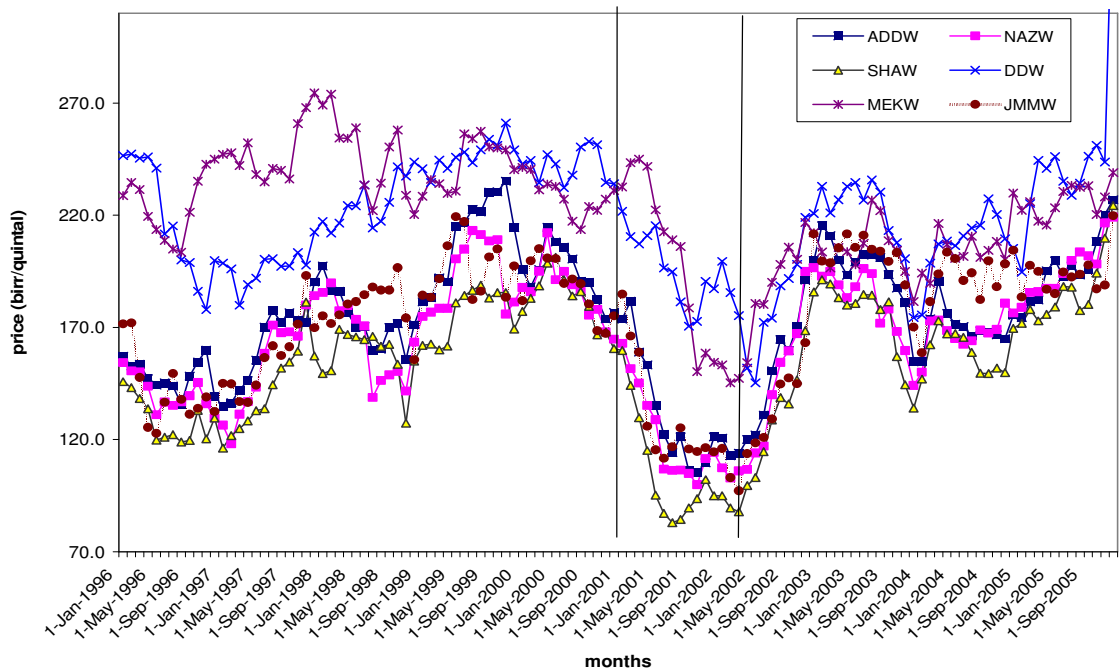
Source: EGTE

Figure 3.5.b: Trends of deseasonalized wholesale price (birr/quintal) of maize in the two periods.



Source: EGTE

Figure 3.5.c: Trends of deseasonalized wholesale price (birr/quintal) of white wheat in the pre and post construction period.



Source: EGTE

3.5. Levels of Wholesale Price of Grains

The average wholesale price of mixed teff of the selected markets ranges between the smallest of 170.7 birr/quintal of Nekemte to the relatively higher value of 249 Birr/quintal of Dire Dawa. Both the actual and average price (annual average price) of the selected markets has shown a slack in the year 2001 due to the bumper harvest observed during the year. On the other hand a significant surge has been observed in the periods, from 1998 to 1999 and from 2002 to 2003. From 2003 on the average price of mixed teff has shown an increasing trend for each market.

Looking at table 3.2 (below), it can be seen that in the preconstruction period the average price of mixed teff of the respective towns ranges within the highest value of 247 birr /quintal of Dire to the lowest of 161 birr /quintal of Nekemte over the respective periods, though the period may vary, based on the completion date of the roads of the respective towns.

On the other hand, after the construction of the roads, the average price of mixed teff for the respective periods, of each towns have risen ranging from the highest of 253 birr /quintal of Dire to 186 birr/quintal of Nekemte.

The average wholesale price of white wheat can also be viewed from table 3.2 below where the average price is situated with in a range of 153.7 to 221.4 birr/quintal. The average price has shown a significant fall on the move from 2000 to 2001 while price of a quintal of white wheat on average has risen in periods from 1998 to 1999 and from 2002 to 2003.

Before construction of the roads, the average price of white wheat ranges between the highest value of Mekelle, 232 birr/quintal to Shashemene's value of 157 birr/quintal. In the period, after construction of the roads, except that of Jimma that has showed a slight rise, the average prices of the other markets have declined. This could be typified by Mekelle's average price

that goes from 232 birr/quintal of the pre construction period to 205 birr/quintal of post construction period.

Regarding, the average price of maize, the values run from the smallest of 85.8 birr/quintal of Nekemte to 141.1 birr/quintal of Mekelle. Overtime, the average price movement of maize- of all the markets have declined significantly in the period 2001 due to the production boom which in the absence of matching demand and lack of appropriate measures to accommodate the excess supply, was easily translated on prices.

Concerning the average price of maize, for the respective markets, before and after construction of roads, it can be seen from table (3.2) that the mean price of the pre construction period varies between the largest value of 134 birr/quintal, of Mekelle, to the smallest value of 77 birr/quintal of Nekemte.

Similarly, in the period after construction of the roads, the average price of the towns for their respective period has shown increment and ranges between the highest value of 152 birr/quintal of Mekelle to the lowest value of 99 birr/quintal of Nekemte.

A significant rise of wholesale price of maize was observed in the periods 1999 and 2003. The average prices of the deficit markets are always higher than the other markets over the stated periods while the average price of Nekemte is almost the lowest over the entire period.

Relative to the pre construction period the average price of maize has shown a marginal rise in the post construction period.

In general, the average movement of the three cereals happen to have the same kind of trend- given that their price trend have shown a declining pattern in the period 2001 owing to the bumper harvest observed during the period, which in one way or another affected the three

cereals. Besides, the three cereals have shown the same surge in the periods from 1998 to 1999 and from 2002 to 2003.

3.6. Variability of price level

The volatility of price spreads of mixed teff as measured by coefficient of variation (CV), for the selected markets is estimated. Consequently, in the before construction period regarding mixed teff markets, the surplus areas: Jimma, Nekemte and Bahir Dar have showed a larger volatility as is revealed by higher value of their respective coefficient of variations. On the other hand the deficit areas, Mekelle and Dire, have produced a relatively lower value of coefficient of variation, by then volatility. But in the post construction period, Mekelle has joined Bahir Dar and Nekemte in place of Jimma, and revealed a higher amount of volatility, CV.

In contrast to the other crops the coefficient of variation in the teff market depicts the highest coefficient of variation around 1998 and 1999 for all markets. One similarity with the other crops is that there is a serious fluctuation in most of the markets especially in Addis Ababa, Nazareth, Nekemte, Dire Dawa, Bahir Dar and Jimma. The other markets, Shashemene and Mekelle show a relatively less fluctuation.

A peculiar movement was observed in the teff market of Nekemte where the highest value was recorded in 1997 (0.16). It then follows a fluctuating trend over the years under analysis until 2005 when it assumes its lowest value (0.43). The CV in the teff markets in Nazareth and Dire Dawa follow the trend observed in Addis Ababa. This means there is a yearly fluctuation and finally the CV assumes lower value in 2005 compared with the average of the period under consideration.

The coefficient of variation of white wheat for the Addis Ababa market has fluctuated between a minimum of 0.04 and a maximum of 0.23 within the period under consideration. The highest values were observed during the year 2001-2002, a period in which there was a deflationary situation across the country. The same is true for the other five markets under discussion. The coefficient of variation for wheat has been the highest in 2002 in all the markets led by the highest 0.27 in Shashemene. With the exception of Mekelle and Dire Dawa where the recorded highest were in 2001 and 2005 respectively, the rest of the markets under study peaked in 2002. The results of the CV show that the surplus areas are more volatile than the deficit areas, producing relatively higher level of CV.

On the other hand, regarding volatility of white wheat markets, all the markets, except that of Jimma, have shown a relatively higher (larger) degree of volatility in the post construction period than were in the pre construction period. But, Jimma's CV has shown a relatively lower volatility in the post construction period (See table 3.2).

Compared to wheat, the maize market nation wide has a higher coefficient of variation. Nekemte has the highest coefficient of variation reaching around 0.45 in the 2002. With slight differences the coefficient of variation in Addis Ababa, Nazareth, Shashemene and Nekemte trends together. This means it increases from 1996-1997 then declines in 1998 picks up again in 1999 drops in 2000. After that it maintains its low value into 2001 and surges drastically in 2002. Up until 2004 it declines to an even lower value than in the late 90s and shows a small increase in 2005. In the rest of the markets too, with the exception of Bahir Dar, similar trends can be observed from the data of the coefficient of variation.

The maize markets, like the mixed teff markets, have shown a relatively lower level of volatility for the deficit markets as measured by their respective CV in both periods. Besides,

along with Bahir Dar, Mekelle and Nekemte, that have shown a declining value of CV in the post construction period, Jimma have shown a significant amount of reduction in the CV from 41.7% of the pre construction period to 24.1% of the post construction period.

Table 3.2: Summary statistics of monthly wholesale prices (birr/quintal) of the selected markets in the before and after construction periods.

Markets	Before construction			After construction			The Entire Period		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
mixed teff									
Nazereth	207.1(13.7)	265	148	217.0(15.5)	277	156	212.0(27.6)	277	148
Shashemene	208.0(15.2)	270	148	217.0(16.1)	277	160	212.4(27.2)	277	148
Nekemete	160.5(20.3)	239	104	185.9(16.9)	224	113	170.7(68.9)	239	104

Dire Dawa	247.0(9.6)	296	187	252.7(11.2)	310	193	249.4(-9.8)	310	187
Mekelle	223.3(13.9)	284	154	239.9(18.0)	308	139	229.9(9.7)	308	139
Jimma	182.0(22.1)	284	120	218.4(15.1)	271	139	196.2(43.4)	284	120
Bahir Dar	173.9(18.1)	227	119	215.8(19.3)	273	117	190.7(48.9)	270	117

white wheat									
Nazereth	167.3(16.5)	225	111	161.3(21.5)	217	97	164.3(8.8)	225	97
Shashemene	157.3(18.6)	210	103	150.0(25.7)	215	80	153.7(19.5)	215	80
Nekemete	-	-	-	-	-	-	-	-	-
Dire Dawa	220.9(11.1)	268	175	215.2(16.6)	367	142	218.6(-45.4)	367	142
Mekelle	232.3(10.6)	273	144	204.8(12.6)	247	135	221.3(-48.2)	273	135
Jimma	162.5(20.4)	232	86	185.7(15.1)	226	107	171.2(2)	232	86
Bahir Dar	-	-	-	-	-	-	-	-	-

white maize									
Nazereth	102.5(24.4)	153	58	109.6(30.5)	173	53	106(0.2)	173	53
Shashemene	95.7(31.0)	168	50	103.4(34.6)	175	45	99.5(6.7)	175	45
Nekemete	76.8(39.7)	153	27	99.4(29.8)	142	30	85.8(20.4)	153	27
Dire Dawa	128.9(20.2)	197	87	137.0(25.2)	208	83	132.2(-26)	208	83
Mekelle	133.9(20.8)	199	73	151.8(18.1)	189	82	141.1(-4.9)	199	73
Jimma	79.8(41.7)	167	33	109.5(24.1)	149	41	91.0(15.2)	167	33
Bahir Dar	97.3(37.4)	204	43	120.3(24.1)	165	50	6.2(-0.3)	204	43

-, indicate statistics are not computed due to inadequate data.

-figures in parenthesis are coefficient of variation around their mean

Source: Computed based on the data from EGTE

3.7. Spatial price Difference

Spatial price difference, as an indication of potential profit margin and as a means of assessing the level and direction of market integration, is useful in highlighting the degree of market integration. Accordingly, the average wholesale price difference of Addis Ababa market with the already specified markets is computed and put in table (3.3).

Consequently, the mere average price difference of mixed teff between Addis Ababa and major terminal selected markets is situated between 9.8 to 68.9 birr/quintal. The values in parenthesis (see table 3.3) indicate the higher price of the respective markets than Addis due probably to the markets' dependence on Addis for their supply.

Accordingly, as can be seen from the table (3.3) that in the pre construction period, the average price difference of mixed teff have shown a larger (relatively significant) difference between Addis and the other markets. The average price difference between addis and surplus areas is a relatively higher than those of the deficit areas: Nekemte (73.7 birr/quintal) Bahir Dar (60.3 birr/quintal) and Jimma (49.7 birr/quintal) have shown the larger difference each with respect to Addis. While the two deficit areas, Mekelle and Dire, have produced average price difference of 11.0 and 13.0 birr /quintal, respectively. This phenomenon probably implies that Addis is rather a consumption centre than is a terminal or distribution centre.

Mekelle's positive average price difference could be due to the fact that Mekelle's market might be supplied by Bahir Dar on another route. Furthermore, it can be said that the markets are not efficient in that Nekemte, given the grains are homogenous, a market with closer proximity to Addis, shows a larger average price difference with Addis than the relatively far markets: Bahir dar and Jimma.

Similarly, in the post construction period, except for those of Nazareth and Shashemene, the average price differences of the respective mixed teff markets with Addis have shown a significant decline. Particularly, Bahir dar has declined by half from 60.3 birr/quintal of the pre construction period, to 31.7 birr/quintal of post construction period demonstrating a probable impact of better road infrastructure, which might have created a better integration. Besides, the average price difference between Addis and the deficit areas, even though the direction remained the same, have declined.

Concerning, the average price differential of white wheat for the markets ranges between 2 to 48.2 birr/quintal. Here also, as can be seen from table 3.3, the negative signs of corresponding

values of the deficit markets indicate that the deficit markets prices are higher than the Addis Ababa market indicating the deficit markets are linked to Addis as a source of their supply.

Regarding the average wholesale price difference of white wheat markets with Addis in the post construction period, the deficit markets' Dire's and Mekelle's, average price difference have declined significantly, see table (3.3). In the post construction period relative to that of the pre construction period, Nazreth and Shashemene too have shown a marginal decline. Jimma's average price difference with Addis has on the other hand produced a somewhat different picture in that in the pre road construction period Jimma had a lower average price than Addis while in the post construction period it is Addis that has a lower price, though not that much significant, indicating that in the latter period Jimma is rather supplied by Addis.

In the case of spatial difference of maize the lowest price difference with Addis is that of Nazreth with 0.2 birr/quintal and Mekelle's price difference has happened to be the highest i.e. 34.9 birr/quintal. Still, the negative signs indicate a higher price level than that of Addis and indicate the direction of flow (table 3.3).

In the comparison of the pre and post road construction period of maize markets, while Nekemte, Jimma and Bahir Dar have showed a bit higher average price difference in the post construction period, the average price difference of the other markets with Addis have marginally declined. In fact, the average price difference between Addis and Dire has declined by half in the post road construction period showing the probable impact of road infrastructure.

Generally, the average price difference of the three cereals with Addis, teff has shown a larger margin or average price difference between Addis and the surplus markets where as maize and white wheat have produced larger average wholesale prices between the deficit markets

and Addis, in both periods. The results designate that Addis is rather a consumption centre for teff where as it could as well serve as a terminal (distribution centre) market for the other two grains: maize and wheat.

Table 3.3: Average price difference between Addis Ababa and the selected markets in the periods before and after construction of the roads

Markets	Before construction			After construction			The Entire Period		
	Teff	Maize	Wheat	Teff	Maize	Wheat	Teff	Maize	Wheat
Nazereth	27.4	0.4	10.2	27.8	0	7.3	27.6	0.2	8.8
Shashemene	26.4	7.2	20.2	27.9	6.2	18.6	27.2	6.7	19.5
Nekemete	73.7	9.3	-	1.6	22.1	-	68.9	20.4	-
Dire Dawa	(13.0)	(32.8)	(50.6)	(5.2)	(15.8)	(37.7)	(9.8)	(26.0)	(45.4)
Mekelle	11.0	(37.8)	(62.1)	7.6	(30.5)	(27.3)	9.7	(34.9)	(48.2)
Jimma	9.7	14.4	5.3	32.7	16.5	(3.6)	43.4	15.2	2.0
Bahir Dar	60.3	(1.2)	-	31.7	1.1	-	48.9	(0.3)	-

-, indicate statistics are not computed due to inadequate data.

Source: Computed based on the data from EGTE

3.8. The Degree of Correlation

Though is kind of outdated, correlation coefficient could still show, to a certain degree, the level of market integration. The degree of market integration between Addis Ababa and the selected markets and hence, can roughly be tested by the correlation coefficient exists between them. Accordingly, looking at mixed teff, the correlation coefficient of the markets with the central market varies between 0.63 to 0.814 and apart from Nazereth and Jimma, including the deficit markets, the regional markets correlation with Addis is less than 0.80 indicating Addis Ababa is more of a consumption center than is a distribution center. This can easily be seen from the moderate degree of correlation of the deficit areas with the central market.

The deficit markets, Mekelle and Dire Dawa, are better correlated with other markets: Dire Dawa with Nazreth and Mekelle with Bahir Dar. Besides, though Jimma is well integrated with Addis, it is better integrated with Nekemte through another route and this could explain

the moderate correlation coefficient exist between Addis and Nekemte for mixed teff market. The results indicate that, even though the roads are being constructed in a radial configuration mechanism, and the roads between most regional markets are not as such in a good state, some of the markets do still show cointegration.

As can be expected, the correlation coefficients of the majority of the mixed teff markets have shown a marginal rise after the construction of the road. But two markets: Nazareth, and Shashemene have shown a declined level of correlation coefficient in the post construction period. This could be due to the two markets can be typified as more of wheat and maize producing areas; besides, the simultaneous construction of roads to many markets, in almost the same period, including NAZ and SHA, also, might have led to a better integration of surplus areas of teff markets, such as BDR, or other places which may not be in the discussion.

Regarding the level of white wheat market integration, the average correlation between Addis Ababa and the regional markets shows a figure between 0.55 and 0.83. The lowest value of correlation coefficient represents the correlation with Dire Dawa; the good correlation trend of Dire Dawa is undermined by the negative correlation coefficients registered during 1996 and 1998. The negative correlation, negatively related price pattern, could be due to a probable impact of food aid as food aid granted to Dire Dawa areas could have an immediate effect on the Dire Dawa market without affecting the Addis Ababa market. As can be expected the highest level of wheat market correlation is observed with Nazareth.

The periods 1997, 2000 and 2002 except for Mekelle in 1997 (with correlation coefficient of 0.50), can be taken as periods with higher spatial market integration of white wheat, with

correlation coefficients of greater than 0.82, for each markets with Addis. On the other hand, the years 1996 and 1998 can be taken as a very low wheat market integration periods- as the degree of correlation of the markets with Addis yields a maximum of 0.63 correlation coefficient, here almost all of the selected markets have showed a correlation coefficient of less than 0.5. Mekelle market is weekly integrated with all the markets under discussion, with a maximum of 0.55 correlation coefficient observed with Addis. Nazreth and Shashemene have shown the strongest correlation among the six selected markets. Besides, both markets and Jimma are well integrated with Addis Ababa.

