ISET

WORKING PAPER SERIES

Measuring Food Price Volatility in Georgia

Salome Gelashvili, Patima Mamardashvili

International School of Economics at Tbilisi State University
16 Zandukeli Street, Tbilisi 0108, Georgia
www.iset.ge

Measuring Food Price Volatility in Georgia

Working Paper

Salome Gelashvili, Phatima Mamardashvili

International School of Economics at Tbilisi State University

Abstract

Food price volatility is an important determinant of access to food. Given Georgia's low self-sufficiency ratio (34%) and its dependence on international markets, Georgia has few mechanisms to control food price volatility, particularly when it is driven by international market conditions. The goal of this paper is to measure the price volatility of wheat, potato and maize flour in Georgia, and define major drivers of volatility through a time series analysis of retail prices of those three food products, which account for a significant share of households' spending on food. Results of the analysis are expected to contribute to Georgia's policy on food security, as well as agricultural policy in general.

1. Introduction

Changes in food prices is a global challenge, and particularly important for developing countries where spending on food is relatively high. Major concerns about food price dynamics and volatility are usually driven by the concerns about food security. (FAO, OECD, 2011). Food prices and volatility affect all the dimensions of food security. High and volatile prices lead to reduced and unstable access to food, and issues with proper nutrition.

High food prices are a problem for net importers of food because high prices reduce consumers' purchasing power. In addition to this, high price/low income countries who are importing food suffer from higher pressure to finance increased import costs through increasing exports, which frequently leads to local currency depreciation. Government spending also becomes higher due to the increased need for government interventions (e.g. food consumption subsidies) to mitigate the consequences of high prices. (FAO, OECD, 2011).

Low food prices, on the contrary, negatively affect food exporting countries, which generate major income from food exports, and food producers in general.

Both food producers and consumers are concerned not only about price levels but price volatility as well. Price volatility causes supply side inefficiencies, creates problems on the demand side, and is hard to deal with for majority of governments of less developed and developing countries. Increased price volatility negatively affects producers' profits and their decisions regarding investments. Since volatility is associated with uncertainty, it distorts resource allocation in agricultural production, leading to sub-optimal solutions and potential price spikes. Increased price volatility may also result in increased speculative trading (Filho C,M,, Torero M, 2011).

Price volatility and its implications for food security are very important for the South Caucasus countries which are still in the process of developing food security laws (this concerns only Azerbaijan and Georgia, since Armenia has a law on food security), early warning systems, market price information systems, etc. (ISET, 2016).

Georgia is a developing country where an average household spends more than 40% of its budget on food (GeoStat, 2015). Given such a large share of overall spending on food, Georgian consumers are very sensitive to food prices and food price volatility.

In light of the fact that during the last 10-15 years, food prices in Georgia have been steadily increasing, an analysis of food price dynamics and volatility has become more and more important for producers, consumers, traders and policy makers.

