
**University of Pretoria**
*Department of Economics Working Paper Series*

# The Effects of Monetary Policy on Real Farm Prices in South Africa

Goodness C. Aye
University of Agriculture, Makurdi, Nigeria
Rangan Gupta
University of Pretoria

Working Paper: 2011-19
October 2011

Department of Economics
University of Pretoria
0002, Pretoria
South Africa
Tel: +27 12 420 2413

**The Effects of Monetary Policy on Real Farm Prices in South Africa**

**Goodness C. Aye[*] and Rangan Gupta[**]**

**Abstract**

This study provides empirical evidence of aggregate, anticipated and unanticipated and asymmetric (positive and negative) effects of monetary policy on real agricultural prices in South Africa over the monthly period of 1970:01-2010:12. For this purpose, we use the Vector Autoregressive (VAR) model coupled with the monetary misperception model to distinguish between anticipated and unanticipated monetary policy shocks. Results show that the actual, anticipated and unanticipated monetary policy had significant effect on real farm prices. These findings are robust when the shocks are modelled as recursive residuals. Moreover, the positive monetary policy was consistently significant either at specific lags or jointly. With exception of the recursive anticipated monetary policy, the negative components were consistently insignificant. Further, the hypothesis of asymmetric effect was supported for the recursive anticipated monetary policy only. The effects observed in this study are quantitatively small and accounts for only a very small percentage (1.5 percent - 6.5 percent) of the variation in real farm prices.

Key words: Monetary policy, real farm price, asymmetric effects, recursive residuals
JEL Classification: C12, E52, Q11

## 1. Introduction

The response of different sectors in an economy to monetary policy is very important to policy decisions. This paper focuses on the agricultural sector in South Africa. According to Government Communication Information Systems, (2010), the primary agriculture's

[*] Lecturer, Department of Agricultural Economics, University of Agriculture, Makurdi, Nigeria, Email: aye_goody@yahoo.co.uk..
** Professor, Department of Economics, University of Pretoria, Pretoria, 0002, South Africa, Email: Rangan.Gupta@up.ac.za.

contribution to GDP in South Africa is about 3 percent. Although, this is very low, agriculture's importance lies in its backward and forward linkages with other sectors in the economy (Guisán and Expósito, 2001; Atherinos and Aguyao, 2002). The establishment and maintenance of food security, foreign exchange earnings and employment, makes it an important integral part of the South African economy. This paper investigates the effects of monetary policy on real agricultural prices using monetary misperceptions and vector autoregressive (VAR) models. Understanding the effects of monetary policy on real agricultural prices is essential to sustainable growth in this sector and the entire economy. Rather than considering nominal farm prices, this paper considers real farm prices, as farm optimization decisions are based on the latter. Real agricultural producer prices have great implications for investment decisions, resource allocation, incomes, profitability, food security and even farmers' ability to anticipate future agricultural producer prices (Naude, 1995).

Theory predicts that the anticipated portion of money supply growth will not influence real economic variables such as real prices and real output; only the random, unanticipated portion has real impact (Lucas, 1973; Devados et al., 1990). Rational expectations theory also predicts that monetary policy will be neutral in the short and long run, because the agents are not mistaken on average. However, existing empirical evidence on the effects of monetary policy on agricultural prices has been mixed or inconclusive (Starleaf 1982; Bessler, 1984; Chambers, 1984; Devados and Meyers, 1987; Sephton, 1989; Lapp, 1990; Belongia, 1991; Isaac and Rapach, 1997; Awokuse, 2005; Mustaq et al., 2011). As far as we are aware, only two studies have considered the impact of monetary policy on agricultural prices in South Africa. Naude (1995) used quarterly data (1983-1992) to analyse the impact of monetary policy on relative agricultural producer prices in South Africa. The rational expectations approach was employed. He found that the unanticipated money supply shocks from the three monetary aggregates (M1, M2 and M3) did not have significant effect on any of the two relative agricultural producer prices defined for the study. Further, he found that the anticipated money supply did not, in general, have significant effect on relative agricultural prices. Another study in South Africa by Asfaha and Jooste (2007) investigated the long- and short-run effects of monetary changes on relative agricultural prices using the Johansen approach for cointegration test and the Vector Error Correction Model (VECM) respectively.

Their cointegration results rejected the long-run money neutrality hypothesis.[1] The results for the dynamic relationships indicated that agricultural prices adjusted faster than industrial prices to innovations in money supply, providing evidence for the hypothesis that agricultural prices overshoot their long-run values in the short run. None of these studies, however, considered the asymmetric effects, i.e., whether positive and negative monetary policy, anticipated or unanticipated, have the same effect or not on real farm prices.[2]

It is against this background that this paper analyses the effects of monetary policy or shocks on agricultural prices in South Africa under a wide range of specifications. The actual, anticipated and unanticipated monetary policy indicators are considered. Each monetary policy indicator is considered first as a complete (total) series. Next, they are separated into positive (expansionary) and negative (contractionary) policy or shocks. These distinctions permit a best evaluation of the degree of homogeneity of the effects of monetary policy (Chu and Ratti, 1997; Huchet, 2003). Failure to recognize an asymmetry between positive and negative monetary shocks might lead to a conclusion that surprises do not matter. In this paper, unanticipated monetary shock is modelled as both ordinary and recursive residuals. This is an important methodological contribution of this paper. The use of recursive (sequential) residuals is motivated by the fact that as new information is updated, economic agents might change their behaviour. Thus, this study considers recursive shocks as an important monetary policy indicator. They are a linear transformation of ordinary residuals. They are obtained by adding one observation at a time, that is, starting from the first $k$ observations, one obtains $(T-k)$ forward recursive residuals. An important property of recursive residuals is that, they are asymptotically independently and identically distributed. Unlike ordinary residuals, they do not have the problem of deficiencies in one part of the data being spread over the entire residuals (Rasekh, 2006). Recursive residuals are also not subject to as much masking (outliers hiding each other) and swamping (making non-outliers look like outliers) as ordinary residuals. Although it is possible for outliers to occasionally remain unidentified, their presence can still be detected by the normal probability plot failing to pass through the origin. This is due to another advantage recursive residuals have over ordinary

[1] We found no cointegration between real farm prices (nominal and real) and monetary aggregates. The cointegration found by Asfaha and Jooste (2007) could be as a result of interactions with other variables included in their model.

[2] Studies on asymmetric effects of monetary policy in other sectors include: Cover, 1992; Thoma, 1994, Chu and Ratti, 1997; Garcia and Schaller, 1999; Weise, 1999; Ravn and Shola, 2004. For studies relating to specifically Africa, on monetary policy and its interaction with the real sector see, Feridun et al., 2005; El Bouhadi and Benali, 2006; Khamfula, 2006. ,

residuals-they are not constrained to sum to zero. Recursive residuals also allow one to test for a change of regime, which ordinary residuals are not well suited for and they are much more sensitive to model misspecification (Galpin and Hawkins, 1984; Kianifard and Swallon, 1996).

Results obtained are used to shed light on six research questions: First, do actual changes in the money supply affect real agricultural prices in South Africa? Second, do actual positive and negative monetary policies have asymmetric effects on real farm prices in South Africa? Third, does unanticipated monetary shock (ordinary or recursive) affect real agricultural prices in South Africa? Fourth, do unanticipated positive and negative monetary policy shocks (ordinary or recursive) have asymmetric effects on real farm prices in South Africa? Fifth, does anticipated monetary policy affect real agricultural prices in South Africa? Sixth, do anticipated positive and negative monetary policy shocks have asymmetric effects on real farm prices in South Africa? The rest of the paper is organized as follows: Section 2 outlines the data and the empirical models, while Section 3 presents the empirical results. Finally, Section 4 concludes.

## 2. Empirical Procedure

### 2.1 The Data

This study used monthly data from 1970-2010. The monetary aggregates considered were M1, M2 and M3. However, discussions are limited to M3 as similar results were obtained for M2. Results for M1 indicated the existence of the *price puzzle*, where by a negative shock to M1 led to an increase in the real farm price consistently. This, in turn warranted the need to use broader measures of money which seemed to encompass a bigger information set capturing the true dynamics of monetary policy. Real farm price (RFP), is the agricultural producer price index deflated by the consumer price index. The log levels and growth rates of real farm prices and M3 can be found in appendix 1. Appendix 1 shows the non-stationarity of the data series. It can also be inferred that real farm prices and M3 do not trend together. It also provides an informal evidence of stationarity of the growth rates. All variables were formally tested for unit root using both the Augmented Dickey-Fuller (1979) and Phillips and Perron (1988) tests. Results show that they are all non-stationary and integrated of order one, I(1). Hence the first differences of logarithms (growth rates) of all variables were used in estimations. Using the Johansen (1991) approach for cointegration test, no evidence of cointegration between real farm prices and any of the money supply measures could be

detected. Thus, the VAR approach was considered to capture the short-run dynamics..[3] Data for the study are obtained from the South African Reserve Bank and Statistics South Africa.

### 2.2 The Empirical Models

The procedure followed involves the estimation of monetary misperceptions and VAR models. In each of the models, two stages are followed namely: the estimation of the monetary policy supply processes and the real farm price equations. In the first stage, two monetary policy processes are estimated and are represented by equations (1) and (2):

$$DM3_t = \gamma_{0_t} + \sum_{i=1}^{6} \gamma_i DM3_{t-i} + O\_UDM3_t \quad (1)$$

$$DM3_t = \delta_{0_t} + \sum_{i=1}^{6} \delta_i DM3_{t-i} + R\_UDM3_t \quad (2)$$

where $DM3_t$ is the actual money supply (M3) time t growth rate, $O\_UDM3_t$ is the unanticipated component of M3 growth, which is the ordinary residual series from the first money supply process. $R\_UDM3_t$ is the unanticipated component of M3 growth, which is the recursive (sequential) residual series from the second money supply process. To obtain the recursive residuals, a basis set of *k* points is required to obtain initial estimates of the *k* parameters of the model. Thereafter, the remaining *T-k* observations are entered one by one, and a predicted value, $\hat{DM3}_t$, for the *j*th observation (*j = k + 1,...,T*) is obtained using parameter estimates calculated from only the *j-1* observations previously entered. A recursive residual is the scaled difference between the observed $DM3_t$ and this predicted value. Thus, no observation is used in predicting itself. The Likelihood ratio statistic (LR), Akaike information criterion (AIC), Final prediction error (FPE), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) tests were conducted to determine the optimal lag length for the growth rate of M3. Majority of the tests (LR, SC and HQ tests) suggest that DM3 is an AR (6) process. The difference between the actual money supply growth and the respective residual series (unanticipated component) in equations (1) and (2) are the corresponding anticipated component of M3 growth.

