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Full Length Research Paper

The nature of inflation in Malawi up to the early 2000s

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This paper examines the possible sources of inflation in Malawi's economy since 1970s. Using vector autoregressive models of order two in changes of the variables, impulse response functions as well as error variance decomposition analysis, this study has established that changes in money supply, exchange rates, past values of inflation, recessions and booms were the main determinants of inflation. Further it is found that there was a clear differential impact between booms and recessions on inflation such that the impact of recessions was more pronounced though it was less persistent. These results are in line with those obtained from Malawi's regional partners such as Zambia, Mozambique, Tanzania, Kenya and South Africa in related studies, however, this study is unique because it takes an advanced step forward to show using fairly sophisticated analysis that booms and busts present differential challenges to the macroeconomy and indeed inflation. Policies aimed at controlling money supply, interest rates as well as exchange rates are desired, as changes in these variables do generate significant changes in inflation levels. The implication of the established asymmetric effects of booms and busts on inflation is that inflation modelling must treat booms and slumps differently if the true impact of real output on inflation is to be precisely established empirically.

Key words: Inflation, recessions and economic booms, vector auto regressions, generalized impulse response.

INTRODUCTION

The monetary view contends that inflation could be largely a monetary phenomenon, the control of which requires as a necessary condition, control of money supply in such a way that it grows at a rate consistent with the growth of demand for money at stable prices. The monetarist view contends that in general, rising prices and balance of payments deficits are caused by pressure of internal demand, in turn attributable to an excess supply of money. Monetarists postulate that money supply is exogenous rather than endogenous implying that it can be controlled by monetary authorities (Ghatak, 1995). Empirical evidence from more than four decades on the monetarist view seems mixed with the works of various early authors including Harbeger (1963), confirming demand pull inflation using the monetary demand framework. Vogel (1974) used a functional form originally used by Harberger (1963) in a study of Chilean inflation, to the LA countries and also found evidence that money supply was influential in determining inflation.

The structuralist approach, seeks to explain inflation as well as other imbalances in developing countries in terms of certain special characteristics of their production and foreign trade. To explain the rising trend in prices for developing countries, structuralists argue that the rise may partly be due to the inelasticity of food supply. Ghatak (1995) argues that food supply lags behind demand generated by the expansion of incomes in the non-agricultural sector and this causes food prices in developing countries to rise. Food being an important component of developing economies, its price rise generally translates into an increase in the general price level. The condition above, aided by other structural characteristics of developing countries generally do results in inflationary processes. Ghatak (1995) gives an example of a situation where a country faces a foreign exchange constraint which makes it impossible to import enough food to prevent a further rise in its relative price. In such a case, urban wage earners will press for higher wages to compensate for a fall in their real incomes. If granted, these could result in a further increase in food demand and a further rise in food prices.

Empirical work on structural causes of inflation has generally been bedevilled by patchy data on some theoretically crucial factors. In some cases data on some

variables has generally been difficult to obtain. The few studies that exist have mixed results with some of them ending inconclusively. Argy (1970) found that structural indicators were not significant in a study for some 22 least developed countries (LDCs). Argy attributed the finding to the lack of enough quantifiable data on structural indicators.

There have also been several detailed studies on the determinants of inflation in Eastern European countries especially those which were under the soviet regime. For example using a structural co-integration approach, Kim (2001) used quarterly data from 1990-1994 to investigate determinants of inflation in Poland. It was found that Polish inflation was largely determined by external transmission effect and a cost push inflation driven by higher wages. They found that monetary policy had not affected inflation implying that monetary policy was subordinate to exchange rate policies.

Several studies on the topic have also been conducted in countries neighbouring Malawi. In Tanzania, Laryea and Sumaila (2001) concluded that inflation was generated more by monetary factors than real ones. Further they concluded that an increase in output would decrease inflation. In one of Malawi's trading partners, Kenya, Durevall and Ndung'u (2001) found that inflation was induced by exchange rate, foreign prices and terms of trade using error correction mechanism. They further argued that enhanced production of maize would keep inflation at lower levels as maize contributed greatly to the final general price index in Kenya.