In the case of the post construction period of white wheat wholesale price correlation of the regional markets with Addis, with the exception of Jimma, all the other markets have shown an improvement in the degree of integration, as measured by a higher value of correlation coefficient. Jimma's correlation coefficient with Addis was 0.88 in the pre construction period, while it has shown a reduced level of correlation coefficient of 0.78 in the post construction period.

In the case of maize market integration of the selected markets with Addis, a better picture of level of market integration as measured by correlation coefficient is registered. Consequently, the correlation coefficients are situated with in a value of 0.66 of Mekelle and 0.90 of Nazreth. Mekelle's correlation coefficient with Addis over the stated periods is undermined by the negative correlation coefficient (of negative 0.69) registered during 1996 period. The negative correlation coefficient observed during this period indicates the two markets do have a negative relationship of price pattern in that the price rise in one market is mostly followed by the price decline in the other market and this could be due to a time lag of shipment between Addis to Mekelle and also probably owing to an expectation formation of the Mekelle market about the price relationship of Addis with Mekelle.

During post 1999, except for few markets, the respective markets have shown a strong correlation of maize markets. On the other hand, with the exception of Nazreth and Jimma, the other markets have revealed a weak integration among themselves as can be explained by a lower correlation coefficient in both 1996 and 1998. This might be because the deficit markets could be supplied from other sources in that Dire Dawa would probably be supplied by Nazreth yielding a fair correlation coefficient of 0.77; and Mekelle supplied by Bahir Dar, with a correlation coefficient of 0.74.

Moving across the years, the maize markets were strongly correlated with Addis in the years 1997, 1999 and 2002 showing a minimum, of 0.81, correlation coefficient in the stated periods.

Likewise, regarding the degree of integration of maize of the regional markets with Addis of the pre construction period, the correlation coefficients of the respective markets (with Addis) ranges between 0.98 of Jimma to the lowest value of 0.64 of Bahir Dar. In fact, four out of the seven markets have shown a correlation coefficient of greater than 0.91 see table (3.4).

In the post construction period, except that of Jimma, all the maize markets have shown a better correlation with Addis producing a correlation coefficient that ranges between the largest value of 0.98 of Nazreth to the lowest of 0.87 of Dire Dawa. Jimma's correlation coefficient has declined from a 0.98 value of pre construction period to 0.91 of post construction period.

Generally, for mixed teff and maize the average wholesale price of all the markets under consideration has shown a significant rise in the post construction period than the other period. On the other hand, the wheat market except for that of Jimma has revealed a decline for all the markets, in the post-construction period. This phenomenon could be the probable

impact of food aid, for wheat is the mostly preferred commodity of various food aid granting organizations.

In the pre construction period all the surplus markets under consideration were found to be well integrated where as the deficit areas were found to be isolated from the central market. In the post construction period, however Jimma happened to be a little bit isolated.

In all the three cereals, the regional markets have revealed a better correlation coefficient in the post construction period as compared to the pre construction period. But one thing looks unclear is the case of Jimma where it has shown a reduced correlation coefficient in maize and wheat in post construction period. Besides, Jimma's market does usually show an antagonistic trend relative to the other markets. In fact, based on an informal interview made to traders and truck drivers who engage in grain business between Addis and Jimma, the road condition between the two cities is not, even currently, in a good state in that the road rehabilitation program of the 2002, hasn't as such improved the road condition. This is because another construction, which is currently underway, by constructing a lengthy and narrow detour roads, has negatively affected market integration between the two markets. Besides, as most drivers, who engage in grain freight transportation, would prefer to go at nighttime, the drivers also mentioned that there is a potential threat of 'bandits' in recent period, across the two towns, and hence, they may not prefer to go in that route.

Table 3.4: Spatial correlation of monthly wholesale prices (birr/quintal) of mixed teff, white maize and white wheat in the two periods.

Markets	Distance from Addis (km)	Before construction			After construction		
		Teff	Maize	Wheat	Teff	Maize	Wheat
Addis ↔ Nazereth	98	0.87	0.94	0.92	0.86	0.98	0.97

Addis ↔ Shashemene	253	0.90	0.92	0.87	0.79	0.97	0.96
Addis ↔ Nekemete	327	0.72	0.93	-	0.88	0.94	-
Addis ↔ Dire Dawa	515	0.82	0.76	0.75	0.85	0.87	0.79
Addis ↔ Mekelle	784	0.72	0.86	0.60	0.84	0.95	0.81
Addis ↔ Jimma	346	0.85	0.98	0.88	0.88	0.91	0.78
Addis ↔ Bahir Dar	465	0.80	0.64	-	0.86	0.87	-

Source: Computed based on data from EGTE

Chapter Four

4. Methodology and Specification of the model

4.1. Time series Decomposition

The analysis of time series is based on the assumption that successive values in the data file represent consecutive measurements taken at equally spaced time intervals. Every time series is believed to have two components: deterministic (or predictable), slow long run evolution, and stochastic (or random) (Madalla, 1992).

In general, any time series analysis can be thought composed of parts in some way related to one another or the ‘whole: secular trend (T), seasonal (S), cyclical (C) and irregular (I) components. The first three components are deterministic which are called “signals”, while the last component is a random variable, which is called “noise”. For example a time series variable P_t is composed of:

$$P_t = S_t \cdot T_t \cdot C_t \cdot I$$

where the subscript ‘t’ denotes a particular time period.

The purpose of these time series decomposition and adjustment is to make appropriate decisions upon production, storage and marketing, both for producers and traders.

Trend (T): A trend is a relatively smooth long-term movement of a time series and it represents a general systematic linear or (most often) non-linear component that changes over time and does not repeat or at least does not repeat within the time range captured by our data. Trends can be upward, downward or horizontal.

Trend Analysis uses linear and nonlinear regression with time as the explanatory variable, it is used where pattern over time have a long-term trend. Unlike most time series forecasting techniques, the trend analysis does not assume the condition of equally spaced time series. If, for example, P is the long period's price of a commodity and t is the time period, the trend component, as a linear function of time variable, can be explained as:

$$T_i = \alpha + \beta t_i \dots\dots\dots$$

(4)

where T_i = trend component of price during period i

t_i = the value of time variable during period i

α = constant term

β = trend coefficient of the time variable t

In this regression the coefficient of the time variable indicates the rate of change of the trend variable relative to a unit change, in the time variable whereas the constant term does not have any economic sense (Goetz. S. and Weber. T.H , 1986).

Seasonal variation (S): Seasonalities are regular fluctuations, which are repeated from year to year with about the same timing and level of intensity. If a repetitive pattern is observed over some time horizon, the series is said to have seasonal behavior and these seasonal effects

are usually associated with calendar or climatic changes (i.e., usually price falls post harvest). Based on supply and demand forces related to agricultural, production and marketing tend to follow a certain seasonal pattern. On the supply side following the biological nature of production, agricultural prices usually take seasonal movements. On the other hand, following seasonal demand fluctuations, price would also take a certain seasonal movement.

Cyclical variation (C): can be described as an upturn or downturn not tied to seasonal variation that can usually results from changes in economic conditions. Cyclic oscillations are general up-and down data changes: due to changes e.g. in the overall economic environment (not caused by seasonal effects) such as regression- and-expansion.

Suppose there is a deviation from a long run equilibrium, which exists between price and production of a given commodity; it is believed that those forces that caused a shift away from the static equilibrium would be expected to bring back to the equilibrium. However, since there is a time lag to adjust production, to any price change, the price and production may not return back to the original position, they rather may circulate around it. This is what is called cyclical component (Getnet, 2005).

Irregular variation (I): are any fluctuations not classified as one of the above. This component of time series is unexplainable; there fore it is unpredictable.

These four components could be independent each from all of the others and hence the behavior of the series could turn out to be simply the sum of its parts, which are additively related. However, many researchers believe that the component parts are unlikely to be perfectly independent of one another and are therefore multiplicatively related.

The first step in isolating the components is smoothing the object series with a centered moving average (CMA)³ and at this stage if the smoothing is to be done by moving average, it is conventional to specify the number of observations (n) from 12 to 15 elements in the moving average set. For example, in a monthly data, if n is chosen to be 12, any seasonal price movements observed in the series over the twelve months would completely be eliminated. In the process, the number of elements in the set can be diminished to the number of remaining rows in order to encounter the loss of data occur at the end of a CMA series, as the end of the series is approached. This would leave us with a combination of T.C series, as the seasonal and irregular influences are smoothed from the time series. The technique of using centered moving average for a specified time period helps in representing the actual value by the average of that value and a given number of observations taken immediately before and after it (Goetz. S. and Weber. T.H, 1986).

The technique of CMA has significant advantages in that it can take the trend of the original time series, it can show any cyclical variations around the time series and it can eliminate very short term instability (seasonal and random) appearing in the original series.

The second step entails that computing the ratios of the original time series (T.C.S.I) to the results of the first step (T.C), which by cancellation (or division) leaves a combination of S.I series and this basis for the name of the technique, “ratio-to-moving average”.

The third step involves smoothing of the S.I series of the previous step to eliminate the irregular influences, leaving an isolated seasonal series, S.

³ The formula for CMA¹² is:

$$CMA_t = \left[\sum_{i=t-5}^{i=t+5} P_i + \sum_{i=t+6}^{i=t+11} P_i \right]$$

The fourth step, involves, computing the ratios of (S.I) to the corresponding result of S, which by cancellation (or division) yields an isolated irregular, I, series.

The next step engages, trend regression on the unidirectional range of the time series variable, so as to produce an isolated T series.

The final step, involves computing the ratios of the results of the first step (T.C) by the results of the fifth step (T), which by cancellation yields an isolated, C, series.

4.2. The Model

The study employs the Threshold Autoregressive (TAR) model of cointegration in the form of Error Correction Model (ECM) of Engle Granger two step methodology.

To begin with, the fact that variables may tend to have a long run relationship while they are still non-stationary led to the formulation of the Error Correction Model (ECM) technique of identifying their long-term relationship along with the short term dynamics.

The long-run is a state of equilibrium where economic forces would tend to be stable, while the short run depicts the disequilibrium state where adjustment to the equilibrium is occurring. Upon dealing with non-stationary data, equilibrium could be very much related to the concept of cointegration and hence, if there is no sign of cointegration between the variables to be analyzed, trying to relate them would often lead to spurious regressions which don not reflect long-run economic relationships but, rather, reflect the 'common trends' contained in most non-stationary time series. Cointegration is also related very closely to the use of short-run error correction models which helps in showing the link between the long and short run approach to econometric modeling (Harris, 1995).

In fact, Engle and Granger (1987) show that if Y_t and X_t are cointegrated of order d, b where $d \geq b > 0$, commonly expressed as: $Y_t, X_t \sim I(d, b)$ the two variables are integrated of order d and there exists a linear combination of these variables which is integrated of order $d-b$. Thus the resulting linear combination is an ECM, $CI(d, b)$, then there must exist an ECM. Provided that the terms in levels cointegrate, the Granger's representation theorem for dynamic modeling, through ECM, guarantees that spurious regression would not occur. The ECM has several advantages for it incorporates, given that terms are cointegrated, both short-run and long run effects.

As a prologue to the Threshold Autoregressive (TAR) Model and as a subsequent step of the cointegration analysis the Engle Granger two step approach is followed. Hence, according to Engle – Granger approach of cointegration, if we have two non- stationary variables containing a unit root (i.e. $I(1)$ variables), then they can be described as being cointegrated if the error term is stationary (i.e. $I(0)$ ⁴). That is the stationarity of the residuals, as can easily be tested using the Augmented Dickney Fuller (ADF) test, is believed to indicate whether the variables are cointegrated or not (Enders and Sikilos, 1999).

The first stage of the two-step methodology of the Granger representation model entails using OLS to estimate the long-run equilibrium relationship of two or more variables as:

$$X_{1t} = \beta_0 + \beta_2 X_{2t} + \beta_3 X_{3t} + \dots + \beta_n X_{nt} + U_t \dots \dots \dots$$

(5)

where: X_{it} are the individual $I(1)$ components of X_t , β_i 's are the estimated parameters, and U_t is the disturbance term which may be serially correlated.

⁴ When we have an $I(0)$ error term, with two $I(1)$ variables, in effect the drift process in the $I(1)$ variables have cancelled each other out to produce an error term with no drift.

The second-step focuses on the OLS estimate of ρ in the regression equation:

$$\Delta U_t = \rho u_{t-1} + \varepsilon_t \dots\dots\dots (6)$$

where: ε_t is a white noise disturbance, and the residuals from (5) are used to estimate (6).

Accepting the alternative hypothesis (i.e., rejecting the null hypothesis of no cointegration ($2 < \rho < 0$)) implies that the residuals in (5) are stationary with mean zero. As such, (5) is an attractor such that its pull is strictly proportional to the absolute value of U_t . The Granger-representation theorem guarantees that if $\rho \neq 0$, (5) and (6) jointly imply the existence of an error-correction representation of variables in the form:

$$\Delta X_{it} = \alpha_i (X_{1t-1} - \beta_0 - \beta_2 X_{2t-1} - \beta_3 X_{3t-1} - \dots - \beta_{nt} X_{nt-1}) + \dots + V_{it} \dots\dots\dots (7)$$

The above equations are based on the assumption of symmetric⁵ adjustment; but these cointegration and their extensions are misspecified if adjustment towards long-term equilibrium is asymmetric. Consequently, as an effort to incorporate the problems of the EG Model, the basic Threshold Autoregressive (TAR) model, which is developed by Tong (1983), allows the degree of autoregressive decay to depend on state of the variable of interest. This is in contrast to standard models of cointegrated variables, Engle-Granger (1987) and Johansen (1996) tests, which implicitly assume linearity and symmetric adjustment. Following the approach used by Enders and Sikilos (1999), an alternative specification of the error correction model is developed and in that (6) can be written as:

$$\Delta U_t = \rho_1 I u_{t-1} + \rho_2 (1-I) u_{t-1} + \varepsilon_t \dots\dots\dots (8)$$

⁵ Symmetry indicates that any deviation from the equilibrium would be approached by traders in the same way regardless of the direction and magnitude.

where: I_t is the Heaviside indicator function such that:

$$I_t = \begin{cases} 1 & \text{if } U_{t-1} \geq \tau \\ 0 & \text{if } U_{t-1} < \tau \end{cases} \quad \text{or} \quad \dots\dots\dots (9)$$

and: τ = the value of the threshold.

If the various (x_{it}) are not cointegrated, there is no threshold τ and the value of ρ_1 and/or ρ_2 is equal to zero. In such circumstances, Andrews and Ploberger (1994) and Hansen (1996) show that inference is difficult since the nuisance parameters are not identified under the null hypothesis (Enders, 2001).

The value of the threshold, τ , is usually unknown, however, in many economic applications; researchers set τ to zero so that the co integrating vector coincides with the attractor.

As the value of the threshold of the deviations from the long term equilibrium between the cointegrating variables is unknown, it is necessary to estimate τ along with the value of ρ_1 and ρ_2 . Consequently, to determine the value of the threshold, following Chan (1993)'s methodology the threshold value is searched over the potential threshold values so as to minimize the sum of squared error from the fitted model. According to Chan (1993) this method yields a super-consistent estimate of the threshold value.

In searching the potential threshold values by then the threshold value, a Monte Carlo simulation technique is undertaken.

4.2.1 Monte Carlo (MC) Simulation

“Science is what we understand well enough to explain to a computer.”

Donald E. Knuth

In those periods before the introduction of electronic computers, researchers were confronted with a single option of predicting an outcome of an experiment only through making use of a theory that provided an approximate description of the system under consideration. The reason why an approximate theory was almost always used is that there are very few model systems for which the equilibrium properties can be computed exactly. Therefore, most properties were envisaged on the basis of approximate theories.

Given adequate information about the behavior of variables under consideration these theories will provide us with an estimate of the properties of interest. Unfortunately, our knowledge of the variables of interests is quite limited. As a result, problem would occur if we wish to test the validity of a particular theory by comparing directly to experiment. Incase if we come across that theory and experiment disagree, it may mean that our theory is wrong, or that we have an incorrect estimate of the behavior of the variables, or both. Clearly, it would be very nice if we could obtain essentially exact results for a given system, without to rely on approximate theories. Computer simulations allow us to do precisely that. Consequently, with help of computer simulations, on the one hand, the calculated properties of a model system can be compared with those of an experimental system: if the two disagree, it means that our model is inadequate, i.e. we have to improve on our estimate of the behavior. On the other hand, the result of a simulation of a given model system can be compared with the prediction of an approximate analytical theory applied to the same model. If we now find that theory and simulation differ, we know that the theory is shaky. So, in this case, the computer simulation plays the role of the ‘experiment’ that is designed to test the theory. This method of screening

theories before we apply them to the real world is called ‘computer experiment’. Now days, Computer experiment have become ordinary practice, to the extent that they now provide the first (and often the last) test of a new theoretical outcome. Computer simulation methods are gaining in importance and popularity as viable and useful tools for research and education (Frenkeel 2004).

4.2.1.1. What is Monte Carlo Simulation?

Monte Carlo simulation is a very important technique named after the city (in the province of Monaco, South of France) famous for its (gambling) casinos; the Monte Carlo method replaces a difficult deterministic problem with a stochastic problem with the same solutions; labor intensive work can be replaced by cheap capital intensive simulation. The method makes extensive use of random numbers. It is employed for simulation of a large variety of phenomena in a very many different disciplines (Nielson, 2003).

Monte Carlo Simulation is a methodology or tool of understanding the behavior of a certain model or statistic under a given conditions. For example, it is difficult to assess the actual impact of multicollinearity on estimates of a given regression because in real life we almost never know the true value of the parameters. However, with the help MC simulation, the same type of analysis can be performed on data with known characteristics. We know these characteristics, because we manufacture the data to have those characteristics (Ferral, 1995).

Monte Carlo method makes use of random numbers to solve a problem. Accordingly, in order to carry out a Monte Carlo simulation, we require a sequence of numbers which are random, independent, real and uniformly distributed in the range zero to one. Strictly, we can call a sequence of numbers random, if and only if it is generated by a random process like tossing of a coin. This phenomenon is known to be truly random at least according to the present day

theories. In order to follow a safe procedure, one has to generate once and for all, a fairly long sequence of random numbers from a random physical process and employ this sequence in its Monte Carlo simulations.

Since these numbers, generated by deterministic algorithms, are predictable and reproducible they cannot be called random. Hence, they rather be called pseudo random numbers. In that case, we shall be satisfied with pseudo random numbers if we find they go through tests of randomness satisfactorily (Murthy, 2003).

