Vol. 7, Issue:1, January: 2019
ISSN:(P) 2347-5404 ISSN:(O)2320 771X

Food Price Volatility in urban areas of Rwanda: Short and Long Run Perspective Analysis

JEAN CHRYSOSTOME NGABITSINZE
Senior Lecturer, Department of Rural Development and Agricultural Economics, University of Rwanda

MARY KABARUNGI
Assistant Lecturer, Department of Animal Production, University of Rwanda

Abstract:
This study provides an empirical analysis of food price volatility in urban areas of Rwanda in short as well as in long run perspective. Both the theory and the empirical studies were viewed in order to identify behaviour of food price volatility function for the period (2005-2016) in terms of the factors described above. The study used Engle Granger co-integration method to find out co-integration between variables. The estimation of results from co-integration provides evidence of the food price volatility in long-run. Also, the coefficient of vector error correction term for the model of general food and vegetables price index is negatively and statistically significant and it is equal to -0.06 .This is an indicator, which shows that only vegetables price volatility could lead to general food price volatility in short run .Therefore the study suggest that, the economy should control all independent variables (bread and cereals, milk, cheese and eggs, fruit, meat and vegetables) in long run and vegetables prices especially in short term. Also policy makers should focus mainly on the organisation of producers in order to control market price.

Keywords: *Co-integration, vector error correction term, price volatility, price index, bread and cereals, milk, cheese and eggs, fruit, meat and vegetables*.

1. General Introduction

1.1 Introduction

The food price volatility is an international concern threatening the economy of developed and undeveloped countries and it starts with the sort of distinctive food markets where both supply and demand curves are highly inelastic, meaning neither responds much to price changes in the short run.

The price volatility and its effects on food security is a complex matter with many dimensions, agricultural and non-agricultural, short and long-term, with highly differentiated impacts generally on consumers and producers in developed and developing countries, particularly on businesses, consumers and farmers and the submission for a systematic and internationally coordinated response building on the lessons learned as a result of the 2007-2008 food crisis(FAO, 2011).

The food price volatility is one of the major challenges facing the global agricultural system today, this was most vibrantly illustrated during the global food crisis of 2007-2009 when price spikes occurred for key staple food commodities such as wheat, rice, maize, and soybeans. Given the variety of reactions by governments of countries experiencing similar food price shocks, the 2007-2009 crisis offered an excellent natural experiment for generating knowledge on responses to price volatility in particular and on the political economy of agricultural policy-making more generally (Pinstrup-Andersen: Oxford, P. 508).

Food price volatility is the variation in agricultural prices over time. There are multiple causes of food price volatility including the supply and demand of crops, drought and other adverse weather conditions, and financial speculation. While not all fluctuations are problematic, price spikes and rapid declines can cause issues for food security, living standards, and the overall economy. Volatility in food prices has the most striking effects on developing countries. When producers have little skill to expect or adapt to food price spikes, short-term and long-term planning becomes difficult, causing the mismanagement of production (the Lugar center).

There are other causes of food price volatility in SSA where Rwanda belongs and these include:
✓Energy Crisis and lagging internal investment in energy: Increases in fuel oil prices (SSA)
✓Global climate change that also transmit supply crisis to SSA
✓Shocks due to economic decline, particularly the Global economic crisis of 2007/2008
✓Limited impact programmes that depend on donor financing, with limited sustainability
✓Limited investments in agricultural land and related infrastructures
✓Poor market access for smallholder farmers
✓Poor support for agriculture and general attention shift from agriculture as a development driver

1.2 Background of the Study

Food price volatility is closely linked to the concept of food security, i.e., its four pillars of food availability, economic and physical access to food, food consumption, and stability (vulnerability and shocks) over time (FAO 1996, 2015). The slow progress in reducing hunger and malnutrition and the role of volatile agricultural markets in the food crises of 2007/2008 and 2010 fuelled concerns about the stability and reliability of the global food system.

The UN in collaboration with countries and international organizations prioritized food security into Millennium Development Goals (MDGs), where the first goal is to end hunger, attain food security and better nutrition and promote sustainable agriculture. The G20 countries leaders at their summit meeting in November 2010 requested FAO, IFAD, IMF, OECD, UNCTAD, WFP, the World Bank and the WTO to work with key stakeholders to develop options for G20 consideration on how to better ease and manage the risks associated with the price volatility of food and other agriculture commodities, without distorting market behaviour, eventually to protect the most vulnerable.

According to the FAO, price volatility has been extremely rare in agricultural markets, but the global food system is becoming increasingly vulnerable to it. The 2011 NGO report argued that "volatility becomes a question for concern and for possible policy response when it induces risk-adverse manners that leads to inefficient investment decisions and when it creates problems that are outside the capacity of producers, consumers, or nations to cope."

But Christopher Barrett of Cornell University and Marc Bellemare at Duke University argue in Foreign Affairs that high prices, not volatility, are the real problem. "all over the world but especially in low-income countries, the poor are overwhelmingly net food consumers, while farmers are generally better-off net sellers," they compete. "Increasing prices harm consumers by reducing their purchasing power but benefit producers by increasing their profits."

While the global food crisis between 2007 and 2010 resulted in remarkable commodity price increases in Rwanda, we are clearly concerned with variations in agricultural food prices over time which cannot be predictable and as a result, generate a level of uncertainty which increases risks for producers, traders, consumers and governments and may lead to sub-optimal decisions.

As a result of the global food crisis of 2007–2008 and the recovery of food prices in 2010, there is extraordinary concern in high and volatile food prices. The 2011 State of Food Insecurity in the World, jointly published by the Food and Agriculture Organization (FAO), the International Fund for Agricultural Development, and the World Food Programme, concentrates on the impact of volatile food prices on food security in developing countries (FAO, IFAD, and WFP 2011). Agricultural Outlook 2010–2011, produced by the Organization for Economic Cooperation and Development (OECD) and the FAO, also focuses on the issue of food price volatility (OECD and FAO 2011).

The 2011 Global Hunger Index, prepared by the International Food Policy Research Institute (IFPRI) adopt food price volatility as the special theme for 2011 (IFPRI 2011). In October 2010, the United National Committee on World Food Security commissioned a study of food price volatility, which resulted in a report published in October 2011 (HLPE 2011). And in June 2011, the ministers of agriculture of the G20 countries prepared an action plan to address food price volatility (G20 2011).

1.3 Problem statement

Small import dependent countries, especially in Africa, were deeply affected by the food and economic crises. Indeed, many countries are still in crisis in different parts of the world. Some large countries were able to protect themselves from the crisis through restrictive trade policies and functioning safety nets, but trade insulation increased prices and volatility on international markets (FAO, 2011).

Food price volatility can increase due to stronger linkages between agricultural and energy markets, as well as an increased frequency of weather shocks. Therefore, this study is interested in analyzing food price volatility in Rwanda in order to identify the contribution of each independent variable because food represents a large share of farmer income and the budget of poor consumers; large price changes have large effects on real incomes.

The reason for the interest in the topic is the constant volatility in food prices and is an important source of risk for poor households through unavailability of food, lower purchasing power, inadequate food consumption and shift to even less-balanced diets, with harmful effects on health in the short and long run (HABYARIMANA J. Baptiste et al, 2016).

Around 90% of the Rwandan population depend on agriculture for its livelihood; most of them allocate a large share of their budgets to food (FAO et al. 2011, 14). Within rural areas, semi subsistence farmers are partially insulated from the effect of fluctuations in staple food prices, while cash-crop farmers, commercial grain producers, wage labourers, and those with non-farm enterprises are more vulnerable (Benson et al. 2008). Therefore to analyze the independent variables causing food price volatility in Rwandan urban markets.

Rwanda is one of the world's poorest countries and it experienced a GDP per capita of US$718 (NISR, 2014). The poverty definition in Rwanda reflects multidimensional elements and is reflected in a complex inter linkage of past problems that cannot be resolved easily. The poor do not have enough land, income, or resources and have little or no access to basic needs (Republic of Rwanda, 2002).

Recent surveys indicated that the percentage of people living under poverty has dropped by 5.8% from 44.9% in 2011 to 39.1% in 2014 and during the same period, extreme poverty dropped from 24.1% to 16.3%. The most recent Household Living Conditions Survey (EICV3 2010/2011 and EICV 2013/2014) shows that the gap between the poor and non-poor may be widening. Rwanda's economy is increasingly experiencing the predominance of the service sector as it gained importance relative to agriculture over the

recent years. The annual average inflation was at 2% for 2015 (NISR). Foreign exchange controls have been liberalized and the banking system is sound and successful.

While the GINI coefficient was 0.522, 0.490 and 0.448 (2005/06 EICV2, 2010/11 EICV3 and 2013/14 EICV4 respectively), The backbone of the economy is agriculture, which employs 72% of Rwandan working population while it ensures food security for all Rwandans (NISR: EICV 2013/2014).

It is also noteworthy that food prices are the most important driver of inflation in Rwanda. Food consumption accounts for 35 percent of the total Consumer Price Index (CPI) basket. Food prices decline during 2009 and 2010, following the height of the global food crisis which impacted Rwanda indirectly towards the end of 2008. From the peak in food inflation of 30.9 percent in December 2008, it declined constantly to an average of 16.9 percent in 2009 and 1.8percent in 2010. These trends reflect in equal part local food market conditions and price trends handed-through from world food prices.

The vision of Rwanda is to convert itself from subsistence agricultural to a knowledge-based economy by 2020. The achievement of this vision will require an intensification and market-orientation of agriculture on one hand and a diversification of the economy through a production of non-agricultural sectors on the other hand. Agriculture is one of two key growth engines for Rwanda.

The strategic focus on Agriculture, through continued public investments has contributed to marked productivity increases and solid agriculture growth over recent years. However, in order to maintain these productivity increases in the future and fully understand the growth potential for agriculture sector, the following should be done;
(i) Reducing dependency on rain-fed agriculture through greater use of different models of irrigation.
(ii) Better erosion control and integrated soil fertility management
(iii)Diversifying agriculture production, in particular agricultural export goods, for example in areas of horticulture and flowers
(iv)Changing the skills profile of people employed in agriculture, to foster the creation of increased agricultural off-farm employment such as agro-processing and other value chain activities
(v)Developing a market-based food crop distribution system to contribute to country-wide food security.
Continued agriculture growth through the channels outlined above will benefit agriculture growth and increase food security.

1.4 The scope of the study

1.4.1 The subject scope

Prices of consumed products vary from time to time and differ depending on the region where those products are consumed. The change in consumer price is measured and is known as consumer price index. Consumer price index is given by household consumption of all products available in Rwanda. Consumer price index is complex but this study considers only price indices of food staff that are mostly consumed by Rwandan households. Among them includes bread and cereals, vegetables, fruits, milk cheese and eggs and meat.

