Grain Market Research Project

VERTICAL AND SPATIAL INTEGRATION OF GRAIN MARKETS IN ETHIOPIA:

IMPLICATIONS FOR GRAIN MARKET AND FOOD SECURITY POLICIES

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WORKING PAPER 9
GRAIN MARKET RESEARCH PROJECT
MINISTRY OF ECONOMIC DEVELOPMENT AND COOPERATION
ADDIS ABABA
JANUARY 1998

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by

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December 1997

Paper presented at the Grain Market Research Project Workshop, December 8-9, 1997, Nazarteh, Ethiopia. Support for this research was provided by the United States Agency for International Development Mission to Ethiopia and by the Ministry of Economic Development and Cooperation of the Government of Ethiopia, under the Food Security II Cooperative Agreement. The Authors gratefully acknowledge comments from members of Technical Committee of the Grain Market Research Project. The ideas and interpretations expressed herein are those of the authors and do not necessarily reflect the views of sponsoring agencies.

EXECUTIVE SUMMARY

The major objective of this study was to assess the performance of grain markets in Ethiopia at the individual market levels and for groups of markets which are spatially linked. By examining the nature of relationships among producer, wholesale, and retail prices in individual markets and among different markets, the study is also aimed at improving the understanding of the grain market operation under the emerging new grain market structure. Such information, can encourage informed policy debate and dialogue among planners, policy makers, researchers, NGO's and donor agencies and contributes toward the formulation of effective grain marketing policies. Various analytical techniques such as the descriptive assessment of the levels and volatilities of grain prices and price spreads and the econometric tests of price transmission within and across markets were used to assess the efficiency of vertical and spatial integration of grain markets in Ethiopia. The price analysis was also complemented by field level knowledge of the operation of grain markets in Ethiopia. The new Market Information System (MIS) price data base, which has been operational since August 96 by the Grain Market Research Project (GMRP) of the Ministry of Economic Development and Cooperation (MEDAC) was used.

The results indicate that the grain markets in Ethiopia exhibit a high degree of vertical and spatial integration. The study also demonstrates the usefulness of the new MIS price data base in understanding the operation of grain markets and in evaluating grain market performance. This section presents a summary of the major findings of this study and a brief discussions of the findings in light of their implications for policy formulations in the areas of price stabilization and food aid management. However, the interpretations of these results should be taken rather cautiously as the time frame used in this study was very short and similar follow-up studies are needed as the MIS price data base builds up. Some of the options available to improve the vertical and spatial integration of grain markets in Ethiopia are also highlighted.

Major Findings

- Within a particular market the share of producer's price as of the retail price averaged 93% for white teff, 91% for white wheat and 86% for maize. As compared to the pre-liberalization period, producer's price share of retail price for white teff, white wheat and maize increased by 32%, 33% and 42%, respectively. In 1995 constant prices, the average producer prices for white teff, white wheat and maize also increased by 63, 60 and 19 birr/quintal, respectively.

- The average wholesaler and retailer price spread were comparable for the three cereals, the wholesaler spread for the cereals considered varied from 6 to 8 birr/quintal and was found to be higher than the retailer spread which varied from 4 to 5 birr/quintal. The proportion of gross price spread as of retail price was 14%, 9%, and 7% for maize, white wheat and white teff, respectively. Thus, the proportion of gross price spread as of the retail price was found to be the highest for maize. This might be because of the difference in the extent of risk associated with moving the grain across the marketing levels.

- In general, the spatial wholesale price spreads between Addis Ababa and other selected markets were found to be very high. The proportion of spreads as of wholesale price in Addis Ababa (or other markets with higher wholesale price than Addis Ababa's wholesale price) was found to be greater than 20% in 10 of 30 cases, greater than 15% in 13 of 30 cases and greater than 10% in 26 of 30 cases. Among the surplus markets, for all cereals, the highest spatial wholesale price spread was observed between Addis Ababa and Shambu market which has poorly developed market infrastructure.

- For a particular market the volatilities of price levels across different marketing levels were found to be very similar indicating that there is integration among different marketing levels. For example, the volatility of white teff price levels across the three marketing levels was either the same or differed only by 1-2% indicating similar level of price volatility across marketing levels in a given market. The coefficient of variation for producers and wholesale price levels are the same in one case and differed by 1% in six of the seven cases. The volatility of white teff price levels at wholesale and retail levels was also found to be very similar in that out of fourteen cases the volatility is found to be the same in seven of the cases, differed by 1% in six of the cases and by 2% only in one case. The volatility of producer and retail prices differed by 1% in four of the six cases and differed by 2% in 2 of 6 cases.

- The volatility of white wheat price levels across different marketing levels was also found to be very similar, it was either the same or differed by 1-2% indicating similar level of price volatility across marketing levels. For the six of individual markets considered, the coefficients of variation for producers and wholesale price levels was the same in one of the case, differed by 1% in four of the cases and by 2% in one of the case. The volatility of price levels at wholesale and retail levels was also found to be very similar in that out of twelve cases the volatility was found to be the same in seven cases, differed by 1% in two cases and by 2% only in three cases. The volatility of producer and retail prices differed by 1% in four of the six cases and differed by 2% in 2 of 6 cases.

- The volatility of white maize price levels across the three marketing levels was either the same or differed by 1-3% indicating similar level of price volatility across marketing levels. For four of the maize markets considered, the coefficients of variation for producer and wholesale price levels differed by 1% in two cases and by 2% in two cases. The volatility of price levels at wholesale and retail levels was found to be the same in one of 12 cases, differed by 1% in seven of 12 cases, by 2% in three of 12 cases and by 3% only in one case. The volatility of producer and retail prices differed by 2% in one of the four cases and differed by 3% in 3 of 4 cases.

- There was a high level of volatility in price spreads among different marketing levels which indicates that there was high level of risk for the traders in passing grain from one level to another. The average standard deviation of wholesaler and retailer spread varied from 1 birr/quintal to 3 birr/quintal, in terms of the coefficients of variation the volatility of wholesaler and retailer spread varied from 26% to 39%.

- The volatility of spatial wholesale price spread between Addis Ababa and other selected markets was very high, in terms of the coefficient of variation, the volatility was greater than 10% in all of the cases, greater than 20% in 26 of 30 cases and greater than 50% in 12 of 30 cases. Thus, the high level of volatility of spatial wholesale price spread indicates the high risk involved in moving grain across markets. There are many factors contributing to the high level of volatility in spatial wholesale price spread like the imposition of kella charges which increases the uncertainties of grain movements between markets.

- There was very strong linkages among the prices of different marketing levels for a particular market, the correlation coefficient for price levels were found to be greater than 0.90 in all of the cases, except in Jimma market between wholesale and retail prices of white teff. The correlation coefficient for the first difference prices (changes) also indicate that there were strong relationships among the cereal price changes at different marketing levels, except for white teff between wholesale and retail price changes in Jimma market and between producer and wholesale price changes for Alamata market.

- The computed correlation coefficients between the spatial wholesale price levles were significant at a probability of less than 10% in all cases, except for Mekele market in the case of white teff and white maize. The spatial correlation coefficient was greater than 0.60 in 23 of 30 cases, greater than 0.70 in 18 of 30 cases and greater than 0.80 in 12 of 30 cases. However, the correlation coefficient for wholesale price changes was not statistically significant in most of the cases, it was not significant in 11 of 12 for white teff, in 7 of 10 cases for white wheat and in 6 of 9 cases for white maize. The lower price correlation coefficient might be because weekly price changes are to short for prices in different markets to adjust.

- In general, the correlation coefficients between Addis Ababa and surplus markets wholesale price levels was found to be higher than that of between Addis Ababa and deficit markets. The correlation coefficient between Addis Ababa and deficit markets was found to be lower than 0.80 in all of the cases while the correlation coefficient between Addis Ababa and surplus markets were found to be greater than 0.80 in 11 of 19 cases considered. This indicates that Addis Ababa market was more integrated to the markets in surplus producing areas than to the markets in the deficit areas which also implies that Addis Ababa market was more of a terminal market rather than a center of distribution (transhipment) for the grain marketed in the country.

- The null hypothesis of no causal relationship between white teff wholesale and producer prices was not rejected for three of the seven markets and in four of the seven markets there was either one-way or two-way causal relationship between wholesale and producer prices. Generally, the causality from producer to wholesale was found to be stronger than that of from wholesale to producer indicating that producer price is the driving force in determining the wholesale price for white teff in individual markets.

- On the other hand, there was a two-way causal relationship in three of the fifteen markets, one-way causal relationship from white teff wholesale to retail price in four of the fifteen markets and from retail to wholesale price in three of the fifteen markets. In the case of the causal relationship between white teff producer and retail prices there was no causal relationship in two of the six markets considered and there was one-way causal relationship in three of the cases, either from producer to retail or from retail to producer and two-way causal relationship in one case.

- For white wheat, the null hypothesis of no causal relationship between wholesale and producer prices was not rejected for four of the six markets while in two of the six markets there was one-way causal relationship. The causal relationship between wholesale and retail prices was tested for twelve markets, in five of the cases there was no causal relationship between the wholesale and retail prices and there was a two-way causal relationship in one case. On the other hand, one-way causal relationship from wholesale to retail price was observed in four of the cases and from retail to wholesale in two of the cases. In the case of the causal relationship between producer and retail prices there was no causal relationship in all of the cases considered, except in one case from producer to retail.

- The null hypothesis of causal relationship between wholesale and producer prices of white maize was not rejected for three of the five markets and there was two-way causal relationship between wholesale and producer prices in one case and one-way causal relationship from producer to wholesale in another case. There was no causal relationship between wholesale and retail prices of maize in six of the thirteen markets, two-way causal relationship in two of the cases, one-way causal relationship from wholesale to retail price in three of the cases and from retail to wholesale price in two of the cases. In the case of the causal relationship between producer and retail prices there was two-way causal relationship in one case, one-way causal relationship from retail to producer in two of cases and no causal relationship in one case..

- The test of causality in wholesale prices of white teff, white wheat and maize between Addis Ababa and other selected markets involved 28 cases. There was no causality only in one case, Addis Ababa wholesale price caused wholesale prices in other selected markets in 10 of the cases, wholesale prices in selected markets caused wholesale price in Addis Ababa in 3 of the cases and they both caused each other in 14 of the cases. Thus, one-way or two-ways, there was strong causal relationship between the cereal wholesale prices of Addis Ababa and other selected markets.

- For the three cereals considered, the null hypothesis of symmetric price transmission for a given market between possible pairs of price levels having a causal relationship was not rejected in any of the cases. Thus, the results indicate that there was a high degree of transmission of price changes in one level to another, cereal markets in Ethiopia are vertically integrated. The null hypothesis of symmetric spatial relationship between Addis Ababa and other selected markets wholesale prices was also not rejected in all cases which indicates that there was spatial integration of markets for the cereals considered, for 27 of 28 markets where causal relationship exists the change in

Addis wholesale was also reflected in wholesale price changes at different other markets and vice versa.

Policy Implications

- *Price stabilization*: Governments trying to stabilize prices are confronted with budget constraints to undertake the stabilization programs which highlights the importance of designing and implementing cost-effective stabilization programs. In this regard, the knowledge of the extent of vertical and spatial integration of grain markets is very crucial in making decisions regarding which prices (producer, wholesale and retail) and markets (all or few of them) to stabilize. The study indicated that grain markets in Ethiopia are integrated vertically and horizontally. The vertical integration of grain markets implies that if the government stabilizes producer prices the effects of stabilization can also be transmitted across wholesale and retail prices within a market. Under this condition, for example, the government can stabilize producer prices by stabilizing the wholesale prices and vice versa, then the government's decision as to which price level to stabilize depends on cost consideration and ease of implementing the program.

- On the other hand, the spatial integration of grain market implies that if the government intervenes in a given market the effects of government intervention in that particular market can also be transmitted across the markets which are spatially integrated. The important policy implications of this result is that it is not important for the government to intervene in all markets, by just intervening in a few important markets, the government can stabilize prices in other regions.

- *Foodaid management:* Foodaid plays a key role in saving lives of people dying from famine resulting from drought or other catastrophes. However, when it is not well targeted to the people with no effective demand, foodaid depresses the producer prices in the local markets by increasing the supply of grain. The depressed prices disrupts the producers incentive to use productivity increasing modern technologies which negatively affects the long run development of foodaid recipient country. Thus, it is very essential that the governments pay careful attention in managing foodaid distribution. In this regard, understanding the nature of grain market integration provides useful insights in devising effective foodaid distirbution and utilization systems so as to minimize the negative impacts of foodaid. In general, grain markets in Ethiopia are spatially integrated which implies the effect of foodaid released in a given market can be transmitted across markets which are spatially integrated. In other words, the prices in surplus markets might be depressed to the extent that foodaid released reaches people with effective demand in grain deficit areas.

- *Improving the integration of grain markets:* The integration of grain markets plays a crucial role in improving the food security situations of a given country. If the markets are well-integrated, price signals direct the flow of grain, price increases resulting in supply shortfalls in a given market attracts grain flows from other markets where the prices are low thus reliving food shortages. The degree of market integration also determines the level of intervention required by the government to correct the

inefficiencies in the grain market, the better the grain market integration the lesser is the intervention required by the government in the market.

- Even though, the grain markets studied appear to be integrated spatially there were high spatial price differentials. The inadequately developed marketing infrastructure might partly explain for the high spatial price differentials and improving the marketing infrastructure such as the transportation network, provision of storage facilities and market information service improves the spatial integration of markets. The vertical integration of grain markets at the individual markets level can also be improved by relaxing entry barriers to the grain trade and removing information asymmetry among various market participants.

- It was also observed that the spatial price differentials were characterized by high volatility which increases the risk of spatial arbitrage. The grain movement controls which have been implemented across different regions with different level of intensity, rules and regulations might explain the high level of spatial price spread volatility by creating uncertainties in the costs of moving grain across markets. Thus, abolishing grain movement controls or making it more transparent and uniform across the regions increases the integration of grain markets in Ethiopia.

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1. INTRODUCTION

The prices of agricultural products are influenced by many factors such as the changes in the costs of production and marketing, government marketing policies, and supply and demand situations, structure and concentration of marketing channels, to mention but a few. 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 related to the concept of price transmission through the vertical marketing system, in other words, the vertical integration of marketing system. The analysis of price transmission in a vertical marketing system 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 at other marketing levels (Kinnucan et al., 1987; Palaskas, 1995; Pick et al., 1990; Ward, 1982). The approach used in the analysis of grain price transmission through vertical marketing system could also be used to analyze the nature of price transmission across markets which are spatially linked.

In the contexts of Ethiopian grain markets, there are several reasons for assessing the grain price transmission through the vertical marketing system and across spatially linked markets, in other words vertical and spatial integration of grain markets. Understanding the nature of the existing grain price transmission allows to answer some of the important questions like what are the directions and extent of wholesale and retail prices responses to the changes in the producer price? For example, in Ethiopia, the year 1995/96 witnessed a huge production increase and grain prices were unusually lower, especially, at the producer level. Then, the important question is how and to what extent this price decrease at the producer level was felt at the wholesale and retail levels? Are the wholesale price responses to price increases and price decreases at the producer (or retail) levels equal? Are the consumers benefitting from the producer price decreases through retail price decreases? Thus, the analysis of grain price transmission is used to assess the efficiency of vertical market integration and to identify price response rigidity in the marketing system.

