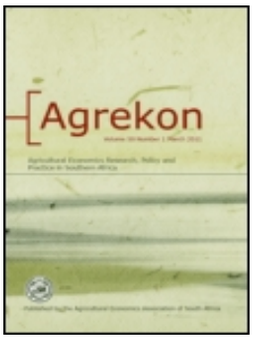

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RECONSIDERING THE ROLE OF FOOD PRICES IN SOUTH AFRICAN HEADLINE INFLATION

L. Rangasamy[1] and E. Nel[2]

ABSTRACT

The conventional wisdom is that food price shocks are temporary and hence do not usually warrant specific attention in policy formulation. However, more recently, empirical evidence has shown that food price shocks are persistent and have a strong bearing on inflation outcomes. This paper shows that this is indeed the case for South Africa. South African food prices are volatile and the price shocks are persistent. Food inflation is an important determinant of underlying inflationary pressures in the South African economy. Thus, policy should give particular attention to food price movements if inflation is to be kept in check.

Keywords: inflation, monetary policy, food policy

JEL CLASSIFICATION

E31, E52, Q18

1 INTRODUCTION

Economic theory suggests that policy should ignore temporary price shocks. The conventional wisdom is that food price shocks are temporary and hence do not usually warrant specific attention in policy formulation. However, more recently, empirical evidence has shown that food price shocks can be persistent and hence it can have a strong bearing on inflation outcomes (Walsh 2011:19). This paper attempts to throw more light on this issue by considering the impact of food price movements on inflation outcomes in South Africa.

This issue is of particular relevance given that international food prices are expected to remain at high levels for the foreseeable future (FAO 2013). In addition, concerns about the likely continued depreciation in the exchange rate of emerging market economies is likely to put additional pressure on food prices in many of these economies.

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The paper is structured as follows: section 2 provides a brief review of the empirical literature and outlines the contribution of this study to the empirical work on South African food inflation. Section 3 highlights the trends in South Africa food inflation while the next section discusses the importance of food price movements for underlying inflationary pressures and inflation outcomes. The last section concludes.

2 A BRIEF REVIEW OF EMPIRICAL LITERATURE

Food is an important component of the consumer's utility function, and hence, food price movements can have important implications for consumer welfare (Catão and Chang 2010). Ignoring food price movements could lead to economic outcomes that do not optimise consumer welfare (Anand and Prasad 2010; Catão and Chang 2010; Wodon and Zaman 2008). In general, food price shocks have a larger impact on the welfare of the poor than the rich since food makes up a larger component of the poor's consumption basket. Recent estimates for South Africa show that the poorest 30 percent of the population spend approximately 44 percent of their income on food with the inflation rates of the commodities consumed by these consumers also being higher than the rate for the food category captured in the aggregate consumer price index (CPI; National Agricultural Marketing Council 2014:5). This, in effect, implies that there is a 'potential negative impact on food affordability from the poor consumers' perspective' (National Agricultural Marketing Council 2013:8).

Historically, international food prices have been volatile but recently those volatilities have increased (Chavas, Hummels and Wright 2013:7). Current indications are that food prices are likely to remain volatile over the next couple of years (FAO 2013). Since food is an essential component of the consumption basket, food price movements have a significant impact on inflation trends. Hence, the recent swings in international food prices have received increased attention in policy and academic circles. In general, the focus has been on the implications of these movements on domestic prices and the appropriate policy responses required to offset the adverse effects of these movements.

There is a large body of empirical evidence that shows that commodity prices have strong and long-lasting effects on inflation outcomes (Pedersen 2011:20–21; Cecchetti 2007; Catão and Chang 2010; Bilke and Stracca 2008; Wodon and Zaman 2008; Cecchetti and Moessner 2008). This is particularly the case for emerging and developing economies where inflation expectations are generally less well anchored and the food component makes up a larger share of the consumption basket (IMF 2011).

Food price movements can affect headline inflation in two ways. First, it contributes *directly* to general or headline consumer price inflation through its

share in the consumption basket. Secondly, food price increases can also affect headline inflation *indirectly* through its impact on non-food inflation. In this case, food prices affect intermediate input prices and inflation expectations which, in turn, feed through to more generalised price increases in the economy. Food inflation that leads to higher inflation expectations could influence price and wage-setting behaviour and hence generate what has come to be known as second-round price effects in the economic literature.

Food price movements can have a bearing on inflation outcomes (Cecchetti and Moessner 2008). Evidence indicates that the explanatory power of food inflation for future headline inflation is much higher than that for energy price inflation in emerging economies (Pedersen 2011). In emerging market economies food price movements make a large direct contribution to headline inflation as a result of its high weight in the consumption basket. In addition, the second round effects of food price shocks are much higher in developing countries (Galesi and Lombardi 2009).

If food price movements have a strong bearing on inflation outcomes, then measures of core inflation which exclude food price movements could give a distorted picture of inflationary pressures in the economy. Walsh (2011) has shown that core inflation measures that eliminate food price movements do indeed present biased estimates of the underlying inflationary pressures in the economy. Biased estimates of inflationary pressures could compromise the quality of monetary policy decisions – an incorrect estimate of inflationary pressures could result in non-optimal monetary policy decisions being made.