The second stage involves ten different specifications of real farm price to ensure that results obtained are robust. The various lag length criteria applied on each of the RFP specifications

[3] The results of the unit root and cointegration tests are available from the authors upon request.

suggested different lags. However, the LR suggested 12 and 13 lags in most cases. Moreover, most monetary policy studies used 12, 13 or 14 lags in the case of monthly data (Bessler, 1984; Devadoss and Meyers, 1987; Khan, 2008). Hence, in this study, 13 lags were considered as optimal for each specification; long enough to eliminate any serial correlation from the residuals. Equation (3) analyses the effects of actual money growth rate ($DM3$) on real farm price growth rate ($DRFP$) without making any distinction between expansionary or contractionary policy:

$$DRFP_t = \alpha_{0t} + \sum_{i=0}^{13} \alpha_{it} DM3_{t-i} + v_{1t} \tag{3}$$

Equation (4) gives the effect of positive ($DM3\_POS$) and negative ($DM3\_NEG$) actual money growth rate on real farm price:

$$DRFP_t = \beta_{0t} + \sum_{i=0}^{13} \beta_{it} DM3\_POS_{t-i} \sum_{i=0}^{13} \chi_{it} DM3\_NEG_{t-i} + v_{2t} \tag{4}$$

Effects of ordinary unanticipated monetary shock, $O\_UDM3$, is given in equation (5):

$$DRFP_t = \chi_{0t} + \sum_{i=0}^{13} \chi_{1t} O\_UDM3_t + v_{3t} \tag{5}$$

Effects of positive ($O\_UDM3\_POS$) and negative ($O\_UDM3\_NEG$) ordinary unanticipated monetary shock is given in equation (6):

$$DRFP_t = \varphi_{0t} + \sum_{i=0}^{13} \varphi_{it} O\_UDM3\_POS_{t-i} \sum_{i=0}^{13} \eta_{it} O\_UDM3\_NEG_{t-i} + v_{4t} \tag{6}$$

Equation (7) gives the effects of the recursive unanticipated monetary shock, $R\_UDM3$, while equation (8) gives the effects of the positive ($R\_UDM3\_POS$) and negative ($R\_UDM3\_NEG$) recursive unanticipated monetary shock.

$$DRFP_t = \kappa_{0t} + \sum_{i=0}^{13} \kappa_{it} R\_UDM3_{t-i} + v_{5t} \tag{7}$$

$$DRFP_t = \lambda_{0t} + \sum_{i=0}^{13} \lambda_{it} R\_UDM3\_POS_{t-i} \sum_{i=0}^{13} \sigma_{it} R\_UDM3\_NEG_{t-i} + v_{6t} \tag{8}$$

The effects of ordinary anticipated monetary policy, $O\_ADM3$, is given in equation (9)

$$DRFP_t = \mu_{0t} + \sum_{i=0}^{13} \mu_{1t} O\_ADM3_t + v_{7t} \tag{9}$$

The effects of positive ($O\_ADM3\_POS$) and negative ($O\_ADM3\_NEG$) ordinary anticipated monetary policy is given in equation (10):[4]

$$DRFP_t = \pi_{0t} + \sum_{i=0}^{13} \pi_{it} O\_ADM3\_POS_{t-i} \sum_{i=0}^{13} \varpi_{it} O\_ADM3\_NEG_{t-i} + v_{8t} \quad (10)$$

The effects of recursive anticipated monetary policy, $R\_ADM3$, is given in equation (11):

$$DRFP_t = \rho_{0t} + \sum_{i=0}^{13} \rho_{1t} R\_ADM3_t + v_{9_t} \quad (11)$$

The effects of positive ($R\_ADM3\_POS$) and negative ($R\_ADM3\_NEG$) recursive anticipated monetary policy is given in equation (12):

$$DRFP_t = \xi_{0t} + \sum_{i=0}^{13} \xi_{it} R\_ADM3\_POS_{t-i} \sum_{i=0}^{13} \psi_{it} R\_ADM3\_NEG_{t-i} + v_{10t} \quad (12)$$

where $v_{1t} - v_{10t}$ are the corresponding random errors for each of the RFP specifications.

For the VAR, model, the procedure is the same. All variables and transformations are same as in the misperceptions models except that estimations were implemented within a VAR framework.

## 3. Results and Discussions

### 3.1: The Effects of Actual Money Supply on Real Farm Prices

The estimates of the effects of actual money supply growth on real farm prices are presented in Table 1. The results show that actual money supply growth has significant effect on real farm prices. This is evidenced by the significance of the 7th and 10th lags as well as the joint significance of all variables. A number of hypotheses were tested to determine both the general and asymmetric effects of positive and negative monetary policy on real farm prices. These include (i) test of the null hypothesis that the coefficients on the positive or negative monetary policy are jointly zero; (ii) test of the null hypothesis that the sum of the coefficients on the positive or negative monetary policy is zero; (iii) test of joint equality of coefficients on positive and negative monetary policy and (iv) test of equality sums of coefficients on positive and negative monetary policy. The Wald statistics from testing these hypotheses are presented in the lower panel of Table 1. The positive actual money supply

[4] The equation with positive and negative is not estimated because, all values were positive, hence only total ordinary anticipated money is reported.

growth has positive and significant effect on real farm prices at the 1st, 7th and 10th lags. The two hypotheses of non-significance were rejected for the positive actual money. This implies that, positive monetary policy has significant effect on real farm prices in general. However, neither the contemporaneous nor any of the lagged negative money supply growth has significant effect on real farm prices. None of the hypotheses could be rejected for the negative component. Asymmetric effect could not be established for positive and negative actual money supply growth.

Table 1: Effects of Actual Money Growth on Real Farm Prices

| Variable | Actual M3 Growth | | Positive/Negative M3 | |
|---|---|---|---|---|
| | Coeff. | P.value | Coeff. | P.value |
| Constant | 0.000 | 0.972 | -0.002 | 0.673 |
| DM3 | -0.060 | 0.517 | - | - |
| DM3(-1) | 0.122 | 0.195 | - | - |
| DM3(-2) | 0.048 | 0.598 | - | - |
| DM3(-3) | 0.108 | 0.247 | - | - |
| DM3(-4) | 0.022 | 0.816 | - | - |
| DM3(-5) | 0.035 | 0.709 | - | - |
| DM3(-6) | 0.148 | 0.117 | - | - |
| DM3(-7) | 0.232 | 0.014*** | - | - |
| DM3(-8) | 0.011 | 0.909 | - | - |
| DM3(-9) | -0.144 | 0.121 | - | - |
| DM3(-10) | -0.276 | 0.003*** | - | - |
| DM3(-11) | -0.096 | 0.296 | - | - |
| DM3(-12) | -0.094 | 0.317 | - | - |
| DM3(-13) | -0.097 | 0.299 | - | - |
| DM3_POS | - | - | -0.095 | 0.411 |
| DM3_POS(-1) | - | - | 0.197 | 0.088* |
| DM3_POS(-2) | - | - | -0.009 | 0.939 |
| DM3_POS(-3) | - | - | 0.134 | 0.242 |
| DM3_POS(-4) | - | - | 0.002 | 0.985 |
| DM3_POS(-5) | - | - | 0.065 | 0.572 |
| DM3_POS(-6) | - | - | 0.158 | 0.174 |
| DM3_POS(-7) | - | - | 0.220 | 0.059* |
| DM3_POS(-8) | - | - | 0.031 | 0.784 |
| DM3_POS(-9) | - | - | -0.096 | 0.402 |
| DM3_POS(-10) | - | - | -0.376 | 0.001*** |
| DM3_POS(-11) | - | - | -0.075 | 0.509 |
| DM3_POS(-12) | - | - | -0.080 | 0.487 |
| DM3_POS(-13) | - | - | -0.011 | 0.920 |
| DM3_NEG | - | - | 0.049 | 0.884 |
| DM3_NEG(-1) | - | - | -0.234 | 0.488 |
| DM3_NEG(-2) | - | - | 0.342 | 0.309 |
| DM3_NEG(-3) | - | - | -0.064 | 0.849 |
| DM3_NEG(-4) | - | - | 0.106 | 0.753 |

| | | | | |
|---|---|---|---|---|
| DM3_NEG(-5) | - | - | -0.105 | 0.756 |
| DM3_NEG(-6) | - | - | 0.042 | 0.902 |
| DM3_NEG(-7) | - | - | 0.298 | 0.377 |
| DM3_NEG(-8) | - | - | -0.047 | 0.889 |
| DM3_NEG(-9) | - | - | -0.293 | 0.385 |
| DM3_NEG(-10) | - | - | 0.220 | 0.513 |
| DM3_NEG(-11) | - | - | -0.295 | 0.381 |
| DM3_NEG(-12) | - | - | -0.170 | 0.619 |
| DM3_NEG(-13) | - | - | -0.531 | 0.122 |
| F-ratio | 1.531 | 0.096* | 1.040 | 0.412 |
| POS = 0 ; $\chi(14)$ | - | - | | 0.073* |
| SUM (POS) = 0; $\chi(1)$ | - | - | 0.065 | 0.845 |
| NEG = 0; $\chi(14)$ | - | - | | 0.922 |
| SUM (NEG) = 0; $\chi(1)$ | - | - | -0.681 | 0.560 |
| POS = NEG; $\chi(14)$ | - | - | | 0.892 |
| SUM (POS) = SUM(NEG); $\chi(1)$ | - | - | 0.476 | 0.582 |

***, **, * denotes significance at 1 percent, 5 percent and 10 percent respectively

The results from the VAR model are presented in the form of the impulse response functions and variance decomposition graphs. The impulse response functions and variance decompositions depict the effects and relative importance of monetary policy on real farm prices respectively. The impulse response and variance decomposition of RFP with respect to actual money supply are given in Figures 1 and 2 respectively.[5] The impulse response shows that innovations in actual money caused an initial increase in RFP up to the 8th month. The effect became approximately zero by the 25th month. The variance decomposition shows that actual money supply growth accounted about 4.4 percent of the variation in real farm prices. Figure 3 is a combined RFP impulse response of RFP to actual positive and negative money supply growth. An initial increase in RFP due to a shock in the positive actual money was observed and the trend remained positive up to the first 9 months before it temporarily became negative. By the 37th month RFP had completely returned to its original level. Similar innovation in the negative actual money supply caused an initial decline in RFP. The variance decomposition shown in Figure 4 shows that positive and negative actual money supply growth contributed 4.4 percent and 1.6 percent respectively to the variation in RFP.

