Monetary Policy Shocks, Agricultural Growth, and Food Inflation in Developing Agrarian Economies: Misled Central Banks?

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ABSTRACT
Implementation of tight monetary policy by central banks is theoretically expected to cool down the economy through subdued output and demand, hence inflation. This paper assesses the response of agriculture sector growth and food inflation to increased policy rate in Malawi, a typical low-income agrarian economy. We use the Bayesian Structural Vector Auto-regressive (B-SVAR) model on data from 1986 to 2023 to analyze the response of agriculture sector growth and food and overall inflation to positive monetary policy shock (increased policy rate by the central bank). Our results reveal a rather interesting picture where tight monetary policy reduces the growth of the sector and fuels both food and overall inflation. In essence, the implementation of unconventional monetary policy by reducing policy rate can actually spur growth of the agriculture sector which would translate into an increased supply of food on the market and controlled food and overall inflation in developing agrarian economies where the agriculture sector is the main contributor to Gross Domestic Product and overall inflation is largely driven by food prices.

KEYWORDS
Monetary policy; Agriculture; Inflation; Bayesian Structural VAR

1. Introduction

Agricultural growth and food prices are widely recognized in the literature as crucial for developing countries, where agriculture significantly contributes to economic growth and food inflation heavily influences overall inflation. Various studies have focused on establishing factors that determine the growth of the agriculture sector (see for example Habanabakize and Dickason-Koekemoer (2024), Hemming et al. (2018), Liliane and Mutengwa (2020), Vibeke Bjornlund and Rooyen (2020)) and determinants of food inflation (see for example Emre, Niko, and Ali (2016) and Kuma and Gata (2023)). The role of the central banks, being the authorities responsible for monetary policy implementation, has also been the spotlight considering the critical role that the banks play in determining the cost of borrowing (capital) for investing in agriculture sector and controlling inflation (Muroyiwa et al. (2014) and Ginn and Pourroy (2020).

Theoretically, central banks use monetary policy tools, such as the policy rate, to control inflation through various channels including the credit and interest rate[1] but

[1]Under the Interest Rate channel, expansionary monetary policy (e.g. reduced policy rate) lowers the cost of borrowing for economic agents (firms and households) through reduced commercial banks interest rates as now the banks can also borrow from the central bank at a lower rate ((Oyadeyi 2023)). This in turn induces increased

the effects extend to influencing the growth of various sectors, including agriculture. In this study we investigate the effect of central bank's monetary policy on agriculture growth and food prices in a developing and predominantly agrarian economy characterised by low financial inclusion[2] Interestingly, we find that the use of tight monetary policy does not only reduce agriculture sector output but, against the expectations, also further pushes up food inflation, signifying how a reversed (nonconventional) monetary policy implementation can actually be beneficial for agriculture dependent developing countries.

We conduct our analysis in the context of Malawi, a least developed country in south east Africa. Just like many other developing countries, agriculture remains the backbone of Malawi's economy and the situation is very likely to remain so as the current main policy agenda (Malawi 2063) has highlighted "Agricultural Productivity and Commercialization" as the first pillar among the three pillars and seven enablers (GoM 2020). The sector has also historically been identified as key to economic growth and development by the country through various other policies including the Poverty Reduction Strategy, Malawi 2020 Vision, and the three series of the Malawi Growth and Development Strategies that operationalized the Vision 2020 [3]. It is therefore not surprising that the sector has remained the main contributor to the annual Gross Domestic Product (GDP), contributing an annual average of more than 20% (see, for example, (GoM 2023a). Of course, this has been the trend in many other developing countries, and the sector has been highlighted as the key to economic growth and development in several studies (see, for example, Loizou et al. (2019), Khan, Jamshed, and Fatima (2019), Sadoulet and Janvry (2020) and Etuk and Ayuk (2021).

Over time, Malawi has experienced slow growth and development and this is also reflected in the growth of the various important sectors including agriculture. The agriculture sector growth has averaged way below the 6% commitment as per the Comprehensive African Agriculture Development Programme (CAADP) Framework ((AU 2014)). The slow growth in the sector is partly, if not largely, a factor of the lack of significant investments in the sector (Muyanga et al. (2020) and Matchaya, Nhlengethwa, and Chilonda (2014)). The majority of farmers continue to use no, and sometimes, low-scale technologies in their farming ((Verhorst et al. 2020)). Despite some strides, government investment in the sector has also remained lower than desired, for example, through the first Medium-Term Implementation Plan (MIP-1), government planned to invest hugely and facilitate the establishment of at least one megafarm in each district by 2025 but the same is yet to materialize ((GoM 2021)). This is regardless of the fact that, and as noted by Chafuwa (2017), key investments

borrowing for investment and consumption, and hence economic activities, but lowers savings. Contractionary monetary policy leads to the reverse outcome on investment, consumption, and saving. On the other hand, the Credit channel focuses much on the availability (supply) of credit and credit worthiness of the borrowers. Based on this channel, expansionary monetary policy increases funds available for lending by the commercial banks (bank lending channel) and improves the creditworthness of borrowers through decreased interest and increased asset prices (balance sheet channel) ((Nguyen and Dinh 2022)). The increased funds availability and improved creditworthness of borrowers incudes investment and economic activities. Just like under the interest rate channel, a contractionary monetary policy yields reversed effects on investment and economic activities.

[2]Implementation of an effective monetary policy depends on the state of financial inclusion in the economy (Oanh, Van, and Dinh 2023). Many developing countries remain less financially included and access to formal financial services remains a challenge.

[3]The poverty reduction strategy paper can be found here, The Vision 2020 document can be found here, The MGDS III can be found here

in agriculture require government intervention due to the huge initial costs associated with the investments.

At the centre of investment which translates into growth of almost each and every sector is the cost of funds known as the interest rate. The cost of borrowing has not been favourable either. Between 2000 and 2023, the lending rate averaged 35.5% and the minimum was 23.8% in 2011. These lending rates are a product of the policy rate set by the Central Bank (Reserve Bank of Malawi (RBM)) and the Bank has consistently adjusted the policy rate upwards to combat inflation (see Monetary Policy Committee reports e.g. RBM (2024). Due to the increased policy rate, the cost of borrowing has remained high in Malawi.

The slow growth and low productivity of agriculture including heavy dependence on rainfed farming has had a very significant effect on inflation. Between 2000 and 2023 headline inflation averaged 15.6% and recently the rate has been on a worrisome trajectory with the Central Bank projecting a 33.5% by December 2024 (RBM 2024). In Malawi, overall inflation is a factor of food and non-food inflation and the former has been the main driver of overall inflation with headline inflation following the seasonality of food inflation (Wu 2017). The central bank which implements the monetary policy recently stated that it has limited control over food inflation which leaves the overhead inflation (their main target) vulnerable to volatilities and uncertainties [4]. Besides, it is a known fact that the mandate of the bank does not exclude food inflation. Considering the strong connection between monetary policy, agriculture sector growth, and inflation, this study sought to analyze the direct role of the Central Bank through monetary policy implementation in the agriculture sector. Related studies that have been conducted on monetary policy in Malawi include Ngalawa (2024), Simwaka et al. (2012), Chavula (2016), and Mangani (2011). The departure of our paper is that we consider the direct (explicit) nexus between monetary policy, agriculture sector growth, and inflation. We do this on two basis; 1) food inflation has been on the rise and is a significant contributor to headline inflation, the Central Bank has been tightening the monetary policy, the agriculture sector has consistently experienced erratic growth; and 2) previous studies (including Ngalawa (2024) only implicitly considered agriculture sector growth through overall economic growth.

