PRICE DISCOVERY IN THE WHOLESALE MARKETS FOR MAIZE AND BEANS IN UGANDA

A Thesis

by

ANNETTE KUTEESA

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2005

Major Subject: Agricultural Economics

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Approved as to style and content by:

David A. Bessler (Chair of Committee)	Fredrick O. Boadu (Member)
Larry G. Gresham (Member)	John P. Nichols (Interim Head of Department)

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ABSTRACT

Price Discovery in the Wholesale Markets for Maize and Beans in Uganda.
(May 2005)
Annette Kuteesa, B.Sc., Makerere University Kampala (MUK), Uganda
Chair of Advisory Committte: Dr. David A. Bessler

Market information services established in 1999 were aimed at the promotion of market efficiency through provision of information across the nation. While the responsible bodies have improved the knowledge of prices, information exchange and flow, as a result of competition between markets, is not known and questions of market effectiveness still stand.

This study examines market efficiency based upon response to price signals across Ugandan markets. We focus on information exchange for maize and beans among 16 key markets. We study weekly price data from the first week of 2000 to the last week of 2003 from each of the sixteen markets. Each commodity is studied separately using Vector Autoregessions (VARs) and Directed Acyclic Graphs (DAGs). The two techniques are widely used to show market risk and causal relations in time series data. While results are presented individually for each commodity, the markets are comparable.

In determining market efficiency, we test for stationarity of the data, explore the magnitude of forecast error decompositions over time across markets, and observe the patterns of communication based on DAGs. We find that markets are more efficient in exchanging information on maize than beans. Communication of data is mostly between markets in eastern, western, and central parts of Uganda. Overall, markets are very slow in reacting to information in the short run.

Information from the Mbale and Iganga markets, which are located in areas of high production, is very valuable in the maize trade. However, of the two markets, it is data from the Mbale market, located near the border with Kenya, which is of paramount importance. Specifically, price is discovered in Mbale in the maize trade. Our results also show the Gulu market, which is situated in an insecure zone, to be very responsive to price signals over the long run.

In the case of beans, it is the price signals from Tororo and Jinja that cause more disruption in most of the markets. Price is discovered in these two markets. A majority of the markets is more affected by data from Jinja than Tororo. This segmentation in market price discovery suggests an existing market failure. Arua and Gulu are found to be the least responding markets in regards to price signals for beans. We do not find information from the Kampala market to be important in either the maize or beans trade.

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CHAPTER I

INTRODUCTION

1.1 Statement of the problem

Agriculture is at the center of Uganda's economy. The sector provides nearly all food needs and a majority of the employment. Almost half of gross domestic product (GDP) and much of export earnings come from agriculture. Following the market liberalization policies that occurred in the early 1990s, the country has continued to experience economic growth, some of which comes from agricultural trade (mostly exports).

Until recently, Uganda's agricultural policy was focused on world markets and potential commodities such as coffee, tobacco, cotton, tea and cut flowers. While gains[1] from these commodities rose, the level of poverty (specifically absolute poverty)[2] in the nation remained high. The country was forced to rethink its strategy towards agriculture to not only expand key exports, but also to commercialize the sector including rural areas and increase profits of the poor farmer.

In 1999 it was discovered that while production increased, markets were not responding to the changes in supply. One crucial need was provision of market information, which led to the founding of information bodies under the Institute of International Tropical Agriculture (IITA) and National Agricultural Advisory Services (NAADS). The two organizations collect and convey market information at national and local levels. The distribution of information has improved the knowledge of prices across markets. However, price discovery is not known and concerns of market efficiency across the country remain.

This thesis follows the style and format of the *American Journal of Agricultural Economics.*

[1] Gains are values from the Uganda Bureau of Statistics (UBOS).
[2] Morrissey, Rudaheranwa, and Moller (2003) discuss poverty with respect to coffee.

Agricultural price fluctuation in Uganda, like in many other Sub-Saharan countries, is well explained in terms of production patterns and in several cases is used to identify food deficit areas. Bean and maize price variations are not exempted from this judgment. The Famine Early Warning Systems (FEWS), for example, on many occasions cites supply changes in the two commodities as the leading cause of market price alterations. In the July 2000 monthly newsletter on food security and vulnerability in Uganda, maize prices were reported as high, implying reduced amounts and availability. In the same bulletin, an observed decline in the price of beans suggested increased quantities from the current harvest. Similar reasons are given in additional news reports (see FEWs; Uganda monthly reports 2000a,b,c, 2001a,b, 2002a,b,c,d, 2003a,b,c, 2004a,b; see also Muganga et al. market information service reports 3, 4, 5, and 6). Although the impact of local supply on market price cannot be denied, neither can the influence of price information from other markets. In the price discovery process, markets incorporate all new information turning it into price. Research reveals that when price information is conveyed, it induces competition between participants in the market (Schroeder, Ward, Mintert, and Peel, 1997). Their actions of buying and selling then alter price (this does not include issues of price determination which is only brought about by broad factors of supply and demand). In Uganda, market participants' actions are not tied to one market since information is communicated to and from other key markets across the nation. How relevant then are information signals from a particular market on price in other markets across the nation?

The maize and beans markets are important here because of the multiple roles they fulfill. The two foods are actively sold on the domestic market and have of lately found their way to the regional markets. Production of these crops is nationwide and is encouraged to further food security. Beans are consumed nearly every day by families, however maize is only a staple in the eastern region (Robbins and Ferris, 1999a). Government and the private sector's (non-government organizations) concern for these commodities has mostly been on production rather than marketing through provision of inputs, training, and supporting crop breeding research. Market reforms that have benefited these commodities include deregulation, improvement in the road transportation (seeWattman, 1999), and the recent market information service. Among the three reforms affecting market efficiency, it is the provision of information that can have a direct impact on its transparency and competition in the marketing of agricultural goods (see RATIN, www.ratin.net). Although the process of information dissemination is important, it does not demonstrate the existing price exchange and flow as brought about by competition between and among markets.

Knowledge of price translation of the two commodities across markets is more vital today because of rising cross border trade. Data from FEWS (http://www.fews.net) and Foodnet (http://www.foodnet.cgiar.org) concerning Uganda indicate that the trade has resulted in changes in price extending to inner markets such as Iganga and Kampala. While the gains or losses in prices are clearly observed in a particular market, its movement is still a mystery.

Uganda is faced with insecurity in parts of the north and to a minimal extent in some parts of the west, where traces of rebel activity still exist. The presence of war has been known to discourage trade (Reliefweb/USAID, 2004, http://www.reliefweb.int; FEWS 2002a, 2003a,c), hence, information exchange in these places. Yet markets in these areas have continued to be a target of Market Information Service (MIS) activities. What then is the role of these markets in the price discovery process of maize and beans?

Much of the empirical market research in Uganda has been directed towards market integration and traditional exports especially coffee (See Rapsomanikis, Hallam, and Conforti, 2003, 2004). It's only recently that maize has received attention under the subject (Rashid, 2002, 2004). However, similar attention to beans is not forthcoming. Even though these studies show that Ugandan markets are more integrated today than in the past and do identify important relationships, they never reveal market risk resulting from information exchange or nature of price discovery. Further, some studies such as the recent work of Rashid (2004) on the integration of maize markets have produced mixed findings, whereby causal results indicated the central market Kampala is not dominant in long run price formation, but coefficients of common integrating vectors suggest the opposite. Such results signify the need to further investigate the maize market. Exploring matters of price discovery will augment market research and help policy makers understand better some of the issues of market integration in Uganda.

1.2. Objectives of the study

The major aim is to make clear how domestic markets of maize and beans react to price information, specifically wholesale prices. Uncovering such knowledge is not only important to local individuals engaged in trade, but also to the private and government sector which have strongly advocated for production of these commodities and are involved in market restructuring.

The study proposes to:

1. explore the responsiveness of each market to price signals of maize and beans. Are markets slow or quick to translate information?
2. summarize dynamic relationships existing among markets in exchanging information in the short- and long-run periods.
3. identify significant markets influencing price of maize and beans over time and establish where price is discovered.

In investigating the above objectives, a combination of Vector Autoregressions (VARs) and Directed Acyclic Graphs (DAGs) econometric techniques are employed. Vector autoregressions (VARs) are widely applied in macroeconomic analysis with their use ranging from data description and forecasting to tests of fully specified models. The techniques have the ability to capture both short- and long-run dynamic relationships among markets while imposing minimal restrictions. Structural relationships between markets in contemporaneous time are determined through the use of directed acyclic graphs.

This section introduces and explains the nature and importance of the study. It puts forward the aims of this study and the methods through which they are attained. The rest of the investigation falls under four chapters. Chapter II presents the various aspects surrounding the Ugandan agricultural sector and talks about the production and marketing of maize and beans and their status in markets of our interest. The third chapter elaborates the methodology used in obtaining results and cites previous studies of where such methods have been used. The full discussion of the results is given in Chapter IV. Chapter V summarizes and concludes the findings of this study.

CHAPTER II

AGRICULTURE AND MARKET INFORMATION IN UGANDA

Agriculture production and marketing have long benefited Uganda's economy. This chapter presents Uganda as a country and describes important characteristics of its agricultural sector. Of importance to this study are two commodities, maize, and beans, we discuss how these are grown, and marketed. The country has taken on several market reforms. Market linearization is one of the reforms however; this discussion is directed towards domestic market information services as these have had a more impact on the trade of domestic commodities like those centered on in this study. In this chapter, markets of our interest are isolated and briefly described.

2.1 Overview of Uganda and agriculture

Uganda is a multicultural developing country found in the east of Africa. It is bordered by Kenya, Tanzania, Rwanda, the Democratic Republic of Congo, and the Sudan. The country covers 241,038sq km of space, of which 197,097sq km is land, and 43,941sq km is water, and swamp. It has a population of 25.4 million increasing at a rate of 3.4% per year (UBOS, 2003). GDP is $5.8 billion growing at 5.3% per year while per capita GDP is $1,260 growing at a rate of 1.8% per year (The World Bank Group, 2002; UBOS, 2003; Bartleby, 2003, www.bartleby.com)

The Ugandan economy is dominated by agriculture. The sector employs 80% of the population and provides services for various industries. For decades the industry has continued to highly contribute to the nation's GDP. In 2002 the sector accounted for approximately 40% of total GDP arising from exports (UBOS, 2003).

Agricultural production is rain fed and is done mainly for food. Food crops are cultivated on small size farms of less than 2 hectares (FAO, 1998). Key foods are the bananas, cassava, millet, beans, maize and Irish potatoes. Soybean, peas, rice, and sesame seed are minor crops. The share of food in Uganda's consumption expenditure is 46.6% (UBOS, 2003). Sometimes produce is sold to generate income. Production is carried out using simple tools of hoes; at times oxen ploughs and tractors are employed. Women and children provide most of the labor. The country also grows cash crops for export. Traditional cash crops are coffee, cotton, tea, and tobacco. Non-traditional crops include vanilla, cocoa beans, cut flowers, and roses. The latter have gained ground in recent years against the former in shares of exports due to increased world prices (Robbins and Ferris, 1999a). Fish, meat, and dairy products are also produced as sources of protein. Fish is another important export. In addition to the weather, productivity in Uganda is still constrained by the environment as whole. Among these constraints are access to land, low soil fertility, deforestation, pests, and diseases. Some of the other limitations include lack of modern farming methods, and access to credit; low prices for produce, high prices of inputs, poor roads and access to markets, illiteracy, and social problems such as weak and ineffective organizations (FAO, 1998; Europa, www.deluga.cec.eu.int).

The major importers of Uganda's produce are the European Union (EU) and the Common Market for East and Southern African (COMESA) countries. In 2002, the EU absorbed 33% and COMESA 23% of total value exports. Exports to Asia and North America are relatively small and constituted 9%, and 2%, respectively, in the same year. The United States receives 80% of total value exports to North America (UBOS, 2003). Currently, the country is taking advantage of the recently established African Growth and Opportunity Act (AGOA) trade agreement with the U.S. Uganda is also a member of the World Trade Organization (WTO).

Marketing in Uganda is influenced by information distributing organizations (see section 2.4). Also present is the Uganda National Bureau of Standards (UNBS), which regulates food quality of semi to fully processed agricultural foods. The Ministry of Agriculture

Animal Industry and Fisheries (MAAIF) Phytosanitary Department, monitors food standards destined for the export market. However, there are no uniform set standards on the domestic market. As a result, produce is sold in many forms, colors, and sizes.

Uganda's economy is considered a success with rapid agricultural growth. It owes much of this progress to the structural reforms of privatization and market liberalization that began in the 1990s (The World Bank Group, 2000).

2.2 Production and marketing of maize and beans

Beans and maize are widely produced in Uganda. Cultivation of the crops is being encouraged by government and non-government organizations for purposes of food security and income generation. Table 2.1 and figure 2.1 give the production of maize and beans in tonnes. The central region produces most of the beans, while the eastern region grows much of the maize in the country. The crops are grown in production plots that are mixed with other crops and also as pure stands. All production is dry land as opposed to irrigated. Because rainfall patterns are seasonal, production is as well. Production variability is thought to be the leading cause of price fluctuations.

Beans are sold as dry and fresh seeds and also as fresh pods. Maize is bought as dry seed, flour, and fresh and dry cobs. There are generally four types of markets facilitating trade including village, assembly, wholesale, and roadside markets. Village markets are a market outlet for local farmers and a source for local consumers and intermediary traders. About 3000 such markets exist in Uganda. Assembly markets are stations for lorry loads of produce and also function as retail centers. They are found in towns or villages by the roadsides. Wholesale markets are found in large urban towns. In these markets produce is graded and sold in large quantities to consumers, processors, and large traders for export. Roadside retail markets are another outlet for farmers. They are located near major roads. Weighing is mainly done in the urban and village centers in standard units of Kilogram. Other forms of measurement are buckets, tins, and cups used especially for the fresh produce. The products are usually marketed side by side; marketers who deal in maize will usually sell beans too (Robbins and Ferris, 1999a).

Table 2.1. Regional productions in tonnes for 2000

Crop	Central	Eastern	Western	Northern
Maize	151,078	407,672	123,599	56,828
Beans	150,129	91,136	194,911	59,477

Note: Production statistics are based on UBOS National Household Survey Report 99/00.

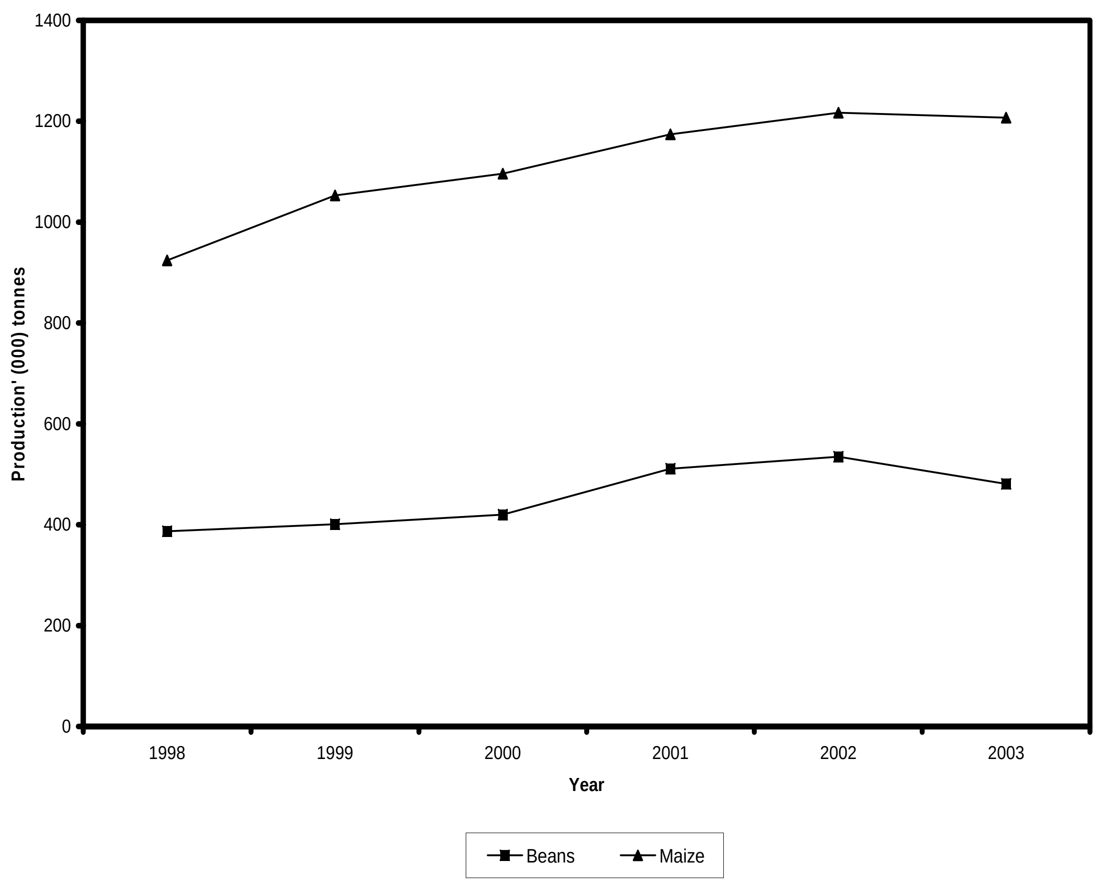

Figure 2.1. Production trend of maize and beans in Uganda 1998 to 2003.
Note: Production figures for 2002 are estimates and 2003 are projections and do not include post-harvest losses. Source: MAAIF and UBOS.

In Uganda, the marketing of maize and beans is in the hands of the private sector. Supply and demand forces move to set price. However, the impact of these forces is supplemented by donations (specifically maize) from the World Food Programme (WFP) to refugee camps in war torn areas. Trade in the commodities may be done by individuals, groups, or companies. Marketing at the farmers' level is less competitive than at the traders' level. Farmers and locals are encouraged to form groups to gain market power and reduce marketing costs. Traders buy produce from farmers, and transport and sell it to retailers usually at a fixed price. There exist itinerant traders who supply to the inactive traders. Prices are arrived at by bargaining. Also, retailers tend to collude and set a uniform price. There is some minimal speculation within the market where a few individuals hold the produce and release it once price rises. However this is trivial and has no apparent effect on prevailing price (Robbins and Ferris, 1999a).

Generally, the country lacks well developed storage facilities (FAO, 1998). Most of the produce is sold at harvest time. A few traders have silos for maize storage in urban centers. In the rural areas, maize can be kept in cribs. Standardization procedures are not enforced and quality may only be judged by observations and feel of hands.

Markets are accessed by roads using bicycles, vehicles, motor bicycles, and tractors. Commodities are also carried on the head or shoulders by locals to trading centers. Clear road communication networks exist between major urban towns, which make it possible for traders to access goods at any time. This is not necessarily so with market centers away from the main towns as the feeder roads and community roads tend to be impassable during the rainy seasons.

Currently, maize is exported to Kenya and Tanzania. In addition, the World Food Programme (WFP), the Red Cross, and the United Nations High Commission for Refugees (UNHCR) purchase considerable amounts of maize from the market. Beans are being exported to Kenya (RATIN, 2004, http://www.ratin.net; FEWS, 2004, http://www.fews.net). Although the two commodities score a place among exports, their contributions to GDP have not yet been isolated.

Beans and maize are cooked in the many forms that they are purchased except for dry maize seeds that are usually first turned into flour. Beans are a frequent sauce for households in Uganda. Maize is mostly common to homes in the eastern region where it featured as a staple, but is also eaten in smaller proportions by families elsewhere in the country. The police, hospitals, schools, and the army are reported to purchase and consume large amounts of these foods. According to Robbins and Ferris (1999a), maize is considered more of a cash than a food crop. Only 43% of total maize production in Uganda is eaten by households.

2.3 Insecurity

Production and marketing are affected by insecurity in the northern, eastern and western parts of Uganda (FEWS, 2002a, 2003a,c; Reliefweb/USAID, 2004, http://www.reliefweb.int). For over a decade, the northern region has experienced violence and war between the government and LRA rebels. The war has extended to some parts of eastern Uganda as well. In addition, the two regions are from time to time attacked by the Karamojong tribe that moves to and from the Kenya-Uganda border, raiding cattle and destroying crops. The conflict in western Uganda is linked to the ongoing fighting in the neighboring Democratic Republic of Congo (DRC) and although fighting is reported to have diminished during 2003, the area is still insecure. Uganda's neighbors, including Rwanda, the Sudan, and the DRC, are also involved in conflicts which have led to the influx of refugees in the country. This unsafe situation is blamed for a considerable level of poverty; since people can not cultivate food they ultimate do not have anything to sell to generate income. In reports by Reliefweb and USAID, markets are said to be the source of food to people in these areas. However, during periods of war it becomes risky for traders to carry out marketing activities and for individuals to purchase food. Food supplements are supplied by the World Food Programme (WFP).

2.4 Market information in Uganda

There have been a few organizations handling agricultural commodity market information. The National Agricultural Research Organization (NARO)/ Ministry of Agriculture Animal Industry and Fisheries (MAAIF) government market information service (MIS) existed prior to mid-1999 and was responsible for delivering information to district centers. Due to inefficiency the service was ended (Robbins and Ferris, 1999a).

The Agribusiness Development Centre (ADC) continues to deal with information on non- traditional agricultural exports (NTAEs) and aims to increase exports especially of maize, beans, cut flowers and vegetables. Through the regularly held meetings, it encourages exchange of information between government, traders, and farmers' union representatives.

The Institute of International Tropical Agriculture (IITA) and National Agricultural Advisory Services (NAADS) market information services (MIS) have recently formed and are in charge of the domestic market information. These information services came into being based on need to commercialize agriculture in the Plan for Modernization of Agriculture (PMA). PMA is directly connected to the Policy to Eradicate Absolute Poverty (PEAP) which aims to eliminate absolute poverty by 2017 (38% of the population in Uganda live on less than a dollar/day. A majority of these people deal in agriculture). Under the PMA, all participants involved with the domestic market should be able to access all relevant information needed for obtaining or delivering a good.

Prior to the establishment of these bodies, domestic agricultural markets were found to be uncompetitive and lacking in transparency in nearly six years after market deregulation. Farmers lacked information, and consequently, production was not a response to demand, nor were markets reacting to supply. In several instances, the farmers were receiving very low prices such as 84% less than the prevailing market price of their produce. In some areas people were ignorant of the existence of a market for their produce, and as a result produced only for subsistence use (Robbins and Ferris, 1999b).

Founded in 1999, IITA/MIS gathers and disseminates national market data, which is the interest of this study. The organization's objectives are to offer data about agricultural commodity markets to locals involved in market activities and for planning and food security. The body operates in several urban markets, 20 of which include Jinja, Kamuli, Iganga, Pallisa, Mbale, Soroti, Tororo, Kumi, Lira, Apac, Gulu, Arua, Mbabara, Masindi, Kasese, Kabale, Rwakai, Masaka, Kampala, and Luwero. Information in these town markets is assumed to be representative of their entire district.

NAADS/MIS deals with local market information services and targets rural areas, especially small traders and farmers. This organization works in six districts including Soroti, Tororo, Mukono, Kibale, Kabale, and Arua. Its role is to provide information on market trends, problems, and the basis for the ongoing market price. The end purpose is to enable farmers to gain bargaining power and take advantage of collective marketing.

Information gathered is that of commodity prices (off lorry, wholesale, retail), trade volumes, and quality of produce, weather conditions, market flow, and other important issues regarding markets. Intensity of collection may vary with size and activities in particular market or centre. Data is communicated through newspapers, radio, mobile phones, the internet, and fax. Radio information is communicated in local languages. Recipients of this information include individuals, various local, national, and international organizations, especially USAID's Famine Early Warning System (FEWS) and World Food Programme (WFP), which are responsible for monitoring food situations in countries. The two organizations use the data on important food prices, and supply and demand levels to help them achieve this goal.

Since IITA/MIS began its activities a little over four years ago, reports have been released concerning several of the named urban markets where price changes on a number of commodities have occurred due to improved communication. Although the exchange of information within a market is interesting, this study looks at information exchange among markets in relation to maize and beans. We center on sixteen of the twenty urban towns mentioned above. The four markets were left out because of lack of complete data sets for the four years. The selected markets and their status to maize and beans commodities are briefly described below:

2.4.1 Northern markets

The Arua market is located furthest in the northern part of the country. It serves a population of 881,500[3] persons living within the town of Arua. It is nearer to Gulu and Masindi than any other selected markets. Produce sold in the market comes mainly from Arua district and neighboring areas. This market is not known for large volumes of maize trade because the natives tend to grow more millet, and cassava, which constitute much of their diet. Beans are grown in smaller proportions.