Elsewhere, numerous empirical studies have demonstrated consistent patterns for money–price relationships for various market economies. Monetarists argue that these studies have supported their claim that inflation can be produced only by a more rapid increase in the quantity of money than of output, and it is thus regarded as a purely monetary phenomenon (Friedman, 1969). Al-Mutairi, (1995) employed vector autoregressions (VAR) to examine the causes of inflation in Kuwait taking advantages of the VAR, but did not differentiate between the impacts of negative and positive changes in output on inflation, while Narayan et al. (2008) studying the inflation-output nexus in China, found no evidence that higher output volatility increases average inflation using an Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) framework. Employing a related methodology, bivariate Generalized Autoregressive Conditional Heteroscedasticity (GARCH), Lee (1999) found evidence that there was a trade-off between inflation variability and output variability.

The question about the nexus between inflation and growth for India was examined in Singh and Kalirajan, (2003) and it was concluded from the findings that monetary policy had a potential crucial role to maintain price stability. Catao and Terrones (2005) studying fiscal deficits and inflation in 107 countries over 1960-2001 found that fiscal deficits yielded an increase in money base which in turn led to increases in inflation. Even though their results supported that of King and Plosser (1985), one would argue that their inability to distinguish between the effects between booms and busts on inflation might have compromised the consistency of their estimates due to mis-specification and hence their study, just as is the case with most of those reviewed herein would benefit from the implied asymmetric specification proposed below.

Fedderke and Schaling, (2005) studying the South African data employed a Phillips curve in investigating the link between inflation, labour costs, output gap, the real exchange rate and inflation expectations using multivariate co-integration techniques. They found some evidence of cost-push inflation, while assuming a linear output effect on inflation. The study by Kaseeram et al. (2004) found that inflationary inertia played a major role in inflationary process in the South African economy but again there was no attempt to examine the asymmetric effects of real output on inflation. Hendry (2001) studying the UK inflation, found that inflation was driven by many variables related to different theories such as, excess demand from all sectors of the economy, constant price GDP, nominal broad money supply, interest rates (treasury bills rate), nominal effective exchange rate and its past values.

Statement of the research problem

Higher levels of inflation are generally undesirable in an economy for the following reasons and many others. Firstly, sustained price rises regardless of source, lead to a fall in real wages and to a distribution of income in favour of profits and low paid workers not protected by trade unions tend to suffer most. And this type of income distribution tends to stimulate the production of luxury goods leading to a lopsided development. Secondly, inflation often has an adverse effect on balance of payment of a country's current and capital account and thereby aggravates the foreign exchange constraint on development. A rise in domestic prices relative to those of trading partners and competitors encourages imports and discourages exports unless exchange rates are varied simultaneously. Thirdly, price changes introduce uncertainty in an economy unless they are expected. This may seriously impede rational planning of investment and consumption expenditures in both private and public sectors (Ghatak, 1995; Gujarati, 2003).

In Malawi, the rate of inflation has changed unpredictably since independence in 1964. Below is a presentation of inflation trend in Malawi since the 70's. From the Figure 1, it can be seen that inflation in Malawi has been fluctuating and seems to have fluctuated a lot after the early years of 1990. Despite these fluctuations there are not many rigorous studies that have endeavoured to investigate the main causes and propagating