1.4.2 The geographical scope

The data regarding Consumer price index are collected from all areas of Rwanda both urban and rural, but this study considers only food price indices from urban areas as shown by the table below.

Table 1: Areas where prices data are collected

Kigali	Urban – Kigali city Rural – Kabuga
Northern Province	Urban – Gicumbi, Musanze Rural – Gaseke, Byangabo
Southern Province	Urban – Nyamagabe, Huye, Muhanga Rural – Karambi, Gasarenda, Kamonyi
Eastern Province	Urban–Nyagatare, Rwamagana, Ngoma Rural– Gafunzo, Nyamata, Mimuri, Ntunga
Western Province	Urban – Karongi, Rusizi, Rubavu Rural–Rubengera, Bugarama, Mahoko

2. Literature Review and Theoretical Framework

2.1 Introduction

Food Agricultural Organization (FAO) considers the Price fluctuations as a common feature of well-functioning agricultural product markets, but when these become large and unexpected (volatile) they can have a negative impact on the food security of consumers, farmers and entire countries.

Indeed, the Price volatility has a strong impact on food security because it affects household incomes and purchasing power. Simply put, it can transform vulnerable people into poor and hungry people. Price volatility also interacts with price levels to affect welfare and food security.

The higher the price, the stronger the welfare consequences of volatility for consumers, while the opposite is true for producers (HLPE). The Food price volatility poses fundamental challenges and opportunities to economists who formulate commodity models to generate information useful to food market agents.

2.2 Ideas from experts

Food price surges reduce the purchasing power of households that are weekly linked to markets and remain obstacle in the way to feed the poor adequately. Thus, Food price surges lead poor people to limit their food consumption and shift to even less-balanced diets, with harmful effects on health in the short and long run.

However, in the light of the government of Rwanda efforts aimed to ensure food security to its population, food price volatility could capture the attention of the government of Rwanda. Therefore, food price policies should be oriented to the stabilization of price of food which price volatility granger cause price volatility in the other food commodities that have pooling and pushing effects on the prices of those other food commodities. (HABYARIMANA &Als, 2014). There are many causes of price volatility. The Food and Agricultural Organization (FAO) et al. (2011) mention the following determinants:

- Growing populations and incomes in emerging and developing countries will add significantly to the demand for food in the coming decades.
- The demand for food and feed crops for the production of biofuels is changing with changes in technology, policy and the prices of traditional fuels.
- Agricultural commodity prices are becoming increasingly correlated with oil prices. Oil prices affect agricultural input prices directly (e.g. through the price of fuel and fertiliser) as well as through the impact on biofuels, which are introducing new sources of fluctuation.

- The lower ratio of stocks to the new higher levels of demand and supply increases the risk that changes in demand or supply will have large price effects, and there are also uncertainties about stock levels in some parts of the world.
- Climate change has increased uncertainty in terms of expectations of future prices.
- Stronger demand for food crops and animal products in conjunction with slow growth in agricultural productivity and low stocks results in upward pressure on prices.
- The changes that are driving price trends upward, including population growth, increased affluence (leading to more demand for animal protein), urbanization and the move towards biofuels, are putting more pressure on finite resources such as land and water, with uncertain effects, potentially resulting in more volatility.
- Currency fluctuations may be increasing, leading to more volatility in local prices.
- Policy measures put in place by governments to reduce fluctuations within their own markets (e.g. import or export restrictions and taxes and increased stocks) increase price movements in the rest of the world. The stronger the attempt to isolate the domestic markets from the rest of the world, the stronger the impact on world price fluctuations. The CAP is one example of this type of influence on volatility.

In recent high profile reports (FAO et al., 2011; HLPE, 2011; Tangerman, 2011) have analyzed various measures to prevent, manage or cope with price volatility. There seems to be a general consensus that, due change and increased linkages between food markets and volatile energy markets, food price volatility is here to stay (Dawe and Timmer, 2012).

Following the rise in the volatility of world agricultural commodity prices in recent years, the variability of food price inflation around the world has also augmented to different degrees. The rise of agricultural commodity prices translates into a rise of food prices at the domestic level, which has an inevitable impact on consumers and households, not only in developing countries but also in the poorest and most vulnerable in developed countries. The literature suggests that the relationship between food prices and food policies may be weak (Mc Corriston, 2012). Still, the link among the two is obvious and the impact on consumers depends on the extent to which agricultural commodity prices are passed through to consumer food prices. This transmission is usually incomplete, and limits food price volatility impacts (Gilbert and Morgan, 2010). These authors claim that higher or more volatile prices may cause greater welfare loss to consumers who allocate a larger proportion of their income to food. As food price levels rise, the expenditure committed to other necessities, such as health or education, falls, hitting poor households and increasing the vulnerability of the poorer households.

2.3 Some key concepts

Price levels, Price volatility (variability) and Unpredictability of prices. In analyzing and presenting literature review on food prices volatility, it is important to distinguish between several related, but different, concepts. One important distinction is that between average prices over time and variability (volatility) of prices over time (FAO, 2011).

It is possible for average prices to change without any change in variability. One simple way this might happen would be if a food importing country was to impose a constant tariff on imports; the tariff would make food more expensive, but in most circumstances it would have no effect on the variability of domestic prices. Conversely, it is also possible to have a change in price variability with no change in the average level. This might happen, for example, if the weather became more variable but food production remained the same on average (FAO, 2011).

Price levels and price volatility are related they are both determined by supply and demand. In addition, high prices tend to be correlated with high volatility. Initially, high prices encourage people to draw down their stocks, which can moderate price changes that would otherwise have been caused by supply and demand shocks. However, once stocks have been drawn down, the system is vulnerable to a further supply or demand shock; the absence of the buffer means that price variation will tend to be greater than if stocks were available.

Despite this relationship, it is still important to distinguish between the two concepts. For one, prices can be high but stable. For another, the costs and benefits of high prices are very different from the costs and benefits of volatile prices, as described in 'Costs and benefits of high and low food prices' and 'Costs and benefits of volatile and unpredictable prices' (Dewbre et al 2008).

Another crucial distinction is that between variability and unpredictability. Prices show variability for many reasons, but some price changes may be largely predictable. The classic example of predictable changes in food prices is seasonality, whereby prices are lowest during and soon after harvest and highest immediately before harvest.

While seasonal changes are not exactly constant from year to year, they are often similar from one year to the next. Weather shocks, on the other hand, are typically unpredictable and may lead to unpredictable changes in prices, especially if stocks are low to begin with. Therefore, some price changes are relatively easy to anticipate and others are much harder to predict. Predictable changes in prices have different costs and benefits than unpredictable changes.

2.4 Food price Volatility measurement

In their book, "Food price volatility. Philosophical Transactions of the Royal Society B", C.L. Gilbert and C.W. Morgan (2010) showed that the simplest way to measure price volatility is the coefficient of variation (CV).

This is the standard deviation of prices over a particular time interval divided by the mean price over the same interval. One advantage of this measure is that it has no units. This makes it easy to compare, for example, domestic price volatility measured in different countries. However, the CV can create misleading impressions if there are strong trends in the data, because trend movements will be included in the calculation of volatility.

Moreover, there is no universally accepted method for removing the trend component because different observers will have different ideas about the nature of the underlying trend (e.g. linear, quadratic). As an alternative to the CV, economists often use the standard deviation of changes in the logarithm of prices (C.L. Gilbert and C.W. Morgan, 2010). This also has no units, but is less affected by strong trends over time.

2.4.1 The state of international food prices

In 2007–08, the price of almost every food item sharply increased in global markets. Prices rose quickly, across the board, as much as they had in the historic 1974 food price crisis. At their peaks in the second quarter of 2008, world food price indices were three times higher than in the beginning of the 2000s. Prices have since dropped, mainly because of favorable weather conditions and slowing food demand resulting from the global financial crisis and decline, but they remain high compared with prices five years ago.

The two episodes (2008 and 2011) have showed little variation in affected commodities. In both cases, the prices of wheat, maize, and soybeans were much higher than in the early 2000s. Dairy products, meat, palm oil, and cassava also experienced sharp price hikes.

The prices of butter and milk, for example, tripled between 2003 and 2008, and the prices of beef and poultry doubled. In contrast to 2007–08, the sugar price in 2011 has spiked to 300 percent of its level in 2002–04. The price of rice, which experienced a fivefold rise in 2007–08, seems relatively low in 2011.
A look at historical trends shows that volatile food prices are not new phenomena. Global food prices were in series of crises throughout the early 1970s. Some authors estimate that in real terms the agricultural commodity price peaks of the 1970s were much higher than those of 2007–08 (Piesse and Thirtle 2009).

Cereal prices in the 1980s and early 1990s increased between two and five times in the course of a year in famine-prone areas of Africa, causing acute human tragedies (von Braun, Teklu, and Webb 1998).
Many price forecasts predict an increase in agricultural prices in the short to medium term. By the year 2020, real prices are anticipated to be 20 percent higher for cereals and 50 percent higher for meats compared with previous decades (OECD-FAO 2011). Whether high food prices will create incentives to increase production to counteract the price peaks remains to be seen.

2.4.2 Food price changes

Agricultural commodity markets are inherently volatile because of their strong links with natural shocks. In the recent volatility of 2007–08 and 2011, however, the slopes are so steep and the peaks are so high that they seem to reflect an extraordinary phenomenon in commodity markets.
It seems essential at this point to distinguish between the different terms used in referring to price changes. Price movements can be described as trends, volatility, or spikes.

2.4.2.1 A price trend is the smooth, long-term average movement of prices over time; it shows the general tendency of prices for a certain period of time.

2.4.2.2 A price spike refers to a change in price levels over a shorter period of time, usually between two consecutive observations. It takes a negative or positive value that causes a crisis. Positive values are generally perceived as high prices, and the highest positives as price spikes. The most common way of measuring price spikes is using percentage change as the logarithm of the rate of period-over-period prices.

2.4.2.3 Price Volatility on the other hand is the dispersion of a price series from the mean. It is usually measured in terms of standard deviations of the price change.

Volatility includes only ups and downs from the mean. It does not measure direction; rather it measures price risks. Realized volatility can be decomposed into high-frequency volatility and low-frequency volatility (Peterson and Tombek 2005). High-frequency volatility refers to weather- and disease-related shocks that last for a season or less. Low-frequency volatility loosely refers to variability that persists for more than one season. Managing low-frequency volatility is more challenging than managing high-frequency volatility. High-frequency volatility is closely related to short-term price spikes.