[5] The corresponding impulse response functions showing the 2 S.E bands for this and all other VARs in this study are presented in Appendix 2.

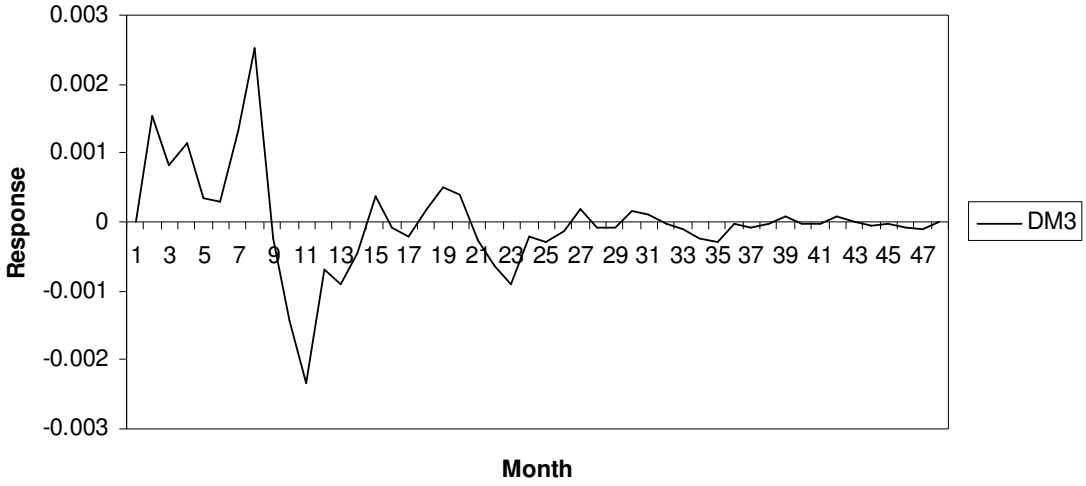


Figure 1: Impulse response of DRFP to a one S.D innovation in DM3

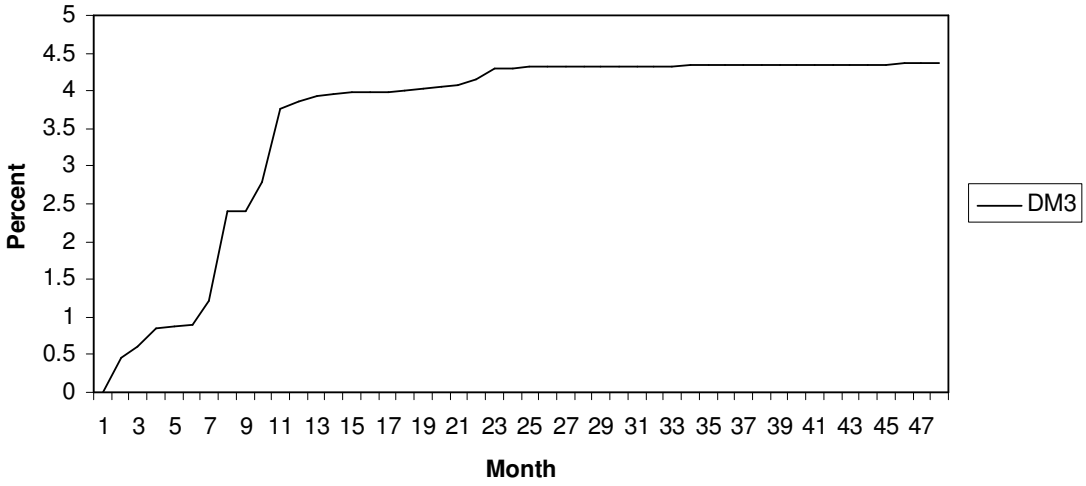


Figure 2: Percent real farm price variance due to actual money supply

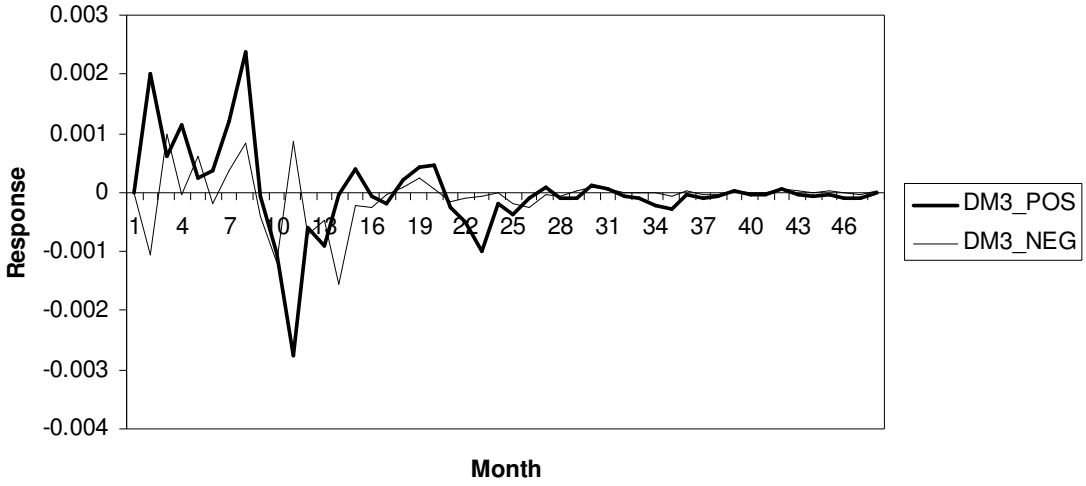


Figure 3: Impulse response of DRFP to a one S.D innovation in positive and negative DM3

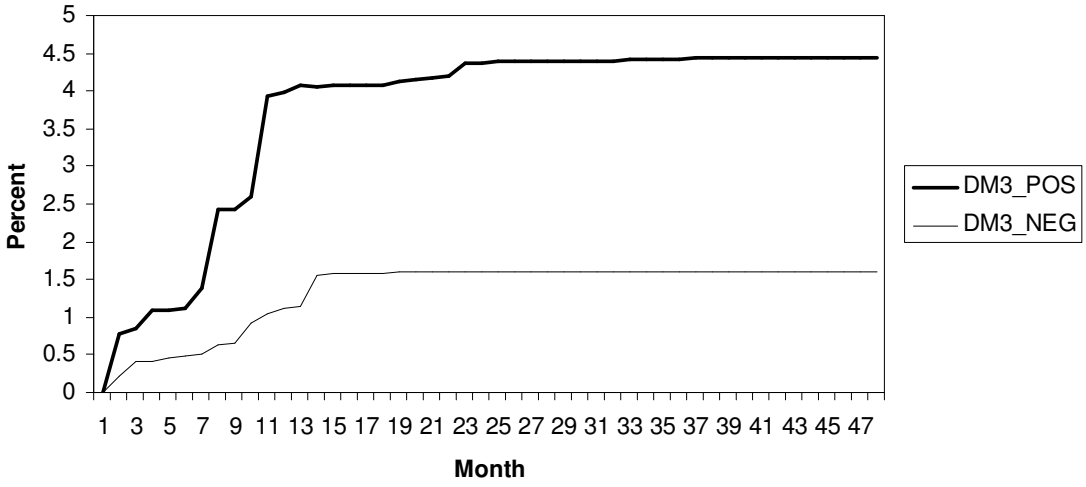


Figure 4: Percent real farm price variance due to positive and negative actual money supply

**3.2 The Effects of the Ordinary Unanticipated Monetary Shocks on Real Farm Prices**

The effects of unanticipated monetary shock represented by the ordinary residual are presented in Table 2. The ordinary unanticipated monetary shock had significant impact on real farm prices at the $7^{th}$ and $10^{th}$ lags. However, the joint significant of all the variables were rejected. The positive ordinary shock was significant at the $10^{th}$ lag whereas the negative component was marginally significant at the $7^{th}$ lag. The F-ratios show that the ordinary unanticipated monetary shock with its positive and negative components were statistically

insignificant and are therefore neutral. Further, the distinction between positive and negative monetary policy shocks is irrelevant in explaining real farm prices when monetary policy is indicated by ordinary unanticipated shock. The results from the VAR model are presented in Figures 5 to 8. The response of RFP to ordinary unanticipated monetary shock was initially positive. The highest variance of RFP attributable to ordinary unanticipated monetary shock was 3.7 percent. As expected the positive and negative components caused respectively an initial rise and decline in RFP. Whereas the positive shock contributed 4.1 percent to the variation in RFP, the negative shock contributed 1.6 percent.

