Dynamic linkages between Food Price Fluctuations and Exchange Rates: Evidence from Ghana

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*Abstract***.** This study examines the causal relationship between food prices and exchange rates in Ghana based on monthly time series data for the period 2008-2013. The study uses the Granger causality approach based on the classical unit root tests and employs the Vector autoregression model (VAR) in the estimation. Two testable hypotheses were investigated: (1) Do exchange rates Granger-cause food price fluctuations? And (2) Do food price fluctuations Granger-cause exchange rates? The empirical results of the study show that there is unidirectional causal relationship between food prices and exchange rates in Ghana. The results suggest that there was causality from food prices to exchange rate and not the converse.

*Key words***:** Food Price, Exchange rate, Granger-Causality, Unit Root, Vector auto regression model (VAR), Ghana
JEL classification: M31

1 Introduction

Food prices have been fluctuating wildly over the last four years, hurting both consumers and producers (Ghanem, 2011). It is arguably, one of the fundamental elements that undermine the prospects of developing countries for economic growth, development and poverty reduction, and has predominantly become an issue of global concern, causing real problems in many countries. Policy makers, governments and market actors are concerned, as evidenced by Former French President Nicolas Sarkozy's decision to prioritize food price volatility at the G-20[1] agenda in 2011 under his chairmanship.
Extreme and persistent food price fluctuations come at a cost, since governments, policy makers and market actors will have difficulty planning ahead and adjusting to the fluctuating market signals. As unpredictable changes, or "shocks", in food prices surpass a certain critical level and persist at those levels, traditional policy prescriptions and coping mechanisms are likely to fail (FAO, 2010).
Food price fluctuations and exchange rate volatility in Ghana cannot be underestimated as it poses significant threat to consumption and marketing, macroeconomic stability, food security and overall development achievements. It is a macroeconomic concern because consumers depend largely on food imports and these imports are significant in the government budget and current account balance. Ghana's current account balance[2] (% of Gross Domestic Product) was -8.93 as of 2011. Its highest value over the past 6 years was -5.17 in 2006, while its lowest value was -11.66 in 2008 (Index Mundi, 2011).
In recent times, concerns have been expressed about the true state of food prices in Ghana and their attendant effects on the household. A study conducted by Food Security Ghana (2013)[3] revealed a staggering 73 percent food price hike between October 2011 and March 2013. According to the study, Banku (1 Portion) which is an indigenous meal prepared with

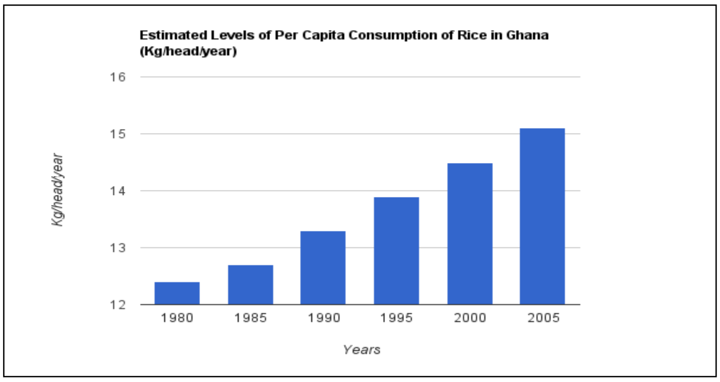
[1] G20 is a group of finance ministers and central bank governors from 19 of the world's largest economies, and the European Union, mandated to work to promote growth and economic development across the globe.

[2] The Current account is one of the two primary components of the balance of payments. It is the sum of the balance of trade (i.e., net revenue on exports minus payments for imports).
[3] Food Security Ghana is a blog that looks at the situation of food security in Ghana and the sub-region.
The Ghanaian Cedi denoted by GHC, is the official currency of Ghana. One(1) Ghana Cedi (GHC) is equivalent to 0.51 US dollars as at April,26,2013(source: Business Ghana)

maize, witnessed an increase in price of 300% – from 0.50 Ghana cedis (GHC) in October 2011 to GHC 2.00 in March 2013. Gari (400grams), an indigenous food made from cassava, increased from GHC 0.35 to GHS 1.00 over the same period, representing a 186% increase. The price of Potato Chips (1 Plate) increased by 120% with prices rising from GHC 5.00 in October 2011 to GHC 11.00 in March 2013. In a rejoinder, the Ghana Ministry of Food and Agriculture (MOFA) rejected the study, arguing that it does not support the reality on the ground. These dissenting and incoherent views, about food price fluctuations, make it imperative to examine its nature and the associated causes to enable policy makers and various stakeholders make informed decisions.