It is also important to distinguish between price trends and price volatility in their effects on producers and consumers. High food prices are motivation for net food producers to produce more food. Whenever food prices are on an upward trend relative to input prices, farm income will grow, encouraging agricultural investment. On the other hand, rising food price trends can impose tremendous challenges on poor people who spend much of their income on food.

Price volatility, however, is a challenge for both consumers and producers. Volatility introduces risks that affect a risk-averse agent's decision making. The impact of price risk on smallholder producers has been extensively studied (Binswanger and Rosenzweig 1986).

For households in developing countries that are net food sellers, the marginal utility of income is negatively correlated with risk, causing lower input use and production under risk than under assurance. For households that are net buyers, the marginal utility of consumption is negatively related to price risk, causing lower consumption under risk than under assurance.
The formation of volatility may follow a different path from the formation of high food prices. Whereas high food prices are caused by an increase in demand or reduction in supply, volatility can be created by supply and demand shocks, market manipulation, and high prices themselves. However, the relationship between price level and volatility is not well defined.

There is a general feeling that an increase in price level increases volatility. What is certain, however, is that the high prices of 2007–08 and 2011 have been accompanied by high price volatility (Gilbert and Morgan 2010).

2.4.2.4 Nonlinearity in global food price dynamics

The price effects of fundamental changes in demand and supply tend to occur gradually as increasing or decreasing price trends. E.g., when demand for biofuel increases, prices move upward steadily; there is little reason for changes in biofuel demand to lead to extreme price swings because demand tends not to change very quickly.

When fundamentals are changing gradually over time, market actors may not change their behavior immediately, but when changes in supply or demand reach a certain level, market actors may start to behave differently. They may be driven by sensations and trends rather than by fundamentals and behave in less rational way. The unreasonable behaviors triggered by increasing fundamentals may create a tipping point in food price movements beyond which markets become more volatile.

When prices are rising, traders and governments may start to panic and aggressively respond through stockpiling, price controls, and trade restrictions. These reactions create tensions and market disruptions. These factors cause not only inter-temporal nonlinearity, but also nonlinearity in spatial price transmission across countries and regions.

Nonlinear price movement implies that stabilizing food supply and demand protects consumers and producers against extreme short-term spikes and low-frequency price volatility. The resurfacing of price spikes in 2011 is clear evidence of how markets can remain volatile once they receive a serious shock.

2.4.2.5 Price volatility and the poor

Food prices based on market activities are almost always volatile. Markets follow the natural fluctuations of supply shocks and the instabilities of food demand. Although this volatility brings risks to both consumers and producers, it cannot be avoided. Attempting to avoid such normal volatility costs the economy far more than its direct costs (Newbery and Stiglitz 1981).

Price stabilization usually leads to inefficiencies and benefits only part of society. Some observers (such as Bellemare et al. 2011) empirically argue that the welfare gain from eliminating volatility would be concentrated on the upper 40 percent of a society. Given the current worldwide extreme volatility with

spikes, however, we argue that certain conditions may justify policy actions to prevent such extreme events.

2.4.2.6 Underlying factors and their diverse effects

Because of the changing global economic environment caused by scarcity and technology, the livelihoods of many poor people directly or indirectly depend on global markets to which their local markets are connected. The change in international food prices reaches poor people in poor countries through the global price transmission system.

Thus, the impact of international food prices on local economies depends on the extent of price transmission across borders. Price transmission refers to the co-movement of prices in two or more spatially separated markets.

The co-movements of prices do not necessarily require physical flow of goods and services; the flow of price information alone can transmit prices across borders. Many studies suggest that the recent high and volatile world food prices have been transmitted strongly to local markets in poor countries (Minot 2011; Dawe 2008; Conforti 2004). However, the transmission is not complete.

Whereas some local markets absorb international market shocks in as little as a week, some markets remain unresponsive to global shocks. Prices in regions characterized by permanent surplus or deficit are more correlated to global reference prices than those in regions with an occasional surplus or deficit because of switching transport margins in these cases.

Prices of widely traded commodities such as wheat and maize are more highly correlated across countries than prices of spatially restricted commodities, such as rice. Even for rice, though, some empirical studies suggest that one-third of the change in the world rice price has been transmitted to local markets (Dawe 2008).

Spatially, price transmission has been less complete in African markets than in Asian and Latin American markets (Conforti 2004). In some cases, for instance where strong regulations determine domestic prices, it is impossible to causally associate local price changes with global price changes. Moreover, large underlying causes of the co-movement of prices (e.g. a global recession or a weather event of global significance) can move the prices of all food commodities simultaneously worldwide.

The transmission of domestic wholesale food prices to retailers and producers also matters for the real cost of volatility at the household or farm level. Agricultural prices have long
been characterized by stickiness: a price reduction spreads to the farm gate price faster than a price increase, and a price increase spreads to the retail price faster than a price decrease. These days, however, there is little empirical evidence for the stickiness of agricultural prices.

Prices have been transmitted increasingly quickly and proportionally as a result of a rapid improvement in infrastructure, information, and trade liberalization over the past two decades. Price stickiness might, though, still play a significant role in some developing countries, where infrastructure and competition are not yet well developed.

A rapid rise in food prices associated with an increase in volatility affects poor people in many ways. The most important effects are a reduction in real income and increased income instability. The extent of income reduction and instability depends on a number of factors, including the share of income derived from the food sector and the share of food budget expenditure. If the share of income from agriculture is

high, a rise in food prices increases real income, if expenditure share is kept constant. If the food expenditure share is high, a rise in food prices decreases real income.

2.4.2.7 Based on the share of income from the food sector and the amount of expenditure on food, three groups of people can be identified

1. Urban consumers: These consumers do not produce food, so increased food prices have no effect on their nominal income, but rising food prices do reduce their initial real income. The size of the reduction depends on the share of food expenditures in their total spending and on overall inflation. Poorer people spend most of their income on food.
2. Rural net buyers: Because these buyers buy more than they sell, the net-income effect may be negative. In general, poor rural people tend to have a high food expenditure share and a low supply response, so their real income is likely to fall. Many poor rural people in developing countries are landless and earn their incomes mainly from off-farm activities and employment. Such people are highly vulnerable to food price spikes.
3. Rural net sellers: This group of households benefits both from increased income (keeping production constant) and from increased production. Both effects raise their total income. The size of the production effect depends on supply elasticity. In areas where factor markets are imperfect, the supply response is generally low.

Though the real income of this group has a chance of increasing with increased food prices, it could remain constant or even decline if food inflation disproportionately pushes up overall inflation. The benefit to these households also depends on access to markets and the cost of inputs. If the cost of inputs increases proportionally with food prices, the net benefit would be reduced.

Poor people respond to price changes more strongly than the rest of the population by changing caloric intake. Calorie price elasticity of the whole food demand taken together is less than for individual food items, because of the possibility of shifting from high-calorie foods to low-calorie foods when prices increase.

Both income and price elasticity are generally high for poor people. Estimates of price elasticity with a two-stage demand model from 114 countries show that food demand in low-income countries is more responsive to changes in food prices than in middle- and high-income countries, with price elasticity for food averaging -0.59 for low-income countries and -0.27 for high-income countries (Seale et al. 2003).

They may increasingly spend their work time on richer farmers' fields to earn a living or get food donations. The urban poor often borrow money for consumption or use their small working capital, becoming indebted in ways that are difficult to recover quickly. The overall impacts of such draw down of assets are reflected in the long-term production and income generation capacity of the poor. Thus, food price volatility of this kind increases and prolongs poverty and makes income distributions more unequal.

2.4.2.8 Empirical estimates on poverty and hunger

Empirical estimates of the impacts of high and volatile food prices on poor people use three major approaches: simulation (such as FAO 2008; Ivanic et al. 2011), self-reporting (Headey 2011a), and actual measurement. The simulation approach applies elasticity parameters to observed price changes to predict the effect of those price changes on income and consumption.

A recent World Bank simulation suggests that the 2011 food price hike has pushed 68 million people into poverty and pulled 24 million people out of poverty, a net increase of 44 million poor people (Ivanic et al.

2011). Household-level analyses also suggest that – as expected - poor consumers are affected much more than rich households.

An 11-country study of the impacts of high food prices shows that the poorest households, in both urban and rural areas, are the worst affected (Zezza et al. 2008). An increase in food prices often constitutes a transfer from the large majority of consumers to a minority of producers and results in an overall increase in poverty.

2.4.2.9 The macroeconomic indicators of price volatility

The price Volatility is a statistical measure of the dispersion of returns for a given security or market index and it can either be measured by using the standard deviation or variance between returns from that same security or market index. Commonly, the higher the volatility, the riskier the security. Generally speaking, dispersion is the difference between the actual value and the average value. The larger this dispersion or variability is, the higher the standard deviation. The smaller this dispersion or variability is, the lower the standard deviation.

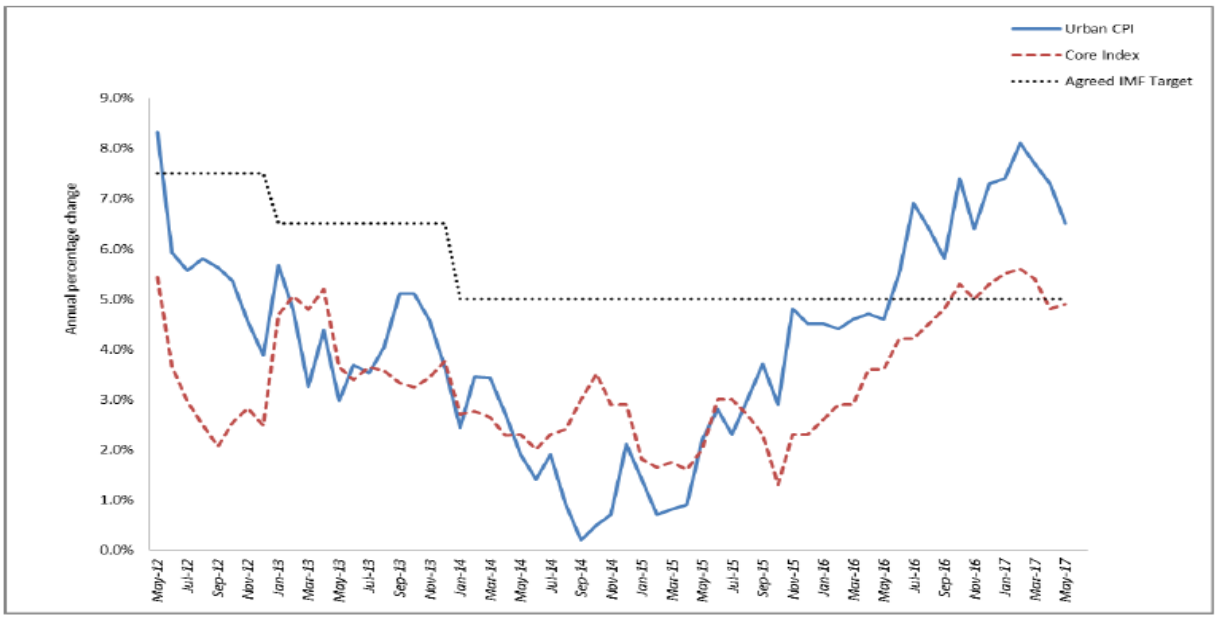
2.4.2.10 The consumer price index

The Consumer Price Index measures the average price level of a basket of goods and services that are purchased by consumers. It represents the inflationary pressures surrounding the economy and it is probably the most crucial indicator of inflation. The CPI is one of the most-used economic indicators to measure changes in the price level of market basket of consumer goods and services purchased by households and to show effect of inflation on their purchasing power.