Figure 1. Food Price Index and CPI Dynamics in Georgia
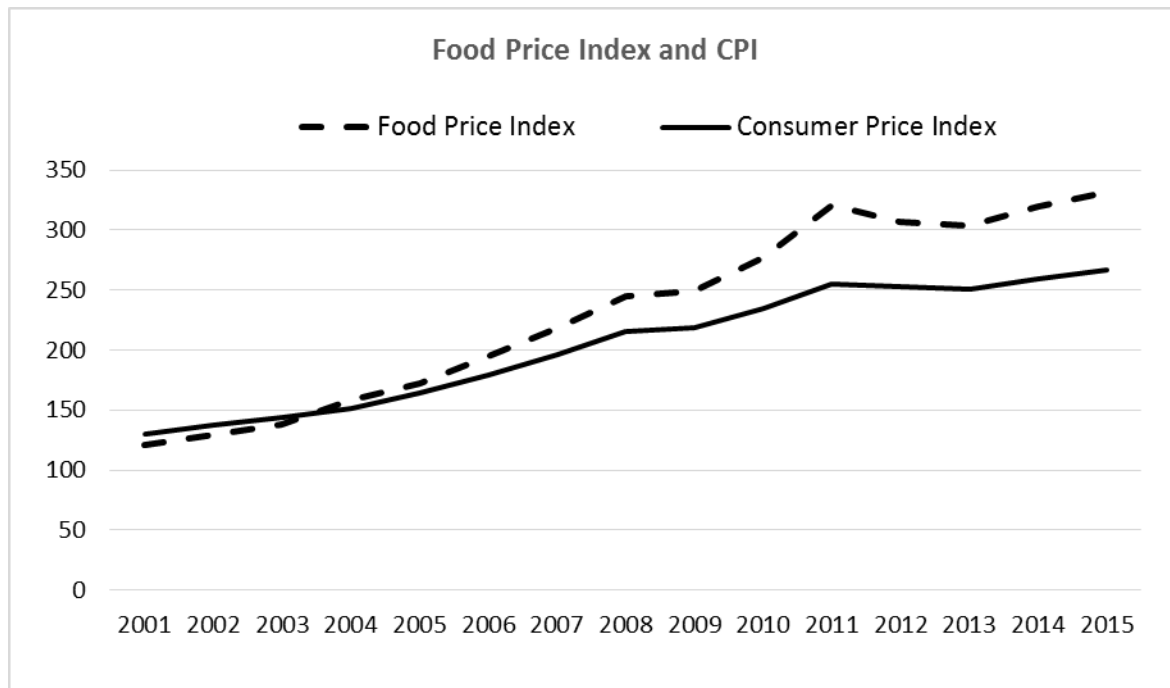
Note: 1998 is the base year, when index=100
Source: National Statistics Office of Georgia (2015)

The aim of this paper is to study the determinants of food prices and identify main drivers of volatility in Georgia, keeping in mind that not all types of volatility are problematic. Seasonal volatility, for example, might not be an issue, whereas unpredictable volatilities not driven by fundamental market forces are usually problematic (FAO et al. 2011).

Our analysis is based on the retail prices of wheat, potato and maize flour, which account for significant portion of households' spending on food. Wheat flour represents a case of extreme import dependency, since more than 90% of wheat is imported to Georgia. Potato is an example of low import dependency, with a self-sufficiency ratio of 91%, although it is still among the first ten food import commodities. Maize flour is an example of commodity which is less dependent on imports, and less commercialized compared to wheat flour and potato.

This investigation of major drivers of food price volatility will enable the government utilize relevant risk management tools to reduce uncertainty and the negative consequences of food price spikes.

2. Literature Review

Jordaan, H., Grové, B., Jooste, A. et al. (2007) measured price volatility of five food commodities by looking at the daily spot prices of yellow maize, white maize, wheat, sunflower seed and soybeans on the South African Futures Exchange. They apply the GARCH approach to estimate the price volatility of white maize, yellow maize and sunflower, since volatility in the prices of these crops varies over time. As to the wheat and soybeans, the standard error of the ARIMA process was considered as the measure of price volatility for those crops. The authors found that white maize's price was the most volatile, and the wheat price was the least volatile. These results could affect farmers' decision-making regarding investments in crops. Thus, risk-averse farmers may prefer to invest in wheat and sunflower seeds, whereas farmers interested in investing in maize might think about some risk management techniques that would help to reduce uncertainty caused by the relatively high price volatility of the crop.