The Gulu market is surrounded by insecurity, which limits supply of commodities from both within the district and nearby areas. A population of 478,300[3] found in Gulu town are the immediate beneficiary of the market's supplies. The Gulu market is more directly accessed by way of Masindi and Lira. The activities of the World Food Programme involving distribution of maize in the Gulu district have also caused market distortions.

[3] Statistics are from Uganda Bureau of Statistics, 2003

Lira is also found in the north of the country. Nearest markets are Gulu, Soroti, and Masindi. Although somewhat insecure, this market is known to be more active in the trade of maize and beans, unlike the first two markets. The town of Lira has population of 778,500[4] people that mainly rely on millet and cassava as their staples. Overall, markets in the north of the country are faced with the highest levels of poverty in the country, and at the same time they have poor road and market infrastructure.

2.4.2 Eastern markets

Soroti, Mbale, Tororo, Iganga, and Jinja are the eastern markets dealt with in this study. They are located in a region known to produce large quantities of maize in the country. With the exception of Soroti, all other markets are found in districts that consume a considerable amount of maize and beans. Soroti is located close to the Mbale and Lira markets and serves an immediate population of 387,100[3]. Traders in this market tend to trade more closely with the town of Mbale.

Mbale is one of the large markets in Uganda. A population of 738,400[3] persons live in the surrounding urban area. This market is located near the border with Kenya and tends to experience considerable cross border trade. It is known for large volumes of trade in maize, with the produce coming mainly from within the Mbale district and other areas, especially Jinja and Iganga districts. The district of Mbale also produces substantial amounts of maize, and beans. It is close to Soroti and Tororo markets.

Tororo market is similar to Mbale in that it experiences a lot of cross border trade with Kenya. The majority of the population that it serves carries out more trading than farming, and as result the locals tend to benefit from the food coming from surrounding areas. Its population size of the town of Tororo is 572,600[3] which directly benefits from the market's services.

The Iganga market is a relatively small but very active in maize trading, probably because it is located within the major maize producing district in Uganda. It is found in Iganga town which contains 734,300[3] people.

Jinja is another large market in terms of maize trade. This market is located in an industrialized district. Some of the industries therein utilize maize as a raw product. The Jinja district also produces large quantities of maize. There are 423,700[3] people living within the Jinja town. Of all eastern major markets, it is nearest to Kampala, the nation's capital city, and is the gateway to all other markets in that region. In several instances, traders from Kenya have bypassed Mbale and traveled down to Iganga and Jinja in search of maize.

2.4.3 Western markets

The Mbarara district is known for producing substantial amounts of beans consequently, the market is more active in the trading of the commodity than maize. The district also produces considerable quantities of maize. In addition, the market receives produce from other areas, especially from the nearby districts. It serves an immediate population of 1,112,200[3] in Mbarara town.

The Masindi market is found in Masindi town, which contains 488,600[3] people. It is nearer to the Luwero than to the Gulu and Lira markets. Many of the traders traveling to and from Arua, Gulu, and Lira pass near this market. Like in other markets, produce sold within Masindi market comes from the district and nearby area. Masindi district produces relatively high amounts of maize, and is frequented by traders especially in the second season. People living in this area feed mostly on millet cassava and beans.

Kasese is another market which experiences cross border trade; in this case between Uganda and the Democratic Republic of Congo. The town's population is 548,600[3]. In the past few years, the district has encountered insecurity originating from the DRC.

However, this is reported to have died down. To get to this town, one can pass through Masaka, Rwakai, and Mbarara. The Kasese market depends on produce from the district and surrouding areas.

Kabale is one of the poorer districts in Uganda. People here grow a lot more bananas, and beans than maize. As a result, the market deals more in the former two commodities than maize. The Kabale town has 475,200[3] people, who immediately profit from the market's services. This market is the nearest market to Rwanda. The western districts account for the highest level of beans production in the country.

2.4.4 Central markets

The Rwakai market serves a population of 478,000[3] people living in Rwakai town. The Rwakai district is known to grow more bananas than maize. The market gets maize and beans produce from within the district and other areas.

Masaka is a relatively large market. Traders here deal more in bananas than maize. The district also grows beans. Most of the traders traveling from Kampala to the named western towns, excluding Masindi or vice versa, pass near this town. The town contains 772,100[3] people.

The Kampala market supplies the capital city and is composed of several major market units found in divisions. Generally, it is known to be the largest wholesale market for either maize or beans. Kampala district has very little agriculture production, almost non-existent, and as such depends on food from other areas. The market serves a population of 1,244,400[3] in the town center. People in Kampala are multicultural and receive a higher standard of living than those in other towns. Bananas are the dominant food, but in the last few years, maize consumption has increased. Usually Kampala prices are higher than those in other markets. In addition, a particular type of price, for example the wholesale price, shows high variation from one market unit to the next.

Traders in Kampala take advantage of the consumer ignorance factor, and better standard of living of consumers when setting prices.

The Luwero market is relatively small. People living in the Luwero district grow maize, but not as much as in the eastern districts. The population is also poor. The market serves 484,100[3] people living in the surrounding urban center. Traders going to Masindi, Lira, Gulu, and Arua pass by this market.

In all of the above described markets, beans are planted within their districts of location although the level varies between them.

CHAPTER III

THEORY OF PROCEDURES AND APPLICATIONS

In this chapter we discuss the concepts behind the methods that were used in analysis of data. The vector autoregression (VAR) technique is introduced as a form of time series analysis. Vector autoregressions take on certain assumptions, we specify these and discuss data treatments to that must done to meet the set theory. We mention the means through which vector autoregressions reveal results and their interpretation. Directed Acyclic Graphs (DAG) is a more recently introduced analysis technique that has helped improve the performance of vector autoregressions in investigating data. In this chapter we center on the mechanism surrounding directed acyclic graphs that empowers it to yield graphs and their interpretation. To attach more meaning to the methods we end by presenting related literature where they have been applied to examine various situations.

3.1 Theory of procedures

3.1.1 Time series (TS) and vector autoregression (VAR) models

The capacity of vector autoregression (VAR) techniques to jointly investigate dynamic relations among a set of models in a vector has made them popular to econometricians. VARs are particularly desirable because of their ability to produce accurate forecasts with minimal restrictions, unlike other mechanisms.

Vector autoregression (VAR) models are built from simple time series models. In general, a time series model of a random variable y_t is dependent on its past values and the present and past values of its disturbance error term (ε_t) (Griffiths, Hill and Judge, 1993). A simple univariate model can be expressed as:

$$y_t = \partial + \theta_1 y_{t-1} + \theta_2 y_{t-2} + ...\theta_p y_{t-p} + \varepsilon_t$$

The error term ε_t has a mean of zero and variance σ_e^2. The above model is also called an autoregressive (AR) model of order *p*, where *p* represents the number of lags required to induce ε_t to be uncorrelated through time, $E(\varepsilon_t, \varepsilon_{t-k}) = 0$. A simple way of writing this is AR (*p*).

A VAR model is vector consisting of more than one such random variable. The model expresses the current values of endogenous variables as a function of the intercept and lagged values of endogenous variables. Each variable is allowed to affect every other variable in the system including itself based upon past values, which mechanism gives the dynamic nature of vector autoregression. For a simple illustration, take an example of two codependent endogenous random variables y_{t1} and y_{t2} that are jointly determined, where

$$y_{t1} = \alpha_1 + \alpha_2 y_{t2} + \alpha_3 y_{t-1,1} + e_{t1}$$

$$y_{t2} = \beta_1 + \beta_2 y_{t-1,1} + \beta_3 y_{t-1,2} + e_{t2},$$

Here α_i and β_i are parameters estimated by ordinary least squares regressions. For purpose of forecasting the above structural equations are reduced to the following forms:

$$y_{t1} = \pi_{11} + \pi_{12} y_{t-1,1} + \pi_{13} y_{t-1,2} + v_{t1}$$

$$y_{t2} = \pi_{21} + \pi_{22} y_{t-1,1} + \pi_{23} y_{t-1,2} + v_{t2}$$

These reduced-form equations makeup a vector autoregression model of order one that is VAR(1). As can be seen, the current values of the endogenous variables are a function of the intercept and lagged values of the endogenous variables. This VAR(1) model can easily be expressed as vector equation:

$$y_t = \delta + \theta y_{t-1} + v_t,$$

where $y_t = \begin{bmatrix} y_{t1} \\ y_{t2} \end{bmatrix}$ $\delta = \begin{bmatrix} \pi_{11} \\ \pi_{21} \end{bmatrix}$ $\theta = \begin{bmatrix} \pi_{12} & \pi_{13} \\ \pi_{22} & \pi_{23} \end{bmatrix}$ $v_t = \begin{bmatrix} v_{t1} \\ v_{t2} \end{bmatrix}$; and

v_t is the reduced error term.

The above expression is a vector autoregression model for bivariate observations (y_{t1}, y_{t2}). The VAR model can be expanded to include more p lags:

$$y_t = \delta + \theta_1 y_{t-1} + \theta_2 y_{t-2} + \ldots\ldots. + \theta_p y_{t-p} + v_t$$

VAR models are assumed stationary, meaning that they exhibit constant mean $E[y_t] = \mu$ over time and covariance matrix between vector y_t and y_{t+k} depend on only $k = (k = 0,1,2\ldots\ldots)$ and not on t. It is also assumed that the reduced errors have a mean $E[v_t] = 0$ and are uncorrelated, but contemporaneous covariance between them exists. Following the bivariate VAR(1) model we show covariance as:

$$\text{cov}(v_t) = \begin{bmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \end{bmatrix} = \begin{bmatrix} \text{var}(v_{t1}) & \text{cov}(v_{t1}, v_{t2}) \\ \text{cov}(v_{t2}, v_{t1}) & \text{var}(v_{t2}) \end{bmatrix},$$

where w_{12} is contemporaneous correlation between reduced-form error.

By taking on these assumptions, TS analysis disregards trends so data series should be checked for random walk and stationarity of θ matrices verified before proceeding with further analysis.

3.1.2 Determining stationarity

Time series data is not always stable. Data tend to wander off overtime leading to a non-constant mean, variance, and covariance of error terms. This condition is called non-stationarity and must be absent or eliminated in order to achieve appropriate results. The concept of stationarity of data technically includes the order of integration. Series are said to be integrated with order zero I(O) if found to be stationary, i.e., the error term about the mean. Non-stationary data has to be made stationary by taking differences (d). If only one difference is necessary to induce stationarity, the series is called I(1) and may be termed I(d), depending on the number of differences (d) that were taken to bring stability. Ordinarily, if y_t is the series then $y_t = \alpha y_{t-1} + \varepsilon_t$; if $|\alpha|$<0 then y_t is stationary I(0); if $|\alpha|=1$, y_t is non-stationary and I(1); and if $|\alpha|>1$, y_t wanders off and we need more than one difference to bring it to stationarity.

Formal tests for stationarity are the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF). The basis of these tests is the critical value of the t-statistic equal to -2.89 at the 5% level of significance for a large sample. This value was generated by Monte Carlo methods and takes on the null hypothesis that series are non-stationary, if the analysis returns a t-statistic value equal to or greater than the critical value. The null is rejected otherwise and the series confirmed stationary.

The Dickey Fuller (DF) test is applicable in the absence of a trend. Trended data series must be transformed by either estimation of time trend regression or taking differences. Discussion of either method, though interesting, is trivial in this study since raw data did not require detrending. The DF test is first carried out starting on actual data (y_t); if this is non-stationarity, then differences on the series are tested until a stable data set is attained. The equation for obtaining t-statistic (DF-value) for y_t is expressed as:

$$\Delta y_t = \beta_0 + \beta_1 y_{t-1},$$

where Δy_t is the first difference of series y_t , β_0 is the intercept, and β_1 is the estimated parameter for lagged y_{t-1}.

The Augmented Dickey-Fuller test searches for the presence of trend and importance of higher order lags and takes on the following form:

$$\Delta y_t = \beta_0 + \beta_1 y_{t-1} + \beta_3 T_t + \sum_{i=1}^{n} \sigma_i \Delta y_{t-i},$$

where β_3 is the slope parameter estimated for trend (T), while σ_i shows the significance of different higher order lags. This study uses both tests; outcomes are explained in the next chapter. It is important to note that stationary series in a market imply lack of market integration and non-stationary data signify market integration.

3.1.3 Selecting the number of lags

Because VARs utilize lags, it is crucial that the optimal number of lags for a model be determined. This study utilizes Schwarz Loss (SL) function as the tool for selecting lengths. The criterion was introduced by Schwarz (1978) and has performed very well in Monte Carlo studies. The preference for this measure is due to the fact that it is sensitive to and can greatly penalize coefficients of additional lagged variables in large samples unlike other measures like the Akaike Information Criterion (AIC). The Schwarz Loss function is symbolically represented as:

$$SL_m = \ln(\sigma_m^2) + [m(\ln(T))]/T,$$

where T represents sample size.

The Schwarz Loss value rises with an increase in m = number of βs, while holding T constant. The best model is that with the lowest Schwarz Loss value. In several studies (e.g. Bessler and Yang, 2003; Jerko, Mjelde and Bessler, 2004) the Schwarz Loss technique is used to support other tests. In this study Hannan and Quinn's Phi (Φ) criterion is used to confirm lag length selection. This is expressed as follows:

$$\text{Phi: } \log(RSS) + 2.01(K) \log(\log T)/T,$$

where (RSS) is the residual sum of squares, K is the number of regressors, and T is the number of observations.

The reason for choosing (Φ)is that it has shown to perform well in smaller samples (Binkley and Bessler, 1982). is that it performs well in smaller samples. The Schwarz Loss measure produces optimal results in large samples (in limit asymptotic samples). However, its performance in small samples is questionable. The use of the two techniques helps validate the correct lag.

3.1.4 Predictability among variables in a vector autoregression model

In 1969, Granger introduced the Granger causality test, which checks for prediction of variables based upon causal relations that exist between them and lagged variables in the

VAR model The test utilizes the F-values obtained using ordinary least squares regressions on levels of series (Granger, 1974 and 1980; Griffth, Hill and Judge, 1993). . In ascertaining causality that variable X Granger causes variable Y, the following equations can be specified:

$$Y_t = \alpha_{10} + \sum_{j=i}^{p} \alpha_{1j} Y_{t-j} + \varepsilon_{1t}$$

$$Y_t = \alpha_{20} + \sum_{j=1}^{p} \alpha_{2j} Y_{t-j} + \sum_{k=1}^{q} \beta_{2k} X_{t-k} + \varepsilon_{2t},$$

where α_{1j} and α_{2j} are parameters relating to Y_t and its lagged variables, β_{2k} are parameters relating to Y_t and past values of X_t, and ε_{1t} and ε_{2t} are white noise residuals.

The Granger causality test based on the above equations, assumes the null hypothesis that $\beta_{21} = \beta_{22} = ...\beta_{23} = 0$, simply stating that variable X does not Granger cause variable Y. The hypothesis can be confirmed by calculating the F-statistic using the following expression:

$$F^* = \frac{SSE_1 - SSE_2}{q} \Big/ \frac{SSE_2}{N - p - q - 1},$$

The SSE_1 and SSE_2 represent the sum of squared residuals from ordinary least squares of the first and second equations, respectively. N is the number of time series observations on Y_t. Under the null F* is distributed (q, N-p-q-1) degrees of freedom. The null is rejected for large values of F* or low values of associated levels of significance and variable X is said to Granger cause variable Y. This means that variable X helps predict variable Y. By establishing causality of variables, Granger's test has implications for short-and long-run dynamics. In this study, we determine predictability of sampled variables based on one lag in the VAR model.

3.1.5 Impulse response functions and forecast error variance decompositions

VAR results are visualized through impulse response functions (IRFs) and forecast error variance decompositions (FEVs), which summarize the dynamic interactions of variables in the system. The reason for this is that individual VAR coefficients are hard to interpret. Through the named mechanism, VAR forecasts extrapolate expected values of current and future values of each of the variables using observed lagged values of all variables, assuming no further shocks. The impulse response function (IRF) traces out the expected responses of current and future values of each of the variables to a shock in one of the VAR equations.

The forecast error variance decompositions (FEVs) provide the percentage of the variance of the error made in forecasting a variable at a given horizon due to a specific shock. According to Sims (1980) and Bessler (1984) relations among the modeled system's time series can be discerned using forecast error variance decompositions (FEV). This system of forecasted error variance disintegrations also brings to light the strength and dynamic timing (short and long run) of such a relation. Basically, if a large proportion of forecast error variance of a variable is accounted for by other variables in the VAR system, then that variable is endogenous. However, if most of the FEV decompositions are explained by that variable, then it is exogenous. Aspects of a variable leadership characteristic over other variables in the model deduced using FEVs are based on the preceding stated relations and also on the exogenous variable, accounting for more percentage error variance in the endogenous variable.

Residuals of VAR models are known to have the problem of orthogonalization, which can lead to obtaining suspect forecast error variance decompositions and impulse responses. This issue is solved by including outcomes of contemporaneous causal relations yielded through directed acyclic graphs (DAGs) analysis of variables in question.

3.2 Directed acyclic graphs (DAGs)

Direct acyclic graphs (DAGs) take on several forms of definitions, but more generally are illustrations showing causal flow among a set of variables. For a set of variables {A, B, C, D}, variable A causes variable B if the illustration shows A→B. If the picture shows that C—D, a relationship is said to exist between C and D, but one cannot tell which variable causes the other. Symbols → and — are called directed and undirected edges, respectively. Directed acyclic graphs have no direct cyclic paths, that is to say, no variable is repeated more than once.

The characteristic of DAGs that singles it out as a unique tool of analysis is that it takes advantage of the non-time sequence asymmetry in causal relation and does not assume a priori theory of structure models. The basis of this technique to assign causal flow is that of the d-separation (otherwise called screening off phenomena), which utilizes conditional independence between variables. This concept of assigning causal relations among three or more variables has just been recently introduced by Pearl, who in 1995 proposed d-separation as a graphical characterization of conditional independence and proceeded to give the following formal definition:

> ***Definition:*** *Let X, Y, and Z be three disjoint subsets of vertices in a directed acyclic graph G, and let p be any path between a vertex in X and a vertex in Y, where by "path" we mean any succession of edges regardless of their directions. Z is said to block p if there is a vertex w on p satisfying one of the following: (a) w has converging arrows along p, and neither w nor any of its descendants are on Z, or, (b) w does not have converging arrows along p, and w is in Z. Further, Z is said to d-separate X from Y on graph G written* $(X \perp Y / Z)_G$,*, if and only if Z blocks every path from a vertex in X to vertex in Y.*

Given a causal graph G, the d-separation principle will assist in deciding whether a set of variable X is independent of another set Y, given a third set Z.

In line with Pearl (1995), literature (e.g., Awokuse and Bessler, 2003; Vera, 2000; Kaloo, 2002) has maintained that "a directed acyclic graph is a design representing conditional independence as implied by recursive product decomposition:

$$pr(x_1, x_2, x_3, ..., x_n) = \prod_{i=1}^{n} pr(x_i / pa_i),$$

where pr is the probability of vertices $x_1, x_2, x_3 ....., x_n$ and pa_i is realization of some subset of the variable that precedes x_i in order (X_1, X_2, ……,X_n). The d-separation here characterizes the conditional independence relations given by the equation. If a directed acyclic graph is formulated in which the variables corresponding to pa_i are represented as the parent direct causes of xi, then the independencies implied by the equation can be read off the graph using the above notion of d-separation."

Spirtes, Glymour, and Scheines (2000) present a causal graph as pipeline carrying information. Their work shows the three forms of causal relations. If X, Y, and Z are vertices, then a variable is a collider if arrows converge into it; X→Y←Z (*inverted causal fork*). Here unconditional association (correlation) between X and Z is zero; i.e., the two variables are d-separated and no information can flow from one to the other. But if there is conditioning Y, then association between the X and Z is not zero. As put forward by Papineau (1985), a common effect does not screen off joint causes. If U, V, and W is another set of variables that is characterized by diverging arrows such that U←V→W (*causal fork*), then unconditional association between U and W is non-zero as since they are not d-separated. However, conditioning on V leads to zero association between the two variables; a common cause results in the screening off of its joint effects. For a set of variables I, J, and K such that the causal flow is I→ J→K (*causal chain*), conditioning on J will yield zero association between I and K, otherwise unconditional association between the two is not zero.

The principle of d-separation is applied in the PC algorithm (*marketed today as TETRDII software*), which builds directed graphs using the concept of sepset. PC algorithm was developed by Spirtes, Glymour, and Scheines. Basically it is an ordered set of commands which start with an unrestricted set of relationships and continues in a stepwise manner to finally assign causal flow among variables.

Concisely, the algorithm works by first forming an undirected graph (variables are connected by edges). Edges are then successively removed based on zero correlation or partial correlation (conditional correlation). The conditioning variable on removed edges between two variables is the sepset of variables whose edge has been removed (for vanishing zero order conditioning information the sepset is empty). Edges are directed in the following manner. Consider triples X-Y-Z such that X and Y are adjacent as are Y and Z, but X and Z are not adjacent. Direct edges as $X \rightarrow Y \leftarrow Z$ if Y is not in the sepset of X and Z. If $X \rightarrow Y$, Y and Z are adjacent, X and Z are not adjacent and there is no arrowhead at Y, then orient Y-Z as $Y \rightarrow Z$. If there is a directed path from X to Y and an edge between X and Y, then direct (X-Y) as $X \rightarrow Y$.

In constructing directed acyclic graphs, Fisher's z is used to test whether conditional correlations are significantly different from zero. The test is expressed as:

$$z(\rho(i,j|k)n = ½(n-|k|-3)^{½} \text{x}\ln\{(|1+\rho((i,j|k)|)\text{x}(|1+\rho((i,j|k)|)^{-1}\}.$$

Here n is the number of observations used to estimate the correlations, $\rho(i,j|k)$ is the population correlation between series i and j conditional on series k, and $|k|$ is the number of variables in k (that is conditioned on). If i,j and k are normally distributed and $r(i,j|k)$ is the sample correlation of i and j and k, then the distribution of $z(\rho(i,j|k)n)$- $z(\rho(i,j|k)n$ is standard normal.

3.3 Applications

One of the areas where vector autoregressions (VARs) and directed acyclic graphs (DAGs) are widely accepted instruments for uncovering information is that of market-price analysis. The methods have made clear how underlying factors operate within the market-price systems, shown consequences of new measures or intervention, and have furthered academic knowledge. Following their discovery, researchers have proceeded to apply one or both techniques to price analysis in almost every field, but especially in finance, economics, and agriculture. Although there have been a number of studies on price discovery, we are not aware of any literature where structural VARs and DAGs have been used for the cases of maize or beans. However, this does not hinder a review of literature regarding other commodities where the methods have been successfully used.

The efficiency of markets to search out information across time will depend on whether they are cash or futures markets. Generally, studies (e.g., Garbade and Silber, 1983) have shown that futures markets are more efficient in facilitating information flow over long periods. In empirical analysis of price discovery in the wheat futures markets, Yang and Leathum (1999) found that cash markets functioned poorly in discovering price in the long run. The study used VARs to investigate dynamic relationships of three futures markets. Results showed that the price discovery process was greatly influenced by the moderately sized market, the Kansas City Board of Trade. The study highlighted that presence of substitutes (other forms of wheat) and market size (volume of trade), when tied to the level of speculation, will influence information flow across markets.

A recent study of millet prices conducted by Bessler and Kergna (2002) is one of similar settings (Mali in West Africa). The study employed VARs and DAGs to examine dynamic interactions and causal relations of markets in Bamako. It was found that the wholesale market Niarela was highly exogenous, implying that it was the origin of price discovery and dominated the process in the long run. Also, many of the markets were not responsive to new information or perturbations. The suggested reason for this was the existence of a form of price leadership. However, the authors proposed further exploration of other influences including institutional arrangements, common ownership of supplies across markets, and long-term marketing agreements among wholesalers and retailers to help understand the non-responsiveness of several markets.

The role of cost transportation in price discovery is important. In answering questions of price discovery between spatially separated commodity markets and the transportation market linking them together, Bessler and Haigh (2002) employed DAGs and error correction models (ECMs). Their results revealed that transportation rates are critical in the price discovery process and that markets were highly interconnected with transportation and commodity export markets influencing (sending information to) the inland commodity market. However, there is a feedback effect on the transportation market from commodity markets over longer horizons.