In terms of spatially linked markets, the analysis of price transmission can be used to assess the nature of price relationship and the direction of causal relationship between grain prices in surplus and deficit areas. Which markets, those in grain deficit or grain surplus areas, are very important in determining the grain prices? What is the nature and extent of price responses in the surplus areas to the price changes in major grain deficit or consuming areas and vice versa? Answers to these questions are very important to design and guide effective government market interventions such as price stabilization and food aid distribution policies. For example, in a situation where grain markets in deficit and surplus areas are well integrated the government can minimize the costs of its market intervention and still be effective by concentrating its activity in a fewer important markets. If the markets are very well integrated the effects of government intervention in fewer markets can easily be transmitted to markets in other locations.

Review of the experiences of market reform in Eastern and Southern African countries by Jayne and Jones (1997) indicate that one of the challenges for the future is that the development of market mechanisms which can reduce the small farmers vulnerability to price and supply instability thereby reducing the costs of government stabilization programs. In this

regard understanding and strengthening the mechanisms of grain price transmission helps to formulate cost-effective price stabilization programs and in assessing the effects of food aid on grain prices. In 95/96 cropping season the depressed producers' price had prompted the government to implement producers' price support intervention to purchase maize and wheat from the farmers through the Ethiopian Grain Trade Enterprise (EGTE). The increase in local grain production also made the EU to contemplate the local purchase of foodaid grains through local traders and other trading companies instead of import. These interventions might have affected wholesale or producer prices of cereals and the analysis of price transmission allows to assess the extent of changes in cereal prices at the producer and/or retail level in response to wholesale or producer price changes.

The government's effort to stabilize grain prices at the producer level might have entailed excessive costs because of small quantities of grains collected and large number of farmers which might be involved. This indicates the government's costs of stabilizing grain prices might be lower if prices are stabilized at the wholesale level rather than at the producer level. However, for the stabilization effort to be effective at the wholesale level, there has to be a downward passing through of grain price increase at the wholesale level to the producer level. The EU's local purchase of food aid grain might have increased the grain prices at the wholesale level, but does this increase also imply an increase in the producer's price in the local markets? It is also possible that the EU's program might have increased retail prices[1]. In other words, the price transmission analysis would allow to explore the stimuli-response relationship among different price levels which help in designing effective marketing policies.

The analysis of price transmission in the vertical marketing system can also be used to investigate the incidence of increases or decreases in the marketing costs. For example, the "kella" charge represents increases in marketing costs and are collected at the wholesale level, but how is this cost shared among producers, wholesalers and retailers? Similarly, one can question how the benefits of the decreases in the marketing costs (for example, due to improvement in the marketing infrastructure) are distributed among the different market participants? For example, Tomek and Robinson (1991) argue that in a competitive market structure decreases in the transportation costs must pass to producers as a higher prices and as a lower prices to consumers.

1.1. Problem Statement

The liberalization of grain markets in Ethiopia has significantly changed the structure of grain markets. In the post-liberalization period, contrary to the pre-liberalization period, the activities of private grain traders has increased tremendously. In 1996 cropping season more than 95% of the grain marketed by the farmers was handled by the private grain trade sector (Asfaw and Jayne, 1997). On the other hand, the government's role in the grain trading activity decreased and accounted only for less than 5% of the grain marketed. Thus, there is new emerging grain marketing structure which is dominated by private traders as opposed to the pre-liberalization period of heavily government controlled marketing system.

[1] Wolday et al. (1997) argue that without the EU's local grain purchase the wholesale grain prices would have been much lower during 1996/97 cropping season. Then, could it also be argued that without the EU's intervention producers' prices would have been much lower?

The monitoring of the impacts of market liberalization on grain prices in Ethiopia, so far, is mainly limited at the wholesale level (for example, see Asfaw and Jayne, 1997). There is very limited information on the nature of price relationships among producers, wholesalers and retailers in the vertical grain marketing system and spatial price linkages under the new emerging grain marketing structure. The outcome of such price transmission analysis is crucial for the understanding of the relationship between prices at different levels of marketing and locations which provides insight into the new marketing issues and policies important for the liberalized markets: price stabilization programs and food-aid managements.

1.2. Objectives of the Study

The major objective of this study was to assess the efficiency of vertical and spatial integration of grain marketing system in Ethiopia and to draw policy recommendations to improve the performance of grain markets in particular and the Ethiopian economy in general. The study assess the nature of grain price relationships at different marketing levels and marketing locations and determines which marketing levels and market locations play a leading role in grain price formation. The specific objectives of this study are:

1. Determine the level and variability of grain prices and price spreads for different marketing levels and across markets,

2 Determine the causal relationship in grain prices between different marketing levels and across markets, and

3. Determine the extent of price transmission through the different marketing levels and across markets and thus the vertical and spatial integration of grain markets.

2. CONCEPTUAL FRAMEWORK

Price transmission is the passing through of prices through either in the vertical or spatial marketing system and is related to the pricing behavior of different market participants. If the marketing system is well-integrated, then price increases should be transmitted to the same extent as the price decreases, i.e., there is no rigidity of price adjustment in the marketing system (Goletti and Babu, 1994). If the conditions of perfectly competitive market prevail the expected relationship between different price levels is that the price change at a given marketing level is also felt, more or less in similar magnitude, at the other marketing levels[2]. In spatially linked markets, the level of price changes in markets located in different locations are also expected to be similar. Any deviation from this norm implies some sort of inefficiencies and the need for investigations. Asymmetric price relationships, in which price change at a given marketing level (location) produces unequal price change at different marketing levels (locations) exists when the market is not competitive.

There are several factors which could influence the pricing behavior of different market participants at a given marketing level such as traders access to and assimilation of market information, structural differences and diversity at each marketing level, and the nature of the products (Kinnucan et al., 1987; Ward, 1982). This section, based on existing information, provides the description of Ethiopian grain market structure at three levels: producer market, wholesale market and retail market and how these structures relate to the grain pricing behavior of different market participants.

The structure and the conduct of market participants have a direct implication for the nature of grain price relationships between different marketing levels and the direction of causality. The term market structure refers to the number of buyers and sellers, their size distribution, the degree of product differentiation, and the ease of entry of new firms into an industry (Branson and Norvell, 1983). Based on the nature of grain price transmission through the vertical marketing system inference can be made about the efficiency of grain marketing and the competitiveness of grain marketing at different marketing stages.

In Ethiopia there are four major channels through which producers sell their produce in the local markets (Gebremeskel et al., 1997). The largest channel is farmers direct sell to the inter-regional wholesalers (private traders, private companies and EGTE) which accounted for 35.7% of the grain marketed. The farmers also sold their grain directly to the local consumers (31.4%) and retailers (19.8%) in the local markets. About 12.1% of the grain was also purchased from the farmers by the local assemblers who majorly (76%) sold to the inter-regional traders. Thus, directly or indirectly through the local assemblers, the wholesale traders accounted for the largest share of grain marketed by the farmers.

In the local markets, small quantities of grain is brought to the market by a large number of small farmers. There is no concentration of grain marketing at the producers' market level in which only few farmers dominate the local market. The individual producers have a negligible

[2] Tomek and Robinson (1991, page 79-89) provide four conditions of perfectly competitive markets that buyers and sellers do not influence market price, products are homogeneous, there is no government intervention and collusion among firms and there is free entry to and exit out of business.

influence on the grain price in the local markets, in other words, they are price takers. With in the same geographic area the quality of grain they supply to the markets are also not differentiated, but there are variabilities in grain quality for different geographic locations.

In the trader survey conducted by the GMRP the market share of wholesale traders was computed for the whole (nationally) and individual markets surveyed based on the annual volume of grain purchases by the traders (Gebremeskel et al., 1997). The survey indicates that at the national level there was concentration of wholesale traders but not at the individual markets level. At the national level, for the total markets surveyed 90% of the wholesale traders accounted only for 57% of the grain marketed while the largest 10% of the wholesale traders accounted for 43% of the grain marketed. This indicate that there is a concentration of grain market structure at the wholesale level and the wholesale traders might be influencing market prices when buying the grains from the producers and selling to the retailers or consumers. However, the concentration of the wholesale traders at the national level might be due to geographic concentration of production and it might also be important to see the concentration of wholesale traders at the individual market level.

Gebremeskel et al. (1997) used the average four-firm concentration ratio to assess the concentration of wholesale traders in individual markets for all grains and different types of cereals. The average four firm concentration ratio for all grains was found to be greater than 33% only in 3 of 11 markets while for individual cereals, the concentration ratio was less than 33% in 7 of 9 markets for teff, in 4 of 6 markets for wheat and in 3 of 6 markets for maize. According to Kohls and Uhl (1985) an average four-firm concentration ratio in a market which is not concentrated is less than or equal to 33%. Thus, at the individual markets level, the wholesale markets in Ethiopia are not concentrated. Under this condition, one might hypothesize the direction of causal relationship is either from wholesale market to the producer or from the producer to the wholesale market and the wholesalers are not exercising market power. Further more, if the wholesale traders are not exercising market power, it can be hypothesized that in the local market producer prices respond equally to price decreases and price increases at the wholesale level. In other words, there is symmetric relationship between wholesale and producer prices.

The structure and organization of retail grain markets in Ethiopia are not well studied. However, from the researchers observations there are no big retail groceries engaged in retailing grains. In the local markets small traders and families with low income buy grains and sell it to the consumers in the same market or transport to other bigger markets to get some profit. There are also a number of flour mills in the urban areas which are engaged in retailing of grains. In some cases, the wholesale traders themselves are also engaged in retailing of grains. As such, there is no concentration of grain markets at the retail level in which case it is possible to hypothesize that retailers influence the prices at which they buy from the wholesalers and sell to the consumers. It is also possible to hypothesize that wholesale traders are operating competitively when selling the grains to the retailers. Thus, the price changes at the retail level might also be responding equally to the price increases and the price decreases at the wholesale level.

There are also other factors which affect the nature of price relationships among marketing levels and spatial markets such as the flow of information through the marketing system and individual market participants access to market information, costs of transportation and the nature of the products. The lack of or insufficient market information flow through the

marketing system and high costs of transportation affect the price linkages negatively. Regarding the nature of products, Ward (1982) indicates that price linkages should be stronger for perishable products such as fresh vegetables requiring a minimal transformation. The grains marketed in Ethiopia also do not undergo significant transformation until they reach the consumers and the processors. On the other hand, Ward (1982) argues that agricultural products having many uses and requiring considerable transformation should show weak price relationships among the exchange points.

3. DATA COLLECTION AND THE SCOPE OF STUDY

The availability of accurate and reliable price data at the different marketing stages is very important for analyzing the relationship among the producer, wholesale and retail prices. In the past, the understanding of the nature of relationship between the producer, wholesale and retail prices was very limited owing to the absence of such data base. There are governmental and non-governmental organizations which have been involved in the grain price data collection. However, a well-organized and systematic method of price data collection at different marketing levels was non-existent until the establishment of the Grain Marketing Research Project's (GMRP) Market Information System (MIS) in August of 1996. This data collection is currently in its pilot phase and cereal price data and flow information is being collected for five major cereals: teff, barley, wheat, sorghum and maize in 26 representative grain markets. As experience gains and the project proves viability it is expected that the geographic and commodity representations of the markets will expand.

The data for this study is based on a weekly MIS price data base, twelve months weekly price data collected from August 1996 to July 1997 deflated by CPI (1995=100) for Addis Ababa market is used. This data base, though of short duration, provides a unique opportunity to assess the relationship among producer, wholesale and retail prices. The report is also partly intended to demonstrate the usefulness of such price data base in understanding the operation and performance of grain marketing system and providing an insight into the formulation of effective marketing and pricing policies.

4. ANALYTICAL FRAMEWORK AND EMPIRICAL MODELS

The first stage of the analysis involves descriptive assessment of grain price levels and price spreads at different marketing stages (producer, wholesale and retail) and market locations. For this purpose, descriptive statistics like mean, standard deviation, coefficient of variation and price correlation coefficients were used[3]. The magnitude of price spread and the differences in the variability of price levels at different marketing levels and locations were used to give an initial insight into the efficiency of grain marketing. If the vertical (or spatial) marketing system is efficient or well coordinated the price spread should not be excessively large and the price variability must be similar at different levels (or locations) in the vertical (or spatial) grain marketing system. The fact that there is very little transformation as the grain moves through the vertical (or spatial) marketing system also indicates that the various price spreads should be reasonably low. Price correlation coefficients were also used to see the strength of price linkages between different marketing levels and across markets.

In the second stage of the analysis, the nature of grain price transmission through different marketing levels and across markets was assessed to see the vertical and spatial integration of grain markets. The first approach in the analysis of grain price transmission is to determine which marketing levels (or locations) plays an important role in determining grain prices. This is concerned with establishing the direction of causal relationship in grain prices in the vertical (or spatial) marketing system. Assessing the existing grain market structure and conduct can provide insights into the pricing behavior of different market participants and the causal directions of price linkages. However, in this paper the causal directions between different price levels were also tested empirically using Granger causality test. For example, the model to test the null hypothesis that in a given market the wholesale price causes retail price can be given as follows[4]:

$$R_t = \theta_1 + \alpha_{1i}\sum_{i=1}^{n} R_{t-i} + \beta_{1i}\sum_{i=1}^{n} W_{t-i} + \varepsilon_{1t} \qquad \textbf{(1)}$$

where R_t is the retail price at time t, θ_1 is the intercept, α_{1i}s are the coefficients on the lagged values of retail prices, β_{1i}s are the coefficients on the lagged values of wholesale prices, i is the lag length used for retail and wholesale prices and ε_{1t} is the disturbance term at time t. On the other hand, to test the null hypothesis that the retail price does not cause the wholesale price the model given in equation (1) was modified as follows:

$$W_t = \theta_2 + \alpha_{2i}\sum_{i=1}^{n} R_{t-i} + \beta_{2i}\sum_{i=1}^{n} W_{t-i} + \varepsilon_{2t} \qquad \textbf{(2)}$$

where W_t is the wholesale price at time t and the other variables are defined in the same way as for equation (1). Several hypothesis of causality could be tested based on the models

[3] The use of conditional variance might be more appropriate to measure the volatility of price levels and price spreads, however, due to short duration of the time series price data used standard deviation and coefficient of variation are used in this study.

[4] The model specifications used for testing the symmetry of price transmission is the same for both vertical and spatial marketing systems.

presented in equations (1) and (2) using either the F-test or the maximum likelihood ratio test: (1) only wholesale price causes retail price, (2) only retail price cause wholesale price, (3) both wholesale and retail prices cause each other, and (4) both wholesale and retail prices do not cause each other.

The null hypothesis that only wholesale price causes retail price is accepted if the sum of β_{1i}s in equation (1) is significantly different from zero and the sum of α_{2i}s in equation (2) is not significantly different from zero. On the other hand, wholesale and retail prices are independent if the sum of β_{1i}s in equation (1) and the sum of α_{2i}s in equation (2) are not significantly different from zero. The wholesale and retail prices cause each other if the sum of β_{1i}s in equation (1) and the sum of α_{2i}s in equation (2) are significantly different from zero. The tests of causality was done at different lag lengths, starting from one week lag, instead of determining just one appropriate lag length using AIC or SIC because of short duration of the data used.

