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Title of paper: Cassava price volatility: evidence from Ghana

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Abstract

Recent years have witnessed a sharp increase in many commodity prices in general. This study is focused on examining cassava price and its volatility in the Volta region of Ghana. Secondary data was collected on cassava price and key variables that determine price volatility. Our results show that cassava price averagely increases significantly by 46% annually with the volatility level of 30.8% annually and 177.8% over the period (1970-2012). Furthermore, Inflation and exchange rate were positive and significant determinants of the price of cassava whilst cassava yield, inflation and exchange rate had significant positive relationship with the volatility of cassava price. Based on the finding of the study, it is recommended that policies stabilizing inflation, exchange rate, establishment of price controls, designing output risk insurance and training farmers in value addition will help address the challenge of a volatile cassava price.

Key-words: Price volatility, regression

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Introduction

Food price volatility is a major agricultural phenomenon especially in developing countries, considering that agriculture is the main source of livelihood for the people. Over the decade, food price volatility in general, has received a considerable attention in the growing body of literature largely due to its far-reached economic and social consequences (Prakassh, 2011). Several authors (Ivanic & Martin, 2008; de Hoyos & Medvedev, 2011; Anderson & Roumasset, 1996; Cohen & Garrett, 2009) have concluded that higher and more volatile food prices will yield substantial adverse consequences on the welfare of farmers generally and more specifically hurt poor net consumer since food is typically a large share of expenditure for the poor. Campton Wiggins and Sharada (2010) further disclosed that food price volatility can have significant impacts on the effective purchasing power, even if they do not directly affect nominal per se. Cassava is one main and widely consumed staple food crop especially in African countries including Ghana with enormous economic and social importance, and therefore its price volatility imposes pressing challenges especially to the farmers and other investors (Timmer, 1995). Volta region is one of the leading producers of cassava in Ghana and for that matter experience the phenomenon of cassava price volatility resulting in adverse impact on the farmers in the area (Ministry of Food and Agriculture [MoFA], 2011).

Although there is perceived high cassava price volatility in the major cassava production areas, there is a paucity of work done and little literature to unveil the real trend and provide sound empirical credence and evidence for policy formulation and investment decision making. Therefore, an understanding of the nature of volatility is required to mitigate its effects and further empirical work is needed to enhance our current understanding. This study therefore examines cassava price volatility in the Volta region of Ghana. Specifically, the study seeks to (1) examine the cassava price trend over the period in the study area; (2) estimate the level of volatility within and over the entire period under consideration; (3) examine the factors that influence cassava price and its volatility in the study area; (4) Suggest policy formulation for price volatility management.

Materials and methods

Price volatility

While the volatility of a time series may seem like a rather obvious concept, there are in fact several different potential measures of a series' volatility. For example, if a price series has a mean, then the volatility may be interpreted as its tendency to have values very far from this mean. Alternatively, volatility may be interpreted as a series' tendency for large changes in its values from period to period. A high rate of volatility according to the first measure needs not imply a high volatility according to the second. Another commonly held notion is that volatility is defined in terms of the degree of forecast error. A series may have large period to period changes, or large variations away from its mean, but if the conditional mean of the series is able to explain most of the variance, then a series may not be considered volatile.

In the field of agricultural economics, most of the literature contains two main types of historical volatility measurements, conditional and unconditional. While mean deviation (MD) generates series of deviations over time, Simple approaches like the coefficient of variation (CV) and the standard deviation of the log returns (SDLOG) provide a measure of total price variation. Alternatively, the generalized autoregressive conditional heteroskedasticity (GARCH) models first remove the predictable component of prices before measuring volatility (conditionally to the mean equation). It is the main tool to measure volatility, but, in the context of this paper, it is a strong assumption to make that small producer in developing countries can correctly anticipate all the predictable components. Removing this predictable component implies a reduction of price variations before computing the volatility measure. These variations impact the farmers and poor people whether they are theoretically predictable or not because their response possibilities can be rather inelastic (Pierre, Morales-Opazo, & Demeke, 2014).