Similarly to Jordaan, H. et al., Ano Sujithan K., Avouyi-Dovi S. and Koliai L. (2014) focused on a particular set of commodities, and measured price volatility for cocoa, coffee, corn, soybeans, sugar and wheat; however, their volatility estimation strategy was different. The commodities were selected due to their major role in global food market and their importance for the economies of developing countries. The authors discussed several measures of volatility, focusing on standard dispersion indicators and presenting the dependence structure between standard deviation (SD), the rolling mean absolute deviation (MAD) and the inter-quartile ratio (IQR) for the prices of selected commodities. In order to estimate the impact of determinants on volatility the authors employed a dynamic multivariate framework, and in particular, the Bayesian vector autoregressive (BVAR) model. The explanatory variables affecting price volatility were represented by the commodity's price, the Standard and Poor's 500 stock index (the main factor describing global financial markets), monthly global GDP (macroeconomic factor), Merrill Lynch Biofuels spot price index (indicator for biofuel market) and oil prices for both WTI and Brent crude oil. As a result of the analysis, the authors concluded that price return

shocks, GDP shocks and biofuel price shocks drive volatility down for most of the commodities, whereas oil price shocks and financial market shocks drive volatility up.

Shively E.G. (1996) investigated maize price volatility with respect to economic reforms in Ghana. He applied the ARCH model to identify the impact of lagged prices, domestic production, exchange rates, and production in neighboring countries on deflated maize prices and conditional variances in maize prices. The author discussed the process of commodity price determination under the theory of competitive storage behavior under rational expectations. He considered a three-agent economy model including a class of producer-consumers, speculators holding inventories, and a class of agents dealing with exports. Based on this theory, the equilibrium price function for maize was defined by past prices, domestic and regional harvests, and exchange rates. The central hypothesis tested and finally rejected in this study was that reduction of government interventions in the agricultural sector increased maize price variability in the post-reform period.

In their paper, Gilbert C. L. and Morgan C. W. (2010) discuss whether world price spikes like one in 2008 are likely to repeat in the future. They also discuss the major causes of food price volatility, emphasizing production and consumption shocks, stockholding and actions of speculators who deal with stocks, and the futures or derivative contracts. Another section of the paper is devoted to the discussion of the consequences of food price volatility on economy and individual level for both poor and rich countries. The authors focus on the negative effect of price shocks to poor countries, which are usually net importers of food products. Sudden increases in prices can cause poor nutrition and hunger in those countries because of high spending on food. The authors discuss short-term measures (export controls and price subsidies), and long-term measures (regulated food trade environment, EU's Common Agricultural Policy (CAP)) to minimize the negative outcomes of food price volatility.

Kornher L. and Kalkuhl M. (2013) discuss determinants of food price volatility in developing countries. They consider supply side factors such as imports, stocks, future price expectations and incomplete competition; demand side factors including population and income growth; and macroeconomic factors such as interest rates, inflation, exchange rates, political stability and governance. They also look at transaction costs, consisting of global oil prices, freight rates, trade barriers and transit costs; agricultural policies, including production subsidies, export bans and

stabilization interventions; and international prices, represented by future prices at major commodity exchanges and export prices at main ports. Two estimation techniques are used to assess the impact of various exogenous variables on domestic price volatility. First, they apply a system GMM estimation, and then a two-step IV estimation using the residuals from the GMM. Findings suggest that stocks, production, international price volatility, and governance significantly affect domestic price variability.

FAO, IFAD, IMF et al. (2011), in their policy paper discuss various policy measures to deal with price volatility. They distinguish between measures designed to reduce volatility, and measures that help cope with its consequences. Recommendations are provided at individual, national, regional, and international levels. Some of the most frequently applied measures include agricultural insurance and preparation of contingency plans, etc. The report also discusses the mechanisms of international cooperation to implement policy measures addressing global food price volatility.

3. Data

This analysis is based on quarterly retail food price data for the period 1999 – 2015, for three food commodities:, potato, wheat and maize flour. The prices of those commodities are obtained from the National Statistics Office of Georgia. The effect of inflation on prices is removed by deflating the nominal prices with the consumer price index (CPI), which results in real prices.

Exogenous variables include production of respective commodities (in physical terms), imports (in monetary values), real GDP, exchange rates and oil prices. Quarterly production, import and real GDP data is available from National Statistics Office of Georgia, and data on exchange rates (GEL/USD) comes from the National Bank of Georgia. Oil prices are represented by Europe Brent spot prices (FOB) and are obtained from U.S. Energy Information Administration.