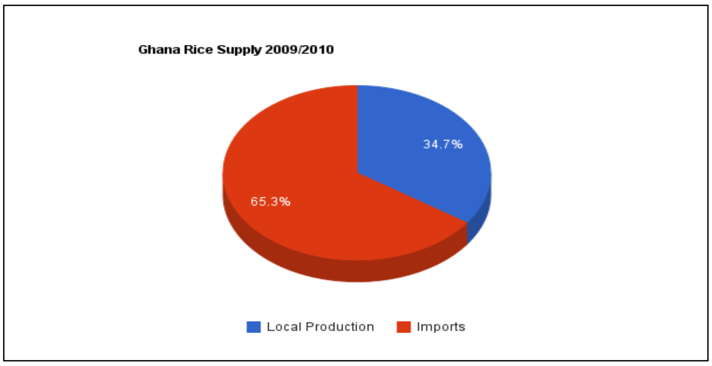
On the causes of food price fluctuations and spikes, there is an ongoing debate and it is a disputable issue in policy making meeting. The common perception is that, the emergence of substantial depreciation of the country's currency against the US dollar, and other major trading currencies, and its unpredictability largely explains the food price fluctuations and spikes. This assertion is based on the fact that in 2008 an importer paid GHC 1.00 for US $1.00, but at the beginning of April 2012, the same importer paid GHC 1.74 for US $1.00. This means that year-on-year depreciation of the Ghana cedi against the US dollar was 74 per cent over a three-year period. The assertion is further supported by the fact that the economy thrives on food imports hence the rapid depreciation of the national currency causes an exchange rate pass through to food prices: firms incurring foreign exchange losses pass on these losses to the consumer in the form of price increases to ensure that their working capital is protected. According to the National Rice Development Strategy (NRDS)[4] of Ghana (2009), over the last 10 years (1999-2008) per capita rice consumption increased from 17.5 kilograms (kg) to 38.0 kilograms which is over 117 percent increase. By 2018 it is estimated that it will grow to 63 kg while the MOFA rice balance sheet for 2009-2010 indicate a local supply of 34.7 percent, with imported rice filling the demand gap of 65.3 percent.

The graph below shows that the per capita consumption of rice in Ghana has steadily grown from 12.4 Kg in 1980 to 15.1 Kg in 2005. However, according to the National Rice Development Strategy (NRDS) for Ghana the per capita rice consumption in Ghana is currently 38 kg and that is expected to rise to 63kg in 2015. (Food Security Ghana, 2013)



Source: Food Security Ghana.

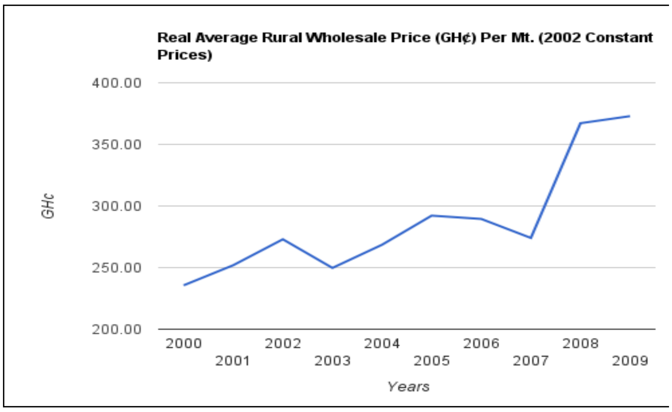
The graph below indicates Rice supply for 2009/2010 fiscal year. Local supply was 34.7% while imported rice filled the demand gap of 65.3% in 2009 – 2010 (Food Security Ghana, 2013).



Source: Food Security Ghana.

The graph below clearly shows price fluctuations and huge price spike in 2008. Although the percentage rise in the price of rice slowed down, prices did not come down. (Food Security Ghana, 2013).

[4] National Rice Development Strategy (NRDS) is a program (strategy) began in 2009 by the government of Ghana with the goal of doubling rice output and cutting imports in half.



Source: Food Security Ghana.