Table 2: Effect of Ordinary Unanticipated Monetary Shock on Real Farm Prices

| Variable | UM3 Growth | | Positive & Negative UM3 | |
|---|---|---|---|---|
| | Coeff. | P.value | Coeff. | P.value |
| Constant | -0.001 | 0.484 | 0.001 | 0.807 |
| O_UDM3 | -0.058 | 0.538 | - | - |
| O_UDM3(-1) | 0.115 | 0.220 | - | - |
| O_UDM3(-2) | 0.034 | 0.708 | - | - |
| O_UDM3(-3) | 0.089 | 0.330 | - | - |
| O_UDM3(-4) | 0.019 | 0.839 | - | - |
| O_UDM3(-5) | 0.054 | 0.551 | - | - |
| O_UDM3(-6) | 0.145 | 0.114 | - | - |
| O_UDM3(-7) | 0.251 | 0.006*** | - | - |
| O_UDM3(-8) | 0.037 | 0.689 | - | - |
| O_UDM3(-9) | -0.084 | 0.361 | - | - |
| O_UDM3(-10) | -0.171 | 0.062* | - | - |
| O_UDM3(-11) | -0.015 | 0.867 | - | - |
| O_UDM3(-12) | -0.051 | 0.585 | - | - |
| O_UDM3(-13) | -0.019 | 0.842 | - | - |
| O_UDM3_POS | - | - | -0.082 | 0.634 |
| O_UDM3_POS(-1) | - | - | 0.231 | 0.179 |
| O_UDM3_POS(-2) | - | - | -0.012 | 0.944 |
| O_UDM3_POS(-3) | - | - | 0.067 | 0.693 |
| O_UDM3_POS(-4) | - | - | -0.101 | 0.554 |
| O_UDM3_POS(-5) | - | - | 0.270 | 0.114 |
| O_UDM3_POS(-6) | - | - | 0.093 | 0.588 |
| O_UDM3_POS(-7) | - | - | 0.210 | 0.220 |
| O_UDM3_POS(-8) | - | - | 0.105 | 0.539 |
| O_UDM3_POS(-9) | - | - | -0.074 | 0.666 |
| O_UDM3_POS(-10) | - | - | -0.449 | 0.009*** |
| O_UDM3_POS(-11) | - | - | -0.027 | 0.876 |
| O_UDM3_POS(-12) | - | - | -0.115 | 0.506 |
| O_UDM3_POS(-13) | - | - | 0.033 | 0.848 |
| O_UDM3_NEG | - | - | -0.041 | 0.824 |
| O_UDM3_NEG(-1) | - | - | 0.008 | 0.967 |
| O_UDM3_NEG(-2) | - | - | 0.094 | 0.606 |
| O_UDM3_NEG(-3) | - | - | 0.121 | 0.507 |

| | | | | |
|---|---|---|---|---|
| O_UDM3_NEG(-4) | - | - | 0.142 | 0.434 |
| O_UDM3_NEG(-5) | - | - | -0.171 | 0.348 |
| O_UDM3_NEG(-6) | - | - | 0.184 | 0.311 |
| O_UDM3_NEG(-7) | - | - | 0.294 | 0.105 |
| O_UDM3_NEG(-8) | - | - | -0.039 | 0.830 |
| O_UDM3_NEG(-9) | - | - | -0.080 | 0.658 |
| O_UDM3_NEG(-10) | - | - | 0.130 | 0.473 |
| O_UDM3_NEG(-11) | - | - | 0.007 | 0.968 |
| O_UDM3_NEG(-12) | - | - | 0.025 | 0.891 |
| O_UDM3_NEG(-13) | - | - | -0.071 | 0.696 |
| F-ratio | 1.280 | 0.216 | 0.952 | 0.539 |
| POS = 0 ; $\chi(14)$ | - | - | | 0.310 |
| SUM (POS) = 0; $\chi(1)$ | - | - | 0.149 | 0.811 |
| NEG = 0; $\chi(14)$ | - | - | | 0.938 |
| SUM (NEG) = 0; $\chi(1)$ | - | - | 0.603 | 0.411 |
| POS = NEG; $\chi(14)$ | - | - | | 0.836 |
| SUM (POS) = SUM(NEG); $\chi(1)$ | - | - | -0.454 | 0.699 |

***, **, * denotes significance at 1 percent, 5 percent and 10 percent respectively

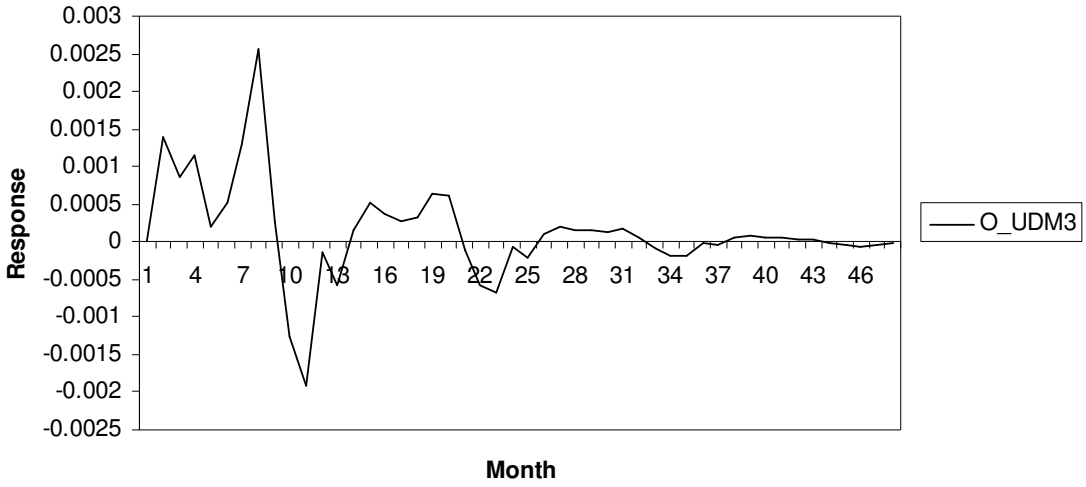


Figure 5: Impulse response of DRFP to a one S.D innovation in ordinary monetary shock

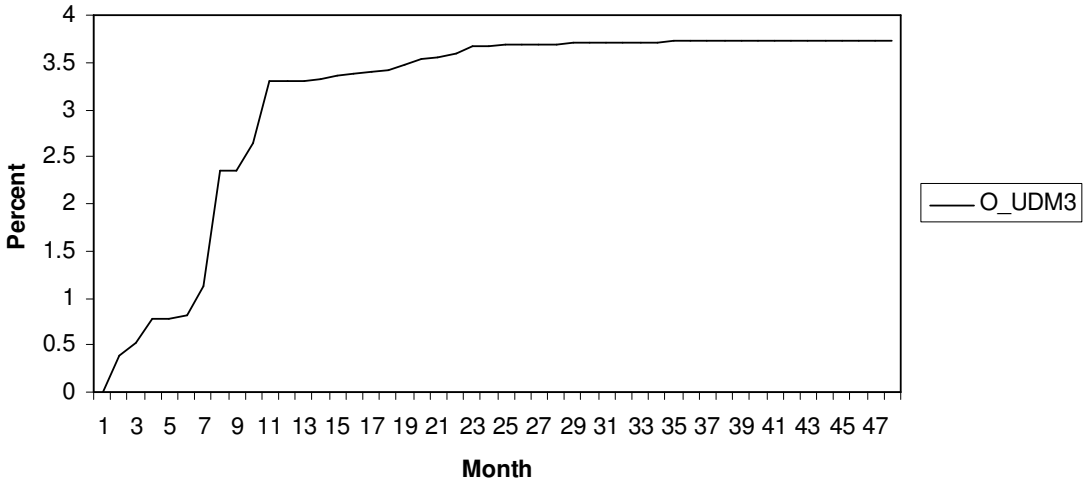


Figure 6: Percent real farm price variance due to ordinary monetary shock

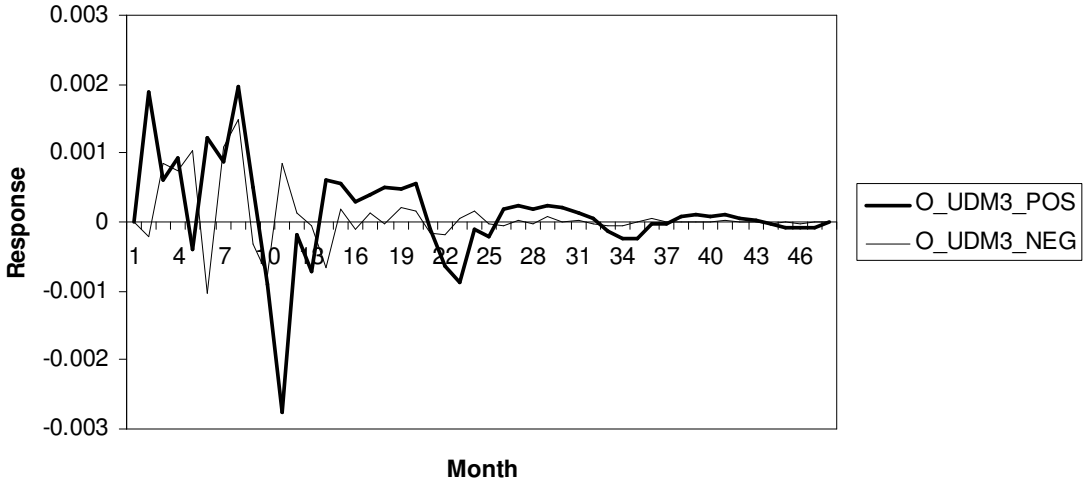


Figure 7: Impulse response of DRFP to positive and negative ordinary monetary shock

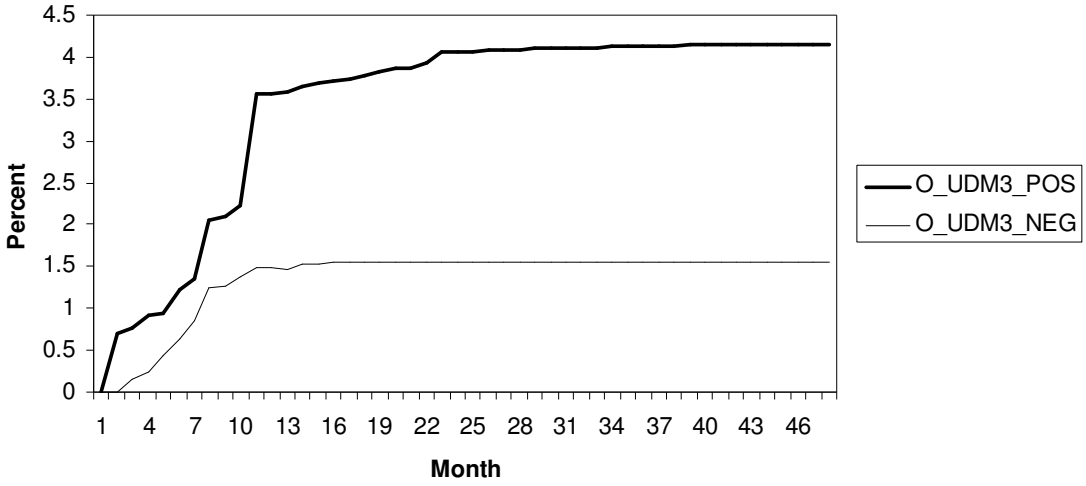


Figure 8: Percent real farm price variance due to positive and negative ordinary monetary shock