Selecting an appropriate measure of volatility is crucial as results might differ depending on this choice. The simplest way to measure price volatility is the CV, 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 unit. It allows then easy comparison of, for example, domestic price volatility measured in different countries. Other method of measuring volatility with computational ease is mean deviation (MD) which can generate time series for further analysis. As mentioned earlier, an often used alternative to the CV is the SDLOG (Balcombe, 2009; Gilbert & Morgan, 2010; Huchet, 2011; Minot, 2012). This measure also has no unit, but it is less affected by strong trends over time. For low levels of instability, it is approximately equal to the coefficient of variation.

Volatility in this study is concerned with the variability of the price series around its central value, that is, the tendency for individual price observations to vary far from its mean value. Thus volatility is often defined as high deviations from central tendency. In this study, coefficient of variation and mean standard deviation were considered for measuring volatility.

Data

In order to examine price volatility of cassava in Ghana, monthly cassava price data from 1970 to 2012 were collected from the Statistical, Research and Information Directorate (SRID) of Ministry of Food and Agriculture (MoFA). Furthermore, to examine the determinants of cassava price volatility, secondary data were collected on the relevant variables including inflation from Ghana Statistical Service; exchange rate and interest rate from Bank of Ghana, rainfall and temperature from Ghana Metrological Service; and yield from SRID of MoFA also from 1970 to 2012.

Data Analysis Techniques

Various analysis techniques were employed in the study. Firstly, time series plot was used to examine cassava price trend. Secondly, coefficient of variation (CV) and mean deviation (MD) were used in measuring volatility and analysis of variance for inferring statistical significance in volatility within different time period. The CV and MD are defined as follows;

$$CV = \text{Standard deviation}\text{Mean} * 100 \qquad (1)$$

$$MD = \text{price values} - \text{mean price value} = \square - \ddot{x} \qquad (2)$$

The Method of Ordinary Least Squares (OLS)

Although there are several methods of obtaining the sample regression function as an estimator of the true population regression function in regression analysis, the method that is used most frequently is that of least squares (LS), more popularly known as the method of ordinary least squares (OLS). Given the population regression function (PRF) as

$$Y_i = B_1 + B_2X_i + u_i \tag{3}$$

Since the PRF is not directly observable, sample regression function (SRF) is estimated from it as

$$Y_i = b_1 + b_2X_i + e_i \tag{4}$$

Which we can rewrite as

e_i = actual Y_i - predicted Y_i

$= Y_i - \hat{Y}$

$$= Y_i - b_1 - b_2X_i \tag{5}$$

This shows that the residuals are simply the differences between the actual and estimated Y values. Now the best way to estimate the PRF is to choose b_1 and b_2, the estimator of B_1 and B_2 in such a way that the residual e_i is as small as possible. There are several methods of doing this, but in regression analysis the one that is used most frequently is the method of ordinary least squares (OLS), which states that b_1 and b_2 should be chosen in such a way that the residual sum of squares (RSS) Σe_i^2 is small as possible.

Minimize: $\Sigma e_i^2 = \Sigma(Y_i - \hat{Y})^2$

$$= \Sigma(Y_i - b_1 - b_2X_i)^2 \tag{6}$$

Result and Discussion

A graphical illustration of cassava output price has been depicted in Figure 1 and 2 to examine the price movement and fluctuations over the period. The last decade (1992-2012) recorded the highest level of price variability as compared to the previous decades which recorded higher to relatively low level of fluctuation. This could be due to the influence of macroeconomic variables among others. This result is consistent with Huchet (2011) who reported that the degree of price fluctuation of most agricultural commodities is higher over the last decade than the previous. Other studies which confirm the result include Gilbert and Morgan (2010) who agreed to high fluctuation of agricultural prices. Again, International Institute of Tropical Agriculture [IITA] (2004) also disclosed that agricultural output prices increase over time but at decreasing rate.