There has been limited work on the impact of food price movements on headline inflation in South Africa. In general, the empirical evidence shows that core measures which incorporate food price movements have a higher predictive content for future inflation outcomes than those which exclude food price movements (Blignaut, Farrell, Munyama and Rangasamy 2009; Rangasamy 2009, 2011). Between 2006 and 2008, food price movements accounted for around 40 percent of core inflation in South Africa (Rangasamy 2011:19). This research extends the analysis of food price movements in South Africa in two ways. First, the study spans a longer period (1975 to 2013) than has been the case in previous studies (Rangasamy 2009, 2011). Secondly, the study uses the vector autoregressive (VAR) methodology to analyse the impact of food price movements, which provides a better understanding of the propagation effects of food price movements in South Africa.

3 A BRIEF REVIEW OF SOUTH AFRICAN FOOD INFLATION

Figure 1 depicts the movements in the Food and Agriculture Organisation's (FAO) international food price index and South Africa's food price index, both expressed in terms of Rand[3]. There are two characteristics worth noting in figure 1. First, South Africa's food price increases have in general, tended to exceed international food movements. Secondly, South Africa's food price movements have, in general, been following a consistent upward trend, unlike the case with international food prices which have also declined at times (eg between 2002 and 2005, and 2008 and 2009). Thus, domestic influences have an important bearing on South African food price movements (Rangasamy 2011).

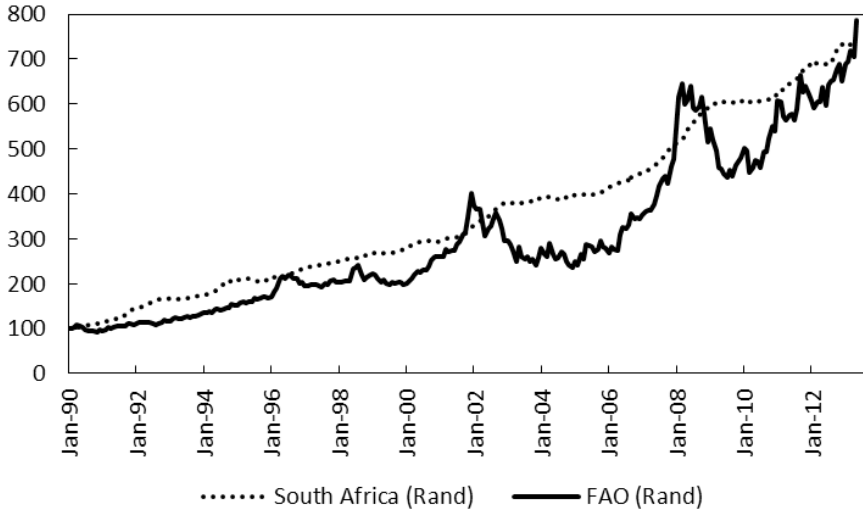

Figure 1: Domestic and international food price movements
Source: StatsSA and FAO

3 The FAO food price index was chosen since it resembles the South African food basket more closely than the International Monetary Fund or World Bank food index.

Figure 2 depicts the trends in food and non-food inflation and provides an indication of how South Africa's food inflation compares to inflation in the rest of the economy[4]. South Africa experienced double-digit inflation rates during the 1980s and the beginning of the 1990s. Both food and non-food inflation declined during the 1990s. Of interest, however, is that with the exception of July 2001, food inflation has consistently exceeded non-food inflation. In addition, while there is a positive correlation between food and non-food price movements, food inflation has been much more volatile than non-food inflation.

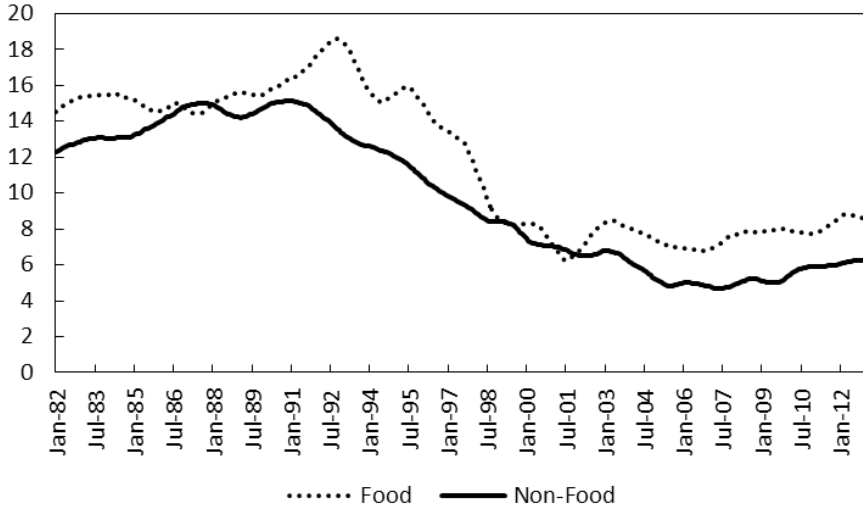

Figure 2: Trends in food and non-food inflation
Source: StatsSA and own calculations

It is important to bear in mind that base effects can have a strong bearing on inflation rates. Figure 3 shows the movements in the price indices of food and non-food. These indices reflect cumulative price effects over time. Food prices moved in line with non-food prices up until the end of the 1980s. Since 1990, food price increases have outpaced non-food price increases. There was an eight-fold increase in food prices as compared to a five-fold increase in non-food prices

4 Inflation is calculated as the year-on-year change in prices as reflected in the consumer price index (CPI). Non-food prices are the sum of all the components of the CPI excluding food prices (see Annex 1 for how the non-food price index is calculated). Although food price data is available from the mid-1970s onwards, the trend is calculated as a six-year moving average of the inflation rates which in effect gives a starting date of 1982.

between 1990 and 2013. Food price increases have also accelerated since 2005 as is evident in the steeping of the slope of the food price index.