However, the Consumer Price Index as a measure of inflation has some limitations: It is not fully representative and it will be inaccurate for the 'non-typical' household, it is spending patterns, it is changing quality of goods and services, and finally CPI is slow to respond to new products and services. (NISR, 2014)

Figure 1:Annual changes in urban CPI

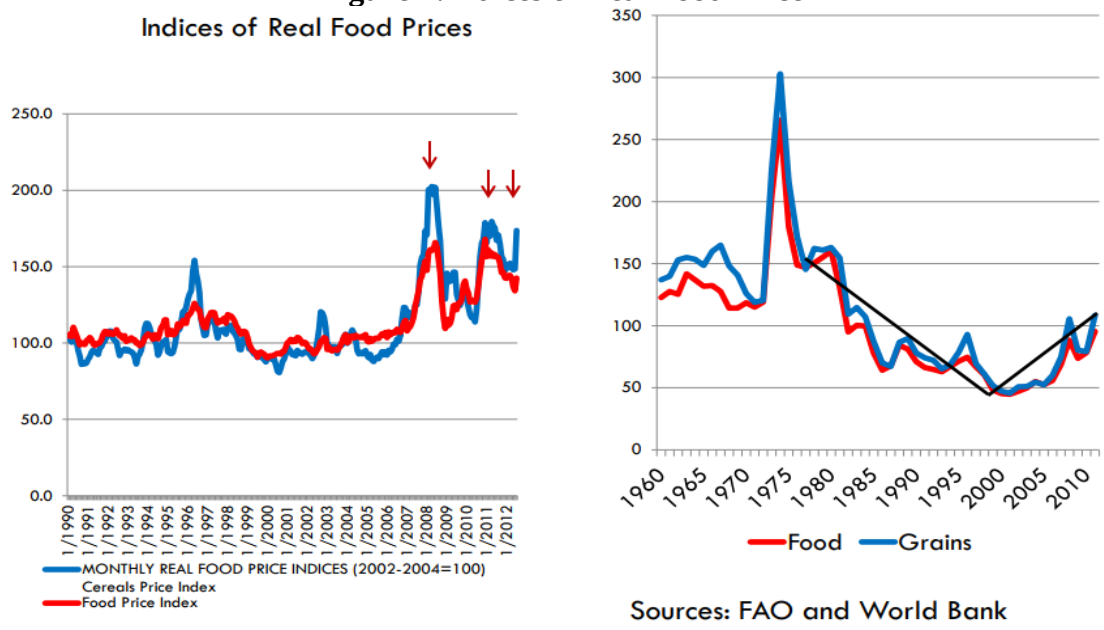
Annual changes in urban CPI (May 2012 – May 2017)

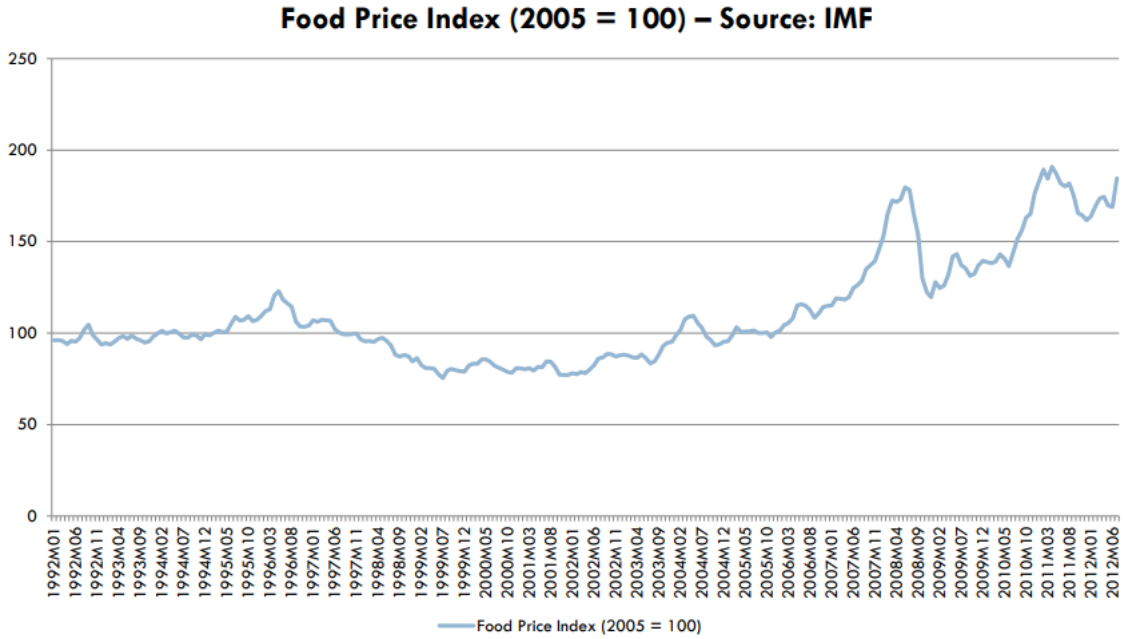


2.4.2.11 Global food price volatility for real food prices

In the simplest sense, price changes result from shifts in supply and demand where these price changes will be most severe & erratic when shock to demand or supply is large and when there is little scope in the short-run of adjusting to the shocks through augmenting supply, increasing production, or adjusting trade and consumption ("inelastic demand"). The figures below show the global price volatility of some product and general food price indices according to John STAATZ (2012).

Figure 2:Indices of Real Food Price





2.4.2.11 The food price volatility and food insecurity

2.4.2.11.1 The food insecurity as an impact of price volatility

The estimated impact of the price shock of 2006–08 on the number of undernourished varied markedly across regions and individual countries. Some large countries were able to insulate their markets from the crisis through restrictive trade policies and protect their consumers through safety nets. However, trade insulation increased prices and volatility in international markets. Small import-dependent countries, especially in Africa, were deeply affected by the food and economic crises. Indeed, many countries are still in crisis in different parts of the world, particularly the Horn of Africa.

These crises are challenging our efforts to achieve the Millennium Development Goal (MDG) of reducing the proportion of people who suffer from hunger by half by 2015. Even if the MDG were to be achieved by 2015 some 600 million people in developing countries would still be undernourished. Having 600 million human beings suffering from hunger on a daily basis is never acceptable.

The diversity of impacts, both within and between countries, points to a need for improved data and analysis so that governments can implement better policies. Better and more predictable policies can not only reduce unwanted side-effects on other countries, but can simultaneously reduce food insecurity and domestic price volatility at home FAO, 2011,P.4).**2**

3. Research Methodology

3.1 Introduction

This study is subjected to analyze food price index volatility and its determinants. The econometric approaches applied include; Granger methodology to find out the long term relationship between variables, test of stationality. Unit root tests are conducted first since the stationary property of series is the premise for the other techniques. The co integration test measures the relationships between set of variables. If co integration is found, it means that between set of variables there is long run links. In contrast, if no co integration, they have no long - run links.Lets look at these techniques and how will be used within this study:

3.2 Stationarity of time series data

3.2.1 Meaning of stationarity

One of the important types of data used in empirical analysis is time series data. This type of data poses several challenges to econometricians and to practitioners. Most empirical works based on time series data assume that the underlying time series is stationary. A time series, whose statistical properties such as mean, variance, autocorrelation are all constant over time, is said to be stationary. Most statistical methods are based on the assumption that the time series can be approximately using mathematical transformations. A stationarizedserie is relatively easy to predict since its statistical properties will be the same in the future as they have been in the past.

Thus, finding the sequence of transformations needed to stationarize a time series often provides important clues in the search for an appropriate forecasting model. However, most economic time series are generally integrated of order one [I (1)], that is, they generally become stationary only after taking their first differences. Loosely speaking, a time series is said to be stationary if its mean and variance do not vary systematically over time (Gujarati, 2003). "Non-stationarity of time series has always been regarded as a problem in econometric analysis" (Charemza and Deadman, 1992). Since the contributions by Granger and Newbold (1974, 1986), Dickey and Fuller (1979), Nelson and Plosser (1982**)** it is known that estimation of time series equations may be subjected to spurious regression results. Spurious results arise due to the existence of common trends (stochastic or deterministic) running through the data and not due to the

strength of the regressors‟ explanatory power reflecting the fundamental economic relationship between variables suggested by theory.

3.2.2 Stationary and non-stationary time Series

In addition to the question of whether the model should be estimated using a single equation approach (e.g. OLS) or a systems estimator, it is necessary also to consider the underlying properties of the processes that generate time series variables. Models containing non-stationary variables will often lead to the problem of spurious regression, whereby the results obtained suggest that there are statistical significant relationships between the variables in the regression model when in fact all that is obtained is evidence of contemporaneous correlations rather than meaningful causal relationship (Harris, 1995). In a basic data generating process, suppose that a variable $Y_t$is generated by the following (first-order autoregressive) process.

$$y_t = \varphi y_{t-1} + u_t \quad (1)$$

In the above relationship, current values of Y_t, depend on their preceding value, y_{t-1} plus a white noise disturbance term. The white noise error term satisfies all the classical conditions and hence is normally distributed with mean of zero and constant variance.

In a stationary time series, $Y_t$stationary is present if the following conditions are met:

$$Mean = E(Y_t) = \mu \quad (2)$$

$$Variance = E(Y_t - \mu)^2 = \sigma^2 \quad (3)$$

$$Co\,variance = \upsilon(k) = E[(Y_{t-u})(Y_{t+k-u})] \quad (4)$$

In equation $y_t = y_{t-1} + u_t$ (5) there is no parameter attached to y_{t-1} , meaning that the parameter is 1. This gives evidence that it is emanating from a random walk process in which the series $Y_t$is said to have a unit root (non-stationary). The variance of $u_t$is not constant. It becomes larger as time passes and in actual fact, it tends to infinity.