After the causal direction is established for grain prices between the two price levels, the next step is to assess the nature of price response at a given marketing level once the change in price occurred at marketing level which is causing price change at another level. For example, in a given market, let us say wholesale price causes retail prices, then the question is whether the retail price responses to wholesale price decreases and increases are equal. In other words, this analysis determines whether the effects of downward and upward price movements at the wholesale level on the retail price changes are equal. Generally, in the literatures of price transmission analysis two concepts are distinguished: (1) price symmetry, a condition in which the effects of upward and downward price movements at a given marketing level in response to price changes at another level are equal, and (2) price asymmetry, a condition in which upward and downward price movements have un-equal effects on price changes at another level.

Empirical models which can be used to assess the nature of grain price transmission through marketing channels are already developed and applied (see Ward, 1982; Kinnucan et al., 1987; Palaskas, 1995). For example, following Ward (1982) and Kinnucan et al. (1987), the econometric model to assess the price transmission between the wholesale and retail prices assuming a causal relationship is running from wholesale to retail can be formulated as follows:

$$\Delta R_t = \alpha_i \sum_{i=0}^{k} CPPW_{t-i} + \beta_i \sum_{i=0}^{k} CNPW_{t-i} + \varepsilon_t \qquad \textbf{(3)}$$

where ΔR_t is the change in the retail price in a given market at time t, $CPPW_t$ is the cumulative increases in wholesale prices up to the time period t and α_is are the coefficients on the current and lagged values of $CPPW_t$, $CNPW_t$ is the cumulative decreases in wholesale prices up to the time period t and β_is are the coefficients on the current and lagged values of $CNPW_t$, i denotes the lag length on cumulative upward and downward changes in wholesale and retail prices.

Pick et al. (1990) argue that the econometric model given in equation (3) assumes that the change in retail prices is affected only by the upward and downward movements of the wholesale prices in the current and previous periods. Other factors, like marketing costs,

which might affect the retail price changes are not included and they suggest the inclusion of trend variable to capture the changes in the marketing costs[5]. Thus, equation (3) was modified as follows:

$$\Delta R_t = \phi T + \alpha_i \sum_{i=0}^{k} CPPW_{t-i} + \beta_i \sum_{i=0}^{k} CNPW_{t-i} + \varepsilon_t \qquad \textbf{(4)}$$

where ϕ is the coefficient on the trend variable T and the other variables are as defined in equation (3). However, the inclusion of lagged independent variables in the regression model as in equation (4) is prone to multicolinearity problem which decreases the accuracy of statistical estimation. To overcome the multicolinearity problem the α_is and β_is coefficients were estimated using the polynomial distributed lag model (see Appendix 1).

From equation (4) the test of price symmetry was based on the test of the equality of the coefficients on upward and downward price movements using Wald coefficient restriction tests. The null hypothesis for this test is that the effects of upward and downward price movements in the wholesale price on the retail price change are equal, i.e., there is symmetric relationships between wholesale and retail prices. In terms of the regression coefficients given in equation (4), price symmetry implies the equality of the sum of α_is and the sum of β_is. On the other hand, the rejection of the null hypothesis of the equality of the two coefficients indicates the existences of price asymmetry. For example, if the sum of the coefficients on the current and lagged downward price movements are lower than the sum of the current and lagged upward price movements of wholesale prices it indicates retail prices respond more to price increases than to price decreases at the wholesale level. In other words, wholesalers pass price increase to retailers more than they do pass price decreases which implies price asymmetry. Several other interpretations could also be made based on the signs and whether the α_is and β_is coefficients are statistically significant.

[5] It would have been more logical to use a time series data on marketing costs instead of just only trend variable, however, there was very limited time series data on marketing costs for markets studied.

5. RESULTS AND DISCUSSIONS

5.1. Descriptive Analysis of Vertical and Spatial Integration of Grain Markets

As a prelude to the econometric tests, descriptive statistics such as the mean, standard deviation (coefficient of variation) and price correlation coefficient were used to assess the efficiency of vertical and spatial integration of grain markets. This section provides the measurement of the levels and volatilities of real producer, wholesale and retail prices and the price spreads among these three price levels for maize, white teff and white wheat for selected markets. The assessment of the levels and volatilities of spatial wholesale price differentials and spatial wholesale price correlation coefficient between Addis Ababa and selected markets are presented. Twelve months' cumulative upward and downward movements in producer, wholesale and retail price levels were also measured for different markets.

5.1.1. The Level of Grain Prices and Price Spreads Among Different Marketing Levels and Across Markets

5.1.1.1. Grain price levels: The average real producer, wholesale and retail prices of white teff, white wheat and maize and the price spreads among the different marketing levels are given for several markets in Tables 1 to 3. The number of markets considered for each grain varied based on the availability of continuous weekly price data for each of the markets. The white teff average real producer, wholesale and retail price for the markets considered was about 157, 165 and 170 birr/quintal, respectively (Table 1). For white wheat the average real producer, wholesale and retail price was 131, 139 and 144 birr/quintal, respectively (Table 2). In the case of maize, the real producer, wholesale and retail price was 62, 68 and 72 birr/quintal, respectively (Table 3).

For the individual markets the share of producer's price as of the retail price averaged 93% for white teff, 91% for white wheat and 86% for maize. During the Derg period the producers' share of official retail price under the government marketing channel was 61%, 58% and 44% for white teff, white wheat and maize, respectively, (Asfaw and Jayne, 1997). Thus, compared to the pre-liberalization period producer's price share of retail price for white teff, white wheat and maize increased by 32%, 33% and 42%, respectively. In 1995 constant prices, the average producer prices for white teff, white wheat and maize also increased by 63, 60 and 19 birr/quintal, respectively.

Among the three cereals, the producer's share of retail price was lower for maize as compared to white teff and white wheat. In other words, the share of price spread as a percentage of retail price was the highest for maize. This might be because of the relatively higher storage cost for maize. In terms of the markets considered, the lowest producer price and producer's share of retail price for all cereals was observed in Shambu market which, relatively, as compared to other markets, has weak market infrastructure such as road and communication network.

Table 1. White Teff Average Real (1995=100) Price Levels and Price Spreads in Birr/qt for Several Markets in Ethiopia (August 1996 to July 1997)

	Price levels			Price spreads		
Markets	Producer	Wholesale	Retail	Wholesaler spread	Retailer spread	Producer's share of retail price(%)
Addis Ababa	-	221.77	239.57	-	17.82	-
Nazeret	-	205.39	210.62	-	5.23	-
Ambo	161.44	171.01	177.63	9.57	6.62	91
Inchini	162.84	169.01)	173.53	6.17	4.52	94
Hosaena	138.16	144.39	149.03	6.24	4.63	93
Shambu	112.24	120.35	124.21	8.11	3.86	90
Jima	-	167.25	175.07	-	7.25	-
Shewarobit	179.64	187.08	192.59	7.44	5.51	93
Mekele	-	251.39	256.53	-	5.26	-
Alamata	177.89	190.27	-	13.7	-	-
Shashamane	188.91	194.94	201.34	6.03	6.39	94
Gonder	-	181.60	189.90	-	8.08	-
Nakempt	-	145.34	150.73	-	5.40	-
Ghimbie	-	164.80	167.31	-	2.51	-
Dessie	-	209.14	215.16	-	6.03	-
Dire Dawa	-	260.81	268.89	-	8.08	-
Mean*	157.21	164.46	169.72	7.26	5.26	93

Note: "-" Indicates that the average price levels and price spreads are not calculated for a given market due to insufficient number of observations.

* Indicates the mean is calculated for markets where the price data is available for all the three marketing levels.

5.1.1.2. Level of price spreads across marketing levels: The grain price spreads among the different marketing levels were computed for individual markets and the results are given in Tables 1, 2 and 3. For white teff the average wholesaler price spread was 7 birr/quintal while the average retailer price spread was 5 birr/quintal. The average wholesaler spread for white wheat was 8 birr/quintal and the average retailer price spread was 5 birr/quintal. In the case of maize, the average wholesaler spread was 6 birr/quintal and the average retailer price spread was 4 birr/quintal.

Table 2. White Wheat Average Real (1995=100) Price Levels and Price Spreads in Birr/qt for Several Markets in Ethiopia (August 1996 to July 1997)

	Price levels			Price spreads		
Markets	Producer	Wholesale	Retail	Wholesaler spread	Retailer spread	Producer's share of retail price (%)
Addis Ababa	-	151.00	163.53	-	12.53	-
Nazeret	-	142.59	149.81	-	7.23	-
Ambo	113.37	121.90	128.01	8.53	6.10	89
Inchini	116.29	122.48	127.38	6.19	4.91	91
Shashamane	123.89	129.51	135.12	5.62	5.61	92
Hosaena	113.44	118.42	122.30	4.98	3.88	93
Shambu	92.79	100.48	104.23	7.70	3.74	89
Jima	-	145.04	152.04	-	7.00	-
Dessie	-	162.05	167.73	-	5.68	-
Dire Dawa	-	196.96	206.26	-	9.30	-
Mekele	225.41	241.77	247.45	16.36	5.68	91
Metu	-	172.16	176.23	-	-	-
Mean*	130.87	139.09	144.08	8.23	4.99	91

Note: "-" Indicates that the average price levels and price spreads are not calculated for a given market due to insufficient number of observations.

* Indicates the mean is calculated for markets where the price data is available for all the three marketing levels.

The average wholesaler and retailer price spread were comparable for the three cereals, the wholesaler spread for the cereals considered varied from 6 to 8 birr/quintal and was found to be higher than the retailer spread which varied from 4 to 5 birr/quintal. The proportion of gross price spread as of retail price was 14%, 9%, and 7% for maize, white wheat and white teff, respectively. Thus, the proportion of gross price spread as of the retail price was found to be the highest for maize.

This might be because of the difference in the extent of risk associated with moving the grain across the marketing levels.

At the individual market level, especially for Addis Ababa market, the retailer price spread for all the grains considered were found to be very high. The retailer spread was also found to be relatively higher for major consumer markets such as Dire Dawa and Gonder as

Table 3. White Maize Average Real (1995=100) Price Levels and Price Spreads in Birr/qt for Several Markets in Ethiopia (August 1996 to July 1997)

	Price levels			Price spreads		Producer's share of retail price (%)
Markets	Producer	Wholesale	Retail	Wholesaler spread	Retailer spread	
Addis Ababa	-	80.78	93.44	-	12.65	-
Shashamane	70.34	75.60	81.42	5.26	5.81	86
Hosaenna	-	84.54	88.04	-	3.50	-
Dangila	58.08	62.47	65.11	4.37	2.70	89
Nakempt	-	60.89	65.88	-	5.00	-
Shambu	45.10	52.16	54.85	7.05	2.70	82
Dessie	-	84.99	90.63	-	5.64	-
Shewarobit	75.22	81.93	87.38	6.71	5.45	86
Dire Dawa	-	112.50	120.45	-	7.96	-
Mekele	-	123.29	128.50	-	5.21	-
Gonder	-	89.51	100.66	-	11.05	-
Jimma	-	66.31	72.23	-	5.93	-
Mean*	62.19	68.04	72.19	5.85	4.17	86

Note: "-" Indicates that the average price levels and price spreads are not calculated for a given market due to insufficient number of observations.

* Indicates the mean is calculated for markets where the price data is available for all the three marketing levels.

compared to other markets. This might be due to higher retailing costs or differences in the cost of living in the big consumer markets. The major transfer cost, though the exact estimate is not made, in moving grains across the marketing levels are handling costs such as putting grains in to the bugs and storage cost for a very limited period of time.

5.1.1.3. Level of spatial wholesale price spread: Addis Ababa market was assumed to be the major grain consumer market as well as a major market center for collection and redistribution (transhipment) of grain to other grain deficit markets. As a result, Addis Ababa market was taken as a focal market in studying the spatial integration of grain markets. Spatial wholesale price differential between Addis Ababa and other selected markets was computed for the three cereals and the results are given in Table 4. White teff spatial wholesale price spread between Addis Ababa and surplus producing markets varied from 17 birr/quintal to 102 birr/quintal and accounted for 8% to 46% of wholesale price in Addis

Table 4. Spatial Wholesale Price Differentials and Correlation Coefficients Between Addis Ababa and Selected Markets in Ethiopia (August 1996 to July 1997)

Markets	Distance from Addis (km)	Spatial price differential (birr/quintal)[1]			Volatility of price differential[2]			Spatial price correlation coefficient[3]		
		White teff	White wheat	White maize	White teff	White wheat	White maize	White teff	White wheat	White maize
Surplus markets										
Inchini	80	52.73 (24)	28.52 (19)	-	11.56 (22)	8.67 (30)	-	0.78 (0.03*)	0.87 (-0.05*)	-
Nazeret	98	17.05 (8)	8.59 (6)	-	11.84 (69)	6.40 (75)	-	0.83 (0.05*)	0.95 (0.19*)	-
Ambo	125	51.28 (23)	29.28 (19)	-	11.66 (23)	10.98 (38)	-	0.83 (0.21*)	0.81 (0.04*)	-
Hosaenna	232	77.65 (35)	32.49 (22)	-	9.81 (13)	6.93 (21)	-	0.84 (0.14*)	0.93 (0.08*)	-
Shashamane	251	27.06 (12)	21.58 (14)	5.32 (7)	13.69 (51)	6.89 (32)	6.99 (131)	0.69 (-0.03*)	0.92 (0.33)	0.95 (0.47)
Shambu	314	101.56 (46)	50.80 (34)	28.48 (35)	13.07 (13)	14.15 (28)	9.60 (34)	0.69 (0.16*)	0.63 (0.29)	0.80 (0.31)
Nekemet	327	76.84 (35)	-	19.73 (24)	12.87 (17)	-	6.49 (33)	0.71 (0.23)	-	0.91 (0.26)
Jimma	346	58.17 (26)	-	14.47 (18)	29.40 (51)	-	8.50 (59)	0.54 (-0.07*)	-	0.91 (0.22*)
Dangila	485	-	-	18.31 (23)	-	-	10.18 (56)	-	-	0.77 (0.14*)
Deficit markets										
Dessie	401	-	-11.05 (7)	-12.25 (14)	-	13.55 (123)	6.59 (54)	-	0.63 (-0.19*)	0.55 (0.17*)
Dire Dawa	515	-38.68 (15)	-45.42 (23)	-31.53 (28)	21.73 (56)	15.56 (34)	11.21 (36)	0.53 (-0.06*)	0.48 (0.08*)	0.73 (0.14*)
Shewarobit	552	34.66 (16)	-	-9.35 (11)	12.19 (35)	-	6.54 (70)	0.73 (0.20*)	-	0.70 (0.05*)
Alamata	600	26.04 (12)	-	-	10.79 (41)	-	-	0.79 (0.08*)	-	-
Mekele	783	-29.64 (12)	-90.77 (38)	-42.51 (34)	19.23 (65)	17.03 (19)	16.45 (39)	0.22* (-0.12*)	0.40 (-0.16*)	0.01* (-0.16*)

Note: "-" indicates that the correlation coefficient was not computed for a given pair of price levels due to insufficient number of observations.

* Indicates that the correlation coefficient was not statistically significant at a probability of less than 10%.

