Mathematics and Statistics: Open Access
Received: Feb 17, 2016, Accepted: May 21, 2016, Published: May 26, 2016
Math Stat, Volume 2, Issue 2
http://crescopublications.org/pdf/msoa/MSOA-2-015.pdf
Article Number: MSOA-2-015

Research Article Open Access

Determinants of Monthly Domestic Price Volatility of Sesame Seed in Metema Area, North Gondar, Ethiopia

Anteneh Asmare Godana*, Yibeltal Arega Ashebir, Tewodros Getinet Yirtaw, Zinabu Teka Melese

University of Gondar, College of Natural and Computational Science, Department of Statistics, Gondar, Ethiopia

***Corresponding Author:** Anteneh Asmare Godana, University of Gondar, College of Natural and Computational Science, Department of Statistics, Gondar, Ethiopia, E-mail: antasmare@gmail.com

Citation: Anteneh Asmare Godana, Yibeltal Arega Ashebir, Tewodros Getinet Yirtaw and Zinabu Teka Melese (2016) Determinants of Monthly Domestic Price Volatility of Sesame Seed in Metema Area, North Gondar, Ethiopia. Math Stat 2: 015.

Abstract

The aim of this study was to model and identify the determinants of monthly domestic price volatility of sesame seed in North Gondar, Metema, Ethiopia during December 2001 to December 2014 GC. The volatility in the domestic price of sesame seed varied over months, suggesting the use of GARCH family approach. Thus, family of special time series models, namely, ARCH, GARCH, TGARCH and EGARCH models with ARIMA mean equations were fitted to the data. The best fitting model among each family of models was selected based on how well the model captures the variation in the data and the optimal lag specification accessed via AIC and SBIC. Comparisons of the symmetric and asymmetric model were carried out based on the significance of the asymmetric term in TGARCH and EGARCH models. Statistically significance asymmetric term and least forecast error from the model established that EGARCH model with GED distributional assumptions for residual were superior to the GARCH and TGARCH models. Therefore, ARIMA (0, 0, 1)-EGARCH (4, 4) with GED was chosen to be the best fitting models for monthly domestic price volatility of sesame seed. Moreover, it was found that from candidate explanatory variables, export price for sesame, fuel oil price, exchange rate (dollar-birr), general inflation, inflation for non food items had statistically significant effects on the current month domestic price volatility of sesame seed.

Keywords: Price Volatility; Time Series Data; ARIMA; ARCH; GARCH; TGARCH; EGARCH Models.

1. Introduction

Agricultural households in developing countries face a variety of risks. The most visible manifestation of these risks is high food price instability, which, because of its inherent economic and political implications, has attracted the attention of almost all actors in food policy making over the past few decades. However, all actors agree on one point, i.e. the direct consequences of price instability on consumers, producers, as well as on overall economic growth. For poor consumers, consequences of price instability are severe. Since a large share of their income is spent on food, an unusual price increase forces them to cut down food intake, take their children out of school, or, in extreme cases, simply to starve. Even when such price shocks are temporary, they can have long term economic impacts in terms of nutritional well-being, labor productivity, and survival chances (Hoddinott, 2006; Myers, 2005).

Ethiopia is such a country. It is constrained by a limited import capacity; food price variability in its domestic market is very high, the country's integration with the world market is low. Furthermore, despite the government's almost complete withdrawal from the market, price variability has actually worsened rather than improving in recent years.

Therefore, it is crucial to examine the pattern of domestic price volatility and identify its determinants on sesame seed. The differences between the variability in the prices among commodities are important for private investment decisions in farming and farm product marketing (Heifner & Kinoshita, 1994). According to Jordaan et al. (2007) the accurate measurement of the stochastic component in prices may contribute to the decision maker being able to make more informed decisions when choosing one crop over another. It may also contribute to policy decisions regarding the possible implementation of commodity price stabilization programmers. Examining the underlying causes of oil seeds price volatility has great role for managing price instability for producers, consumers, whole sellers and agricultural price policy reforms for the country as well.