Taking the first difference ofY_t can make time series stationary:

$$\Delta y_t = y_t - y_{t-1} \quad (6)$$

This series will be stationary as it is equal to the classical disturbance term. Therefore, it has a mean of zero (mean stationary) and a constant variance (variance stationary) and covariance stationary as covariance between values of the series and those at other time periods $\text{cov}(y_t, y_{t-1})$ is constant. Thus the first difference of a random-walk process is stationary and is integrated of order one i.eI(1). If stationarity is attained after differencing the series *p* times, then the series is integrated of order *p*i.eI(*p*).

3.2.3 Unit root and stationarity tests

Many time series exhibit trend or non-stationary behavior. Before any empirical estimation is conducted it is necessary to conduct pre-unit root tests to understand the underlying data generating process for application of suitable methodology. Many approaches can be performed to examine the stationarity of time series data. But the most popular approaches are Augmented Dickey-Fuller (ADF) test, Phillips-Perron test (PP), Kwiatkowski Phillips Schmidt Shin (KPSS, 1992) test. In this study we only perform the ADF test.

The null hypothesis is that series does contain a unit root (non-stationary process) against the alternative of stationary. To test for the presence of a unit root, we need to calculate the T-statistic and then compare it to the corresponding critical value at different significant levels. If the null hypothesis is rejected, it is concluded that a series y_t which includes drift (intercept), trend or none doesn‟t contain a unit root.

Furthermore, it is also very important to select the appropriate number of lagged difference term p. Too few lags may lead to the over rejecting the null hypothesis when it is true, while too many lags may reduce the power of the test to reject the null. One suggested solution is based on Information criteria such as Akaike Information Criterion (AIC), the Schwartz Bayesian Information Criterion (SBIC). In other words, we determine the appropriate lag length which minimizes the information criteria. The main criticism of the Augmented Dickey-Fuller (ADF) test is the power of the test which is very low if the process is nearly non-stationary which means the process is stationary but with a root close to the non-stationary boundary (Ya Xu et al., 2010).

3.2.4 Granger causality

The Granger (1969) approach to the question of whether x causes y is to see how much of the current y can be explained by past values of x and then to see whether adding lagged values of x can improve the explanation. Y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x's are statistically significant. Note that two-way causation is frequently the case; x Granger causes y and y Granger causes x.

In this study, the independent variables bread and cereals, fruits, milk, cheese and eggs, meat, vegetables price index will be tested if they Granger cause dependent variable which is food price index. The unity root test of residuals for each couple has been done to confirm long term relationship between each independent variable and dependent variable. The long term relationship is confirmed when the residual is stationary (has no unit root).

3.2.5 Cointegration technique based on VAR

The concept of cointegration was developed by Engle and Granger. If two or more series are themselves non-stationary, but a linear combination of them is stationary, then the series are said to be co-integrated.
Generally, two approaches are broadly applied to test co-integration. One is Engle-Granger test which is only used to a single equation. An alternative is the Johansen approach that is suitable for a multivariate case. In general, co-integration test permits the test of hypotheses about the long-run equilibrium between the non-stationary variables. In order to investigate the relationship between variables underlying food price volatility, the Engle-Granger co-integration technique is used in this study.

3.2.6 Specification of Cointegrating equation

3.2.6.1 Functional specification of the equation

According to the economic theory and empirical literatures discussed in chapter two, they conclude that food related variables undergone price volatile. An econometric investigation begins with the specification of the econometric model underlying the phenomenon of interest (Gujarat: 2007) quoted by (UdonsahIdorenyin L: 2008). Specification of a model generally is a function of the theoretical relationship between or among variables, the nature of study objectives and type of data. Asogwa (2009) this has to do with expressing the model in mathematical and econometric form which would be used to explore the economic phenomenon.

In this study, five selected independent variables are considered to influence food price volatility in Rwanda. The specification of the functional form of the model gives:

$$F = f(BC, FR, MCE, MEAT, VEGET) \quad (7)$$

Where:
F=Food
BC= Bread and Cereals.
FR= Fruit

MCE = Milk, cheese and Eggs.
MEAT= Meat
VEGET= Vegetables

4. Econometric Specification of the Model

Econometricians assure a stochastic model that accounts for a random variable (ε_t) that cannot be explained on the dependent variable. The random variable(ε_t) , captures other factors which affect food price index model specification in its stochastic form. Then, linear relationship between variables is stated as follows:

$$LF_t = \beta_0 + \beta_1 LBC_t + \beta_2 LFR_t + \beta_3 LMCE_t + \beta_4 LMEAT_t + \beta_5 LVEGET_t + \varepsilon_t \quad (8)$$

Where L stands for Logarithm.

β_0 *is an intercept*

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ *are slope coefficients*

ε_t = represents an error term which is assumed to be a white noise error.

4.1 Method of Evaluation of significance of variables

We will use two criteria to evaluate the results obtained from the regression analysis. They are:
i. Evaluation based on economic criteria (signs expectation).
ii. Evaluation based on statistical criteria.

4.2 Evaluation based on economic criteria (Signs Expectation)

This entails examining the economic meaning fullness of the model with regard to the expected signs of the parameters and their conformity/nonconformity to economic theory.

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ are expected to have a positive signs since increase in each independent variable would bring about an increase in dependent variable according to the above literatures.

4.3 Evaluation based on statistical criteria

The T-Test

The test is carried out to ascertain whether the individual variables are statistical significant.

4.4 Data and data sources

This study employs monthly price indices time series data of the following variables: Food, Bread and Cereals, Fruits, Milk, cheese and Eggs, Meat and Vegetables.
The data set spanning the period 2005-2016 was collected from the National Institute of Statistics of Rwanda in the price unit.

4.5 Descriptions and formulas applied to get the price index data used in this study analysis

4.5.1 Index Calculation: Basic Indexes

The CPI provides an estimate of the price change between any two periods. The algebraic formula used to estimate this price change is called an index number formula.

Basic indexes for the 1,053 elementary aggregates use the Jevons index formula: an unweighted geometric mean of the items in the area-item combination:

$$I_{a,i}^{t} = I_{a,i}^{t-1} \times \prod_{k=1}^{K_{a,i}} \left(\frac{p_k^t}{p_k^{t-1}} \right)^{\frac{1}{K_{a,i}}} \qquad \boldsymbol{a} = 1,\ldots,8; \boldsymbol{i} = 1,\ldots,117$$

$$I_{a,i}^{0} = 100.0 \qquad (9)$$

$K_{a,i}$ = the number of items in item category $\boldsymbol{i}$ in area $\boldsymbol{a}$

Notice that the price collected in the current period is divided by its price collected in the previous period. The geometric average of these short-term ratios is multiplied by the previous index. The previous index is the previous period's average of short-term ratios times the index before that. This "chaining" of the average of short-term ratios continues back to the beginning of the index.

4.5.2 Index Calculation: Aggregate Indexes

To calculate the second stage of the CPI, NISR introduced—the Modified Laspeyres formula. This is a variant of the Laspeyres formula, which is the theoretical target formula for the CPIs of most countries.

The modified Laspeyres formula uses expenditures from an earlier period updated for price change to February 2014. The formula for the CPI for Rwanda is:

$$\mathrm{I}_{Rwanda}^{t} = \frac{\sum_{a=1}^{10}\sum_{i=1}^{117} Q_{a,i}^{Feb14} I_{a,i}^{t}}{\sum_{a=1}^{10}\sum_{i=1}^{117} Q_{a,i}^{Feb14} I_{a,i}^{Feb14}} = \sum_{a=10}^{10}\sum_{i=1}^{117} S_{a,i}^{Feb14} \left(\frac{I_{a,i}^{t}}{I_{a,i}^{Feb14}} \right) \qquad (10)$$

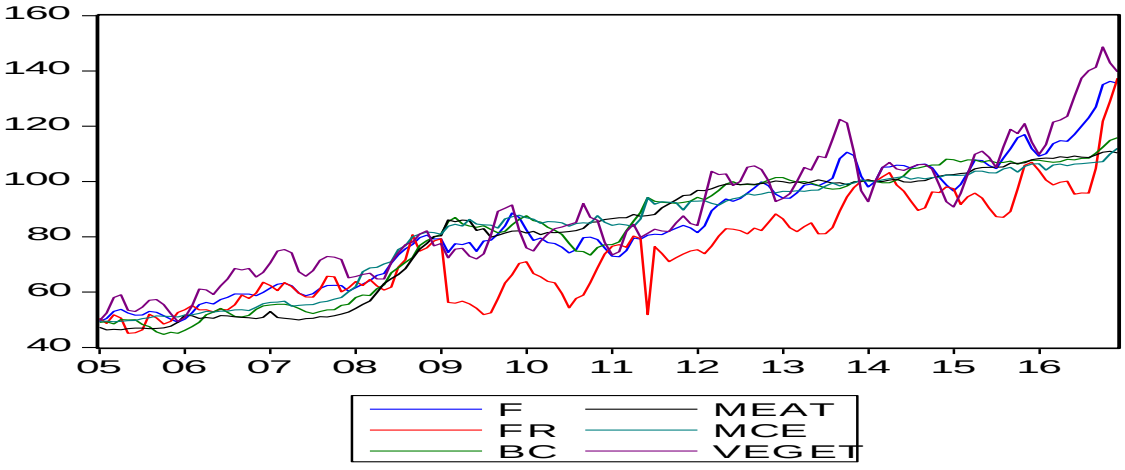
$$S_{a,i}^{Feb14} = \frac{e_{a,i}^{Feb14} \times \left(\frac{I_{a,i}^{Feb14}}{I_{a,i}^{2010/11}} \right)}{\sum_{a=10}^{10}\sum_{i=1}^{117}\left[(e_{a,i}^{Feb14}) \times I_{a,i}^{2010/11} \right]} \qquad (11)$$

The Modified Laspeyres index for period t is a weighted average of the change in the basic indexes from February 2014 period t. Period t (indicated by superscript t) can be any time period subsequent to February 2014. The weights are estimated expenditure shares from the household budget survey for 2010/2011 adjusted for price change to February 2014, the month just prior to their first use in the CPI.