[1] Figures in parenthesis are percentage of wholesale price differential as of Addis Ababa wholesale price (or other market where Addis Ababa price wholesale is lower which is indicated by putting negative sign in front of the wholesale price differential)

[2] Figures in parenthesis are the coefficient of variation.

[3] Figures in parenthesis are the correlation coefficient for wholesale price changes

Ababa market. On the other hand, the spread between Addis Ababa and selected grain deficit markets varied from 26 birr/quintal to 39 birr/quintal and accounted for 12% to 16% of the wholesale price for Addis Ababa (or cereal deficit markets).

In the case of white wheat the spatial wholesale price spread between Addis Ababa and surplus markets varied from 9 birr/quintal to 51 birr/quintal and accounted for 6% to 34% of Addis Ababa wholesale price. On the other hand, the spread between Addis Ababa and deficit markets varied from 11 birr/quintal to 91 birr/quintal and accounted for 7% to 38% of the wholesale prices in deficit markets. The spatial wholesale price spread for maize between Addis Ababa and grain surplus markets varied from 5 birr/quintal to 28 birr/quintal and accounted for 7% to 35% of wholesale price in Addis Ababa market while between Addis Ababa and selected grain deficit markets the spread varied from 9 birr/quintal to 43 birr/quintal and accounted for 11% to 34% of wholesale prices in deficit markets.

In general, the spatial wholesale price spreads between Addis Ababa and other selected markets were found to be very high. The proportion of spreads as of wholesale price in Addis Ababa (or other markets with higher wholesale price than Addis Ababa's wholesale price) was found to be greater than 20% in 10 of 30 cases, greater than 15% in 13 of 30 cases and greater than 10% in 26 of 30 cases. Among the surplus markets, for all cereals, the highest spatial wholesale price spread was observed between Addis Ababa and Shambu market which has poorly developed market infrastructure. For example, the spatial wholesale price spreads for white teff and white wheat between Addis Ababa and Inchini were higher than that of between Addis Ababa and Nazeret. Addis Ababa market is closer to Inchini market than to Nazeret by 18 kms, however, the road linking Addis Ababa to Nazeret is by far better than the road linking Addis Ababa and Inchini markets.

The size of spatial wholesale price differential can be used to assess the efficiency of spatial market integration and the direction of grain flow between Addis Ababa market and selected grain surplus and deficit markets. For example, the white teff wholesale price spreads between Addis Ababa and other deficit markets give little indication of grain flows from Addis Ababa to the deficit markets for two reasons. First, for some grain deficit markets like Shoarobit and Alamata the wholesale prices were lower than that of Addis Ababa. Second, for Mekele market the white teff wholesale price was higher than that of Addis Ababa market, however, the price spread for this market was relatively low to offset the transfer cost. There is a possibility of grain flow from Addis Ababa to Dire Dawa, however, Dire Dawa market could be better supplied by Nazeret market than by Addis Ababa market. For Mekele and other deficit markets in the north Gojam region might be the major source of white teff supply. Thus, for white teff, Addis Ababa market is more of a major terminal (consumer) market than a center for distributing teff to other deficit markets in Ethiopia.

In the case of white wheat and maize, the wholesale price spreads indicate that there are in flows of wheat and maize to Addis Ababa from surplus producing markets and out flows from Addis Ababa market to other deficit areas of Dire Dawa and Mekele markets. Thus, for maize and wheat, Addis Ababa market is both major consumer and major distributing center. However, it is very interesting to note that the maize wholesale price spread between Addis Ababa and Shashamane, one of the most important maize producing area in Ethiopia, was very low. This indicates the fact that maize produced in the Shshamane area was not majorly flowing to Addis Ababa market, rather it was consumed in the Southern Region and in addition to this there might be cross-border trading with Kenya.

Generally, the markets are linked spatially but the spreads are relatively large. The higher size of spread might be mainly due to under developed market infrastructure and lack of communication. This highlights the importance of investment in transport sector and provision of market information to improve the spatial integration of grain markets.

5.1.2. The Volatility of Grain Price Levels and Price Spreads at Different Marketing Levels and Across Markets

5.1.2.1. Volatility of price levels: The variability of grain prices at different marketing levels in the vertical and spatial marketing systems was measured using standard deviation and coefficients of variation and results are given in Tables 5, 6 and 7. For white teff producer, wholesale and retail price variability as measured by the standard deviation averaged 17 birr/quintal while in terms of the coefficient of variation the average variability in producer, wholesale and retail price was 12%, 11% and 10%, respectively (Table 5). The average standard deviation for white wheat producer price was 17 birr/quintal and the average coefficient of variation was 14% (Table 6). At the wholesale level the average standard deviation for the white wheat price levels was 16 birr/quintal while the average coefficient of variation was 13%. The average standard deviation of retail price levels for white wheat was 16 birr/quintal and the average coefficient of variation was 12%. In the case of maize the average standard deviation of producer, wholesale and retail price was 13 birr/quintal and in terms of the coefficients of variation the average variability in producer, wholesale and retail price was 21%, 20% and 18%, respectively (Table 7).

For a particular market the volatilities of price levels across different marketing levels were found to be very similar. For example, the volatility of white teff price levels across the three marketing levels was either the same or differed only by 1-2% indicating similar level of price volatility across marketing levels in a given market. The coefficient of variation for producers and wholesale price levels are the same in one case and differed by 1% in six of the seven cases. The volatility of white teff price levels at wholesale and retail levels was also found to be very similar in that out of fourteen cases the volatility is found to be the same in seven of the cases, differed by 1% in six of the cases and by 2% only in one case. The volatility of producer and retail prices differed by 1% in four of the six cases and differed by 2% in 2 of 6 cases.

Table 5. The Variability * of White Teff Real (1995=100) Price Levels and Price Spreads in Birr/qt for Several Markets in Ethiopia (August 1996 to July 1997)

	Price levels			Price spreads	
Markets	Producer	Wholesale	Retail	Wholesaler spread	Retailer spread
Addis Ababa	-	17.55 (0.08)	13.68 (0.06)	-	7.01 (0.39)
Nazeret	-	21.61 (0.11)	21.41 (0.10)	-	2.15 (0.41)
Ambo	20.52 (0.13)	20.91 (0.12)	21.26 (0.12)	2.20 (0.23)	2.46 (0.37)
Inchini	17.65 (0.11)	17.38 (0.10)	16.93 (0.10)	1.73 (0.28)	1.61 (0.36)
Hosaenna	17.94 (0.13)	17.42 (0.12)	17.82 (0.12)	2.40 (0.38)	3.41 (0.74)
Shambu	15.23 (0.14)	15.23 (0.13)	14.76 (0.12)	2.15 (0.27)	1.30 (0.34)
Jima	-	27.09 (0.16)	27.10 (0.15)	-	1.92 (0.26)
Shewarobit	15.42 (0.09)	14.95 (0.08)	14.12 (0.07)	1.33 (0.18)	1.33 (0.24)
Mekele	-	12.59 (0.05)	12.51 (0.05)	-	1.68 (0.32)
Alamata	14.79 (0.08)	17.15 (0.09)	-	7.12 (0.52)	-
Shashamane	17.61 (0.09)	17.38 (0.09)	16.87 (0.08)	1.34 (0.22)	1.99 (0.31)
Gonder	-	13.68 (0.08)	15.23 (0.08)	-	3.78 (0.47)
Nakempt	-	15.93 (0.11)	16.21 (0.11)	-	1.32 (0.24)
Dessie	-	15.02 (0.07)	14.14 (0.07)	-	2.38 (0.39)
DireDawa	-	25.08 (0.10)	23.60 (0.09)	-	2.92 (0.36)
Mean	17.40 (0.12)	17.21 (0.11)	16.96 (0.10)	2.79 (0.26)	2.02 (0.39)

Note: * The price variabilities are measured by the standard deviation and the coefficient of variation (%)

"-" Indicates that the standard deviation (coefficient of variation) for the average price levels and price spreads are not calculated for a given market due to insufficient observations.

Table 6. The Variability * of White Wheat Real (1995=100) Price Levels and Price Spreads in Birr/qt for Several Markets in Ethiopia (August 1996 to July 1997)

	Price levels			Price spreads	
Markets	Producer	Wholesale	Retail	Wholesaler spread	Retailer spread
Addis Ababa	-	17.33 (0.11)	14.41 (0.09)	-	6.46 (0.52)
Nazeret	-	19.57 (0.14)	17.78 (0.12)	-	4.67 (0.65)
Ambo	17.87 (0.16)	17.89 (0.15)	18.08 (0.14)	1.83 (0.21)	1.54 (0.25)
Inchini	16.76 (0.14)	16.46 (0.13)	16.51 (0.13)	2.31 (0.37)	1.57 (0.32)
Shashamane	16.14 (0.13)	16.02 (0.12)	16.31 (0.12)	0.92 (0.16)	1.12 (0.20)
Hosaenna	17.93 (0.16)	18.19 (0.15)	18.77 (0.15)	2.84 (0.57)	2.67 (0.69)
Shambu	14.26 (0.15)	14.79 (0.15)	15.00 (0.14)	1.66 (0.22)	1.41 (0.38)
Jima	-	15.85 (0.11)	16.30 (0.11)	-	3.98 (0.57)
Dessie	-	9.98 (0.06)	9.81 (0.06)	-	1.74 (0.31)
Dire Dawa	-	12.38 (0.06)	11.50 (0.06)	-	3.04 (0.33)
Mekele	16.11 (0.07)	13.25 (0.05)	13.00 (0.05)	6.74 (0.41)	2.32 (0.41)
Metu	-	12.82 (0.07)	16.63 (0.09)	-	-
Mean	16.51 (0.14)	16.10 (0.13)	16.28 (0.12)	2.72 (0.32)	1.77 (0.38)

Note: * The price variabilities are measured by the standard deviation and the coefficient of variation (%)

"-" Indicates that the standard deviation (coefficient of variation) for the average price levels and price spreads are not calculated for a given market due to insufficient observations.

Table 7. The Variability* of White Maize Real (1995=100) Price Levels and Price Spreads in Birr/qt for Several Markets in Ethiopia (August 1996 to July 1997)

	Price levels			Price spreads	
Markets	Producer	Wholesale	Retail	Wholesaler spread	Retailer spread
Addis Ababa	-	15.82 (0.20)	16.23 (0.17)	-	4.66 (0.37)
Shashamane	19.89 (0.28)	20.02 (0.26)	20.17 (0.25)	1.44 (0.27)	1.15 (0.20)
Hosaenna	-	17.00 (0.20)	18.44 (0.21)	-	2.21 (0.63)
Dangila	11.34 (0.20)	11.45 (0.18)	11.26 (0.17)	1.41 (0.32)	1.06 (0.39)
Nakempt	-	14.88 (0.24)	14.92 (0.23)	-	1.16 (0.23)
Shambu	10.94 (0.24)	11.91 (0.23)	11.74 (0.21)	1.97 (0.28)	1.31 (0.49)
Dessie	-	6.45 (0.08)	7.08 (0.08)	-	1.75 (0.31)
Shewarobit	8.78 (0.12)	9.08 (0.11)	9.08 (0.10)	1.21 (0.18)	1.38 (0.25)
Dire Dawa		14.17 (0.13)	13.40 (0.11)	-	2.07 (0.26)
Mekele	-	4.77 (0.04)	6.40 (0.05)	-	2.49 (0.48)
Gonder	-	9.86 (0.11)	10.50 (0.10)	-	5.54 (0.50)
Jimma	-	19.47 (0.29)	19.61 (0.27)	-	1.80 (0.30)
Mean	12.74 (0.21)	13.12 (0.20)	13.06 (0.18)	1.51 (0.26)	1.23 (0.33)

Note: * The price variabilities are measured by the standard deviation and the coefficient of variation (%)

"-" Indicates that the standard deviation (coefficient of variation) for the average price levels and price spreads are not calculated for a given market due to insufficient observations.

The volatility of white wheat price levels across different marketing levels was also found to be very similar, it was either the same or differed by 1-2% indicating similar level of price volatility across marketing levels. For the six of individual markets considered, the coefficients of variation for producers and wholesale price levels was the same in one of the case, differed by 1% in four of the cases and by 2% in one of the case. The volatility of price levels at wholesale and retail levels was also found to be very similar in that out of twelve cases the volatility was found to be the same in seven cases, differed by 1% in two cases and by 2% only in three cases. The volatility of producer and retail prices differed by 1% in four of the six cases and differed by 2% in 2 of 6 cases.

The volatility of white maize price levels across the three marketing levels was either the same or differed by 1-3% indicating similar level of price volatility across marketing levels (Table 7). For four of the maize markets considered, the coefficients of variation for producer and wholesale price levels differed by 1% in two cases and by 2% in two cases. The volatility of price levels at wholesale and retail levels was found to be the same in one of 12 cases, differed by 1% in seven of 12 cases, by 2% in three of 12 cases and by 3% only in one case. The

volatility of producer and retail prices differed by 2% in one of the four cases and differed by 3% in 3 of 4 cases.

In general, for the individual markets, for the three cereals considered similar level of price volatility was observed across the marketing levels indicating that there is integration among different marketing levels. Maize price levels were found to be most volatile as compared to white teff and white wheat price levels.

5.1.2.2. Volatility of price spreads among marketing levels: A high level of volatility was observed for the price spreads among different marketing levels as compared to the price levels. For example, the average standard deviation of white teff wholesaler price spread was 3 birr/quintal and the average coefficients of variation was 26%. The standard deviation for the retailer price spread averaged 2 birr/quintal while its coefficients of variation averaged 39%. In the case of white wheat the average standard deviation for wholesaler price spread was about 3 birr/quintal and in terms of the coefficients of variation the volatility of wholesaler price spread averaged 32%. On the other hand, the volatility of retailer price spread as measured by the standard deviation averaged about 2 birr/quintal while the average coefficients of variation was 38%.

The average standard deviation of maize wholesaler price spread was 1.50 birr/quintal and in terms of the coefficient of variation the volatility averaged 26%. The volatility of retailer price spread as measured by the standard deviation averaged 1 birr/quintal and the coefficients of variation averaged 33%.

Generally, there was a high level of volatility in price spreads among different marketing levels which indicates that there was high level of risk for the traders in passing grain from one level to another. The average standard deviation of wholesaler and retailer spread varied from 1 birr/quintal to 3 birr/quintal, in terms of the coefficients of variation the volatility of wholesaler and retailer spread varied from 26% to 39%.

5.1.2.3. Volatility of spatial wholesale price spreads: The volatility of spatial wholesale price spread between Addis Ababa and other selected markets was also computed for the three cereals and the results are given in Table 4. For white teff the standard deviation of spatial wholesale price spread between Addis Ababa and surplus producing markets varied from 10 birr/quintal to 29 birr/quintal and in terms of the coefficient of variation it varied from 13% to 69%. On the other hand, the spatial wholesale price spread for white teff between Addis Ababa and deficit markets varied from 11 birr/quintal to 22 birr/quintal and the coefficient of variation varied from 35% to 65%.

For white wheat the standard deviation of spatial wholesale price spread between Addis Ababa and surplus producing markets varied from 6 birr/quintal to 14 birr/quintal and in terms of the coefficient of variation it varied from 21% to 75%. On the other hand, the spatial wholesale price spread for white wheat between Addis Ababa and deficit markets varied from 14 birr/quintal to 17 birr/quintal and the coefficient of variation varied from 19% to 123%.