The crux of this assertion is that, with the soaring per-capita consumption, of food like rice, coupled with the high imported demand and the continuous depreciation of the national currency against the US dollar, food price fluctuations is inevitable. It is in light of this background that this study is carried out.

Since the 2007-08 food crisis, many thoughtful analyses and research have attended to address the causes and impacts of high and volatile food prices and have proposed solutions to the crisis. These researches have covered global as well as local food price dynamics and policy reactions. However the differences in policy environment, coupled with the political and economic sensitivity to food price variability, makes the analysis complex and dynamic. This situation therefore calls for a comprehensive and continuous assessment of the problem to provide evidence-based and timely knowledge for policy makers. In the literature, there are many empirical studies to disclose the relationship between macroeconomics variables such as exchange rates, money supply, interest rate and food prices fluctuations and spikes. However, the direction of causality still remains largely unsolved in both empirics and theory. This study intends to investigate the causal relationship between food prices fluctuations and exchange rates in Ghana using monthly data from 2008-2013.

The rest of the study is structured as follows: section 2 will contain a brief literature review. Data, Methodology will be presented in section 3 and empirical results in section 4. Concluding remarks and policy implication are reserved for section 5.

2 Literature Review

According to Sahminan (2002) Exchange rate movements are transmitted to domestic prices through three channels: (i) prices of imported consumption goods, (ii) prices of imported intermediate goods, and (iii) domestic goods priced in foreign currency. Through imported consumption goods and domestic goods priced in foreign currency, exchange rate movement affects domestic prices directly. Through imported intermediate goods, exchange rate movement affects domestic price through production cost of the consumption goods.

Studies conducted by Canetti and Green (1991) have shown that exchange rate movements affects changes in consumer prices in a number of Sub-Saharan African Countries. In their study, they found that both the bivariate and trivariate Granger causality tests indicate that exchange rates had a significant causal effect on prices in Tanzania, Sierra Leone, and Democratic Republic of Congo.

According to Shively (1996), the immediate effect of the devaluation of the national currency and the switch from a fixed exchange rate regime to a managed float, in Ghana in 1983, was a higher and more volatile price, followed by lower and less volatile prices. In a study to test whether Ghana's devaluation increased the variability of maize prices, Shively (1996) concluded that an increase in maize price variability due to devaluation was brief. Gilbert (1989) exemplifies the role of exchange rates in determining food prices. He contends that exchange rates can affect food prices mainly through the mechanisms of international purchasing power and the effect on margins for producers with non-US dollar accounts.

Roache (2010) also finds that inflation and exchange rate are the macroeconomic variables that really matter for food price volatility. He opined that policy response in the face of high food price volatility is very challenging and demanding and seems to have impaired consumption and investment decisions made by households and businesses, respectively. Grennes and Lapp (1986) studied the extent to which macroeconomic factors that generate inflation alter relative agricultural prices. They upheld the hypothesis that the real aggregated agricultural prices was altered by the level of exchange rate, money prices, or inflation. Yeboah, Shaik, and Quaicoe (2012) explored the dynamics of food price changes in thirteen (13) low-income countries and seven (7) middle income countries. Their modeling suggests that the only factors that persistently explain soaring food prices are contemporaneous and one-year lagged exchange rate and income.

3 Data and Methodology

3.1 Data

Monthly time series data covering the period 2008-2013 for which data was available was used. The food index of the consumer price index (CPI) and the interbank exchange rate between the Ghana Cedis and the US dollar was used in the study. Data were obtained from the Bank of Ghana monetary time series data. The exchange rate of the Ghana cedi against, for example, the US dollar is quoted as the number of Ghana cedis required to purchase one US dollar. The Bank of Ghana is the most dominant player in the foreign exchange market and it is responsible for 90 percent of the total amount of transactions in the market (Modern Ghana, 2012).The natural logarithms of the variables were used for the estimation. The final sample consists of 66 observations.

3.2 Trends in the Food Price Index of the Consumer Price Index (CPI) and the Exchange Rate

The graph below depicts the path traced by the exchange rate and the food price index over the period under study. From the graph we see swings in exchange rate and food price index with an upward trend. Beginning 2008 we see a continuous depreciation of the cedis. This was on account of the continued persistence of the consequences of the excesses of election year 2008 arising from the political business cycle. A trend reversal occurred after July 2009 with the cedi appreciating almost immediately after an agreement on a stabilization program signed with the International Monetary Fund (Modern Ghana, 2012).