4. Method

The methodology for identification of price volatility dynamics through standard dispersion measures is similar to the methodology suggested by Ano Sujithan K., Avouyi-Dovi S. and Koliai L. (2014), whereas the estimations for price determination and price volatility follow the methodology suggested by Shively E. G. (1996).

Price volatility dynamics of wheat, potato and maize flour are presented using SD, MAD and IQ and allow for judgement about the periods of relatively low and high volatility. As for the estimation of the commodity price determination process and determinants of price volatility, two major equations estimated for selected commodities are presented below:

$$Price = \beta_0 + \sum_{i=1}^{s} \beta_i Price_{t-i} + \alpha_1 Prod + \alpha_2 Imports + \alpha_3 Exr + \alpha_4 GDP + \alpha_5 Oil + \alpha_6 rend + \varepsilon \quad (1)$$

$$\varepsilon^2 = \gamma o + \sum_{i=1}^{s} \gamma_i \varepsilon^2_{t-i} + \sum_{i=1}^{s} \mu_i Price_{t-i} + \lambda_1 Prod + \lambda_2 Imports + \lambda_3 Exr + \lambda_4 GDP + \lambda_5 Oil + \lambda_6 trend + v \quad (2)$$

It is expected that higher prices in previous periods are positively correlated with current period prices. It is also expected that higher production reduces prices and increases inventories. Thus, higher production should lead to smaller price rises.

Unlike production, imports are expected to have a positive correlation with price levels and volatility, because higher imports imply a high dependency on international prices. High international prices are usually finally (with some lag) transmitted to importing countries. However, it is also true that imports increase the overall supply, which might cause a decrease in prices. Currency depreciation leads to an increase in exports and reduced inventories causing increase in prices.

GDP is expected to be positively correlated with food prices because GDP represents the demand side factor, and higher GDP is associated with higher income, thus resulting in an increased demand for food and higher prices.

Oil prices are expected to be positively correlated with food prices, because they represent a portion of transaction costs. High transaction costs eventually translate into higher commodity prices.

As to volatility, higher volatility in previous periods is expected to cause higher volatility in the current period. The same is expected in case of lagged prices. Production is expected to be negatively correlated with volatility. GDP is likely to be negatively correlated with volatility, because as GDP increases the government has more resources to reduce price volatility. Currency depreciation is expected to increase exports, thus reducing inventories and increasing price volatility. Oil prices are expected to be positively correlated with the price volatility.

The price of respective commodities is a dependent variable in the first equation, and squared residuals (variance) from the estimation of the first equation is a dependent variable in the second equation. The Dickey-Fuller test for stationarity was applied to all the series and non-stationary series were transformed into stationary through the differencing. Thus, the first differences in oil prices, exchange rates, wheat and maize prices are used in estimations. Lag selection criteria suggests using one lag of a respective dependent variable in estimations for wheat flour and potato, and two lags for maize flour.

The OLS estimation of equation (1) was performed for all three commodities, and residuals were checked for normality, serial correlation and heteroscedasticity. The Shapiro-Wilk test was applied to residuals to check for normality, the Breusch-Godfrey LM test was used to check for autocorrelation, and the Breusch-Pagan and White's tests were applied to test for heterescedasticity. The final estimation technic (ARCH or OLS) for each commodity was selected based on the results of those tests.