2. Policy context

The development of Malawi's agricultural sector has been a longstanding government priority since the colonial era, with agriculture recognized as a cornerstone of economic growth[5]. Over time, Malawi's main agricultural sector growth and development policy priorities have shifted between promoting estate-led agriculture mainly to drive export revenues, and supporting smallholder farming with an eye of ensuring national food security. While tobacco, cotton, tea, and sugarcane constitute the main cash crops for export, maize dominates as the main staple crop, followed by cassava, and beans (Kherallah and Govindan 1997).

Until the late 1980s, the government primarily used direct price controls to influence agricultural commodity prices, especially for smallholder farmers, through marketing

[4]Read the article here

[5]Malawi, then called Nyasaland, was colonized by the British government from 1891 to 1964(McCracken 2012)

boards (Green 2009, 1986). This regulation indirectly influenced labor and land allocation between estate and smallholder farming, thus influencing cash crop and food crop outputs. For instance, low prices for smallholder cash crops discouraged farmers from shifting land and labor resources towards these crops, maintaining a supply of affordable labor for estates and supporting food crop production (Ng'ong'ola 1986). The role of marketing boards in enforcing these regulatory measures became more prominent with the creation of the Agricultural Development and Marketing Corporation (ADMARC) in 1971. ADMARC, played a central role in stabilizing prices, managing market access, overseeing grain reserves, and supporting both estate and smallholder sectors in line with government priorities (Christiansen and Stackhouse 1989; Tomlinson et al. 1989).

Following the implementation of structural adjustment programs in Malawi between 1981 and 1994, ADMARC's role was redefined as the "buyer and seller of last resort", mandated to intervene and stabilize market prices and protect both producers and consumers using government pre-set minimum and maximum prices (Christiansen and Stackhouse 1989)[6]. This shift paralleled an expanded role for the RBM, which, after adopting the Reserve Bank of Malawi Act of 1989, moved from a monetary policy characterised by fixed interest and exchange rates to a focus on price stability, economic growth, and employment through interest rate adjustments and money supply controls (Chirwa 1999; Ngalawa and Viegi 2011). Since then, controlling overall inflation, which is largely driven by food inflation, remains central to the RBM's mandate for price stability and economic growth (Ngalawa and Viegi 2011).

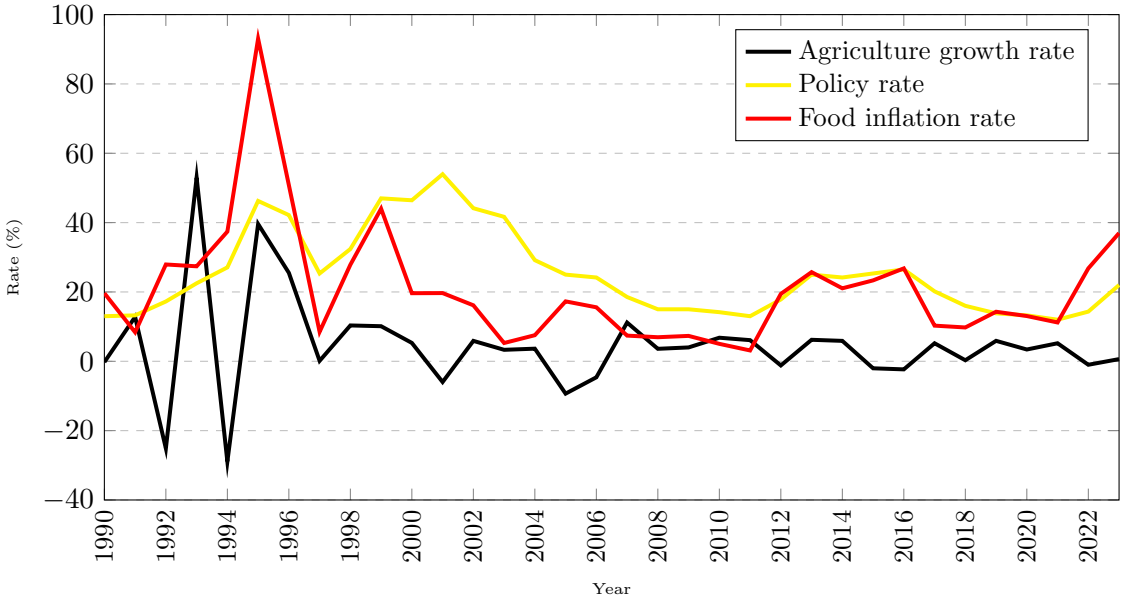
Between 1990 and 2023, the Malawi government implemented several initiatives to boost agricultural productivity and output. However, most of the initiatives leaned towards achieving food security in the country. For instance, in 1995, the government repealed the Special Crops Act, which had restricted smallholder farmers from growing high-value cash crops like tobacco and cotton, with the intention of expanding their income potential to enable them purchase food and diversifying agricultural production (Cammack 2004). In 1999, the government collaborated with Sasakawa Global 2000 to introduce a nationwide food crop intensification project. The initiative provided smallholders with starter packs, including maize, legumes, and fertilizers, which contributed to a 32% increase in maize output by the end of the year (Knorr, Gerster-Bentaya, and Hoffmann 2007). Another critical policy was the launch of the Farm Input Subsidy Programme (FISP) in 2005 to address recurrent food shortages and declining maize production. Targeting resource-poor smallholder farmers, FISP aimed to improve access to subsidized seeds and fertilizers, boosting productivity and therefore stabilizing food supply(Arndt, Pauw, and Thurlow 2016; Chibwana 2014).

Despite these policy initiatives, Malawi's agricultural growth exhibited significant volatility in the 1990s, and slow growth to recessions between 2000 and 2023 (see Figure 1 below) . Food inflation closely mirrored agricultural growth during this period, in most cases, surging during years of poor harvests and lowering when production improved. For instance growth spiked to 12.8% in 1991 but plummeted to -25.1% in 1992, rebounded in 1993 with an impressive growth of 52.9%, only to contract sharply to -28.9% in 1994[7]. Food inflation soared to 27.9% in 1992. Similar

[6]Overtime ADMARC's role in stabilizing crop prices has diminished significantly

[7]During this period, Malawi experienced recurrent droughts, in 1992 and 1994. In addition The Malawi

Figure 1.. Policy rate, agriculture growth, and food inflation in Malawi: 1990-2023



Data sources: World Development Indicators and RBM

patterns are seen in most years between 2000 and 2023. However, when the country had high agriculture growth rate in 1995, surprisingly food inflation climbed further to 37.4% in the year[8]. During the 1996-1998, and the 2017-2020 periods, food inflation co-moved with agriculture growth. Yet in 1999, growth had stabilized when food inflation rose to above 40%. Between 2006 and 2011, high and stable agricultural growth rates were accompanied by low food inflation rates[9]