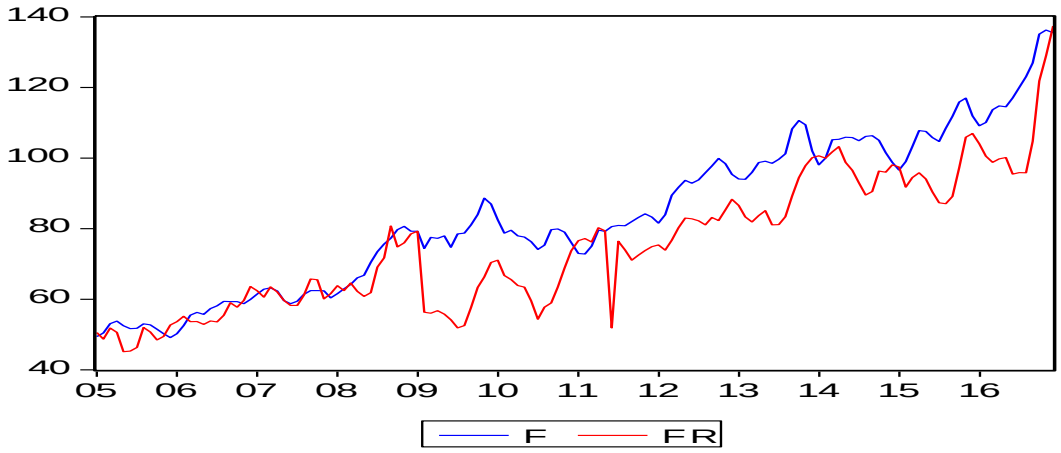
5. Research Findings and Analysis

5.1 Preliminary analysis by figures

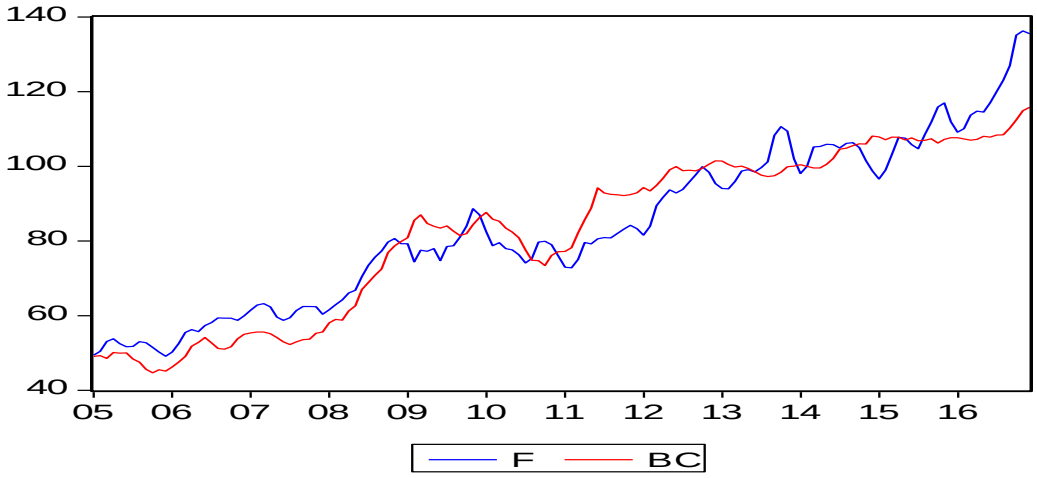
Figure 3: Preliminary analysis by figures



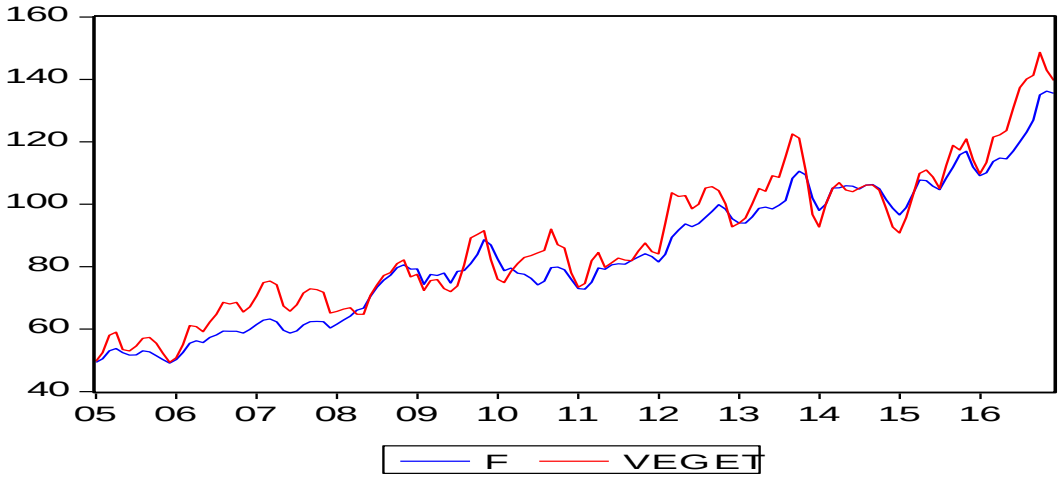
Vol. 7, Issue:1, January: 2019
ISSN:(P) 2347-5404 ISSN:(O)2320 771X



The graph above examines the relationship between food price index and other variables. The graph shows that fruit price index and food price index generally are not related as one of them increases the other one decreases.

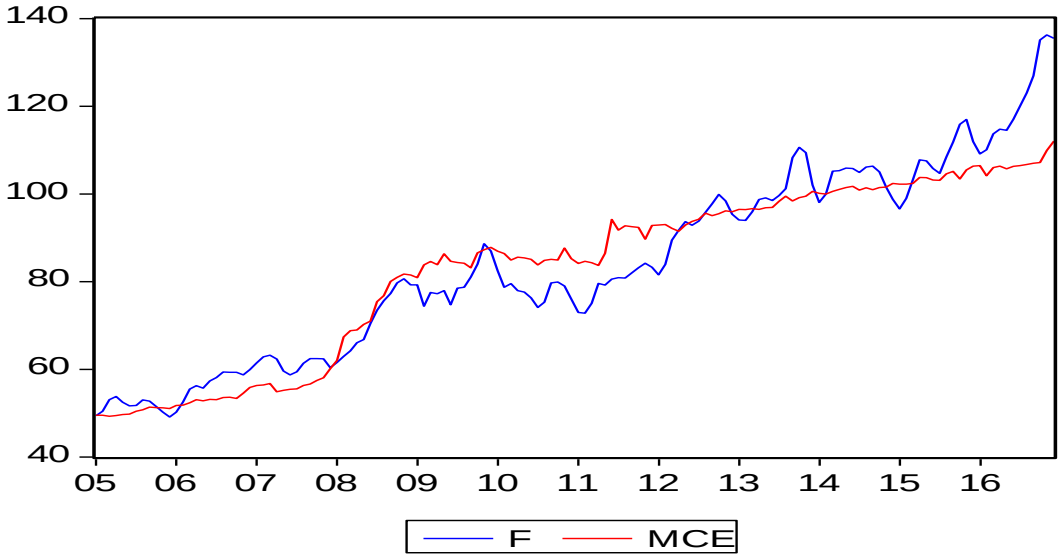


Bread and cereals price index and food price index from 2005 to 2009 they move in the same direction, from 2009 to 2010 they move in opposite direction, from 2010 to 2013 they move in same direction and from 2013 to 2016 they move in opposite direction. Generally, Bread and cereals price index and food price index are related.

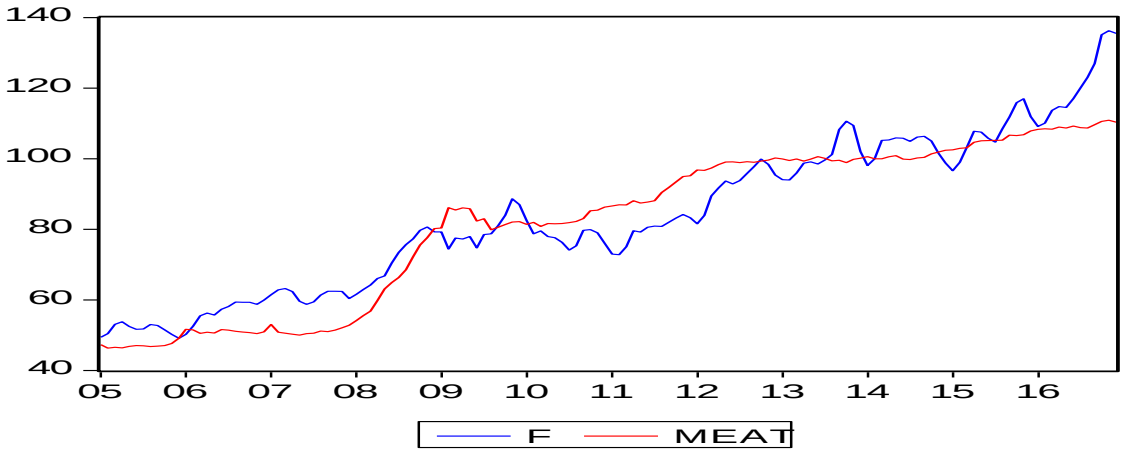


Vol. 7, Issue:1, January: 2019
ISSN:(P) 2347-5404 ISSN:(O)2320 771X

Food and vegetables price indices, generally are related as they are moving in the same direction in almost all years.



Food and milk, cheese and eggs price indices are moving in opposite direction in almost all years.



Food and meat price indices are not related as they are moving in the opposite direction almost all years.

5.2 Test of unit root test of each variable

Table 2: Test of unit root test of each variable

The results of testing unit root in raw data shows that at 95% Confidence level, test statistics for all series "F,

			Interpolated Dickey-Fuller			
		T-statistics	**1% critical value**	**5% critical value**	**10% critical value**	**MacKinnon approximation P-value**
Log_F	At level	-0.19	-3.48	-2.88	-2.58	0.94
	1st difference	-9.68	-3.48	-2.88	-2.58	**0.00***
Log_BC	At level	-1.07	-3.48	-2.88	-2.58	0.73
	1st difference	-7.09	-3.48	-2.88	-2.58	**0.00***
Log_FR	At level	-1.11	-3.48	-2.88	-2.58	0.71
	1st difference	-13.40	-3.48	-2.88	-2.58	**0.00***
Log_MCE	At level	-1.63	-3.48	-2.88	-2.58	0.46
	1st difference	-10.98	-3.48	-2.88	-2.58	**0.00***
Log_MEAT	At level	-1.60	-3.48	-2.88	-2.58	0.48
	1st difference	-5.00	-3.48	-2.88	-2.58	**0.00***
Log_VEGET	At level	-0.56	-3.48	-2.88	-2.58	0.87
	1st difference	-9.80	-3.48	-2.88	-2.58	**0.00***

BC, FR, MCE, MEAT and VEGET" are not statistically significant and this tells us that there is unit root in all series at level. The results testing unit root in logged data show that all six series have unit root at 95% confidence level. This study uses first difference of logged data for all series to rend them stationary and test if all series satisfy stability condition. Test of unit root in differenced data "First difference" show that there is no unit root in all series and that all series are stationary.