Babula, Bessler, and Payne (2004) used vector autoregressions and directed acyclic graphs to investigate dynamic relationships among wheat- related markets. The impulse response functions suggested that wheat market shocks did not have noticeable effects on wheat based, value-added markets far downstream. However, forecast error variances (FEVs) decompositions clearly demonstrated that wheat market events have important effects on downstream markets over the long horizons beyond a crop cycle. FEVs also indicated that movements in downstream wheat-based markets had some important effects on the wheat market during the same long-run period.

The work of Yang and Bessler (2003) in analyzing the international price transmission in stock index futures markets challenges earlier findings (Eun and Shim ,1989) by demonstrating how Choleski results can be seriously misleading in innovation accounting analysis with the U.S. market placed near or at the top. U.S. and U.K. markets were found to share the price leadership role and European markets were greatly influenced by the German and U.K. market. DAG results from the study indicated the Japanese market to be isolated from all other markets.

Results from the VAR model used by Mjelde and Paggi (1989) to examine the relationship among domestic corn prices in Texas and Illinois and the New Orleans export price, showed that export price was influenced by corn prices of the two states.

Forecast error decompositions revealed that there was increasing exogeneity between the export price and Texas and Illinois corn markets.

Awokuse (1998) explored model identification and forecasting under structural break of macroeconomic variables, by substituting graph theory (directed acyclic graphs) for Choleski decompositions of VAR analysis. Models based on directed graphs were found to produce plausible inferences on the interaction among the macroeconomic variables. Forecasts from alternative models indicated that vector autoregression (VAR) in level specification is sometimes appropriate for modeling cointegrated data and that imposing cointegration restrictions on a VAR model does not always produce improved long-range forecasts.

When investigating the role of price discovery in the U.S Treasury market between orderly flow, liquidity, and yield curve, Brandt and Kavajecz (2002) utilized vector autoregressions (VARs). They found their results were consistent with the set hypothesis that in the absence of material public information flow, orderly flow imbalances account for a substantial portion of the day, fluctuations of yield curve and that the role of orderly flow depends on the liquidity in the Treasury market.

Bessler (1996) studied the gold exchange standard and its role in determining four agricultural commodity prices during a single year of the Great Depression. He investigated the theory that increases in prices in the United States could be achieved through the abandonment of the fixed gold standard. The study involved examining the relationships of variables using a VAR model. Based on results, it was discovered that gold price fluctuations did have strong effects on prices of cotton, corn, hog, and lard.

CHAPTER IV

RESULTS

4.1 Data

The study analyzes weekly prices of maize and beans from sixteen Ugandan markets, described in section 2.4, over the period of January 2000 to December 2003. All prices are averages of daily observations and measured in units of shillings. With the exception of Kampala, where off lorry prices are used, data from all other towns are wholesale prices. The choice of off-lorry over wholesale price of Kampala was based on argument from IITA/MIS that the latter was incomparable to prices of all other towns elsewhere in the country. Prices for the two commodities are studied separately. There were no data transformations; all information was used in its original form. Missing values were dealt with using the previous week's price. All empirical results of data were done using RATS software and contemporaneous results by Tetrad II software.

4.2. Summary statistics

Tables 4.1a and 4.1b present the summary statistics of maize and beans, respectively, over the entire period of 2000:1-2003:52. In the case of maize, the mean wholesale price is highest in the Arua market (at shs256.1), followed by Masaka, Luwero, and Mbarara. Arua is isolated from the rest of the other key markets and is surrounded by areas producing low quantities of maize, which could explain the elevated price. In general, high prices suggest insufficient maize reserves within these markets. The lowest mean price is shs191.6 in Masindi, followed by that in the Iganga and Gulu markets. Masindi is located in a district known to produce relatively substantial amounts of maize, which may explain the low price. While Arua has a high standard deviation, ranking second, its coefficient of variation (CV) is not as high (ranks 8). On the other hand, Masindi has a somewhat low standard deviation (73.0) ranking 10 and its coefficient of variation relatively high (ranks 4). The coefficient of variation (CV) demonstrates relative price deviation. The differences in price variation may be due to volume of trade, with Arua experiencing less trading activities than Mansindi.

Overall, Masaka experiences the highest price variation for maize, with the coefficient of variation and standard deviation ranks at 1. The elevated CV and standard deviation may suggest high trading activities in this market. The CV and standard deviation of the Gulu market are totally the opposite, ranking 16, which indicates that this market experiences the least amount of maize trading activities compared to other markets.

The highest wholesale mean price for beans occurs in Soroti. However, the market does not show much variation in price with the standard deviation and coefficient of variation at ranks 11 and 13, respectively. This implies minimal trade in this commodity within this particular market. Markets that have low mean prices are Rwakai (shs352.9) and Kasese (shs392.0), suggesting the presence substantial amounts for trade. In addition these markets have high price variation, indicating that there might be more trade for beans going on in these centers than elsewhere.

In comparing the two commodities, maize is observed to have more price variation than beans based on the coefficient of variation (CV), while wholesale mean price for beans is nearly twice as high as wholesale maize prices. This result suggests more trading activity in the maize commodity than beans. It should, however, be noted that these are deterministic results and can be inconclusive when dealing with price variation. This is because they only describe differences within, a particular market, but fall short of showing where that variation is coming from and do not take into consideration the time aspect. In other words, questions of whether the price difference in a market totally is brought about by that particular market or other markets, in part or in whole cannot be answered. Such information can only be provided by the dynamic results.

Table 4.1a: Summary statistics of the price of maize for 16 markets from 2000:1 to 2003:52

	Mean		SD		CV	
Market	**Mean**	**Rank**	**SD**	**Rank**	**CV**	**Rank**
Arua	256.1	1	92.1	2	0.360	8
Gulu	192.6	14	53.9	16	0.280	16
Iganga	192.5	15	70.9	12	0.368	7
Jinja	203.3	12	76.7	7	0.377	6
Kabale	220.1	5	69.7	14	0.317	15
Kasese	195.9	13	81.1	4	0.414	2
Lira	203.9	11	68.9	15	0.337	13
Luwero	231.2	3	77.2	6	0.333	12
Masaka	235.7	2	97.8	1	0.415	1
Masindi	191.6	16	73.0	10	0.381	4
Mbale	215.0	7	73.6	9	0.342	10
Mbarara	223.8	4	89.2	3	0.399	3
Rwakai	207.9	10	78.7	5	0.379	5
Soroti	211.3	9	75.4	8	0.357	9
Tororo	211.8	8	71.2	13	0.336	11
Kampala	218.8	6	71.3	11	0.326	14

Table 4.1b: Summary statistics of the price of beans for 16 markets from 2000:1 to 2003:52

	Mean		SD		CV	
Market	**Mean**	**Rank**	**SD**	**Rank**	**CV**	**Rank**
Arua	433.8	8	60.5	16	0.139	16
Gulu	416.9	11	86.6	13	0.208	12
Iganga	426.9	9	104.9	10	0.246	10
Jinja	440.2	4	111.0	4	0.252	7
Kabale	412.2	13	110.6	5	0.268	3
Kasese	392.0	15	128.8	1	0.329	1
Lira	447.2	3	99.4	12	0.222	11
Luwero	460.1	2	75.32	14	0.164	14
Masaka	397.1	14	106.0	8	0.267	4
Masindi	436.2	7	71.7	15	0.164	14
Mbale	420.5	10	106.1	7	0.252	7
Mbarara	412.3	12	105.5	9	0.256	6
Rwakai	352.9	16	111.9	3	0.317	2
Soroti	488.6	1	100.6	11	0.206	13
Tororo	438.2	5	114.5	2	0.261	5
Kampala	437.4	6	107.9	6	0.247	9

Notes to table 4.1a and 4.1b: The Mean refers to the simple average of the observed prices in each market for sample period 2000:1-2003:52. SD is the standard deviation related to price observations for each market. CV gives the coefficient of variation determined as SD/Mean. Ranks of means, standard deviation, and coefficient of variation are based on the number of markets. Scores are in descending order: that is from highest to the lowest. In table 4.1b, two markets take on the rank 7 and another two take on rank 14, so positions 8 and 15 do not exist.

4.3 Plots of the price of maize and beans

Plots of the maize and bean prices in the sixteen markets are given in figures 4.1 and 4.2. The graphs show no trend in data. They also show price oscillations in the markets over the whole sample period suggesting that there is on going trade in the two commodities.

4.4 Stationarity of data

Non-trended time series data are also known to exhibit random walks, whereby new information moves the series away from its historical mean over an extended time period. Therefore, the maize and beans data series of each of the sixteen markets are suspected to be non-stationary. The Dickey-Fuller (DF) test and Augmented Dickey Fuller (ADF) were used to test the null hypothesis that series are non-stationary, based on the equations presented in section 3.1.2. Results of the tests are presented in tables 4.2a and 4.2b.

The null was rejected if the associated t-statistic with β_1 was less than critical value -2.89 at the 5% level and the series are said to be stationary. However, if the associated t-statistic was greater or equal to the critical value, we failed to reject the null and the series are said to be non-stationary.

In reference to the DF test, nearly all maize price series are non-stationary, except, the Jinja, Kabale, and Kasese series. However, all t-statistic values for bean prices are less than the critical value -2.89, indicating that the series are stationary. The Q-statistic (Ljung Box) is associated with autocorrelation of the residuals of each series. Under the null hypothesis of uncorrelated residuals, it is asymptotically distributed with 36 degrees of freedom. The null is rejected for a high value of Q or low values of p (less than 0.05). We reject the null of white-noise residuals for the maize series of Kampala and Kabale, and also for the bean series of Masaka. We, however, fail to reject the null of white-noise residuals for all other series.

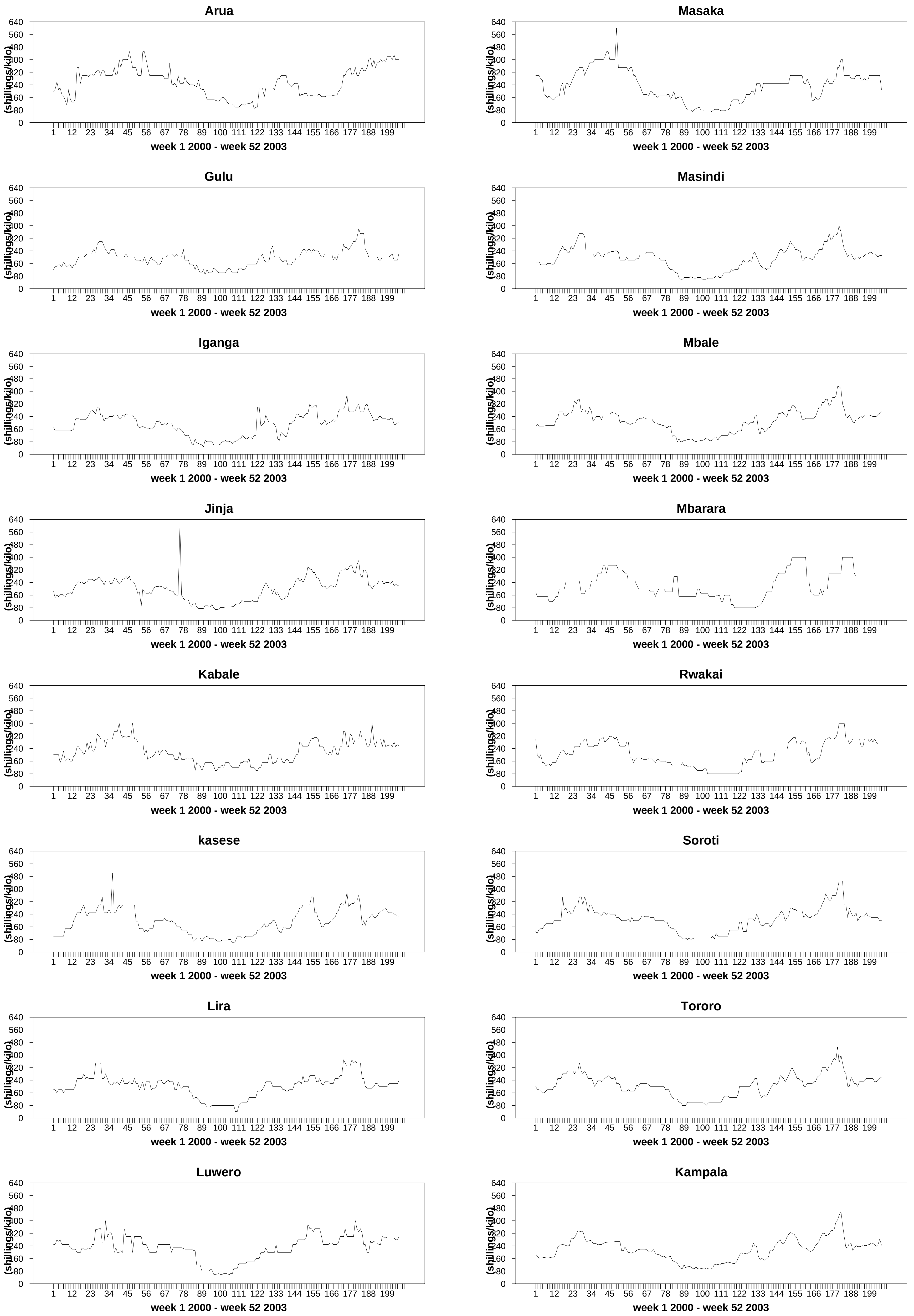

Figure 4.1. Prices of maize from 16 markets in Uganda, 2000 to 2003 weekly observations.

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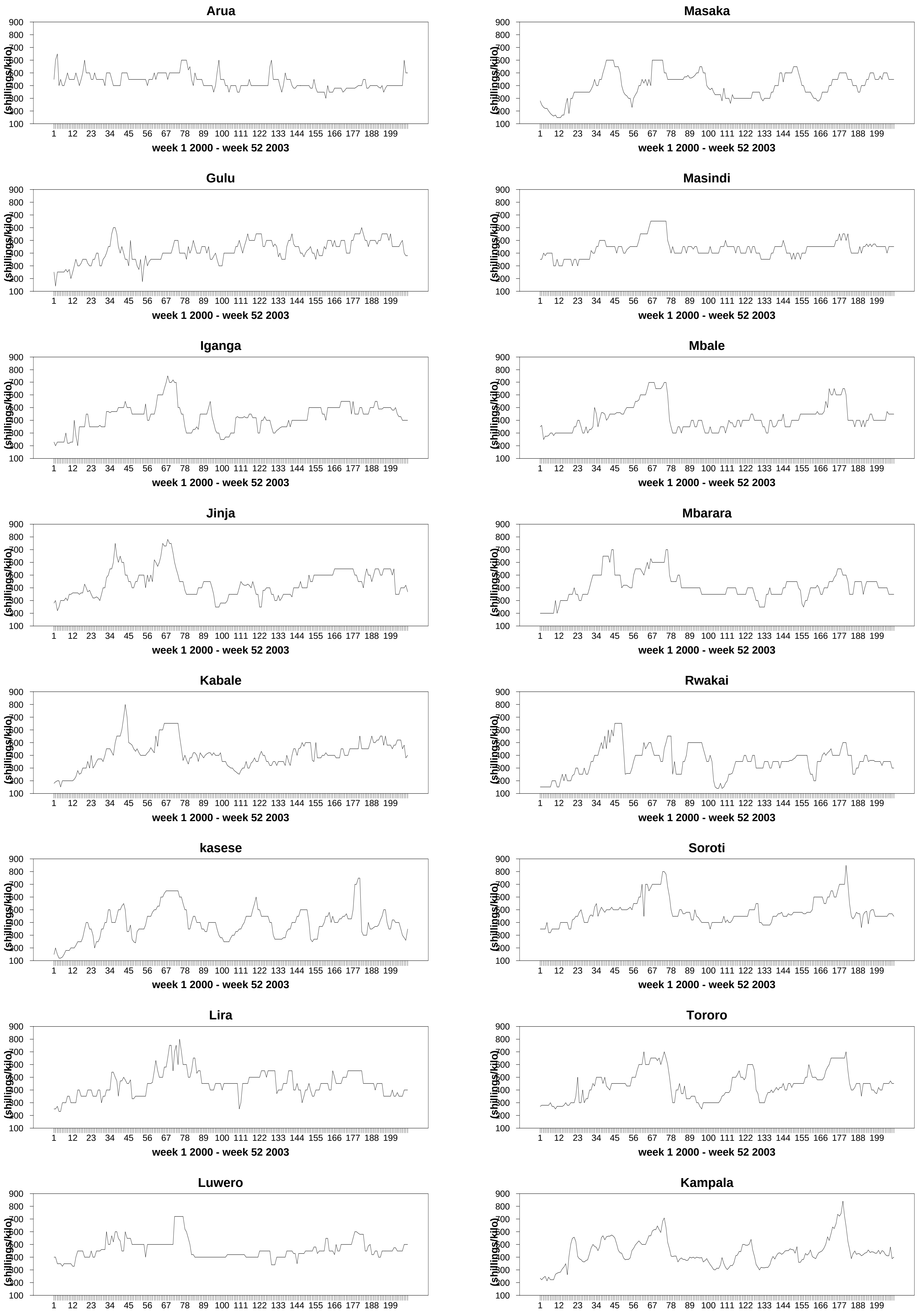

Figure 4.2. Prices of beans from 16 markets in Uganda, 2000 to 2003 weekly observations.

Table 4.2a. Tests of non-stationarity for the prices of maize from 16 markets from 2000:1 to 2003:52

	Dickey-Fuller (DF)				Augmented Dickey Fuller (ADF)				
Market	**t-stat**	**Q(36)**	**p-val**	**D**	**t-stat**	**k**	**Q(36)**	**p-val**	**D**
Arua	-2.44	28.73	0.80	F	-2.03	1	27.22	0.85	F
Gulu	-2.81	29.66	0.76	F	-2.65	1	28.88	0.79	F
Iganga	-2.69	43.90	0.17	F	-2.68	1	46.67	0.18	F
Jinja	-4.78	49.30	0.07	F	-2.26	3	17.20	1.00	F
Kabale	-3.34	55.13	0.02	R	-2.13	2	35.51	0.49	F
Kasese	-3.14	44.16	0.16	F	-2.34	1	31.43	0.69	F
Lira	-2.31	29.66	0.66	F	-2.11	1	30.05	0.75	F
Luwero	-2.78	50.11	0.06	F	-2.15	1	40.52	0.28	F
Masaka	-2.38	39.21	0.33	F	-1.89	1	34.66	0.53	F
Masindi	-1.91	48.04	0.90	F	-2.28	1	38.43	0.36	F
Mbale	-1.96	21.56	0.97	F	-1.19	2	18.50	0.99	F
Mbarara	-2.30	35.27	0.52	F	-2.32	1	34.79	0.52	F
Rwakai	-2.00	38.30	0.37	F	-2.07	1	38.28	0.37	F
Soroti	-2.45	27.59	0.84	F	-2.07	1	22.16	0.97	F
Tororo	-1.98	35.31	0.50	F	-2.02	1	35.01	0.51	F
Kampala	-1.83	57.22	0.01	R	-2.54	1	27.79	0.83	F

Table 4.2b. Tests of non-stationarity for the prices of beans from 16 markets from 2000:1 to 2003:52

	Dickey-Fuller (DF)				Augmented Dickey Fuller (ADF)				
Market	**t-stat**	**Q(36)**	**p-val**	**D**	**t-stat**	**k**	**Q(36)**	**p-val**	**D**
Arua	-5.42	27.02	0.86	F	-4.44	1	25.91	0.89	F
Gulu	-4.71	43.13	0.19	F	-3.97	1	37.5	0.40	F
Iganga	-3.67	40.26	0.29	F	-3.39	1	44.21	0.16	F
Jinja	-2.90	35.20	0.51	F	-2.27	1	34.67	0.53	F
Kabale	-3.58	38.83	0.34	F	-3.36	1	39.64	0.31	F
Kasese	-3.67	47.37	0.10	F	-4.26	1	35.59	0.49	F
Lira	-4.42	31.34	0.69	F	-3.07	2	24.24	0.93	F
Luwero	-4.00	40.12	0.29	F	-3.65	1	38.84	0.38	F
Masaka	-3.20	56.42	0.02	R	-3.68	3	30.89	0.71	F
Masindi	-3.48	34.38	0.55	F	-2.98	1	31.31	0.69	F
Mbale	-2.90	19.19	0.99	F	-2.95	1	19.88	0.99	F
Mbarara	-3.10	40.39	0.27	F	-3.17	1	39.63	0.31	F
Rwakai	-3.73	37.91	0.38	F	-4.23	2	21.36	0.97	F
Soroti	-3.61	26.40	0.88	F	-3.15	1	24.24	0.93	F
Tororo	-3.13	27.88	0.83	F	-3.04	1	27.74	0.84	F
Kampala	-2.97	37.11	0.42	F	-3.54	1	25.73	0.90	F

Note to table 4.2a and 4.2b: Columns 1-4 fall under DF test and columns 5-9 are under the ADF test. Column D shows the decision for white noise with F for fail to reject and R for reject the null hypothesis.

The t-statistic values for the ADF in the case of the maize series are greater than the critical value. Thus, we fail to reject the null that the series are non-stationary. Mbale shows the highest deviation from stationarity. All bean series except Jinja are observed to be stationary (I(0)), based upon the t-statistic values in table 5 when compared with the critical value. The lack of stationarity in the maize series suggests integration of the market with respect to this commodity. However, this is not so with the beans price except that from Jinja. Therefore, we expect this market to be more active in exchanging information on maize than beans. In addition, non-stationarity of the data, calls for taking differences (d), but since variations are small between series, we ignore the action considering that it would further complicate our analysis. We choose a levels VAR instead of a differenced VAR.

We fail to reject the null for white noise in all series under the ADF meaning that all residuals are white noise. Included in the ADF test is the number of lags k of the dependent variable that minimized the Schwarz loss in the ADF regression. In obtaining k, one to four lags of the dependent variable were employed in the ADF regression. The suitable k was selected if the regression returned the least Schwarz Loss value. The Schwarz loss value was minimized at the lags listed in column k for maize and beans, respectively. Because these ADF test results show data that is white noise, we carry on with both the maize and bean series in dynamic analysis.

4.5 Lag length selection

Dynamic analysis using a vector autoregression model requires it be constructed using the correct number of lags. We determined the optimal number of lags using the Schwarz Loss function (SL) and Hannan and Quinn's Phi criterion described earlier in chapter III. Table 4.3 gives the results of lag length selection for the maize and beans observations. The best lag is one, where both the Schwarz Loss and Phi are minimized, which implies that our VAR model is lagged one period.

Table 4.3. Selection of lag length for the maize and beans series using Schwarz Loss (SL) and Hannan and Quinn's Phi

	Maize		Beans	
Lags	**Schwarz loss**	**Phi-value**	**Schwarz loss**	**Phi-value**
0	111.8994	111.7432	130.9046	130.7483
1	104.0214	101.5696	121.8948	119.4430
2	108.4491	103.6897	127.0601	122.3007
3	113.1714	106.1044	131.3380	124.2710
4	117.5702	108.1957	136.0808	126.7063
5	121.9203	110.2383	140.2782	128.5961
6	125.9367	111.9471	144.1393	130.1497
7	129.0864	112.7892	147.4555	131.1583
8	131.6607	113.0559	150.3397	131.7349
9	132.9667	112.0544	151.6617	130.7493
10	132.8506	109.6307	150.5634	127.3435

4.6 Dynamic results

Findings include Granger's causality tests among markets, directed acyclic results forecast error decompositions, and impulse response functions. These results for the maize and beans observations from 2000:1 to 2003:52 were generated separately through ordinary least squares (OLS) estimation of the following VAR model:

$$X_t = \beta_0 + \beta_{j,x1}\, PARU_{(t-1)} + \beta_{j,x2}\, PGUL_{(t-1)} + \beta_{j,x3}\, PIGA_{(t-1)} + \beta_{j,x4}\, PJIN_{(t-1)} + \beta_{j,x5} PKAB_{(t-1)} + \beta_{j,x6}\, PKAS_{(t-1)} + \beta_{j,x7}\, PLRA_{(t-1)} + \beta_{j,x8}\, PLUW_{(t-1)} + \beta_{j,x9}\, PMAS_{(t-1)} + \beta_{j,x10}\, PMDI_{(t-1)} + \beta_{j,x11}\, PMBL_{(t-1)} + \beta_{j,x12}\, PMBR_{(t-1)} + \beta_{j,x13}\, PRWA_{(t-1)} + \beta_{j,x14}\, PSOR_{(t-1)} + \beta_{j,x15}\, PTOR_{(t-1)} + \beta_{j,x16}\, PKAM_{(t-1)} + \varepsilon_j(t),$$

where X_t takes on the price observations of Arua (PARU), Gulu (PGUL), Iganga (PIGA), Jinja (PJIN), Kabale (PKAB), Kasese (PKAS), Lira (PLRA), Masaka (PMAS), Masindi (PMDI), Mbale (PMBL), Mbarara (PMBR), Rwakai (PRWA), Soroti (PSOR), Tororo (PTOR) and Kampala (PKAM), ordered 1 to 16; β_0 is the intercept, while β is the coefficient associated with changes in current observations to changes in the lagged variables; εt is the white noise residuals, t is the current period, and t-1 is the observation lagged one week.