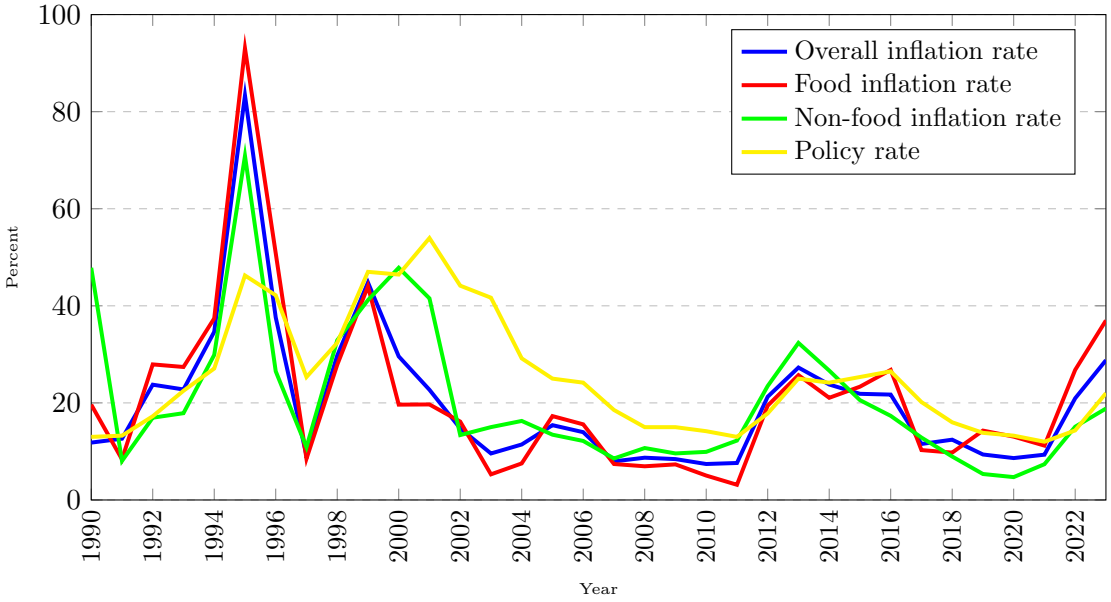
As seen in Figure 2 below, the movements of food inflation in Malawi, significantly affect the overall inflation, which is the target for the RBM's monetary policy. The RBM responded to the overall inflationary pressures by adjusting the policy rate. For instance, as seen in Figure 2 in response to the high inflation of the period between 1991 and 1994, the RBM implemented contractionary monetary policy. Similarly, following a sharp rise in food inflation, and overall inflation from 1997 to 1999, the RBM also raised the policy rate. However, despite falling food inflation between 2000 and 2001, the RBM maintained its contractionary monetary policy stance by keeping the policy rate high, targeting overall inflation which was higher than food inflation, and largely influenced by non-food inflation. Non-food inflation fell sharply between 2001 and 2002, leading to lower overall inflation which remained subdued below 20% until 2011. During this period, the RBM adopted expansionary monetary policy, gradually reducing the policy rate from 41.67% in 2003, to 13% by 2011. However, the RBM maintained a contractionary monetary policy during the period between 2012 to 2016, to curb inflation partly driven by non-food inflation and partly by food inflation.

Kwacha depreciated by 290% against the US Dollar (read more here)

[8]According to (IMF 1997), most smallholder farmers had abandoned food production in favour of cash crop production such as tobacco following the repeal of the Special Crops Act

[9]Notably, during this period the government was implementing the FISP, alongside a de-facto peg regime of the exchange rate. See Munthali, Simwaka, and Mwale (2010) and Chibwana (2014)

Figure 2.. Inflation Trends in Malawi: 1990-2023



Data sources: World Development Indicators and RBM

More recently, begining 2021, inflation rates have remained elevated in Malawi [10]. At the onset of the rise in the inflation rates in 2021, the International Monetary Fund recommended tight monetary policies to keep a looming rising inflation in check (IMF 2021). Similarly, in its African Economic Outlook 2024 report, the African Development Bank projected inflation in Malawi to remain elevated in 2024 (AfDB 2024). Thus it recommended further tightening of the monetary policy for the country, just as in all other countries experiencing high inflation such as Egypt, Ethiopia, Ghana, Nigeria, and Zimbabwe. However, how does the Reserve Bank of Malawi's monetary policy, whether contractionary or expansionary, truly influence food price inflation, which largely drives overall inflation, and agricultural growth, which drives overall growth of the economy, in the Malawian context?

3. The Methods

3.1. *Empirical Model*

We estimate a Bayesian structural vector autoregressive (B-SVAR) model as expressed in (1)

$$\mathbf{A}_0\mathbf{Y}_t = \sum_{j=1}^{p} \mathbf{A}_j\mathbf{Y}_{t-j} + \Lambda'\mathbf{N}_t + \Psi'\mathbf{E}_t + \Omega\eta_t \tag{1}$$

[10]The economy faced global supply shocks e.g the COVID-19 pandemic and the Russia-Ukraine war. Locally, the economy had suffered from devastating cyclone Freddy in february 2023, which destroyed crops and livestock (see (GoM 2023b))

where $\mathbf{Y}_t = (i_t \quad \alpha_t \quad \pi_t^f \quad d_t)'$ for $1 \leq t \leq T$ is a vector of endogenous series namely nominal policy rate(i_t), a measure of agricultural growth (α_t), nominal food inflation $\left(\pi_t^f\right)$ and accumulated central government domestic debt(d_t).$\mathbf{A}_j$ is a matrix of structural parameters for $0 \leq j \leq p$ with $\mathbf{A}_0$ being non-singular and representing a matrix of contemporaneous structural parameters; $\mathbf{N}_t$ is a matrix of deterministic terms (e.g., time trends and(or) constants, as the case may be); $\eta_t = (\eta_t^{i_t} \quad \eta_t^{\alpha_t} \quad \eta_t^{\pi_t^f} \quad \eta_t^{d_t})'$ is a vector of perpendicular structural shocks such that $E(\eta_t \eta_t') = \mathbf{I}$ while $\mathbf{E}_t$ represents a vector of exogenous variables. Specifically, we control for precipitation levels and population to account for the influence related to climate and labour on agricultural growth. In the food inflation model, we control for exchange rate and GDP per capita to account for imported inflation and general change in demand due to changes standard of living. Defining $\mathbf{X}_t = (\mathbf{Y}_{t-1} \ldots \mathbf{Y}_{t-p} \quad \mathbf{N}_t \quad \mathbf{E}_t)$, $\beta = \left(\mathbf{A}_0^{-1}\mathbf{A}_1 \ldots \mathbf{A}_0^{-1}\mathbf{A}_p \quad \mathbf{A}_0^{-1}\Lambda' \quad \mathbf{A}_0^{-1}\Psi'\right)'$, we then write the model (1) compactly in reduced form as (2)

$$\mathbf{Y}_t = \mathbf{X}_t\beta + \epsilon_t \tag{2}$$

where $E(\epsilon_t \epsilon_t') = \Sigma = E\left(\mathbf{A}_0^{-1}\eta_t\eta_t'\mathbf{A}_0^{-1\prime}\right) = \mathbf{A}_0^{-1}\Omega\mathbf{A}_0^{-1\prime}$ is the varaiance-covariance matrix of the composite innovations (ϵ_t).

We estimate the model using Bayesian estimation techniques to avoid small-sample bias[11]. According to Litterman (1986), Bayesian estimation techniques offer the best solution to the concerns about overparameterization that all VAR models naturally face. Although we avoid being drawn into an otherwise exciting space of Bayesian VAR modeling, we briefly discuss the relevant issues to our context. Further details on this discussion can be found in Dieppe, Legrand, and Van Roye (2016), Litterman (1986), and Doan, Litterman, and Sims (1984).