For maize the standard deviation of spatial wholesale price spread between Addis Ababa and surplus producing markets varied from 7 birr/quintal to 10 birr/quintal and in terms of the coefficient of variation it varied from 33% to 131%. On the other hand, the spatial wholesale

price spread for white maize between Addis Ababa and deficit markets varied from 7 birr/quintal to 17 birr/quintal and the coefficient of variation varied from 36% to 70%.

In general, the volatility of spatial wholesale price spread between Addis Ababa and other selected markets was very high, the volatility was greater than 10% in all of the cases, greater than 20% in 26 of 30 cases and greater than 50% in 12 of 30 cases. Thus, the high level of volatility of spatial wholesale price spread indicates the high risk involved in moving grain across markets. There are many factors contributing to the high level of volatility in spatial wholesale price spread like the imposition of grain movement control which increases the uncertainties of grain movements between markets.

5.1.3. Grain Price Correlation Coefficient Among Different Marketing Levels and Across Markets

The strength of linkage among the prices at the different marketing levels are measured using correlation coefficients for price levels and changes and the results are given in Table 8. There was very strong linkages among the price levels at different marketing levels, the correlation coefficient for price levels were found to be greater than 0.90 in all of the cases, except in Jimma market between wholesale and retail prices of white teff. The correlation coefficient for the first difference prices (changes) also indicate that there were strong relationships among the cereal price changes at different marketing levels, except for white teff between wholesale and retail price changes in Jimma market and between producer and wholesale price changes for Alamata market.

The price correlation coefficient for white teff, white wheat and white maize wholesale price levels and changes between Addis Ababa and other selected markets is given in Table 4. The computed correlation coefficients between the wholesale price levels were significant at a probability of less than 10% in all cases, except for Mekele market in the case of white teff and white maize. The spatial correlation coefficient was greater than 0.60 in 23 of 30 cases, greater than 0.70 in 18 of 30 cases and greater than 0.80 in 12 of 30 cases.

In general, the correlation coefficients between Addis Ababa and surplus markets wholesale price levels was found to be higher than that of between Addis Ababa and deficit markets. The correlation coefficient between Addis Ababa and deficit markets was found to be lower than 0.80 in all of the cases while the correlation coefficient between Addis Ababa and surplus markets were found to be greater than 0.80 in 11 of 19 cases considered. This indicates that Addis Ababa market was more integrated to the markets in surplus producing areas than to the markets in the deficit areas which also implies that Addis Ababa market was more of a terminal market rather than a center of distribution (transhipment) for the grain marketed in the country. However, the correlation coefficient for wholesale price changes was not statistically significant in most of the cases, it was not significant in 11 of 12 cases for white teff, in 7 of 10 cases for white wheat and in 6 of 9 cases for white maize. The lower

Table 8. The Correlation Coefficient Among Producer (P), Wholesale (W) and Retail (R) Real (1995=100) Price Levels (changes) of White Teff, White Wheat and White Maize for Several Markets in Ethiopia (August 1996 to July 1997)

	White teff			White wheat			White maize		
Markets	P&W	W&R	P&R	P&W	W&R	P&R	P&W	W&R	P&R
Addis Ababa	-	0.93 (0.51)	-	-	0.93 (0.67)	-	-	0.96 (0.60)	-
Nazeret	-	0.99 (0.91)	-	-	0.97 (0.59)	-	-	-	-
Ambo	0.99 (0.943)	0.99 (0.95)	0.98 (0.88)	0.99 (0.94)	0.99 (0.93)	0.99 (0.86)	-	-	-
Inchini	0.99 (0.95)	0.99 (0.95)	0.99 (0.91)	0.99 (0.94)	0.99 (0.98)	0.98 (0.89)	-	-	-
Shashamane	0.99 (0.97)	0.99 (0.90)	0.99 (0.86)	0.99 (0.99)	0.99 (0.99)	0.99 (0.98)	0.99 (0.88)	0.99 (0.96)	0.99 (0.83)
Hosaenna	0.99 (0.87)	0.98 (0.73)	0.97 (0.65)	0.99 (0.87)	0.99 (0.89)	0.98 (0.78)	-	0.99 (0.95)	-
Shambu	0.99 (0.93)	0.99 (0.96)	0.99 (0.92)	0.99 (0.92)	0.99 (0.92)	0.99 (0.90)	0.99 (0.94)	0.99 (0.93)	0.99 (0.90)
Jimma	-	0.67 (0.22*)	-	-	0.97 (0.83)		-	0.99 (0.93)	-
Dessie	-	0.99 (0.81)	-	-	0.98 (0.97)	-	-	0.97 (0.90)	-
Dangila	-		-	-	-	-	0.99 (0.96)	0.98 (0.96)	0.98 (0.93)
Shewarobit	0.99 (0.97)	0.99 (0.97)	0.99 (0.95)	-	-	-	0.99 (0.94)	0.99 (0.90)	0.98 (0.84)
Dire Dawa	-	0.99 (0.94)	-	-	0.97 (0.92)	-	-	0.99 (0.95)	-
Mekele	-	0.99 (0..90)	-	0.91 (0.64)	0.98 (0.94)	0.91 (0.67)	-	0.94 (0.86)	-
Gonder	-	0.97 (0.80)	-	-	-	-	-	0.85 (0.26)	-
Nakempt	-	0.99 (0.96)	-	-	-	-	-	0.99 (0.93)	-
Ghimbie	-	0.99 (0.93)	-	-	-	-	-	0.99 (0.89)	-
Metu	-		-	-	0.97 (0.93)	-	-	-	-
Mean	0.99 (0.93)	0.99 (0.91)	0.99 (0.86)	0.98 (0.88)	0.99 (0.94)	0.97 (0.85)	0.99 (0.93)	0.99 (0.94)	0.99 (0.88)
Alamata	0.9 1(0.20*)	-	-	-	-	-	-	-	-

Note: "-" Indicates that the correlation coefficient was not computed for a given pair of price levels due to insufficient number of observations.
* Indicates that the correlation coefficient was not statistically significant at a probability of less than 10% price correlation coefficient might be because weekly price changes are too short for prices in different markets to adjust.

5.1.4. Upward and Downward Movements in Grain Prices at Different Marketing Levels and Across Markets

5.1.4.1. Price movements across marketing levels: As an initial step in analyzing the extent of price transmission in a vertical marketing system the upward and downward movements in producer, wholesale and retail grain prices were computed and compared. Over the past twelve months period, since August 96, on average the cumulative upward movement in white teff producer price was 121 birr/quintal and the average downward movement was 117 birr/quintal (Table 9). The average upward movement in white teff wholesale price was 122 birr/quintal while on average the downward price movement was 118 birr/quintal. The average upward movement in retail prices was 125 birr/quintal while on average the downward movement was 121 birr/quintal.

For white wheat, the average cumulative upward movement in white wheat producer price was 132 birr/quintal while the average downward movement was 99 birr/quintal (Table 10). The average upward movement in wholesale price was 130 birr/quintal and the average downward movement was 100 birr/quintal. At the retail level, the average upward movement in retail prices was 132 and the average downward movement in retail price was 103. In the case of maize the average upward movement in producer price was 77 birr/quintal while the average downward movement was 52 birr/quintal (Table 11). The average upward movement in wholesale price was 79 birr/quintal and the average downward price movement was 52 birr/quintal. The average downward movement in retail prices was 78 birr/quintal while the average upward movement in retail price was 51 birr/quintal.

For individual markets, the cumulative upward movements in white teff, white wheat and white maize prices at the different marketing levels (at the producer, wholesale and retail) were found to be very similar and their cumulative downward movements at the different marketing levels were also found to be similar indicating that there was a vertical integration of grain markets. However, in general, at all the market levels the upward movements in white teff, white wheat and maize prices were greater than the downward movements. In other words, over the last twelve months period, the producer, wholesale and retail prices increased more than they decreased. The net increase in cereal prices were similar across the marketing levels but varied for different grains. On average, there was a net increase in the producer, wholesale and retail prices of white teff by 4 birr/quintal while for white wheat and maize the average net increase was 30 birr/quintal and 26 birr/quintal, respectively. Thus, the net increase was the lowest for white teff as compared to white wheat and maize.

It is also important to note the patterns of upward and downward movements of prices at the different marketing levels for individual markets. For white teff, in surplus producing areas, there was a general pattern that across all the marketing levels the price increases were greater than price decreases. On the other hand, for the markets in the deficit areas price decreases were greater than the price increases. This pattern of price movement implies decrease in price spread between surplus and deficit markets and hence an improvement in grain marketing efficiency over the study period. For white wheat and maize such pattern was not observed in that prices at all marketing levels increased more than they decreased,

Table 9. Cumulative Real (1995=100) Price Increases and Decreases for White Teff at Different Market Levels (August 1996 to July 1997) for Several Markets in Ethiopia

	Market levels					
	Producer		Wholesale		Retail	
Markets	Increase	Decrease	Increase	Decrease	Increase	Decrease
Addis Ababa	-	-	157.79	182.23	137.37	152.82
Nazeret	-	-	122.67	137.24	116.07	131.78
Ambo	147.10	144.97	149.97	144.53	163.62	158.16
Inchini	144.29	132.35	127.97	121.26	121.03	117.47
Hosaenna	120.44	109.23	127.14	117.12	144.82	134.96
Gonder	-	-	125.02	108.37	134.69	113.94
Shambu	101.51	83.35	110.32	88.32	106.84	87.00
Ghimbie	-	-	179.67	165.61	172.30	154.27
Jimma	-	-	377.75	383.33	191.63	196.09
Shewarobit	92.39	104.97	104.84	113.59	100.37	106.17
Mekele	-	-	92.35	99.42	87.03	93.29
Alamata	180.66	109.63	81.71	121.33	-	-
Shashamane	121.18	124.29	113.87	124.41	110.33	121.13
Nakempt	-	-	131.51	124.76	141.24	136.71
Dessie	-	-	93.36	109.88	84.81	101.47
DireDawa	-	-	172.88	183.68	169.78	172.56
Mean	121.15	116.53	122.35	118.21	124.50	120.82

Note: "-" Indicates that the cumulative price increase(decrease) are not computed for a given market level due to insufficient number of observations.

except for white wheat in the case of Dire Dawa market where the decreases in the wholesale and retail prices were greater than the price increases.

5.1.4.2. Wholesale price movements across markets: The pattern of upward and downward movements in wholesale prices for different markets can also be used to infer about the spatial integration of grain markets. Similar level of wholesale price increases and similar level of wholesale price decreases between two markets indicate that these markets are

Table 10. Cumulative Real (1995=100) Price Increases and Decreases for White Wheat at Different Market Levels (August 1996 to July 1997) for Several Markets in Ethiopia

	Market levels					
	Producer		Wholesale		Retail	
Markets	Increase	Decrease	Increase	Decrease	Increase	Decrease
Addis Ababa	-	-	125.42	90.39	159.57	126.82
Nazeret	-	-	148.39	126.09	101.76	78.62
Ambo	127.42	92.12	129.16	99.20	119.58	88.79
Inchini	147.53	124.51	147.08	125.20	160.75	145.17
Shashamane	132.63	105.58	133.07	105.22	133.04	102.34
Hosaenna	122.34	88.76	140.21	103.69	126.43	91.08
Shambu	91.76	57.80	94.16	62.48	110.03	76.42
Jimma	-	-	214.64	178.08	228.69	187.84
Dessie	-	-	164.08	153.58	172.68	157.17
Dire Dawa	-	-	186.96	202.02	174.82	187.00
Mekele	170.11	127.44	135.68	103.60	144.60	116.78
Metu	-	-	125.27	86.09	141.18	88.64
Mean	131.97	99.37	129.89	99.90	132.41	103.43

Note: "-" Indicates that the cumulative price increase(decrease) are not computed for a given market level due to insufficient number of observations.

spatially integrated. Across markets, the wholesale price increases were greater than the wholesale price decreases for 75% (31 of 41) of the cases.

In the case of white teff, the magnitude of white teff wholesale price increases and decreases for Addis Ababa market were similar to that of the markets in the surplus producing areas and Dire Dawa market. On the other hand, the magnitude of white teff wholesale price increase and decrease for other grain deficit markets in the North like Mekele, Alamata, Shoarobit and Dessie were very similar but by far lower than that of Addis Ababa market. These

Table 11. Cumulative Real (1995=100) Price Increases and Decreases for White Maize at Different Market Levels (August 1996 to July 1997) for Several Markets in Ethiopia

	Market levels					
	Producer		Wholesale		Retail	
Markets	Increase	Decrease	Incrrease	Decrease	Increase	Decrease
Addis Ababa	-	-	123.70	80.27	157.15	107.11
Shashamane	86.41	55.77	81.92	48.44	86.38	50.06
Hosaenna	-	-	141.85	103.53	143.03	105.86
Dangila	88.78	57.17	91.21	58.10	88.99	55.87
Nakempt	-	-	90.86	42.38	92.07	43.76
Shambu	64.30	41.48	71.34	44.68	65.25	40.75
Dessie	-	-	53.72	39.21	59.97	45.40
Shewarobit	67.59	53.14	69.98	56.48	70.33	57.82
Dire Dawa	-	-	159.66	146.44	156.65	140.66
Mekele	-	-	65.08	61.46	83.87	62.48
Gonder	-	-	187.91	160.44	134.96	103.67
Ghimbie	-	-	127.66	95.02	155.84	118.19
Jimma	-	-	126.16	71.78	124.68	63.60
Mean	76.77	51.89	78.61	51.93	77.74	51.13

Note: "-" Indicates that the cumulative price increase(decrease) are not computed for a given market level due to insufficient number of observations.

indicates that, for white teff, among the grain deficit markets, Addis Ababa market was more integrated with Dire Dawa market than to the markets in the North. In the case of grain surplus markets, the wholesale price increases were found to be similar with that of Addis Ababa market but the wholesale price decreases were quite lower than that of Addis Ababa market.

For white wheat, the wholesale price increases and decreases for Addis Ababa and surplus markets were found to be very similar indicating spatial integration of wheat market between Addis Ababa and surplus markets. However, in the case of deficit markets the wholesale price increase and decrease in Addis Ababa market were found to be very similar with that of Mekele market while for Dire Dawa market both the wholesale increase and decrease were higher than that of Addis Ababa market. Thus, for white wheat, Addis Ababa market was found to be more integrated to Mekele than Dire Dawa market.

In the case of white maize, the wholesale increases and decreases in the Northern grain deficit markets like Mekele, Dessie and Shoarobit were found to be very similar to that of Dangila market than to Addis Ababa market. For other markets there was no clear pattern in the wholesale price movements, the wholesale price increase and decrease in Addis Ababa market was found to be greater than that of most of the markets in the surplus producing areas and Mekele market and they were lower than that of Dire Dawa market.