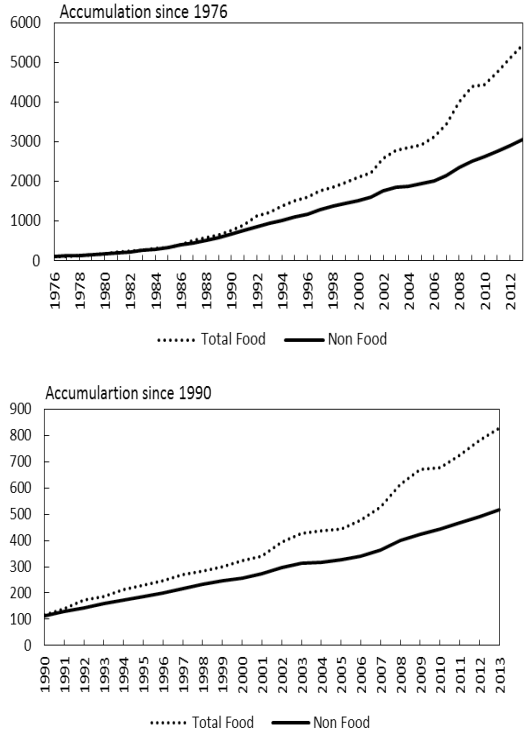

Figure 3: Food and non-food prices
Source: StatsSA and own calculations

Price shocks have a bearing on the inflation process. A shock that is more persistent will have a larger and much longer lasting effect on price increases. For this purposes, we estimate an auto-regressive model where the AR(1) coefficient reflects the level of persistence[5]. In addition to the level of persistence, of interest

5 We estimate the following model, $\pi_t^f = c + \sum_{k=1}^{2} \beta_k \pi_{t-k}^f$. π_t^f is food inflation in period t and is the measure of persistence. General equilibrium modelling can also be used to analyse the impact of price changes on the economy. In this case, the transmission of price shocks on the different sectors can be ascertained. However, given its reliance on input-output tables and social accounting matrices, this approach is not only static in nature, but its accuracy is also dependent on how frequently these tables or matrices are revised.

is whether food price shocks have become more persistent over time. For this purpose, we undertake a recursive estimate based on monthly data[6]. Figure 4 depicts the AR(1) estimates which indicate that the food shocks are not only persistent but have also increased over time[7]. There has been a noticeable increase in the persistence of food price shocks since 1995, implying that shocks to food prices have a large and lasting impact on food inflation.

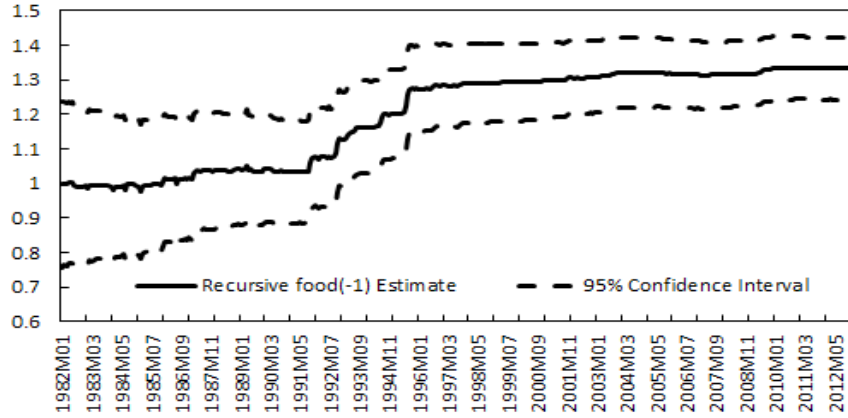

Figure 4: Persistence effect of food price shocks
Source: StatsSA and own calculations

The more volatile food price shocks are relative to non-food shocks, the more noise is added to the signal depicting underlying inflationary pressures in the economy (Walsh 2011:6). Figure 5 depicts the volatility of food and non-food inflation in South Africa. The standard deviation, calculated by using six-year moving averages is used as a measure of volatility. Two important characteristics are evident from these calculations. First, food price volatility is significantly higher than non-food inflation. Secondly, since the mid-2000s food price volatility has increased while non-food price volatility has declined.

6 The first estimate is based on data for six years (ie 1976 to 1982).

7 Six-year rolling window estimations also revealed a similar pattern with the level of persistence increasing from the mid-1990s onwards (results available from authors on request).