Many results in econometrics are asymptotic, i.e. for $T \rightarrow \infty$, and often difficult to get a firm understanding of the results. Simulation methods are often useful to answer question like how should we think of repeated sampling? What is the exact meaning of a central limit theorem? How does a given estimator work in finite samples? What is the probability of success in the game Soliter? The above questions are very difficult analytical problems, but a machine could play, for example the Soliter game, M times, and for $M \rightarrow \infty$ we could estimate the probability.

Moreover, questions like what is the finite sample distribution of an estimator? is a kind of difficult, however, in most situations we could generate M samples and look at the empirical distribution of estimates (Nielsen, 2003).

Below Monte Carlo experiments that can be used to test the null hypothesis of no cointegration against the alternative of cointegration with thresholds (TAR) adjustment are described.

One problem in using TAR model is that standard maximum likelihood (ML) estimation algorithms cannot be applied because the log likelihood function is not continuously

differentiable with respect to the threshold parameter. As a result, in order to overcome this problem, researchers implement a grid search (GS) over a feasible region of the threshold space. For a specified threshold value, the TAR model is piecewise linear in the remaining parameters and thus linear in the remaining parameters and thus linear estimation techniques can be applied (Coakley et.al, 2000)

Consequently, in order to conduct a Monte Carlo experiment that can be used, 50,000 random-walk process of the following form were generated:

$$X_{1t} = X_{1t-1} + V_{1t}, \quad t= 1, \dots, T \dots\dots\dots (10)$$

$$X_{2t} = X_{2t-1} + V_{2t}, \quad t= 1, \dots, T \dots\dots\dots (11)$$

where T denotes the number of usable observations.

For sample size of T, two sets of T normally distributed and uncorrelated Pseudo-random numbers with standard deviation equal to unity were drawn to represent the (V_{1t}) and (V_{2t}) sequences. Randomizing the initial values of X_{1t} and X_{2t} , the next T values of each were generated using (10) and (11). For each of the 50,000 series, the TAR model given by (5), (8) and (9) is estimated (after estimating τ .)

However, to estimate the value of τ , for each of the 50,000 X_{1t} and X_{2t} series, the long-term equation in the form of (5) is estimated. As in the presence of asymmetric adjustments ρ_1 and ρ_2 differ, the mean will be a biased estimator of the threshold and hence Chan's (1993) approach should be followed in that, the residuals predicted from the regression will be saved, and then, the saved residuals would be ordered in ascending order and called

$U_{1\tau} < U_{2\tau} < \dots < U_{T\tau}$ then the upper and lower 15% of the residual series, i.e. $(U_{i\tau})^6$ values, would be discarded and the middle 70% would be considered as a potential candidates to be the threshold value.

To find the threshold value, each of the threshold candidates are estimated in the form of equation (8) and (9) and the threshold value that produces the minimum residual sum of squares would be considered as the threshold, τ , value. Besides, the two coefficients of the error correcting terms, ρ_1 and ρ_2 , would be estimated in the process, simultaneously. Since the threshold values are unidentified under the null hypothesis, standard tests are inappropriate, and hence a need arises to estimate the critical values through, again the method of Monte Carlo simulation. Using this threshold value, for each estimated equations from the previous simulations, the two t-statistics for the null hypotheses $\rho_1=0$ and $\rho_2=0$ along with the F-statistic for the joint hypothesis $\rho_1=\rho_2=0$, are recorded. The largest of the individual t-statistics is called t-max, and F-distribution is called F-statistics (Enders and Sikilos, 1999).

4.3. The Data

The analysis of this paper is entirely based on secondary price data collected from Ethiopian grain Trade Enterprise (EGTE), and Ethiopian Road Authority (ERA).

The main data required for the estimation of market integration using TAR are: the wholesale white wheat price of the different markets and the completion date of the construction of roads.

In addition, based on data availability, road construction route and importance of the towns as a major terminal market, six markets are chosen for the empirical analysis: Addis Ababa

⁶ 15% of the upper and lower values of the ordered residual series are excluded from the grid search identifying τ to ensure sufficient degrees of freedom are present in each regime.

(ADDW), Nazareth (NAZW), Shashemene (SHAW), Dire Dawa (DDW), Mekelle (MEKW) and Jimma (JMMW). Furthermore, based on its size and location advantage Addis Ababa (ADDW) is chosen as the central market.

All the data for all the markets are in a monthly basis and covers periods from January 1996 to December 2005 and they are all in a wholesale level and deseasonalized, but based on the completion date of the roads constructed between Addis and the regional markets, the date series breaks somewhere. The completion date of the constructed road between Addis and the respective markets is: for NAZ and SHA is Feb. 2001, for DD and MEK is December 2001 while JMM's completion date is in April 2002. Consequently, the period before the date is regarded as a period with relatively poor quality of road whereas the period after the construction is considered as a period with a better road quality and condition and analysis is based on a before /after approach.

Here construction could refer to upgrading, new construction, rehabilitation or all. Since, the roads from Addis Ababa to the towns under consideration could be constructed on discontinued phases and/or lengths and though significant number of construction phases have been going on, the completion date of the phase with the longest distance is considered as the demarcation date of the before after approach.

The main assumption used in this analysis is that, in the two periods under consideration, the main significant factor between the two periods that can affect market integration is only transpiration cost and costs related to transport infrastructure and costs related with road infrastructure and hence, other transaction cost components are assumed insignificant.

Empirically the Northern markets, including Mekelle, are poorly integrated with the central market, mainly for wheat. The connection between the white wheat markets seems rather poor

especially Dire Dawa and Mekelle are much more isolated in the periods from 1991-1998 (resal 1999).

Based on a couple of empirics (Negassa 2003, resal 1999), Dire and Mekelle would be expected to be weakly integrated with Addis market; where as the surplus producing markets are expected to produce a better level of integration.

Chapter Five

5. Empirical Analysis

5.1. Pre estimation tests

As the time series properties of the variables should be tested prior to engaging in econometric modeling strategy, various standard pre estimation tests, including unit root tests, were performed to obtain economically intuitive results:

5.1.1. Augmented Dickey Fuller (ADF) tests

As an improvement on the Dickey-Fuller (DF)⁷ test, and to incorporate the potential problems of it, Dickey and Fuller further refined their work and developed Augmented Dickey Fuller (ADF) test. And hence, if a sample Y_t follows an AR(p) process but it is used as an AR (1) DF model, then the error term will be autocorrelated to compensate for the misspecification of the dynamic structure of Y_t (Harris, 1995). Autocorrelated errors would make the use of the DF distributions inappropriate, because the distributions are based on the assumption that U_t is 'white noise'. The ADF test is comparable to the simple DF test but involves adding an unknown number of lagged first differences of the dependent variable to capture autocorrelated omitted variables that would otherwise, by default, enter the error term, μ_t (an alternative approach to adding lagged first differences of the dependent variable is to apply a non-parametric correction to take account of any possible autocorrelation; this is the Phillips and Perron approach)

As a result, assuming that Y_t follows a P^{th} order autoregressive process:

⁷ The problem with the DF test emanates from its assumption that the error terms are 'white-noise' and they are iid(0, δ^2), and hence, if a simple AR(1) DF model is used when in fact the dependent variable follows an Autoregressive Moving Average (ARMA) process, or an AR(P) process, the error's will be auto correlated to compensate for the misspecification of the dynamic structure of the variable.

$$Y_t = \psi_1 Y_{t-1} + \psi_2 Y_{t-2} + \dots + \psi_p Y_{t-p} + \mu_t \dots \dots \dots (12)$$

or

$$\Delta Y_t = \psi_1^* Y_{t-1} + \psi_1^* \Delta Y_{t-1} + \psi_2^* \Delta Y_{t-2} + \dots + \psi_{p-1}^* \Delta Y_{t-p+1} + \mu_t \dots \dots \dots (13)$$

where $\psi_1^* = (\psi_1 + \psi_2 + \dots + \psi_p) - 1$. If $\psi^* = 0$, against the alternative $\psi^* < 0$, then Y_t contains a unit root.

The ADF model tests for the null of a stochastic trend (non-stationary) against the alternative of a deterministic trend (stationary) and it is as follows:

$$\Delta Y_t = \psi_1^* Y_{t-1} + \sum_{i=1}^{p-1} \psi_i^* \Delta Y_{t-i} + \mu + \gamma_t + \mu_t \quad \mu_t \sim \text{IID}(0, \delta^2) \dots \dots \dots (14)$$

The ADF can further be extended to permit for moving average (MA) parts in the μ_t . It is generally believed that MA terms are present in many macroeconomic time series after first differencing (e.g., time average data, an index of stock price with infrequent trading for a subset of the index, the presence of errors in the data, etc.).

Central to the ADF model is the selection of the appropriate lag-length; this is because, too few lags may results in over- rejecting the null when it is true (i.e. adversely affecting the size of the test), while too many lags may reduce the power of the test (since unnecessary nuisance parameters reduce the effective number of observations available), and hence appropriate lag selection criterion should be used (Harris 1995).

Accordingly, in the period after the construction of the roads, all the series of the variables considered are found to be $I(1)$ in level terms, Akaike Information Criterion (AIC) indicates one optimal lag for all the variables under consideration.

In the post construction period, Nazareth and all the other markets are significant at 5 and 1% significant levels respectively. However, AIC indicates that Addis, Jimma and Dire Dawa are stationary at one lag, Shashemene includes two lags where as Mekelle and Jimma included three lags and in order to save space the long-term regression results are put in annex 5.

5.1.2. Cointegration tests

The residual based ADF test for cointegration assumes that the variables in the OLS equation are all $I(1)$, such that the test for cointegration is whether $\varepsilon \sim I(1)$ against the alternative that $\varepsilon \sim I(0)$

It is only really applicable to use the single equation approach when there is a single unique cointegration vector and when all the right hand-side variables are weakly exogenous (Harris 1995).

If there are $n > 2$ variables in the model, there can be more than one cointegration vectors. It is possible for up to $n-1$ linearly independent cointegration vectors to exist, and this has implications for testing and estimating cointegration relationship. Only when $n=2$ it is possible to show that cointegration vector is unique. Though Johansen's method of cointegration test is superior to ADF in many ways, for a bi-variate analysis ADF can also be very much reliable (Harris, 1995).

Even though the EG approach is popular and widely used it should be used with a proper precaution. The potential problems with the residual based approach of Cointegration might

be that firstly, the ADF test often indicates acceptance of the null hypothesis (no cointegration), when in fact cointegration is present; and secondly the ADF test is best when there is a long time span of data, rather than large amounts of observations over a short time span. This can be a problem with financial data which tends to cover a couple of years, but with high frequency data (i.e. daily data).

The main difference of Johansen's method with bi-variate tests for cointegration, the two may give different results, would be, that given that the Johansen's method is a maximum likelihood based test, (Engle Granger is OLS based), it requires a large sample where as the ADF test better suited for moderate size of observations.

Following the first step of Engle-Granger approach of cointegration, the long-run relationships of the variables are estimated and the residuals from the above regression equations are tested for stationarity using ADF. The ADF test statistics are calculated without a constant and trend since the cointegration equations are already estimated with a constant (Enders 1995).

According to Granger (1995), if there is evidence of co integration between two or more variables, then a valid error correction model should also exist between the two variables. Hence, this error correction model can be considered as a representation of the short-term dynamic relationship between the two variables. The error correction term in the ECM incorporates the long run information about the two variables in to our model.

An error correction model includes only $I(0)$ variables as a result, all of the nonstationary variables are first- differenced, to produce stationary variables. If the variables are cointegrated, the error correction term which is the residual from the cointegrating relationships, lagged one time period, will be $I(0)$.

To apply the above formulation, Equation (5) can be rewritten here as:

$$X_{1t} = \beta_0 + \beta_2 X_{2t} + \beta_3 X_{3t} + \dots + \beta_n X_{nt} + U_t \dots \dots \dots (15)$$

where: X_{1t} , here, represents the price series of ADDW at time t while X_{2t} stands for the price series of individual regional markets, at period t , β_i are the estimated parameters, and U_t is the disturbance term which may be serially correlated. Besides, as our model is a bi-variate analysis, the other explanatory variables, $\beta_3 X_{3t} + \dots \beta_n X_{nt}$, are nonexistent in the long run model.

Accordingly, equation (15) can be written for any two markets as, for example for ADDW and NAZW:

$$ADDW_t = \beta_0 + \beta_2 NAZW_t + U_t \dots \dots \dots (15')$$

where $ADDW_t$ and $NAZW_t$ indicate the deseasonalized wholesale prices of Addis and Nazereth at time t , respectively; β_i are the estimated parameters, and U_t is the disturbance term which may be serially correlated.

If the residuals from (15') are stationary, the two markets could be considered cointegrated and hence, eq (8) and (9) can be estimated for (15'), so as to understand the level and degree of integration between the two.

Consequently, the results of table 5.1 present the ADF tests on the residuals from the linear regression of Addis on a constant and the respective markets. The results indicated in table are mixed, in that ADDW and NAZW are cointegrated as can be evidenced by the results of the

ADF which are significant at 1% significance levels, in both the pre and post construction periods.

Table 5.1: Results of Residual Based Augmented Dickney Fuller (ADF) tests for cointegration

Cointegrating Markets	ADF test values	
	Before construction period	After construction period
ADDW and NAZW	-4.10***	-3.23***
ADDW and SHAW	-3.46***	-3.86***
ADDW and DDW	-3.02***	-3.18***
ADDW and MEKW	-2.04**	-2.56**
ADDW and JMMW	-4.00***	-1.88*

*, **, *** indicate level of significance at 10%, 5% and 1% significance level respectively.

Regarding the cointegration of ADDW and SHAW, the ADF result shows that there is better degree of cointegration between the two markets, in the post construction period compared to the pre construction period, as evidenced by the value of ADF, which is significant at 1%.

Dire and Addis have shown a fair degree of cointegration as their ADF shows significance at nearly 1% in both periods. On the other hand, Addis and Mekelle's markets are weakly integrated as the ADF value marginally rejects the null hypothesis of no cointegration at 5% significance level in both periods.

A very interesting picture is that of Jimma, as the ADF result shows a strong level of cointegration, in pre construction period which is significant at 1% where as, in the post construction period, it failed to show cointegration even 10% significance level.

In sum, while those markets with a relatively closer proximity to Addis have shown a better level of cointegration with the central market, the deficit markets and distant markets have

shown no change in the two periods. Dire is fairly cointegrated with Addis, where as Addis and Mekelle are modestly or weakly integrated.

Data can be partitioned in to the long-term equilibrium and the rest, as by assumption, deviations from a valid equilibrium⁸ will be a stationary process. This can be very useful in applied work.

The presence of a cointegrating set of variables is required for a valid ECM so as not to produce a classical spurious regression.

The existence of cointegration implies that Granger causality must exist in at least one direction between the variables of the system. As a result, direction of causality between the markets under consideration are estimated and presented below.

5.1.3. Causality

Looking at the causality between Addis and the respective markets, in the pre construction period, NAZW granger causes ADDW and the causality is unidirectional. On the other hand, in the same period, it is ADDW that Granger causes SHAW as can be evidenced by the rejection of the null of no granger causation at 5% significance level.

Again in the pre construction period ADDW causes DDW, but there is no causality between MEKW and ADDW. In the case of Jimma, in the period before construction of the road, it causes ADD as evidenced by rejection of the null at 1% significance level; there is also a tendency of ADDW causing JMMW at 5% significance level indicating existence of simultaneity between the two markets.

⁸ By equilibrium it is meant that the relationship which will hold on average a long period of time (not necessarily market clearing).

Looking at the situations of the causality of the respective markets in the post construction period, NAZW clearly causes ADDW; while SHAW unlike the pre construction period now turned out to cause ADDW at 5% significance level and MEKW remained the same. In contrast to the pre construction period, in the post construction period the causation between Addis and Jimma is unidirectional and it is ADDW that granger causes JMMW.

5.2. Application of the Error Correction TAR Model to the Ethiopian White Wheat Markets

5.2.1. The long run relationship

The long run relationship of the regional markets and Addis are estimated in the form of (15'), and in order to save space, put in annex 5. However, before estimating equation (15') the markets must pass a test of cointegration, otherwise the regression would turn out to be the classical spurious regression; and as can be seen from annex 5, all the coefficients of all cointegrated markets, which indicate their long term relationship, are significant at 1%.

5.2.2. Results of Monte Carlo Simulation

As explained above, since the value of the threshold of the deviations from the long term equilibrium⁹ between the two markets, ADDW and the other respective markets is unknown, it is necessary to estimate τ along with the values of ρ_1 and ρ_2 . Consequently, to determine the value of the threshold, Chan (1993)'s methodology which according to Chan himself, yields a super-consistent estimate of the threshold value, is followed in that a Monte Carlo based grid search is undertaken on the potential threshold values, and the potential threshold values were estimated in the form of (8) and (9), in order to find the value that minimizes the

⁹ The major reason why relationship is not always in equilibrium centers on the inability of economic agents to adjust to new information instantaneously.

residual sum of squares. According to Chan (1993) this method yields a super-consistent estimate of the threshold value.

However, in a priori, in search of the potential threshold values by then the threshold value, a Monte Carlo simulation is undertaken: and hence, in order to conduct a Monte Carlo experiment that can be used, 50,000 random-walk process of the following form were generated: and (10) and (11) are rewritten here:

$$X_{1t} = X_{1t-1} + V_{1t}, \quad t= 1, \dots, T \dots\dots\dots (10')$$

$$X_{2t} = X_{2t-1} + V_{2t}, \quad t= 1, \dots, T \dots\dots\dots (7')$$

where T denotes the number of usable observations.

For T=45, 48,59,61,72 and 75¹⁰, two sets of T normally distributed and uncorrelated Pseudo-random numbers with standard deviation equal to unity were drawn to represent the (V_{1t}) and (V_{2t}) sequences. Randomizing the initial values of X_{1t} and X_{2t}, the next T values of each were generated using (10') and (11'). For each of the 50,000 series, the TAR model given by (5), (8) and (9) is estimated (after estimating τ .)

Then for each of the 50,000 X_{1t} and X_{2t} series, the long term equation in the form of (15') is estimated. As in the presence of asymmetric adjustments ρ_1 and ρ_2 differ, the mean will be a biased estimator of the threshold and hence Chan's (1993) approach should be followed. Accordingly, the residuals predicted from the regression, 15', were saved, and then, the saved residuals were ordered in ascending order and called $U_1^\tau < U_2^\tau < \dots < U_T^\tau$ then the upper

¹⁰ The T values represent the no of observations of the respective markets before and after construction of roads based on the completion date of the road between Addis and each markets

and lower 15% of the residual series, i.e. (U_i^τ) values, were discarded and the middle 70% were considered as a potential candidates to be the threshold value.