Contrary to frequentist estimation of VAR models, the Bayes approach treats the model parameters (compactly denoted $\vartheta = \{\beta, \Sigma\}$) as random variables with an unknown prior probability distribution given as $f(\vartheta)$. The goal is to identify ϑ by combining the distribution of prior distributions $f(\vartheta)$ together with the likelihood function of the model (denoted as $f(\mathbf{Y}_t|\vartheta)$) using a Bayes rule 3

$$f(\vartheta|\mathbf{Y}_t) = \frac{f(\mathbf{Y}_t|\vartheta)\, f(\vartheta)}{f(\mathbf{Y}_t)} \propto f(\mathbf{Y}_t|\vartheta)\, f(\vartheta) \tag{3}$$

The posterior distribution, $f(\vartheta|\mathbf{Y}_t)$, is then used to compute all posterior moments of the model parameters. To pin down the unobserved prior distribution $f(\vartheta)$, we invoke the original Minnesota approach which is fully discussed in Litterman (1986)[12].

[11] However, for comparison purposes, we also estimate Equation 2 using the standard maximum likelihood estimation approach. We report results of both estimation techniques, but we focus on Bayesian estimation results when interpreting and discussing the results.

[12] Five possible priors could be used to pin down $f(\vartheta)$ (a) the original Minnesota prior (b) the natural conjugate normal-Wishart (c) the independent normal-Wishart prior (d) the normal-diffuse prior and (e) the dummy observation prior (Dieppe, Legrand, and Van Roye 2016; Litterman 1986; Doan, Litterman, and Sims 1984). Under the original Minnesota prior, Σ is assumed to be known and defined as $\Sigma = \widehat{\Sigma}$. This means that $f(\vartheta) \equiv f(\beta)$, which is assumed to be a multivariate normal distribution such that $\beta \sim N(\beta_0, \Gamma_0)$. For normal Wishart prior, both β and Σ are assumed unknown, and $f(\beta)$ is assumed multivariate normal while $f(\Sigma)$ is assumed inverse Wishart distribution. Finally, under the normal diffuse/Jefrey's prior, both β and Σ are assumed unknown and $f(\beta)$ is assumed multivariate normal while $f(\Sigma)$ is assumed Jeffrey's prior.

Before applying the Bayesian techniques, we must indicate that the innovations in our model are nonspherical as there are cross-equation correlations across the system. Because they are composite functions of structural shocks, innovations in Equation 2,$\epsilon_t = \mathbf{A}_0^{-1}\eta_t$, do not have structural interpretations. However, the ultimate objective of this analysis is to identify the dynamic response of a measure of agricultural growth to policy interest rate shocks. Consequently, it is imperative to carefully estimate the responses to "structural" shocks as opposed to "composite" shocks. In technical terms, we need to transform Σ into a diagonal matrix. This will transform the composite shocks (ϵ_t) into spherical shocks. We do this by invoking the standard Choleski decomposition.

Specifically, we set $\Omega = \mathbf{I}$ such that $\Sigma = \mathbf{A}_0^{-1}\mathbf{A}_0^{-1\prime}$. In addition, we implement contemporaneous restrictions on $\mathbf{A}_0$. In this context, we assume that the policy interest rate does not contemporaneously respond to shocks on agricultural growth and the other endogenous series. At the same time, we allow shocks to the policy interest rate to influence the other endogenous series. Having estimated the model in this fashion, we then estimate the dynamic response of α_t following a shock to i_t, also known as the impulse response function(IRF):

$$IRF(h) = \frac{\partial \alpha_{t+h}}{\partial \eta_t^{i_t}}, \quad h = 1, 2, 3, ...H \tag{4}$$

where $\eta_t^{i_t}$ represents the structural shock to nominal interest rate while $IRF(h)$ is the *short-run* response of the measure of agricultural output to the shock.

3.2. *Data*

We use data from 1986 to 2023 from various sources. Data on Policy (bank) rate, exchange rate, domestic debt, food, non-food and overall inflation was sourced from the Reserve Bank of Malawi [13]. On the other hand, data on real GDP per capita, population, and agriculture sector growth was sourced from the World Bank Development Indicators (WDI) [14]. For rainfall (precipitation) we used data from the Climate Change Knowledge portal of the World Bank.

[13]Inflation, Policy Rate, Domestic Debt, and Exchange Rate data can be accessed from RBM

[14]Data on Real GDP per Capita, Population, and Agriculture sector growth rate can be accessed WDI, While Precipitation data can be accessed here

Table 1.. Summary Statistics

Series	Observations	Mean	Standard Deviation	Minimum	Maximum
Agriculture Sector Growth Rate (%)	40	4.134	13.282	-28.921	52.98
Precipitation(Millimeters)	39	1055.635	155.247	725.62	1401.25
Population (Millions)	40	13,155,020	3,895,881.9	7,339,002	20,931,751
Real GDP per Capita (US$)	40	448.40	78.47	330.661	573.4
Overall Inflation (% change of overall CPI)	40	20.02	13.98	7.412	83.33
Real Narrow Money Balances(Million MKW)	40	958.43	606.28	285.79	2708.504
Policy interest rate (%)	40	23.09	12.22	10	53.96
Nominal Exchange Rate (MKW/US$)	40	243.715	323.88	1.45	1162.58
nominal Domestic Debt(Million MKW)	40	2,961,83.09	6,251,82.77	169.7	27,209,09.2
Food Inflation (% change of food CPI)	34	21.02	17.21	3.13	93.05
Non-food Inflation (% change of non-food CPI)	34	20.79	14.85	4.705	70.89

Table Notes: Local Malawian currency is officially called "Malawian Kwacha" denoted in short as "MKW". As such, in this table, wherever is written "MKW" it means "Malawian Kwacha". For example, "MKW/US$" under nominal exchange rate implies that the exchange rate is reported as "Malawi Kwacha per United States Dollar". The data on food inflation and non-food inflation starts from 1990 to 2023 hence the reported 34 observations under those series. The observation period for all the other series span 1984 to 2023.

The summary statistics reveal several key trends. The agriculture sector shows significant variability in growth, with a mean growth rate of 4.13% but a high standard deviation of 13.28%, highlighting fluctuations, including a sharp decline to -28.9% and a peak of 52.98%. Food inflation averaged 21.02%, slightly above non-food inflation, reflecting the importance of food prices in driving overall inflation. Precipitation varies less over time, averaging 1,055.6 millimeters. However, the minimum of 725.02 mm against a maximum 1401 mm indicates occurrence of huge upswings in rainfall, suggesting droughts and possible flooding. Over the study period, population grew, by nearly tripling from 7.3 million to 20.9 million. Real GDP per capita averaged $448 while monetary indicators, such as the policy interest rate and exchange rate, also display variability, with the policy rate averaging 23.09% and peaking at 53.96%, and the exchange rate moving from as low as MWK1.45 per US Dollar, to MWK1,162 per US Dollar.