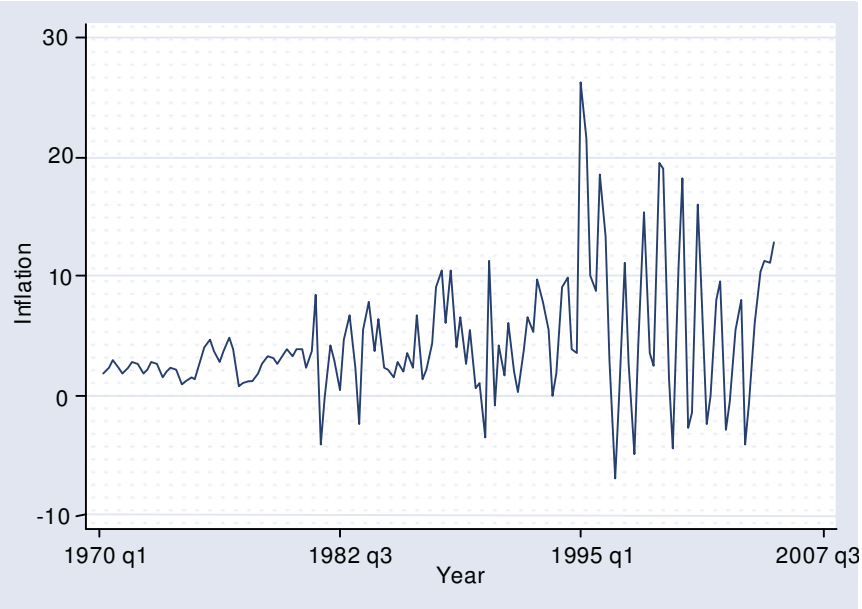

Figure 1. Inflation in Malawi since 1970.

factors of inflation in Malawi yet high levels of inflation are undesirable. Again, a quick examination of Malawi's output and price data suggests that unlike years of bumper harvest which are not associated with high inflation, drought years are associated with high inflation which sounds opposite of what would obtain from the mainstream theory of inflation and output which argues that output should be positively related to inflation. There are reasons therefore to believe that among other factors, economic booms and recessions have differential impacts on the future inflation rates.

The common shortcoming of the studies discussed previously is that they did not explicitly take into account that the impact of negative and positive growths in GDP on inflation could be different. If this is an important definition of the output variable in the inflation equation, estimates from studies that omit this view could be inconsistent and biased. In the end such biased estimates could misinform policy making. More crucially, there seems to be no published studies in this direction on the topic for Malawi, known to the author, which is a serious gap considering that inflation modelling is a key policy issue.

The purpose of this study is to examine the factors that determine inflation in the Malawian context with an aim of providing the basis for advising policy makers on how best they could tackle inflation. In this regard, the following hypotheses are tested: Firstly, the study tests whether or not the effect of economic recessions and booms on the rates of inflation are equal. Secondly, the study tests whether or not changes in money supply, real exchange rate, real interest rates, real output booms and real output busts do affect changes in future rates of inflation.

In so doing, this paper makes two major contributions relevant to the academia as well as to policymakers in Malawi. Firstly, it provides evidence whether or not it may be important for purposes of policymaking to differentiate the effects of recessions from that of booms on inflation in order to know the true effect of GDP on inflation and secondly it contributes directly to the shallow pool of literature on Malawi's empirical macro-economic dynamics. These potential contributions are of crucial importance not only because they can lead to sober policy formulation, but also because they would motivate further study of the issues discussed. It is from against this background that this study is.

To test the hypotheses formulated herein, this paper employs generalised impulse response functions and forecast error variance decompositions from a vector autoregressive model in changes of the level variables with a lag order of two where selection has been guided by Akaike Information Criteria (AIC) and Schwartz Bayesian Criteria (SBC) model selection procedures, and the sole knowledge that the model needed to be free from autocorrelation.

ECONOMETRIC METHODOLOGY AND DATA

The VAR

This paper considers Sims (1980) VAR of order p to analyse the impacts of each variable's error term on others. Later the system is modified to an extent that the variables used are transformed nonlinearly using Hamilton (1996) net specifications and the asymmetric specifications. The nature of the variables dealt with here is such that none could be assumed to be strictly exogenous.

They are endogenous and this fact renders the usual ordinary least square methodology inconsistent and biased.