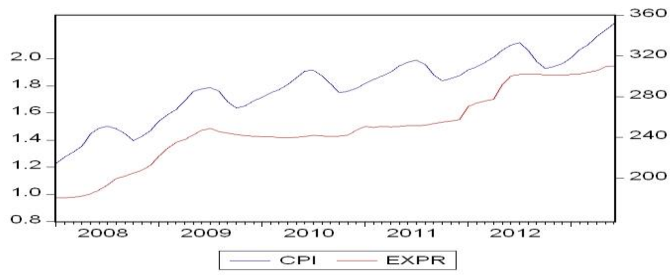


Figure 1: Trends in CPI-Food index and Exchange Rate (GHC/US$). Source-Bank of Ghana

3.3 Unit - Root Tests

Time series data are often assumed to be non-stationary; thus the first step in this analysis is to establish the stationary relationship between the variables to avoid spurious regression. Also since Granger causality holds only for stationary variables, unit roots tests have to be performed on all the variables involved in order to ensure the validity of the usual test statistic (F-statistic t-statistic and R-square). For the purpose, Augmented Dickey Fuller tests (ADF) of stationary are used in the study.

3.4 Augmented *Dickey Fuller (ADF) Test*

The ADF test is based on the estimate of the following regressions:

$$\Delta Y_t = \alpha Y_{t-1} + \delta_i \sum_{i=1}^{m} \Delta Y_{t-1} + \mu_t \quad (1)$$
$$\Delta Y_t = \beta_0 + \alpha Y_{t-1} + \delta_i \sum_{i=1}^{m} \Delta Y_{t-1} + \mu_t \quad (2)$$
$$\Delta Y_t = \beta_0 + \beta_1 TR \;\; \alpha Y_{t-1} + \delta_i \sum_{i=1}^{m} \Delta Y_{t-1} + \mu_t (3)$$

Where Y_t is defined as : CPI and Exchange Rate, Δ is the differencing operator, *TR* is the time trend and μ_t is the white noise residual of zero mean and constant variance. { β_0, $\beta_1, \alpha, \delta_1, \delta_{2,\ldots\ldots}\ \delta_m$ } is a set of parameters to be estimated.

H_O: α =0 (Y_t is non-stationary)

H_1: α ≠ 0 (Y_t is stationary)

The non-stationary hypothesis of the Augmented Dickey-Fuller (ADF) can be rejected if the t-test statistic from these tests is negatively less than the critical value. By way of explanation, by the Augmented Dickey Fuller (ADF) test, a unit root exists in the series Y_t; if the null hypothesis of α equals zero is not rejected (Gujarati 1995). Also since the determination of lag lengths is very critical and sensitive in Granger-causality test, the Akaike Information Criterion (AIC) has been used in order to find an appropriate lags length.

3.5 Granger Causality Test

The Granger no-causality test used in time series analysis to examine the direction of causality between two economic series has been one of the main subjects of many econometrics studies for the past three decades. The Granger procedure is selected because it consists the more powerful and simpler way of testing causal relationship (Granger, 1986). According to the Granger (1969) causality approach, a variable 'Y' is granger caused by 'X' if 'Y' can predicts better from past values of 'Y' and 'X' than from past values of 'Y' alone. To analyze Granger causality between food prices fluctuations and exchange rate the following Vector autoregression model (VAR) is estimated:

$$CPI_t = \sum_{i=1}^{n} \alpha_i \; EXPR_{t-1} + \sum_{k=1}^{n} \beta_i \, CPI_{t-1} + \mu_{1t} \quad (4)$$

$$EXPR_t = \sum_{i=1}^{n} \delta_i \; CPI_{t-1} + \sum_{k=1}^{n} \lambda_i \, EXPR_{t-1} + \mu_{2t} \quad (5)$$

Where, CPI is the Food Index of the Consumer Price Index and EXPR is Exchange Rate (GHC/US$), 't' denotes the time period (one month) and 'k' and 'i' are the number of lags.μ_{1t}, μ_{2t} are the error terms and they are assumed to be mutually uncorrelated. Equation (4) postulates that current CPI is related to past values of itself as well as past values of EXPR, and equation (5) postulates a similar behavior for EXPR.