Construction of the above model is based on the findings in section 4.5. Incorporated into the VAR models are causal orderings in contemporaneous time from figure 4.5 for the case maize and figure 4.6 in the case of beans to ensure that simulation of the model generates impulse response functions and forecast error decompositions representative of observed market relationships.

4.6.1 Testing for the dynamic pattern among variables

Tables 4.4a and 4.4b show the levels of significance associated with F-tests on the βs in the above model for each of sixteen price series for maize and beans, respectively. Contemporaneous information in the regression was excluded when obtaining the values. Levels of significance were chosen over direct F-tests because they are easier to interpret. These figures test βs for the null that lagged variables do not Granger cause the given current market price. We reject low significance levels (below 0.05) and accept the alternative that the lagged price variables do Granger cause the linked current price. In general, the best lagged variable predictors of current price are those whose level of significance is zero.

From table 4.4a regarding maize prices, the lagged price which best predicts (based on zero) the prevailing price in Arua is from Arua; in Gulu is from Gulu and Kampala; in Iganga is Iganga and Mbale; in Jinja is from Iganga; in Kabale is from Kabale and Kasese; in Kasese is from Kasese; in Lira is from Lira and Mbale; in Luwero is from Luwero; in Masaka is from Masaka; in Masindi is from Lira, Masindi, Mbale, Rwakai and Soroti; in Mbale is from Mbale; in Mbarara is from Mbarara and Kampala; in Soroti is from Mbale and Soroti; in Tororo is Mbale and Tororo; and that in Kampala is from Kampala and Mbale markets. Clearly it can be seen that previous price information from Mbale will significantly affect more markets than any data from other markets. The Mbale market is located near the border of Kenya, which is the largest consumer of maize from Uganda. In addition, market is found in one of the districts that produce high quantities of maize. This finding suggests frequent trading activity between this market and other markets.

It can also be observed that the Luwero maize market price exhibits exogeneity among the sixteen series. It is the only market price Granger caused by its past prices. Only last week's prices of the Luwero market will help predict its current maize price. Notice that this market, although it had a high mean (refer to table 4.1a), showed a low CV value suggesting low trading activity in maize.

The Masindi maize market appears to be the most affected by past prices in other markets although the level of their impact varies. Masindi's current maize price is Granger caused by past prices of seven other markets namely Gulu, Iganga, Lira, Mbale Rwakai, Soroti and Kampala. This is one of the markets, which indicate a high CV value, suggesting substantial trade in this commodity. Second to this is the price of Mbale, Tororo, and Kasese. All three markets are near the border.

Jinja is maize price is the only market price observed to be endogenous. This market's current price is Granger caused by past information from other markets, including Iganga and Kasese. This implies that previous observations of the Jinja maize price are not that significant in predicting that market's current price.

Past maize price information from the Kampala can be seen to affect more markets including Gulu, Lira, Masindi, Mbale, Mbarara, Rwakai, and Tororo. Concisely, it has a more diverse impact on the market. However, its coefficients show a lower impact compared to those of the Mbale market on the whole. This wide effect could be because Kampala is the capital city and depends on food from elsewhere in the country. Granger's tests also show a lot of feed back relationships, especially in markets that are in close proximity with each other, suggesting that there is forth and back flow of information between markets.

Table 4.4a: Levels of significance associated with the F-test on each maize price series in the equation of VAR(1) model

Lagged variable	Equation															
	PARU	PGUL	PIGA	PJIN	PKAB	PKAS	PLRA	PLUW	PMAS	PMDI	PMBL	PMBR	PRWA	PSOR	PTOR	PKAM
PARU	0.00*	0.44	0.25	0.69	0.56	1.00	0.89	0.63	0.06	0.05	0.58	0.46	0.00*	0.67	0.40	0.99
PGUL	0.12	0.00*	0.70	0.69	0.53	0.01*	0.07	0.77	0.18	0.02*	0.02*	0.97	0.67	0.63	0.02*	0.02*
PIGA	0.02*	0.76	0.00*	0.00*	0.18	0.04*	0.55	0.64	0.51	0.01*	0.40	0.18	0.30	0.86	0.45	0.22
PJIN	0.23	0.86	0.13	0.18	0.38	0.47	0.98	0.95	0.53	0.44	0.28	0.08	0.72	0.26	0.05	0.77
PKAB	0.90	0.78	0.72	0.44	0.00*	0.01*	0.12	0.50	0.02*	0.14	0.62	0.14	0.18	0.55	0.04	0.52
PKAS	0.51	0.43	0.79	0.02*	0.00*	0.00*	0.83	0.50	0.66	0.56	0.13	0.25	0.26	0.67	0.02*	0.03*
PLRA	0.97	0.27	0.66	0.16	0.28	0.10	0.00*	0.61	0.13	0.00*	0.03*	0.87	0.05	0.13	0.17	0.38
PLUW	0.77	0.16	0.63	0.36	0.26	0.16	0.10	0.00*	0.42	0.98	1.00	0.88	0.47	0.96	0.04*	0.75
PMAS	0.18	0.22	0.11	0.20	0.20	0.73	0.48	0.20	0.00*	0.28	0.37	0.47	0.96	0.86	0.05	0.49
PMDI	0.84	0.27	0.11	0.29	1.00	0.03*	0.01*	0.44	0.81	0.00*	0.69	0.05	0.09	0.17	0.06	0.86
PMBL	0.62	0.10	0.00*	0.06	0.41	0.86	0.00*	0.09	0.06	0.00*	0.00*	0.53	0.22	0.00*	0.00*	0.00*
PMBR	0.05	0.57	0.86	0.13	0.04*	0.03	0.08	0.48	0.55	0.45	0.66	0.00*	0.48	0.15	0.72	0.76
PRWA	0.08	0.56	0.13	0.93	0.46	0.68	0.53	0.10	0.83	0.00*	0.24	0.19	0.00*	0.96	0.41	0.12
PSOR	0.21	0.05	0.09	0.33	1.00	0.30	0.98	0.94	0.22	0.00*	0.02*	0.73	0.80	0.00*	0.17	0.26
PTOR	0.88	0.92	0.69	0.26	0.68	0.11	0.15	0.18	1.00	0.86	0.04*	0.27	0.05	0.33	0.00*	0.59
PKAM	0.48	0.00*	0.45	0.58	0.52	0.38	0.04*	0.29	0.67	0.01*	0.01*	0.00*	0.00*	0.11	0.01*	0.00*

Notes: PARU = prices in Arua; PGUL= prices in Gulu; PIGA= prices in Iganga; PJIN= prices in Jinja; PKAB= prices in Kabale; PKAS= prices in Kasese; PLRA= prices in Lira; PMAS= prices in Masaka; PMDI = prices in Masindi; PMBL = prices in Mbale; PMBR= prices in Mbarara; PRWA= Rwakai; PSOR= prices in Soroti; PTOR= prices in Tororo and PKAM =Prices in Kampala
Asterisk (*) represents the rejected levels of significance for the respective F-tests.

Table 4.4b: Levels of significance associated with the F-test on each beans price series in the equation of VAR(1) model

Lagged variable	Equation															
	PARU	**PGUL**	**PIGA**	**PJIN**	**PKAB**	**PKAS**	**PLRA**	**PLUW**	**PMAS**	**PMDI**	**PMBL**	**PMBR**	**PRWA**	**PSOR**	**PTOR**	**PKAM**
PARU	0.00*	0.02	0.22	0.55	0.04	0.70	0.01*	0.65	0.81	0.75	0.47	0.57	0.34	0.74	0.05	0.56
PGUL	0.06	0.00*	0.60	0.60	0.27	0.60	0.55	0.69	0.63	0.18	0.01*	0.02*	0.74	0.38	0.91	0.99
PIGA	0.96	0.92	0.00*	0.06	0.00*	0.80	0.09	0.55	0.74	0.79	0.12	0.02*	0.14	0.12	0.25	0.41
PJIN	0.14	0.21	0.00*	0.00*	0.00*	0.02*	0.74	0.54	0.28	0.22	0.11	0.00*	0.52	0.93	0.65	0.01*
PKAB	0.77	0.68	0.04*	1.00	0.02*	0.02*	0.45	0.95	0.21	0.14	0.44	0.01*	0.77	0.08	0.59	0.48
PKAS	0.17	0.04*	0.91	0.09	0.02	0.00*	0.13	0.15	0.23	0.34	0.16	0.15	0.69	0.04	0.81	0.42
PLRA	0.38	0.08	0.41	0.04*	0.16	0.54	0.00*	0.17	0.23	0.27	0.48	0.21	0.56	0.66	0.66	0.48
PLUW	0.05	0.37	0.13	0.08	0.06	0.69	0.07	0.00*	0.22	0.28	0.74	0.20	0.12	0.08	0.86	0.52
PMAS	0.48	0.26	0.92	0.08	0.02*	0.30	0.83	0.59	0.00*	0.96	0.35	0.18	1.00	0.73	0.05	0.65
PMDI	0.67	0.56	0.20	0.14	0.35	0.00*	0.02*	0.05	0.20	0.00*	0.06	0.00*	0.44	0.71	0.64	0.27
PMBL	0.41	0.04*	0.75	0.54	0.76	0.93	0.67	0.36	0.30	0.00*	0.00*	0.19	0.63	0.00*	0.00*	0.11
PMBR	0.08	0.10	0.97	0.00*	1.00	0.34	0.43	0.07	0.17	0.43	0.36	0.00*	0.00*	1.00	0.82	0.33
PRWA	0.40	0.12	0.54	0.88	0.40	0.35	0.64	0.67	0.18	0.05*	0.44	0.70	0.00*	0.03*	0.11	0.11
PSOR	0.66	0.48	0.73	0.98	0.02*	0.00*	0.46	0.61	0.01*	0.61	0.95	0.10	0.23	0.00*	0.04*	0.04*
PTOR	0.08	0.05	0.11	0.01*	0.85	0.45	0.01*	0.96	0.14	0.82	0.06	0.76	0.17	0.17	0.00*	0.76
PKAM	0.14	0.83	0.67	0.18	0.33	0.00*	0.54	0.01*	0.00*	0.33	0.00*	0.00*	0.05	0.01*	0.00*	0.00*

Notes: PARU = prices in Arua; PGUL= prices in Gulu; PIGA= prices in Iganga; PJIN= prices in Jinja; PKAB= prices in Kabale; PKAS= prices in Kasese; PLRA= prices in Lira; PMAS= prices in Masaka; PMDI = prices in Masindi; PMBL = prices in Mbale; PMBR= prices in Mbarara; PRWA= Rwakai; PSOR= prices in Soroti; PTOR= prices in Tororo and PKAM =Prices in Kampala
Asterisk (*) represents the rejected levels of significance for the respective F-tests.

In the case of the beans price, the Arua market is observed to be the only market whose current price depends on merely its past observations. This non-price responsive characteristic may be because this market is isolated from other markets. This finding is consistent with the statistics, which suggest low trade in the commodity. All other market prices are Granger caused by themselves and at least one other market.

The Mbarara beans price appears to be the most responsive market price as it is Granger caused past observations from six other markets, concisely from Gulu, Iganga, Jinja, Kabale, Masindi, and Kampala.

The prominent lagged price in predicting the present beans price in Arua is from Arua; in Gulu is from Gulu; in Iganga is from Iganga, and Jinja; in Jinja is from Jinja; in Kabale is from Iganga, and Jinja; in Kasese is from Kasese, Masindi, Soroti, and Kampala; in Lira is from Lira; in Luwero is from Luwero; in Masaka is from Masaka and Kampala; in Masindi is from Masindi, and Mbale; in Mbale is from Mbale, and Kampala; in Mbarara is from Jinja, Mbarara, Masindi, and Kampala; in Rwakai is from Mbarara, and Rwakai; in Soroti is from Mbale, and Soroti; in Tororo is from Masindi, Tororo, and Kampala; and in Kampala is from Kampala. It can be observed that each market significantly affects its self. Like in maize, there are multiple significant causal relations. Here, previous information from Kampala followed by that from Jinja and Mbale will have a more significant impact on the marketing of beans. The lagged price of Kampala again shows the most diverse impact on the price of beans. These tests too show feedback relationships among markets. Results from Granger's F-test only give us the statistical significance information, but do not show the magnitude of its impact. They, however, suggest to us what to expect as we proceed with findings from the forecast error decompositions and impulse response functions. Take note that Granger's tests are based on one lag period.

4.6.2 Directed acyclic graph results

Based on the VAR model specified and fit to the maize and beans data, we compute residual series for each market. The variance- covariance matrix on the residuals from each of the sixteen markets offers evidence on the contemporaneous relationships among markets. The lower elements of the correlation matrix for 16 markets for each, maize and beans are presented in figures 4.3 and 4.4 below.

$Corr(\varepsilon_t) =$

Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
1.0000															
0.0792	1.0000														
0.0609	−0.0171	1.0000													
−0.2405	−0.0616	0.5152	1.0000												
0.1010	−0.0197	−0.1099	0.2004	1.0000											
−0.1237	0.0016	0.2360	0.4081	0.0653	1.0000										
0.1569	−0.0160	0.1328	−0.0252	0.0984	−0.0269	1.0000									
0.0319	−0.1027	−0.0141	0.0000	−0.1995	−0.0029	0.1389	1.0000								
−0.0745	0.0259	0.0861	−0.0612	−0.0145	0.1728	0.1940	0.1152	1.0000							
−0.0235	0.0327	0.2078	0.4382	−0.1738	0.0946	0.1725	0.0410	0.0890	1.0000						
0.0308	−0.1129	0.0966	0.5133	0.0118	0.1057	0.3212	0.0350	0.0157	0.3032	1.0000					
0.0691	−0.1567	0.1115	0.2527	0.1776	0.0397	−0.0515	−0.0813	0.0181	0.0574	−0.0107	1.0000				
0.1611	0.0127	−0.0631	0.0378	0.0195	0.1699	−0.0410	−0.0218	0.1190	0.0059	0.0003	0.0227	1.0000			
0.1579	−0.0268	0.0990	0.4538	0.1422	0.0959	0.1144	−0.1320	−0.1680	0.0978	0.1833	−0.0171	0.1523	1.0000		
0.0293	−0.0878	0.3057	0.4624	−0.0534	0.1089	0.1309	0.0538	−0.0642	0.1356	0.3311	0.0772	−0.0485	0.1419	1.0000	
−0.1467	−0.0955	0.2218	0.3027	−0.0370	0.2266	0.1905	0.0776	0.1315	0.4036	0.4833	0.0436	0.1462	0.0839	0.2836	1.0000

Figure 4.3. Maize correlation matrix.

Notes: Aru=Arua, Gul=Gulu, Iga=Iganga, Kab=Kabale, Kas=Kasese, Lra=Lira, Luw=Luwero, Mas=Masaka, Mdi=Masindi, Mbl=Mbale, Mbr=Mbarara, Rwa=Rwakai, Sor=Soroti, Tor=Tororo, and Kam= Kampala.

The matrices show very low correlation values between markets less than 0.2 in the case of beans and less than 0.52 in the case of maize, suggesting slow translation of new information from one market to another. The slightly higher values among the maize markets indicate better information exchange when compared to the beans markets. Moreover, this is further confirmed by the mean correlation; $0 < 0.15(beans) < 0.19(maize) < 1$. These results show the maize markets to be more dependent on each other than are the beans market. They indicate to us that more information exchange occurs in maize than beans marketing. There is consistency between these findings and the dynamic outcome discussed earlier.

$Corr(\varepsilon_t) =$

Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
1.0000															
-0.2011	1.0000														
0.0039	0.0375	1.0000													
-0.0242	-0.0222	0.1547	1.0000												
-0.0148	0.0853	0.0447	0.0347	1.0000											
0.0413	-0.0521	-0.1120	-0.1078	0.2075	1.0000										
0.0131	0.0153	-0.0608	0.0427	0.0237	0.0683	1.0000									
0.0099	0.0015	0.0284	0.0068	0.1405	-0.0611	0.0571	1.0000								
0.0126	-0.0589	0.0261	0.0873	0.0694	0.0290	0.0165	-0.0912	1.0000							
-0.1323	0.1422	0.0346	0.1130	0.0108	-0.1078	0.1139	0.0062	0.0160	1.0000						
-0.0305	0.0320	-0.0304	0.1066	0.2057	0.1544	0.1218	-0.2397	-0.0228	0.1305	1.0000					
-0.0283	-0.0150	-0.1170	0.0826	0.3370	0.0718	0.0196	0.1179	-0.0017	-0.0737	0.01436	1.0000				
-0.0294	0.1391	0.0492	-0.0717	0.0318	0.0191	-0.1833	-0.1115	-0.0171	-0.0515	0.0768	0.0642	1.0000			
-0.1075	0.0401	0.0752	0.1051	0.1741	0.1186	0.1311	-0.0555	0.0451	0.0820	0.1600	0.0437	-0.0554	1.0000		
-0.1371	0.0164	0.0971	0.0626	0.2167	0.1839	0.1224	0.0120	-0.1856	0.1641	0.2959	0.1896	0.0657	0.0868	1.0000	
0.1185	0.0974	0.0116	-0.0100	0.1154	0.1956	0.0792	0.0604	-0.0778	0.0605	0.1645	0.1303	0.0722	0.0037	0.1831	1.0000

Figure 4.4. Beans correlation matrix.

Notes: Aru=Arua, Gul=Gulu, Iga=Iganga, Kab=Kabale, Kas=Kasese, Lra=Lira, Luw=Luwero, Mas=Masaka, Mdi=Masindi, Mbl=Mbale, Mbr=Mbarara, Rwa=Rwakai, Sor=Soroti, Tor=Tororo, and Kam= Kampala.

The highest correlation in the maize market is 0.5133 between the Jinja and Mbale markets, and that in the beans market is 0.3370 between the Kabale and Mbarara markets. Jinja is known for large consumption of maize, probably because of the presence industries. Mbale is a border town and a key producer of maize. Mbarara and Kabale are near each other and are located in the districts that produce substantial amounts of beans, which could suggest the key relation between them.

The correlation values shown above only suggest relationships among the markets and do not show the direction of communication between them. Information flow was obtained by applying PC algorithm (Tetrad II software) to the correlation matrices. Figures 4.5 and 4.6 show the results at the 10% level of significance.

It can be seen from figure 4.5 concerning maize, that exchange of price information is mainly between markets in the eastern, central, and western parts of Uganda. Arrows are observed emerging out of Arua, Lira, Masaka, Luwero, Iganga, and Mbarara, but none going into them, indicating that these markets send out information to other maize markets, and therefore are exogenous in contemporaneous time. Four of these markets, excluding Iganga and Lira, are located in areas which have low levels of maize supplies and have relatively high mean prices. However, like the other independent markets, Iganga is a relatively small wholesale market and is faced with excess supplies when compared to Kampala and Jinja; this could explain why it sends out information. With the exception of Masaka, information from all the exogeneous markets will, by means of Masindi, Tororo, and Mbale markets, wind up in Kampala and by means of Kasese and Soroti end up in Rwakai. The latter are receivers of information. Kampala is the largest wholesale market; however, it depends on supplies from elsewhere in the country, which may suggest why information ends up here.

It can be observed that Jinja collects almost all maize price information from other markets and sends it to Kampala via Masindi and to Rwakai via Soroti and Kasese. Jinja is one of the large trading towns for maize in Uganda. In addition, this market is found in region with high levels of maize supplies and is located near Kampala. The town also has industries that utilize large quantities of maize as raw materials and is reported to have silos (see Ferris and Robins, 1999a) for storing maize grain. Information from Masaka will bypass the Jinja market and end up in Rwakai through Soroti and Kasese.

The Gulu maize market is one that does not exert any influence at all to any of the maize markets in contemporaneous time; it neither receives nor sends out information. This may be explained by the fact that the market is located in an insecure part of the country and has insufficient maize supplies. Besides this the Gulu market is affected by the food distributions from the world food program, which works in the surrounding areas which may distort its market in the short run.

Figure 4.6 shows less price communication among markets regarding the beans commodity in contemporaneous time. Only nine out of sixteen markets have arrows leading into or out of them as is observed from the figure. Many of these markets are in the western and eastern parts of the country. This suggests inefficiency in the market as a whole indicating the presence of small quantities for trade.

Masindi and Kasese are the exogenous markets as arrows lead away from them and none come into them. Statistical results suggested Kasese to have more trading than other markets; this could explain why it is the origin of information. Masaka, Luwero, Soroti, and Mbarara are information sinks. Mbarara and Masaka are found in areas that produce large quantities of beans, which might explain why they are receivers of information. Luwero and Soroti are smaller markets in terms of beans, but have high prices.

All information concerning the price of beans from source markets goes through Tororo, from where it is sent directly to Masaka or via Mbale to Luwero or by way of Kabale to Mbarara, and Soroti. Tororo, Kabale, and Mbale are near the border which may be why they act as intermediate markets for flow of information. In addition, the Kabale market is surrounded by a region that produces high proportions of beans. All other markets, including Kampala, Arua, Gulu, Lira, Jinja, Iganga, and Rwakai, do not influence the information at all in the beans market as they neither cause nor receive information. Concisely, they are by themselves in contemporaneous time. This kind of behavior may be because they have insufficient supplies or are small markets for beans. Insecurity and high poverty levels may be added in the case of the Gulu and Arua markets.

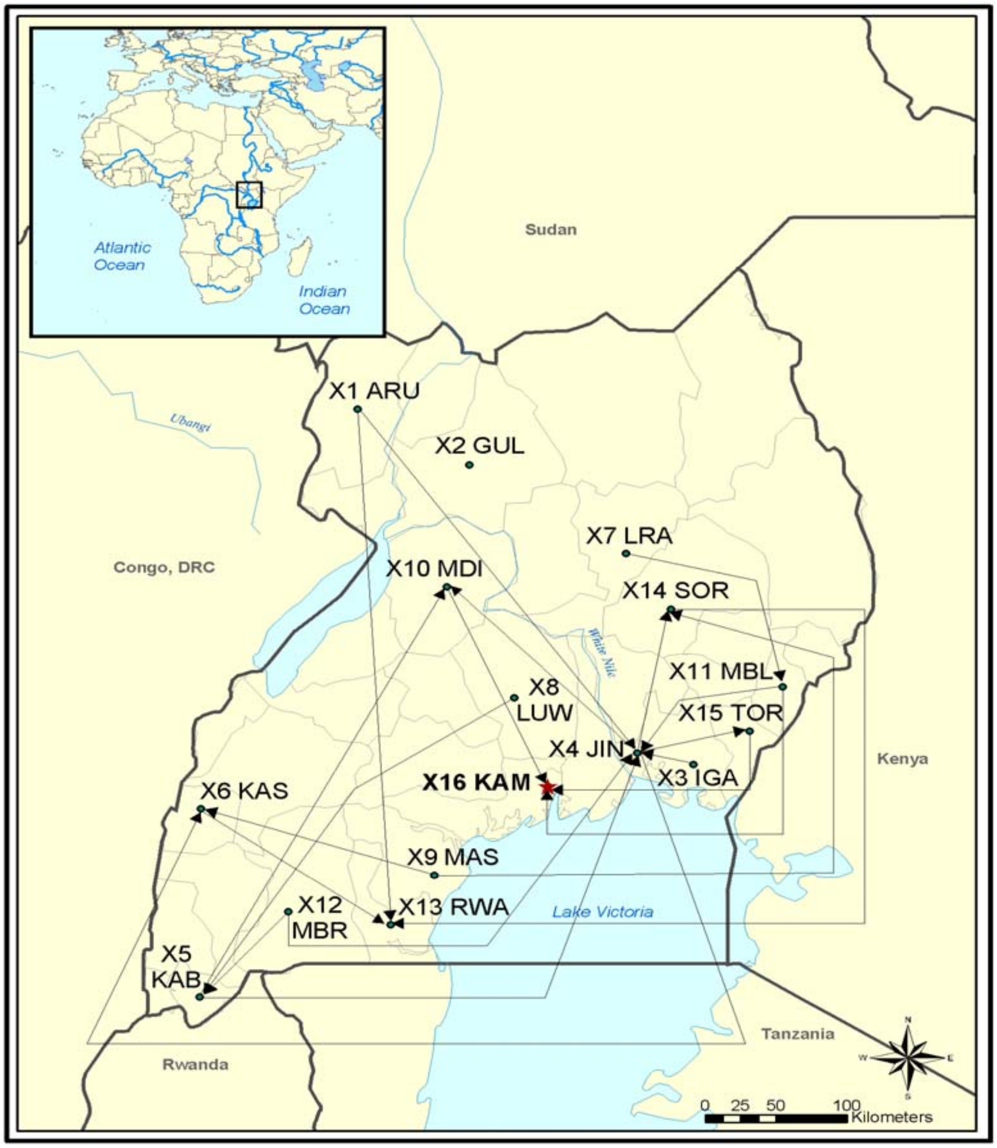

Figure 4.5. Directed acyclic graphs on innovations from 16 maize markets in Uganda at the 10% level.