5.2. Econometric Analysis of Vertical and Spatial Integration of Grain Markets

This section presents the results of Granger causality tests to determine the nature of causal relationship among price levels in the individual markets as well as between the wholesale price levels in Addis Ababa and other selected markets. The nature of causal relationships between different price levels indicate the extent to which the prices at respective marketing levels provide a better prediction of the price at other levels. It also provides clues as to which marketing levels (or locations) play a driving force in the price determination. The results of econometric tests of price transmission among producer, wholesale and retail prices in individual markets and the transmission of wholesale price changes between Addis Ababa and other selected markets were also presented. The test of price transmission measures the nature and extent to which a given market price level responds to changes in another price level in the same or different markets.

5.2.1. Direction of Price Linkages in Vertical Marketing System

The causal relationship between white teff wholesale and producer prices was investigated for seven markets (Table 12). The null hypothesis of no causal relationship was not rejected for three of the seven markets and in four of the seven markets there was either one-way or two-way causal relationship between wholesale and producer prices. Generally, the causality from producer to wholesale was found to be stronger than that of from wholesale to producer indicating that producer price is the deriving force in determining the wholesale price for white teff in individual markets.

For five of the fifteen markets there was no causal relationship between white teff wholesale and retail prices (Table 13). On the other hand, there was a two-way causal relationship in three of the fifteen markets, one-way causal relationship from wholesale to retail price in four of the fifteen markets and from retail to wholesale price in three of the fifteen markets. In the case of the causal relationship between white teff producer and retail prices there was no causal relationship in two of the six markets considered and there was one-way causal relationship in three of the cases, either from producer to retail or from retail to producer and two-way causal relationship in one case (Table 14).

In the surplus markets the causality from white teff wholesale to retail price was found to be stronger than that of from retail to wholesale price which indicates that the wholesale price determines the retail prices in the surplus markets. Similar causal pattern was also observed for the major deficit markets of Dire Dawa and Mekele in that wholesale price was found to

Table 12. F-tests for Causal Relationship Between Wholesale and Producer Prices of White Teff for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships							
	H_o: Wholesale price does not cause producer price (1 to 4 weeks lag)				H_o: Producer price does not cause wholesale price (1 to 4 weeks lag)			
Markets	1	2	3	4	1	2	3	4
Ambo	0.02	0.95	1.24	1.14	1.85	1.49	1.35	0.93
Inchini	13.62[3]	8.01[3]	5.02[3]	3.20[2]	5.74[2]	2.63[1]	1.86	1.36
Shashamane	3.80[1]	0.62	0.86	0.26	0.39	1.79	1.18	0.60
Hosaenna	0.98	0.44	0.42	1.03	11.45[3]	5.39[3]	3.64[2]	3.15[2]
Shambu	1.87	0.93	0.80	0.41	0.05	0.51	0.92	1.27
Shewarobit	0.04	0.78	0.76	1.04	0.25	1.97	1.71	1.57
Alamata	1.62	2.94[1]	2.08	1.34	13.16[3]	6.21[3]	6.13[3]	4.41[3]

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

Table 13. F-tests for Causal Relationship Between Wholesale and Retail Prices of White Teff for Different Markets in Ethiopia, August 1996 to July 1997

	Causal relationships							
	H_o: Wholesale price does not cause retail price (1 to 4 weeks lag)				H_o: Retail price does not cause wholesale price (1 to 4 weeks lag)			
Markets	1	2	3	4	1	2	3	4
Addis Ababa	0.59	0.69	0.35	0.30	15.56[3]	5.51[3]	2.94[2]	2.11[1]
Nazeret	0.01	0.20	0.31	0.22	4.34[2]	2.31	1.62	1.28
Ambo	4.75[2]	2.69[1]	1.80	1.44	0.92	0.89	0.70	1.03
Inchini	5.58[2]	3.43[2]	2.17	1.49	0.79	1.20	0.96	0.83
Hosaenna	7.57[3]	6.66[3]	4.73[3]	3.82[3]	0.93	3.10[1]	2.83[2]	2.07
Gonder	0.86	0.70	0.25	0.13	2.30	1.99	1.96	1.47
Shambu	0.10	0.36	1.05	1.11	0.48	0.77	1.18	1.32
Ghimbie	4.30[2]	3.80[2]	2.45[1]	1.66	12.25[3]	6.65[3]	4.12[2]	3.07[2]
Jimma	0.48	0.24	1.12	0.92	23.54[3]	12.75[3]	6.67[3]	4.74[3]
Dessie	1.53	1.01	1.18	1.01	2.52	1.93	1.15	1.10
Shewarobit	0.03	0.58	0.28	0.40	0.67	1.10	0.65	0.88
Mekele	4.59[2]	0.50	1.40	2.63	0.01	0.48	1.73	4.42
Shashamane	0.24	0.24	2.48[1]	2.86[2]	2.48	1.87	3.26[2]	2.83[2]
Nakempt	1.71	0.86	0.34	0.39	0.01	0.41	0.41	0.27
DireDawa	3.12[1]	0.93	0.97	1.72	0.03	0.52	0.77	1.76

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

Table 14. F-tests for Causal Relationship Between Producer and Retail Prices of White Teff for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships							
	H_o: Retail price does not cause producer price (1 to 4 weeks lag)				H_o: Producer price does not cause retail price (1 to 4 weeks lag)			
Markets	1	2	3	4	1	2	3	4
Ambo	0.18	0.60	0.58	1.04	4.56[2]	2.18	1.54	1.68
Inchini	5.51[2]	4.51[2]	3.18[2]	2.25[1]	0.10	1.04	1.31	0.89
Hosaenna	0.17	1.44	1.64	1.29	21.37[3]	13.17[3]	8.75[3]	6.25[3]
Shambu	1.87	0.66	0.76	0.27	0.02	0.45	1.91	1.07
Shewarobit	0.66	0.26	0.23	0.28	0.13	0.25	0.29	0.21
Shashamane	5.79[2]	1.67	1.48	2.67[2]	0.07	1.26	1.14	2.76[2]

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

be the driving force in determining the retail prices in these markets. On the other hand, for Addis Ababa and Nazeret markets, the causality was from retail to wholesale price indicating that the retail prices were the driving force in determining wholesale prices in Addis Ababa and Nazeret markets. Regarding the causal relationship between producer and retail prices there was no clear pattern, however, it seems that producer to retail was stronger than retail to producer.

For white wheat the causal relationship between wholesale and producer prices was investigated for six markets (Table 15). The null hypothesis of no causal relationship was not rejected for four of the six markets while in two of the six markets there was one-way causal relationship between wholesale and producer prices. The causal relationship between wholesale and retail prices was tested for twelve markets and all the possible causal relationships were observed (Table 16). In five of the cases there was no causal relationship between the wholesale and retail prices and there was a two-way causal relationship in one case. On the other hand, one-way causal relationship from wholesale to retail price was observed in four of the cases and from retail to wholesale in two of the cases. In the case of the causal relationship between producer and retail prices there was no causal relationship in all of the cases considered, except in one case from producer to retail (Table 17).

Table 15. F-tests for Causal Relationship Between Wholesale and Producer Prices of White Wheat for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships							
	H_o: Wholesale price does not cause producer price (1 to 4 weeks lag)				H_o: Producer price does not cause wholesale price (1 to 4 weeks lag)			
Markets	1	2	3	4	1	2	3	4
Ambo	0.30	0.85	0.99	0.61	0.60	0.44	0.94	0.57
Inchini	0.78	0.80	1.36	0.82	0.19	0.04	1.10	0.70
Shashamane	0.13	0.09	0.11	0.17	0.91	0.46	0.37	0.31
Hosaenna	0.45	0.32	2.03	1.40	8.59[3]	4.72[2]	4.57[3]	4.00[3]
Shambu	2.60	0.55	0.58	0.81	0.01	0.58	0.74	0.79
Mekele	4.32[2]	1.94	1.26	0.81	0.01	0.13	0.88	0.88

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

Thus, the causality test for white wheat markets indicates that there was no causal relationship between producer and wholesale price for most of the markets. However, for the white wheat surplus producing area of Hosaenna the producer price was found to cause the wholesale price and in a wheat deficit area of Mekele the wholesale price was found to cause the producer price. In markets which are located in surplus producing areas the causal relationship from retail to wholesale was stronger than from wholesale to retail while in markets located in major wheat deficit markets the causal relationship from wholesale to retail was stronger than from retail to wholesale. Thus, in surplus producing areas retail

Table 16. F-tests for Causal Relationship Between Wholesale and Retail Prices of White Wheat for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships							
	H_o: Wholesale price does not cause retail price (1 to 4 weeks lag)				H_o: Retail price does not cause wholesale price (1 to 4 weeks lag)			
Markets	1	2	3	4	1	2	3	4
Addis Ababa	9.48[3]	3.48[2]	2.08	1.51	0.34	1.38	1.27	0.89
Nazeret	0.11	0.68	0.60	0.94	20.53[3]	8.58[3]	7.12[3]	4.61[3]
Ambo	0.42	2.04	1.38	1.11	1.43	1.67	0.65	0.48
Inchini	1.20	1.59	0.78	1.91	0.02	1.13	0.29	1.79
Shashamane	1.30	1.43	1.27	1.14	2.21	1.59	1.09	1.13
Hosaenna	0.52	0.64	0.70	0.57	8.19[3]	4.65[2]	3.58[2]	3.00[2]
Shambu	6.99[2]	3.75[2]	1.98	2.14[1]	0.37	1.91	0.37	0.73
Jimma	2.19	0.28	0.46	1.06	2.42	1.62	0.38	0.96
Dessie	4.13[2]	1.27	1.04	0.89	1.98	1.01	1.23	0.96
Dire Dawa	0.56	0.24	0.68	0.54	0.29	0.10	0.72	0.45
Mekele	5.09[2]	1.71	1.24	1.07	1.60	0.73	0.73	0.55
Metu	1.22	3.21[1]	2.81[1]	2.60[1]	0.50	5.57[3]	3.54[2]	2.62[1]

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

Table 17. F-tests for Causal Relationship Between Producer and Retail Prices of White Wheat for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships							
	H_o: Retail price does not cause producer price (1 to 4 weeks lag)				H_o: Producer price does not cause retail price (1 to 4 weeks lag)			
Markets	1	2	3	4	1	2	3	4
Ambo	2.56	0.75	0.32	0.16	1.06	0.80	1.32	1.10
Inchini	1.17	0.84	0.72	0.95	0.85	0.35	0.80	0.92
Shashamane	0.46	0.45	0.63	0.42	0.04	0.60	1.07	0.79
Hosaenna	0.96	1.20	1.37	0.97	2.22	1.48	1.92	1.61
Shambu	0.16	1.88	0.87	1.05	1.97	4.98[2]	2.58[1]	2.17[1]
Mekele	1.28	0.73	0.50	0.53	0.54	0.30	0.84	0.62

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

prices determine wholesale prices while in deficit areas the wholesale prices determine the retail prices. There was no causal relationship between producer and retail prices for white wheat except in relatively wheat surplus area of Shambu market.

The causal relationship between wholesale and producer prices of white maize was investigated for five markets (Table 18). The null hypothesis of no causal relationship was not rejected for three of the five markets and there was two-way causal relationship between wholesale and producer prices in one case and one-way causal relationship from producer to wholesale in another case. There was no causal relationship between wholesale and retail prices of maize in six of the thirteen markets (Table 19). On the other hand, there was two-way causal relationship in two of the cases, one-way causal relationship from wholesale to retail price in three of the cases and from retail to wholesale price in two of the cases. In the case of the causal relationship between producer and retail prices there was causal relationship in all of the markets considered, except in one case (Table 20). There was two-way causal relationship in one case and one-way causal relationship from retail to producer in two of cases.

For maize, in Shashamane market, one of the important maize surplus market, there was two-way causal relationship among all possible pairs of market levels, except between wholesale and retail prices. In a major maize deficit markets of Addis Ababa, the wholesale price was the driving force in determining the retail price. The causal relationship between retail and producer price was also found to be stronger from retail to producer than from producer to retail price. The GMRP trader survey indicates an average four-firm concentration ratio of about 21% for maize while implies competitive market structure for the wholesale traders engaged in maize trade.

Table 18. F-tests for Causal Relationship Between Wholesale and Producer Prices of White Maize for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships							
	H_o: Wholesale price does not cause producer price (1 to 4 weeks lag)				H_o: Producer price does not cause wholesale price (1 to 4 weeks lag)			
Markets	1	2	3	4	1	2	3	4
Shashamane	3.72[1]	14.77[3]	9.25[3]	9.72[3]	0.22	7.57[3]	5.77[3]	7.60[3]
Dangila	0.05	0.24	0.29	0.23	1.45	0.94	0.72	0.71
Shambu	0.21	0.09	1.47	1.13	0.23	0.40	0.25	0.20
Metu	1.48	1.43	0.17	0.87	0.17	2.12	2.73	2.99[2]
Shewarobit	0.99	0.79	0.59	1.35	0.03	0.07	0.06	1.04

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

In summary, the tests of causal relationship between producer and wholesale prices of white teff, white wheat and maize involved 21 cases, 40 cases between wholesale and retail prices and 16 cases between producer and retail prices. There was no causal relationship betwen producer and wholesale prices in 7 of 21 cases, wholesale price caused producer price in 6 of 21 cases, producer price caused wholesale price in 5 of 21 cases and they both caused each other in 3 of 21 cases. Thus, in some cases the producer price determines wholesale price while in other cases wholesale price determines produce price.

There was no causal relationship between wholesale and retail prices in 16 of 40 cases, wholesale price caused retail price in 11 of 40 cases, retail price caused wholesale price in 7 of 40 cases and they both caused each other in 6 of 40 cases. Generally, wholesale prices, regardless of being in deficit or surplus area, was found to cause retail prices indicating that wholesale prices are the deriving forces in determining the retail prices. Regarding the relationship between producer and retail prices there was no causal relationship between the two in 8 of 16 cases, producer price caused retail price in 3 of 16 of the cases, retail price cause producer price in 3 of 16 cases and they both caused each other in 2 of 16 cases. Thus, the causality test does not give a clear general direction in the relationship between producer and retail prices.

5.2.2. Direction of Wholesale Price Linkages in a Spatial Marketing System

The spatial causal relationship was investigated for wholesale prices of maize, white teff and white wheat between Addis Ababa and other selected markets. The results of F-test for the causal relationship are given in Tables 21 to 23. In the case of white teff, in most of the cases

there was a two-way causal relationships between Addis Ababa and other markets wholesale prices (Table 21). The causal test depicts an important causal relationship between Addis Ababa

Table 19. F-tests for Causal Relationship Between Wholesale and Retail Prices of White Maize for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships							
	H_o: Wholesale price does not cause retail price (1 to 4 weeks lag)				H_o: Retail price does not cause wholesale price (1 to 4 weeks lag)			
Markets	1	2	3	4	1	2	3	4
Addis Ababa	10.46[3]	3.09[1]	2.28[1]	2.40[1]	0.90	1.51	1.40	0.59
Shashamane	0.52	3.22[2]	3.53[2]	2.30	3.48[1]	2.01[1]	2.77[1]	2.33[1]
Hosaenna	0.41	2.45[1]	1.49	1.16	3.49[1]	3.18[1]	1.63	1.29
Dangila	3.30[1]	1.91	1.89	0.92	0.44	0.46	0.65	0.32
Gonder	0.55	0.75	0.77	1.21	2.06	1.84	0.41	0.45
Nakempt	0.36	1.25	1.25	0.88	1.62	1.48	1.47	1.13
Shambu	0.16	0.63	0.51	0.32	1.13	0.95	1.23	0.87
Dessie	0.24	0.23	0.94	1.32	1.69	1.77	1.31	1.80
Shewarobit	0.02	0.95	0.57	0.85	3.13[1]	3.91[2]	3.00[2]	2.93[2]
Dire Dawa	0.01	0.77	0.49	1.02	1.27	1.32	1.05	1.41
Mekele	1.05	0.63	0.86	2.50[1]	0.02	0.29	0.16	0.85
Ghimbie	2.08	0.31	0.92	0.91	0.19	0.34	0.45	0.56
Jimma	0.21	1.02	0.90	1.25	2.96[1]	0.98	0.58	1.02

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

and other markets white teff wholesale prices, in surplus markets the causal relationship from other markets to Addis Ababa was found to be stronger than from Addis to other markets. Thus, the wholesale prices in surplus markets were found to be the driving force in determining Addis Ababa's wholesale prices for white teff. On the other hand, the wholesale price in Addis and other deficit markets were found to influence each other.