5.3 Estimation of long term relationship

Discussion based on the graph above could mislead. The reason why it is necessary to proceed to the estimation of coefficients that could give more information on the relationship between variables. Therefore the following paragraphs will concentrate on estimation of coefficients.

5.4 Specification of the model to estimate

The general model to be estimated establishes the relationship between independent variables and dependent variable. It is now specified as follows:

$$LF = \beta_0 + \beta_1 LBC + \beta_2 LMCE + \beta_3 LFR + \beta_4 LMEAT + \beta_5 LVEGET + \varepsilon_t \quad (11)$$

Where

LF: Logarithm of food price index

β_0: Intercept

β_1, β_2, β_3, β_4, β_5 : Are the coefficients

LBC: Logarithm of bread and cereals price index

LMCE: Logarithm of milk, cheese and eggs price index

LFR: Logarithm of fruits price index

LMEAT: Logarithm of meat price index

LVEGET: Logarithm of vegetables price index

ε_t: Error term at period t

5.4.1 Estimation of the general model and discussion

The estimated equation with real coefficients is:

LF=-0.21+0.33LBC+0.29LMCE+0.15LFR-0.21LMEAT+0.48LVEGET+e_t(12)

(-3.89) (5.62) (4.20) (7.45) (-3.38) (19.49)

In order to confirm the long term relationship between LF and all variables, the residual (e) should be stationary means that has no unit root.

We need to generate the series of residual e and then we perform the unit root test for it. Then

e_t= LF+0.21-0.33LBC-0.29LMCE-0.15LFR+0.21LMEAT-0.48LVEGET (13)

It is found that t-calculated is -3.76 which is greater than MacKinnon critical value 1.95 in absolute value. This result of unit root test confirmed that residual *e* is stationary i.e has no unit root. Hence there is long term relationship between LF and all other variables.

Based on probabilities and t-values (see Annex1) the results show that all the coefficients of equation (12) are statistically significant.

5.4.2 Analysis by price index couples

As there could be a specific relationship between general food price index and price index of each independent variable, it is necessary to conduct a specific analysis by price index couples.

5.4.3 Specification of models by couples

The models by couples are specified as follow:

$LF = \beta_0 + \beta_1 LBC + \varepsilon_t$ (14)

$LF = \beta_0 + \beta_1 LMCE + \varepsilon_t$(15)

$LF = \beta_0 + \beta_1 LFR + \varepsilon_t$ (16)

$LF = \beta_0 + \beta_1 LMEAT + \varepsilon_t$(17)

$LF = \beta_0 + \beta_1 LVEGET + \varepsilon_t$(18)

5.4.5 Estimation of models by couples and discussion

The estimated models relating the general food and other variables:

$LF = 0.60 + 0.86LBC + e_t$ (19)

(6.6) (41.7)

There is a long term relationship between couples of LF and LBC if the residual has no unit root

$e_t = LF - 0.60 - 0.86LBC$ (20)

The residual series is stationary at the first difference and it is found that t-calculated -8.1 is greater than MacKinnon critical value 1.95 in absolute value. Hence the couple LF and LBC has a long term relationship.

$LF = 1.16 + 0.96LMCE + e_t$ (21)

(1.5) (38.4)

There is a long term relationship between couples of LF and LMCE if the residual has no unit root.

$e_t = LF - 1.16 - 0.96LMCE$ (22)

The residual serie is stationary at the first difference and it is found that t-calculated -9.6 is greater than MacKinnon critical value 1.95 in absolute value. Hence the couple LF and LMCE has a long term relationship.

$LF = 0.22 + 0.97LFR + e_t$ (23)

(1.4) (26.7)

There is a long term relationship between couples of LF and LFR if the residual has no unit root.

$e_t = LF - 0.22 - 0.97LFR$ (24)

The residual serie is stationary at level and it is found that t-calculated -3.6 is greater than MacKinnon critical value 1.95 in absolute value. Hence the couple LF and LFR has a long term relationship.

$LF = 0.75 + 0.83LMEAT + e_t$ (25)

(7.39) (35.77)

There is a long term relationship between couples of LF and LMEAT if the residual has no unit root. Let generate the seriee_t

$e_t = LF - 0.75 - 0.83LMEAT$ (26)

The residual serie is stationary at first difference and it is found that t-calculated -8.78 is greater than MacKinnon critical value 1.95 in absolute value. Hence the couple LF and LMEAT has a long term relationship.

$LF = -0.05 + 1.00LVEGET + e_t$ (27)

(0.68) (51.29)

There is a long term relationship between couples of LF and LVEGET if the residual has no unit root. Let generate the seriee_t

$e_t = LF + 0.05 - 1.00LVEGET$ (28)

The residual serie is stationary at level and it is found that t-calculated -2.23 is greater than MacKinnon critical value 1.95 in absolute value. Hence the couple LF and LVEGET has a long term relationship.

5.4.6 Error correction model

As it is necessary to analyze the short term dynamics between variables for concluding is real long term relationship, the following paragraphs concentrate on short term dynamics analysis between variables.

5.4.7 Specification of error correction models

In order to analyze the short term dynamics between variables, the error collection models are specified as follows:

$\Delta lf = \alpha_1 \Delta lbc + \alpha_2 creslbc_{t-1} + u_t$ (29)

$\Delta lf = \alpha_1 \Delta lmce + \alpha_2 creslmce_{t-1} + u_t$ (30)

$\Delta lf = \alpha_1 \Delta lfr + \alpha_2 creslfr_{t-1} + u_t$ (31)

$\Delta lf = \alpha_1 \Delta lmeat + \alpha_2 creslmeat_{t-1} + u_t$ (32)

$\Delta lf = \alpha_1 \Delta lveget + \alpha_2 creslveget_{t-1} + u_t$ (33)

5.4.8 Estimation of models and discussion

$\Delta lf = 0.36\Delta lbc - 0.04creslbc_{t-1} + u_t$ (34)

(3.31) (-1.34)

$\Delta lf = 0.30\Delta lmce - 0.04creslmce_{t-1} + u_t$ (35)

(2.29) (-1.60)

$\Delta lf = 0.08\Delta lfr + 0.01creslfr_{t-1} + u_t$ (36)

(2.56) (1.04)

$\Delta lf = 0.22\Delta lmeat - 0.03creslmeat_{t-1} + u_t$ (37)

(1.57) (-1.12)

$\Delta lf = 0.43\Delta lveget - 0.06creslveget_{t-1} + u_t$ (38)

(15.38) (-4.20)

From the estimation of short term dynamics of the specified models, it found that the coefficient of error correction term on vegetable price index is the only one which is negatively and statistically significant. In fact, the error correction term also known as the speed of adjustment shows how much time would be taken by the economy to reach at long term equilibrium.

The size of the speed of adjustment on vegetables price index with respect to general food price index is -0.06 showing that the economy will converge towards the long run equilibrium approximately in one year following a shock.

This confirms the real existence of long term relationship between vegetables and general food price indices. Also the F-statistic of 2631.566 shows global significance of the model (LF and LVEGET) gives the authority to interpret that there is price index elasticity transmission. Here means 1% change in vegetables price index induces 43% of change on general food price index.
On the other hand, there is no real existence of long term relationship for all other variables and food price index as the error correction term coefficients are not negatively and statistically significant.

6. Summary Conclusion and Policy Implications

This chapter consists of three main sections; a summary of the work, conclusion and recommendations for policy makers and for future researchers.

6.1 Summary

This study has revealed in detail the "Food price volatility analysis in Rwandan urban markets". The study used an Econometric analysis for the data of price indices spanning the period 2005-2016. The macro economic variables used were general food, bread and cereals milk cheese and eggs, meat, fruits and Vegetables price indices.

Different literatures both Economic theory and empirical investigation have resulted in a number of facts and arguments that indicates the volatility of prices from period to period. Prices fluctuate based on changes in supply and demand. When supply increases, prices tend to go down and when there is a shortage, prices go up.

When demand increases, prices increase and when it decreases, prices tend to fall. This study dealt with food staff variables related to agriculture where volatility in prices may due to Weather shocks, Climate change, Energy shocks, Exchange rate fluctuations and slowing agricultural productivity growth.

In order to investigate the volatility of price indices for the variables the study considered, an econometric analysis was applied. In this study precisely in its third chapter we discussed all the relevant statistical estimation concepts and techniques as well as the specification of the models to estimate the relationship between variables the study considered.

The stationality test shows that all variables LF, LBC, LMCE, LFR, LMEAT and LVEGET using ADF become stationary after performing the first difference i.e they were integrated at order one. The equation of co-integration of all variables showed that there is a long run relationship between them. The long term relationship was confirmed also by an analysis of price index by couples.

The results from the estimation of short term dynamics of the specified models, it found that the coefficient of error correction term on vegetable price index is the only one which is negatively and statistically significant. That means that among all variables used, only vegetables price index has short run

relationship with general food price index. Finally chapter five includes the summary of findings, conclusion and recommendations for policy makers.

6.2 Conclusion

This research tries to analyse the volatility on food price. The monthly price index time series spanning the period 2005-2016 have been used to estimate a linear regression models.

The focal aim of this study is to test the null hypothesis that Food price volatility causes are statistically significant against alternative hypothesis that Food price volatility causes are not statistically significant. These hypotheses were tested by using econometric techniques by applying Engle-Granger co-integration method. The results are found to support null hypothesis in long-run for all variables both for the linear equation including all variables and for equations by couples. This implies that price volatility on all independent variables induces volatility on general food prices.

The results in short run dynamics showed that only the error correction term for vegetables price index is statistically significant where its size of the speed of adjustment with respect to general food price index is -0.06 showing that the economy will converge towards the long run equilibrium approximately in one year following a shock. This result was also confirmed by the F-statistic of 2631.566 for the short run model of vegetables and general food price indices. This means that in short run only vegetable price volatility causes price volatility on general food.

Therefore the economy should control all independent variables (bread and cereals, milk, cheese and eggs, fruit, meat and vegetables) in long run and vegetables prices especially in short term.