More specifically, this study has employed econometric methods to explore the patterns and determinates of domestic price volatility of Sesame seed in Metemma, Ethiopia over the period from December 2001 to December 2014 G.C by developing separate GARCH, TGARCH and EGARCH models with Box-Jenkins model for conditional mean specification.

2. Methodology

2.1. Data

To assess the average monthly domestic price volatility and its determinants on sesame seed in Metemma area, Ethiopia, the data for the study has been obtained from CSA, NBE, ECX and EPE, as secondary data on monthly basis observed from December 2001 to December 2014 GC.

2.2. Statistical Models

The Box-Jenkins time series model such as Autoregressive (AR), Moving Average (MA) and ARMA are often very useful in modeling general time series data. However; they all require the assumption of homoskedaticity (or constant variance) for the error term in the model. But, this may not be appropriate when dealing with some special characteristics in the financial and agricultural price time series and this causes the introduction to ARCH (Autoregressive Conditional Heteroskedasticity) model which was proposed by Engle (1982) and generalized by Bollerslev (1986) and Taylor (1986).

Therefore, to come up with the objectives of the study, after identifying the presence of ARCH effects, separate GARCH, TGARCH and EGARCH models has been employed in this study to investigate the pattern of domestic price volatility and its determinants for sesame seed with joint estimation of a mean and a conditional variance equation as model specification given below.

Let Y_t be the returns of average monthly domestic price, ε_t be error term (residual) from mean equation with mean zero and conditional variance σ_t^2 and given the historical information on the average domestic price return series as $\left(Y_1, Y_2, ..., Y_t\right)$, thus the ARMA (m, s) mean model (Box-Jenkins, 1976) is given as:

$$Y_t = \varpi + \sum_{i=1}^{m} \psi_i y_{t-i} - \sum_{j=1}^{s} \theta_j \varepsilon_{t-j} + \varepsilon_t \qquad (1)$$

An Autoregressive Conditionally Heteroskedasticity model for the variance of the errors which is known as an ARCH (q) model proposed by Engle (1982), the conditional variance is given by

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 \qquad (2)$$

Generalized by Bollerslev (1986) as GARCH (p, q) which allow the conditional variance to be dependent upon previous own lags as model, then the full model for GARCH (p, q) has two parts the mean model and the conditional variance model given below;

$$Y_t = \varpi + \sum_{i=1}^{m} \psi_i y_{t-i} - \sum_{j=1}^{s} \theta_j \varepsilon_{t-j} + \varepsilon_t \quad \sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \qquad (3)$$

$$\alpha_0 > 0, \alpha_i \geq 0, \beta_j \geq 0 \; for i = 1,2...q$$

and $j = 1,2...p$

EGARCH (p, q) models with mean equation and the variance of residuals at a time t given as:

$$Y_t = \varpi + \sum_{i=1}^{m} \psi_i y_{t-i} - \sum_{j=1}^{s} \theta_j \varepsilon_{t-j} + \varepsilon_t$$

$$\log\left(\sigma_t^2\right) = \alpha_o + \sum_{i=1}^{q} \alpha_i \left| \frac{\varepsilon_{t-i}}{\sigma_{t-j}} \right| + \sum_{i=1}^{q} \lambda_i \left(\frac{\varepsilon_{t-i}}{\sigma_{t-j}} \right) + \sum_{j=1}^{p} \beta_j \log\left(\sigma_{t-j}^2\right) \qquad (4)$$

The full model of TGARCH model with mean equation and conditional variance equation is given as:

$$Y_t = \varpi + \sum_{i=1}^{m} \psi_i y_{t-i} - \sum_{j=1}^{s} \theta_j \varepsilon_{t-j} + \varepsilon_t$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \lambda_i S_{t-i} \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \qquad (5)$$

$$S_{t-i} = \begin{cases} 1 if \varepsilon_{t-i} < 0 \\ 0 if \varepsilon_{t-i} \geq 0 \end{cases}$$

$$\alpha_0 > 0, \alpha_i \geq 0, \beta_j \geq 0 \; for i = 1,2...q$$

and $j = 1,2...p$

where $S_{t-i} = \begin{cases} 1 if \varepsilon_{t-i} < 0 \\ 0 if \varepsilon_{t-i} \geq 0 \end{cases}$ That is, depending on whether ε_{t-i} is above or below the threshold value of zero.