**3.3 The Effects of the Recursive Unanticipated Monetary Shocks on Real Farm Prices**

The results of the effects of the recursive unanticipated monetary shocks on real farm prices are presented in Table 3 and Figures 9 to 12. It is interesting to note that unlike the ordinary unanticipated monetary shock, the recursive unanticipated monetary shock had a significant impact on RFP. Although the impact is only significant at the $6^{th}$, $7^{th}$ and $10^{th}$ lags, the F-value shows that all the variables (contemporaneous and lagged) are jointly significant in explaining real farm prices. The positive shock was significant at the $5^{th}$, $7^{th}$ and $10^{th}$ lags. However, the variables were jointly statistically insignificant. The negative shocks were both individually and jointly insignificant. The hypothesis of symmetric effect of the positive and negative monetary shocks could not be rejected. The impulse response functions and variance decomposition graphs confirmed these results. The positive recursive monetary shock contributed about 5.2 percent to the variation in RFP by the $48^{th}$ month while the negative recursive monetary shock contributed about 1.5 percent.

Table 3: Effect of Recursive Unanticipated Monetary Shock on Real Farm Prices

| Variable | Total UM3 Growth | | Positive & Negative UM3 | |
|---|---|---|---|---|
| | Coeff. | P.value | Coeff. | P.value |
| Constant | -0.001 | 0.486 | 0.000 | 0.942 |
| R_UDM3 | -0.066 | 0.479 | - | - |

| | | | | |
|---|---|---|---|---|
| R_UDM3(-1) | 0.125 | 0.181 | - | - |
| R_UDM3(-2) | 0.057 | 0.534 | - | - |
| R_UDM3(-3) | 0.096 | 0.297 | - | - |
| R_UDM3(-4) | 0.034 | 0.708 | - | - |
| R_UDM3(-5) | 0.062 | 0.502 | - | - |
| R_UDM3(-6) | 0.159 | 0.084* | - | - |
| R_UDM3(-7) | 0.294 | 0.002*** | - | - |
| R_UDM3(-8) | 0.083 | 0.370 | - | - |
| R_UDM3(-9) | -0.066 | 0.475 | - | - |
| R_UDM3(-10) | -0.153 | 0.096* | - | - |
| R_UDM3(-11) | -0.028 | 0.761 | - | - |
| R_UDM3(-12) | -0.038 | 0.683 | - | - |
| R_UDM3(-13) | 0.050 | 0.597 | - | - |
| R_UDM3_POS | - | - | -0.072 | 0.675 |
| R_UDM3_POS(-1) | - | - | 0.223 | 0.193 |
| R_UDM3_POS(-2) | - | - | 0.038 | 0.822 |
| R_UDM3_POS(-3) | - | - | 0.089 | 0.599 |
| R_UDM3_POS(-4) | - | - | -0.078 | 0.647 |
| R_UDM3_POS(-5) | - | - | 0.301 | 0.078* |
| R_UDM3_POS(-6) | - | - | 0.106 | 0.535 |
| R_UDM3_POS(-7) | - | - | 0.293 | 0.087* |
| R_UDM3_POS(-8) | - | - | 0.179 | 0.294 |
| R_UDM3_POS(-9) | - | - | -0.090 | 0.598 |
| R_UDM3_POS(-10) | - | - | -0.405 | 0.018** |
| R_UDM3_POS(-11) | - | - | -0.054 | 0.750 |
| R_UDM3_POS(-12) | - | - | -0.158 | 0.358 |
| R_UDM3_POS(-13) | - | - | 0.121 | 0.482 |
| R_UDM3_NEG | - | - | -0.072 | 0.688 |
| R_UDM3_NEG(-1) | - | - | 0.038 | 0.833 |
| R_UDM3_NEG(-2) | - | - | 0.084 | 0.640 |
| R_UDM3_NEG(-3) | - | - | 0.111 | 0.536 |
| R_UDM3_NEG(-4) | - | - | 0.161 | 0.369 |
| R_UDM3_NEG(-5) | - | - | -0.189 | 0.292 |
| R_UDM3_NEG(-6) | - | - | 0.197 | 0.276 |
| R_UDM3_NEG(-7) | - | - | 0.282 | 0.117 |
| R_UDM3_NEG(-8) | - | - | -0.021 | 0.906 |
| R_UDM3_NEG(-9) | - | - | -0.030 | 0.867 |
| R_UDM3_NEG(-10) | - | - | 0.129 | 0.471 |
| R_UDM3_NEG(-11) | - | - | -0.003 | 0.985 |
| R_UDM3_NEG(-12) | - | - | 0.093 | 0.608 |
| R_UDM3_NEG(-13) | - | - | -0.037 | 0.837 |
| F-ratio | 1.562 | 0.086* | 1.105 | 0.327 |
| POS = 0 ; $\chi(14)$ | - | - | | 0.176 |
| SUM (POS) = 0; $\chi(1)$ | - | - | 0.493 | 0.443 |
| NEG = 0; $\chi(14)$ | - | - | | 0.932 |
| SUM (NEG) = 0; $\chi(1)$ | - | - | 0.741 | 0.282 |
| POS = NEG; $\chi(14)$ | - | - | | 0.812 |
| SUM (POS) = SUM(NEG); $\chi(1)$ | - | - | -0.248 | 0.828 |

***, **, * denotes significance at 1 percent, 5 percent and 10 percent respectively

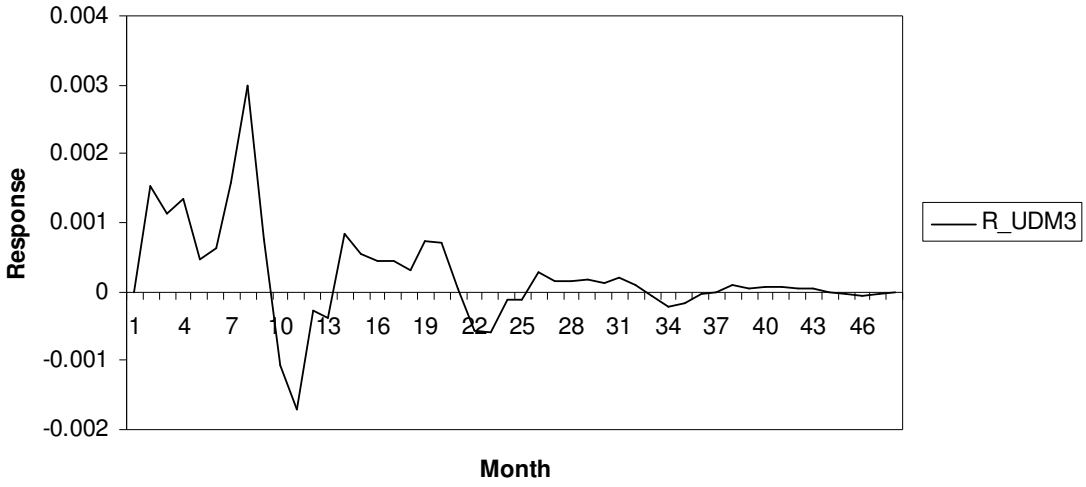


Figure 9: Impulse response of DRFP to a one S.D innovation in recursive monetary shock

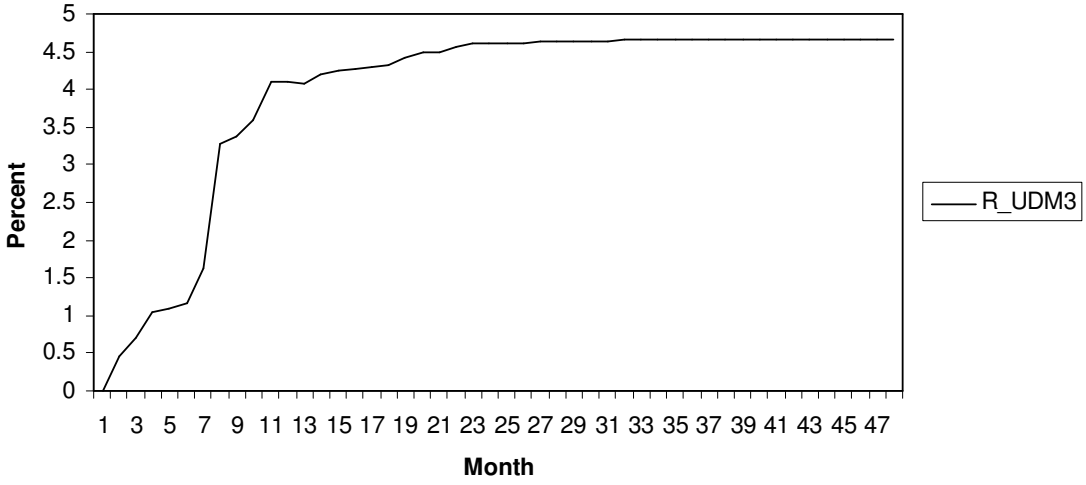


Figure 10: Percent real farm price variance due to recursive monetary shock

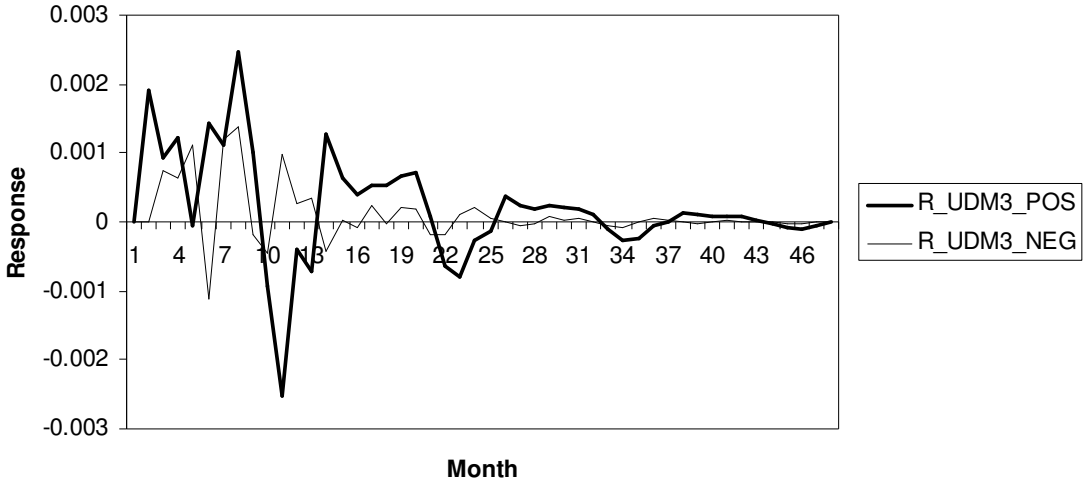


Figure 11: Impulse response of DRFP to positive and negative recursive monetary shock