5. Results and Conclusions
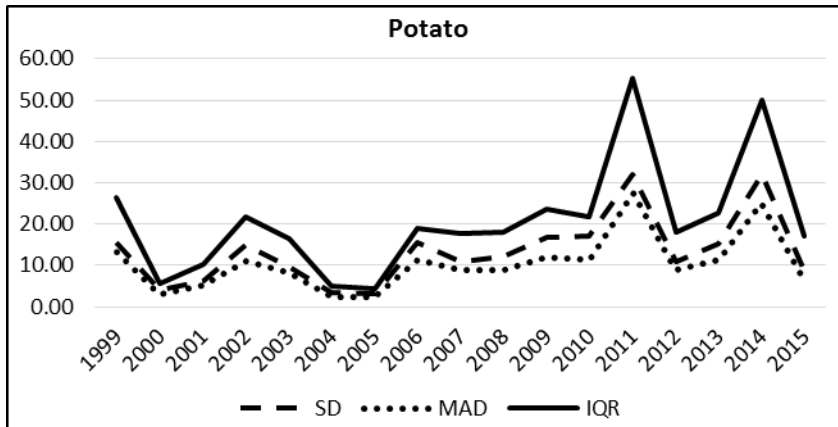
5.1 Price Volatility Dynamics

Price volatility dynamics using standard measures of dispersion (SD, IQR and MAD) for selected commodities are as follows:

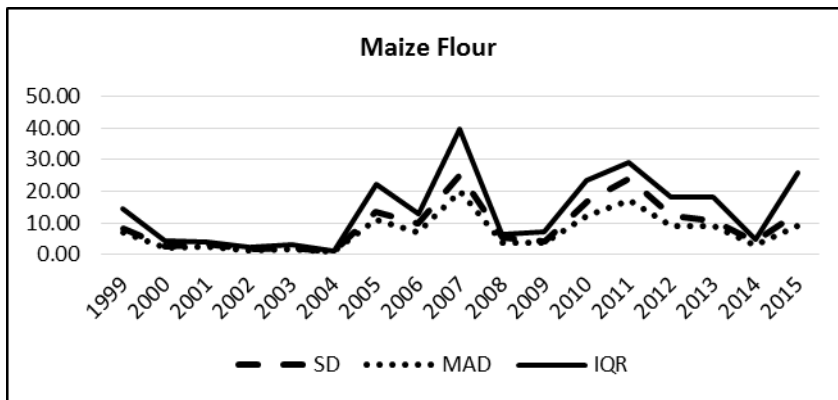**Figure 2. Wheat flour price volatility dynamics**
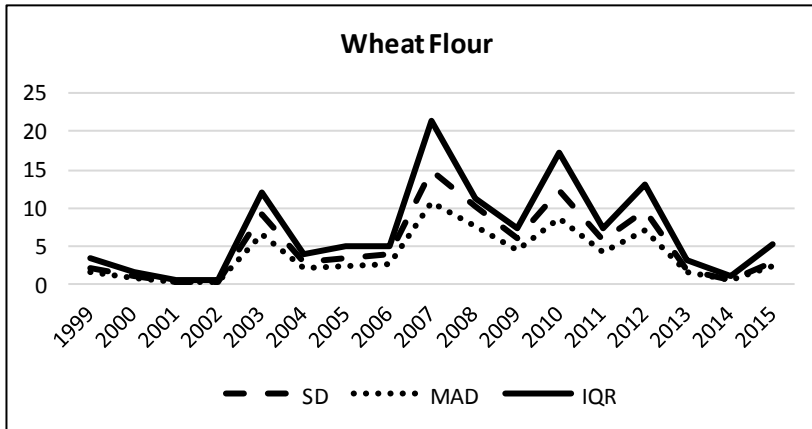
Source: Authors' calculations

Figure 3. Potato's price volatility dynamics

Source: Authors' calculations

Figure 4. Maize flour price volatility dynamics

Source: Authors' calculations

According to the data, wheat prices seem to be the most volatile out of the three commodities examined. Potato prices exhibited higher volatility in recent years beginning in 2011, whereas maize prices had higher volatility back in 2006-2008.