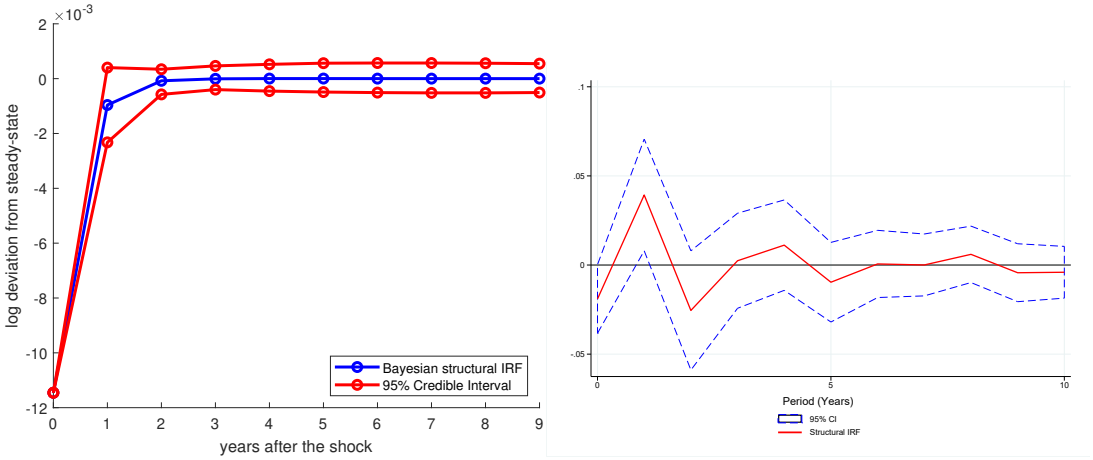
Before subjecting the series to econometric analysis, we filter out the trends from the variables. Specifically, we use Stock and Watson (1999)'s one-sided HP filter. According to Pfeifer (2014), unlike the two-sided filters, for example the Hodrick and Prescott (1997) or the Baxter and King (1999), the one-sided HP filter uses only the previous values to restrict the trend, which is in line with the VAR model solution which takes the form of a backward-looking state-space system. Figure 7 and Figure 6 present the filtered cycles of selected series used in the analyses.

4. Empirical Results and Discussion

Figure 3 and Figure 4 respectively present the estimated reactions of agricultural sector growth and food inflation to a percentage increase in policy rate over 10 years. We present the responses estimated from both Bayesian structural VAR and standard structural VAR. In Figure 3, specifically the "Bayesian" results[15], we observe subdued agricultural sector growth following a percentage increase in policy rate. Specifically, when a Central Bank raises the policy rate by 1%, agricultural productivity decreases by about 0.011% . The results are in line with findings by Wagan et al. (2018), Akbar and Jabbar (2017), and Ahiadorme and Akoto (2024).

[15]Similar results are observed from the "standard VAR" model in terms of direction and magnitude although the statistical significance. We attribute the differences in terms of statistical significance between the Bayesian VAR and the standard VAR results to the failure of the standard VAR model to handle small samples.

Figure 3.. Impact of contractionary monetary policy shock on agricultural sector growth



((a)) Bayesian structural VAR ((b)) standard structural VAR

Figure Notes: The impulse response functions under "Bayesian SVAR" are estimated from a time-invariant first-order B-SVAR. We included the constant term in the estimation model. For comparative purposes, we present results derived from a standard structural VAR model estimated using maximum likelihood estimation denoted "standard SVAR". In both VARs, we included central government domestic debt, amount of rainfall and population size as exogenous variables. The central government domestic debt was included following Cochrane (1998)'s fiscal theory of the price level (FTPL) that argue that economic agents' expectations about the ability of the fiscal authority to service its debt causes inflation, which, in this case, may eventually determine agricultural productivity. The inclusion of amount of rainfall was to to account for the dependency of agricultural productivity on rainfall and weather conditions. Finally, the inclusion of the population size was to capture "agricultural labour " input, given that the agricultural growth model is, essentially, a growth model.

At first glance, the results may seem to confirm the existence of an interest rate channel of monetary policy in Malawi where the increase in nominal interest rate contracts current consumption, which in turn results in subdued output. However, such a conclusion would be erroneous! To explain this, let us use the conventional dynamic IS curve (DIS) and the new Keynesian Phillips curve (NKPC), respectively specified in Equation 5a and Equation 5b, upon which the standard interest rate channel is based[16].

$$\widetilde{Y}_t = E_t\widetilde{Y}_{t+1} - \frac{1}{\sigma}\left(i_t - E_t\pi_{t+1} - r_t^n\right) \tag{5a}$$

$$\pi_t = \beta E\pi_{t+1} + \kappa\widetilde{Y}_t \tag{5b}$$

where $\widetilde{Y}_t$ denotes the logarithmic deviation of the real output from its natural level, i_t represents the nominal policy interest rate, π_t represents inflation, r_t^n represents natural interest rate. Further, E is an expectation operator while $\sigma \in (0, +\infty)$ and $\kappa > 0$ are parameters. Evidently, from Equation 5a, a positive shock to nominal interest rate i_t is expected to reduce output $\widetilde{Y}_t$ given that, ideally, economic agents substitute current consumption for government bonds that are now attractive due to the increase in interest rate. The reduction in output (in this case, agricultural output) entails that, according to the NKPC Equation 5b, inflation should go down as-well. After all, the relationship between inflation(π_t) and output ($\widetilde{Y}_t$) is positive

[16]More details on the standard DIS and NKPC can be found in Galí (2018)

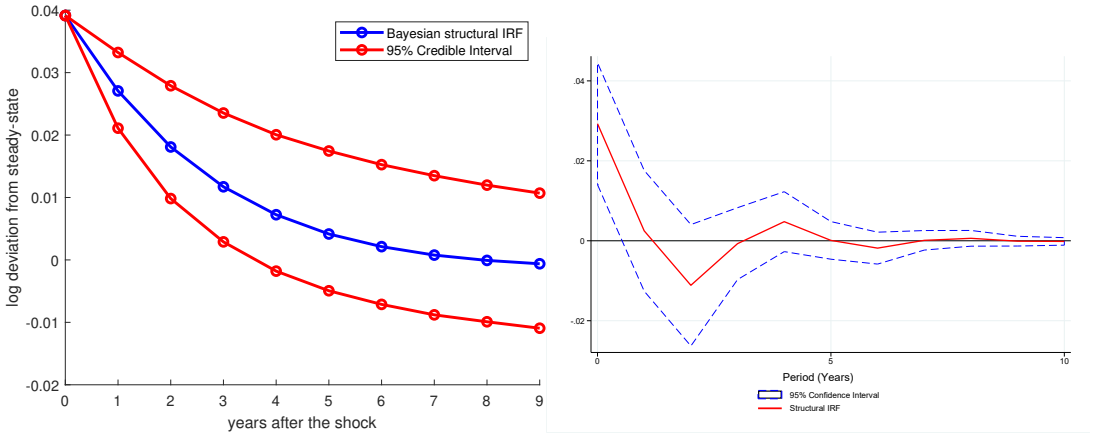
($\kappa > 0$).

This standard theoretical prediction, however, is not what we observe in Figure 4 and Figure 3. Specifically, from Figure 4, we notice that food inflation jumps by about 0.04% following the percentage increase in policy rate. In fact, from Figure 3, we notice that overall inflation also responds positively by about 0.03% following a percentage increase in policy rate. These findings are in direct contradiction to the standard interest rate channel which, according to the NKPC Equation 5b, predicts deflation following an increase in policy rate as shown in Equation 5a and Equation 5b.