Notes: X1-X16 represent markets ordered 1 through 16 used in VAR analysis. ARU=Arua, GUL=Gulu, IGA=Iganga, KAB=Kabale, KAS=Kasese, LRA=Lira, LUW=Luwero, MAS=Masaka, MDI=Masindi, MBL=Mbale, MBR=Mbarara, RWA=Rwakai, SOR=Soroti, TOR=Tororo, and KAM= Kampala. To show a clear pattern of exchange, we exclude lakes Kyoga, Albert, and George from the map. Source of the map is Texas A&M University, Spatial Sciences Laboratory 2003.

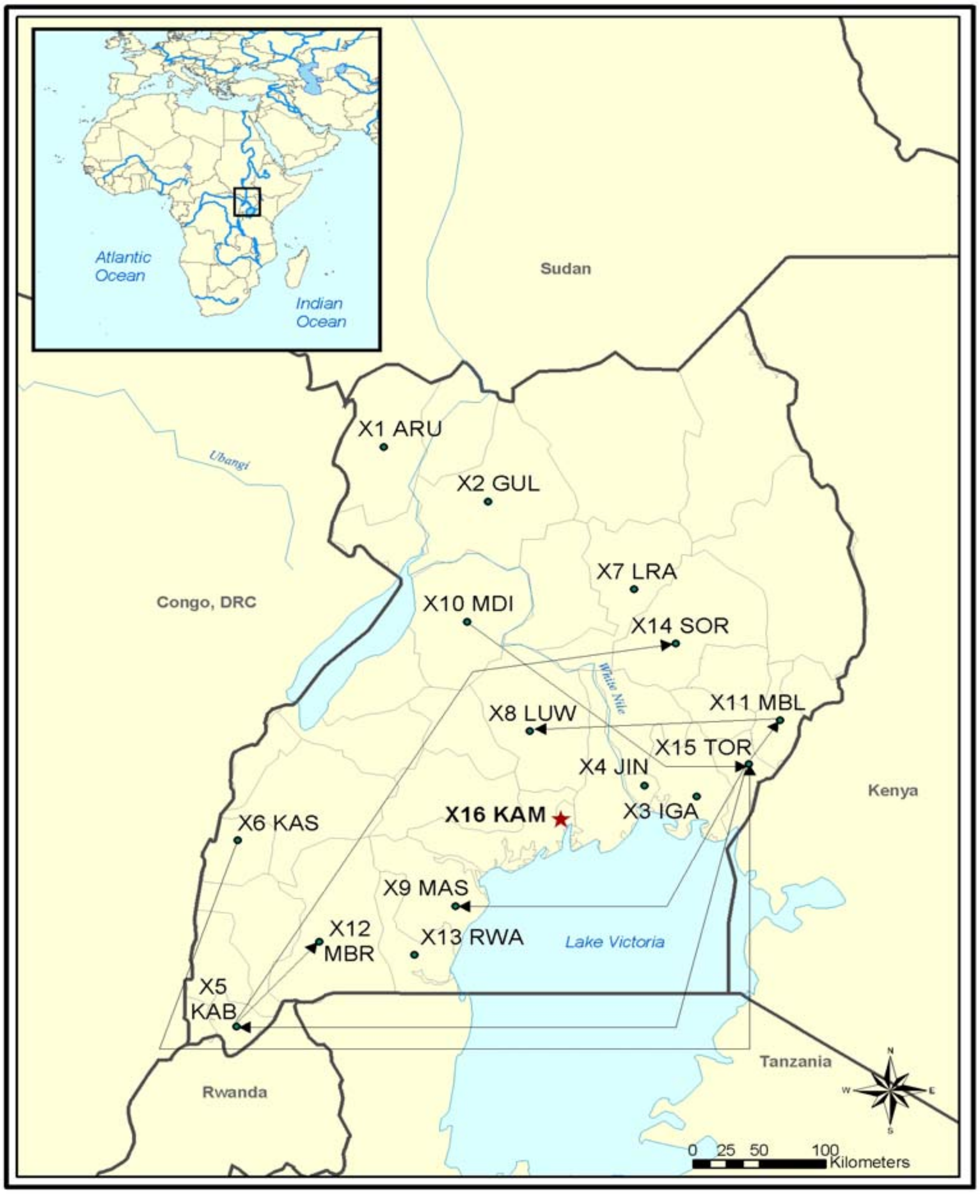

Figure 4.6. Directed acyclic graphs on innovations from 16 beans markets in Uganda at the 10% level.

Notes: X1-X16 represent markets ordered 1 through 16 used in VAR analysis. ARU=Arua, GUL=Gulu, IGA=Iganga, KAB=Kabale, KAS=Kasese, LRA=Lira, LUW=Luwero, MAS=Masaka, MDI=Masindi, MBL=Mbale, MBR=Mbarara, RWA=Rwakai, SOR=Soroti, TOR=Tororo, and KAM= Kampala. To show a clear pattern of exchange. we exclude lakes Kyoga, Albert, and George from the map. Source of the map is Texas A&M University, Spatial Sciences Laboratory 2003.

As discussed these results are only for instantaneous time, and therefore are subject to the prevailing market conditions. Full strength of these relationships can only be revealed further by the forecast error variance decompositions and impulse response functions to which we turn to.

4.6.3 Forecast error variance decompositions (FEVs)

The forecast error variance decompositions (FEVs) for maize and beans are presented in tables 4.5a and 4.5b respectively provide the in-depth information to establish market interactions overtime. A market(s) is exogenous or endogenous in a particular time period based on the proportions of its uncertainty that is explained for by other market(s) in question. If a large proportion of forecast error decompositions is accounted for by other markets, then that particular market is dependent, but independent otherwise. The tables show values at horizons 0, 1, 5, and 23. Horizon represents week, with 0 signifying contemporaneous time, 1 and 5 signifying the short run and intermediate run and 23 signifying the long run. The figures across each horizon approximate 100%.

Overall, markets are dependent on maize price information generated from within the markets themselves in contemporaneous time. Instantaneous causal relations discussed in section 4.7 appear to be weak as all sixteen markets show a high price variation of over 70% as being determined by themselves. There is a very small market risk being generated from the causal relations. In the short-run markets retain this kind of behavior, which may be because traders do not have enough time to process the information or there could be existing poor market infrastructure.

Changes occur in horizon (week 5) whereby 50% of markets become endogenous including Kasese, Lira, Masindi, Mbale, Rwakai, Tororo, Soroti, and Kampala. In these markets, more price risk is generated by the total of information coming from all other markets than from within themselves. In four of these markets, the most price disrupting information comes from Mbale. Kasese is more influenced by information from Iganga,

Table 4.5a. Forecast error variance decompositions (FEVs) on weekly maize prices from 16 markets in Uganda

Horizon	ARU	GUL	IGA	JIN	KAB	KAS	LRA	LUW	MAS	MDI	MBL	MBR	RWA	SOR	TOR	KAM
ARU																
0	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	96.09	0.35	0.85	0.45	0.02	0.19	0.02	0.01	0.42	0.00	0.18	0.28	0.49	0.47	0.00	0.18
5	79.78	0.96	6.74	0.51	0.19	0.51	0.45	0.17	4.50	0.05	0.63	3.09	1.44	0.51	0.07	0.40
23	48.37	1.79	16.60	1.81	0.68	2.32	0.65	0.61	8.09	0.09	8.19	4.23	1.36	3.38	1.58	0.25
GUL																
0	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.06	90.14	0.01	0.02	0.00	0.23	0.10	0.39	0.21	0.95	1.34	0.02	0.07	1.19	0.00	5.26
5	0.28	52.58	1.20	2.84	0.26	0.37	7.55	1.11	0.49	3.25	13.21	0.04	2.06	2.09	0.57	12.20
23	0.14	19.29	10.14	9.72	0.29	1.80	10.64	0.34	0.79	2.05	24.66	0.03	3.86	8.57	4.11	3.60
IGA																
0	0.00	0.00	100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.11	0.02	90.14	0.35	0.10	0.00	0.17	0.02	0.26	0.74	6.59	0.00	0.38	0.86	0.04	0.21
5	0.64	0.46	59.84	2.85	0.12	1.44	1.54	0.04	0.76	1.14	19.84	0.22	2.19	4.92	1.90	2.10
23	0.60	4.05	34.38	8.23	0.06	3.42	4.72	0.06	0.53	0.74	24.56	0.57	3.41	9.03	4.00	1.62
JIN																
0	1.36	0.00	5.15	89.76	1.30	0.00	0.11	0.04	0.00	0.00	1.77	0.51	0.00	0.00	0.00	0.00
1	1.16	0.03	8.98	77.63	1.16	2.23	1.66	0.29	0.13	0.59	4.20	0.81	0.00	0.35	0.62	0.16
5	0.83	1.23	13.40	56.37	0.79	3.36	3.14	0.53	0.29	0.44	11.97	0.95	0.48	2.37	2.67	1.18
23	0.46	4.65	14.87	32.53	0.37	3.99	5.61	0.29	0.37	0.48	20.67	0.74	2.25	7.35	4.34	1.02
KAB																
0	0.00	0.00	0.00	0.00	93.77	0.00	0.00	3.19	0.00	0.00	0.00	3.04	0.00	0.00	0.00	0.00
1	0.02	0.08	0.46	0.01	87.58	5.04	0.22	2.51	0.93	0.00	0.36	2.38	0.12	0.00	0.09	0.20
5	0.30	1.38	5.75	1.76	63.04	10.83	0.94	1.66	3.35	0.04	4.32	1.96	0.19	1.43	1.10	1.94
23	0.27	4.59	14.51	6.51	25.57	9.93	1.72	0.82	2.32	0.07	17.30	1.26	1.58	7.30	3.51	2.74
KAS																
0	0.04	0.00	0.14	2.50	0.04	93.89	0.00	0.00	3.32	0.00	0.05	0.01	0.00	0.00	0.00	0.00
1	0.08	1.27	2.57	6.84	2.50	78.72	0.62	0.12	2.90	1.95	0.24	0.47	0.03	0.36	0.97	0.33
5	0.16	4.16	12.28	9.14	3.15	44.04	0.80	0.11	1.92	1.81	11.19	0.56	0.70	5.10	2.88	0.99
23	0.12	5.64	16.97	10.25	1.49	22.43	3.12	0.15	0.99	1.00	20.12	0.28	3.06	9.31	4.49	0.57
LRA																
0	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.06	0.52	0.31	1.33	0.54	0.02	86.30	0.71	0.09	2.06	5.53	0.05	0.07	0.00	0.82	1.59
5	0.21	3.60	5.53	7.80	0.53	0.55	45.39	0.64	0.08	3.77	22.3	0.22	1.04	3.88	3.68	0.77
23	0.19	6.03	13.53	10.44	0.29	1.88	21.36	0.26	0.25	2.09	26.04	0.12	3.04	8.97	5.14	0.34
LUW																
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.08	0.02	0.06	0.00	0.14	0.23	0.00	96.13	0.17	0.14	1.42	0.02	0.51	0.01	0.61	0.46
5	0.25	1.13	1.69	1.78	0.13	0.81	1.70	66.48	0.92	0.20	14.43	0.54	2.56	1.79	2.30	3.26
23	0.12	5.20	11.22	8.02	0.06	3.57	4.84	24.18	0.43	0.39	23.83	0.46	3.27	8.06	4.43	1.90

Table 4.5a Continued

Horizon	ARU	GUL	IGA	JIN	KAB	KAS	LRA	LUW	MAS	MDI	MBL	MBR	RWA	SOR	TOR	KAM
MAS																
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.41	0.26	0.06	0.06	1.08	0.05	0.22	0.28	95.52	0.01	1.45	0.13	0.01	0.41	0.00	0.06
5	2.95	0.31	2.45	0.16	4.23	2.26	1.02	1.11	77.27	0.03	4.03	0.38	0.10	1.74	0.21	1.76
23	2.88	2.95	14.52	4.26	3.01	5.88	1.22	0.95	35.61	0.04	15.61	0.23	1.35	6.81	2.65	2.02
MDI																
0	0.35	0.00	1.34	23.43	0.07	0.00	0.03	0.00	0.00	74.04	0.46	0.27	0.00	0.00	0.00	0.00
1	0.38	0.52	3.61	21.20	0.30	0.01	4.08	0.01	0.20	58.41	6.30	0.16	1.28	1.69	0.00	1.84
5	0.44	4.19	10.26	14.23	0.13	1.46	10.32	0.01	0.12	22.21	23.09	0.06	3.43	6.61	2.14	1.31
23	0.20	6.16	15.15	12.71	0.08	2.54	9.29	0.06	0.23	8.54	26.05	0.03	3.91	10.03	4.51	0.50
MBL																
0	0.00	0.00	0.00	0.00	0.00	0.00	5.77	0.00	0.00	0.00	94.23	0.00	0.00	0.00	0.00	0.00
1	0.01	0.82	0.63	2.67	0.01	0.52	8.57	0.00	0.12	0.21	80.15	0.08	0.24	1.64	1.34	3.00
5	0.04	5.38	6.72	8.80	0.09	3.08	10.12	0.02	0.25	1.02	48.77	0.17	1.57	6.25	4.02	3.67
23	0.04	7.01	13.65	11.05	0.07	3.53	8.94	0.08	0.37	0.88	34.71	0.12	3.04	9.92	5.22	1.38
MBR																
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
1	0.13	0.00	0.30	0.05	0.57	0.42	0.00	0.04	0.01	0.77	0.13	94.03	0.27	0.04	0.47	2.77
5	0.80	0.15	0.77	0.04	1.95	4.44	0.73	0.03	0.05	2.83	0.26	73.33	1.82	0.30	0.55	11.94
23	0.67	3.40	5.46	3.81	2.20	9.83	1.16	0.08	0.31	1.91	9.08	40.28	1.53	3.61	1.88	14.80
RWA																
0	3.34	0.00	0.00	0.01	0.00	1.98	0.00	0.00	0.11	0.00	0.00	0.00	94.22	0.34	0.00	0.00
1	2.19	0.03	0.30	0.12	0.48	2.87	1.35	0.03	0.16	0.39	0.51	0.01	83.84	0.39	0.97	6.38
5	2.62	1.91	5.38	1.42	1.02	8.34	1.90	0.07	1.29	0.80	5.49	0.16	45.38	0.97	2.20	21.06
23	1.09	5.90	16.67	7.81	0.54	7.86	2.85	0.28	0.93	0.31	21.67	0.15	13.27	8.53	4.56	7.57
SOR																
0	0.05	0.00	0.19	3.27	0.05	0.00	0.00	0.00	1.06	0.00	0.06	0.02	0.00	95.29	0.00	0.00
1	0.07	0.04	0.14	2.59	0.15	0.05	2.81	0.01	0.89	0.92	12.72	0.10	0.00	78.06	0.40	1.06
5	0.04	3.27	4.24	6.80	0.27	1.17	11.16	0.03	0.38	2.00	31.06	0.07	1.40	32.62	2.24	3.26
23	0.04	6.30	12.92	10.56	0.17	2.51	9.93	0.07	0.41	1.39	28.93	0.02	3.26	17.62	4.76	1.09
TOR																
0	0.18	0.00	0.69	12.03	0.17	0.00	0.01	0.01	0.00	0.00	0.24	0.07	0.00	0.00	86.60	0.00
1	0.12	0.71	1.59	17.26	0.48	1.29	1.74	0.51	0.31	1.43	7.21	0.29	0.10	0.50	63.97	2.53
5	0.07	5.45	7.87	14.98	0.46	3.29	8.09	0.47	0.97	2.28	22.17	0.18	1.45	5.35	23.42	3.50
23	0.06	7.01	13.75	13.22	0.26	3.21	8.84	0.23	0.85	1.43	25.30	0.09	3.05	9.47	11.92	1.31
KAM																
0	0.00	0.00	0.02	0.30	0.00	0.00	0.00	0.00	0.00	1.57	0.03	0.00	0.00	0.00	0.19	97.88
1	0.00	0.74	0.60	0.82	0.07	1.20	1.34	0.01	0.16	1.24	8.15	0.04	0.41	0.41	0.12	84.69
5	0.00	5.04	6.61	6.69	0.03	4.01	5.70	0.07	0.18	1.04	26.28	0.09	2.20	5.87	2.49	33.68
23	0.02	6.86	14.13	10.42	0.02	4.22	6.91	0.13	0.19	0.81	27.31	0.10	3.38	10.22	4.77	10.54

Notes: Markets are represented by ARU=Arua, GUL= Gulu, IGA=Iganga, KAB=Kabale, KAS=Kasese, LRA=Lira, LUW=Luwero, MAS=Masaka, MDI=Masindi, MBL =Mbale, MBR=Mbarara, RWA=Rwakai, SOR=Soroti, TOR=Tororo, and KAM= Kampala.

Table 4.5b. Forecast error variance decompositions (FEVs) on weekly bean prices from 16 markets in Uganda

Horizon	ARU	GUL	IGA	JIN	KAB	KAS	LRA	LUW	MAS	MDI	MBL	MBR	RWA	SOR	TOR	KAM
								ARU								
0	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	95.98	0.67	0.00	0.42	0.02	0.19	0.17	0.74	0.06	0.00	0.09	0.60	0.10	0.05	0.52	0.38
5	79.48	4.21	0.36	1.63	0.23	0.57	0.22	3.36	0.43	1.51	0.57	3.26	0.57	0.26	2.63	0.70
23	68.95	5.62	0.56	3.42	1.26	0.59	0.97	3.58	0.87	2.89	1.57	4.62	0.57	0.25	3.26	1.02
								GUL								
0	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.18	93.81	0.00	0.28	0.22	0.99	0.63	0.14	0.15	0.13	1.29	0.53	0.31	0.13	0.22	0.01
5	3.33	73.06	0.02	1.26	1.72	4.34	2.59	0.22	0.31	1.62	2.89	1.37	2.5	1.51	3.13	0.14
23	3.529	58.39	0.20	1.59	2.03	4.62	2.71	0.65	0.53	2.53	3.09	2.80	5.41	1.91	9.76	0.25
								1GA								
0	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.36	0.05	89.29	6.99	0.80	0.04	0.15	0.43	0.00	0.67	0.08	0.00	0.05	0.03	1.03	0.03
5	0.57	0.05	46.32	29.16	3.74	0.03	2.10	3.52	0.43	3.21	0.66	0.50	0.30	0.54	8.35	0.51
23	0.74	0.14	24.66	32.75	6.35	0.50	5.05	4.31	1.26	2.96	1.02	0.50	0.45	0.48	14.83	4.01
								JIN								
0	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.07	0.04	0.74	93.17	0.12	0.15	0.78	0.47	0.32	0.80	0.04	1.45	0.00	0.00	1.59	0.26
5	0.16	0.03	1.94	69.10	3.10	0.50	3.85	1.27	2.32	3.23	0.25	3.76	0.17	0.04	8.66	1.65
23	0.47	0.04	3.01	51.97	6.31	1.24	6.84	1.89	2.60	2.82	1.26	2.36	0.44	0.05	14.36	4.34
								KAB								
0	0.00	0.00	0.00	0.00	97.43	0.13	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	2.36	0.00
1	0.90	0.21	0.02	3.30	88.14	1.46	0.41	0.61	0.60	0.41	0.08	0.00	0.09	1.40	2.21	0.16
5	1.43	0.71	0.24	22.70	52.59	3.42	1.06	4.42	0.96	2.75	0.50	2.08	0.54	4.83	1.32	0.45
23	0.76	0.74	0.71	34.16	29.28	2.20	2.84	5.22	1.46	5.63	0.81	4.08	0.39	3.44	5.02	3.27
								KAS								
0	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
1	0.03	0.04	0.01	0.82	1.62	88.46	0.07	0.02	0.11	3.20	0.00	0.15	0.10	3.30	0.04	2.01
5	0.14	0.04	0.03	8.47	2.02	55.97	0.15	1.10	2.53	11.82	0.28	1.45	1.82	6.38	1.95	5.87
23	0.37	0.04	1.46	14.68	2.45	32.07	2.35	1.55	4.64	9.63	3.45	1.41	3.96	4.00	13.36	4.59
								LRA								
0	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0-00	0.00	0.00	0.00
1	1.42	0.07	0.71	0.02	0.03	0.85	92.87	0.57	0.01	1.71	0.01	0.13	0.03	0.14	1.37	0.06
5	2.63	0.11	1.20	0.04	0.23	5.42	70.23	1.07	0.78	9.00	1.66	0.80	0.29	0.36	5.89	0.31
23	1.85	0.39	1.88	4.44	0.86	4.78	46.37	1.24	2.91	9.36	6.85	0.81	2.67	0.58	13.97	1.05
								LUW								
0	0.00	0.00	0.00	0.00	0.00	0.01	0.00	97.27	0.00	0.01	2.49	0.00	0.0	0.00	0.23	0.00
1	0.05	0.03	0.09	0.07	0.07	0.39	0.41	94.19	0.04	0.87	1.83	0.67	0.02	0.07	0.16	1.06
5	0.04	0.10	0.15	0.90	0.93	0.98	1.46	74.25	0.36	2.99	3.09	2.12	1.24	0.17	0.47	10.75
23	0.20	0.26	1.63	14.83	3.30	1.64	4.62	42.61	1.72	2.42	4.35	1.58	2.52	0.46	7.33	10.53

Table 4.5b continued

Horizon	ARU	GUL	IGA	JIN	KAB	KAS	LRA	LUW	MAS	MDI	MBL	MBR	RWA	SOR	TOR	KAM
								MAS								
0	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	97.52	0.09	0.00	0.00	0.00	0.00	2.27	0.00
1	0.01	0.04	0.02	0.19	0.20	0.09	0.26	0.24	90.64	0.11	0.19	0.33	0.21	1.43	3.91	2.13
5	0.07	0.66	0.04	9.08	1.37	1.34	0.74	3.69	53.45	1.13	3.46	4.19	1.15	5.20	5.99	8.44
23	0.10	1.03	0.17	25.64	3.15	2.51	1.32	4.94	25.94	5.74	4.49	7.94	0.89	4.68	5.25	6.22
								MDI								
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.02	0.32	0.02	0.28	0.49	0.28	0.25	0.21	0.00	93.61	3.37	0.12	0.50	0.07	0.30	0.15
5	0.10	0.34	0.28	7.38	1.94	1.59	0.28	1.63	0.14	68.24	8.58	0.16	2.54	0.95	5.62	0.21
23	0.30	0.16	2.19	19.15	4.16	1.31	2.90	3.09	1.50	35.79	7.39	0.19	2.82	0.95	16.20	1.91
								MBL								
0	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.32	90.96	0.00	0.00	0.00	8.28	0.00
1	0.11	1.10	0.55	0.43	0.05	0.29	0.10	0.02	0.10	1.97	82.14	0.16	0.08	0.00	11.31	1.61
5	0.33	2.42	3.04	7.44	1.09	0.76	1.23	1.15	1.00	2.64	54.74	0.17	1.07	0.16	16.70	6.07
23	0.71	1.42	4.97	19.83	4.11	2.44	5.46	2.64	1.98	1.35	28.68	0.12	1.38	0.17	20.37	4.38
								MBR								
0	0.00	0.00	0.00	0.00	7.43	0.01	0.00	0.00	0.00	0.01	0.00	92.37	0.00	0.00	0.18	0.00
1	0.07	0.89	1.15	2.12	9.58	0.35	0.29	0.26	0.19	2.75	0.55	79.20	0.02	0.63	0.11	1.85
5	0.20	1.09	1.55	14.48	10.32	0.70	2.06	0.25	1.36	7.80	0.43	50.90	0.27	2.60	0.10	5.90
23	0.23	0.61	1.66	27.44	10.14	0.70	5.45	1.06	2.78	7.21	0.70	29.19	0.68	1.95	5.16	5.04
								RWA								
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.18	0.02	0.47	0.07	0.12	0.09	0.06	0.39	0.00	0.21	0.02	1.47	95.65	0.33	0.38	0.56
5	0.84	0.02	0.78	2.41	0.70	0.12	0.13	1.99	0.02	0.36	0.60	6.78	77.33	0.40	1.36	6.17
23	0.69	0.03	0.87	17.81	2.62	0.26	1.83	3.18	1.37	1.38	0.99	8.69	49.364	0.84	3.20	6.90
								SOR								
0	0.00	0.00	0.00	0.00	4.32	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	95.57	0.11	0.00
1	0.03	0.16	0.68	0.00	3.51	1.67	0.05	0.67	0.02	0.22	6.39	0.00	0.69	82.48	2.09	1.36
5	0.44	1.38	1.92	4.33	1.97	1.57	0.26	0.68	1.05	3.42	16.15	0.00	4.23	40.16	10.55	11.90
23	0.77	0.91	4.06	16.69	3.37	2.59	4.46	1.75	2.80	2.01	12.31	0.21	4.41	16.44	19.79	7.42
								TOR								
0	0.00	0.00	0.00	0.00	0.00	4.94	0.00	0.00	0.00	3.52	0.00	0.00	0.00	0.00	91.53	0.00
1	0.78	0.00	0.28	0.03	0.00	4.32	0.04	0.01	0.40	3.73	2.76	0.01	0.30	0.95	84.30	2.10
5	2.19	0.02	1.18	3.30	0.18	2.19	0.17	0.88	2.07	3.13	8.79	0.21	2.77	2.13	60.10	10.70
23	2.12	0.04	3.63	12.29	1.47	2.80	3.00	2.13	2.93	1.78	8.59	0.78	3.78	1.35	45.78	7.52
								KAM								
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.06	0.00	0.12	0.96	0.14	0.10	0.08	0.06	0.02	0.20	0.64	0.15	0.26	0.89	0.01	96.30
5	0.26	0.06	0.53	11.93	0.17	0.11	0.19	1.06	1.05	0.15	0.89	0.95	1.64	2.46	1.38	77.19
23	0.62	0.07	2.09	22.10	1.92	1.26	3.63	1.79	3.25	0.30	1.79	1.03	2.62	1.75	10.21	45.58

Notes: Markets are represented by ARU=Arua, GUL= Gulu, IGA=Iganga, KAB=Kabale, KAS=Kasese, LRA=Lira, LUW=Luwero, MAS=Masaka, MDI=Masindi, MBL =Mbale, MBR=Mbarara, RWA=Rwakai, SOR=Soroti, TOR=Tororo, and KAM= Kampala.

while Rwakai is more affected by information from Kasese, second only to the disruption caused by the information coming from within these markets during this period.