5.2 Estimation of commodity price determination process and determinants of price volatility

Table 1. Determinants of prices

Independent Variable	Dependent Variable is Deflated Commodity Price		
	Wheat Flour (ARCH)	Potato (OLS)	Maize Flour (OLS)
Lagged price 1	0.233**	0.500***	0.407***
	(0.119)	(0.097)	(0.135)
Lagged price 2	-	-	-0.170
	-	-	(0.133)
Production	0.014	-0.060***	0.032**
	(0.026)	(0.014)	(0.012)
Imports	-0.002	2.945**	0.690
	(0.075)	(1.323)	(1.390)
Real GDP	0.005**	-0.002	0.001
	(0.002)	(0.004)	(0.004)
Diff oil price	0.202	0.115	0.085
	(0.133)	(0.173)	(0.172)
Diff exch rate	2.479	-4.885	-1.548
	(21.063)	(29.863)	(31.012)
Time	-0.246**	0.169	-0.075
	(0.119)	(0.248)	(0.299)
Constant	26.117	24.889	7.301
	(16.469)	(33.470)	(40.553)
Log Likelihood	-219		
R squared	-	0.56	0.29
N	66	67	65

Note: *** indicates 1 percent significance level, ** 5 percent significance level, * 10 percent significance level

The first line shows coefficients, standard errors are given in parentheses

For wheat flour and maize flour prices are represented by first differences

Table 2. Determinants of price volatility

	Dependent Variable is Variance in Commodity Prices		
Independent Variable	**Wheat Flour (ARCH)**	**Potato (OLS)**	**Maize Flour (OLS)**
Lagged variance 1	0.077	-0.022	0.101
	(0.127)	(0.018)	(0.127)
Lagged variance 2	-	-	-0.101
	-	-	(0.120)
Lagged price 1	-0.083	94.795***	-1.300*
	(0.317)	(2.578)	(0.715)
Lagged price 2	-	-	2.397***
	-	-	(0.689)
Production	-0.044	-10.095***	0.269***
	(0.066)	(0.273)	(0.063)
Imports	0.471***	684.989***	7.972
	(0.121)	(25.405)	(7.137)
Real GDP	-0.010*	-0.503***	0.011
	(0.006)	(0.071)	(0.024)
Diff oil price	-0.424*	23.543***	-0.567
	(0.231)	(3.210)	(0.880)
Diff exch rate	62.307	-1034.185*	-296.931*
	(38.615)	(576.438)	(164.194)
Time	0.287	34.317***	-0.222
	(0.298)	(4.599)	(1.625)
Constant	-18.225	-4417.534***	19.218
	(40.611)	(622.804)	(221.175)
Log Likelihood	-262		
R squared	-	0.99	0.41
N	65	66	63

Note: *** indicates 1 percent significance level, ** 5 percent significance level, * 10 percent significance level

The first line shows coefficients, standard errors are given in parentheses

For wheat flour and maize flour prices are represented by first differences

5.2.1 Wheat flour

Tests showed that residuals from the OLS estimation of equation (1) are normally distributed, not serially correlated but heteroscedastic, leading to the conclusion that OLS estimation yields inefficient estimates of population parameters. In order to account for heteroscedasticity, the ARCH model was applied to estimate equations (1) and (2).

The estimation of equation 1 (Table 1) shows that higher prices in previous periods leads to higher current period prices. This result coincides with expectations. Higher real GDP positively affects prices, which is also in line with expectations. Both domestic production and imports are insignificant in the case of wheat flour. Prices decrease over time can be explained by relatively improved logistics and higher competition in the market compared to the nineties. The insignificance of domestic production is not surprising; however, imports were expected to be significant.

As to volatility equation (Table 2) imports, real GDP and oil prices are the only significant variables. Higher imports lead to higher volatility, as expected in cases of high dependence on international markets. The negative coefficient for real GDP also coincides with expectations. However, the negative coefficient for oil prices is counterintuitive.

Some of the unexpected results can be explained by the fact that the self-sufficiency ratio for wheat in Georgia is only 8%, implying that the country is highly dependent on wheat imports. At the same time, the market for wheat flour production is not very competitive due to the low number of importers. The estimation does not contain any market structure related variable or international price variable. These two variables would be likely to improve model specifications when included into the equations.