Before we explain the possible mechanism behind these results, we first compare them to the results that have been reported in literature elsewhere. Specifically, we note that these results contradict findings by Sami and Makun (2024) and Wagan et al. (2018) who found that tight monetary policy reduces food inflation in India, China, Brazil, Russia, and South Africa, and India and Pakistan, respectively. Other studies, however, have reported findings similar to our current findings, for example, Bhattacharya and Jain (2020) and Iddrisu and Alagidede (2020). Using panel data from developed and emerging economies, Bhattacharya and Jain (2020) found positive and significant effect of tight monetary policy on food inflation while Iddrisu and Alagidede (2020) concluded that rising food prices can actually be further be destabilized by tight monetary policy in South Africa. We now move to our explanation of the results, that is, "how do we explain the observed unconventional response of inflation(both food and overall), to interest rate shocks?"

To begin with, we explain why the standard monetary policy channel fails in this context. As we have observed, the standard interest rate channel would entail a reduction in both output and inflation given the DIS and NKPC,respectively presented in Equation 5a and Equation 5b. However, while we find that agricultural growth goes down, inflation(both food and overall) surge in response to contractionary monetary policy shock. Our explanation for this is that the standard monetary policy channel presented in Equation 5a and Equation 5b assumes that households are forward-looking. That is, it assumes that households not only have access to formal financial institutions but also have the capacity to save.

Figure 4.. Impact of contractionary monetary policy shock on food inflation



((a)) Bayesian SVAR ((b)) standard SVAR

Figure Notes: The impulse response functions under "Bayesian SVAR" are estimated from a time-invariant first-order B-SVAR. We included the constant term in the estimation model.For comparative purposes, we present results derived from a standard structural VAR model estimated using maximum likelihood estimation denoted "standard SVAR". In other words, it represents the Response of the variable in question following a one percentage increase in the policy rate.

Under such scenario, whenever there is an increase in nominal interest rate, these forward-looking households would forego current consumption and invest in the "now-rewarding" government bonds. This reduces aggregate demand which would reduce both output and inflation. However, in Malawi, most households have no access to formal financial institutions, let alone the capacity to save. Specifically, between $2010 - 2020$, the proportion of households with access to formal financial institutions in Malawi moved from 8.3% to 17.7%, which implies an average of 13% as reported in NSO (2019).

Consequently, only a meager proportion of the population responds to changes in interest rate; hence the change in aggregate demand is minimal. It is not surprising, therefore, that the response of agricultural growth following a percentage increase in nominal interest rate is very small (only 0.011% to be exact as shown in Figure 3). If anything, it should be the case that only a few suppliers who are financially included are affected (through the rising cost of borrowing and hence capital) against the majority of consumers who are not financially included. The subdued agricultural productivity growth, emanating from the contractionary monetary policy shock, translates into low supply of food on the market and, therefore, increased food prices hence the observed jump in food inflation in Figure 4. Given that a huge proportion of the consumer price index in Malawi is dominated by food items, the rise in food inflation automatically implies that the overall inflation rises as well hence the observed jump in overall inflation in Figure 3.

5. Sensitivity Analysis

In estimating Equation 2, we made several modeling and estimation decisions that may have influenced the results presented in section 4. In this section, we present the

sensitivity of the results presented in section 4 to changes in some of those modelling and estimation decisions. First, the Equation 2 is a time-invariant structural VAR model. In other words, in estimating model Equation 2, we assumed that the model parameters β and Σ do not vary with time. This assumption may not be appropriate, particularly with regard to Σ. Specifically, it is known that the volatility of agricultural productivity varies over time on account of, say, rainfall patterns and weather and climatic conditions. Consequently, estimating a time-variant structural VAR model, therefore, would seem appropriate. As such, as robustness analysis, we estimated a time-varying version of Equation 2 and the results are presented in Figure 5. As observed in Figure 5, we notice that while agricultural productivity responds negatively to contractionary monetary policy shock, food inflation responds positively. This is in line with our earlier findings from a time-invariant structural VAR model presented in Figure 3 and Figure 4.The assumption of "time-invariant" parameters made in Equation 2, therefore, did not influence the results reported in Section section 4.

Secondly, we estimated a version of model Equation 2 without the various control variables. This exercise was done to check if the results we have presented in section 4 are dependent on the inclusion of the control variables. As shown in Figures 1 and 2, the results are the same as reported earlier.

6. Conclusion

Just like many developing countries, Malawi's economic growth largely depends on the agriculture sector. Despite the significant role that the sector plays, it has experienced stagnating growth and food inflation has been on the rise in Malawi. In this paper, we ask if the Central Bank can use the traditional monetary policy instruments in influencing not only the sector's growth but also food inflation. Specifically, we estimated the response of agriculture sector growth and food inflation to changes in monetary policy rate. We find that contractionary monetary policy hinders agricultural sector growth and, consequently, fuels food inflation. These results indicate that Central Banks can positively influence agricultural sector growth and, consequently, food inflation if they embark on unconventional approach to monetary policy.

Specifically, in an economy that is characteristically dependent on agriculture, fighting inflation entails that the Central Bank should reduce the interest rate as opposed to increasing it. This will stimulate aggregate demand and, consequently, increase agricultural output. Ultimately, the increased output will reduce food prices.Given that in such economies, food prices form a huge proportion of the consumer price index, the reduced food prices will result in an overall reduction of inflation. The standard monetary policy actions where the Central Bank "fights" inflation through raising the policy rate achieves the opposite. Through its negative effect on agricultural output, it fuels food inflation which, eventually, triggers overall inflation. Reducing the policy rate in times of high inflation seems to be an approach that would provide gains in both reduced inflation and growth of the agricultural sector. However, this is against the general advice offered to the central banks in developing agrarian economies;

perhaps, the banks have been misled this far[17].

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[17]The Monetary Policy Committee of the Reserve Bank of Malawi has consistently depended on the standard monetary policy and in times of inflation, the committee has consistently increased policy despite acknowledging the inflation to food prices (Read more here), The international organizations like the African Development Bank and the International Monetary Fund have also largely proposed the standard monetary policy (more details here and here)

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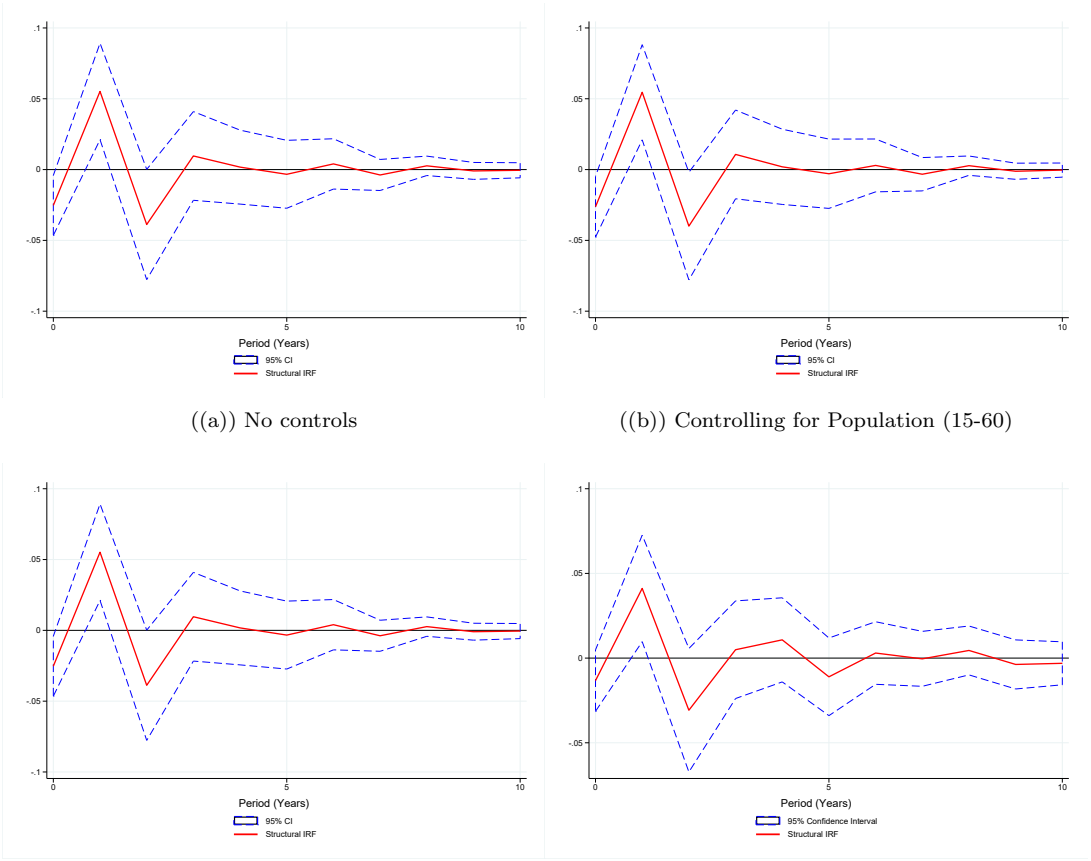
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7. Appendices