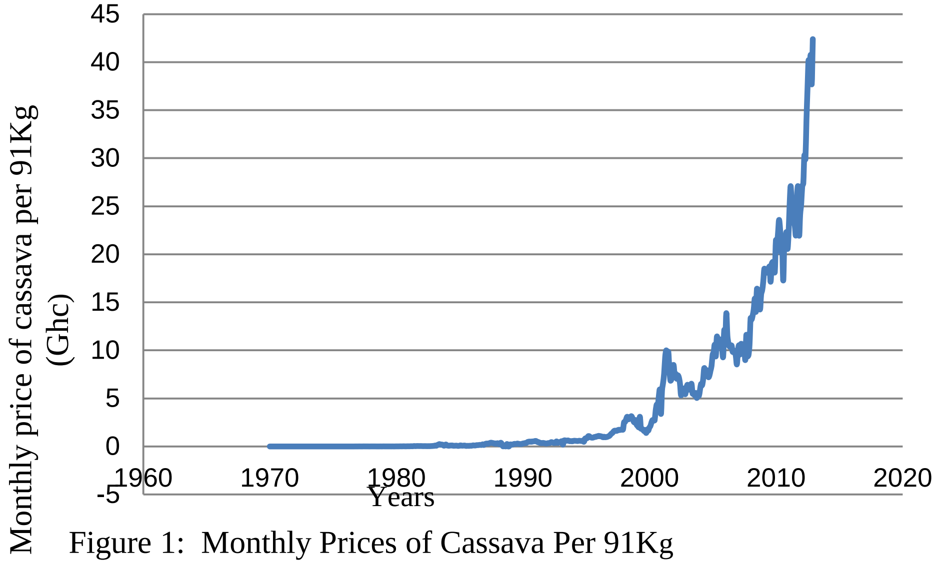

Figure 1: Monthly Prices of Cassava Per 91Kg

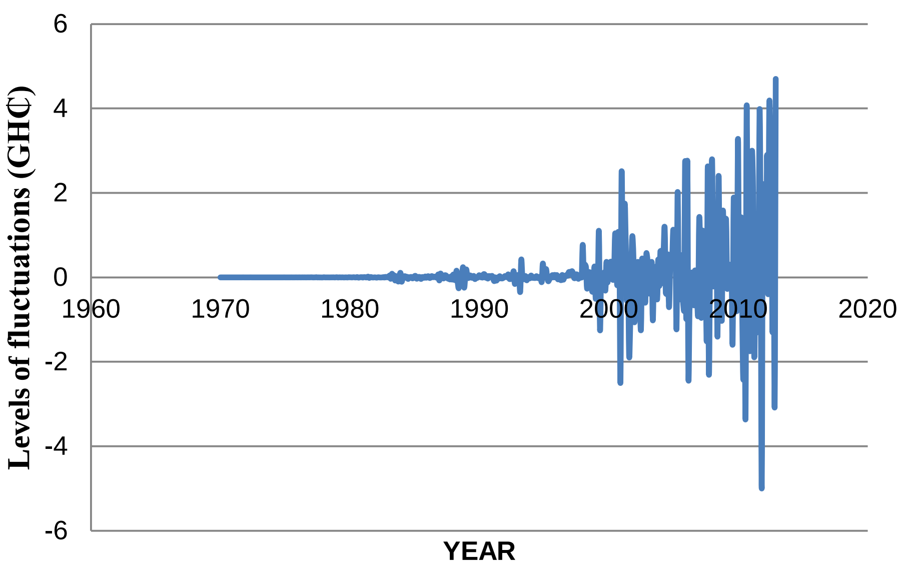

Figure 2: Levels of Fluctuations of Cassava Price

Cassava price trend was analysed (by regressing the series on time) and results displayed in Table 1. The result shows that cassava price increases significantly by 46.1% every year. Also, 56.3% of the variation in the price of cassava occurs over time while F statistics shows the significant of model in fitting the data.

Table 1: Regressing the Series on Time

Response variable: cassava price in Gh¢	
Variable	Coefficients
Intercept	-913.990(126.425)***
Time(year)	0.461(0.063)***
R^2	0.563
F statistics	52.77***
Adjusted R^2	0.552

Notes: standard errors in parentheses; *** denotes significance at 0.1% level.