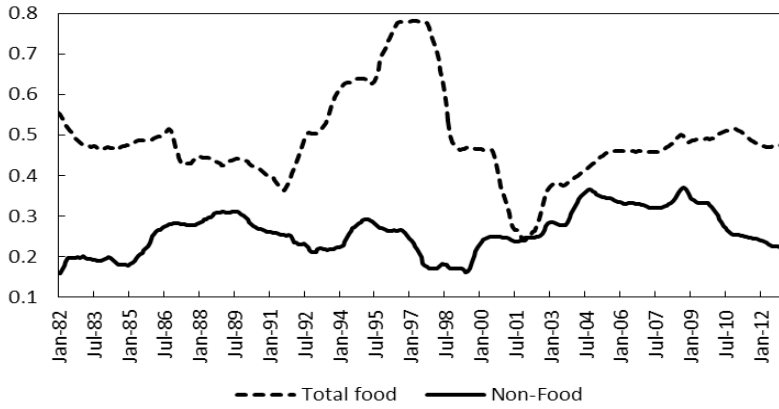

Figure 5: Rolling standard deviation (volatility) of food and non-food inflation
Source: StatsSA and own calculations

This section highlighted three characteristics of South African food inflation. First, food inflation has exceeded non-food inflation in South Africa. Secondly, food price shocks are more persistent and the magnitude of these shocks has increased over time. Finally, food prices have been more volatile than non-food price movements. The implications thereof are explored in the next section.

4 THE IMPORTANCE OF FOOD PRICE MOVEMENTS FOR HEADLINE INFLATION

This section analyses the impact of food price movements on headline inflation. Figure 6 shows the direct contribution of food and non-food inflation to headline inflation. It is evident that non-food products make a larger contribution to headline inflation. This is not surprising given that non-food products account for a larger share of the consumption basket.

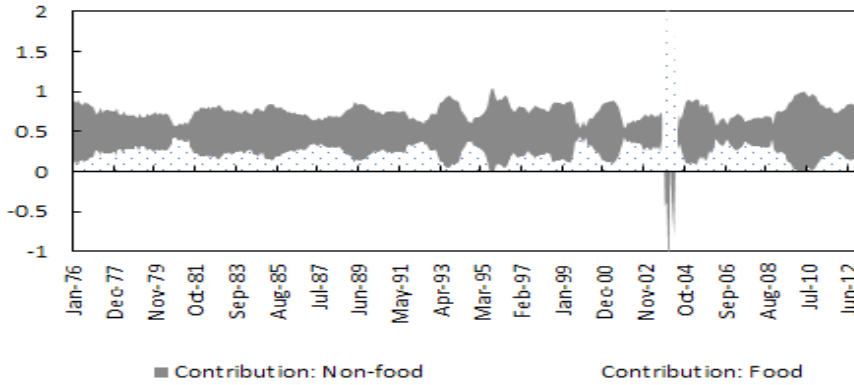

Figure 6: Contribution to headline inflation against weights ratio
Source: StatsSA and own calculations

However, the contribution of food relative to its weight in the consumption basket gives a vastly different picture. For much of the period under analysis, the contribution of food inflation to headline inflation exceeded its weight in the CPI (see figure 7)[8]. Between 1975 and 2013, the contribution of food price movements to headline inflation was, on average, approximately 1.2 times its weight in the CPI basket. More recently, in the post-crisis period, food prices have contributed approximately 1.3 times more than its weight to headline inflation. It is important to bear in mind that this represents the 'direct' contribution of food prices to headline inflation.

8 The spike in 2004 is due to a significant decline in non-food inflation from 10.6 percent in January 2003 to -0.4 percent in April 2004. Headline inflation declined from 11.6 percent to 0.3 percent in May 2004. However, food inflation declined from 15.7 percent to 2.7 percent in the same period.

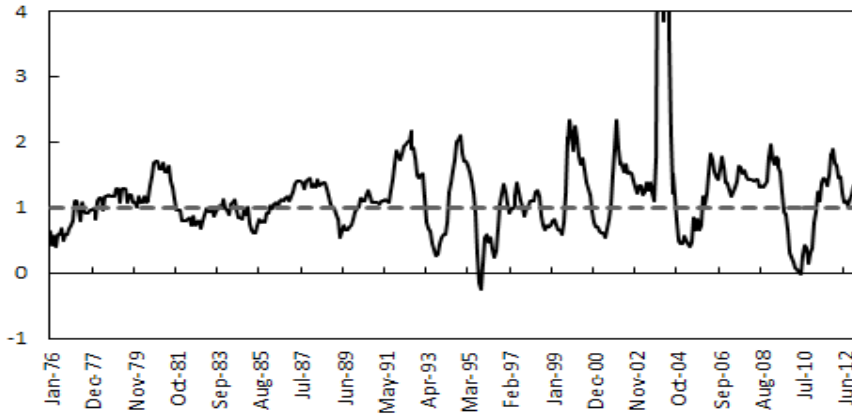

Figure 7: Ratio of contribution to headline inflation relative to weight (food)
Source: StatsSA and own calculations

Food price movements can also have 'indirect' or 'second round' impacts which can also have a bearing on the inflation process. As pointed out earlier, this occurs when food prices are used as an input in the production of other products and/or when food price movements affect inflationary expectations which, in turn, cause a rise in wages and other prices in the economy.

What is the impact of food prices on underlying inflationary pressures in the South African economy? As a start, we evaluate whether there is any causal link between South African food price movements and non-food price movements. The Toda and Yamamoto (1995) Granger causality test is used for this purpose.[9] The results (see table 1) indicate that there is bidirectional causality between food inflation and non-food inflation. In other words, the causal effects run from non-food to food and vice versa. In effect, this implies that keeping food prices in check also requires that policy maintains control over non-food price movements. This provides support to the overall policy objective of maintaining price stability in the economy.