In the case of white wheat the causal relationship was mainly from Addis Ababa to other markets indicating that Addis Ababa market was very important market in determining the

wholesale wheat prices in both surplus and deficit markets (Table 22). The other interesting feature of causality in white wheat wholesale prices between Addis Ababa and other markets is that there was a two-way causal relationship between Addis wholesale prices and wholesale prices of surplus wheat producing markets. On the other hand, in the case of wheat deficit areas the direction of causality was mainly from Addis to other markets in the deficit areas. Thus, Addis Ababa wholesale price is the driving force in determining wholesale prices in the deficit wheat markets of Ethiopia.

Table 20. F-tests for Causal Relationship Between Producer and Retail Prices of White Maize for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships							
	H_o: Retail price does not cause producer price (1 to 4 weeks lag)				H_o: Producer price does not cause retail price (1 to 4 weeks lag)			
Markets	1	2	3	4	1	2	3	4
Shashamane	6.13[2]	6.01[3]	4.84[3]	6.15[3]	0.01	0.86	2.89[2]	2.96[2]
Dangila	0.13	0.26	0.43	0.49	2.07	1.47	0.99	1.06
Shambu	1.26	1.06	2.39[1]	1.78	0.38	0.88	0.58	0.44
Shewarobit	4.45[2]	3.67[2]	2.50[1]	2.47[1]	0.02	1.10	0.57	2.12

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

For maize, for both markets located in surplus and deficit areas, the direction of causality was mainly from Addis Ababa wholesale price to other markets wholesale price (Table 23). However, there was one way causality from Shashamne market to Addis Ababa market and there was no causal relationship between Addis Ababa and Mekele market.

Generally, the test of causality in wholesale prices of white teff, white wheat and maize between Addis Ababa and other selected markets involved 28 cases. There was no causality only in one case, Addis Ababa wholesale price caused wholesale prices in other selected markets in 10 of the cases, wholesale prices in selected markets caused wholesale price in Addis Ababa in 3 of the cases and they both caused each other in 14 of the cases. Thus, one-way or two-ways, there was strong causal relationship between the cereal wholesale prices of Addis Ababa and other selected markets[6].

[6] However, field observations and interviews with traders in the regional markets indicate that the causal direction was from Addis Ababa market to the regional markets, the traders in the regional markets use Addis Ababa market price as their reference and consider their transfer cost in deciding what price to offer to the producers or other suppliers in their market. This observation also suggest causal direction from wholesale to producers in the local markets.

5.2.3. Grain Price Transmission in a Vertical Marketing System and Across Markets

Econometric tests of symmetric price relationships between possible pairs of price levels for a given market and between wholesale prices of Addis Ababa market and other markets having a causal relationship was conducted following the approaches discussed earlier. For the three cereals considered the null hypothesis of symmetric price transmission was not rejected in all cases (Table 24). Thus, the results indicate that there was a transmission of price changes in one level to another, cereal markets in Ethiopia were vertically integrated.

The results of the tests of symmetric price relationship between wholesale prices of white teff, white wheat and white maize for Addis Ababa and other selected markets are given in Table 25. The null hypothesis of symmetric spatial relationship between Addis Ababa and other markets wholesale prices was not rejected in all cases. This indicates that there was spatial integration of markets for the types of cereals considered, for those markets where causal relationship exists the change in Addis wholesale was also reflected in wholesale price changes at different other markets and vice versa.

Table 21. F-tests for Causal Relationship in White Teff Wholesale Prices Between Addis Ababa and Other Markets for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships															
	H_0: Addis wholesale price does not cause wholesale price of a given market (1 to 8 weeks lag)								H_0: A given market wholesale price does not cause Addis wholesale price (1 to 8 weeks lag)							
Markets	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Surplus markets																
Nazeret	2.38	1.79	1.10	2.89[2]	2.06[1]	2.29[1]	2.23[1]	1.94[1]	12.30[3]	3.92[2]	3.59[2]	4.03[3]	4.40[3]	3.86[3]	3.68[3]	5.27[3]
Ambo	1.92	1.10	1.02	1.04	0.72	0.83	0.79	0.66	8.89[3]	2.46[1]	1.76	2.04	1.53	1.62	1.18	1.00
Inchini	2.64	2.02	2.21	1.78	1.81	1.69	1.54	1.81	7.84[3]	2.32	1.28	0.93	0.92	0.65	0.63	0.37
Hosaenna	2.17	2.03	2.81[1]	2.26[1]	2.40[1]	1.39	1.23	1.06	19.60[3]	5.99[3]	3.04[2]	2.24[1]	1.82	1.99[1]	1.78	2.59[2]
Shambu	3.60[1]	1.20	0.44	0.46	0.63	0.57	0.64	0.55	3.45[1]	1.45	1.45	1.13	1.13	0.97	0.83	0.89
Jimma	14.14[3]	5.41[3]	1.63	1.50	1.10	1.29	1.05	1.26	3.11[1]	0.78	1.13	1.21	1.10	1.10	1.15	1.79
Deficit markets																
Shewarobit	1.55	1.81	2.78[1]	2.45[1]	5.25[3]	4.01[3]	3.15[2]	2.83[2]	2.38	0.82	1.30	0.98	1.99	1.75	1.72	1.51
Dire Dawa	5.23[2]	3.45[2]	5.12[3]	3.77[2]	4.50[3]	3.20[2]	2.58[2]	2.35[2]	0.01	2.64[1]	3.08[2]	2.70[2]	2.76[2]	3.38[2]	3.78[3]	2.37[2]
Mekele	6.34[2]	4.99[2]	2.05	1.55	0.86	0.75	0.81	0.96	0.66	4.22[2]	4.64[3]	3.98[3]	3.46[2]	3.28[2]	3.05[2]	2.39[2]
Alamata	2.36	1.18	0.91	0.55	1.17	1.24	0.91	0.77	6.48[2]	3.68[2]	1.12	1.26	1.31	0.94	1.16	0.83

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

Table 22. F-tests for Causal Relationship in White Wheat Wholesale Prices Between Addis Ababa and Other Markets for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships															
	H_o: Addis wholesale price does not cause wholesale price of a given market (1 to 8 weeks lag)								H_0: A given market wholesale price does not cause Addis wholesale price (1 to 8 weeks lag)							
Markets	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Surplus markets																
Nazeret	16.74[3]	7.04[3]	7.27[3]	5.08[3]	4.01[3]	3.01[2]	2.67[2]	2.05[1]	6.76[2]	3.14[1]	2.71[1]	3.21[1]	2.27[1]	1.80	1.39	1.13
Ambo	6.07[2]	2.64[1]	1.92	1.50	1.15	1.41	1.85	1.56	1.22	0.81	0.86	0.97	1.01	1.26	1.15	1.13
Inchini	9.80[3]	5.20[3]	4.00[2]	2.61[2]	1.37	1.58	1.50	1.96[1]	5.56[2]	2.89[1]	2.09	3.80[2]	2.62[2]	2.31[1]	1.88	1.83
Shashamane	14.99[3]	8.30[3]	8.20[3]	6.11[3]	4.60[3]	3.56[3]	2.79[2]	2.45[2]	0.59	0.32	2.17	1.18	1.58	1.86	1.46	1.85
Hosaenna	22.52[3]	13.02[3]	9.12[3]	7.75[3]	6.27[3]	4.70[3]	3.80[3]	3.08[2]	2.70	4.84[2]	7.19[3]	4.50[3]	4.42[3]	3.67[3]	3.25[2]	2.72[2]
Shambu	12.83[3]	8.41[3]	4.10[2]	3.32[2]	2.30[3]	1.59	1.42	2.03[1]	1.43	1.39	1.19	0.59	0.97	1.53	1.23	1.58
Jimma	10.33[3]	4.63[2]	3.60[2]	3.10[2]	2.24[1]	2.12[1]	1.95[1]	1.88	0.01	0.44	0.37	0.54	0.53	0.70	1.28	1.13
Deficit markets																
Dessie	10.29[3]	2.63[1]	3.52[2]	2.62[2]	1.91	1.61	1.66	2.48	1.44	1.01	0.77	2.18[1]	1.82	1.63	1.56	1.25
Dire Dawa	3.02[1]	2.67[1]	2.17	1.50	2.37[1]	1.92	2.34[2]	2.06[1]	1.07	0.58	0.26	0.18	0.24	0.30	0.28	0.32
Mekele	1.27	4.17[2]	3.71[2]	2.73[2]	2.69[2]	2.05[1]	2.42[2]	1.89	0.64	0.62	1.05	0.71	0.76	0.75	0.69	0.78

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

Table 23. F-tests for Causal Relationship in White Maize Wholesale Prices Between Addis Ababa and Other Markets for Different Markets in Ethiopia (August 1996 to July 1997)

	Causal relationships															
	H_o: Addis wholesale price does not cause wholesale price of a given market (1 to 8 weeks lag)								H_o: A given market wholesale price does not cause Addis wholesale price (1 to 8 weeks lags)							
Markets	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Surplus markets																
Shashamane	0.34	0.25	0.34	0.51	0.62	0.57	0.48	0.97	23,27	12,03	7.39[3]	6.89[3]	4.47[3]	3.73[3]	3.66[3]	3.65[3]
Dangila	8.00[3]	4.22[2]	3.50[2]	1.97	1.40	1.09	0.77	0.72	0.17	2.00	1.26	1.08	1.57	1.44	1.53	1.32
Nakempt	15.21[3]	7.90[3]	6.26[3]	5.42[3]	3.82[3]	2.68[2]	2.10[1]	1.84	0.47	0.92	0.60	2.15[1]	1.15	0.99	0.75	0.55
Shambu	7.83[3]	3.65[2]	3.11[2]	3.92[2]	3.06[2]	2.63[2]	2.18[1]	1.59	0.15	0.46	0.35	1.55	0.73	0.55	0.47	0.48
Deficit markets																
Dessie	6.23[2]	5.06[2]	4.15[2]	3.37[2]	5.13[3]	3.74[2]	3.36[2]	3.88[2]	0.09	0.67	1.37	0.25	0.17	0.97	2.95	2.98[2]
Shewarobit	2.82	1.38	3.34[2]	2.67[1]	1.87	1.45	1.23	2.44	3.62[1]	1.14	0.97	0.58	0.92	1.61	1.91	1.31
Dire Dawa	6.66[2]	3.13[1]	2.16	2.34[1]	2.52[2]	2.16[2]	1.82	2.16[1]	1.38	3.89[2]	2.53[1]	1.40	0.69	0.51	0.93	0.89
Mekele	1.52	1.24	1.58	0.35	0.46	0.44	0.35	0.37	1.29	0.85	0.73	0.65	0.67	1.46	1.10	1.07

Note: [1], [2] & [3] Indicate statistical significance at a probability of less than 10%, 5% and 1%, respectively.

Table 24. Tests of Symmetric Relationship Among Producer (P), Wholesale (W) and Retail (R) Prices for White Teff, White Wheat and Maize (August 1996 to July 1997)

	F-test statistics for the test of symmetric relationship among different market levels																	
	P➞W			W➞P			W➞R			R➞W			P ➞R			R➞P		
Markets	Teff	Wheat	Maize	Teff	Wheat	Maize	Teff	Wheat	Maize	Teff	Wheat	Maize	Teff	Wheat	Maize	Teff	Wheat	Maize
Surplus markets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ambo	-	-	-	-	-	-	0.01	-	-	-	-	-	0.16	-	-	-	-	-
Dangila	-	-	-	-	-	-		-	0.01	-	-	-		-	-	-	-	-
Hoosaenna	0.02	0.49	-	-	-	-	0.01	-	1.17	0.06	0.01	-	0.21	-	-	-	-	-
Inchini	0.31	-	-	0.86	-	-	0.40	-	-	-	-	-	-	-	-	0.73	-	-
Jimma	-	-	-	-	-	-	-	-	-	0.01		0.26		-	-	-	-	-
Metu	-	-	0.23	-	-	-	-	0.06	-	-	0.29	-	-	-	-	-	-	-
Nazeret	-	-	-			-	-	-	-	0.13	0.01	-	-	-	-	-	-	-
Shambu	-	-	-	-	-	-	-	0.32	-	-	-	-	-	0.07	0.16	-	-	0.20
Shashamane	-	-	2.10	0.17		0.38	-	-	0.08	-	-	0.01	0.38	-	1.41	0.83	-	0.26
Deficit markets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Addis Ababa	-	-	-	-	-	-	-	0.84	0.31	0.06	-	-	-	-	-	-	-	-
Alamata	0.53	-	-	0.09	-	-	-	-	-	--	-	-	-	-	-	-	-	-
Dessie	-	-	-	-	-	-	-	0.03	-	-	-	-	-	-	-	-	-	-
Dire Dawa	-	-	-	-	-	-	0.19	-	-	-	-	-	-	-	-	-	-	-
Mekele	-	-	-	-	0.01	-	0.03	0.37	1.13	0.45	-	-	-	-	-	-	-	-
Shewarobit	-	-	-	-	-	-	-	-	-	-	-	0.27	-	-	-	-	-	0.03

Table 25. Price Transmission[1] in White Teff, White Wheat and White Maize Wholesale Price Between Addis Ababa Market and Other Markets (August 1996 to July 1997)

	F-test statistics for the tests of symmetry of price transmission					
	Addis Ababa market to other markets			Other markets to Addis Ababa market		
Markets	Maize	Teff	Wheat	Maize	Teff	Wheat
Surplus markets						
Nazeret	-	0.61	0.05	-	0.11	0.83
Ambo	-	0.005	0.25	-	0.27	-
Inchini	-	-	0.50	-	0.023	0.97
Shashamane	-	-	0.034	0.44	-	-
Hosaenna	-	0.21	0.18	-	0.001	0.037
Dangila	0.04	-	-	-	-	-
Nakempt	0.099	-	-	-	-	-
Shambu	0.41	0.66	0.36	-	0.13	-
Jimma	-	0.20	0.087	-	0.42	-
Deficit markets	-	-	-	-	-	-
Dessie	0.48	-	1.64	0.61	-	0.29
Shewarobit	0.47	2.63	-	2.32	-	-
Dire Dawa	0.61	0.01	0.055	0.004	0.06	-
Mekele	-	0.03	0.095	-	0.17	-
Alamamta	-	-	-	-	0.03	-

Note: [1] For the analysis of price transmission four weeks lag period was assumed to capture the lead and lag relationships in price adjustment between two market levels.