Source: Field data, 2014

In splitting the entire period into sub-periods of ten years as proposed by Huchet (2011), Table 2 provides a relatively crude visual indication of whether volatility has been changing over time. The result shows that volatility in cassava price estimated with coefficient of variation, a standard statistical measure recommended by FAO (2011), is increasing and is relatively highest during the last decade (2002-2012) to about 102.0 % than during the previous three decades while the least volatility was recorded within 1970-1980 representing 0.1% . Also, the volatility recorded for the entire period was 177.8% while 30.8% is recorded annually. The trend and the degree of volatility in Table 2 confirm a report by FAO & IMF (2011). Another study with similar findings includes (Pierre, Morales-Opazo & Demeke, 2014). Again, volatility equality tests was conducted with analysis of variance (ANOVA) to make comparisons over time and to see if a clear picture of price volatility emerges within and between the groups. The result shows that volatility varies significantly at 0.1% significant level within and between the groups (Huchet, 2011).

Table 2: Price Volatility Estimates Using Coefficient of Variation and Analysis of Variance

Periods	Volatility (%)	P-value within groups	P-value between groups
1970-1980	0.1	2.21e-09 ***	2.21e-09 ***
1981-1990	2.3		
1991-2001	18.6		
2002-2012	102.0		
1970-2012	177.8		
Yearly	30.8		

Note: *** denotes significance at 0.1% level.

Source: Field data, 2014

According to FAO and IMF (2011), most agricultural commodity markets are characterized by a high degree of volatility. They indicated that three major market fundamentals explain why that is the case. First, agricultural output varies from period to period because of natural shocks such as weather and pests. Secondly, demand elasticities are relatively small with respect to price and supply elasticities are also low, at least in the short run. In order to get supply and demand back into balance after a supply shock, prices therefore have to vary rather strongly, especially if stocks are low. Third, because production takes considerable time in agriculture, supply cannot respond much to price changes in the short term, though it can do so much more once the production cycle is completed. Huchet (2011) also indicated that unstable economic variables such as inflation, exchange rate among others could be the potential cause of high volatility over the last decade.

Determinants of Output Price and Price Volatility

Model 1: Determinants of Cassava Prices

$$\log(\text{price}) = \beta_0 + \beta_1(\log \text{yield}) + \beta_2(\log \text{inflation}) + \beta_3(\log \text{interest}) + \beta_4(\log \text{exchange rate}) + \beta_5(\log \text{temperature}) + \beta_6\text{rainfall} + \varepsilon$$

Table 3 summarizes the regression results of model 1 explaining cassava price as a function of cassava yield, inflation, interest, exchange rate, temperature and rainfall. This model allows us to investigate the influence of cassava yield, inflation, interest, exchange rate, temperature and rainfall on the first moment of cassava price.

Table 3: Parameter Estimates for Determinants of Cassava Prices

Response variable: log (price) in Gh¢	
Control Variable	Coefficient
Intercept	-11.276 (14.684)
Log (yield)	0.115 (0.196)
Log (inflation)	0.791 (0.164)***
Log (interest)	-0.528(0.278)
Log (exchange rate)	1.016(0.073)***
Log(Temperature)	3.66(4.285)
Rainfall	-0.007(0.006)
R^2	0.969
F statistic	191.1 ***
Adjusted R^2	0.965

Notes: standard errors in parentheses; *** denotes significance at 0.1% level.

Source: Field data, 2014

The results suggest that 96.9% of the variation in the cassava price (in Ghana cedis) is caused by the independent variables in the model as shown by R^2. The F-statistics test the overall significance of the regression model. The significant level of F-value implies that the independent variables in the model are good predictors of dependent variable. The number of parameters and the degree of freedom accounted for by the Adjusted R^2 shows the fitness and goodness of each additional variable in the model since its value is close to the R^2.

The findings of the model show that inflation and exchange rate have positive and significant effects on the price of cassava. This means that a percentage change in inflation is expected to increase the price of cassava by 0.79 % and 1% increase in the exchange rate is expected to increase cassava price by 1.02%. This calls for effective management of these macroeconomic variables to provide continuous stable environment against price fluctuation. Moreover, variables such as yield and temperature have positive relationship with the price of cassava while interest rate and rainfall have negative relationship with cassava price though they are not significant.