9 This procedure allows for a test for causality when the time-series data is non-stationary.

Table 1: Toda and Yamamoto Granger causality test

Causality from:	Null hypotheses	Probability	Conclusion
Food inflation to non-food inflation	No causality exist	8.86%	Reject hypothesis
Non-food inflation to food inflation	No causality exist	0.57%	Reject hypothesis

Source: StatsSA and own calculations

In order to further investigate the impact of food prices on underlying inflation, we estimate a VAR model which captures the relationship between food, energy and core inflation. The unrestricted VAR model is specified as follows:

$$\pi_t^i = \alpha_i + \sum_{n=1}^{N} \beta_{in}\, \pi_{t-n}^e + \sum_{n=1}^{N} \delta_{in}\, \pi_{t-n}^f + \sum_{n=1}^{N} \gamma_{in}\, \pi_{t-n}^c + \sum_{k=1}^{K} \varphi_{ik} X_k + \sum_{r=1}^{R} \vartheta_{ir} Y_r + \varepsilon_{it}$$

$$\forall\, i = energy, food, core\,; \forall\, t = 1, \dots, T\,;\ \ \varepsilon_t \sim N(0, \Omega)$$

Where, $\pi_t^e, \pi_t^f, \pi_t^c$ represent the inflation rate at time t for energy, food and core respectively[10].

X_k is the dummy variable capturing the change in monetary policy in February 2000[11]

Y_r is the dummy variable depicting the structural break in food inflation[12]

ε_{it} represents the error term for the different equations (i) at time t

α_i represents the constant for the different equations (i)

Ω represents the variance error term

The VAR model allows for the analysis of the joint dynamics of a set of variables, but to analyse the underlying economic relationship of these variables a structural vector autoregressive (SVAR) model is estimated. The ordering of the endogenous variables in the SVAR model is based on the assumption that a shock to a specific variable has a direct or indirect effect on the rest of the CPI basket, from the least to the most endogenous variable in the basket. In our case, the SVAR model is set

10 Core inflation is calculated as headline inflation less food and energy inflation.

11 A dummy variable (X_k = 1 after February 2000) was used to capture the change in monetary policy regime to inflation targeting.

12 The Chow test was used to confirm a structural break in the food inflation from December 1995. A dummy variable, Y_r, was used to control for the structural break in food inflation (Y_r = 1 from December 1995 onwards).

up such that a shock in energy inflation affects all variables in the same period while a shock in food inflation affects itself as well as core inflation and a shock in core inflation is self-contained. A shock to energy prices has a direct and indirect effect on food prices[13]. The results depict how a shock in food prices is carried through to core inflation (ie headline inflation less food and energy inflation).

The shocks need to be orthogonal in order to describe how the specific inflation rates react over time to once-off unanticipated shocks on the system. This study uses a Cholesky decomposition to restrict the effect of the shocks. We confine the contemporaneous effects of the shock, such that the attention is on the propagation effects of energy and food to core inflation. Thus, restricting the relationship between the error terms of the VAR and the subsequent SVAR model can be depicted in matrix form as follows:

$$\begin{bmatrix} 1 & 0 & 0 \\ b_{21} & 1 & 0 \\ b_{31} & b_{32} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{et} \\ \varepsilon_{ft} \\ \varepsilon_{ct} \end{bmatrix} = \begin{bmatrix} \epsilon_{et} \\ \epsilon_{ft} \\ \epsilon_{ct} \end{bmatrix}$$

where, b_{ij} represents the coefficients and ϵ_{it} the error structure of the SVAR model.

The impulse response functions capture the impact of a shock to food and energy on core inflation. The impulse response analysis is modelled with 95 percent Monte Carlo bootstrap confidence intervals[14]. All the data has been sourced from Statistics South Africa (StatsSA). The data used in the estimations are of monthly frequency for the period January 1976 to May 2013. Energy inflation captures the year-on-year change in the fuel and power category of the CPI[15]. Similarly, food inflation measures the year-on-year change in the food category of the CPI. Core inflation represents headline inflation less food and energy inflation[16].

13 This is a highly plausible assumption since energy is an input in food production. In addition, energy prices also have a bearing on disposal income which, in turn, can influence the demand and price of food products.

14 Twenty thousand bootstrap replications were used.

15 These commodities form part of administered prices. An administered price of a product is determined or influenced by government either directly or indirectly through a government agency or institution without influence of market forces. This category makes up 18.48 percent of the CPI. Administered prices that are directly regulated by government make up 13.70 percent of the CPI and includes products and services such as water, electricity, paraffin, petrol, telephone fees, postage and cell call charges.

16 The core inflation index is given by $\rho_t^c = \frac{\rho_t^h - \rho_t^f . \omega_t^f - \rho_t^e . \omega_t^e}{\omega_t^c}$; where, $\rho_t^h, \rho_t^e, \rho_t^f, \rho_t^c$ represent the price index of headline, energy, food and core respectively for time t. $\omega_t^e, \omega_t^f, \omega_t^c$ represent the weights of energy, food and core inflation respectively for time t and $\omega_t^c = 1 - \omega_t^e, -\omega_t^f$.