Based on the estimates, four different hypotheses about the relationship between EXPR and CPI can be formulated;

I. Unidirectional Granger-causality from EXPR to CPI. In this instance exchange rate increases the prediction of the CPI but not vice versa. Thus $\sum_{i=1}^{n} \alpha_i \neq 0$ $\sum_{i=1}^{n} \delta_i = 0$.
II. Unidirectional Granger-causality from CPI to EXPR. In this instance CPI index increases the prediction of the exchange rate but not vice versa. Thus $\sum_{i=1}^{n} \alpha_i = 0$ $\sum_{i=1}^{n} \delta_i \neq 0$
III. Bidirectional (or feedback) causality. In this case exchange rate increases the prediction of the consumer price index and vice versa. Thus $\sum_{i=1}^{n} \alpha_i = 0$ $\sum_{i=1}^{n} \delta_i = 0$
IV. Independence between EXPR and CPI. In this case there is no Granger causality in any direction. Thus $\sum_{i=1}^{n} \alpha_i \neq 0$ $\sum_{i=1}^{n} \delta_i \neq 0$

4 Empirical Results

4.1 Testing for Stationarity (Unit Root Tests)

The results of the ADF test are reported in Table 1, and also provided in the Appendix (see Table A1, A2, A3, A4, A5 and A6); by taking into account of trend variable and without trend variable in the regression. Based on Table 1, the t-statistics for the food price index from the ADF tests is statistically significant at 0.05 significance level. Therefore we fail to accept the null hypothesis that a food price fluctuation is significantly different from zero (stationary).This means the regression residuals are stationary and hence not spurious. The t-statistics for the exchange rate at current level, with no time trend, from the ADF tests is statistically insignificant. This indicates that exchange rate is non-stationary at their current level form.

When the ADF test is conducted at first difference on the exchange rate, the null hypothesis of non-stationary is rejected at 0.05 significance level as shown in Table 1 below. This is consistent with some previous studies that have demonstrated that most macroeconomics variables contain unit root and thus are integrated of order one, I (1).

Table 1*: Results for the Augmented Dickey-Fuller unit root tests for CPI and EXPR.*

Test Specification	CPI (Food Index)	Exchange Rate(Expr)
Current level, no time trend	-5.2896*	-1.9858
Current level, time trend allowed	-6.9608*	-3.9642*
First difference, no time trend	_	-4.0980*
First difference, time trend allowed	_	-4.2459*

Note: The null hypothesis is that the series is non-stationary or the true process is a random walk with or without drift. The rejection of the null hypothesis for the ADF test is based on the Mackinnon critical value.
**indicates the rejection of the null hypothesis of non-stationary at 5% significant level.*

4.2 Lag Length Criteria

The various criteria for selecting the optimum lag length are computed. Appendix A8 displays the various information criteria for all lags up to the specified maximum by the researcher. The choice of optimum lag length is estimated based on the Akaike information criterion (AIC). From Table A8 in the Appendix it is clear that the smallest value of the AIC (-12.8271) is at lag twelve (12).

4.3 Cointegration Test

Since it has been determined that the exchange rate under examination is integrated of order one I (1), the Cointegration test is performed. We use two multivariate Cointegration tests: The trace test and the maximal eigenvalue test (Johansen, 1988; Johansen and Juselius, 1990,) rather than the Engle-Granger (1987) test, which requires prior knowledge about cointegrating vectors (Dickey et al., 1981). If there is long run relationship between these variables, the residuals from the cointegrating relationship will be considered as exchange rate imbalance affecting CPI symmetrically or asymmetrically. The results of the cointegration tests are reported in Table 2, and also provided in the Appendix (see Appendix Table A7). As reported in Table 2, the trace testing procedure failed to reject the null hypothesis of no-cointegration vector at 5% significance level. Similarly the maximal eigenvalue test failed to reject the no-cointegrating vectors null hypothesis at 5% significance level. This confirms that there is no long run equilibrium relationship between these variables.

Table 2: Maximal eigenvalue and trace test for Cointegration vectors.

Series CPI EXPR							
Trace test				**Maximal eigenvalue test**			
Hypothesized No. of CE(s)	**Trace Statistic**	**0.05 Critical Value**	**Prob.****	**Hypothesized No. of CE(s)**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None	11.5374	15.4947	0.1805	None	9.8694	14.2646	0.2206
At most 1	1.66805	3.8415	0.1965	At most 1	1.6681	3.8415	0.1965

The trace test and Max-eigenvalue test indicate no cointegration at the 0.05 level.
No. of CE(s): denotes number of cointegrated equations.
** denotes rejection of the hypothesis at the 0.05 level.