More specifically, the general inflation rate, food inflation rate, non food inflation rate, exchange rate, saving interest rate, fuel oil price, export price of sesame and monthly seasonal dummies has been introduced into the conditional variance equation as exogenous variables in order to determine the volatility spillover of these variables on average monthly domestic prices returns of sesame seed.

2.3. Procedures for Model Building

The basic frameworks that were followed in order to investigate the pattern of domestic price volatility and its determinants on, sesame seed were follows the following Box and Jenkins approach:

- Test for the presence of unit root (non-stationary) case
- Test for ARCH effects
- Model order selection for GARCH family model
- Model parameter estimation
- Model adequacy checking

3. Results and Discussion

3.1. Descriptive Statistics

The data set used, in this research, were average monthly domestic prices (in Birr per kg) for sesame seed observed from December 2001 to December 2014 GC observed at sample of 16 selected markets in Metema area. The return series were constructed for the price to allow a market wide measure of volatility to be examined. This was calculated as continuously compounded returns which are the first difference in logarithms of closing prices on successive months.

From Figure 3.1, it can be observed that monthly domestic prices show an increasing trend over the study period. In particular, high increases of domestic prices are observed in the year 2008-2014.

Figure 3.1: Average Monthly Domestic Price Trend for Sesame Seed from December 2001 to December 2014 GC

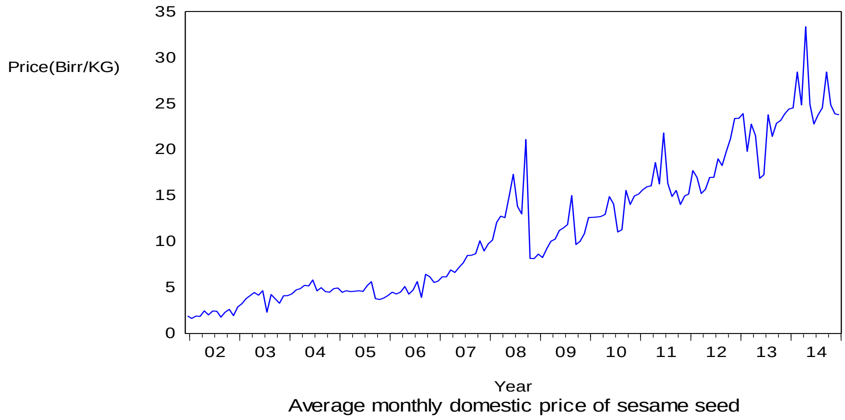

Table 3.1: Summary Results for Average Monthly Domestic Price and Return series for Sesame Seed.

Statistics	Price of Sesame Seed	Return Series of Sesame seed Price
Mean	11.30984	0.016269
Median	10.01060	0.026707
Maximum	33.37603	0.610463
Minimum	1.604900	-0.951741
Std. Dev.	7.527804	0.181771
Skewness	0.615894	-1.149902
Kurtosis	2.321432	9.568774
Jarque- Bera	12.93783	314.8464
Probability	0.001551	0.000000
Observations	157	156

Table 3.1 display summary statistics and normality test for the prices and return series for sesame seed under study. Thus, the empirical result shows that the average monthly domestic price (in birr) per kg for sesame seed was 11.30984 with standard deviation 7.527804. The returns have negative skewness and longer tails, the coefficient of skewness was -1.149902 indicates that the series typically had asymmetric distributions skewed to the left. Also the excess kurtosis coefficient was 9.568774, indicated that the distribution of price return series for sesame seed possess leptokurtic characteristics. Moreover, the implication of non-normality is supported by the Jarque-Bera test statistic which points out that the null hypothesis of normal distribution is rejected at 5% level of significance for price return series. Hence, the price return appropriately contains financial and agricultural time series characteristics such as, long tails and leptokurtosis as documented by Mandelbrot (1963), Cornew et al. (1984) and Hudson et al. (1987).