The Akaike Information Criterion (AIC) was used to choose the appropriate lag length[17]. Diagnostic tests confirmed the stability of the model (the inverse roots of AR characteristic polynomials are within the unit root circle – see annex).

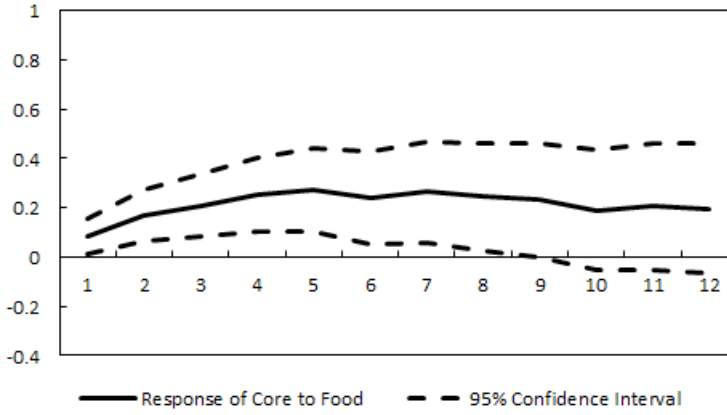

Figure 8: Model 1 – Response of core to a once-off shock in food prices
Source: StatsSA and own calculations

Figure 8 shows that a once-off shock to food prices has a significant effect on core inflation. The magnitude of the pass-through effect of the shock reaches a maximum after five months. The price effects are quite persistent, lasting for approximately nine months with the effects dying down quite slowly.

There are different schools of thought about the importance and relevance of stationary data for VAR models.[18] In order to render the data stationary we undertook a gap analysis by considering the year on year change in the inflation rates in the estimation of equation 1. Figure 9 reflects the impulse response function for a food price shock of the gap analysis. The results are similar to the first model, showing a large response of a twelve month difference in core inflation to a once off shock to the twelve month difference in food prices. Of interest is that

17 The AIC suggested a lag length of 14 which was also supported by the likelihood-ratio (LR) and the final prediction error (FPE).

18 The empirical literature deals with this issue of stationarity by detrending the data (Jacobs, Kuper and Sterken 2003:7). However, Sims et al (1990:136) argue that transforming the data results in a loss of information content. Then there is the issue of the ability of unit root tests to accurately test for stationarity (Gattini et al 2012:15).

the shock is once again persistent lasting for approximately nine months as was the case in the model 1.

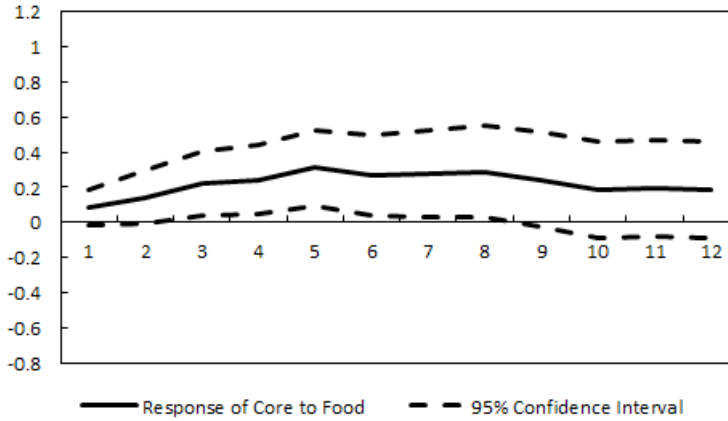

Figure 9: Model 2 (Gap model) - Response of core to a once off shock in food prices
Source: StatsSA and own calculations

The results for the impulse response for both models suggest that food inflation matters. A once off shock to domestic food prices has a significant and persistent effect on core inflation. Stated differently, food inflation has a strong influence on underlying inflationary pressures in the economy. On the other hand, the results indicate that while energy price movements matter for core inflation, these impacts are short-lived (see annex for the full set of impulse responses)[19].

Thus, food prices movements matter for inflation outcomes in South Africa for two reasons. First, the direct contribution of food prices to headline inflation has exceeded its weight in the CPI. Secondly, food price movements have an important bearing on underlying inflationary pressures in the South African economy.

If food inflation impacts headline inflation in the long run, but is not included in the core measure of inflation it would lead to core inflation systematically underestimating headline inflation (Cecchetti 2007). Excluding food inflation from non-food inflation is only justified if the long-run mean of food inflation is equal to the long-run mean of non-food inflation. To test this assumption, a test for equality of means between food and non-food was undertaken (see table 2).

19 The effects of energy on core inflation in both models are positive, but are short lived. The price effects last for three months with the maximum effect occurring after one month.

The test results show that the hypothesis of equality of means in food prices and non-food prices is rejected. This implies excluding food prices from core inflation measures would result in biased estimates of underlying inflationary pressures in the South African economy.

Table 2: Equality of means test for food and non-food inflation

Method	Value	Probability
t-test	4.634 724	0
Satterthwaite-Welch t-test*	4.634 724	0
Anova F-test	21.480 67	0
Welch F-test*	21.480 67	0

Source: StatsSA and own calculations

Another way of ascertaining the importance of food price movements is to consider the predictive content of past food price movements on headline inflation. Following Cecchetti and Moessner (2008) we estimated the following model to ascertain whether past food price movements have a bearing on current headline inflation:

$$\pi_t^h = c + \sum_{i=1}^{12} \alpha_i \pi_{t-i}^h + \sum_{k=1}^{12} \beta_k \pi_{t-k}^f \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, π_t^h and π_t^f represent the aggregate inflation rate and food inflation in period t respectively.