"-" Indicates the F-test statistic is not computed due to insufficient number of observations or lack of causal relationship between the two price levels.

6. CONCLUSIONS AND POLICY IMPLICATIONS

The major objective of this study was to assess the performance of grain markets in Ethiopia at the individual market levels and for groups of markets which are spatially linked. By examining the nature of relationships among producer, wholesale, and retail prices in individual markets and among different markets, the study is also aimed at improving the understanding of the grain market operation under the emerging new grain market structure. Such information, can encourage informed policy debate and dialogue among planners, policy makers, researchers, NGO's and donor agencies and contributes toward the formulation of effective grain marketing policies. Various analytical techniques such as the descriptive assessment of the levels and volatilities of grain prices and price spreads and the econometric tests of price transmission within and across markets were used to assess the efficiency of vertical and spatial integration of grain markets in Ethiopia. The price analysis was also complemented by field level knowledge of the operation of grain markets in Ethiopia. The new Market Information System (MIS) price data base, which has been operational since August 96 by the Grain Market Research Project (GMRP) of the Ministry of Economic Development and Cooperation (MEDAC) was used.

The results indicate that the grain markets in Ethiopia exhibit a high degree of vertical and spatial integration. The study also demonstrates the usefulness of the new MIS price data base in understanding the operation of grain markets and in evaluating grain market performance. This section presents a brief discussions of the findings in light of their implications for policy formulations in the areas of price stabilization and food aid management. However, the interpretations of these results should be taken rather cautiously as the time frame used in this study was very short and similar follow-up studies are needed as the MIS price data base builds up. Some of the options available to improve the vertical and spatial integration of grain markets in Ethiopia are also highlighted.

- *Price stabilization*: Governments trying to stabilize prices are confronted with budget constraints to undertake the stabilization programs which highlights the importance of designing and implementing cost-effective stabilization programs. In this regard, the knowledge of the extent of vertical and spatial integration of grain markets is very crucial in making decisions regarding which prices (producer, wholesale and retail) and markets (all or few of them) to stabilize. The study indicated that grain markets in Ethiopia are integrated vertically and horizontally. The vertical integration of grain markets implies that if the government stabilizes producer prices the effects of stabilization can also be transmitted across wholesale and retail prices within a market. Under this condition, for example, the government can stabilize producer prices by stabilizing the wholesale prices and vice versa, then the government's decision as to which price level to stabilize depends on cost consideration and ease of implementing the program.

- On the other hand, the spatial integration of grain market implies that if the government intervenes in a given market the effects of government intervention in that particular market can also be transmitted across the markets which are spatially integrated. The important policy implications of this result is that it is not important

for the government to intervene in all markets, by just intervening in a few important markets, the government can stabilize prices in other regions.

- *Foodaid management:* Foodaid plays a key role in saving lives of people dying from famine resulting from drought or other catastrophes. However, when it is not well targeted to the people with no effective demand, foodaid depresses the producer prices in the local markets by increasing the supply of grain. The depressed prices disrupts the producers incentive to use productivity increasing modern technologies which negatively affects the long run development of foodaid recipient country. Thus, it is very essential that the governments pay careful attention in managing foodaid distribution. In this regard, understanding the nature of grain market integration provides useful insights in devising effective foodaid distirbution and utilization systems so as to minimize the negative impacts of foodaid. In general, grain markets in Ethiopia are spatially integrated which implies the effect of foodaid released in a given market can be transmitted across markets which are spatially integrated. In other words, the prices in surplus markets might be depressed to the extent that foodaid released reaches people with effective demand in grain deficit areas.

- *Improving the integration of grain markets:* The integration of grain markets plays a crucial role in improving the food security situations of a given country. If the markets are well-integrated, price signals direct the flow of grain, price increases resulting in supply shortfalls in a given market attracts grain flows from other markets where the prices are low thus reliving food shortages. The degree of market integration also determines the level of intervention required by the government to correct the inefficiencies in the grain market, the better the grain market integration the lesser is the intervention required by the government in the market.

- Even though, the grain markets studied appear to be integrated spatially there were high spatial price differentials. The inadequately developed marketing infrastructure might partly explain for the high spatial price differentials and improving the marketing infrastructure such as the transportation network, provision of storage facilities and market information service improves the spatial integration of markets. The vertical integration of grain markets at the individual markets level can also be improved by relaxing entry barriers to the grain trade and removing information asymmetry among various market participants.

- It was also observed that the spatial price differentials were characterized by high volatility which increases the risk of spatial arbitrage. The grain movement controls which have been implemented across different regions with different level of intensity, rules and regulations might explain the high level of spatial price spread volatility by creating uncertainties in the costs of moving grain across markets. Thus, abolishing grain movement controls or making it more transparent and uniform across the regions increases the integration of grain markets in Ethiopia.

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ANNEX 1

The first step, in using the polynomial distributed lag model, is to determine the lag length for the lagged independent variables and the degree of polynomial to be used. From the tests of causality four weeks lag was assumed generally for all cases as the most common lag length characterizing the lead and lag relationships between different price levels in the same market and eight weeks lag was assumed for the analysis of price transmission across markets linked spatially. Most commonly, a polynomial degree of 1 or 2 are used, if a polynomial degree of 1 is used it is assumed that the price responses are very immediate and if a polynomial degree of 2 is used the response peaks after certain time laps and the near and very far points have negligible effects. For this study, a polynomial degree of two was used. Thus, this analysis determines whether there is a symmetrical price relationships among different price levels in the same markets and across markets over four weeks period and across markets over eight weeks period.

The second step, after determining the lag length and the degree of polynomial, is to generate the polynomial distributed lagged (PDL) series. For example, assuming lag length of four weeks and a polynomial degree of two, the three PDL series (Z's) were generated for $CPPW_t$ as follows (Pindyck and Rubinfeld, 1991):

$$Z_{0t} = \sum_{i=0}^{4} CPPW_{t-i}$$

$$Z_{1t} = \sum_{i=0}^{4} i * \ CPPW_{t-i}$$

$$Z_{2t} = \sum_{i=0}^{4} i^2 * \ CPPW_{t-i}$$

Likewise, the PDL series (X's) for $CNPW_t$ were generated as follows:

$$X_{0t} = \sum_{i=0}^{4} CNPW_{t-i}$$

Then, the coefficients α_is and β_is of equation (4) were derived based on the coefficients σ_is

$$X_{1t} = \sum_{i=0}^{4} i * \ CNPW_{t-i}$$

$$X_{2t} = \sum_{i=0}^{4} i^2 * \ CNPW_{t-i}$$

and δ_is obtained by running the following OLS regression:

$$\Delta R_t = \phi T + \sigma_0 Z_{0t} + \sigma_1 Z_{1t} + \sigma_2 Z_{2t} + \delta_0 X_{0t} + \delta_1 X_{1t} + \delta_2 X_{2t} + \varepsilon_t$$

Where other variables are as defined before in the text, Z's are polynomial distributed lagged series generated for cumulative price increases in wholesale price series, X's are polynomial distributed lagged series generated for cumulative price decreases in wholesale price series, σ's are coefficients on Z's variables, δ's are coefficients on X's variables and ϵ_t is the disturbance term.

For example, the α_is for the current and lagged CPPW in equation (4) were obtained as follows:

$\alpha_0 = \sigma_0$
$\alpha_1 = \sigma_0 + \sigma_1 + \sigma_2$
$\alpha_2 = \sigma_0 + 2\sigma_1 + 4\sigma_2$
$\alpha_3 = \sigma_0 + 3\sigma_1 + 9\sigma_2$
$\alpha_4 = \sigma_0 + 4\sigma_1 + 16\sigma_2$

Similarly, the β_is coefficients for the current and lagged CNPW in equation (4) were obtained as follows:

$\beta_0 = \delta_0$
$\beta_1 = \delta_0 + \delta_1 + \delta_2$
$\beta_2 = \delta_0 + 2\,\delta_1 + 4\delta_2$
$\beta_3 = \delta_0 + 3\delta_1 + 9\delta_2$
$\beta_4 = \delta_0 + 4\delta_1 + 16\delta_2$

ANNEX 2

GRAIN MARKET RESEARCH PROJECT HOUSEHOLD SURVEY (1995/96 CROP YEAR): COMPARABILITY WITH CENTRAL STATISTICAL AUTHORITY AGRICULTURAL SURVEY (1995/96 CROP YEAR)

Jean Charles Le Vallée

The household-level analysis in this report is derived mainly from two sources. The Grain Market Research Project (GMRP) household survey, implemented in June 1996, and the Central Statistical Authority (CSA) Agricultural Survey, implemented in December 1995. The CSA survey is drawn from a nationally-representative sample of 14,800 households using the CSA sampling frame. The GMRP survey involved 4,218 households included in the CSA survey (hence the GMRP sample is a sub-sample of the CSA survey) and is also nationally-representative with respect to the major agricultural regions of the country, namely Tigray, Oromiya, Amhara, and Southern Regions. The following sub-regions are also considered nationally-representative: Tigray (Tigray); North and South Gonder,East and West Gojam, Agewawi, North and South Wello, Wag Hamra, North Shewa and Oromiya zone (Amhara); East and West Welega, Illubabor and Jima, North, East and West Shewa, Arsi, Bale, Borena, East and West Harerge and Somali (Oromiya); Yem, Keficho, Maji, Shekicho, Bench, North and South Omo, Derashe, Konso, Hadia, Kembata and Gurage, Sidama, Gedeo, Burhi and Amaro (Southern regions). The remaining smaller regions, Afar, Somali, Beni-Shangul and Gumuz, Gambella, Harari, Addis Ababa and Dire Dawa, do not contain sufficient observations for the survey to be considered strictly representative of their region.

The purpose of this annex is to present descriptive statistics on the comparability of key variables contained in the GMRP Household Survey (1995/96 crop year) and the CSA Agricultural Survey (1995/96 crop year). This annex focuses on three key variables in agricultural production: meher crop production, crop area cultivated, and household fertilizer use.

For grain crop production, there are three different national estimates available for the meher season: (a) farmer recall from the GMRP Household Survey; (b) farmer recall from the CSA Agricultural Survey; and (c) crop-cut estimates from the CSA Agricultural Survey (Table 1). Crop cutting involves direct physical measurement within the fields harvested while farmer recall estimates are obtained through surveying farmers after the crops have been harvested (1-2 months after in the case of the CSA Agricultural Survey and 4-5 months afterward in the case of the GMRP survey).

Table 2 shows the correlation coefficients of the three measures of production, with the household being the unit of observation. Strong correlations can be found between the GMRP and CSA farmer recall estimates, particularly for maize, wheat, barley and millet. Correlation coefficients are generally lower between the CSA crop-cut estimates and either the CSA or GMRP farmer recall estimates.

Table 1. National Meher Grain Production Estimates

Source of Estimate	Estimated Production (million metric tons)
GMRP Household Survey Farmer Recall	7.84
CSA Agricultural Survey Farmer Recall	8.51
CSA Agricultural Survey Crop-cut	9.27

As is the case with the CSA data, it is generally found that the measurement of production from crop cuts result in higher estimates than the estimates from farmer recall. A review of the empirical tests of crop-cut versus farmer recall data collection supports the conclusions that crop-cut estimates of production result in upward biases due to a combination of errors (Murphy et al. 1991, Poate and Casley 1985, Verma et al. 1988). These errors relate to biases resulting from poorly executed techniques (Rozelle 1991), large variances due to heterogeneity of crop conditions within farmer plots (Casley and Kumar 1988), and non-random location of sub-plots and tendencies to harvest crop-cut plots more thoroughly than farmers (Murphy et al. 1991). Verma et al. (1988) found that farmer estimates are closer to actual production (derived from weighing farmers' harvests) than crop-cut estimates. In general, tests of crop-cut estimates in Africa have been found to be overestimated by between 18% and 38% (Verma et al. 1988). Farmer recall was also found to result in a smaller variance in production estimates than crop-cut estimates. On the other hand, crop-cut estimates were found to provide more accurate measurements of crop yield.

Table 3 provides estimate of total cropped area by killil. Using the crop-cut method for estimating area, the results give 8 million hectares nationally for both sample sizes.

ANOVA tests were made on production and area data to see if the sub-sample (GMRP survey) was statistically different of the bigger sample size (CSA survey), in other words, if the sub-sample was representative of the bigger sample if randomly selected. At the national level and also at the regional level (i.e. killil), for all grains, we found no results that showed that these two sample sizes were significantly different at the 0.01 level: thus the sub-sample is representative of the bigger sample.

A comparison of mean household fertilizer use can be found in Table 4. Both sample sizes give very similar results.

Table 2. Correlation Coefficients of the Three Measures of Production

	Grain groups	GMRP production (FR)	CSA production (FR)	CSA production (CC)
Maize	GMRP production (FR)	1,000**		
	CSA production (FR)	,636**	1000	
	CSA production (CC)	,222**	,128**	1000
	Number of observations	2370	4352	4304
Wheat	GMRP production (FR)	1		
	CSA production (FR)	,702**	1000	
	CSA production (CC)	,228**	,269**	1,000
	Number of observations	1106	2101	2120
Teff	GMRP production (FR)	1,000		
	CSA production (FR)	,470**	1,000	
	CSA production (CC)	,384**	,285**	1000
	Number of observations	2112	4105	4044
Barley	GMRP production (FR)	1,000		
	CSA production (FR)	,676**	1,000	
	CSA production (CC)	,347**	,269**	1000
	Number of observations	1391	2637	2613
Sorghum	GMRP production (FR)	1,000		
	CSA production (FR)	,410**	1,000	
	CSA production (CC)	,423**	,333**	1000
	Number of observations	1852	3608	3552
Millet	GMRP production (FR)	1,000		
	CSA production (FR)	,622**	1,000	
	CSA production (CC)	,416**	,284**	1000
	Number of observations	424	822	806
Pulses	GMRP production (FR)	1000		
	CSA production (FR)	,200**	1,000	
	CSA production (CC)	,109**	,224**	1000
	Number of observations	1785	3354	3322
Oil seeds	GMRP production (FR)	1000		
	CSA production (FR)	,537**	1,000	
	CSA production (CC)	,369**	,103**	1,000
	Number of observations	666	1250	1193

** Correlation is significant at the 0.01 level (2-tailed).

Table 3. Total Crop Area Compared Between Both Surveys

Killil	Area (MHa) CSA Survey n=14512	Area (Mha) FSS Survey n= 3653
Tigray	481	484
Afar	24	21
Amhara	2938	3116
Oromiya	3617	3533
Somali	60	58
Benishangul	95	93
SNNPR	6978	7188
Gambela	101	39
Harari	44	45
Addis Ababa	98	96
Dire Dawa	74	59
Total	7.94	8.05

Table 4. Mean Percentage of Households Using Fertilizer by Killil

.

Killil	% hh fert use (CSA survey)	% hh fert use (GMRP Survey)
Tigray	45	40
Afar	13	3
Amhara	39	36
Oromiya	49	45
Somali	6	6
Benishangul	23	28
SNNPR	36	29
Gambela	0	0
Harari	81	83
Addis Ababa	97	79
Dire Dawa	34	29

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