To find the threshold value, each of the threshold candidates are estimated in the form of equation (8) and (9) in a GS and from these regressions the threshold value that produces the minimum residual sum of squares were considered as the threshold, τ ; and this process is repeated for all the market pairs under consideration, in order to find their respective threshold values. The estimated threshold values for each market can be seen from table (5.2). Besides, the two coefficients of the error correcting terms, ρ_1 and ρ_2 , of all the regressions were estimated in the process, simultaneously.

Table 5.2: Estimated threshold values between Addis and the regional markets

Threshold values		
Cointegrating		
Markets	Before Construction period	After Construction period
ADDW and NAZW	-3.55729	-3.22154
ADDW and SHAW	-3.55729	-2.66543
ADDW and DDW	2.79490	2.83582
ADDW and MEKW	3.45774	2.910203
ADDW and JMMW	-3.96432	-0.853108

Source: simulation results, 2006

Following the methodology outlined in Enders and Sikilos (1999), since the TAR regressions are unidentified under the standard tests, empirical frequencies were calculated both for t and F distributions. Using these threshold values of each estimated equations from the previous simulations, the two t-statistics for the null hypotheses $\rho_1=0$ and $\rho_2=0$ along with the F-statistic

for the joint hypothesis $\rho_1=\rho_2=0$, are recorded. The largest of the individual t-statistics is called t-max, and F-distribution is called F-statistics. Accordingly, based on an iterative estimation of Monte Carlo simulation on the 50,000 series, for each market pairs and for each period, the t and F-statistic distributions of 1%, 5% and 10% critical values are calculated and put in tables (5.3) and (5.4), respectively.

Table 5.3: Estimated critical values of t-max distribution

Market pairs	Before Construction				After Construction			
	Sample size	90%	95%	99%	Sample size	90%	95%	99%
ADDW and NAZW	61	-2.79	-3.23	-3.94	59	-2.58	-3.11	-3.9
ADDW and SHAW	61	-2.79	-3.23	-3.94	59	-1.92	-2.46	-3.69
ADDW and DDW	72	-1.89	-3.03	-3.87	48	-2.59	-3.13	-3.96
ADDW and MEKW	72	-2.37	-3.03	-3.87	48	-2.66	-3.16	-3.98
ADDW and JMMW	75	-2.75	-3.19	-3.94	45	-1.86	-2.09	-2.57

Source: simulation results, 2006

Table 5.4: Estimated critical values of probability distributions of F-statistics for the estimated parameters.

Market pairs	Before Construction			After Construction		
	Sample size	95%	99%	Sample size	95%	99%
ADDW and NAZW	61	6.799	10.36	59	6.65	10.1
ADDW and SHAW	61	6.799	10.36	59	6.4	9.88
ADDW and DDW	72	4.424	7.966	48	4.44	8.73
ADDW and MEKW	72	4.247	7.778	48	4.38	8.71
ADDW and JMMW	75	6.674	9.927	45	5.47	9.41

Source: simulation results, 2006

The nature of symmetry between the two error correcting terms, $\rho_1 = \rho_2$, can be tested by the standard F-test, while the joint significance, $\rho_1 = \rho_2 = 0$, should be tested by the distribution tables from the simulation results (tables 5.3 and 5.4).

5.2.3 The TAR error correcting terms

The error correction terms tell us the speed with which our model returns to equilibrium after an exogenous shock. As a result, the error correction terms should be negatively signed so as to indicate a move towards long term equilibrium. A positive sign indicates a move away from equilibrium. As the coefficients should lie between 0 and 1, 0 suggests no adjustment one time period later while 1 indicates full adjustment. The error correction terms can be either the difference between the dependent and explanatory variable (lagged once) or the error term (lagged once), they are in effect the same thing.

As part of an econometric modeling strategy, standard statistical tests were performed to ensure the robustness of the modeling results and in order to obtain economically intuitive results.

Accordingly, Ramsey's (1969) RESET technique of model specification test was performed in all the equations; and in all the cases the test couldn't reject the null hypothesis of functional misspecification in the estimated equations. For normality test, Jarque-Bera's technique was used and the test results indicate that the null hypothesis of normally distributed error terms, in all the cases except for NAZW in the preconstruction period, is not rejected. As a result the results of NAZW of the preconstruction period should be analyzed cautiously. Besides, the Breusch-Godfrey LM test indicates there is no serial correlation between the variables considered, up to the fifth lag. Similarly, there is no indication of heteroscedasticity, in all the estimated equations, as shown by White's test. In addition, Engle (1982)'s ARCH test for the existence of heteroscedastic autoregressive errors, indicates the absence of such autoregressive circumstances of heteroscedastic errors. Hence, based on all the above standard statistical diagnostic tests, the estimated models can be considered well specified and reliable; the results of the diagnostic tests are put under table 5.5.

The error correcting terms deserve to be presented here and viewed how they adjust towards the long-term equilibrium, and the TAR model's error correcting terms are estimated and put below:

Table 5.5: Estimation results of the longrun behavior of the Error correction model

Dependent Variable: Change in the error correcting terms, ΔU_t .

Between ADDW and	Explanatory Variables	Before construction Coefficients	t-value	After construction Coefficients	t-value
Nazereth	Iu_{t-1} $(1-I)u_{t-1}$	(0.479)*** (0.656)*	(3.50) (3.11)	(0.635)*** (0.37)	(4.43) (2.33)
Shashemene	Iu_{t-1} $(1-I)u_{t-1}$	(0.29) (0.474)*	(2.21) (3.02)	(0.513)** (3.61)	(3.61) (2.29)
Dire Dawa	Iu_{t-1} $(1-I)u_{t-1}$	(0.18) (0.15)	(1.96) (1.75)	(0.495)* (0.25)	(2.76) (1.67)
Mekelle	Iu_{t-1} $(1-I)u_{t-1}$	(0.06) (0.14)	(0.86) (1.80)	(0.18) (0.38)	(1.37) (2.42)
Jimma	Iu_{t-1} $(1-I)u_{t-1}$	(0.34) (0.448)**	(2.68) (3.34)	(0.2945)* (0.23)	(1.96) (1.49)

***, ** and * indicate significance at 1%, 5% and 10% significance levels, respectively

regression with	Diagnostics	Before construction	After construction
Nazereth	R ²	0.276508 F(2, 57)= 10.89[0.000]**	0.31422 F(2, 55)= 12.6 [0.000]**
	AR 1-2 test:	F(2, 55)= 0.26336 [0.7694]	F(2, 53)= 0.8915 [0.6796]
	ARCH 1-1 test:	F(1, 55)= 0.12322 [0.7269]	F(1, 53)= 1.4918 [0.02273]
	Normality test:	Chi ² (2)= 26.220 [0.0000]**	Chi ² (2)= 4.0423 [0.1325]
	hetro test:	F(4, 52)=1.0364 [0.3974]	F(6, 47)= 0.26811 [0.8971]
	hetro-X test:	F(4, 52)= 1.0364 [0.3974]	F(6, 47)= 0.26811 [0.8971]
	RESET test	F(1, 56) = 1.2781 [0.2631]	F(1, 54) =1.0676 [0.3061]

Shashemene	R ²	0.198223 F(2, 55)= 6.799 [0.002]**	0.2451 F(2, 55)= 8.929 [0.000]**
	AR 1-2 test:	F(1, 53)= 1.1187 [0.3214]	F(2, 53)= 2.1498 [0.1266]
	ARCH 1-1 test:	F(1, 53)= 0.31913 [0.7282]	F(1, 53)= 1.4576 [0.2327]
	Normality test:	Chi ² (2)= 0.17657 [0.9155]	Chi ² (2)= 0.0014049 [0.9993]
	hetro test:	F(4, 50)= 2.2730 [0.0744]	F(4, 50)= 1.0419 [0.3950]
	hetro-X test:	F(4, 50)= 2.2730 [0.0744]	F(4, 50)= 1.0419 [0.3950]
	RESET test	F(1, 54) = 3.0879 [0.0845]	F(1, 54) = 0.065095 [0.7996]
Dire Dawa	R ²	0.115662 F(2, 55)= 3.597 [0.034]*	0.226273 F(2, 44)= 6.4.4 [0.004]**
	AR 1-2 test:	F(2, 53)= 0.87825 [0.4215]	F(2, 42)= 0.48660 [0.6181]
	ARCH 1-1 test:	F(1, 53)= 0.00039819 [0.9499]	F(1, 42)= 1.514 [0.0205]
	Normality test:	Chi ² (2)=4.5852 [0.1010]	Chi ² (2)=5.0480 [0.08013]
	hetro test:	F(4, 50)= 0.32519 [0.8598]	F(4, 39)= 2.1640 [0.0911]
	hetro-X test:	F(4, 50)= 0.32519 [0.8598]	F(4, 39)= 2.1640 [0.0911]
	RESET test	F(1, 54) = 0.59376 [0.4443]	F(1, 43) =2.3446 [0.1330]
Mekelle	R ²	0.0529912 F(2, 44)= 1.231[0.302]	0.161097 F(2, 44)= 4.225 [0.021]*
	AR 1-2 test:	F(2, 42)= 0.20494 [0.8155]	F(2, 42)= 1.0719 [0.3515]
	ARCH 1-1 test:	F(1, 42)= 0.028982 [0.8656]	F(1, 42)= 0.49470 [0.4857]
	Normality test:	Chi ² (2)= 0.20311 [0.9034]	Chi ² (2)= 2.3244 [0.3128]
	hetro test:	F(4, 39)= 0.18256 [0.9461]	F(6, 36)= 0.91945 [0.4925]
	hetro-X test:	F(4, 39)= 0.18256 [0.9461]	F(6, 36)= 0.91945 [0.4925]
	RESET test	F(1, 43) = 1.1114 [0.2977]	F(1, 43) =0.14535 [0.7049]
Jimma	R ²	0.179156 F(2, 44)= 4.802 [0.013]*	0.1485 F(2, 41)=3.575 [0.037]*
	AR 1-2 test:	F(2, 42)= 0.11944 [0.8877]	F(2, 39)= 0.77825 [0.4662]
	ARCH 1-1 test:	F(1, 42)= 0.00057753 [0.9940]	F(1, 39)= 0.00081570 [0.9774]
	Normality test:	Chi ² (2)= 4.8864 [0.0869]	Chi ² (2)= 0.027656 [0.9863]
	hetro test:	F(4, 39)= 0.59578 [0.6678]	F(4, 36)= 0.89548 [0.0.4767]
	hetro-X test:	F(4, 39)= 0.59578 [0.6678]	F(4, 36)= 0.89548 [0.0.4767]
	RESET test	F(1, 43) = 0.79665 [0.3771]	F(1, 40) = 0.0025019 [0.9604]

Source: regression results, 2006

Accordingly, in the before construction period, both the coefficients of the error correcting terms, the threshold model coefficients, are significant at 5% significance level. That is both larger and smaller deviations than the threshold value from long term equilibrium are significant. This indicates that arbitrage would take place whenever any deviation from the long run equilibrium is observed regardless of the threshold value. The threshold value between Addis and Nazareth before construction of road is estimated to be -3.55729 (see table 5.2).

The error correction mechanism between Addis and Nazareth, in post construction period would take a some what different picture as smaller deviations from the equilibrium would immediately (or instantly) arbitrated away while deviations larger than the threshold value would be left to persist over a longer period. This can be understood from the coefficient of IU_{t-1} of the error correcting term which is significant at 1% significant level, whereas the coefficient of $(1-I)U_{t-1}$, which is the larger than the threshold value, is insignificant even at 10% significance level, see the critical values from table 5.3. The results designated that arbitrage between Addis and Nazereth in the Post construction period is inefficient as indicted by the smaller than threshold value error correction mechanism as compared to the larger deviation.

Shashemene's condition is a bit different from that of Nazareth in that in the pre construction period, with a threshold value of -3.55729, smaller deviations from the long term equilibrium as can be emphasized by the value of smaller than the threshold value, are not significant at the conventional significance levels, i.e. 1%, 5% and 10%. But larger deviations would tend to be arbitrated away relatively quicker as is typified by the coefficient of $(1-I)U_{t-1}$ which is significant, though weak, at 10% significance level.

But in the post construction period, with τ of -2.66543, both deviations would be arbitrated away, though smaller deviations from the equilibrium value would immediately arbitrage or cleared away while the larger deviations would be relatively stay for a longer period. Here the coefficient of $Iut-1$ is significant at 5% whereas the coefficient of $(1-I)U_{t-1}$ which shows larger deviation, is significant at 10%. This result indicates that arbitrage between ADDW and SHAW is somewhat inefficient because the smaller deviations rather than the larger once are

being arbitrated away indicating existence of problem of information asymmetry between the markets.

Regarding the wheat market integration between Addis and Jimma, the results show that in the pre construction period, smaller deviations from the long-term equilibrium are left to persist while the traders would immediately clear larger deviations away.

In the post construction period, Addis and Jimma's wheat market shows unclear picture, as both deviations would take a longer period to be corrected, though; smaller deviations from the equilibrium are being arbitrated relatively quicker, as indicated by the coefficient of Iu_{t-1} which is significant at 10%. The coefficient of $(1-I)U_{t-1}$ is insignificant even at 10%. The threshold value in this period is estimated to be -0.853108^{11} .

Concerning the cointegration between Addis and the deficit areas, Dire Dawa and Mekelle, and starting with Dire, in both periods under consideration, larger deviations from the long term equilibrium, though very sluggish, are arbitrated away relative to the smaller deviations, since the coefficient of IU_{t-1} is significant at 10% where as the coefficient of $(1-I)U_{t-1}$ is insignificant at any of the three conventional significant levels.

On the other hand, in the case of Mekelle's level of integration with Addis, the results show, in that in both periods, that all the coefficients of the error correction terms are insignificant at any of the conventional significance levels. This could be related to the longer distance between Addis and Mekelle in that any freight from Addis to Mekelle, Addis is assumed to be supplier for mekelle, would take a relatively longer period (days) and also probably due to the fact that trucks may not prefer to go to the deficit areas, for they may not get a freight in the

¹¹ When τ is closer to zero, it may indicate the absence of error correction mechanism.

return trip. That is there is a time lag between the two cities and arbitrage, regardless of the level of deviation from the long-term equilibrium, is sluggish.

The situation prevailing between ADDW and the deficit areas, i.e. the sluggish nature of the error correction may indicate that ADDW is rather a consumption centre than is a distribution (terminal) centre.

5.2.4. Error Correction Model- The Sort Run behavior

In this section also, diagnostic tests were conducted on all the individual equations and the results show that; except that of Nazereth in the pre construction period which is marginally rejected, all the residuals from the other regressions as shown by the Jarque-Bera tes, are normally distributed. The results also show that there is no problem of serial correlation and hetroscedasticity as measured by Lagrangian Multiplier test for the former and White's test for the hetroscedasticity test. A test was also conducted whether there exists a serial correlation among the variances of the terms; and it was found, through LM tests for ARCH effects, that there is no such problem in any of the equations. Moreover, Ramsy's (1969) RESET test of specification was also performed and the test result reveals that there is no functional misspecification problem; the results of diagnostic tests are put under table 5.6.

The error correction model between ADDW and NAZW, reveal that the short term impacts are significant as the coefficient of $\Delta NAZW$ in both periods is significant at 1%. Regarding the coefficients of the long term behavior indicating variables (error correcting terms), the error correcting variable with deviations under the threshold value is significant at 5% and 1% , in the pre and post construction periods, respectively. On the other hand, the coefficient of the variable with the deviations over the threshold value is not significant. This result

indicates that those deviations, which are over the threshold value, are corrected instantly while the larger deviations would persist for a long time.

If the alternative hypothesis of cointegration is accepted, it is possible to test for symmetric versus asymmetric adjustment since ρ_1 and ρ_2 converge to multivariate normal distribution. As such, the distribution that adjustment is symmetric (i.e. the null hypothesis ($\rho_1 = \rho_2$)) can be tested using the usual F-statistic (Enders and Sikilos, 1998).

Accordingly, to start with the symmetric test between ADDW and NAZW whether the deviations from the long term equilibrium, above and below the threshold value, behave in the same way or not, i.e. $\rho_1 = \rho_2$, a test was conducted in both periods and the test produces the same result, for both periods, in that the null hypothesis of symmetric adjustment can safely be rejected. That is, the adjustment between the two error correcting terms, ρ_1 and ρ_2 , is asymmetric. Besides, the null hypothesis of $\rho_1 = \rho_2 = 0$ of ADDW and NAZW, for both periods, can also be rejected at 1% significance level. As such the F- statistic rejects the null hypothesis of no cointegration at 1% significance level for the F-value of the regression is higher than the F-statistics (see table 5.4).