6.3 Recommendations

Based on findings, researchers suggested some recommendations to policy makers on how to reduce and manage price volatility. The recommendations are the following:

- To create conditions favorable such as land consolidation, application of fertilizers to sustainable development and promotion of agricultural and livestock producers, in order to ensure national food security.
- Integration of agriculture and livestock in a market-oriented economy.
- To create favorable conditions for the increase of livestock produces (milk, meat, eggs, honey, fish) through genetic improvement, feeding and animal health.
- To encourage the private sector through incentive measures to enable it to participate intensively in production, processing and conservation of agricultural products.
- To promote professionalism in agriculture which consists of acquiring thorough techniques for production, marketing and processing agricultural produces.
- Fruits and vegetables make an important source of income to the producers and contribute to the improvement of food. Therefore policy makers should focus mainly on the organisation of producers in order to control market prices.
- Reducing barriers to trade by strengthening WTO disciplines on export restrictions
- Better information on production and stocks
- Regulatory oversight on speculation of food price increase or decrease.
- Weather-based insurance
- Financial reserves and lending facilities for producers.
- More targeted market-compatible social safety nets rather than using trade policy as a social safety net.

References

1 2010 b Speculative influences on commodity futures prices 2006–08. UNCTAD Discussion Paper no. 197. Geneva, Switzerland: UNCTAD On the Costs of Food Price fluctuations in low income countries: Robert J. Mayers;
2 Food price Policy and income distribution in low income countries: John W. Mellor, Volume 27, 1978;
3 Rules, Discretion and Reputation in a Model of Monetary Policy: Barro, Robert J. and David B. Gordon, 1983;
4 Rutayisire, M. J. (2013), "Threshold effects in the relationship between inflation and economic growth: Evidence from Rwanda", *African Economic Research Consortium (AERC)*, 1-33;
5 Salvatore, D. and Diulio, E. (2003), "Principles of economics: Schaum's Easy Outline".
6 Shaun K. Roache; International Monetary Fund (IMF); May 2010T
7 4FAO. 2008. The State of Food Insecurity in the World 2008. High food prices and food security – threats and opportunities. Rome; N. Kumar and A. Quisumbing. 2011. Lugar Center, 1717 Rhode Island
8 Gilbert C (2010), 'Speculative Influences on Commodity Futures Prices 2006–2008', UNCTAD Discussion Paper No 197.e
9 Impact of the Common Agricultural Policy on food price volatility for developing countries Nicola Cantore November 2012,…NW, Ninth Floor, Washington95 434344443
10 John STAATZ 2012 Agricultural Price Volatility: Causes, Impacts & Policy Implications. 4th International Disaster and Risk Conference IDRC Davos 2012 , Switzerland.
11 Abbot P. C., Hurt C., Tyner W. E. 2008 What's driving food prices? Oak Brook, IL: Farm Foundation.
12 Balcombe K.2009 The nature and determinants of volatility in agricultural prices: an empirical study from 1962–2008. In The evolving structure of world agricultural trade (eds Sarris A., Morrison J.), pp. 109–136. Rome, Italy: FAO
13 Braun, J. von and M. Torero, Implementing physical and virtual food reserves to protect the poor and prevent market failure. 10. IFPRI Policy Brief. Washington DC, USA, February 2009.
14 Dwyer, A., G. Gardner and T. Williams, 'Global commodity markets price volatility and financialisation.' In: Bulletin Reserve Bank of Australia June Quarter (2011): pp. 49-58.
15 FAO 2008 Soaring food prices: facts, perspectives, impacts and actions required, Conference proceedings, June 3–5, 2008, Rome
16 Food price Policy: The rationale for Government intervention: Peter c. Timmer;
17 Food Price Volatility and Its Implications for Food Security and Policy:MatthiasKalkuhl, Joachim von Braun, Maximo Torero, 2016, ISBN: 978-3-319-28199-5 (Print) 978-3-319-28201-5 (Online);
18 Ghosh, J., 'The unnatural coupling: food and global finance.' In: Journal of Agrarian Change 10 (2010);
19 Gilbert C. L.2006 'Trends and volatility in agricultural commodity prices'. In Agricultural commodity markets and trade (eds Sarris A., Hallam D.), pp. 31–60. Cheltenham, UK: Edward Elgar
20 Global Food Price Volatility and Spikes: An Overview of Costs, Causes, and Solutions: Joachim Von Braun, Getaw Tadesse,2012;
21 Has food price volatility risen? Christopher L. Gilbert and C. Wyn Morgan, 2010;
22 Irwin S. H., Holt B. R. 2004 The effects of large hedge fund and CTA trading on futures market volatility. In Commodity trading advisors: risk, performance analysis and selection (edsGregoriou G. N., Karavas V. N., Lhabitant F.-S., Rouah F.), pp. 151–182. Hoboken, NJ: Wiley
23 Meijerink, G., S. van Berkum, K. Shutes and G. SolanoHermosilla, Price and prejudice: Why are food prices so high? LEI, part of Wageningen UR, The Hague, The Netherlands, 2011;
24 Miranda M. J., Helmberger P. G.1988 The effects of commodity price stabilization programs. Am. Econ. Rev. 78, 46–58

25 Mundlak Y., Larsen D. F.1992 On the transmission of world agricultural prices. World Bank Econ. Rev. 6, 399–422;or, Washington, D.C. 2003 202.776.1595 www.thelugarcenter.org
26 Price, M., 'The ten things we learnt from the Mifid leak.' In: Financial News (2011). Robles, M., M. Torero and J. von Braun, When speculation matters. IFPRI Issue Brief. IFPRI, Washington, 2009.
27 Subervie, J. (2008), "The variable response of agricultural supply to world price instability in developing countries, Journal of Agricultural Economics, 59 (1): 72-92.
28 Technical background document for the high-level event on:"Food price volatility and the role of speculation"FAO headquarters, Rome, 6 July 2012;
29 Timmer, C. Peter; Falcon, Walter P.; Pearson, Scott R.; Harvard Business School; Food Research Institute. 1983. Food policy analysis. Washington, D.C. : The World Bank;
30 What Explains the Rise in Food Price Volatility? Shaun K. Roache, International Monetary Fund (IMF), May 2010, IMF working Paper N0 10/129;
31 World Agriculture, Commodity Policy and Price Variability: Am.J. Agriculture Economics, 1975;
32 Wright, B., 2009. International grain reserves and other instruments to address volatility in grain markets. Policy Research Working Paper. World Bank, Washington DC, USA, August 2009.
33 Wright, B.D., 'Recent agricultural price volatility and the role of grain stocks.' In: Barcelona: International Food & Agricultural Trade Policy Council, May 2010.

Annexure

Dependent Variable: LFD
Method: Least Squares
Date: 09/07/17 Time: 16:13
Sample: 2005:01 2016:12
Included observations: 144
LF=C(1)+C(2)*LBC+C(3)*LMCE+C(4)*LFR+C(5)*LMEAT+C(6)
*LVEGET

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.215780	0.055465	-3.890383	0.0002
C(2)	0.334144	0.059384	5.626869	0.0000
C(3)	0.295117	0.070177	4.205328	0.0000
C(4)	0.151735	0.020350	7.456081	0.0000
C(5)	-0.215001	0.063460	-3.387996	0.0009
C(6)	0.482085	0.024724	19.49853	0.0000

R-squared	0.990062	Mean dependent var	4.394011
Adjusted R-squared	0.989702	S.D. dependent var	0.263484
S.E. of regression	0.026738	Akaike info criterion	-4.364692
Sum squared resid	0.098659	Schwarz criterion	-4.240950
Log likelihood	320.2578	F-statistic	2749.676
Durbin-Watson stat	0.374013	Prob(F-statistic)	0.000000

Dependent Variable: LF
Method: Least Squares
Date: 09/08/17 Time: 16:30
Sample: 2005:01 2016:12
Included observations: 144
LF=C(1)+C(2)*LBC

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.600814	0.091025	6.600571	0.0000
C(2)	0.867216	0.020764	41.76444	0.0000

R-squared	0.924719	Mean dependent var	4.394011
Adjusted R-squared	0.924189	S.D. dependent var	0.263484
S.E. of regression	0.072547	Akaike info criterion	-2.395366
Sum squared resid	0.747361	Schwarz criterion	-2.354118
Log likelihood	174.4663	F-statistic	1744.268
Durbin-Watson stat	0.161605	Prob(F-statistic)	0.000000

Dependent Variable: LF
Method: Least Squares
Date: 09/08/17 Time: 16:59
Sample: 2005:01 2016:12
Included observations: 144
LF=C(1)+C(2)*LMCE

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.168380	0.110043	1.530131	0.1282
C(2)	0.962917	0.025032	38.46749	0.0000

R-squared	0.912440	Mean dependent var	4.394011
Adjusted R-squared	0.911824	S.D. dependent var	0.263484
S.E. of regression	0.078240	Akaike info criterion	-2.244270
Sum squared resid	0.869262	Schwarz criterion	-2.203022
Log likelihood	163.5874	F-statistic	1479.748
Durbin-Watson stat	0.144929	Prob(F-statistic)	0.000000

Dependent Variable: LF
Method: Least Squares
Date: 09/08/17 Time: 19:32
Sample: 2005:01 2016:12
Included observations: 144
LF=C(1)+C(2)*LFR

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.222125	0.156452	1.419770	0.1579
C(2)	0.972999	0.036429	26.70969	0.0000

R-squared	0.833997	Mean dependent var	4.394011
Adjusted R-squared	0.832828	S.D. dependent var	0.263484
S.E. of regression	0.107730	Akaike info criterion	-1.604588
Sum squared resid	1.648014	Schwarz criterion	-1.563340
Log likelihood	117.5303	F-statistic	713.4074
Durbin-Watson stat	0.407652	Prob(F-statistic)	0.000000

Dependent Variable: LF
Method: Least Squares
Date: 09/11/17 Time: 13:32
Sample: 2005:01 2016:12
Included observations: 144
LF=C(1)+C(2)*LMEAT

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.754142	0.101979	7.395074	0.0000
C(2)	0.833754	0.023305	35.77583	0.0000

R-squared	0.900134	Mean dependent var	4.394011
Adjusted R-squared	0.899431	S.D. dependent var	0.263484
S.E. of regression	0.083558	Akaike info criterion	-2.112766
Sum squared resid	0.991429	Schwarz criterion	-2.071519
Log likelihood	154.1192	F-statistic	1279.910
Durbin-Watson stat	0.125841	Prob(F-statistic)	0.000000

Dependent Variable: LF
Method: Least Squares
Date: 09/11/17 Time: 13:33
Sample: 2005:01 2016:12
Included observations: 144
LF=C(1)+C(2)*LVEGET

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.059476	0.086958	-0.683964	0.4951
C(2)	1.002690	0.019546	51.29879	0.0000

R-squared	0.948802	Mean dependent var	4.394011
Adjusted R-squared	0.948442	S.D. dependent var	0.263484
S.E. of regression	0.059828	Akaike info criterion	-2.780899
Sum squared resid	0.508271	Schwarz criterion	-2.739652
Log likelihood	202.2247	F-statistic	2631.566
Durbin-Watson stat	0.293573	Prob(F-statistic)	0.000000