Equation 1 corrects for autocorrelation in the residuals and the primary variable of concern is the β coefficient. More specifically, if the sum of the β coefficients $(\sum_{k=1}^{12} \beta_k)$ is significantly different from zero, then past food price movements assist in predicting headline inflation. The Wald test (see table 3) shows that the hypothesis of past food inflation having no predictive content can be rejected. In other words, current headline inflation is influenced by past food inflation.

Table 3: Wald test

Null hypothesis	Probability	Conclusion
	0.01	Reject null hypothesis

Source: StatsSA and own calculations

5 SOME POLICY IMPLICATIONS AND CONCLUSION

This paper has shown that South African food price movements are not temporary. In addition, food prices are volatile and price shocks are persistent. Food prices have significant *direct* impacts on headline inflation – the contribution of food prices to headline inflation has tended to exceed its weight in the CPI basket. In addition, food inflation has exceeded non-food inflation for much of the period over the last three and a half decades in South Africa. The results in this paper also show that food price movements have significant *indirect* effects on headline inflation. Thus, food inflation exerts a significant influence on underlying inflationary pressures in the economy. The maintenance of price stability is the cornerstone of South Africa's monetary policy mandate[20]. The results in this paper show that keeping food price movements in check is vital to maintaining overall price stability in the South African economy. So on the monetary policy front, it is imperative that close attention is paid to food price movements. Ignoring food price movements would give a distorted picture of underlying inflationary pressures which, in turn, could result in inappropriate monetary policy measures being implemented.

Appropriate policy responses require giving attention to many key areas. Economic policy needs to address binding constraints confronting domestic agricultural production in South Africa. A comprehensive analysis of this issue is beyond the scope of this paper. However, infrastructure development, increasing competition, a stable regulatory environment and increasing access to financing can promote agricultural productivity in South Africa. Further research that details the priority areas and actual desired policy interventions to secure the most efficient outcomes for South Africa's agricultural sector needs to be undertaken.

In short, food price movements matter and have exerted their influence on the overall cost of living conditions in South Africa. Rising food prices can have severe social implications for the poor. The importance of this issue should not be underestimated as was borne out in the food price-related riots in 2008 and 2011 in African and Middle-Eastern countries. Food price movements should be firmly entrenched in the radar screens of South African policymakers. The monitoring and publication of South African food price movements by the National Agricultural Marketing Council is a valuable first step in this direction[21].

20 South Africa's monetary policy is conducted within an inflation-targeting framework. This entails the maintenance of price stability, which is keeping headline inflation within a target band of 3 to 6 percent. More recently, the mandate of the South African Reserve Bank has been broadened to entail the maintenance of financial stability of which price stability is an important component.

21 The quarterly *Food Price Monitor* is available at http://www.namc.co.za/pages/published-reports/food-price-monitoring.

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ANNEX 1 CALCULATION OF NON-FOOD PRICE INDEX

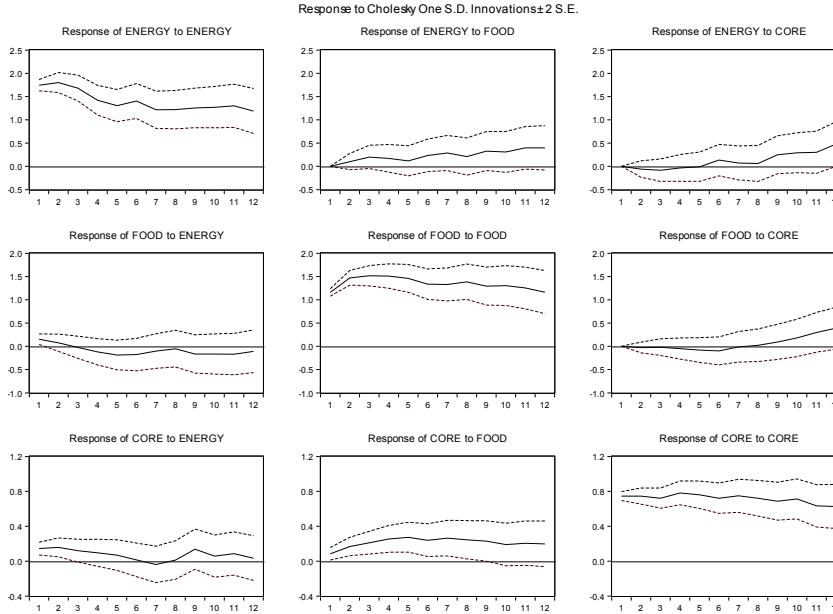
Given $\pi_t^h = \pi_t^f * \omega_t^f + \pi_t^{nf} * \omega_t^{nf}$