Table 5.6: Estimation results of the short run behavior of the Error correction model

Dependent Variable DADDW					
Markets	Explanatory Variables	Before construction Coefficients	t-value	After construction Coefficients	t-value
Nazereth	Constant	0.3725	0.31	1.57	1.29
	DNAZW	0.4853***	5.13	0.5852***	6.39
	Iu_{t-1}	(0.464)***	(3.73)	(0.7918)***	(5.01)
	$(1-I)u_{t-1}$	(0.403)	(1.82)	(0.30)	(1.66)

Shashemene	Constant	(0.53)	(0.31)	1.88	1.43
	DSHAW	0.3626***	2.92	0.59***	6.78
	Iu_{t-1}	(0.17)	(1.24)	(0.796)***	(4.14)
	$(1-I)u_{t-1}$	(0.33)	(1.75)	(0.20)	(1.10)
Dire Dawa	Constant	1.92	0.92	5.39	2.93
	DDDW	0.267**	2.07	0.176***	3.16
	Iu_{t-1}	(0.19)	(1.63)	(0.5397)**	(3.38)
	$(1-I)u_{t-1}$	0.05	0.47	0.05	0.41
Mekelle	Constant	(0.52)	(0.26)	(0.23)	(0.12)
	DMEKW	0.279***	2.52	0.363***	3.05
	Iu_{t-1}	(0.04)	(0.47)	(0.09)	(0.70)
	$(1-I)u_{t-1}$	(0.07)	(0.65)	(0.38)	(2.28)
Jimma	Constant	(0.64)	(0.39)	2.59	1.03
	DJMMW	0.195**	2.18	0.3***	2.38
	Iu_{t-1}	(0.23)	(1.92)	(0.18)	(0.83)
	$(1-I)u_{t-1}$	(0.27)	(2.01)	(0.02)	(0.09)

***, ** and * indicate significance at 1%, 5% and 10% significance levels, respectively

regression with	Diagnostics	Before construction	After construction
Nazereth		0.43322 F(3, 56)= 14.27[0.000]**	0.6360 F(3, 54)= 31.45 [0.000]**
	R ²		
	AR 1-2 test:	F(1, 54)= 1.0817[0.3462]	F(2, 52)= 2.2422 [0.1164]
	ARCH 1-1 test:	F(1, 54)= 0.60552 [0.4399]	F(1, 52)= 1.4852 [0.2285]
	Normality test:	Chi ² (2)= 1.8232 [0.5219]	Chi ² (2)= 0.52226 [0.7702]
	hetro test:	F(6, 49)=1.7135 [0.0759]	F(6, 47)= 0.47967 [0.8201]
	hetro-X test:	F(8, 47)= 1.3427 [0.3413]	F(8, 45)= 0.41470 [0.9061]
Shashemene	RESET test	F(1, 55) = 1.8760 [0.1856]	F(1, 53) = 0.17452 [0.6778]
		0.174676 F(3, 54)= 3.81[0.015]*	0.680478 F(3, 54)= 38.33 [0.000]**
	R ²		
	AR 1-2 test:	F(2, 52)= 3.1724 [0.0501]	F(2, 52)= 2.0083 [0.1445]
	ARCH 1-1 test:	F(1, 52)= 0.056044 [0.8138]	F(1, 52)= 0.97361 [0.03284]
	Normality test:	Chi ² (2)= 0.17657 [0.9155]	Chi ² (2)= 0.87413 [0.6459]
	hetro test:	F(6, 47)= 1.4058 [0.2324]	F(6, 47)= 0.58550 [0.7401]

	hetro-X test:	F(8, 45)= 1.1250 [0.3652]	F(8, 45)= 0.4936 [0.8543]
	RESET test	F(1, 53) = 0.068925 [0.7939]	F(1, 53) = 1.5816 [0.2140]
	R ²	0.17642 F(3, 54)= 3.99 [0.013]*	0.300676 F(3, 43)= 6.163 [0.001]**
	AR 1-2 test:	F(2, 52)= 1.7670 [0.1810]	F(2, 41)= 2.5656 [0.0892]
	ARCH 1-1 test:	F(1, 52)= 0.013969 [0.9064]	F(1, 41)= 0.000973 [0.9753]
Dire Dawa	Normality test:	Chi ² (2)= 0.39344 [0.8214]	Chi ² (2)= 0.50.41 [0.7775]
	hetro test:	F(6, 47)= 1.1268 [0.4535]	F(6, 36)= 0.38592 [0.8832]
	hetro-X test:	F(8, 45)= 1.0446 [0.4911]	F(8, 34)= 0.37517 [0.9264]
	RESET test	F(1,53) = 0.031299 [0.8603]	F(1, 42) = 0.93616 [0.3388]
	R ²	0.171244 F(3, 43)= 3.267[0.018]*	0.26713 F(3, 43)= 5.224 [0.004]**
	AR 1-2 test:	F(2, 41)= 0.12134 [0.8860]	F(2, 41)= 2.18867 [0.0745]
	ARCH 1-1 test:	F(1, 41)= 0.39484 [0.5333]	F(1, 41)= 0.28478 [0.5965]
Mekelle	Normality test:	Chi ² (2)= 3.6664 [0.1599]	Chi ² (2)= 1.3697 [0.5042]
	hetro test:	F(6, 36)= 0.36429 [0.8966]	F(6, 36)= 0.91945 [0.4925]
	hetro-X test:	F(8, 34)= 0.38406 [0.9216]	F(8, 34)= 0.71045 [0.6805]
	RESET test	F(1, 42) = 1.3814 [0.2465]	F(1, 42) = 0.39207 [0.5346]
	R ²	0.1801601 F(3, 43)= 4.081 [0.011]*	0.196079 F(3, 40)=4.1125 [0.009]*
	AR 1-2 test:	F(2, 41)= 0.080826 [0.9225]	F(2, 38)= 0.83294 [0.4426]
	ARCH 1-1 test:	F(1, 41)= 0.26192 [0.6116]	F(1, 38)= 0.78914 [0.3799]
Jimma	Normality test:	Chi ² (2)= 0.039495 [0.9804]	Chi ² (2)= 0.44781 [0.7994]
	hetro test:	F(6, 36)= 1.1072 [0.3774]	F(6, 33)= 1.1495 [0.3564]
	hetro-X test:	F(8, 34)= 0.85185 [0.5651]	F(8, 31)= 1.1138 [0.3812]
	RESET test	F(1, 42) = 0.41316 [0.5239]	F(1, 39) = 0.0021622 [0.9631]

Source: regression results, 2006

Regarding the error correcting model of Addis and Shahemene, the short term behaviors, as explained by a 1% significance level, are considerable in both periods. However, in the preconstruction period, both the error correcting variables are not significant at any of the three conventional significance levels; while in the post construction period the coefficient of smaller deviations has turned out to be significant at 1%.

This occurrence shows that in the post construction period smaller deviations would be arbitrated away immediately where as larger deviations would persist indicating some kind of inefficiency regarding the error correction behavior due probably to problem of information asymmetry.

Similarly, regarding the symmetric nature of the error correcting terms of the ADDW and SHAW, the test results indicate that, in both periods, the null hypothesis of symmetric adjustment i.e. $\rho_1 = \rho_2$, can be rejected at 1% indicating adjustment between the two markets is asymmetric. On the other hand, the null of $\rho_1 = \rho_2 = 0$ can also be tested, for ADDW and SHAW and it was found that the F-statistics rejects the hypothesis at 5% significance level (see table 5.4), showing there is cointegration in both periods.

In the case of Dire Dawa, the short-term error correction variable, Δ DDW, is significant at 5% and 1% significance levels, in the pre and post construction periods, respectively. Both the above and below the threshold value deviations of the preconstruction period are insignificant even at 10%. This phenomenon shows any deviation from the long-term equilibrium would persist for a long period of time regardless of its size, i.e. adjustment is sluggish.

However in the post construction period, the error correcting term over the threshold value is both has increased its speed and also turned out to be significant at 5% indicating that larger deviations would relatively be arbitrated away quicker while the smaller deviations remained to persist for a longer period.

Contrary to the expected signs of the error correcting terms, though not significant, the coefficients of the variable with smaller deviation from the equilibrium is positively signed indicating drifting away from equilibrium. This was the case in both periods of ADDW and DDW.

Regarding the symmetric tests of ADDW and DDW, i.e. $\rho_1 = \rho_2$, the null of symmetric adjustment is rejected at 5% and 1% significance levels in the pre and post construction periods, respectively, revealing adjustment is asymmetric. Similarly, the null of $\rho_1 = \rho_2 = 0$ of the preconstruction period, cannot be rejected even at 5% revealing joint insignificance of the

coefficients of the cointegrating error terms. This result can be considered as consistent with the results of the t max test in that only one of the two coefficients of the error correcting terms is marginally significant at 10% significance level. On the other hand, the null of joint insignificance of the coefficients of the error correction terms, i.e. $\rho_1 = \rho_2 = 0$, of the post construction period, can be rejected at 5% significance level, indicating a moderate degree of cointegration.

In both periods, the situation is the same for ADDW and MEKW in that the short term error correcting variable is significant at 1%, as can be seen from the coefficient of Δ MEKW. But the error correcting terms are insignificant even at 10%.

If one looks at the symmetric test of the coefficients of the error correcting terms of ADDW and MEKW, in the preconstruction period, it can easily be seen that the null of $\rho_1 = \rho_2$ can not be rejected for the F-value of 2.00 is well below the F-distribution where as, it is marginally rejected at 5% in the post construction period. Besides, the null of joint insignificance of the coefficients of the error correcting terms of the same markets in the same period, i.e. $\rho_1 = \rho_2 = 0$ can also not be rejected as the F-value of 2.00 is well under the F-statistic of 4.25 of the 5% significance level (see table 5.4), the F-statistic shows there is no cointegration between the two markets, MEKW and ADDW.

Regarding the cointegration between Addis and Jimma, even though Δ JMMW of both periods are significant at 5% level, both the error correcting terms, in both periods, are insignificant at the conventional significance levels. In the pre construction period, the null of symmetric adjustment between the error correcting terms of ADDW and JMMW, can safely be rejected indicating existence of asymmetric adjustment.

More over, in the same period, the null of joint insignificance of the two coefficients, i.e. $\rho_1 = \rho_2 = 0$, of the two markets can almost be rejected at 1% significance, as the F-value and the value of F-statistic nearly coincides. The result shows existence of cointegration in the period between ADDW and JMMW. But in the post construction period, both the null of symmetry and joint in significance, i.e. $\rho_1 = \rho_2$ and $\rho_1 = \rho_2 = 0$ respectively, cannot be rejected, because the F-value is smaller than the F-distribution table and well under the F-statistic.

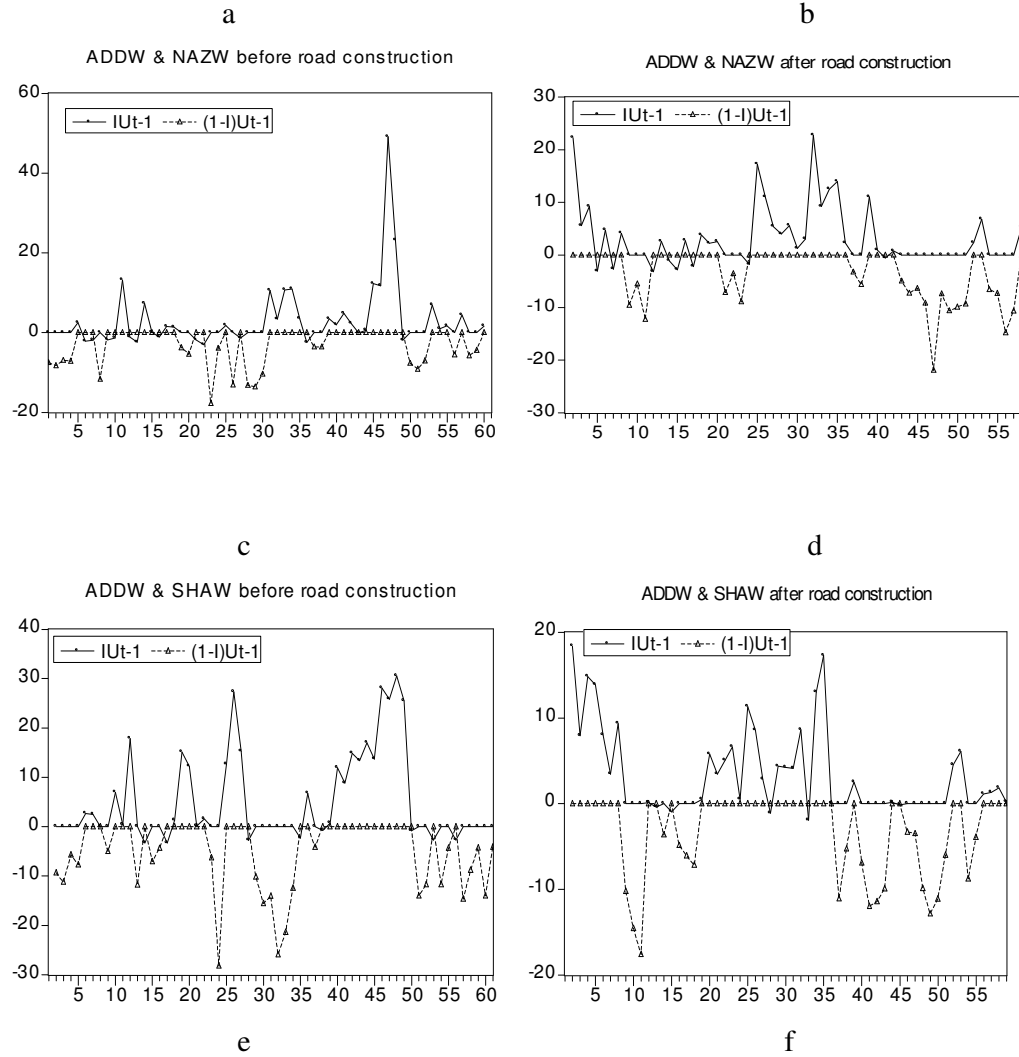
The result clearly shows existence of no-cointegration between ADDW and JMMW in the post construction period, though the result appear surprising, an informal interview made to the traders and truck drivers who travel a lot to Jimma reveal that the route has been under another new construction and the former construction (rehabilitation) couldn't bring the expected change.

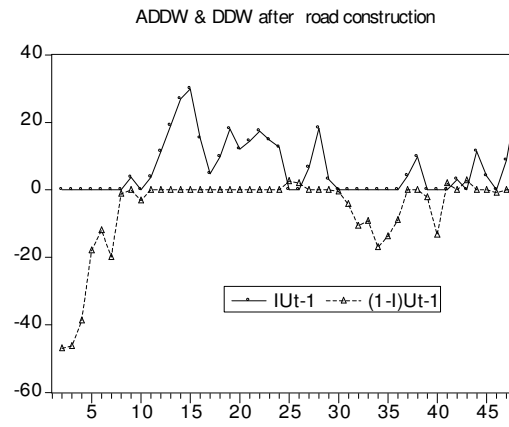
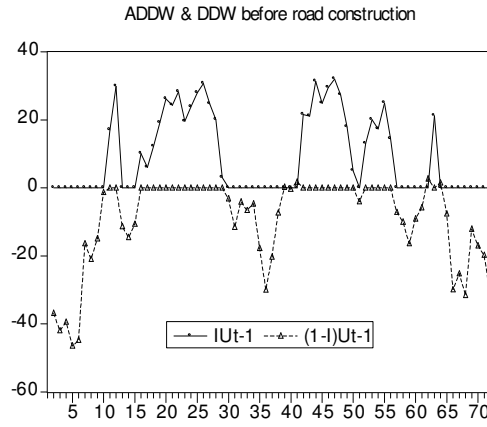
Overall, the speed of adjustment in the period after the road construction of the surplus areas have produced a mixed result as the smaller deviations rather than the larger once are cleared away between ADDW and both NAZW and SHAW, though in the case of SHAW, larger deviation were sluggishly arbitrated away too.

A visual inspection of the trends of the error correcting term variables, figure below, would show the situation of error correction mechanism towards the long term equilibrium. Accordingly, it can be seen from fig.4.1.a that any deviation from the long term equilibrium between ADDW and NAZW would be corrected, regardless of the level of the deviation but in a relative sense, it can be said that smaller deviations are cleared relatively faster. Whereas, in fig. b. it is showed that smaller deviations from the equilibrium are corrected relatively instantly while larger deviations would be left to persist.

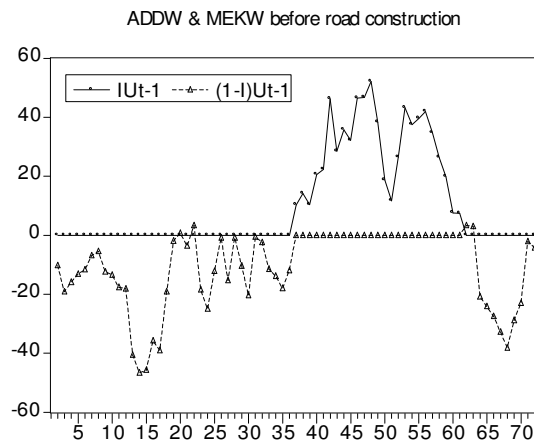
Regarding the trends of ADDW and SHAW in the two periods, the preconstruction period arbitrage is highly sluggish but relatively larger deviations would be weakly arbitrated away, while smaller deviations left to stay for a longer period (fig 4.1 c). But in the post construction period, (fig. d), the situation is somewhat reversed in that smaller deviations would be cleared while larger deviations are left to persist.

Figure 4.1. Trends of error correction terms in the pre and post construction period

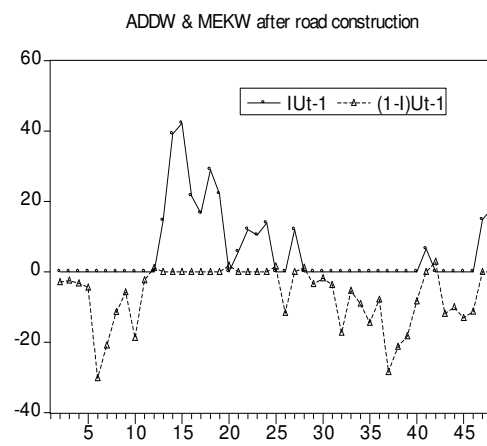




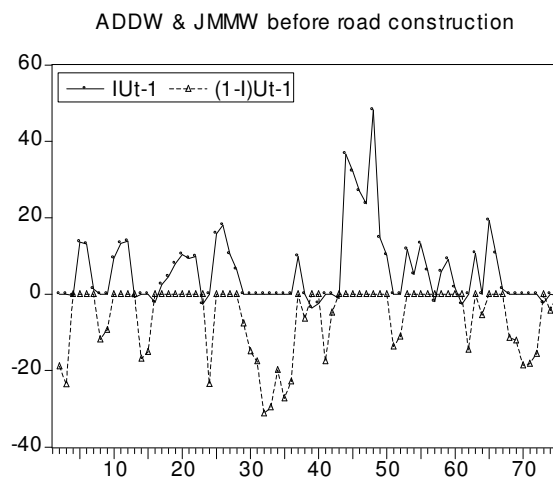
g



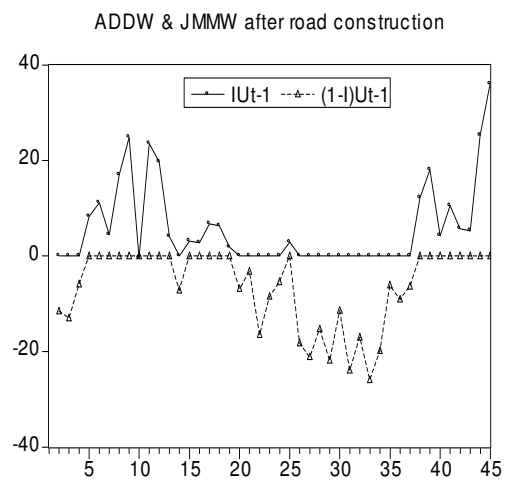
h



i



j



Source: regression results, 2006

In the case of a visual inspection of the trends of the error correction terms of ADDW and DDW the figure shows that larger deviations would relatively be cleared than the smaller deviations would be, in both periods.

Regarding the trends of the error correcting terms of ADDW and MEKW (figure 4.1 g and h) the deviations from the long term equilibrium, regardless of the size, would tend to persist for a longer period rather than making ways towards long term equilibrium, indicating a weaker market integration between ADDW and MEKW.