Appendix A. Tables

Appendix B. Figures

Figure 1.. Impact of contractionary monetary policy shock on agricultural growth



((a)) No controls

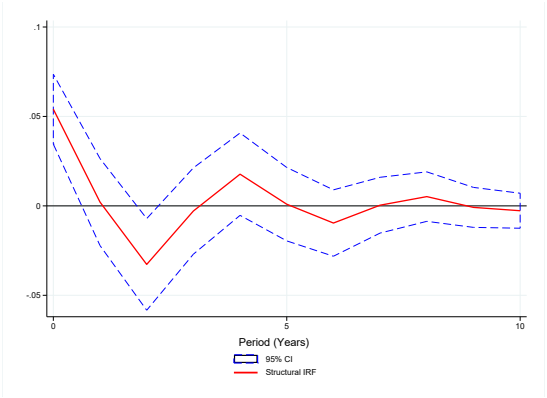
((b)) Controlling for Population (15-60)

((c)) Controlling for Rainfall

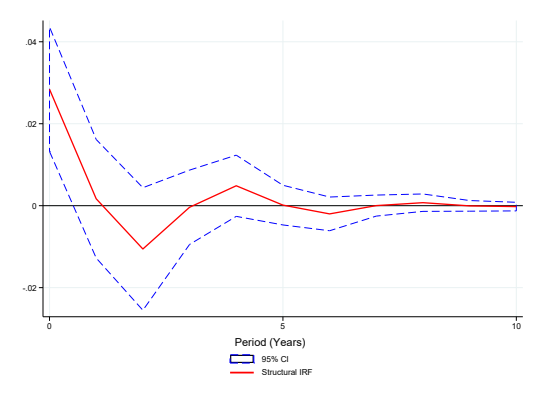
((d)) Controlling for Rainfall and Population(15-60)

Figure Notes: We subjected our results to robustness check by first running a model with no controls. We then controlled for Total Population alone, Rainfall alone, and Rainfall and Population between 15 and 60 years.The results do not deviate to those reported in this study where we controlled for Rainfall and Population (percent of the Total Population between 15 and 60 years).

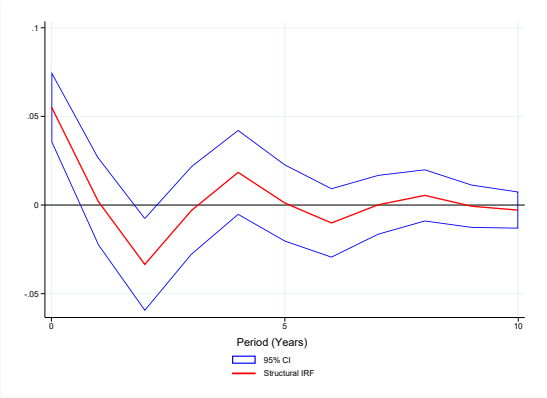
Figure 2.. Impact of contractionary monetary policy shock on Food inflation



((a)) No controls



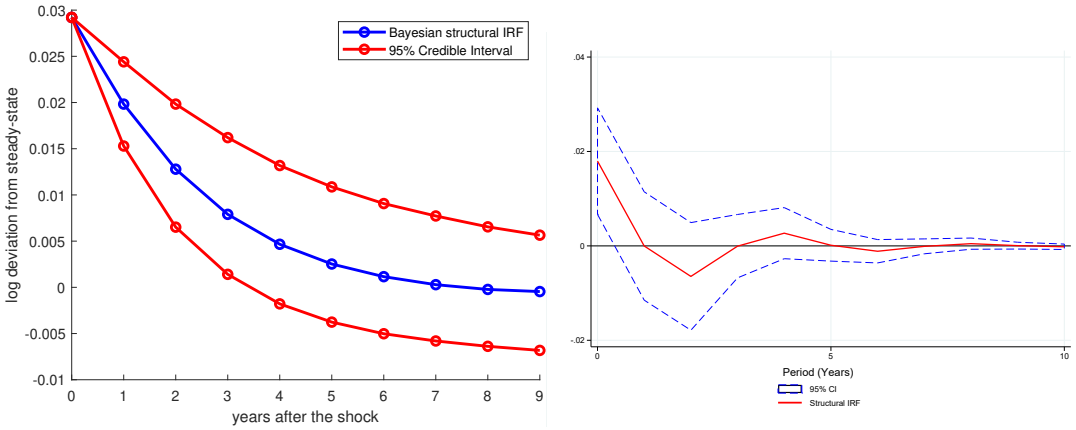
((b)) Controlling for Exchange rate



((c)) Controlling for GDP per Capita

Figure Notes: We subjected our results to robustness check by first running a model with no controls. We then controlled for exchange rate alone, and GDP per capita alone.The results do not deviate from those reported in this study where we controlled for both exchange rate and GDP per capita.

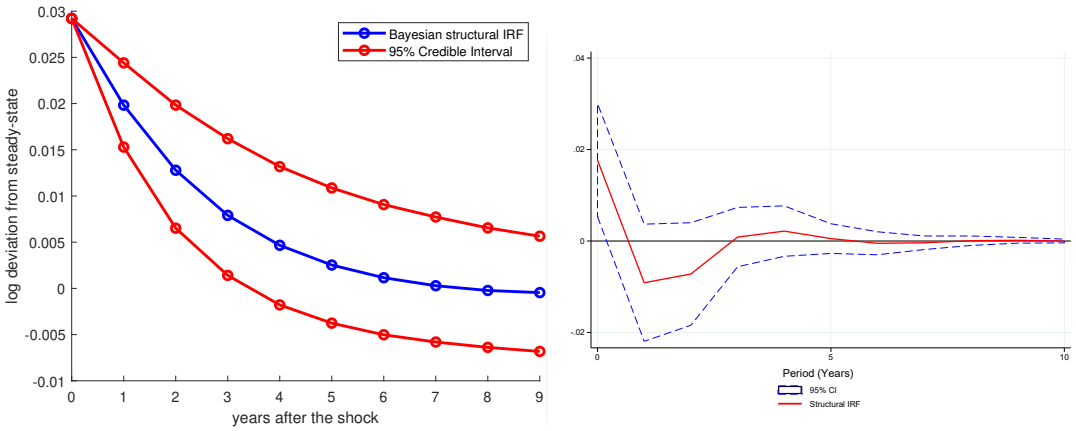
Figure 3.. Impact of contractionary monetary policy shock on overall inflation



((a)) Bayesian VAR ((b)) standard VAR

Figure Notes: These impulse response functions are estimated from a time-invariant first-order B-SVAR. We included the constant term in the estimation model. The red lines represent 95% Credible Interval(CI) bounds while the blue line in-between the CI represents the structural impulse response function. In other words, it represents the Response of the variable in question following a one percentage increase in the policy rate. The y-axis, captures these responses. The assumption here is that before the impact, the variable in question was in steady-state. The numbers on the y-axis, therefore, represent how much(and in which direction) the variable in question deviates away from the steady-state. Tracing out the IRF, one also gets the time it takes before the variable rebounds back to steady-state.