The impact of new information from Mbale over markets becomes more pronounced in the long run. This market is observed to have more effect on price changes in Gulu, Lira, Masindi, Rwakai, Tororo, Soroti, and Kampala than information from within these markets. Noticeably, the Mbale price leads in these markets. The Mbale market is the largest maize trading town nearest to Soroti, Tororo, and Lira. The strategic location and high production probably give this market a dominant effect over other markets in directing price. To get to the Gulu market one can pass via Lira. In the rest of the other markets except in Arua, data from Mbale is second in causing price differences to own price information of the specific market. In one of these markets, which is Luwero, price variation caused by information from Mbale, is nearly as high as that from the former market itself. Maize price variance in Mbale is more influenced by new information from within the market and to a lesser extent by that from Lira and Jinja markets. Results confirm Granger causality test, which showed this market's information as significantly impacting prices of other markets.

The other important information causing price differences in several markets is from the Iganga and Jinja markets. The Iganga market is located in a district with high maize production. In addition to being surrounded by areas having large supplies, Jinja is also known for large consumption of the commodity because of the large industrial base. Concisely, all markets are endogenous in the long-run period.

The Gulu market can be seen to significantly respond to price information from other markets, mostly that from Mbale, Lira, and Iganga in the long run. This particular market is one that is most affected by war, has low maize supplies, and experiences market distortions brought about by food donations from WFP working in the surrounding areas. Because of this background, it would be expected for this market's price not to react to data from elsewhere. However, comparing the FEVs, the Gulu price is observed to respond to incoming information even stronger than prices from the Luwero, Masaka, Mbarara, and Kabale markets. Furthermore this market's information causes more price disruption in other markets than data from the latter plus the Masindi and Kampala markets. The reason for this behavior could be due to differences in consumption habits with Gulu's population consuming more maize than that from the other districts. The other reason could be that the donations are so small to have any significant impact on market price. This finding also indicates that there is some trade occurring between this market and the other markets, especially Mbale.

The Arua maize market is mostly affected by information from the Iganga market, among all information coming from outside the market. Findings are consistent with previous studies, which showed Mbale, Iganga, and Jinja being significant in longrun price formation of maize. However we do not find Kampala to be that important. Markets get little information from Kampala although it's indicated to be statistically important by Granger's tests. Note that these tests exhibited multiple causal relations on price in other words, there is overshadowing of relations, that are straightened out by the FEVs and impulse response functions.

Again contemporaneous relations are seen to be weak concerning the beans price in table 4.5b. Ninety percent of the beans price risk in all markets appears to be caused by themselves at horizon zero. This characteristic is retained by markets throughout the short and intermediate periods except for the Iganga and Soroti markets which become dependent in the fifth week. The total sum of information received from all other markets by each of the two markets mentioned above contributes more to price variation than own price information. These results indicate low bean trading activities over time, probably because the commodity is consumed in large quantities leaving little for trade. To add to this, the cost of beans is much higher than that of maize, making difficult for households to engage in trading activities, especially in the poor communities in the north of the country.

Arua, Gulu, and Jinja remain exogenous over the long-run period. The three markets show 68.95%, 58.39% and 51.97%, respectively, of the bean price variation as caused by themselves. Findings for the Arua market remain consistent with the statistical and F-test results. Apart from the above three markets, all other markets become endogenous in the long run.

Generally, information on the price of beans from Jinja and Tororo is valuable in nearly all markets, with the former causing more price variation than the latter. Clearly Jinja's bean price dominates that in the Iganga, and Kabale markets. The price of beans in Tororo dominates that of Soroti. The impact of data from the two markets on bean marketing is partitioned. Jinja's influence is more pronounced in the western, central, and Iganga market in the east; i.e. 62% of markets. This effect could be linked to distance trade or location. Notice that Jinja exhibits a higher mean price than any of the markets in the stated regions, except Luwero. In addition, it shows a slightly elevated price (almost negligible) compared to Tororo, suggesting that traders in these other markets consider gains from the Jinja market more beneficial. When traveling from the central and western markets, one has to pass by this market to get to the eastern border markets and it costs less than getting to Tororo. Jinja's influence over Luwero could be linked to close proximity. Remember also that stationary tests indicated price observations from the Jinja market to be integrated in the beans market unlike all other series.

Information from Tororo is more valuable to eastern markets nearest to it; i.e., 19% of markets. This market has a lower price than two of these markets. The effect over Mbale could be attached to higher price that Tororo offers. In other words, it could be cheaper to trade with Tororo than traveling to Jinja (which offers nearly the same price), plus it is located near the border with Kenya, which may explain why it shows the above pattern. The high impact of Jinja over most markets could because there is more demand for beans for consumption within the country or there could be another factor. The two leading markets are also seen to influence each other. However, the Tororo market (showing 12.29% price risk as being explained by the Jinja market) is less dependent on Jinja market (14.36% of its price variation as stimulated by the Tororo market). This kind of segmentation also suggests market failure. Note that the outcomes from the FEVs show Kampala to be insignificant in causing market risk opposite of what the Granger tests of causality had determined. The same reason accounted for the case of maize could explain for this irregularity

The given reasons are suggested explanations as to why the markets act in this manner. Extended studies into the marketing structures of the two commodities in the selected towns could give more clarification to the results.

4.6.4 Impulse response functions

Figures 4.7 and 4.8 were generated based on the above described VAR model, including both contemporaneous and lagged information in series. These dynamic results show the response of each series (market) to a one-time shock in itself and other series.

Concerning maize (see figure 4.7), each market can be seen responding to price shocks from itself. Mbale and Iganga are observed to strongly react to shocks from all other markets. The same reasons stated in section 4.6.2 could explain this pattern. Some level of response to sudden maize price changes is also shown in the Jinja, Kasese, Lira, Tororo, and to a small extent, Kampala markets.

Abrupt changes in market price are seen not to affect Arua, Gulu, Kabale, Luwero Masindi, Soroti, and Rwakai. The presence of maize distribution, war, low maize reserves, and poverty may account for why Gulu is non-responsive. Kabale, Luwero, and Rwakai are low producers of maize. The same explanation suggested for the case of Arua market previously may also be true here.

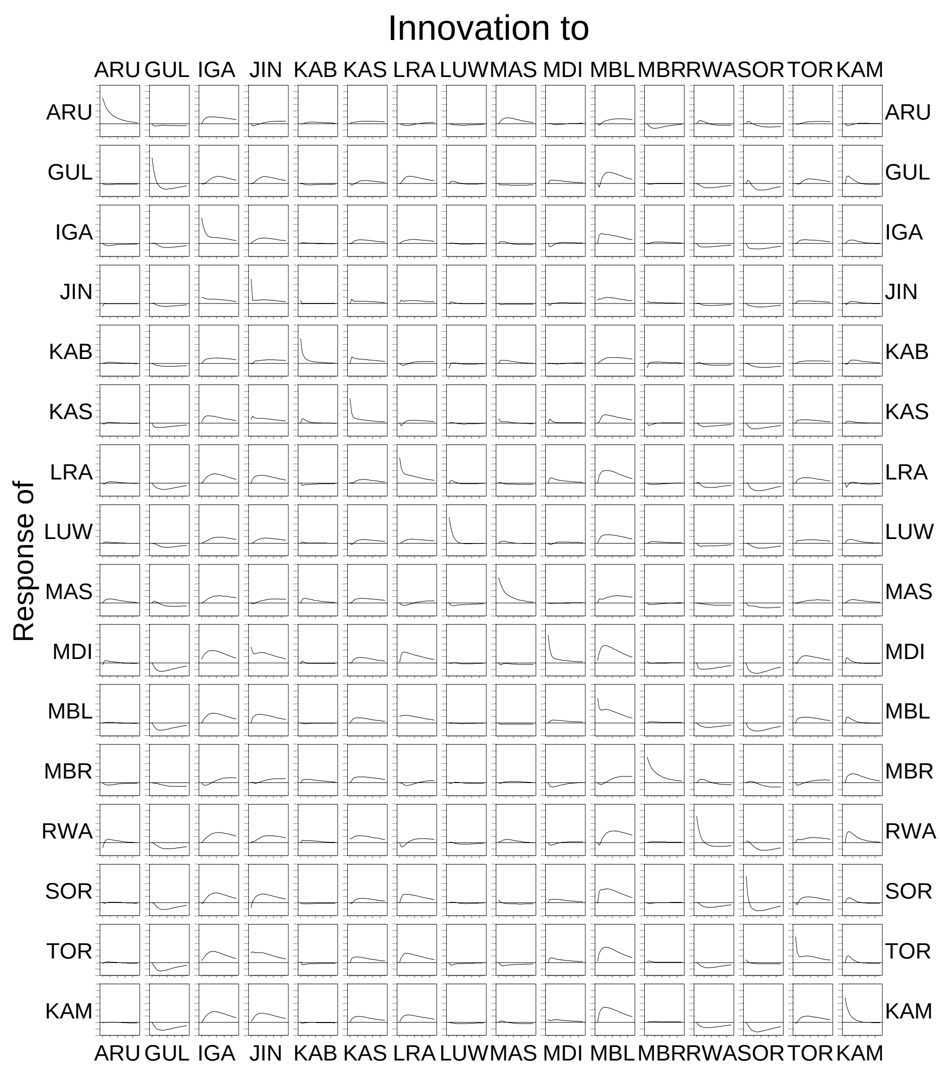

Figure 4.7. Responses of each market to a one-time shock in each maize price series at the 10% level.

Notes: Markets are represented by ARU=Arua, GUL= Gulu, IGA=Iganga, KAB=Kabale, KAS=Kasese, LRA=Lira, LUW=Luwero, MAS=Masaka, MDI=Masindi, MBL=Mbale, MBR=Mbarara, RWA=Rwakai, SOR=Soroti, TOR=Tororo, and KAM= Kampala.

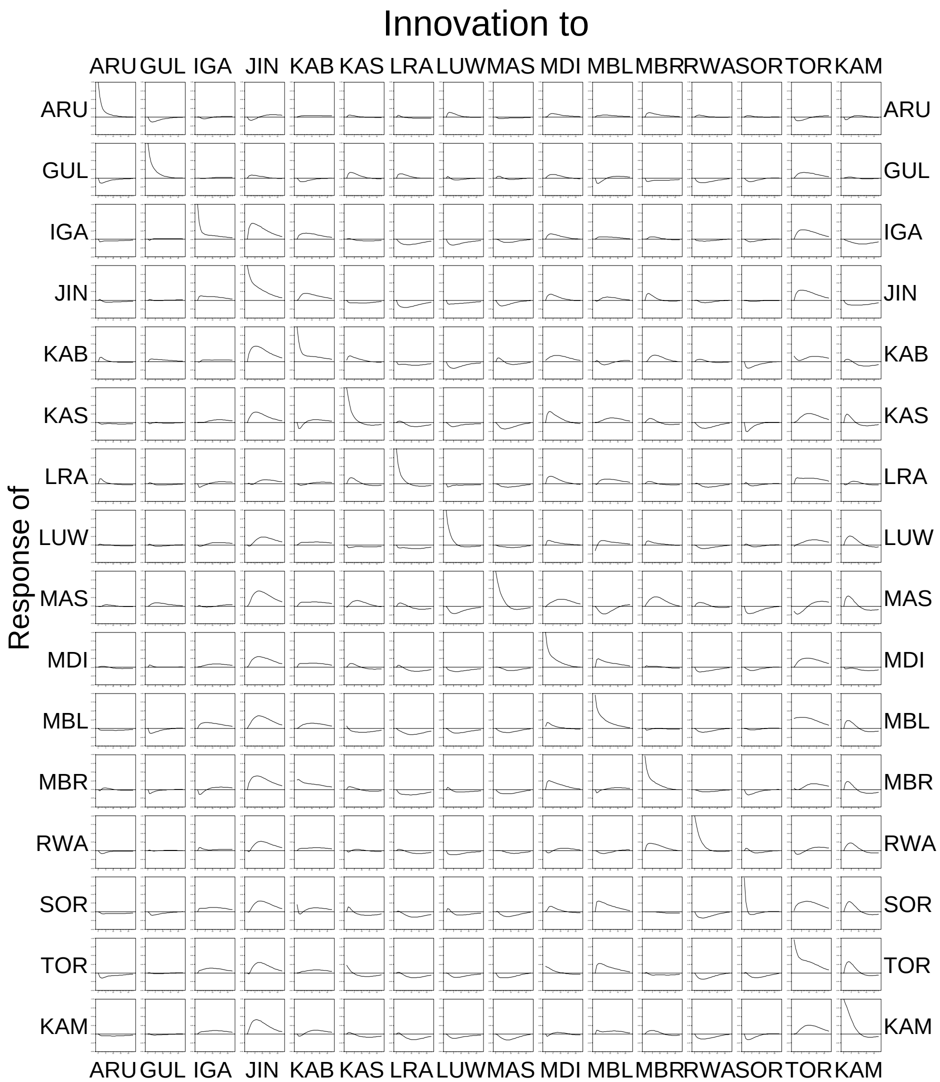

Figure 4.8. Responses of each market to a one-time shock in each bean price series at the 10%level.

Notes: Markets are represented by ARU=Arua, GUL= Gulu, IGA=Iganga, KAB=Kabale, KAS=Kasese, LRA=Lira, LUW=Luwero, MAS=Masaka, MDI=Masindi, MBL=Mbale, MBR=Mbarara, RWA=Rwakai, SOR=Soroti, TOR=Tororo, and KAM= Kampala.

In the case of beans, Jinja and Tororo appear to respond more to price shocks, making them significant markets in the trading of beans. However, shocks occurring in the Jinja market appear to be more pronounced, signifying the importance of this market. Kabale, Kampala, Iganga, Mbale, and Masindi are also somewhat sensitive to price surprises. Kampala's significance is seen here with markets that it Granger causes as was discovered in section 4.6.1. The rest of the other markets are not that responsive to market shocks, especially Arua, Gulu, Rwakai, Lira, Masaka, Luwero, and Soroti, which have collapsed patterns across other series. This could be because the markets do not receive as much information as the sited six markets or they have insufficient bean reserves to trade or are faced with poverty.

CHAPTER V

CONCLUSIONS

The market liberalization policies that occurred in the early 1990s opened Uganda’s economy to growth. But while this was happening, domestic markets stayed inefficient and the level of poverty remained high. The market information bodies under the Institute of International Tropical Agriculture (IITA) and National Agricultural Advisory Services (NAADS) were established to help improve this inefficiency. Although their work of collecting and distributing market information at national and local levels has improved the knowledge of prices across markets, price discovery is not known and questions of market efficiency persist.

This study analyzes the efficiency of Ugandan markets in responding to price signals over time. It targets two food commodities, maize and beans, which are also important sources of food and income for locals and are actively being traded on the regional market. Specifically, the study seeks to answer how fast markets are in communicating information, what relationships they exhibit, and what are the points of price discovery. In attaining these objectives, we focus on weekly wholesale prices of each commodity occurring in the Arua, Gulu, Iganga, Jinja, Kabale, Kasese, Lira, Luwero, Masaka, Masindi, Mbale, Mbarara, Rwakai, Soroti, Tororo, and Kampala markets from the first week of 2000 to the last week of 2003.

The study proceeds in stepwise manner in analyzing the data by first describing each series. Statistical results show that a market having a low mean will not necessarily correspond to having a high price variation, especially in the case of maize. Basically these descriptive findings give characteristics of the observations, but do not tell us where price variation is coming from and how each series is related to the other.

Consequently, we carry on with the detail revealing empirical methods of vector autoregressions and directed acyclic graphs.

Findings tell us that markets are more active in exchanging of information concerning the price of maize than that of beans. Results from the tests for stationarity, specifically the ADF, test first suggest this to us by returning maize series that are non-stationary, thereby indicating an integrated market. However, this is not so with the bean prices where we reject the null hypothesis for all series except for the Jinja market. If this is true, then we would expect to discover more information exchange and interdependence occurring among markets in trading maize than beans in the dynamic results which we actually find. Outcomes from the forecast error variance decompositions demonstrate this, through risk generated in each market as a result of price communication. The exogeneity exhibited by most markets in the marketing of maize in the short run breaks down by week 5 and vanishes in all markets by week 23. The case for beans is that only two markets become dependent in the intermediate run and in the long run, three of the sixteen markets are still independent. In addition, impulse response functions show low reaction to price shocks in the price of beans compared to maize. Furthermore, DAG results show a lower mean correlation and fewer patterns of communication among markets concerning beans than maize. Exchange of information on maize prices is mainly between eastern, central, and western regions; that regarding the price of beans is between the eastern and western parts of Uganda. This kind of result is attributed to the fact that maize does not contribute to the majority of people’s daily diet, making it available for trade unlike the beans.

Overall, markets are inefficient in translating information of the two goods in the short run as each market’s risk is observed to depend more on data coming from within itself. The suggested reason here is that market participants do not have enough time to respond to this information or there is poor market infrastructure. Also, during this period price interaction is mainly between markets located in regions that are less affected by a war. In the long run, each market regardless of location sends and receives information from all other markets as is indicated by the error decompositions.

In the case of maize, this investigation determines information from the Mbale and Iganga markets to be important across markets. These markets are primarily located within areas of high production and their surrounding populations consume substantial amounts of maize, any or all of which could account for why they have a bigger impact in influencing information flow. However, of the two markets, the leading price is that from Mbale which dominates over prices of eight markets and causes a large risk nearly in all other markets, making it the point of price discovery in maize trade. The significance of Mbale is seen all the way from test of stationarity of data were it's series take first place in being non-stationary. Granger's test reveals this market to have a stronger influence over market prices. The full impact of Mbale is exposed by the FEVs and Impulse response. This market is situated near the border with Kenya, which buys a lot of maize from Uganda. This factor coupled with high production probably gives it the dominant characteristic in the maize market. The high risk it generates in other markets demonstrates the response of these markets to tap gains from maize trade through price exchange.

We find that the maize price of the Gulu market reacts to information signals over the long run. The conflict in the north, presence of low maize supplies, and market distortions will only hinder this market's response to price in the short-run, as illustrated by the FEVs and contemporaneous results. Outcomes also indicate that information from Gulu plays a bigger role in the maize markets than that from several other key markets over the long run. Differences in demand for the food, with Gulu having a high demand, could explain why this is so.

Jinja and Tororo emerge as the key markets in the marketing of beans. Concisely, the price of beans is discovered in these two markets. The value of data from Jinja is easily seen throughout empirical analysis. Although this market falls behind Kampala in causing market price under Granger causality tests, the error decompositions clearly show us that it leads the latter. Tororo's dominance is brought to light through the FEVs and impulse response functions. There is clear division of impact among the two markets, with Jinja's data causing more market risk in the western and central markets and Iganga market, while information from Tororo affects prices in the eastern markets nearest to it. This segmentation could be due to distance to trade, which could result in lower gains; statistical results show the two markets to have almost the same price. The strength of Jinja over markets may lay in its strategic location and high price and that of Tororo in border situation. Overall, information from Jinja affects more markets (62%) than does that from Tororo (19% of markets), which could be because there is more demand for beans for consumption than exporting or there could be another factor. Partition in the market suggests existing market failure.

Northern markets of Arua and Gulu are found to be non-reactive to price information of beans, probably because limited supplies and insecurity which may limit data exchange.

Based upon FEVs and impulse response functions, we find that price observations from Kampala although reflected as significant based upon Granger's test have a small impact on either the trade of maize or beans. The F-tests showed multiple causal relations on particular markets which are straightened out by further analysis of FEVs and impulse. This result suggests that information received from Kampala is limited or market participants have more consideration for gains from Mbale and Iganga in the case of maize or Jinja and Tororo in the case of beans in long run.

The above reasons are implied explanations as to why markets behave that way and further research into their structure could shed more light on the subject. Results can be helpful to local individuals engaged in trade and to the private and government sectors involved in market restructuring of the two commodities. This study could assist in price stabilization policies through the central markets causing the highest risk. Findings are similar to earlier studies, yet unlike some of them we do not find Kampala to be important in directing market prices.

REFERENCES

Awokuse, T.O. “Model Identification and Forecasting under Structural Break: Three Essays in Macro Econometrics.” Ph.D. dissertation. Texas A&M University, College Station, 1998.

Awokuse, T.O, and D.A. Bessler. “Vector Autoregressions, Policy Analysis, and Directed Acyclic Graphs: An Application to the U.S. Economy.” *Journal of Applied Economics* 6(May 2003):1-24.

Babula, R.A., D.A. Bessler, and W.S. Payne. “Dynamic Relationships among U.S. Wheat-Related Markets: Applying Directed Acyclic Graphs to a Time Series Model.” *Journal of Agricultural and Applied Economics* 36(April 2004):1-22.

Bartleby. “GDP Per Capita, Referenced from The World Fact Book 2003.” Internet address: http://www.bartleby.com/151/fields/64.html. (Accessed May 02, 2004).

Bessler, D.A. “Agricultural Prices, the Gold –Exchange Standard, and the Great Depression.” *Agricultural Finance Review* 56(1996):47-67.

Bessler, D A. “An Analysis of Dynamic Economic Relationships: An Application to the U.S. Hog Market.” *Canadian Journal of Agricultural Economics* 32(1984):109-24.

Bessler, D. A., and J. Binkley. “Autoregressive Filtering of Some Economic Data Using PRESS and FPE.” Proceedings, American Statistical Association, Business and Economic Statistics Section (1980):261-265.

Bessler, D.A., and J.A. Brandt. “Causality Tests in Livestock Markets.” *American Journal of Agricultural Economics* 64(Febuary 1982):140-44.

Bessler, D.A., and S.W. Fuller. “Railroad Wheat Transportation Markets in the Central Plains: Modeling with Error Correction and Directed Graphs.” *Transportation Research Part E* 36(March 2000):21-39.

Bessler, D.A., and M. S. Haigh. “Causality and Price Discovery: An Application of Directed Acyclic Graphs” Second draft, (2002).Internet address: http://agecon2.tamu.edu. (Accessed August 2004).