ADDW and JMMW's error correction terms are trended as in fig 4.1 i and j and though the figure show the existence of sluggish and loose adjustment, for the sake of comparison, in the pre construction period, larger deviations from the long term equilibrium are corrected while smaller deviations are left to persist for a relatively longer periods. On the other hand, fig j shows that in the post construction period the trend shows that smaller deviations rather cleared relatively faster while larger deviations would relatively persist for a longer period. The results indicate there is weak market integration between ADDW and JMMW, especially in the post construction period. Both the deficit areas under this discussion, DD and MEK can be considered as isolated from Addis; Dire's level of isolation is moderate, though the sign of the smaller than the threshold error correction terms are ambiguous. Mekelle's market can be considered totally isolated.

Chapter Six

6. Conclusions and Policy Implications

6.1. Conclusions

The purpose of this study was to evaluate the degree of grain market integration of the selected regional markets with Addis Ababa before and after the construction of roads. To help the assessment, various descriptive analytical techniques like: price differentials, trend assessments, price volatilities, correlation coefficients; and Econometric test in the form of Error correction threshold Autoregressive (ETAR) are used. Wholesale monthly data from Jan. 1996 to Dec. 2005, of eight markets are considered for the descriptive analysis of mixed teff and maize; where as six markets were used in the analysis of white wheat markets for both descriptive and empirical analysis.

All the mixed teff markets, except those of Jimma and Nekemte, and all white wheat markets except Jimma, have shown a larger level of volatility in the post construction period. On the other hand the volatility in the maize market except for those of NAZM and SHAM has declined significantly for the markets under discussion, in the post construction period. For all the cereals, the deficit areas were found to be less volatile than the surplus areas.

As an indication of the speed and level of adjustment towards the long run equilibrium, the results of the coefficients of the estimated error correcting terms reveal that, for the surplus areas, larger deviations from the long term equilibrium tend to be quickly cleared away while smaller deviation were left to persist. On the other hand, both the deficit areas were found to be insensitive for any deviation from the long term equilibrium, if any such equilibrium exists, indicating the absence of integration between Addis and the deficit areas, a result which couldn't be detected through ADF test.

In the post construction period, the surplus areas under consideration, except Jimma, were found to be integrated with Addis. According to an informal interview made to the traders and truck drivers who travel a lot to Jimma the route between Addis and Jimma hasn't been in a good condition and state and it has been under construction for a long period of time which, they think, would negatively affected the level of market integration. The situation remained somewhat the same for the deficit areas, though Dire Dawa's wheat market have showed a relatively better level, but weak, integration in the post construction period than the pre construction period.

In general, those in the surplus areas and with a closer proximity to Addis have shown a better level of integration in the post construction period though, they have showed insensible form of adjustment towards the long term equilibrium with Addis, as smaller deviations from the long term equilibrium were quickly cleared out while larger deviations were relatively neglected. On the other hand, the deficit areas were found relatively isolated in both periods.

If markets are well integrated, government can easily affect all the integrated markets by intervening in only few important markets without worrying to intervening in all the markets. Accordingly, identifying those markets in the same integration circle would contribute a lot in proper implementation of any agricultural policy and in the effort to realize a well developed agricultural sector. Accordingly, any marketing policy measure of our country targeted at agriculture should realize, among the markets under discussion, the deficit areas are isolated and the surplus areas, except Jimma, are well integrated, in the post construction period.

6.2. Policy Implications

As explained briefly in the descriptive analysis, if not properly monitored, food aid, in kind may adversely affect the demand for market surplus and storage by, directly increasing the

supply of the grain by then depressing the price the suppliers would have got and may adversely affect farmers' incentives to produce more in the long run and could endanger the success of food security policy implemented by the government. This phenomenon indicates there is a need to monitor (control) the timing of food aid imports and delivery so that the food aids will not distort the order of pricing; it may also indicate that there is a need to provide, especially at times of bumper harvest, income support than aid in kind for the needy people in order to stabilize markets and prices so that producers would also be encouraged to increase their output.

The higher volatility of prices of the surplus areas may indicate that the burden of the volatility is borne by the small-scale producers of the areas (Gabre-Madhin and Mazgebou, 2006), besides; they may also show that markets in the country may not be properly integrated probably due to the volatilities in the surplus areas which might be caused by the variability of the demand for the produces. Hence, in order for both the producers in the surplus areas benefit from higher demand and then higher producer price, and the consumer in the deficit areas benefit from the higher supply and then lower price; a mechanism through which agricultural commodities would be moved from areas of relative surplus to areas of relative deficit should be identified.

The deficit and furthest areas are somewhat isolated from the central market, a result which indicates that it might have to do with the geographic differences and distance from the central market. As is also mentioned in Negassa 1997, the price linkages would negatively be affected by the lack of sufficient information and high transportation cost. Moreover, the volatility of the surplus areas and the isolation of the deficit areas from Addis could be related to shortages of mechanisms, such as lack of improved public market information systems (MIS) to speed up both private and public reaction to excess supply and shortages, to create

well integrated markets; indicting a need for government intervention element such as telecommunication facilities and access to local media. A market information system eases a low-cost market solution to at least part of the problem of failure to move agricultural commodities from areas of relative surplus to areas of relative deficit.

It has been mentioned in many articles (e.g. Negassa, 1998) that a well integrated market is typified by a higher level of private sector participation in the arbitraging activity which helps in stabilizing prices across the surplus and deficit areas; demonstrating the need for market development to enhance and encourage the private sector participation, e.g., by providing access to credit, strengthen legal enforcement rules etc.

It is believed, here, that most of the problems associated with level and degree of market integration, in one way or another, are related to the commonly known ‘three *I*’s’: *Infrastructure, Information and Institutions*. The developments of the three ‘*I*’s’ are considered by many researchers as to lift the level of market integration and avoid the trade barriers exist between markets. Given the Government’s objectives of promoting structural transformation, developments of well functioning markets do have diverse importance in the process of the realization of agricultural development, agricultural productivity growth, and food security.

It has been found that the deficit areas under discussion and JMMW in the posts construction period, are a bit isolated from the central market and are not as such well integrated with Addis. This is probably due to, as is said earlier, the under provision of the three ‘*I*’s’: which as a result widens the marketing margin by raising the transaction cost. In fact, one of the three ‘*I*’s’, namely *Infrastructure* in the form of road infrastructure, has been growing over time. However, for a better market integration and the realization of agricultural growth through a well-developed market, road sector alone may not bring the desired outcome,

though its contribution is significant. The infrastructure sector by itself is constituted of, other important factors, for instance warehouse infrastructure, that contribute towards a realization of a well developed market. This calls for the need to concentrate in the development of the stated areas along with the road infrastructure.

However, a coordinated development of the three 'Is' may require a mechanism through which the three 'Is' can be integrated towards a single chain, or channel in such a way they would assist the realization of a well-developed agricultural market system. These all may require the adoption of the system of Commodity Exchange operation; which by its very nature, requires a proper coordination of the three 'Is' and which is believed, if properly managed and executed, to alleviate the abovesly stated problems. The commodity exchange system brings buyers and sellers from different areas equip them with appropriate information on price, i.e. it develops a market information system, by discovering prices through true market fundamentals. Besides, it provides a reliable warehouse for the suppliers (and/or farmers) who may not be able to sell their supply.

References

- Agricultural outlook, October 1999; Assessing Agricultural commodity price variability- Economic Research service /USDA, -
- Alabama Agriculture & Mechanical University, 2005; Marketing Alternatives to Manage Risk; small farmers Research center, - Fact Sheet, -
- Andy Hall, Lynn Mytelka and Banji Oyeyinka, July 2005; Innovation Systems: Implications for agricultural policy and practice.
- Ardeni, P.G ,1989;, Does the Law of One Price Really Hold for commodity prices? American Journal of Agricultural Economics 71:661-669.
- Balke S. Nathan, and Thomas B. Fomby, Aug 1997; Threshold Cointegration. International Economic Review. Vol. 38, No. 3, pp 627-645.
- Barrett , Christopher B., August 2005; Spatial market integration, Cornell University.
- Barrett, Chirstoper B. August 1996; market Analysis Methods: Are Our Enriched Toolkits well suited to Enlivened Market? American Journal of Agricultural economics, vol. 78, No.3, 825-829.
- Baulch , B, 1997; Transfer Costs, Spatial Arbitrage , and Testing for Food Market Integration. American Journal of Agricultural Economics 79: 477-487.
- Bekele, Girma, 2002; The Role of the Ethiopian Grain Trade Enterprise in price Policy. Agricultural Technology Diffusion and Price Policy: Proceeding of a policy Forum in Addis Ababa.2020 Vision Network for East Africa, Report 1. pp. 83-91. Washington D.C. Ethiopian Development Research Institute and International Food Policy Research Institute.

C. W..Li and W..K..Li, May-June, 1996; On a double Threshold Autoregressive Heteroscedastic Time series Model. Journal of Applied economics, Vol. 11 No. 3 pp. 253-277. Department of statistics, University of Hong Kong, Hong Kong.

Camphenhout , Bjorn Van, August 2005; Modeling Trade in Food Market Integration: Method and an Application to Tanzanian Maize Markets-, Institute of Development Policy and Management (IDPM), University of Antwerp- Belgium

Commodity Futures Trading Commission, May, 1997; Policy Alternatives Relating to Agricultural Trade Options Risk-shifting contracts, Division of economic Analysis

D'Angelo, Javier Escobal, and Arturo Vasquez Cordano, 2001; Market integration for agricultural output markets in peru: the role of public infrastructure, Lima, Peru.

Delgado, Christopher L., Nov 1986; A Variance components Approach to Food Grain Market integration in Northern Nigeria. American Journal of Agricultural Economies, vol. 68, No. 4, pp 970-979.

Den Haag, Andreas Springer, Heinze, January 1998; From Hierarchy to cooperation: The Concept of Agricultural Innovation systems.

Dercon, S., 1995,; On market integration and liberalization: Method and application to Ethiopia, Journal of Development Studies, 32 (1) 112-143

Dercon, Stefan, and Bjorn Van Camphenhout, August 1998; Dynamics Price adjustment in Spatially Separated Food Markets with Transaction Costs, Katholieke Univesitie Leuven and Centre for Study of African Economies, Oxford, United Kingdom.

ERA (Ethiopian Roads Authority), 2006; Road Infrastructure Needs Assessment in the context of MDGs (Millennium Development Goals), Addis Ababa, Ethiopia.

Eskola, Elina 2000; Commercialization and poverty in Tanzania: Household- level Analysis, University Copenhagen, - Denmark

Fackler, P.L and Goodwin, B.K, 2001; Spatial Price Analysis. In Gardner, B.L and Rauser, G.C.(Eds), Handbook of Agricultural economics. Vol. 1B Marketing, Distribution and consumption, Elsevier North-Holland, 971-1024

Fafchamps, Eleni-Gabre-Madhin and Bart Minten, April 2003; Increasing returns and market efficiency in Agricultural Trade Market .

Fafchamps, M, and S.Gavian ,1996; The spatial integration of Livestock markets in Niger, Journal of African Economies, 5:366-405.

Ferral, Christopher 1995; Queen's University, Journal of Statistics Education V.3, n.3

Frederic Gonzalez, Pierre Guillotreau, Laurent Le Grel and Michel Siraoni, Feb. 2004; Asymmetry of price transmission with in the French value chain of seafood products; Nantes, France.

Frenkel, Daan, 2004; Introduction to Monte Carlo method, John Von Neumann Institute for Computing (NIC), NIC series, Vol 23, 1-SBN pp 29-60, 2004 Amsterdam, the Netherlands.

Gabre-Madhin, E.Z., 2001; Market institutions, Transaction costs, and social capital in Ethiopian Grain Market, International Food Policy Research Institute: Washington, DC.

Gabre-Madhin, E.Z., and Goggin, I., June 2006; Does Ethiopia Need a Commodity Exchange? An Integrated Approach to Market Development; Ethiopian Strategy Support Program (ESSP), Addis Ababa, Ethiopia.

Gabre-Madhin, E.Z., and Mezgebou. T, February 2006; Price and Volatility in the Ethiopian Grain Market; Addis Ababa, Ethiopia.

Gabre-Madhin, Z. Eleni and Steven Haggblade ; Successes in African Agriculture: Results of an Expert Survey

Gebre-Madhin, Z. Eleni ; 2001; Market Institutions, Transaction costs, and Social Capital in the Ethiopian Grain Market IFPRI- Research Report 124

Gebremeskel Dessalegn T.S Jayne J.D Shaffer, January 1998; Market structure, conduct and performance: constraints on performance of Ethiopian Grain Markets Addis Ababa.

Getnet, K., 2005; Behavior of farmers towards price changes during market liberalization in Ethiopia. PhD Thesis Ghent University, Belgium.

Giovanni Federico, July 2004; Market Integration and Market Efficiency: the case of 19th Century Italy. European University Institute.

GMRP (Grain Markte Research Project), 1997; Market Information no.7, Grain Market Research Project, Ministry of Economic Development and Cooperation, Addis Ababa.

Goetz, S. and Weber, T.H, 1986; Fundamentals of Price analysis in Developing Countries Food System: Michigan State University. Working Paper No.29. Michigan.

Goletti, Franceso, Raisuddin Abmed and Naser Farid, June 1995; structural determinants of Market integration: The case of rice markets in Bangladesh, the developing economies, vol. 33 No. 2.

Goodwin, B.K and Piggott, N.E, 2001; Spatial Market integration in the presence of Thershold effects. Journal of Agricultural Economics, 83:302-317.

Goodwin, B.K and Schroeder, T.C ,1991; Cointegration Tests and Spatial Price Linkages in Regional Cattle Markets. American Journal of Agricultural Economics 73: 452-464

Goodwin, Barry K. and Nicholas E. Piggott, May 2001; Spatial Market Integration in the presence of Threshold effects. American Journal of Agricultural Economies Vol. 83 No. 2 pp 302-317

Granger, F, W.J, Engle, R, 1987; Cointegration and Error Correction: Representation, Estimation and Testing”, Econometrica, Vol. 55, No. 2, 251-276

Haile, Mesfin, Agajie Tesfaye, Lemelem Aregu, and Eyob Mulat, April 2004; Market access versus productivity: the Case of Tef.

Hansen , Bruce E., 1996;Testing for two-regime threshold cointegraion in vector error – correction models, Byeongseon Seo, USA.

Hansen , Bruce E., May 2000; Sample Splitting and Threshold Estimation, Economertica, vol. 68, No. 3 pp 575-603.

Harvey, A.C.1993; Time series models. Harvest Wheatsheaf.p308

Iowa State University , December 1996; Commonly Used Grain Contracts.

Iowa State University, University Extension, PM-1697a, Ames, Iowa Chicago, USA.

Ismet, Mohammed, Andrew P. Barkely and Richard V. Llewelyn, May 1998; Government intervention and market integration in Indonesian rice markets. *Agricultural Economics* 19(1998), 283-295. Jakarta Indonesia.

Jacks, David, 2000,; Market integration in the North and Baltic seas, 1500-1800, working paper No. 55/00, Department of economic History, London school of Economics.

Julie A. Howard, Ali Said, Daniel Molla, Patrick Wiskin, and Seifu Bogale, Sept. 1995; Towards increased domestic cereals production in Ethiopia using a commodity systems approach to evaluate strategic and opportunities .

K.S Chan and Ruey S. Tsay, Jun. 1998; Limiting Properties of the Least Squares estimator of continuous Threshold Autoregressive Model. *Biometrika*, Vol. 85, No. 2 pp 413-426.

K.S Chan, Dec 1990; Testing for Threshold Autoregression, *The Annals of statistics* vol. 18, No. 4, pp 1886-1894.

Maddala , G.S, 1992; *Introduction to Econometrics*. New York. Second Edition.

Matilto : jwb15@psu.edu

Mattias, Lundberg, , 1999; *Agricultural Market Reforms*. Development Economics Research Groups and Poverty Reduction and Economic Management.

Meyers, Jochen, November 2004; Measuring market integration in the presence of transaction costs –a threshold vector error correction approach. Department of Agricultural Economics, George-August University of Gottingen, platz der Gottinger Sieben 5, 37073 Gottingen, Germany.

Murthy, K.P.N, December 2003; An introduction to Monte Carlo Simulations in statistical physics, Theoretical studies section, Material science division IGCAR, Tamilnadu, India,.

Negassa, Asfaw, January 1998; Vertical and spatial integration of grain markets in Ethiopia implications for grain market and food security policies. Grain Market Research project. Addis Ababa.

Negassa, Asfaw, Robert Meyers and Eleni Gabre-Madhin, February 2004; Grain marketing policy changes and spatial efficiency of maize and wheat markets in Ethiopia. MTID discussion paper No.66

Negassa, Assfaw, Robert Myers and Eleni Gebre-Medhin, September 2003; International Food Policy Research Institute Analyzing Grain Market Efficiency in developing countries: Review of existing Methods and extension to the parity Bounds model.-New York

Negassa, Assfaw, T.S Jayne, Addis Ababa, January 1997; The Response of Ethiopian Grain Markets to Liberalize - GMRP.

Nielsen , Heino Bohn, December 2003; An introduction to Monte Carlo simulations and Pc Naïve econometrics 2, institute of Economics, University Copenhagen.

Pennstate College of Agricultural Science, 2003; Agricultural Marketing- knowing and managing Grain Basis

Prabhat Vaze, 2003; A model of Inter-Regional Trade in Grains with Storage –Department of Economics, University of Edinburgh

Ravallion, Martin, Feb 1986; Testing Market integration; American Journal of agricultural Economies, vol. 68 No. 1, 502-109.

Roger Ginder, Jwoka Kola & Marko Taipale June 2002; Iowa state University, University Extension, Spatiality Markets Bring different Risk Management Needs, University of Helsinki, Finland June 2000.

RSDP (Road Sector Development Program) , 2006; Eight Years Assesment of RSDP, Ethiopian Road Authority , Addis Ababa, Ethiopia.

Ruey S. Tsay ,Mar. 1989; Testing and Modeling Threshold Autoregressive process, Journal of the American statistical Association Vol. 84, No. 405, pp 231-240.

Serra, Teresa, Barry.K.Goodwin, Anthony Mancuso, December 2004; Nonparametric Modeling of Spacial Price Relationships- U.S.A

Sexton, R.J, Kling, C.L., Carman, H.f, 1991; Market integration, Efficiency of Arbitrage and imperfect competition: Methodology and Application to U.S celery, American Journal of Agricultural Economics, 568-580

Shikha Jha and P.V. Srinivason, may 2004; Achieving Food Security in a cost Effective Way: implications of Domestic deregulation and reform under liberalized trade . ifpri.