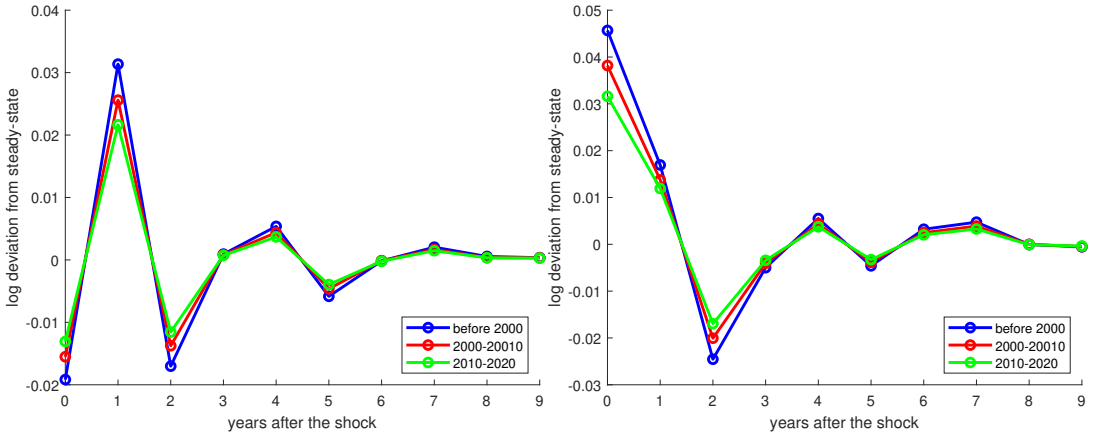
Figure 4.. Impact of contractionary monetary policy shock on food inflation



((a)) Bayesian VAR ((b)) standard VAR

Figure Notes: These impulse response functions are estimated from a time-invariant first-order B-SVAR. We included the constant term in the estimation model. The red lines represent 95% Credible Interval(CI) bounds while the blue line in-between the CI represents the structural impulse response function. In other words, it represents the Response of the variable in question following a one percentage increase in the policy rate. The y-axis, captures these responses. The assumption here is that before the impact, the variable in question was in steady-state. The numbers on the y-axis, therefore, represent how much(and in which direction) the variable in question deviates away from the steady-state. Tracing out the IRF, one also gets the time it takes before the variable rebounds back to steady-state.

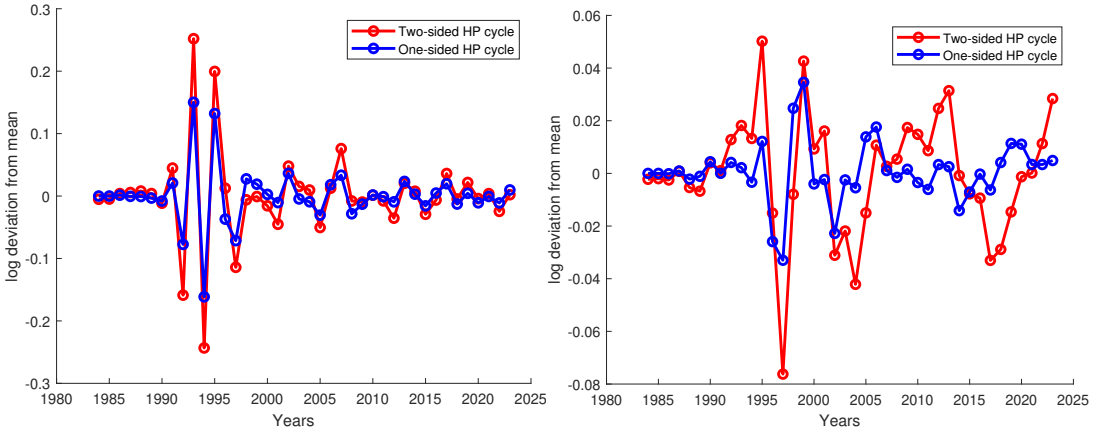
Figure 5.. Impact of contractionary monetary policy shock: Time-Varying B-SVAR



((a)) Agricultural Growth ((b)) Food Inflation

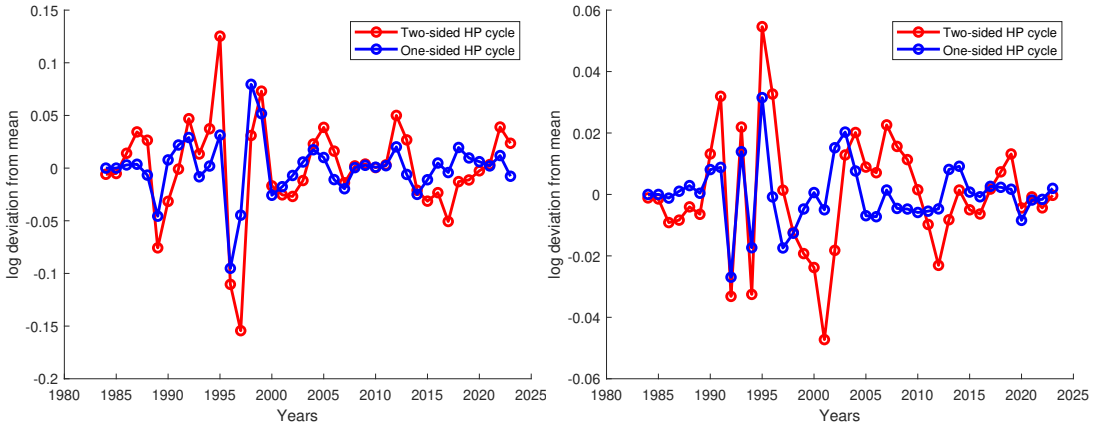
Figure Notes: These impulse response functions are estimated from a time-variant first-order B-SVAR. In this model, we allowed all the model parameters to vary over-time. This means that we estimated response of the variables to shocks in each year over the entire sample period. The lines denoted "before 2000" represent the average response of the variable in question for the period before the year 200. The other lines denoted "$2000-2010$" and "$2010-2020$" are analogously defined. In passing, one notices that the impact of monetary policy shock on agricultural growth and, consequently, food inflation has been declining over the years.

Figure 6.. Comparison of one-sided vs two-sided HP filter



((a)) Agricultural Growth ((b)) Policy Rate

Figure 7.. Comparison of one-sided vs two-sided HP filter



((a)) Overall Inflation

((b)) Real GDP per capita