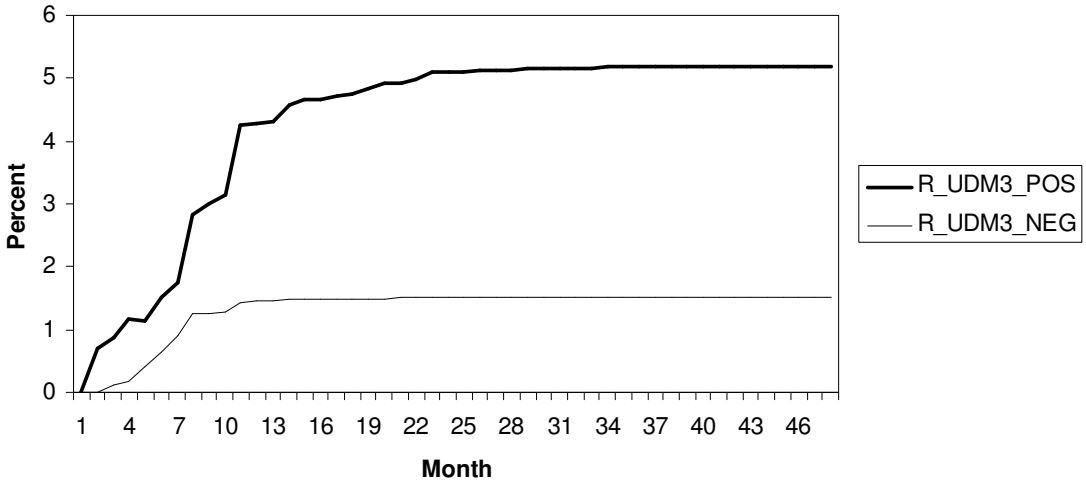


Figure 12: Percent real farm price variance due to positive and negative recursive monetary shock

### 3.4 The Effects of Ordinary Anticipated Monetary Policy on Real Farm Prices

The results for the ordinary anticipated monetary policy is presented in Table 4 and Figures 13 and 14. Ordinary anticipated monetary policy had significant effect on real farm prices at the 1st, 6th and 13th lags. These impacts are also jointly significant as evidenced by the F-ratio. The initial response of real farm price was positive up to the 6th month. However, the effect remained negative from the 7th month up to the 30th month when the effect died out. By the

end of the 48th month, the ordinary anticipated monetary shock could only contribute 5.6 percent to the RFP variation.

Table 4: Effect of Ordinary Anticipated Monetary Shock on Real Farm Prices

| Variable | Total AM3 Growth | |
|---|---|---|
| | Coeff. | P.value |
| Constant | 0.019 | 0.035** |
| O_ADM3 | 0.176 | 0.610 |
| O_ADM3(-1) | 0.573 | 0.098* |
| O_ADM3(-2) | 0.096 | 0.782 |
| O_ADM3(-3) | 0.441 | 0.289 |
| O_ADM3(-4) | -0.120 | 0.773 |
| O_ADM3(-5) | 0.008 | 0.985 |
| O_ADM3(-6) | -1.090 | 0.009*** |
| O_ADM3(-7) | -0.409 | 0.322 |
| O_ADM3(-8) | -0.372 | 0.378 |
| O_ADM3(-9) | 0.459 | 0.272 |
| O_ADM3(-10) | -0.089 | 0.830 |
| O_ADM3(-11) | -0.276 | 0.428 |
| O_ADM3(-12) | -0.448 | 0.199 |
| O_ADM3(-13) | -0.639 | 0.067** |
| F-ratio | 1.692 | 0.054** |

***, **, * denotes significance at 1 percent, 5 percent and 10 percent respectively

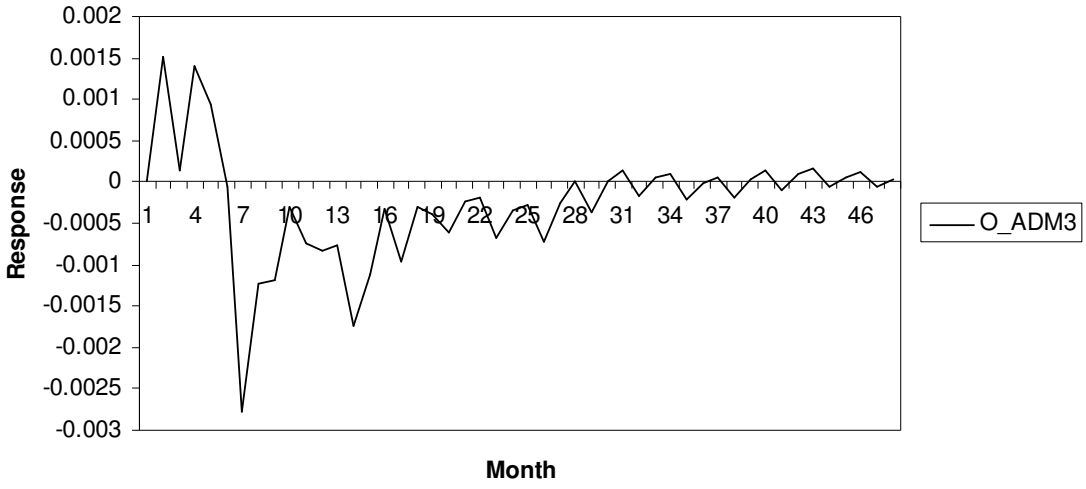


Figure 13: Impulse response of DRFP to a one S.D innovation in ordinary anticipated money

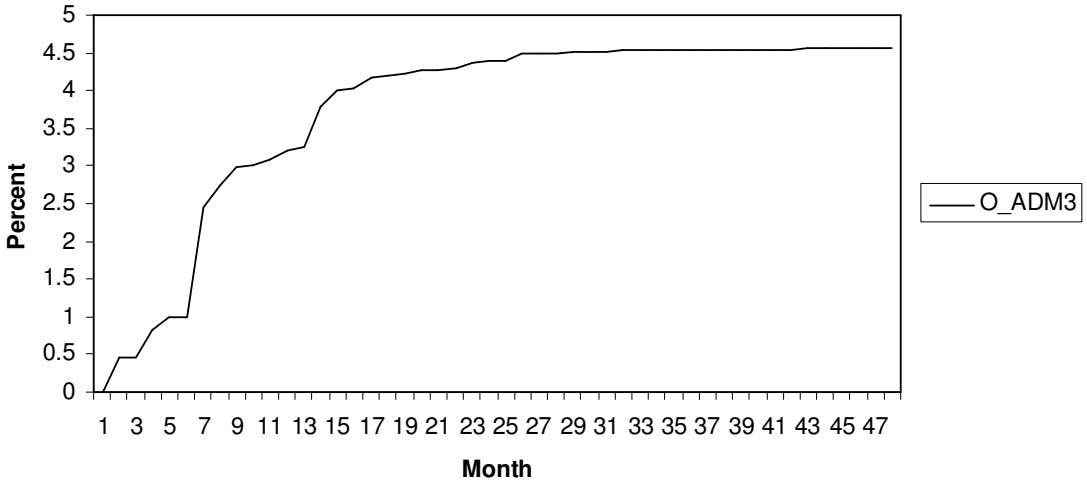


Figure 14: Percent real farm price variance due to ordinary anticipated money supply

**3.5 The Effects of Recursive Anticipated Monetary Policy on Real Farm Prices**

The results as presented in Table 5 shows that the recursive monetary policy had significant impact on RFP at the 1st, 2nd, 6th, 7th and 13th lags. The contemporaneous and lagged variables were also jointly significant. The impulse response function and the variance decomposition graphs are presented in Figures 15 and 16. The initial response of RFP was positive up to the 6th month. From the 7th month, it became negative and remained same most of the periods.. The impact of this shock started dying out after the 26th month. It contributed about 4.8 percent to the variation in RFP.

With respect to the positive and negative recursive anticipated policy, Table 5 shows that the positive component was significant at the 1st, 6th and 13th lags. The negative component was significant at the 2nd, 3rd, 4th, 6th, 7th and 9th lags. The entire hypotheses were rejected. This implies that first, the positive (expansionary) and negative (contractionary) recursive monetary policies have significant effects on real farm prices. Second, the distinction between the positive and negative monetary policies is very important; hence recursive anticipated monetary policy has asymmetric effects. Figures 17 and 18 show the impulse responses and variance decompositions. The initial response of RFP was positive with respect to the positive shock and negative with respect to the negative shock. For the first time, it was observed that the negative monetary policy contributed more to the variation in RFP. Whereas the value is 4.5 percent for the positive shock, it is 6.5 percent for the negative shock.