3.2. Test for Stationarity

As many literatures indicate, most of the time series data possesses non-stationarity property or unit root problem. Thus, in order to check for non-stationarity of prices and their returns ACF, Augmented Dickey-Fuller and Phillips-Perron tests were used.

3.3. ADF and PP Unit Root Tests

ADF and PP unit root tests revealed that all the price series considered were non-stationary as we see in Table 3.2 and Table 3.3. This is because of their corresponding p-values from both ADF and PP test statistic were greater than 0.05. However, test results for monthly domestic prices appear stationary after first difference of logarithmic transformations of average monthly closing prices in to return series for sesame seed which were required for further analysis. This is because of their corresponding p-values from both ADF and PP test statistics were less than 0.05. At 5% level of significance, the null hypothesis of non-stationarity was rejected.

Table 3.2: ADF Unit Root Test for Average Monthly Domestic Sesame Prices and Returns

Price and price Returns	ADF Test Statistic	p-value
Sesame price	0.30273	0.8595
Sesame price Returns	92.5767	0.0000

* indicates statistically significant at 5% level of significance

Table 3.3: PP Unit Root Test for Average Monthly Domestic Sesame Prices and Returns

Price and price Returns	PP Test Statistic	p-value
Sesame price	0.58301	0.7471
Sesame price Returns	73.9553	0.0000

* indicates statistically significant at 5% level of significance

The Case of Predictors:

All the variables are stationary after first difference except general inflation rate which is stationary at level, implying that all explanatory variables except general inflation rate are integrated of order 1, denoted I (1) which are required for further analysis to remove severity of multicollinearity problem in time series.

3.4. Mean Equation Determinations for Testing ARCH Effect

Based on equation (1) thirty six combination of (AR 0-5) by (MA 0-5) were computed for sesame price return series. Optimal lag length was selected based on SBIC provided that no serial autocorrelation in the residuals from specified mean model. The mean equation for average monthly domestic price return series for sesame was formed to be ARIMA (0, 0, 1). Table 3.4 show ARIMA (0, 0, 1) model has the smallest SBIC = -0.752619 and so far selected to be the best fitted model. But all the other fitted AR (0-5) and MA (0-5) combination of models had greater SBIC. To verify the adequacy of selected mean equation, the Ljung-Box Q (k)-test was performed to check for absence of autocorrelation in the residuals for correct specification as the residuals from a model that fits the data well should be uncorrelated.

3.5. Tests for ARCH Effects

To proceed with volatility modeling ARCH effects (whether or not volatility varies over time) in the residuals from the selected ARIMA model should be tested.

The confirmation of the presence of ARCH effect indicates that the volatility in the average monthly domestic price of sesame seed is time varying and appropriateness of employing GARCH family models.

3.6. Optimal Order Selection and Parameter Estimation of GARCH Family Model

Once the ARCH effects are determined, then the optimal lag specifications for GARCH family models were determined prior to the construction of the final model to investigate the determinants of domestic price volatility. After testing for different orders of p and q of GARCH family, it was found that EGARCH (4, 4) under GED distributional assumptions for residuals, EGARCH (1, 3) under Student-t distributional assumptions for residuals and EGARCH (4, 2) under Normal distributional assumptions for residuals for domestic price volatility of sesame seed were selected to be best model to describe the data as they possess minimum SBIC.

Table 3.5: Optimal Lag selected Based on SBIC under Different Distributional Assumptions of Residuals for Sesame Seed.

Model	Error Distribution	SBIC	Asymmetric term (α = 0.05)
ARIMA(0,0,1)-EGARCH(4,4)	GED	-0.181771	Significant
ARIMA(0,0,1)-EGARCH(1,3)	Student- t	-0.854570	Significant
ARIMA(0,0,1)-EGARCH(4,2)	Normal	-0.873800	Significant

The above Table shows optimal lag specification for EGARCH (p, q) models and result reveals that asymmetric terms are statistically significant at 5% level of significance for selected models under specified error distributions for sesame seed. This indicates that asymmetric GARCH class models, specifically EGARCH model are appropriate to assess the determinants of domestic price volatility for sesame seed.