$$\pi_t^{nf} = \frac{\pi_t^h - \pi_t^f * \omega_t^f}{\omega_t^{nf}}$$

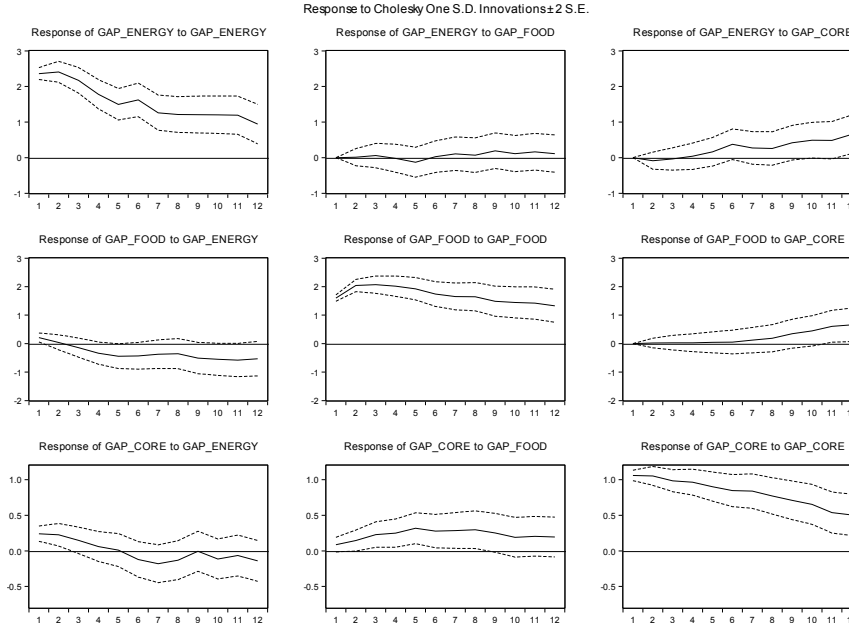
Where, $\pi_t^h, \pi_t^f, \pi_t^{nf}$ represent the headline inflation rate, food inflation rate and non-food inflation rate at time t.w_t^f and w_t^{nf} represent the weight of food and non-food products in the CPI.

ANNEX 2: IMPULSE RESPONSE FUNCTIONS

Model 1

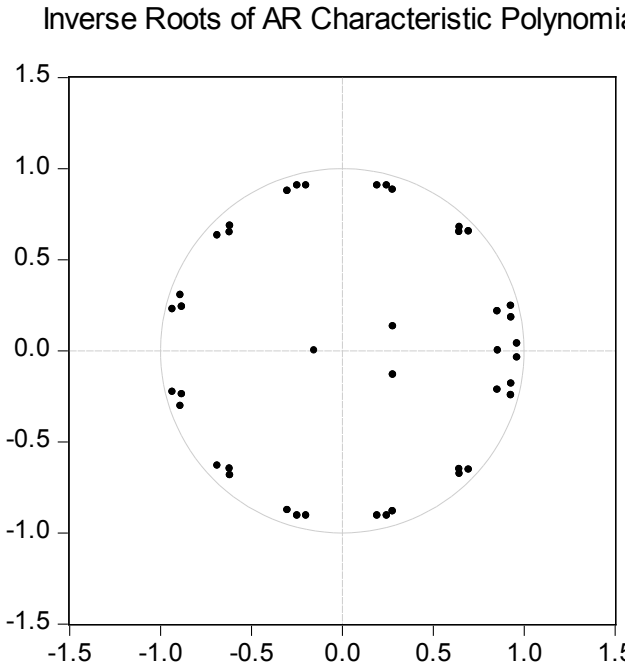


Model 2

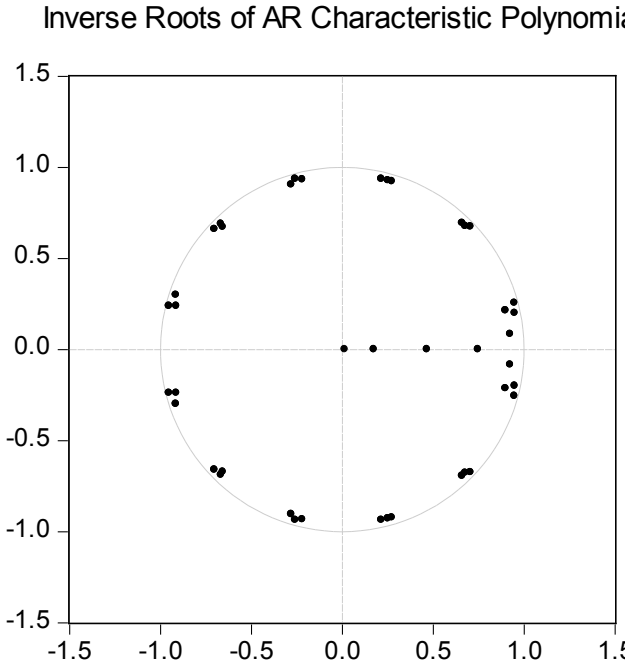

Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of GAP_ENERGY to GAP_ENERGY
Response of GAP_ENERGY to GAP_FOOD
Response of GAP_ENERGY to GAP_CORE
Response of GAP_FOOD to GAP_ENERGY
Response of GAP_FOOD to GAP_FOOD
Response of GAP_FOOD to GAP_CORE
Response of GAP_CORE to GAP_ENERGY
Response of GAP_CORE to GAP_FOOD
Response of GAP_CORE to GAP_CORE

ANNEX 2: STRUCTURAL VECTOR AUTOREGRESSIVE DIAGNOSTICS

Model 1



Model 2


Inverse Roots of AR Characteristic Polynomial
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5