5.2.2 Potato

In the case of potato, tests show that OLS can be applied.
The estimation of equation 1 (Table 1) shows that lagged prices are positively related to current period prices, and production is negatively correlated with prices, which is in line with expectations. A positive coefficient for imports makes sense if imported potatoes are more expensive than domestic potatoes.

As to the volatility equation (Table 2), all the coefficients of significant variables are in line with expectations except for the coefficient for the exchange rate, which was expected to be positive. Thus, high lagged prices increase volatility as expected, and an increase in production reduces volatility, which is also intuitive. The coefficient for imports is positive, implying that higher imports cause higher volatility, which might be the case when markets are well integrated. Higher GDP decreases volatility because, as was already mentioned, richer countries have more resources to deal with uncertainty. A positive coefficient for oil prices also meets expectations.

5.2.3 Maize flour

As was the case for potatoes, after diagnostic tests were performed, equations for maize were estimated using OLS. In the first equation (Table 1), only lagged prices and production turned out to be significant variables. As to coefficients, a positive coefficient for the lagged price meets expectations, whereas a positive coefficient for production is counterintuitive.

In equation 2 (table 2), most of the coefficients are not in line with expectations. This can be explained by the fact that maize is a quite specific crop for Georgia. The self-sufficiency ratio is high and imports are low, as well as the commercialization level. Almost all rural families in Georgia produce maize for self-consumption and cattle feeding. That is why increased production does not necessarily imply that all extra produce is going to be sold in the market. In other words, the price of maize flour is not driven by solely by market forces.

Given the specificities of selected commodities, there is a room for further research and improvement of model specifications for wheat and maize flour.

As to policy implications, currently the government of Georgia implements many agricultural projects, including agricultural insurance, which is still not very popular among farmers. The findings of this study can be used to increase the awareness of farmers about the importance of using agricultural insurance to mitigate the consequences of food price volatility.

Another important implication of this study is that the government should work more actively on the issues of food security, and pay more attention to price analyses of those food products that are

particularly important for Georgian consumers. The proper measurement of food price volatility will help the government to decide whether to enhance price stabilization policies or not. If there is no evidence of volatility, the state can save budget resources spent on subsidies and allocate them differently.

6. References

Ano Sujithan, K., Avouyi-Dovi, S., Koliai, L. (2014). On the determinants of food price volatility. FAO, IFAD, IMF, OECD, UNCTAD, WB, IFPRI, 2011. Price volatility in food and agricultural markets: Policy responses.

Gilbert C. L. and Morgan C. W. (2010). Food Price Volatility. Philosophical Transactions: Biological Sciences, Vol. 365, No. 1554

International School of Economics at Tbilisi State University (2016). Assessing the Food Security Data Relevance and Collection Mechanisms in the South Caucasus. Policy Report.

Jordaan, H., Grové, B., Jooste, A., Alemu, ZG. (2007). Measuring the Price Volatility of Certain Field Crops in South Africa using the ARCH/GARCH Approach. Agrekon, Vol 46, No 3. Kornher L., Kalkuhl M. (2013). Food Price Volatility in Developing Countries and its Determinants.

National Statistics Office of Georgia, http://geostat.ge/index.php?action=0&lang=eng

Norton, W. G., Alwang, J., Masters, A. W. (2006). The economics of Agricultural Development: world food systems and resource use.

Rapsomanikis, G., Hallam, D., Conforti, P. (2003). Market Integration and price transmission in selected food and cash crop markets of developing countries: review and applications.

Robles, M., (2011). Price transmission from international agricultural commodity markets to domestic food prices: Case studies in Asia and Latin America.

Shively E. G., (1996). Food Price Variability and Economic Reform: An ARCH Approach for Ghana. American Journal of Agricultural Economics, Vol 78, No 1.