Moreover, to select appropriate error distribution for selected asymmetric GARCH class models assuming normal, unrestricted Student-t and GED distributions for the error terms from mean equation, the four error statistics: RMSE, MAE, MAPE and Thail Inequality coefficient was applied to evaluate the forecast ability of models using in-sample forecast. Thus, empirical results show that EGARCH (4, 4) model with distributional assumptions for residuals under GED performs best as compared to others, since in all cases RMSE, MAE, MAPE and Thail Inequality Coefficient of EGARCH (4, 4) for monthly domestic price returns of sesame seed, formulated the model with the smallest measure of forecast errors.

Table 3.6: Maximum Likelihood Parameter Estimates of the Volatility Models for Selected Orders with the Incorporated Exogenous Variables for sesame seed.

Parameter	Sesame	
	Mean	Variance
Constant		6.264722*(0.0003)
MA(1)	-0.303998* (0.0000)	
ARCH(-1)		1.358955*(0.0000)
ARCH(-2)		1.103050 *(0.0017)
ARCH(-3)		1.099800* (0.0003)
ARCH(-4)		1.247677*(0.0000)
Asymmetric(-1)		-0.248894 (0.0727)
Asymmetric(-2)		0.057484 (0.7575)
Asymmetric(-3)		0.694535*(0.0001)
Asymmetric(-4)		-0.226026(0.1894)
EGARCH (-1)		-0.167919 (0.2480)
EGARCH (-2)		-0.478420*(0.0008)
EGARCH (-3)		-0.031602*(0.0304)
EGARCH (-4)		0.181379(0.1095)
Food inflation rate		-0.003900 (0.8813)
Non food inflation rate		0.352119* (0.0000)
General inflation rate		-0.043552* (0.0216)
Exchange rate		0.047123*(0.0127)
Saving interest rate		-0.321703 (0.1305)
Fuel oil price		0.000186*(0.0016)
Export Price for Sesame		0.099652*(0.0201)
October		-1.378989 *(0.0043)
November		--2.125135*(0.0000)
December		-3.415568*(0.0000)
January		-2.574955* (0.0011)
February		-3.619124*(0.0000)
March		-2.117945*(0.0226)
April		-2.087702* (0.0402)
May		0.851511(0.3360)
June		1.953022*(0.0289)
July		0.115729 (0.8443)
August		1.492781* (0.0131)

* are statistically significant at 5% level of significance and values inside the bracket denotes p-values of corresponding to test statistic.

From Table 3.6, parameter estimates for volatility models, the coefficient for fuel oil price was positive and statistically significant at 5% level of significance. The link between fuel oil prices and sesame domestic price volatility is likely to be through the fact that a fluctuation on the fuel oil prices affects the costs of transportation. This finding was consistent with finding by Swaray (2007) and Baffes (2007) in the domestic price volatility for agricultural commodities. This indicating that a unit increase in the fuel oil price causes current month's domestic price volatility to increase by 0.000186 for sesame seed in Metema area.

Also, the coefficient of export price for sesame was positive and statistically significant at 5% level of significance. Thus, there is transmission of export price for sesame seed to the domestic price volatility in the area over the study period, this result also inline findings by Adubi, and Okunmadewa (1999) and Braine and Michael (2011) that export price was one of the determinants of domestic price volatility. This indicates that a unit increase in export price of sesame cause domestic price volatility to increase by 0.099652 units for sesame seed in the area.

The coefficient of exchange rate (dollar-birr) was positive and statistically significant at 5% level of significance for domestic price volatility of sesame. Changes in exchange rates reallocate the purchasing power and price incentives across countries without changing the overall agricultural commodities supply demand balance. Dollar devaluation raises prices US producers and consumer's lowers prices of consumers outside the dollar area. This implies that the dollar price of commodities on world market were rises as a result of depreciation, implying a fall in domestic currency say in, Birr and sterling prices (Ridler & Yandle,1972). This result was consistent with finding by Loening et al. (2009), Gilbert (1989), Chambers (1984) and Sarris and Morrison (2009), IMF (2008) Belay (2011) and Anteneh et al. (2014). This indicating that a unit increase of exchange rate (dollar-birr) causes domestic price volatility of sesame seed in Metema area to increase by 0.047123.