4.4 Granger Causality Test

Since the data do not show an explicit cointegration relationship between the series, the VAR model does not include a vector correction term. Based on the results of the integration order determination, we proceed with testing for Granger causality. The results of Granger causality for Equations 1 and 2 are represented in Table 3.

Table 3: Results of Granger-causality Tests

Null Hypothesis	**Wald F-Statistic**	**Probability**	**Lag**
EXPR does not Granger Cause CPI	0.73520	0.70674	12
CPI does not Granger Cause EXPR	2.78345	0.01191	12

The empirical results reported in Table 3 indicate that there is a unidirectional causal relationship between food prices and exchange rate. The results suggest that food price fluctuations play a substantial role in determining the depreciation of exchange rate but the converse does not hold.

5 Conclusion and Policy Implications

The purpose of this paper was to evaluate the casual relationship between exchange rate and food price fluctuations. This empirical study used formal tests of causality developed by C. J. Granger and monthly data for the period 2008-2012. The study primarily revolved around two major questions: first whether exchange rate Granger-cause food price fluctuations and secondly, whether food price fluctuations Granger-cause exchange rate. The empirical results show that there is unidirectional causality between food price fluctuations and exchange rate. The results suggest that there was causality from food prices to exchange rate and not the converse. The result also supports the argument that countries with high inflation (measured by the Consumer Price Index) typically see depreciation in their currency in relation to the currencies of their trading partners. It is also consistent with the findings of Yeboah, Shaik, and Quaicoe (2012) that suggests that contemporaneous and one-year lagged exchange rate persistently explain soaring food prices and also upholds the hypothesis by Grennes and Lapp (1986) that real aggregated agricultural prices were altered by the level of exchange rate.

The implications of these findings are quite critical for the future course of food prices and exchange rate for Ghana. An unchecked food price fluctuation could cause exchange rate depreciation which could affect our international trade position and current account.

From a policy standpoint, the results are important because food price fluctuations and exchange rate policies cannot be set independent of each other and also once a consumer receive a signal that the prices of food are too volatile or unstable, it might lead them to call for increased government intervention to minimize it's repercussions on the exchange rate.

Finally, for practical purposes, both food prices and the exchange rate should be considered as interrelated macroeconomic variables and policy makers must be guided by the relationship between them in the formulation of policies.

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APPENDIX A

Table A1: Unit root tests result for Food Prices (CPI) at current levels with constant and without a trend.

Null Hypothesis: CPI has a unit root
Exogenous: Constant
Lag Length: 9 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.289616	0.0000
Test critical values:	1% level	-3.552666	
	5% level	-2.914517	
	10% level	-2.595033	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CPI)
Method: Least Squares
Date: 08/26/13 Time: 21:23
Sample (adjusted): 2008M11 2013M06
Included observations: 56 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI(-1)	-0.105014	0.019853	-5.289616	0.0000
D(CPI(-1))	0.441608	0.131824	3.349974	0.0016
D(CPI(-2))	-0.199704	0.149078	-1.339592	0.1871
D(CPI(-3))	-0.179839	0.144632	-1.243427	0.2201
D(CPI(-4))	-0.219553	0.142914	-1.536266	0.1315
D(CPI(-5))	-0.236395	0.136367	-1.733516	0.0899
D(CPI(-6))	0.094845	0.132439	0.716139	0.4776
D(CPI(-7))	-0.365388	0.130343	-2.803290	0.0074
D(CPI(-8))	-0.166481	0.140992	-1.180788	0.2439
D(CPI(-9))	-0.330265	0.132296	-2.496402	0.0163
C	0.610950	0.114114	5.353838	0.0000

R-squared	0.822400	Mean dependent var	0.007071
Adjusted R-squared	0.782934	S.D. dependent var	0.018296
S.E. of regression	0.008524	Akaike info criterion	-6.517688
Sum squared resid	0.003270	Schwarz criterion	-6.119851
Log likelihood	193.4953	F-statistic	20.83791
Durbin-Watson stat	1.709332	Prob(F-statistic)	0.000000

Table A2: Unit root tests result for Food Prices (CPI) at current levels with constant and with trend.