The result is consistent with an empirical work by Gilbert (1989) which indicated that inflation level and its variability are major factors that influence food price volatility and can greatly affect the investors including farmers. This assertion was also stated by IMF (2008) which also showed that fluctuations in inflation and exchange rate are condiments for output price volatility.

The positive relationship between the price of cassava and the quantity supplied (cassava yield) is consisted with the economic theory which states a positive relationship between the price of a commodity and its supply. Again, According to FAO (2011), trade in many agricultural commodities is denominated in USD. It further stated that a depreciating USD, as occurred in the years before and up to the peak of the price rises, causes dollar denominated international commodity prices to rise, although not to the full extent of the depreciation. These currency movements added to the amplitude of the price changes observed. They also help to explain why demand remained strong in countries where the currency was appreciating against the dollar and why falling prices were not fully felt in the same countries once the dollar began to appreciate again.

Determinants of Cassava Price Volatility

Before examining the determinants of cassava price volatility, a standard statistical measure called mean deviation (MD) was used to estimate the levels of volatility of cassava price over the period under consideration (FAO, 2011)

Model 2: Determinants of Cassava Price Volatility

Volatility (price) in level = $\beta_0 + \beta_1$(log yield) + β_2(log inflation) + β_3(log interest) + β_4(log exchange rate)+ β_5(log temperature) + β_6 rainfall + ε

Table 4 summarizes the regression results of cassava price volatility as a function of cassava yield, inflation, interest, exchange rate, temperature and rainfall.

Table 4: Parameter Estimates for Cassava Price Volatility

Response variable: volatility of cassava in Gh¢	
Control Variable	Coefficient
Intercept	-14.222 (96)
Log (yield)	3.706 (1.285)**
Log (inflation)	0.609 (1.076)**
Log (interest)	-6.361(1.833)
Log (exchange rate)	1.400(0.481)**
Log(Temperature)	-7.646(28.081)
Rainfall	0.023(0.042)
R^2	0.733
F statistic	16.51. **
Adjusted R^2	0.69

Notes: standard errors in parentheses; ** denotes significance at 1% level.

Source: Field data, 2014

Table 5 shows that 73.3% of the variation in the volatility of cassava price is caused by the explanatory variables in the model, that is, yield, inflation, interest rate, exchange rate, temperature and rainfall as shown by R^2. Furthermore, the result indicates the goodness of fit of the model as shown by F statistics with the significant level of 0.1%. Thus the explanatory variables in the model are good predictors of cassava price volatility. The number of parameters and the degree of freedom as accounted for by the adjusted R^2 shows the fitness and goodness of each additional variable since its value is close to the R^2. The result shows that a percentage change in cassava yield significantly raises the volatility of its price per 91kg by Gh¢ 0.037. This suggests more intervention through the provision of storage facilities, market facilities among others to absorb the surplus. Also, a percentage change in inflation and exchange rate significantly raises the volatility of cassava price per 91kg by Gh¢ 0.006 and Gh¢0.014 respectively. Interest rate, temperature and rainfall however show negative relationship with the volatility of cassava price but are statistically insignificant.

The finding is consistent with FAO & IMF (2011) which reported that increase in agricultural output increase the volatility of its price. The finding also confirms a report by Hutchet (2011) that economic variables such as inflation and exchange rate significantly influence the volatility of agricultural produce. Another work with similar finding is reported by FAO (2011) which indicated significant positive relationship of inflation and exchange rate with food prices.

Conclusion

Previous studies employed a broad based approach to analyze agricultural food price volatility. This study, however, is narrowed to the analysis of cassava price volatility with secondary data collected from 1970 to 2012. The study revealed that cassava price averagely increases significantly by 46% annually with the volatility level of 30.8% annually and 177.8% over the period (1970-2012). Furthermore, inflation and exchange rate were positive and significant determinants of the price of cassava whilst cassava yield, inflation and exchange rate had significant positive relationship with the volatility of cassava price. Based on the finding of the study, it is recommended that policies stabilizing inflation, exchange rate, establishment of price controls, designing output risk insurance and training farmers in value addition will help address the challenge of a volatile cassava price.

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