Table 5: Effect of Recursive Anticipated Monetary Shock on Real Farm Prices

| Variable | Total AM3 Growth | | Positive & Negative AM3 | |
|---|---|---|---|---|
| | Coeff. | P.value | Coeff. | P.value |
| Constant | 0.019 | 0.012*** | 0.015 | 0.074* |
| R_ADM3 | 0.463 | 0.093* | - | - |
| R_ADM3(-1) | 0.496 | 0.073* | - | - |
| R_ADM3(-2) | 0.105 | 0.700 | - | - |
| R_ADM3(-3) | -0.066 | 0.823 | - | - |
| R_ADM3(-4) | -0.128 | 0.663 | - | - |
| R_ADM3(-5) | 0.055 | 0.854 | - | - |
| R_ADM3(-6) | -0.724 | 0.015*** | - | - |
| R_ADM3(-7) | -0.510 | 0.085* | - | - |
| R_ADM3(-8) | -0.698 | 0.018*** | - | - |
| R_ADM3(-9) | 0.100 | 0.725 | - | - |
| R_ADM3(-10) | 0.113 | 0.691 | - | - |
| R_ADM3(-11) | 0.069 | 0.793 | - | - |
| R_ADM3(-12) | -0.217 | 0.413 | - | - |
| R_ADM3(-13) | -0.747 | 0.005*** | - | - |
| R_ADM3_POS | - | - | 0.220 | 0.435 |
| R_ADM3_POS(-1) | - | - | 0.523 | 0.065* |
| R_ADM3_POS(-2) | - | - | 0.326 | 0.245 |
| R_ADM3_POS(-3) | - | - | 0.152 | 0.624 |
| R_ADM3_POS(-4) | - | - | -0.323 | 0.292 |
| R_ADM3_POS(-5) | - | - | -0.113 | 0.716 |
| R_ADM3_POS(-6) | - | - | -0.650 | 0.036** |
| R_ADM3_POS(-7) | - | - | -0.323 | 0.301 |
| R_ADM3_POS(-8) | - | - | -0.438 | 0.163 |
| R_ADM3_POS(-9) | - | - | 0.091 | 0.768 |
| R_ADM3_POS(-10) | - | - | 0.053 | 0.863 |
| R_ADM3_POS(-11) | - | - | -0.101 | 0.719 |
| R_ADM3_POS(-12) | - | - | -0.164 | 0.564 |
| R_ADM3_POS(-13) | - | - | -0.594 | 0.036** |
| R_ADM3_NEG | - | - | -1.200 | 0.757 |
| R_ADM3_NEG(-1) | - | - | -1.047 | 0.788 |
| R_ADM3_NEG(-2) | - | - | -7.600 | 0.012*** |
| R_ADM3_NEG(-3) | - | - | -9.733 | 0.001*** |
| R_ADM3_NEG(-4) | - | - | 7.284 | 0.016** |
| R_ADM3_NEG(-5) | - | - | -0.294 | 0.923 |
| R_ADM3_NEG(-6) | - | - | -5.803 | 0.055* |
| R_ADM3_NEG(-7) | - | - | -5.378 | 0.073* |
| R_ADM3_NEG(-8) | - | - | -3.902 | 0.192 |
| R_ADM3_NEG(-9) | - | - | 5.839 | 0.011*** |
| R_ADM3_NEG(-10) | - | - | -0.677 | 0.769 |
| R_ADM3_NEG(-11) | - | - | 0.193 | 0.933 |
| R_ADM3_NEG(-12) | - | - | -0.440 | 0.880 |

| | | | | |
|---|---|---|---|---|
| R_ADM3_NEG(-13) | - | - | -0.849 | 0.771 |
| F-ratio | 2.303 | 0.005*** | 2.548 | 0.000*** |
| POS = 0 | - | - | | 0.104* |
| SUM(POS) = 0 | - | - | -1.342 | 0.047** |
| NEG = 0 | - | - | | 0.000*** |
| SUM (NEG) = 0 | - | - | -23.605 | 0.023** |
| POS = NEG | - | - | | 0.000*** |
| SUM (POS) = SUM(NEG) | - | - | 22.263 | 0.036** |

***, **, * denotes significance at 1 percent, 5 percent and 10 percent respectively

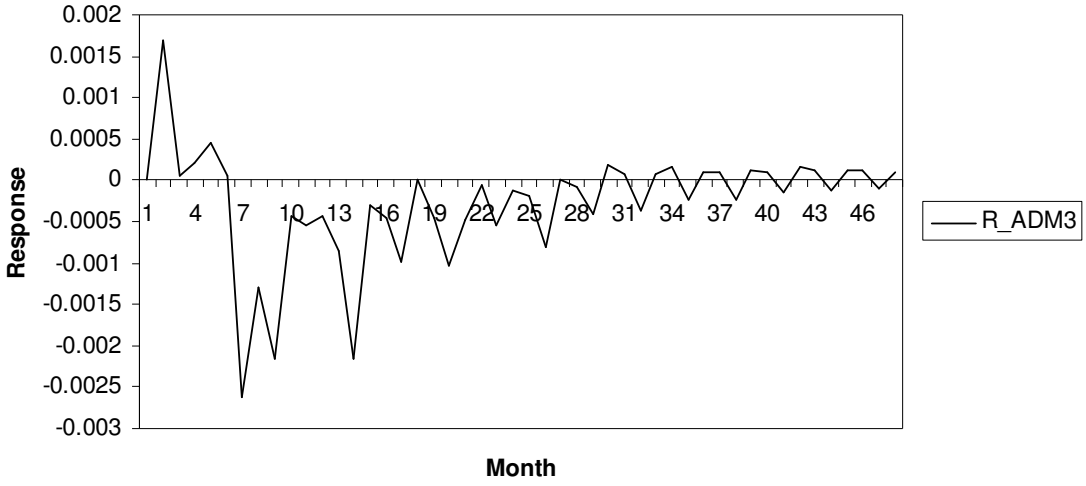


Figure 15: Impulse response of DRFP to a one S.D innovation in recursive anticipated money

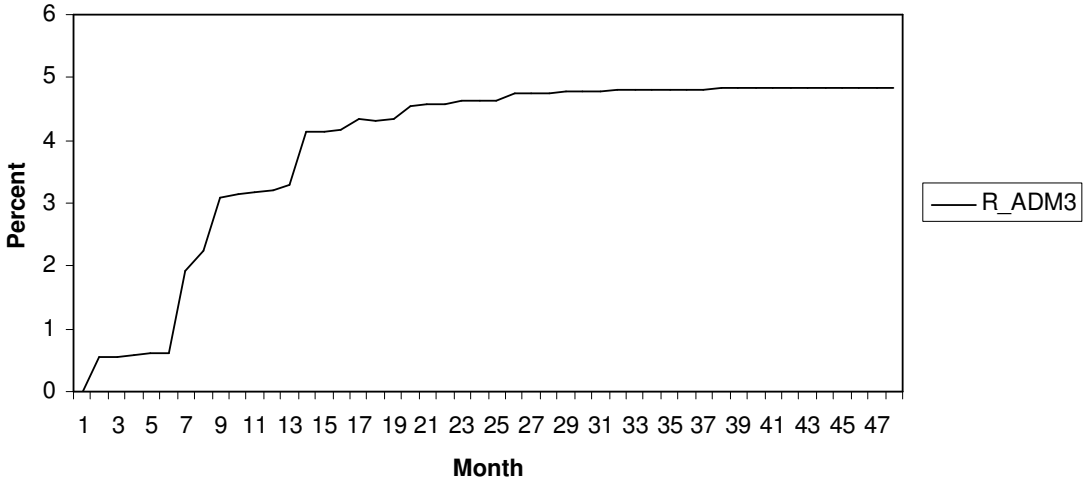

Figure 16: Percent real farm price variance due to recursive anticipated money supply

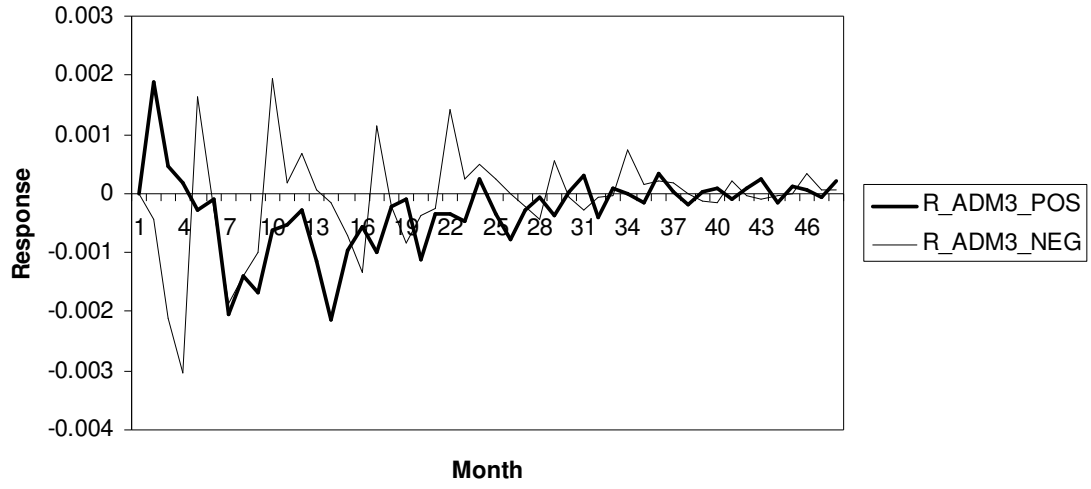


Figure 17: Impulse response of DRFP to positive and negative recursive anticipated money