Null Hypothesis: CPI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 9 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.960773	0.0000
Test critical values:	1% level	-4.130526	
	5% level	-3.492149	
	10% level	-3.174802	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CPI)
Method: Least Squares
Date: 08/26/13 Time: 21:25
Sample (adjusted): 2008M11 2013M06
Included observations: 56 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI(-1)	-0.325837	0.046810	-6.960773	0.0000
D(CPI(-1))	0.459597	0.106363	4.321018	0.0001
D(CPI(-2))	-0.044074	0.124149	-0.355011	0.7243
D(CPI(-3))	-0.001943	0.121896	-0.015941	0.9874
D(CPI(-4))	-0.164183	0.115772	-1.418158	0.1632
D(CPI(-5))	-0.127014	0.112104	-1.133001	0.2634
D(CPI(-6))	0.075017	0.106871	0.701943	0.4864
D(CPI(-7))	-0.276941	0.106574	-2.598573	0.0127
D(CPI(-8))	-0.107624	0.114298	-0.941608	0.3515
D(CPI(-9))	-0.422015	0.108238	-3.898972	0.0003
C	1.823228	0.258424	7.055183	0.0000
@TREND(2008M01)	0.001111	0.000221	5.020099	0.0000

R-squared	0.887078	Mean dependent var	0.007071
Adjusted R-squared	0.858847	S.D. dependent var	0.018296
S.E. of regression	0.006874	Akaike info criterion	-6.934805
Sum squared resid	0.002079	Schwarz criterion	-6.500801
Log likelihood	206.1745	F-statistic	31.42260
Durbin-Watson stat	2.196991	Prob(F-statistic)	0.000000

Table A3: Unit root tests result for Exchange rate (EXPR) at current levels with constant and without a trend.

Null Hypothesis: EXPR has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.985764	0.2923
Test critical values:	1% level	-3.536587	
	5% level	-2.907660	
	10% level	-2.591396	

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXPR)
Method: Least Squares
Date: 08/26/13 Time: 21:32
Sample (adjusted): 2008M03 2013M06
Included observations: 64 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXPR(-1)	-0.018580	0.009357	-1.985764	0.0516
D(EXPR(-1))	0.541916	0.102555	5.284156	0.0000
C	0.012109	0.004265	2.839080	0.0061

R-squared	0.373603	Mean dependent var	0.010803
Adjusted R-squared	0.353066	S.D. dependent var	0.016570
S.E. of regression	0.013328	Akaike info criterion	-5.752198
Sum squared resid	0.010835	Schwarz criterion	-5.651000
Log likelihood	187.0703	F-statistic	18.19120
Durbin-Watson stat	2.000217	Prob(F-statistic)	0.000001

Table A4: Unit root tests result for Exchange rate (EXPR) at current levels with constant and a trend.

Null Hypothesis: EXPR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.964154	0.0151
Test critical values:	1% level	-4.115684	
	5% level	-3.485218	
	10% level	-3.170793	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXPR)

Method: Least Squares
Date: 08/26/13 Time: 23:02
Sample (adjusted): 2008M06 2013M06
Included observations: 61 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXPR(-1)	-0.111946	0.028240	-3.964154	0.0002
D(EXPR(-1))	0.477236	0.117709	4.054358	0.0002
D(EXPR(-2))	-0.002630	0.134437	-0.019561	0.9845
D(EXPR(-3))	-0.061958	0.134264	-0.461462	0.6463
D(EXPR(-4))	0.365925	0.119383	3.065145	0.0034
C	0.016855	0.004969	3.392196	0.0013
@TREND(2008M01)	0.000876	0.000262	3.344350	0.0015

R-squared	0.525545	Mean dependent var	0.010882
Adjusted R-squared	0.472828	S.D. dependent var	0.016938
S.E. of regression	0.012298	Akaike info criterion	-5.851102
Sum squared resid	0.008167	Schwarz criterion	-5.608870
Log likelihood	185.4586	F-statistic	9.969150
Durbin-Watson stat	2.012562	Prob(F-statistic)	0.000000

Table A5: Unit root tests result for Exchange rate in first difference with constant and without a trend.
Null Hypothesis: D(EXPR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.097960	0.0019
Test critical values:	1% level	-3.536587	
	5% level	-2.907660	
	10% level	-2.591396	

*MacKinnon (1996) one-sided p-values.