Among the seasonal dummies added to the EGARCH model, price during, October, November, December, January, February, March and April months had negative coefficients, but price during September, June and August had positive coefficient and statistically significant at 5% level of significance, implying that domestic price during October, November , December, January, February, March and April months had decreasing effect, but price during September, June and August month had increasing effects to the current month variability of domestic price volatility of sesame seed in Metema area.

The coefficient of general inflation rate in the variance equation for sesame seed was negative and statistically significant at 5% level of significance. Thus, there is a sufficient evidence to reject the null hypothesis at 5% level of significance. General inflation was one of the determinants of domestic price volatility of sesame seed. Therefore, a unit decrease in the general inflation rate serves to increases domestic price volatility of sesame seed at current month by 0.043552 units. Also the coefficient of inflation rate for non food items in the variance equation for sesame seed was positive and statistically significant at 5% level of significance. Thus, there is a sufficient evidence to reject the null hypothesis at 5% level of significance. Therefore, a unit increase in the non-food inflation rate serves to increases domestic price volatility of sesame seed at current month by 0.352119. This result was in line with the findings by Chambers (1984).

4. Conclusions and Recommendations

4.1. Conclusions

This study investigates the average monthly domestic price volatility and its determinants on sesame seed in Metema area, Ethiopia, over the study period from December 2001 to December 2014 GC. The results from this study provide evidence to show volatility clustering, leptokurtic distributions and asymmetric effect for average monthly domestic price return series for sesame seed. From empirical result it can be conclude that the volatility in the monthly domestic price of sesame seed has been found to vary from month to month suggesting the use of GARCH family approach. There is strong evidence that there is a persistent volatility in sesame seed over study period.

The forecast performances of the model were evaluated using the MAE, MAPE, RMAPE and Thail inequality coefficient. Asymmetric EGARCH model with GED distributional assumption for residual was found to fit better than GARCH and TGARCH models. Therefore, ARIMA (0, 0, 1) – EGARCH (4, 4) model with GED distributional assumption for Sesame was found to be the best models for fitting data on monthly domestic price return series for sesame seed. There was evidence to conclude that the variance of domestic price returns at current month is influenced by its previous one month's two months, three months and four months lagged volatility sesame seed.

There was also significant evidence that many of the candidate explanatory variables have an impact on monthly domestic price return volatility of sesame seed, over the study period. In monthly series, fuel oil price had a positive impact on domestic price volatility for sesame seed. Likewise, exchange rate (dollar-birr) had positive influence on monthly domestic price volatility of sesame seed. Also, it can be conclude that, general inflation rate and non-food inflation rate had a significant effect on monthly domestic price volatility of sesame seed. Export price for sesame seed had a positive impact on the monthly domestic price volatility of sesame seed.

Among the seasonal dummies added to the EGARCH model, price during, October, November, December, January, February, March and April months had significant decreasing effects, but price during September, June and August had significant increasing effects to the current month variability of domestic price volatility of sesame seed in Metema area.

4.2. Recommendations

As many studies indicated price volatility on agricultural commodities has a negative impact on the economy of the country by making income unstable, for producers, consumers, whole sellers as well as governments in both developing and developed countries and also leads to a major decline in the future output, if they are unpredictable and its determinants not identified. The aim of this study was to model average monthly domestic price volatility and their determinants on sesame seed particularly in Metema area. Thus from empirical findings, this study draws the following recommendations:

- Domestic prices volatilities for sesame seed are affected by export prices. In such a case, the government and concerned bodies should take measure to balance the interest of consumers and investors.
- Import price for fuel oil also had statistically significant increasing effect on the domestic price volatility of sesame seed. Thus, the government should take some measures to regulate and reduce demand of import price for fuel oil.
- Exchange rate (dollar-birr) had statistically significant increasing effect on the domestic price volatility of sesame seed; therefore, policy makers and concerned bodies should take this in to consideration during exchange rate (dollar-birr) monetary policy setting.
- Non-food inflation rate and general inflation rate had statistically significant increasing impact on the domestic price volatility of sesame seed. Therefore, the government, policy makers and concerned bodies should take some measures to undertake inflation due to non-food items as well as general inflations to alleviate domestic price volatility.
- The volatilities in the average monthly domestic prices of sesame varying over time from month to month. September, June and August months had affected the average monthly domestic price volatility of and sesame. Thus, the government and concerned bodies should follow and control the price of sesame seed during those months.