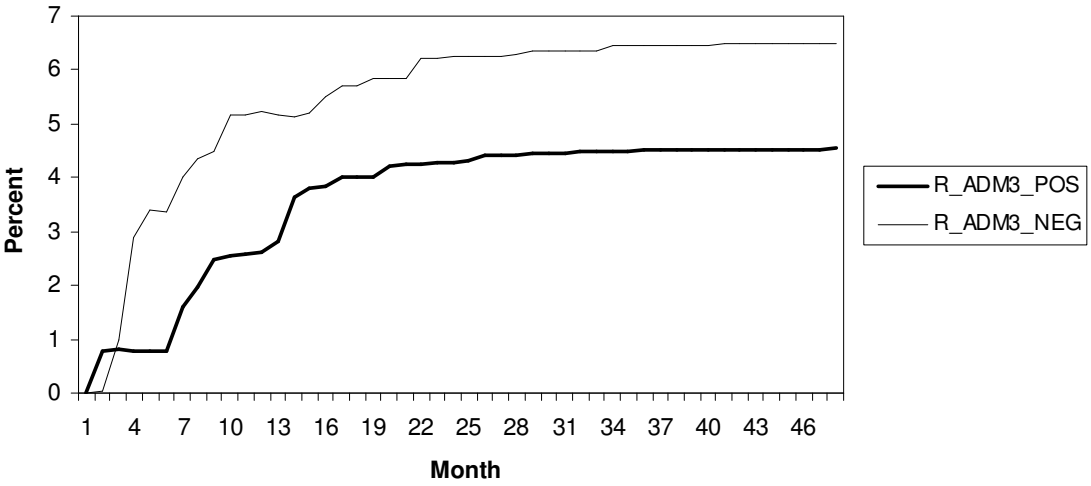


Figure 18: Percent real farm price variance due to positive and negative recursive anticipated money supply

**4. Conclusions**

This study evaluated the effects of monetary policy shocks on real farm prices using the monetary misperception and vector autoregressive models. The actual money supply and its positive component had significant impact on real farm prices. The negative component was

insignificant. The statistical significance of the asymmetric effect between the positive and negative actual money supply growth was not supported. The ordinary unanticipated monetary policy shock and its positive component had significant effect at some lags but jointly the effects were insignificant. Again, the hypothesis of symmetric effect could not be rejected. The recursive unanticipated monetary shock and its positive component had significant effect though the later was jointly insignificant. The negative recursive unanticipated shock was not at all significant with no asymmetric effect. Thus, the outcome of the impact of unanticipated monetary policy shock depends on whether the shock is modelled as ordinary or recursive residuals. When the expected (anticipated) money was used as the monetary policy indicator, all the hypotheses were rejected. First, the anticipated monetary policy (ordinary and recursive, positive and negative) had significant effect on real farm prices. Second, the effect between the positive and negative recursive anticipated policy was asymmetric. These results imply that failure to model differential effects between expansionary and contractionary monetary policy can result in erroneous policy conclusions. This is particularly more important for the anticipated monetary policy. The relatively small effect of monetary policy or shocks on real agricultural prices suggests that there might be other factors which are responsible for the changes in the latter, the investigation of which we leave for future research based on a broader empirical model that would contain variables not only modeling the monetary side, but also the real sector of the economy.

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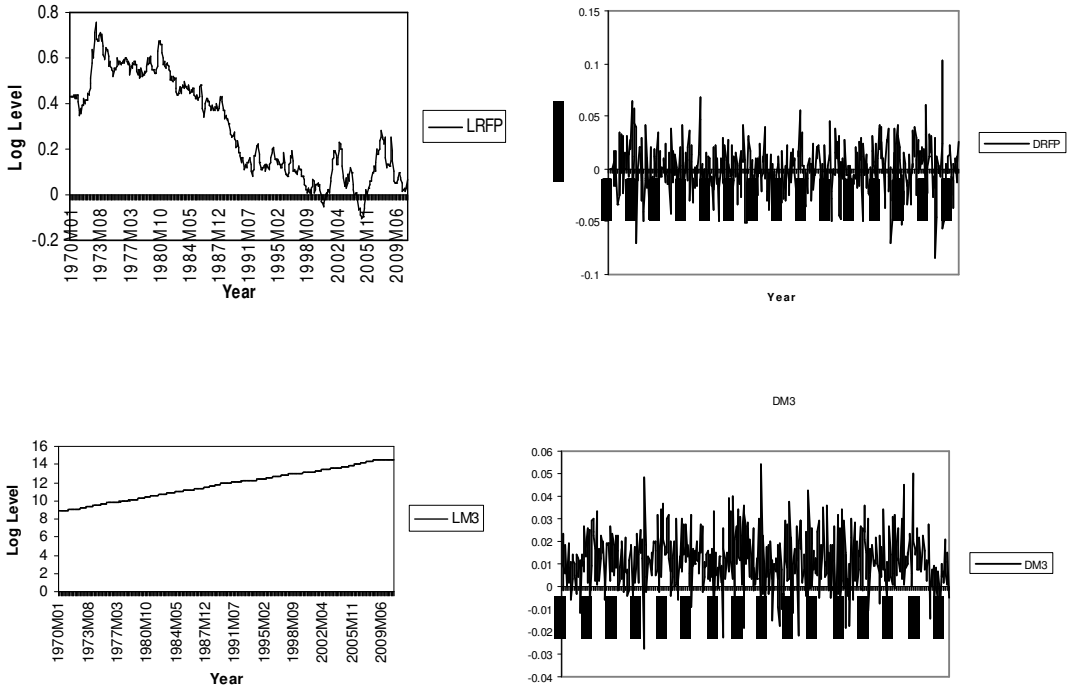
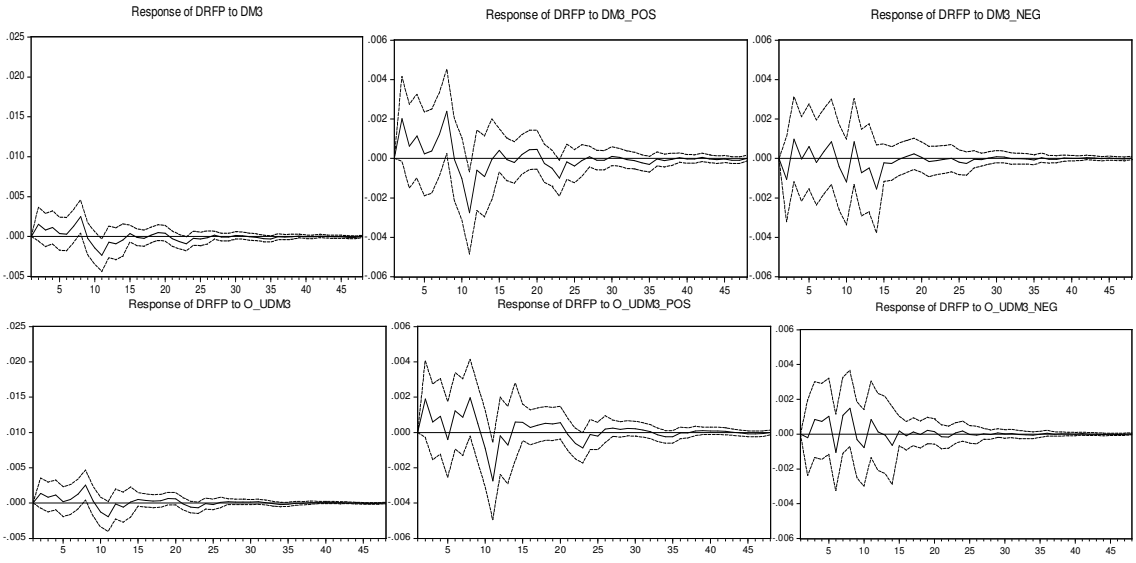
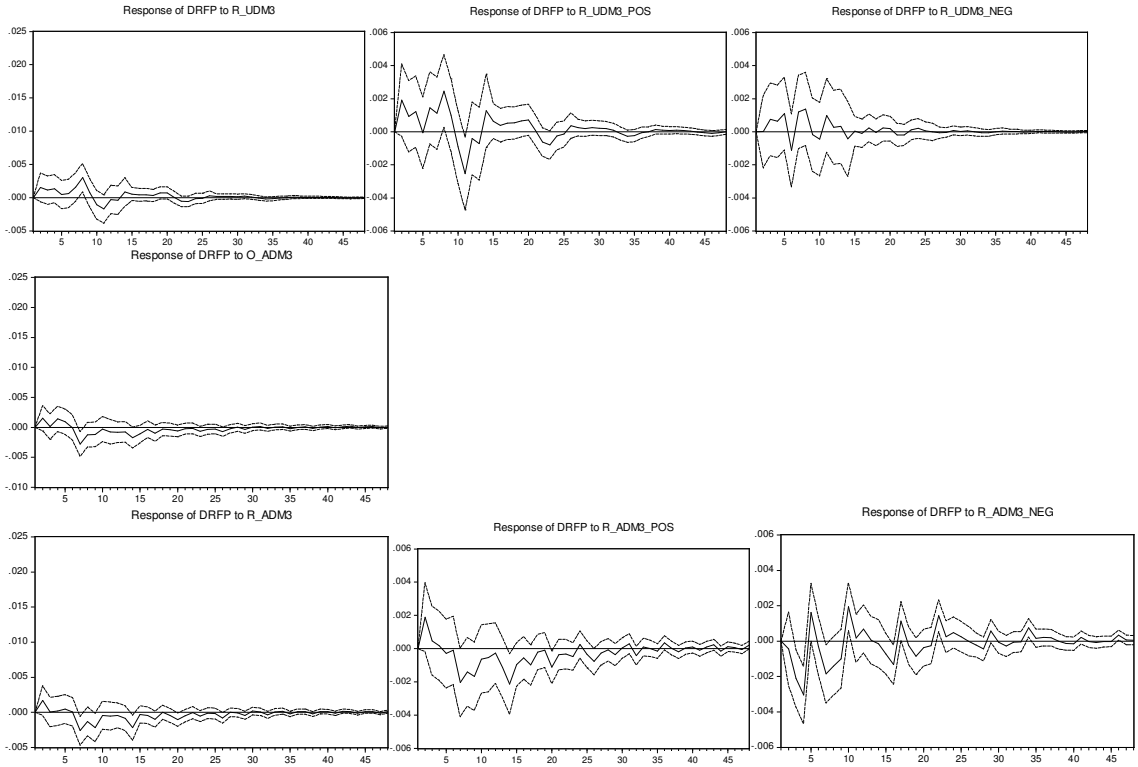
## Appendix 1: The Log Levels and Growth Rates of Real Farm Prices and M3




## Appendix 2: Impulse Response of Real Farm Prices with Two Standard Error Bands




Response of DRFP to R_UDM3
Response of DRFP to R_UDM3_POS
Response of DRFP to R_UDM3_NEG
Response of DRFP to O_ADM3
Response of DRFP to R_ADM3
Response of DRFP to R_ADM3_POS
Response of DRFP to R_ADM3_NEG