Dependent Variable: D(EXPR,2)
Method: Least Squares
Date: 08/26/13 Time: 21:33
Sample (adjusted): 2008M03 2013M06
Included observations: 64 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXPR(-1))	-0.424090	0.103488	-4.097960	0.0001
C	0.004617	0.002035	2.268096	0.0268

R-squared	0.213131	Mean dependent var	6.09E-05

Adjusted R-squared	0.200439	S.D. dependent var	0.015255
S.E. of regression	0.013640	Akaike info criterion	-5.720808
Sum squared resid	0.011536	Schwarz criterion	-5.653343
Log likelihood	185.0659	F-statistic	16.79328
Durbin-Watson stat	1.979589	Prob(F-statistic)	0.000123

Table A6: Unit root tests result for Exchange rate in first difference with constant and a trend

Null Hypothesis: D(EXPR) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.245866	0.0068
Test critical values:	1% level	-4.107947	
	5% level	-3.481595	
	10% level	-3.168695	

*MacKinnon (1996) one-sided p-values.

Dependent Variable: D(EXPR,2)
Method: Least Squares
Date: 08/26/13 Time: 21:36
Sample (adjusted): 2008M03 2013M06
Included observations: 64 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXPR(-1))	-0.446925	0.105261	-4.245866	0.0001
C	0.008389	0.003929	2.134984	0.0368
@TREND(2008M01)	-0.000105	9.39E-05	-1.121586	0.2664

R-squared	0.229030	Mean dependent var	6.09E-05
Adjusted R-squared	0.203752	S.D. dependent var	0.015255
S.E. of regression	0.013612	Akaike info criterion	-5.709970
Sum squared resid	0.011303	Schwarz criterion	-5.608773
Log likelihood	185.7190	F-statistic	9.060550
Durbin-Watson stat	1.975353	Prob(F-statistic)	0.000359

Table A7: Cointegration tests result of Food prices and Exchange rate

Included observations: 63 after adjustments
Trend assumption: Linear deterministic trend
Series: CPI EXPR
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.145002	11.53740	15.49471	0.1805
At most 1	0.026129	1.668045	3.841466	0.1965

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.145002	9.869358	14.26460	0.2206
At most 1	0.026129	1.668045	3.841466	0.1965

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

CPI	EXPR
-0.100844	10.40218
-0.003151	4.301204

Unrestricted Adjustment Coefficients (alpha):

D(CPI)	1.325364	-0.081678
D(EXPR)	0.000367	-0.003264

1 Cointegrating Equation(s): Log likelihood -6.137947

Normalized cointegrating coefficients (standard error in parentheses)

CPI	EXPR
1.000000	-103.1511
	(12.6755)

Adjustment coefficients (standard error in parentheses)

D(CPI)	-0.133655
	(0.04351)
D(EXPR)	-3.70E-05
	(0.00027)

Table A8: Results of VAR Lag Length Criteria

VAR Lag Order Selection Criteria
Endogenous variable: CPI EXPR
Exogenous Variables: C

Lag	LR	FPE	AIC	HQIC	SBIC
0		0.000018	-5.26997	-5.24103	-5.19422
1	292.99	6.6e-08	-10.8579	-10.7711	-10.6307
2	53.375	2.7e-08	-11.7476	-11.6029	-11.3689*
3	8.0803	2.7e-08	-11.7492	-11.5466	-11.2189
4	15.431	2.4e-08	-11.8949	-11.6344	-11.2131
5	16.899	2.0e-8	-12.0694	-11.751	-11.2361
6	1.8628	2.3e-08	-11.9491	-11.5727	-10.9642
7	11.272	2.2e-08	-12.0132	-11.579	-10.8769
8	26.382	1.5e-08	-12.3736	-11.8815	-11.0858
9	14.578	1.4e-08	-12.5026	-11.9526	-11.0632
10	15.434	1.2e-08	-12.6484	-12.0405	-11.0575
11	17.062*	1.1e-08*	-12.8261	-12.1602 *	-11.0837
12	8.0504	1.1e-08	-12.8271*	-12.1033	-10.9331
13	7.1969	1.2e-08	-12.8113	-12.0297	-10.7659
14	5.2595	1.3e-08	-12.7576	-11.9181	-10.5606
15	8.7211	1.4e-08	-12.7717	-11.8743	-10.4232

Significant level used 5%
*Indicates lag order selected by the criteria
LR: sequential modified LR test statistic. **FPE:**Final Prediction Error.**AIC:**Akaike Information Criterion. **HQIC:**Hannan-Quinn Information Criterion. **SBIC:** Schwarz' Bayesian Information Criterion.