Bessler, D.A.,and A. Kergna. “Price Discovery: The Case of Millet in Bamako, Mali” *Journal of African Economies* 11(2002):472-502.

Bessler, D. A., and J. Yang. “The Structure of Interdependence in International Stock Markets.” *Journal of International Money and Finance* 22(2003):261-287.

Binkley, J.K., and D.A Bessler. “Autoregressive Filtering of Some Economic Data Using PRESS and FPE.” Proceedings, American Statistical Association, Business and Economic Statistics Section (1982):261-265.

Brandt, M.W., and K. A. Kavajecz. “Price Discovery in the U.S. Treasury Market: The Impact of Orderflow and Liquidity on the Yield Curve.” Research Draft 2002. Internet address: http://finance.wharton.upenn.edu/~rlwctr/papers/0214.pdf. (Accessed August 2004).

Dickey, D.A., and W.F Fuller. “Distribution of Estimators for Autoregressive Time Series with a Unit Root.” *Journal of American Statistics Association* 74(June 1979):427-31.

Doan, T.A., *RATS: User’s Manual, Version 4*. Evanston, IL: Estima, 1996.

Eun, C. and S. Shim. “International Transmission of Stock Market Movements.” *Journal of Financial Quantitative Analysis* 24(1989)241-25.

Europa. “Plan for Modernization of Agriculture (PMA).” EU & Uganda, Delegation of the European Commission. Internet address: www.deluga.cec.eu.int. (Accessed July 20, 2004).

Famine Early Warning System (FEWS). “Cereal Production Reduced.” Uganda Monthly Report July 20, 2000a. Internet address: http://www.fews.net. (Accessed July 28, 2004).

———. “Rainfall Enables Farmers to Sow Cereals & Pulses.” Uganda Monthly Report August 20, 2000b. Internet address: http://www.fews.net. (Accessed July 28, 2004).

———. “Food Security Conditions Adequate.” Uganda Monthly Report October 20, 2000c. Internet address: http://www.fews.net. (Accessed July 28, 2004).

———. “Food Supply Increases As Harvest Begins”. Uganda Monthly Report July 17, 2001a. Internet address: http://www.fews.net. (Accessed July 28, 2004).

———. “Food Supply Increases as Harvest Hegins.” Uganda Monthly Report October 29, 2001b. Internet address: http://www.fews.net. (Accessed July 28, 2004).

———. "Low Food Prices Continue." Uganda Monthly Report Febuary 26, 2002a. Internet address: http://www.fews.net. (Accessed July 28, 2004).

———. "Civil Security Improves in Western Uganda." Uganda Monthly Report May 23, 2002b. Internet address: http://www.fews.net. (Accessed July 28, 2004).

———. "Stable Crop Prices Favor Food Access." Uganda Monthly Report July 2, 2002c. Internet address: http://www.fews.net. (Accessed July 29, 2004).

———. "Prices Stable; IDP Insecurity Addressed." Uganda Monthly Report October 16, 2002d. Internet address: http://www.fews.net. (Accessed July 29, 2004).

———. "LRA Undermines Food Security in the North." Uganda Monthly Report December 16, 2002e. Internet address: http://www.fews.net. (Accessed July 29, 2004).

———. "June Staple Prices above Average." Uganda Monthly Report July 17, 2003a. Internet address: http://www.fews.net. (Accessed July 29, 2004).

———. "Shortfalls Expected for Food Aid Pipeline." Uganda Monthly Report September 24, 2003b. Internet address: http://www.fews.net. (Accessed July 31, 2004).

———. "Normal Maize Production Level Predicted." Uganda Monthly Report November 21, 2003c. Internet address: http://www.fews.net. (Accessed July 31, 2004).

———. "Regional Agricultural Trade Intelligence Network Food Trade Bulletin for East Africa." 2004a. Internet address: http://www.fews.net. (Accessed July 28, 2004).

———. "Food Security Lags behind Economic Growth in Uganda." 2004b. Internet address: http://www.fews.net. (Accesed July 20,2004).

Food and Agricultural Organsation of the United Nations (FAO). "The State of Food and Agriculture." Part II Regional Overview 1998. Internet address: http://www.fao.org. (Accessed May 15, 2004).

Garbade, K.D., and W. L. Silber. "Price Movements and Price Discovery in Futures and Cash Markets." *The Review of Economics and Statistics* 65(1983): 289-97.

Geiger, D., T. Verma, and J. Pearl. "Identifying Independencies in Bayesian Networks." *Networks* 20(1990):507-34.

Granger, C.W.J., and P.Newbold. "Spurious Regressions in Econometrics." *Journal of Econometrics* 2(1974):111-20.

Granger, C.W.J. "Testing for Causality. A Personal Viewpoint." *Journal of Economic Dynamic and Contro*l 2(1980):329-352.

Griffiths, W.E., R.C. Hill, and G.G. Judge. *Learning and Practicing Econometrics* NewYork: Wiley and Sons. 1993.

International Institute of Tropical Agriculture (IITA). "Developing Better Business Support for SMEs." Internet address: http://www.iita.org (Accessed May 02, 2004).

Jerko, C.A., J.W. Mjelde, and D.A. Bessler. "Dynamic Interactions in the Western United States Electricity Spot Markets." Unpublished typescript, Texas A&M University, College station (2004).

Joen, B.N., and G.M. Von Furstenberg. "Growing International Co-movement in Stock Price Indexes." *Quarterly Review of Economics and Business*. 30(1990):15-30.

Kalloo, M.S. "The Efficiency of Bulk and Fine/Flavor Cocoa Markets: The Case of Trinidad and Tobago." M.S. thesis. Texas A&M University, College Station, 2002.

Mjelde, J.W., and M.S. Paggi. "An Empirical Analysis of Intergrational Price Linkages." *Journal of Regional Science* 29(1989):171-90.

Morrissey, O., N. Rudaheranwa and L. Moller. Trade Policies, Performance And Poverty in Uganda." 2003. Internet address: http://www.odi.org.uk. (Accessed September 06, 2004).

Muganga, A.K., G. Okoboi, and M.T Nahamya. "Market Information Service (MIS), Third Report." Project report for Market Information Service/ International Institute of Tropical Agriculture (MIS/IITA) (April-June 2000). Internet address: http://www.foodnet.cgiar.org (Accessed July 02, 2004).

Muganga, A.K., G. Okoboi, M.T. Nahamya, and M. Namanya. "Market Information Service (MIS), Fourth Report." Project report for Market Information Service/ International Institute of Tropical Agriculture (MIS/IITA) (July-September 2000). Internet address: http://www.foodnet.cgiar.org (Accessed July 02, 2004).

Muganga A.K., M. Namanya, and E.K. Matovu. "Market Information Service (MIS), Fifth Report." Project report for Market Information Service/ International

Institute of Tropical Agriculture (MIS/IITA) (October-December 2000). Internet address: http://www.foodnet.cgiar.org. (Accessed August 31, 2004).

———. "Market Information Service (MIS), Sixth Report." Project report for Market Information Service/ International Institute of Tropical Agriculture (MIS/IITA) (January-March 2001). Internet address: http://www.foodnet.cgiar.org. (Accessed August 31, 2004).

Ousmane, B., and G. E. Shively. "The Response of Local Maize Prices to the 1983 Currency Devaluation in Ghana." Internet address: http://www.ifpri.org (Accessed Dec. 2004).

Papineau, D. "Causal Asymmetry." *British Journal of Philosophical Science* 36(1985):273-289.

Pearl, J. "Causal Diagrams for Empirical Research." *Biometrica* 82(1995):669-710.

Rapsomanikis, G., D. Hallam, and P. Conforti. "Market Integration and Price Transmission in Selected Food and Cash Crop Markets of Developing Countries: Review and Applications." Internet address: http://www.fao.org. (Accessed Dec, 2004).

Rashid, S. "Dynamics of Maize Markets Integration after Liberalization." In *Policies For Improved Land Management in Uganda: Second National Workshop*, eds. E. M. Nkonya, D. Sserunkuuma, and J. Pender. International Food Policy Research Institute, Washington, DC:2002.

———. Spatial Integration of Maize Markets in Post-liberalised Uganda" *Journal of African Economies* 13(March, 2004):102-33.

Regional Agricultural Trade Intelligence Network (RATIN). "Seasonal Drop in Wholesale Maize and Bean Prices in Kenya and Uganda Imminent." Internet address: http://www.ratin.net . (Accessed August 02, 2004).

Reliefweb/ US Agency for International Development (USAID). "LRA activity wanes but aid supply problematic" Uganda Monthly Report 2003a Internet address: http://www.reliefweb.int. (Accessed June 20, 2004).

———. **"**Shortfalls expected for food aid pipeline." Uganda Monthly Report 2003b. Internet address: http://www.reliefweb.int. (Accessed June 20, 2004).

Robbins P. and S. Ferris. "A Preliminary Study of the Maize Marketing System in Uganda and the Design of a Market Information System." Consultancy Report for Foodnet, Commodity Marketing Information Services (CMIS), and International Institute of Tropical Agriculture (IITA). (1999a). Internet address: http://www.foodnet.cgiar.org. (Accessed May 02, 2004).

———. "Stakeholders Meetings for Strengthening the Market Information Service in Uganda." Consultancy Report for Foodnet, Commodity Marketing Information Services (CMIS), and International Institute of Tropical Agriculture (IITA). (1999b). Internet address: http://www.foodnet.cgiar.org. (Accessed May 02, 2004).

Scheines, R., P. Spirtes, C. Glymour, and C, Meek. *Tetrad II: Tools for Causal Modelling. Users Manual*. Earlbaum, Hillsdale, NJ. 1994.

Schroeder, T. C., C. E. Ward, J. Mintert, and D. S. Peel. "Beef Industry Price Discovery: A Look Ahead." In *Price Discovery in Concentrated Livestock Markets: Issues, Answers, Future Directions*, ed W. Purcell. Research Institute on Livestock Pricing, Virginia Tech, Blacksburg:1997.

Sims, C. "Macroeconomics and reality." *Econometrica*, 48(1980):1- 48.

Spirtes, P., C. Glymour, and R. Scheines. *Causation, Prediction, and Search*. MIT Press: Cambridge, MA 2000.

Uganda Bureau of Statistics (UBOS). *Statistical Abstract*. Entebbe, Uganda, 2003.

———. "Uganda National Household Survey 1999/2000, Report on Crop Module." 2002, Entebbe, Uganda.

Vera, F. "Three Essays on Directed Graphs and Model Selection." Ph.D. dissertation. Texas A&M University, College Station, 2000.

Wattam, M. "The Western Uganda Road Maintenance Project, a Case Study in Community Participation" 1999. Internet address: http://www.transport-links.org (Accessed Aughust 2004).

World Bank Group. "Uganda Data Profile." Internet address: http://devdata.worldbank.org. (Accessed May 05, 2004).

Yang, J., and D.J. Leathum. "Price Discovery in Wheat Futures Markets." *Journal of Agricultural Applied Economics* 31(August 1999):359-70.

Yang, J., and D A. Bessler. "The International Price Transmission in Stock Index Futures Markets." *Economic Inquiry* 42(2003):370-86.

APPENDIX

Wholesale prices for beans

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2000/1	450	250	230	280	180	150	250	400	280	350	350	200	150	350	270	235
2000/2	600	140	200	300	190	200	250	400	250	350	360	200	150	350	280	224
2000/3	650	250	230	220	200	150	270	350	230	400	250	200	150	350	280	241
2000/4	400	250	230	250	200	120	230	350	220	380	275	200	150	350	280	249
2000/5	450	250	230	300	150	120	230	350	220	400	275	200	150	400	280	216
2000/6	400	250	230	300	200	130	300	330	200	400	280	200	150	320	280	245
2000/7	400	250	230	300	200	150	300	350	180	400	300	200	150	320	300	225
2000/8	450	270	300	320	200	180	300	350	170	400	300	200	200	350	270	223
2000/9	500	250	220	300	200	180	350	350	160	300	280	200	200	350	270	223
2000/10	450	270	220	350	200	180	350	350	170	300	300	200	200	350	250	268
2000/11	450	200	230	350	200	200	300	350	150	350	300	200	150	350	270	276
2000/12	450	250	230	360	200	200	300	330	150	300	300	250	150	350	270	280
2000/13	450	300	400	360	210	200	300	330	150	300	300	300	200	400	270	285
2000/14	500	350	280	360	230	220	300	400	170	300	300	300	250	400	270	309
2000/15	450	300	200	360	280	250	400	450	170	350	300	300	200	400	280	323
2000/16	400	300	350	350	250	250	400	450	250	350	300	300	250	400	300	350
2000/17	450	320	350	360	260	250	350	450	300	350	300	300	200	400	280	363
2000/18	500	350	350	360	300	280	350	450	180	350	300	350	200	350	280	408
2000/19	600	350	350	430	300	350	350	400	300	350	300	350	200	350	300	507
2000/20	500	350	450	400	300	400	350	400	300	300	300	350	240	420	300	549
2000/21	500	320	450	370	350	400	400	400	350	350	350	400	250	430	300	557
2000/22	500	300	350	380	300	350	400	400	350	350	350	350	300	450	350	525
2000/23	450	300	350	350	400	350	400	450	350	300	400	350	300	450	500	408
2000/24	450	350	350	320	300	300	350	400	350	350	400	300	250	480	300	390
2000/25	500	350	350	320	320	200	350	400	350	350	350	300	250	500	300	381
2000/26	450	400	350	330	350	250	350	450	350	350	300	350	250	450	400	367
2000/27	450	400	350	320	370	250	400	450	350	350	300	350	300	400	300	365
2000/28	450	300	360	300	370	280	400	450	350	350	350	350	250	400	330	375
2000/29	450	300	350	350	370	350	300	460	350	350	300	350	250	400	330	382

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2000/30	450	350	350	400	350	350	350	460	350	350	330	400	300	450	400	430
2000/31	400	370	350	400	400	400	350	460	370	420	330	450	350	460	400	473
2000/32	500	400	470	480	450	400	400	600	400	400	350	500	350	450	450	501
2000/33	500	450	470	500	450	500	400	500	450	400	500	500	400	520	430	487
2000/34	500	450	460	550	450	500	400	500	400	450	450	500	400	550	500	477
2000/35	450	550	470	550	425	400	540	570	400	450	350	500	400	450	500	451
2000/36	400	600	470	600	400	400	540	520	450	500	405	500	450	485	500	480
2000/37	400	600	470	750	500	400	500	600	450	500	460	500	500	520	500	554
2000/38	400	550	470	650	550	450	470	600	500	500	460	650	450	500	450	569
2000/39	400	450	500	600	550	500	350	550	550	500	450	650	550	480	500	538
2000/40	400	400	500	650	550	500	470	530	600	450	400	650	450	500	430	561
2000/41	500	450	500	600	600	530	470	450	600	450	420	650	600	500	415	567
2000/42	500	400	500	600	700	550	500	450	600	450	450	600	500	500	400	567
2000/43	500	350	550	500	800	500	480	600	600	450	450	700	600	520	450	576
2000/44	500	350	500	500	700	330	450	550	600	450	450	700	550	500	450	567
2000/45	450	300	500	450	500	330	450	550	550	450	450	500	650	500	450	553
2000/46	450	500	500	450	490	380	480	550	550	400	460	500	650	500	450	504
2000/47	450	350	450	400	480	270	330	500	550	450	460	500	650	500	450	455
2000/48	450	350	450	400	450	250	330	500	500	450	460	500	650	520	450	436
2000/49	450	350	450	450	430	240	350	500	400	450	450	400	650	500	450	432
2000/50	450	300	450	450	450	330	350	500	350	400	450	420	450	500	450	395
2000/51	450	270	450	500	420	350	350	500	330	400	480	420	250	500	450	381
2000/52	450	350	450	500	400	350	350	500	320	425	500	420	255	500	430	**383**
2001/1	450	300	450	500	400	350	350	500	300	450	500	400	257	520	430	394
2001/2	450	380	530	400	400	380	350	400	230	450	500	400	300	500	500	456
2001/3	400	300	400	500	420	450	450	500	300	450	500	500	350	550	500	470
2001/4	450	330	400	450	430	450	450	500	330	450	550	550	400	550	500	499
2001/5	450	350	450	500	460	450	450	500	350	450	550	550	400	550	550	511
2001/6	450	350	450	450	440	480	460	500	400	500	560	550	400	600	600	529
2001/7	500	350	450	620	420	500	550	500	400	550	600	550	400	600	600	515
2001/8	450	350	500	600	550	500	630	500	450	550	600	525	400	700	600	500
2001/9	500	350	600	570	470	530	550	500	420	550	600	500	450	700	600	500

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2001/10	500	350	600	600	600	530	500	500	450	550	600	550	450	700	600	500
2001/11	500	350	600	650	600	600	500	500	400	550	650	600	475	700	600	535
2001/12	500	400	600	750	600	600	500	500	450	600	700	550	500	650	600	570
2001/13	500	400	650	730	650	630	580	500	400	650	700	630	500	675	650	570
2001/14	500	400	700	730	650	650	580	500	600	650	700	600	450	700	650	606
2001/15	450	400	750	780	650	650	650	500	600	650	700	600	400	700	650	618
2001/16	500	400	700	750	650	650	750	500	600	650	650	600	400	700	630	647
2001/17	500	450	720	675	650	650	550	500	600	650	650	600	400	700	650	619
2001/18	500	500	700	600	650	650	700	720	600	650	650	600	350	700	600	594
2001/19	500	500	700	550	650	650	750	720	600	650	670	600	350	800	650	683
2001/20	500	500	500	500	650	650	600	720	500	650	700	600	450	800	700	710
2001/21	500	400	500	450	550	600	800	720	500	650	700	700	500	780	650	633
2001/22	600	400	450	450	450	600	700	720	450	500	600	700	550	680	600	519
2001/23	600	400	450	450	360	550	600	720	450	450	400	500	550	600	500	468
2001/24	600	400	350	380	400	500	600	620	450	400	350	450	550	500	400	410
2001/25	600	350	300	350	365	500	600	600	450	450	300	450	250	450	300	408
2001/26	525	450	300	350	330	350	500	550	450	400	300	450	350	450	300	410
2001/27	550	400	300	350	380	350	500	500	450	400	300	450	250	450	400	410
2001/28	450	430	300	350	380	400	550	420	450	400	350	500	250	450	400	365
2001/29	400	500	330	350	420	450	650	420	450	400	350	500	250	500	450	383
2001/30	500	450	330	350	420	450	650	400	450	400	300	400	250	500	370	395
2001/31	450	400	350	350	400	400	530	400	450	450	350	400	350	470	370	383
2001/32	450	400	330	400	350	400	550	400	470	450	350	400	350	470	430	383
2001/33	450	400	450	400	420	400	550	400	470	400	350	400	400	480	330	374
2001/34	450	450	450	400	400	350	450	400	480	450	350	400	500	480	330	377
2001/35	400	450	450	450	380	350	450	400	460	450	350	400	500	480	330	400
2001/36	400	450	450	450	400	330	450	400	460	450	400	400	500	420	350	395
2001/37	400	400	450	450	410	330	450	400	470	430	400	400	500	420	350	401
2001/38	400	450	500	450	420	400	450	400	480	450	350	400	500	500	350	391
2001/39	400	350	550	450	420	400	400	400	500	450	350	400	500	450	300	400
2001/40	400	350	430	400	400	400	400	400	500	400	400	400	500	440	300	397
2001/41	350	375	380	350	420	400	400	400	550	400	400	400	500	420	270	395
2001/42	400	400	320	250	400	400	450	400	550	400	400	350	500	400	250	397

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2001/43	500	350	300	250	400	350	450	400	500	400	350	350	450	400	300	364
2001/44	600	300	300	250	400	300	450	400	500	400	300	350	400	400	300	374
2001/45	450	300	250	280	420	280	450	400	400	400	300	350	350	400	300	389
2001/46	450	300	250	280	350	280	400	400	380	400	300	350	350	400	300	363
2001/47	450	400	250	280	350	250	450	400	370	450	350	350	400	350	300	345
2001/48	400	400	270	280	350	250	450	400	380	400	300	350	350	400	300	325
2001/49	400	400	270	300	320	250	450	420	350	400	300	350	200	400	300	303
2001/50	350	400	270	350	310	250	450	420	330	400	300	350	150	400	300	302
2001/51	400	400	300	350	300	280	450	420	330	400	300	350	140	400	300	314
2001/52	400	400	300	350	300	300	450	420	330	400	300	350	139	400	300	312
2002/1	400	400	300	350	280	300	450	420	330	450	350	350	180	400	320	340
2002/2	400	450	420	350	270	330	450	420	280	450	350	350	140	400	350	399
2002/3	350	450	430	350	260	330	450	420	280	450	350	350	150	450	360	349
2002/4	350	500	420	400	250	350	250	420	300	500	300	350	180	400	380	320
2002/5	400	450	420	450	280	350	300	420	300	450	350	400	200	420	380	305
2002/6	400	400	420	430	300	380	450	420	300	450	400	400	250	400	380	318
2002/7	400	450	430	420	300	400	450	420	260	450	380	400	250	400	400	335
2002/8	400	500	420	420	350	450	450	400	330	450	380	400	260	420	500	335
2002/9	400	550	420	430	300	450	450	400	300	450	350	400	300	450	500	355
2002/10	450	500	450	420	300	450	500	400	300	400	350	400	350	450	500	412
2002/11	400	500	450	400	340	450	500	400	300	450	400	350	350	450	520	417
2002/12	400	500	420	450	350	500	500	400	300	450	400	350	350	450	550	448
2002/13	400	500	420	400	380	550	500	400	300	400	350	350	350	450	500	443
2002/14	400	550	420	350	350	600	500	400	300	400	400	350	350	450	500	502
2002/15	400	550	300	350	350	500	500	400	300	400	400	350	400	450	480	500
2002/16	400	550	300	250	400	500	500	450	300	400	400	350	400	450	500	495
2002/17	400	550	400	250	430	450	550	450	300	450	400	400	350	450	600	494
2002/18	400	450	400	380	400	450	550	450	300	450	400	400	350	500	600	504
2002/19	400	450	430	380	400	450	550	450	300	400	450	400	350	500	600	542
2002/20	400	500	400	400	350	450	500	450	350	450	450	400	400	500	600	461
2002/21	400	500	400	400	350	450	550	450	350	450	400	350	400	500	550	407
2002/22	550	500	400	400	320	400	550	450	350	400	400	300	300	550	400	345
2002/23	600	500	350	350	320	400	550	340	350	400	400	300	300	550	370	322

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2002/24	450	450	300	350	350	300	550	340	350	400	400	250	300	400	300	302
2002/25	450	470	300	300	350	270	550	340	300	350	400	250	300	400	300	322
2002/26	450	450	320	300	320	270	370	400	280	350	350	250	300	380	300	318
2002/27	450	370	330	340	350	270	400	400	300	350	350	250	350	380	300	319
2002/28	400	400	340	300	350	270	400	400	300	350	300	350	350	380	350	322
2002/29	350	350	350	320	350	270	400	400	300	350	300	350	350	380	380	321
2002/30	400	350	350	350	350	280	450	400	300	350	400	400	300	380	380	342
2002/31	500	350	350	350	320	280	450	400	350	400	400	350	300	400	400	380
2002/32	450	450	350	350	400	330	450	450	350	400	350	350	350	450	380	408
2002/33	450	500	400	350	350	350	550	450	400	450	350	350	350	450	400	388
2002/34	450	500	350	350	320	350	550	450	400	450	360	350	350	450	420	413
2002/35	400	550	400	330	400	400	550	450	400	450	400	350	350	470	400	431
2002/36	380	470	400	400	450	400	400	430	500	450	400	350	300	470	420	435
2002/37	380	450	400	400	450	400	400	430	500	450	400	350	350	480	420	424
2002/38	400	450	400	400	450	450	350	430	500	450	400	350	350	450	450	431
2002/39	400	450	400	400	450	450	400	430	500	450	350	400	350	450	400	449
2002/40	400	400	400	450	460	500	400	430	500	400	350	450	350	450	400	452
2002/41	400	400	400	400	500	500	300	430	500	400	350	450	350	470	450	452
2002/42	400	370	400	400	470	500	350	430	500	400	350	450	360	460	450	468
2002/43	400	400	400	400	500	500	400	450	500	350	400	450	360	460	420	461
2002/44	400	420	400	400	500	500	400	450	550	400	400	450	370	480	450	458
2002/45	400	430	500	500	500	400	450	450	550	350	400	450	380	480	450	432
2002/46	380	450	500	450	500	270	400	450	550	400	400	450	400	480	450	485
2002/47	380	400	500	450	360	250	350	450	500	400	400	400	400	480	450	361
2002/48	450	400	500	500	350	270	350	480	450	350	450	380	400	480	450	363
2002/49	380	350	500	500	500	270	400	480	400	400	450	275	400	480	450	381
2002/50	350	430	500	500	380	270	400	430	400	400	450	250	400	470	450	385
2002/51	350	380	500	500	380	370	400	450	350	400	450	300	400	470	500	429
2002/52	350	380	500	500	380	370	450	450	350	450	450	300		480	500	419
2003/1	350	380	450	500	400	370	450	450	350	450	450	350	300	480	600	429
2003/2	350	450	450	500	400	400	450	450	350	450	450	400	250	480	550	458
2003/3	300	430	400	500	420	450	450	550	320	450	450	400	250	500	500	408
2003/4	400	500	500	500	400	450	450	550	300	450	450	400	200	600	500	398