Silvapulle, p., and S. Jayasuriya, 1994; Testing for Phillippines Rice Market Integration: A Multiple Cointegration Approach, Journal of Agricultural Economics, 45:369-80

Sinkie, Bekele, June 1995; Market Reform Structure and Efficency in Ethiopia: the case of food grain markets in Arsi cathcment, Addis Ababa University –School of Graduate Studies, Addis Ababa.

Srinivasan, P.V., May 2004; Managing price volatility in an open Economic Environment: The case of Edible oils and oilseeds in India, -Markets, Trade and institutions Division international Food policy Research institute, New York.

Takashi Kurosaki and Marcel Fafchamps, July 2000; Insurance market Efficiency and Crop Choices in Pakistan, No. 12.

Tong , H, 1983; Threshold Models in Non –linear Time Series Analysis. Lecture Notes in Statistics, 21, Berlin, Springer.

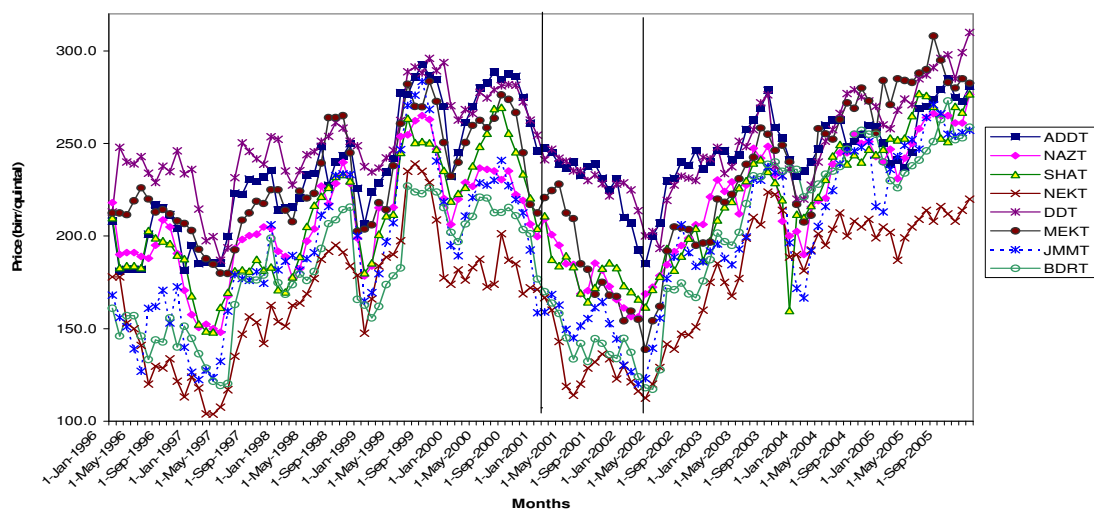
Tong , H. and Lim, K.S, 1980; Threshold autoregression, Limit Cycles and Cyclical data (with discussion). Journal of the Royal Statistical Society , B42, 245-292.

Tschirley, Dakid, Patric Wiskin, Daniel Molla, Dan Clay, January 2003; Improving information & performance in Grain Marketing: An assessment of current market information systems, & recommendations for developing a public grain Markets, IFPRI- New York-

UNDP National Program- UNDP Assistance in 5th country program to Agricultural sector- UNDP Emergencies Unit for Ethiopia

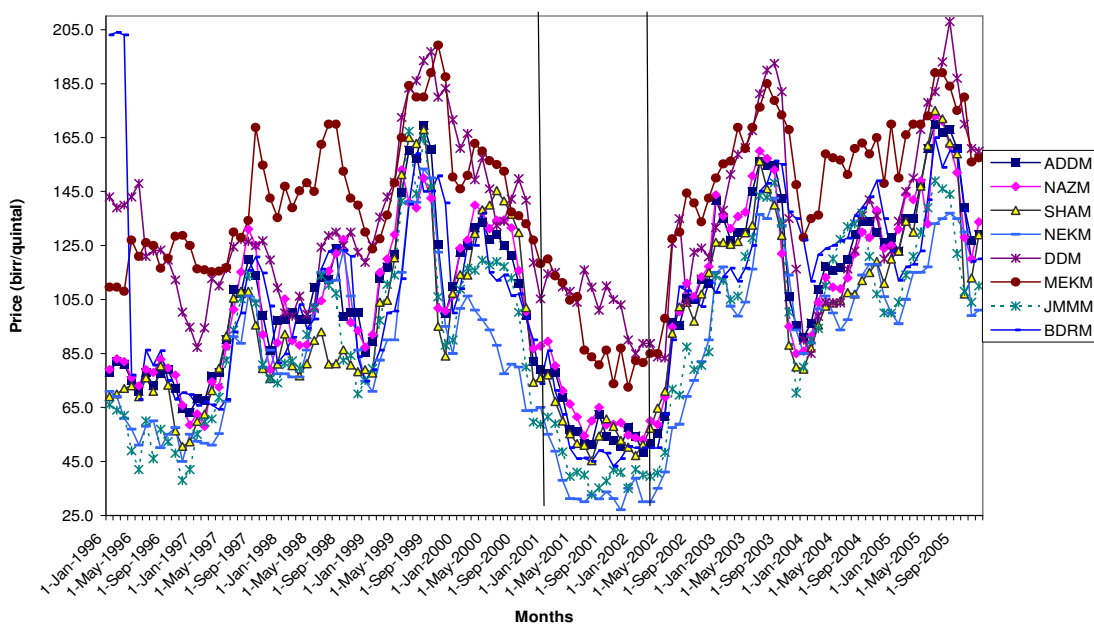
Annex 1

Annex 1.a. trends of wholesale price of mixed teff for selected markets (1996-2005)



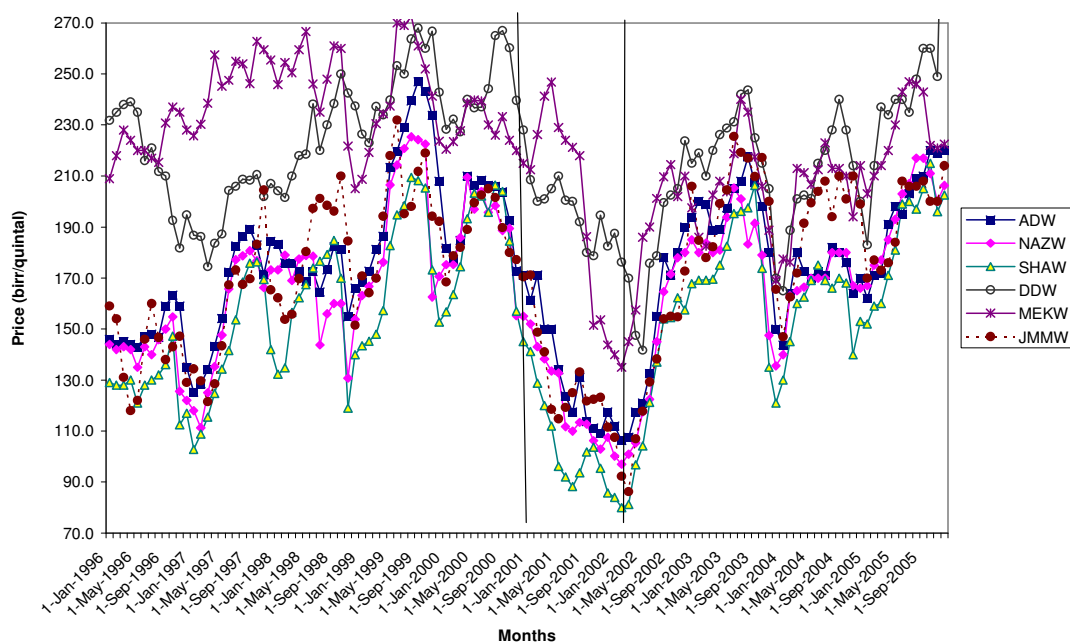
Source: EGTE

Annex 1.b. trends of wholesale price of maize for selected markets(1996-2005)



Source: EGTE

Annex 1.c. trends of wholesale price of white wheat for selected markets (1996-2005)

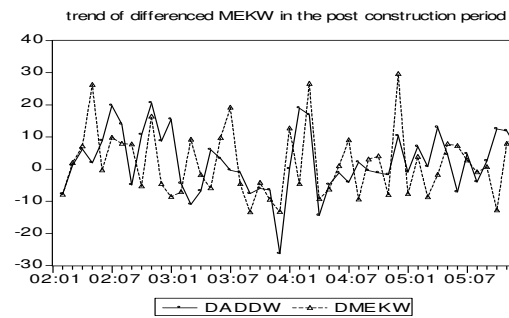
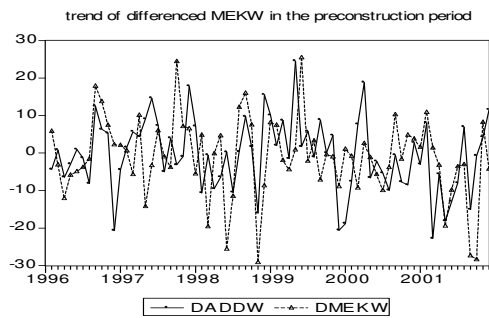
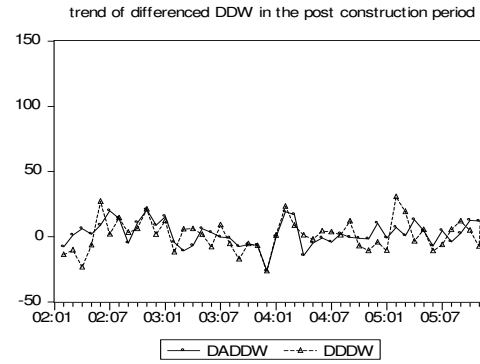
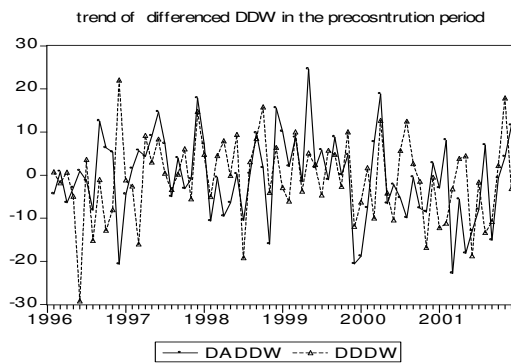
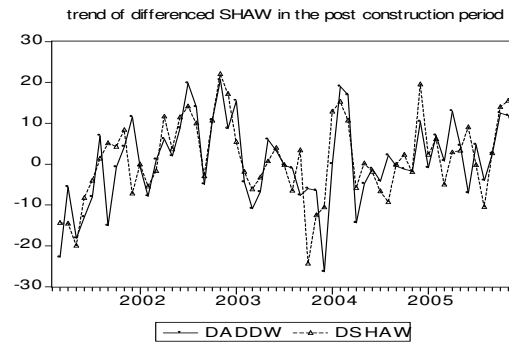
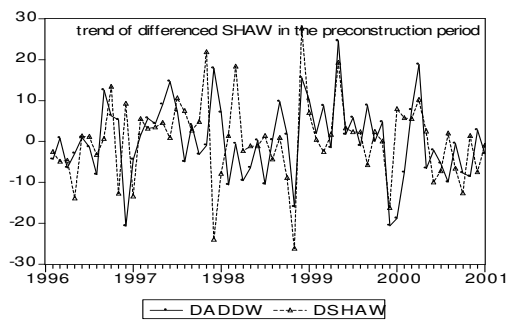
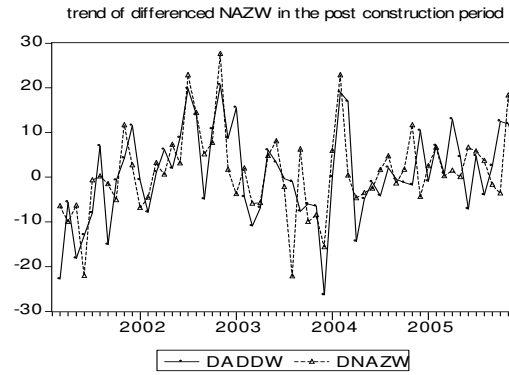
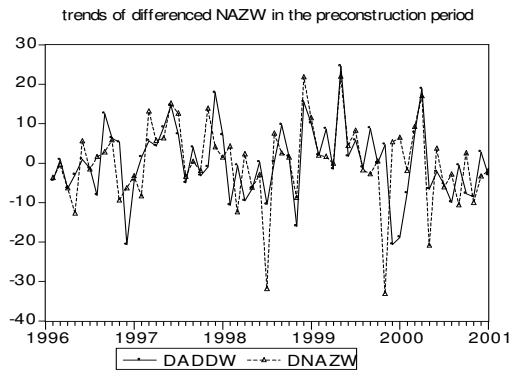


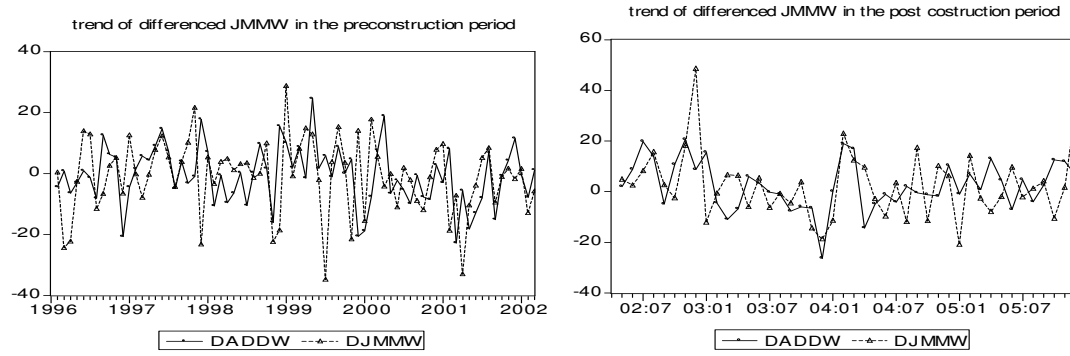
Source: EGTE

Annex 2

Annex 2.1. Trends of the change of the price series of the different markets in the two

periods

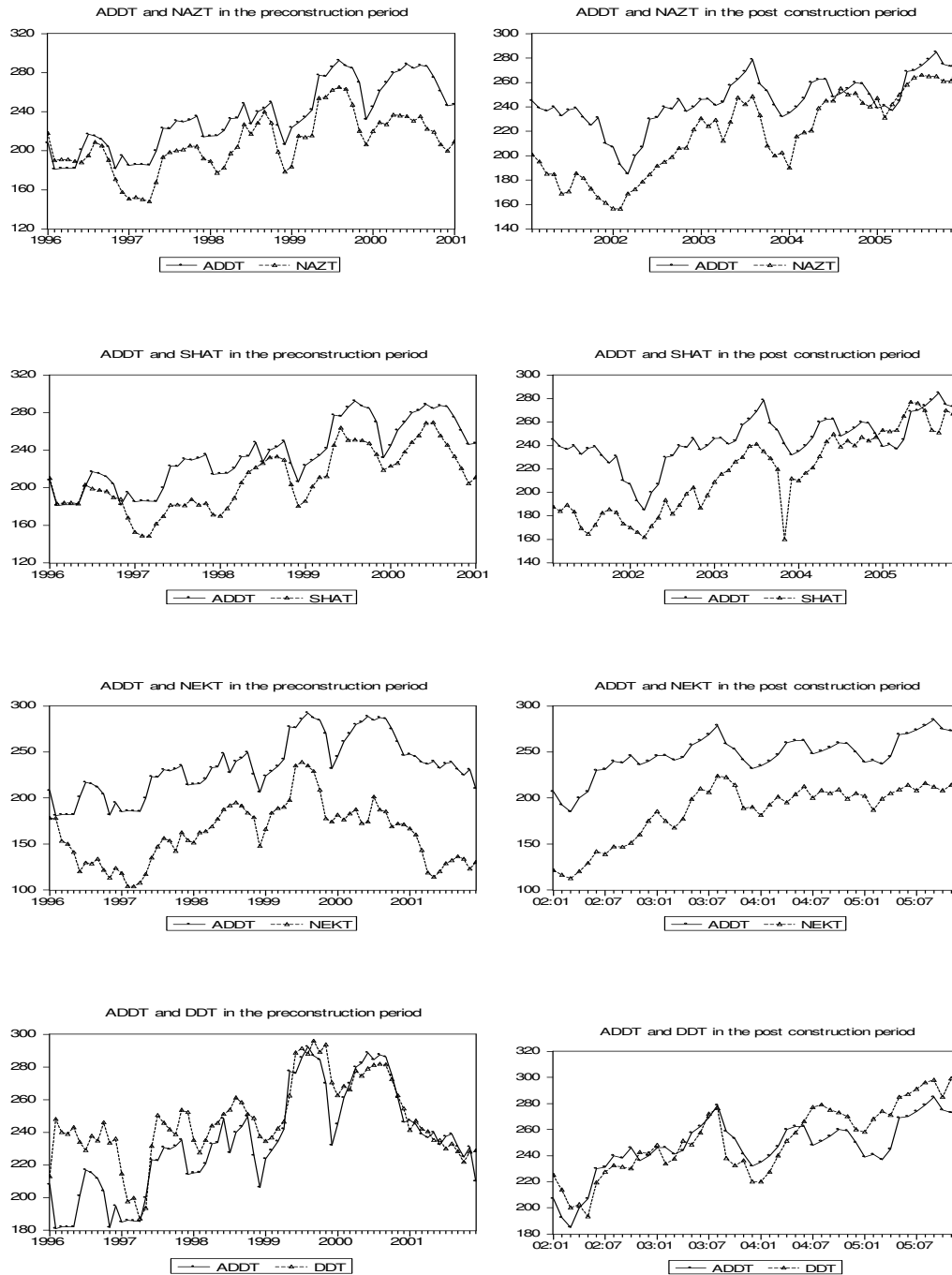


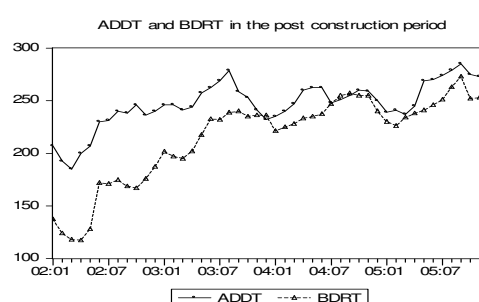
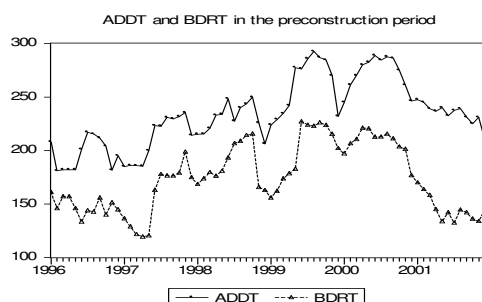
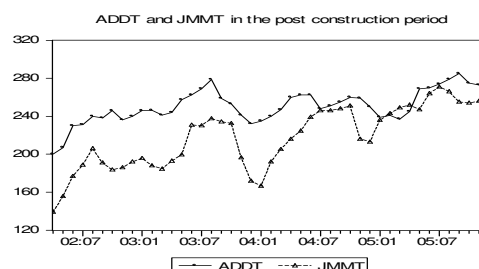
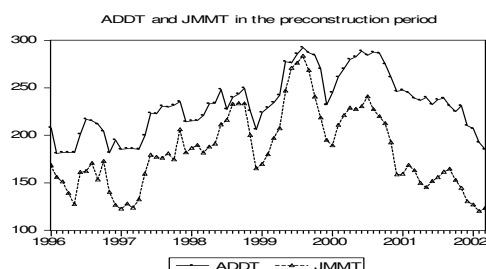
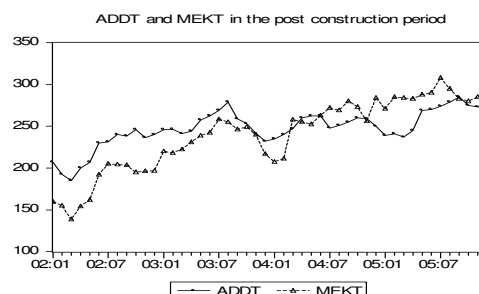
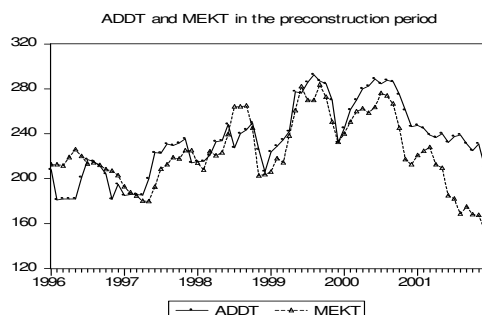