References

- Akgiray, V. (1989). Conditional Heteroskedasticity in Time Series of Stock Returns. Journal of Business, Vol 62, P 55-80.
- Anteneh et.al (2014). Statistical analysis of domestic price volatility of sugar in Ethiopia. American Journal of Theoretical and Applied Statistics. Vol. 3, No. 6, 2014, pp. 177-183.
- Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroskedasticity, Journal of Econometrics, Vol 31, P 307-327.
- Chambers, M. J. and Roy E.B, (1996). A Theory of Commodity Price Fluctuations, Journal of Political Economy, Vol 104, P 924-957.
- Chambers, R. G. and Just, R. E. (1984). Effects of Exchange Rate Changes on U.S. Agriculture, Journals of Agricultural Economics, Vol 73, P 33-43.
- Dickey, D. A. and Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root, Journal of the American Statistical Association, Vol 74, P 427–431.
- Dyton, C. M. (2003). Model Comparison Using Information Measures, Journal of Modern Applied Statistical Methods, Vol 2(2), P 281-292.
- Eleni Gabre-Madhin (2001). Market Institutions, Transaction Costs, and Social Capital in the Ethiopian Grain Market,

International Food Policy Research Institute, Research Report No. 124, Washington, DC.

- Engle, R. F. (1982). Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of United Kingdom Inflation, Journal of Econometrics, Vol 50, P 987-1007.
- Eugene, F. and Fama, M. (1965). The Behavior of Stock-Market Prices, the Journal of Business, Vol 38, P 34-105.
- Gilbert, C. L. (1989). The Impact of Exchange Rates and Developing Country Debt on Commodity Prices, Journal of Economics, Vol 99, P 773–84.
- Gudeta Zerihun Alemu (2005). Causes for Instability in Cereal Production in Ethiopia Working Paper, Department of Agricultural Economics, Faculty of Agricultural and Natural Sciences, University of Free State South Africa.
- Heifner, R. and Randal, K. (1994). Differences among Commodities in Real Price Variability and Drift. The Journal of Agricultural Economics Research Vol 45(3), P 10-20.
- Jean-Philippe, P. (2001). Estimating and Forecasting Volatility of Stock Indices Using Asymmetric GARCH Models and (Skewed) Student-t Densities.
- Ljung, G. M. and G. E. P. Box (1978). On Measure of Lack of Fit in Time series Models. Biometrika, Vol 65, P 297-303.
- Jordaan, H., Jooste, B. A. and Alemu, Z.G. (2007). Measuring the Price Volatility of Certain Field Crops in South Africa: Using the ARCH/GARCH Approach. Journal of agriculture, Vol 46.
- Myers, R. J. and Hanson, S. D. (1993). Pricing Commodity Options when the Underlying Futures Price Exhibits Time-Varying Volatility. American Journal of Agricultural Economics, Vol 75, P 121–130.
- Nelson, D. B. (1991). Conditional Heteroskedasticity in Asset Returns: A New Approach Econometrician, Vol 59(2), P 347-370.
- Nwidobie, B. M. (2011). An Impact Analysis of Foreign Exchange rate Volatility on Nigeria's Export Performance, European Journal of Economics, Finance and Administrative Sciences ISSN 1450-2275 Issue 37, Euro Journals, Inc.2011.
- Phillips, C. B. and Perron, P. (1988). Testing for a Unit Root in Time Series Regression. Biometrics, Vol 75, P 335–346.
- Saris, A. and Morisson, J. (2009). "The Evolving Structure of World Agriculture Trade: Implication for Trade Policy and Trade Agreements" Food and Agricultural Organization of United Nations (FAO).
- Zakoia, J. M. (1994). "Threshold Heteroskedasticity Models" Journal of Economic Dynamic and Control, Vol 18, P 931-955.