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2003/5	350	500	500	500	400	480	400	450	300	450	450	400	200	600	500	390
2003/6	350	500	500	500	400	400	400	450	280	450	470	420	350	600	480	418
2003/7	350	450	500	500	400	450	550	450	280	450	450	400	350	600	480	438
2003/8	380	500	500	550	400	400	500	420	300	450	450	350	350	600	480	443
2003/9	380	450	500	550	380	400	450	500	350	450	450	350	400	600	480	453
2003/10	380	450	500	550	380	400	450	450	350	450	470	400	420	550	500	475
2003/11	380	450	500	550	380	430	450	450	350	450	550	400	400	550	550	505
2003/12	380	500	550	550	450	430	450	500	350	450	500	400	420	600	580	560
2003/13	350	500	550	550	450	450	500	500	400	450	650	450	430	600	600	533
2003/14	360	500	550	550	400	450	500	500	400	450	600	450	450	650	650	588
2003/15	380	400	550	550	400	470	500	500	450	450	600	450	400	650	650	638
2003/16	380	400	550	550	400	430	550	500	450	450	650	480	400	600	650	628
2003/17	380	400	550	550	450	430	550	500	450	500	600	500	400	600	650	663
2003/18	380	500	450	550	450	430	550	500	450	500	600	550	400	650	650	738
2003/19	380	500	550	550	450	500	550	550	500	550	600	550	400	700	650	725
2003/20	380	550	450	500	450	700	550	600	500	500	600	550	450	700	650	745
2003/21	390	550	450	500	450	700	550	600	500	550	650	500	500	700	650	840
2003/22	400	550	450	450	450	750	550	590	500	550	650	500	500	700	650	725
2003/23	400	550	500	450	550	750	550	580	500	500	600	500	500	850	700	645
2003/24	400	600	500	450	450	330	550	580	450	550	400	450	400	700	550	525
2003/25	450	550	450	400	450	300	450	580	450	450	400	350	400	550	450	463
2003/26	450	500	450	500	450	300	450	450	450	400	400	350	400	450	400	390
2003/27	380	500	450	550	450	300	450	450	400	400	400	350	250	430	400	428
2003/28	380	450	450	500	450	400	450	490	400	400	350	450	250	450	420	450
2003/29	400	500	500	500	500	350	450	500	400	400	400	450	300	480	450	425
2003/30	400	500	500	450	550	350	450	420	350	400	400	450	300	470	450	430
2003/31	400	500	500	500	500	360	450	420	350	450	400	450	350	470	450	428
2003/32	400	500	550	550	500	370	400	450	400	400	350	450	350	460	450	413
2003/33	400	470	550	550	520	370	450	450	400	450	400	350	350	460	450	420
2003/34	390	500	490	550	520	380	450	400	400	450	350	400	400	480	450	433
2003/35	380	500	490	500	550	420	450	400	450	470	400	450	400	490	450	438
2003/36	400	550	490	500	550	450	450	450	450	450	400	450	350	490	450	458
2003/37	350	550	500	550	480	500	350	450	500	470	450	450	360	490	450	438

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2003/38	380	550	500	550	550	500	350	450	500	450	450	450	360	500	400	443
2003/39	400	500	500	550	480	400	350	450	500	470	400	450	360	500	400	440
2003/40	400	500	500	550	480	350	350	450	450	470	400	450	350	450	380	433
2003/41	400	500	500	550	480	350	350	450	450	450	400	450	350	450	370	433
2003/42	400	450	480	500	450	420	400	450	450	450	400	400	350	450	420	455
2003/43	400	450	480	550	480	420	350	475	450	450	400	400	350	450	400	428
2003/44	400	450	500	350	480	400	350	475	450	450	400	400	320	450	400	453
2003/45	400	450	450	350	520	400	380	450	500	450	400	400	350	450	450	448
2003/46	400	450	430	350	520	400	350	450	500	450	400	400	350	450	450	420
2003/47	400	480	430	400	520	350	350	450	500	400	470	400	350	450	450	413
2003/48	400	500	400	400	450	300	350	450	450	450	450	350	350	470	450	413
2003/49	600	400	400	400	480	280	400	500	450	450	450	350	350	470	470	480
2003/50	500	380	400	420	380	260	400	500	450	450	450	350	300	470	450	390
2003/51	500	380	400	370	400	350	400	500	450	450	450	350	300	450	450	400
2003/52	500	470	400	370	380	350	380	500	450	450	450	350	300	450	450	393

Wholesale prices of maize

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2000/1	200	120	175	185	200	100	180	250	300	170	180	180	300	130	200	191
2000/2	210	140	150	145	200	100	180	250	300	170	190	150	200	130	180	174
2000/3	260	140	150	160	200	100	160	280	300	170	180	150	180	145	180	163
2000/4	210	150	150	150	200	100	180	270	280	150	180	150	200	150	170	166
2000/5	220	150	150	165	150	100	180	280	270	150	180	150	150	150	160	165
2000/6	180	140	150	165	180	100	180	250	180	150	180	150	150	165	160	167
2000/7	170	170	150	160	220	100	160	250	170	150	185	150	130	180	170	165
2000/8	140	150	150	150	160	150	180	250	160	160	185	150	140	180	170	165
2000/9	110	140	150	170	170	150	180	250	170	160	185	120	140	180	180	165
2000/10	210	150	150	170	180	150	180	250	160	160	185	120	130	180	180	168
2000/11	150	150	150	175	160	150	180	230	150	150	185	120	150	180	180	169
2000/12	130	130	155	170	160	160	180	220	150	160	185	130	150	200	200	170
2000/13	130	150	160	200	190	200	180	220	160	180	215	150	150	200	200	193

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2000/14	150	150	220	220	200	220	200	220	170	200	230	150	180	200	250	231
2000/15	350	180	230	235	250	250	250	200	170	230	270	200	200	200	250	246
2000/16	350	200	230	245	250	250	250	200	230	250	270	200	220	200	250	248
2000/17	250	200	220	240	230	250	250	200	250	270	270	200	230	350	280	250
2000/18	300	200	220	245	220	280	250	230	180	250	245	200	220	270	280	247
2000/19	300	200	220	230	200	300	280	220	250	250	245	250	200	280	280	243
2000/20	300	210	220	240	220	250	250	220	250	230	255	250	210	250	300	240
2000/21	300	220	230	245	280	230	260	220	230	230	265	250	200	260	300	243
2000/22	290	220	250	260	230	250	250	230	250	270	265	250	200	240	300	286
2000/23	310	220	270	260	280	250	250	220	280	250	285	250	200	250	300	286
2000/24	310	230	280	260	230	250	250	250	300	270	340	250	250	280	280	290
2000/25	300	250	270	250	220	250	250	250	330	300	320	250	250	300	300	315
2000/26	320	230	260	260	250	250	350	345	330	330	350	250	250	300	300	336
2000/27	330	280	300	260	330	280	350	345	350	350	350	250	250	350	350	335
2000/28	330	300	300	280	320	300	350	350	350	350	270	170	280	350	300	330
2000/29	300	300	250	260	300	300	350	350	350	350	290	170	280	300	280	334
2000/30	330	300	250	250	300	350	250	260	300	330	290	170	300	350	300	294
2000/31	330	270	210	225	300	250	250	260	330	220	265	200	300	320	280	270
2000/32	300	250	230	250	250	250	280	400	350	220	260	200	250	250	250	271
2000/33	300	230	230	250	300	250	250	300	380	220	300	200	250	300	250	278
2000/34	300	220	240	250	300	270	220	320	380	220	270	250	250	300	250	273
2000/35	300	250	240	230	300	250	210	330	380	220	210	250	250	270	230	256
2000/36	300	250	240	235	300	500	210	300	400	200	225	250	260	250	200	257
2000/37	350	250	250	265	350	250	230	200	400	220	240	250	260	250	220	255
2000/38	300	220	250	270	350	250	220	230	400	230	240	300	260	250	240	247
2000/39	310	200	250	250	350	280	230	200	400	220	240	300	300	240	240	251
2000/40	400	200	230	230	400	300	210	200	400	200	220	300	300	230	230	251
2000/41	350	200	230	240	330	280	230	210	400	200	250	350	310	250	240	257
2000/42	400	200	250	260	310	300	250	200	420	220	250	350	280	250	250	262
2000/43	400	200	240	265	320	300	220	350	450	220	250	300	290	235	260	264
2000/44	400	220	260	280	310	300	220	300	450	230	250	350	300	250	270	266
2000/45	400	200	250	265	315	300	220	300	400	230	250	350	320	240	260	266
2000/46	450	200	250	280	317	300	230	300	400	235	270	350	315	240	250	267

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2000/47	400	200	250	250	320	300	220	300	400	235	265	350	310	240	250	267
2000/48	350	200	250	250	400	300	220	200	400	240	265	350	300	240	260	268
2000/49	350	200	230	235	300	300	250	300	600	240	250	350	310	220	220	268
2000/50	350	180	230	210	300	200	220	300	350	230	250	320	280	220	220	268
2000/51	300	180	180	170	280	190	220	300	350	180	200	320	250	210	210	268
2000/52	**300**	180	170	180	280	150	180	300	350	180	210	320	250	200	170	210
2001/1	450	170	180	200	280	150	230	250	350	180	210	300	250	200	170	233
2001/2	450	200	170	180	200	130	180	250	350	200	200	300	280	200	170	213
2001/3	400	170	170	170	230	140	230	250	330	180	195	250	280	210	180	200
2001/4	350	150	160	170	170	130	230	230	350	180	190	250	180	190	170	197
2001/5	300	180	165	175	180	150	230	200	350	180	195	250	180	220	170	195
2001/6	300	200	160	170	185	150	180	200	300	180	200	250	150	200	170	202
2001/7	300	180	170	195	190	150	190	200	300	180	200	250	170	200	180	205
2001/8	300	180	180	210	200	200	190	200	270	190	220	225	180	200	210	213
2001/9	300	170	210	215	230	200	200	200	250	190	225	200	180	200	200	219
2001/10	300	150	210	215	230	200	240	250	230	220	230	200	180	210	220	220
2001/11	300	150	213	217	200	200	240	250	200	220	230	200	175	230	220	220
2001/12	300	170	190	215	220	200	240	250	180	220	235	200	170	230	220	220
2001/13	300	200	190	210	230	200	220	250	180	220	230	200	170	225	220	220
2001/14	280	200	195	200	230	215	220	250	180	230	225	200	170	225	220	215
2001/15	280	200	190	207	220	200	230	250	170	230	225	200	180	225	210	206
2001/16	280	220	200	195	200	200	240	250	200	230	225	180	180	220	200	208
2001/17	380	220	200	190	200	190	230	250	200	230	225	180	170	220	200	207
2001/18	250	220	200	185	200	200	230	200	180	220	205	180	160	220	200	217
2001/19	240	210	170	185	200	190	230	230	180	200	200	150	150	200	200	195
2001/20	250	200	160	165	170	190	180	230	160	200	200	180	170	200	200	187
2001/21	230	220	150	160	170	165	180	230	170	200	190	200	170	200	200	185
2001/22	300	200	170	160	170	165	230	230	170	180	190	200	160	200	200	181
2001/23	250	200	160	160	220	165	200	230	170	180	185	200	160	200	200	173
2001/24	250	200	150	160	170	140	190	230	170	180	185	200	160	200	200	177
2001/25	250	250	140	140	170	140	200	225	170	180	175	180	160	190	180	168
2001/26	290	180	120	130	170	140	200	220	180	150	170	180	150	190	180	169
2001/27	260	180	120	130	180	140	200	220	180	130	180	180	150	160	180	173

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2001/28	250	180	125	130	180	110	200	220	150	120	180	180	150	155	150	175
2001/29	240	150	100	100	170	110	160	220	170	120	115	180	130	150	130	150
2001/30	240	150	70	90	180	110	160	220	200	110	120	280	130	150	120	143
2001/31	240	150	60	110	170	70	120	210	150	100	115	280	130	140	120	137
2001/32	235	120	100	110	100	80	130	210	160	100	80	280	130	120	120	128
2001/33	230	150	75	85	150	90	130	120	160	70	100	150	130	100	100	115
2001/34	270	120	70	75	140	90	120	120	170	60	80	150	130	100	100	98
2001/35	220	100	65	75	130	90	100	120	150	60	80	150	150	90	80	97
2001/36	210	100	60	75	100	70	90	80	120	70	90	150	130	80	80	121
2001/37	210	120	50	75	125	85	90	80	100	70	90	150	135	90	80	101
2001/38	190	90	90	97	150	95	90	80	80	70	95	150	127	80	100	113
2001/39	150	120	80	97	150	100	70	80	80	70	95	150	120	90	100	111
2001/40	150	100	80	85	150	90	70	90	80	75	100	150	130	80	100	108
2001/41	150	100	80	85	150	85	70	90	70	70	95	150	130	85	100	98
2001/42	150	100	80	100	150	85	80	90	80	65	85	150	120	90	100	94
2001/43	150	130	60	80	130	85	80	60	90	65	80	150	110	90	100	109
2001/44	140	120	60	68	100	80	80	60	95	70	85	200	100	90	100	96
2001/45	140	110	60	68	100	70	80	62	100	70	85	200	100	90	100	95
2001/46	130	100	60	70	120	70	80	65	80	70	90	170	100	90	100	97
2001/47	150	100	65	82	120	70	80	60	80	60	90	170	100	90	100	98
2001/48	160	100	80	82	135	75	80	60	70	60	95	170	110	90	90	101
2001/49	160	100	80	82	120	75	80	65	70	60	105	170	110	90	80	95
2001/50	150	100	90	85	150	75	80	65	70	65	105	170	80	90	90	97
2001/51	130	120	80	85	150	75	80	65	70	65	90	150	80	90	100	95
2001/52	120	130	80	85	150	80	80	55	70	65	85	150	80	90	100	95
2002/1	120	120	85	85	130	80	80	65	75	65	100	150	80	100	100	101
2002/2	120	100	70	87	120	60	80	65	85	70	110	150	80	85	100	126
2002/3	110	100	80	90	120	60	80	100	85	80	110	155	80	120	100	120
2002/4	100	100	80	100	120	70	40	100	85	80	90	155	80	100	100	124
2002/5	100	100	90	105	120	100	40	100	80	70	110	160	80	100	100	119
2002/6	100	130	100	105	120	100	80	130	75	70	120	120	80	100	100	129
2002/7	110	130	100	115	150	100	90	130	75	90	120	120	80	100	120	129
2002/8	120	120	120	130	150	90	100	130	75	100	120	160	80	100	140	132

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2002/9	110	120	110	120	160	90	100	130	80	100	120	160	80	100	140	135
2002/10	120	130	100	120	160	100	100	130	80	100	120	160	80	100	140	137
2002/11	120	150	100	120	150	100	100	140	90	100	145	160	80	140	130	135
2002/12	125	150	110	120	180	100	130	140	130	120	135	100	80	140	130	133
2002/13	120	150	110	120	120	100	130	140	150	110	130	100	80	140	130	129
2002/14	135	150	100	125	120	100	130	140	150	120	130	80	80	140	130	129
2002/15	90	150	120	120	120	110	130	140	150	120	135	80	80	140	130	139
2002/16	100	150	120	120	100	110	130	160	150	120	150	80	80	140	150	163
2002/17	100	170	300	120	100	140	170	160	120	150	150	80	90	190	200	184
2002/18	220	200	300	160	120	140	170	160	120	150	150	80	90	190	200	197
2002/19	220	200	180	160	120	150	170	200	130	180	205	80	170	130	200	188
2002/20	220	220	190	195	150	160	180	200	150	170	205	80	180	130	200	194
2002/21	165	180	200	220	150	180	200	200	180	170	200	80	150	130	200	191
2002/22	220	170	250	240	150	160	230	230	180	170	190	80	170	210	200	198
2002/23	220	170	220	220	150	160	230	200	180	180	200	80	170	210	200	197
2002/24	220	180	200	200	200	180	230	200	200	170	205	80	170	210	220	219
2002/25	220	250	200	200	200	180	230	200	200	220	200	80	200	210	230	259
2002/26	220	270	200	170	140	200	200	200	180	230	240	80	220	200	250	242
2002/27	210	200	190	200	150	200	200	200	250	200	250	85	230	240	250	236
2002/28	250	200	170	160	150	180	200	250	250	180	165	90	230	220	190	180
2002/29	280	200	100	175	180	150	200	200	250	150	125	100	220	180	150	154
2002/30	280	200	90	150	180	130	200	200	200	140	170	110	150	170	130	163
2002/31	300	180	140	130	180	120	200	200	250	130	160	130	150	170	145	153
2002/32	300	170	130	135	150	150	180	200	250	130	140	150	160	180	140	149
2002/33	300	180	120	137	150	160	180	200	250	120	150	180	160	180	140	159
2002/34	300	180	110	155	170	150	170	200	250	130	175	180	160	180	160	171
2002/35	250	150	140	150	170	150	170	200	250	130	170	180	160	160	180	211
2002/36	240	150	200	200	150	150	180	200	250	170	195	180	160	170	200	209
2002/37	230	150	195	205	150	160	180	200	250	180	210	250	160	190	220	217
2002/38	240	170	210	205	150	210	180	250	250	180	215	250	230	210	220	245
2002/39	250	170	215	230	180	210	220	250	250	200	220	280	230	220	210	254
2002/40	250	200	250	260	200	240	220	250	250	230	260	300	230	230	230	272
2002/41	250	200	260	270	200	250	230	280	250	250	260	300	230	250	270	279

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2002/42	170	200	240	250	280	280	230	280	250	250	270	300	230	260	260	260
2002/43	180	230	240	260	270	280	220	280	250	230	260	300	230	240	250	254
2002/44	180	250	230	240	250	300	270	280	250	230	245	300	230	200	230	271
2002/45	185	250	250	260	250	300	230	280	250	250	240	350	230	220	250	297
2002/46	185	230	260	290	250	300	230	300	250	270	280	350	280	230	270	315
2002/47	170	250	260	340	250	300	230	380	300	300	280	350	290	280	300	326
2002/48	170	170	320	325	280	300	270	350	300	280	310	400	300	280	320	321
2002/49	175	230	300	325	305	350	270	350	300	270	310	400	310	270	300	324
2002/50	170	250	300	305	300	350	270	330	300	250	300	400	310	270	280	297
2002/51	170	240	310	305	310	250	270	350	300	250	270	400	270	260	250	291
2002/52	170	240	310	270	310	250	230	350	300	240	270	400	270	260	250	254
2003/1	180	240	200	270	300	210	230	350	300	240	270	400	270	260	240	246
2003/2	180	220	200	250	250	200	250	350	300	180	220	400	290	260	240	230
2003/3	180	230	210	220	250	200	250	300	250	130	220	400	280	230	220	210
2003/4	165	200	190	220	250	160	220	300	250	180	220	400	280	220	200	228
2003/5	165	200	200	210	250	160	210	250	250	200	230	400	280	240	200	226
2003/6	165	200	220	210	200	180	210	250	250	200	240	400	200	220	220	226
2003/7	165	220	220	220	220	180	220	250	280	195	230	250	200	230	220	223
2003/8	170	220	190	200	210	180	230	250	250	195	230	250	220	220	220	212
2003/9	170	220	200	210	200	180	230	250	230	190	230	180	160	220	220	204
2003/10	170	170	205	220	220	190	220	260	140	185	230	170	148	230	220	210
2003/11	170	170	210	220	200	200	220	260	140	190	230	160	160	230	230	223
2003/12	175	180	220	215	250	210	220	250	160	220	240	160	170	240	230	246
2003/13	170	200	210	210	250	220	250	250	150	220	270	160	175	240	260	255
2003/14	170	180	220	230	200	250	250	250	150	250	300	160	170	270	270	270
2003/15	195	220	270	280	200	260	250	260	170	250	300	200	200	280	280	299
2003/16	210	220	290	310	250	300	270	300	200	250	330	160	250	310	320	319
2003/17	230	220	290	320	250	310	270	300	250	300	330	200	280	330	320	324
2003/18	300	280	290	320	350	300	370	300	250	300	350	200	300	370	320	305
2003/19	300	260	310	330	350	300	350	350	280	300	350	200	300	350	300	301
2003/20	330	260	280	320	250	280	330	300	250	350	305	300	310	333	330	317
2003/21	340	250	280	330	250	290	330	300	250	310	320	300	300	330	330	337
2003/22	350	260	270	350	330	300	330	300	250	320	365	300	300	360	360	339

Week	Aru	Gul	Iga	Jin	Kab	Kas	Lra	Luw	Mas	Mdi	Mbl	Mbr	Rwa	Sor	Tor	Kam
2003/23	300	280	270	350	320	310	370	300	270	340	360	300	300	360	380	343
2003/24	310	300	270	310	270	310	350	300	280	340	370	300	310	360	370	349
2003/25	320	300	270	270	270	325	350	300	300	350	400	300	350	360	400	395
2003/26	350	300	280	300	300	325	360	400	350	350	430	300	340	400	450	406
2003/27	300	320	300	350	300	325	350	350	350	400	430	300	400	450	350	435
2003/28	300	380	320	380	300	360	350	330	400	360	420	300	400	450	400	460
2003/29	330	350	270	290	350	300	350	350	400	300	320	400	400	450	350	378
2003/30	350	350	270	270	300	170	250	320	300	250	290	400	400	300	300	299
2003/31	330	350	270	320	300	200	250	250	300	230	240	400	300	300	280	230
2003/32	330	250	310	320	300	170	200	250	300	200	235	400	300	220	200	234
2003/33	350	230	320	300	250	210	190	200	300	220	250	400	270	280	200	260
2003/34	400	200	280	220	250	210	190	200	280	220	230	400	280	250	260	256
2003/35	410	200	260	220	280	230	190	270	280	200	210	400	300	230	240	214
2003/36	350	200	240	200	400	240	190	260	280	180	200	300	300	230	220	228
2003/37	400	200	210	220	280	220	200	270	300	200	225	275	300	250	220	242
2003/38	350	200	220	230	250	220	220	260	300	200	225	275	300	200	220	236
2003/39	380	200	220	230	300	230	220	260	300	190	235	275	300	220	230	236
2003/40	380	180	240	250	300	250	200	250	270	200	240	275	250	230	230	239
2003/41	400	180	240	250	300	260	200	250	270	200	235	275	250	230	230	248
2003/42	390	200	230	250	250	260	200	300	280	210	250	275	300	230	240	242
2003/43	400	200	230	230	300	270	200	295	270	220	250	275	300	250	250	244
2003/44	390	200	230	240	250	280	200	295	270	220	250	275	300	230	250	248
2003/45	420	200	220	240	260	260	200	290	300	230	250	275	280	230	250	249
2003/46	420	200	220	240	260	250	220	290	300	230	245	275	300	220	250	259
2003/47	420	210	230	230	270	250	220	290	300	220	240	275	280	220	250	256
2003/48	400	220	230	250	250	250	220	290	300	220	240	275	300	220	230	248
2003/49	430	180	190	220	280	240	220	290	300	210	240	275	280	220	230	239
2003/50	400	180	190	230	250	240	220	280	300	200	255	275	270	220	240	251
2003/51	400	180	200	220	270	230	220	280	300	210	260	275	270	200	250	285
2003/52	400	230	210	220	250	230	240	300	210	210	270	275	270	200	260	245

VITA

Annette Kuteesa was born and raised in Uganda where she attended high school. In 2000 she graduated from Makerere University, Kampala with a B.Sc. degree in agriculture and with a minor in economics. In 2002 she joined Texas A&M University pursuing an M.S. degree in agricultural economics and graduated in May 2005. She worked as a teaching assistant in the Department of Agricultural Economics at the same university.

Permanent Address:
Bukoto –Nsimbiziwoome,
P.O. Box 22614,
Kampala, Uganda.