Source, Author's computation, based on data from EGTE, 2006

Annex 3

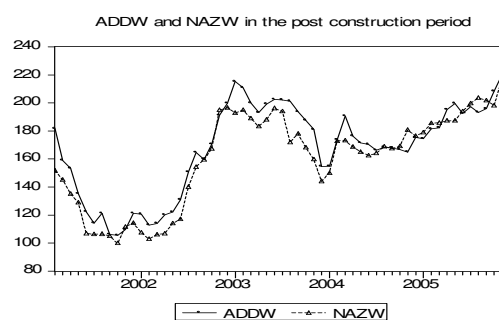
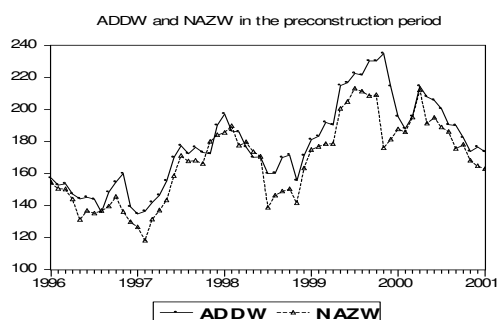
Annex 3.a. Trends of deseasonalized wholesale price (birr/quintal) of Mixed Teff of Addis and the selected regional markets

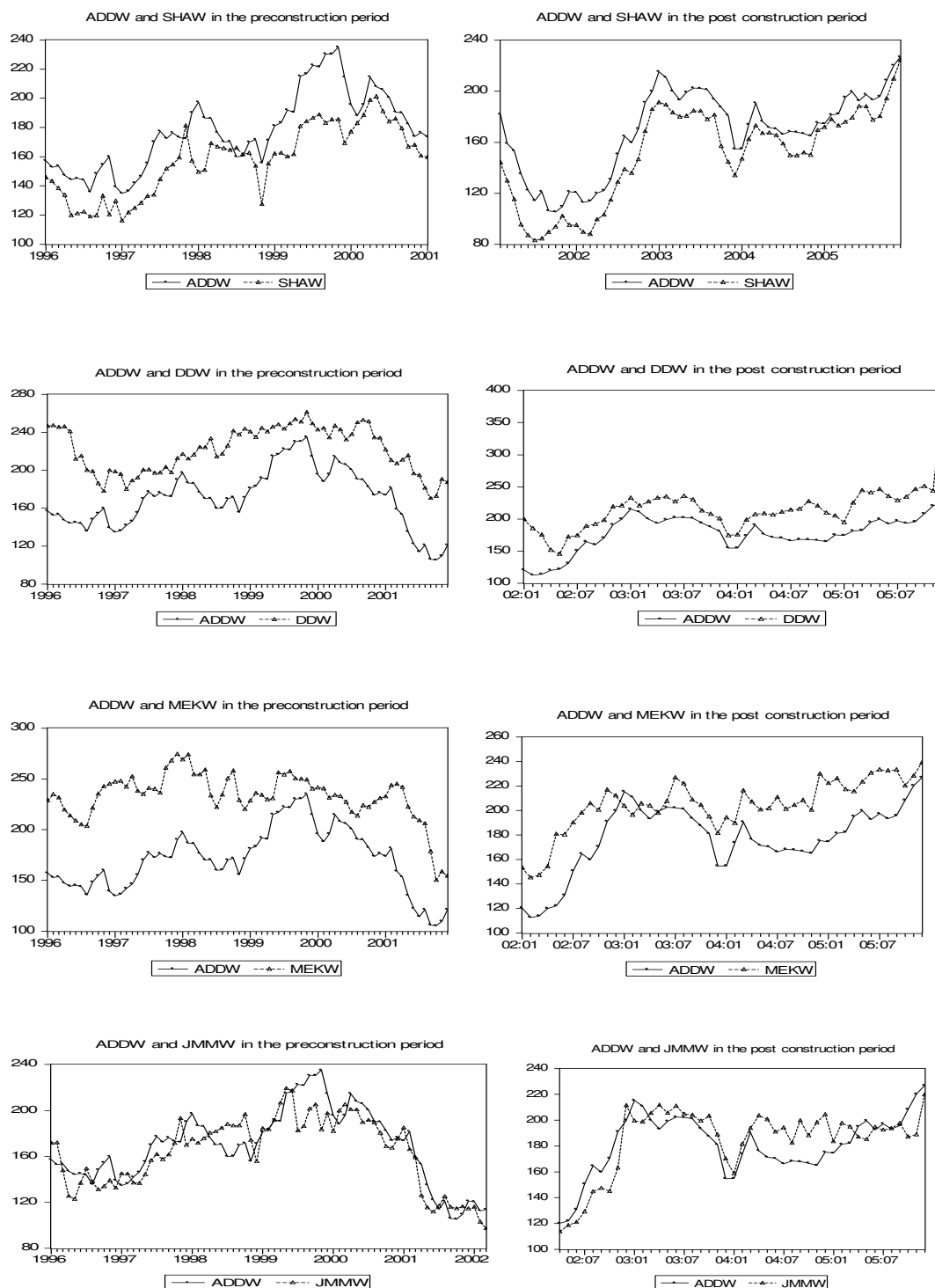




Source: EGTE

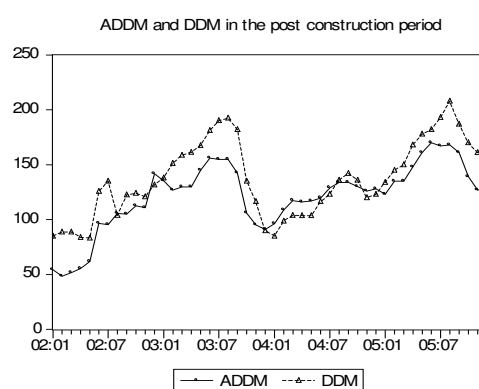
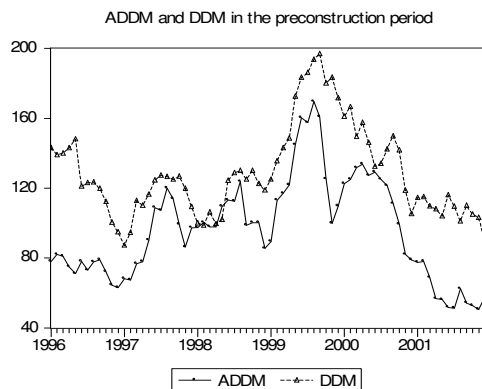
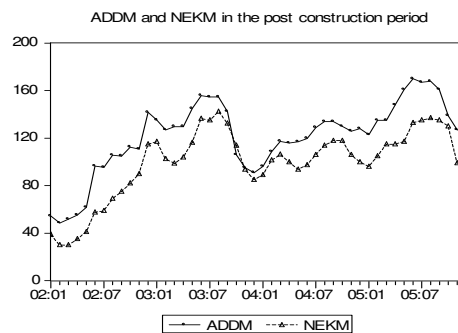
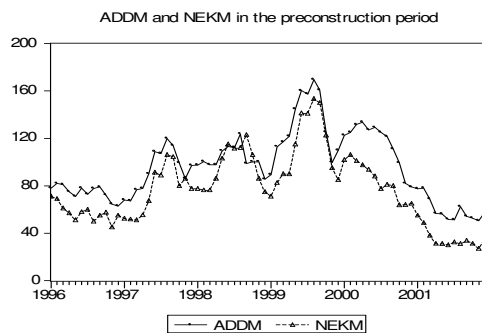
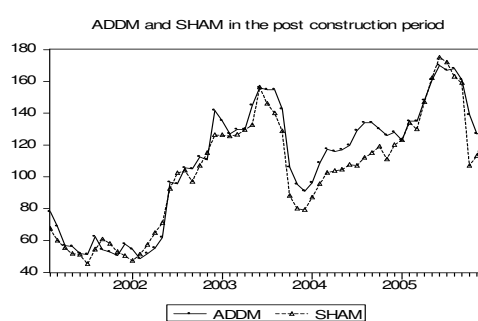
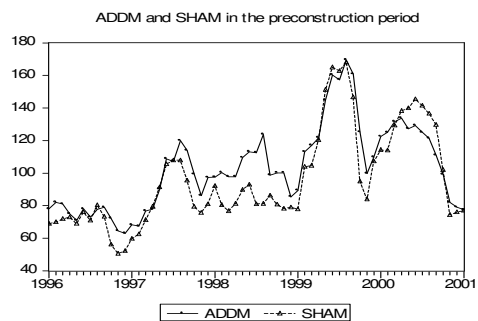
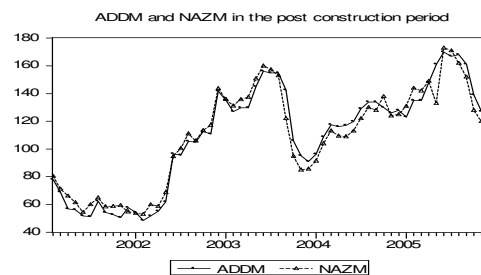
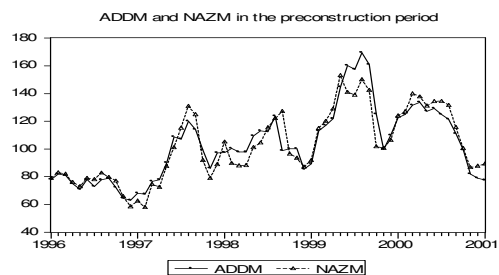
Annex 3.b. Trends of deseasonalized wholesale price (birr/quintal) of White Wheat of Addis and the regional markets.

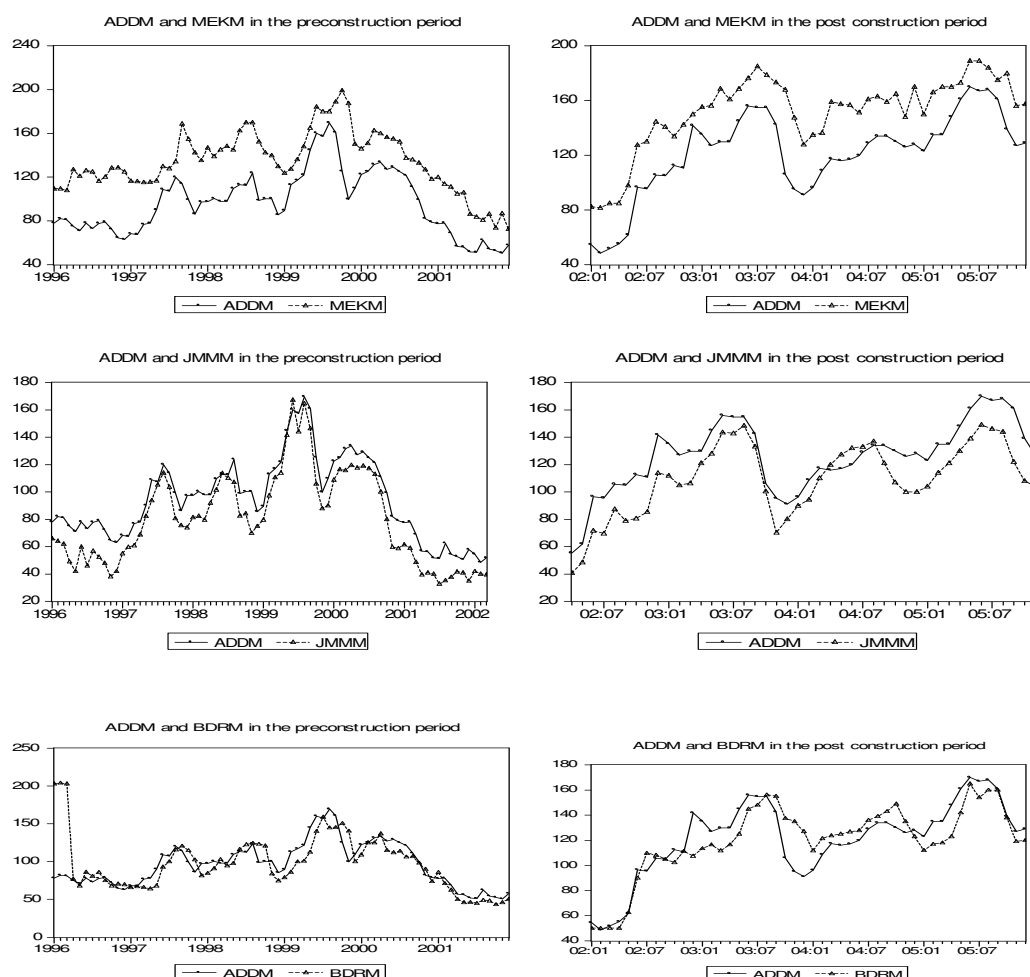




Source: EGTE

Annex 3.c. Trends of deseasonalized wholesale price (birr/quintal) of Maize of Addis and the respective regional markets





Source: EGTE

Annex 4

Annex 4. a. Road Condition Improvement (in %)

Year	Good	Fair	Poor
1997	22	26	52
1998	23	26	51
1999	25	30	45
2000	28	32	41
2001	28	29	43
2002	30	30	40
2003	32	30	38

2004	37	28	35
2005	39	26	35

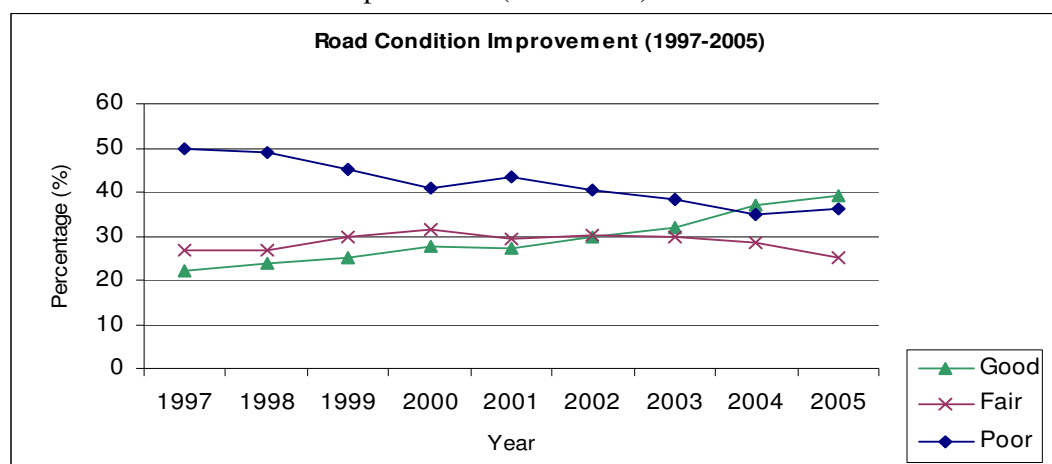
Source: ERA, 2006

Annex 4. b. Change in Road Network and Road Density (1997 – 2004)

Year	Road network in km				Growth Rate (%)	Road Density /1000 popn.	Road density /1000sq. km
	Asphalt	Gravel	Rural	Total			
1997	3708	12162	10680	26550		0.46	24.14
1998	3760	12240	11737	27237	4.5	0.46	25.22
1999	3812	12250	12600	28662	3.3	0.47	26.06
2000	3824	12250	15480	31554	10.1	0.50	28.69
2001	3924	12467	16480	32871	4.2	0.50	29.88
2002	4053	12564	16680	33297	1.3	0.49	30.27
2003	4362	12340	17154	33856	1.7	0.49	30.78
2004	4635	13905	17956	36496	7.8	0.51	33.18
2005	4972	13640	18406	37018	1.4	0.51	33.60

Source: ERA, 2006

Annex 4.c. Road condition improvement (1997-2005)



Source: ERA, 2006

Annex 5

Annex 5.1. Estimation results of the long-term equilibrium between ADDW and the respective markets

Dependent Variable ADDW					
Markets	Explanatory Variables	Before construction Coefficients	t-value	After construction Coefficients	t-value
Nazereth	Constant	12.61	1.46	17.37***	3.13
	NAZW	0.99***	19.28	0.937***	27.84

Shashemene	Constant	0.96	0.72	39.22***	8.73
	SHAW	26.96***	11.50	0.862***	29.62
Dire Dawa	Constant	(36.25)	(1.53)	43.85**	2.60
	DDW	0.934***	8.79	0.62***	8.01
Mekelle	Constant	(7.20)	0.25	(36.92)	(1.68)
	MEKW	0.763***	6.09	1.05***	9.80
Jimma	Constant	18.22**	1.86	52.12***	3.26
	JMMW	0.92***	15.55	0.7***	8.16

***, ** and * indicate significance at 1%, 5% and 10% significance levels, respectively

figures in parenthesis indicate negative sign

Source: regression results, 2006