The Cowles Commission in the past have approached this problem through extensive simultaneous equation modelling techniques, which have recently suffered massive criticisms owing to the 'incredible' restrictions required to identify such systems and indeed some criticism has emanated from the inherent requirement that system variables have to be portioned into exogenous and endogenous ones to permit estimation. Due to these concerns, first conceived by Sims (1980), this paper employs VAR modelling which is not susceptible to these criticisms. Moreover a VAR set-up implies that each equation can be estimated consistently by Ordinary Least Squares (OLS) since all regressors are predetermined (lagged values) therefore not endogenous.

The model below is a VAR (p) set up that this paper considers

$$y_t = c + \sum_{i=1}^{p} \Phi_i y_{t-i} + \varepsilon_t \quad (1.1)$$

Where y_t is a (n × 1) vector of endogenous variables, $c=(c_1 \ldots\ldots\ldots c_n)'$ is an intercept vector of the VAR, Φ_i is the ith n × n matrix of autoregressive coefficients for i=1, 2,……..p, and $\varepsilon_t = (\varepsilon_{1t}, \ldots\ldots\ldots \varepsilon_{nt})'$ is an n × 1 generalization of the white noise process. Explicitly it is assumed that

$$E(\varepsilon_t) = 0; E(\varepsilon_t \varepsilon_s^{'}) = \begin{bmatrix} \Sigma \text{ for t = s} \\ 0 \text{ for t} \neq \text{s} \end{bmatrix},$$

with Σ an n × n symmetric positive definite matrix. This implies that ε's are serially uncorrelated but may be contemporaneously correlated so that $E(\varepsilon_{i_t} \varepsilon_{j_t}) \neq 0$ (Pesaran and Shin, 1998) And Y_t is stable if det (I_{np} - Φ z) $\neq$ 0 for $|z| \leq 1$ (Lutkepohl, 2006).

According to Hamilton (1994), the VAR can be viewed as the reduced form of a general dynamic structural model.

In this paper five variables are employed to examine inflation in Malawi. The variables considered are changes in real GDP, real effective exchange rate, real interest rates, money supply and levels of inflation. While one dimension of this paper is on what recession and booms might do to inflation, the other variables are as crucial as they capture several inflation transmission mechanisms.

Granger causality

As a step towards formal analysis, this paper conducted Granger causality tests to appreciate the possible directions of causality between different sets of variables. A variable x granger causes a variable y if inclusion of lagged values of x improves prediction of y (Gujarati, 2003). The test can be organized as below

$$y_t = c + \sum_{j=1}^{p} \alpha_{11_j} y_{t-1} + \sum_{j=1}^{p} \theta_{12_j} x_{t-1} + \mathrm{e}_{1t}$$

$$y_t = c + \sum_{j=1}^{p} \alpha_{11_j} y_{t-1} + \mathrm{e}_{t} \quad (1.2)$$

Suppose one needs to test if x granger causes y, then one should run both models and noting the residual sum of squares for the first equation as RSS_1 and those of the second equation as RSS_0. Granger test then is based on F-test constructed as below,

$$\frac{(RSS_0 - RSS_1)/P}{RSS_1/(n-2P-1)} \sim F(p, n-2p-1) \quad (1.3)$$

The null hypothesis being that all coefficients of the lagged x in the first equation above is zero against an alternative that it's not zero. In this paper, implementation of Granger tests has been conducted in a VAR setting because this is handy in selecting the lag order of the variables in the test.

Impulse response analysis and error variance decomposition

An impulse response function measures the time profile of the effect at a given point in time on the expected future values of variables in a dynamic system (Hamilton, 1994).

To analyse the system's response to shocks, the VAR above is transformed into an infinite Moving Average process MA (∞) as below:

$$y_t = \mu + \sum_{i=0}^{\infty} \psi_i \varepsilon_{t-1} \quad (1.4)$$

where according to Jimenez-Rodriquez and Sanchez (2005), Ω_0 is an n X n identity matrix and μ is the mean of the process ($\mu = (I_n - \sum_{i=1}^{p} \Phi_i)^{-1} c$). Further, this is linked to the VAR model (3.11) in a way that $\psi_i = \Phi^i$, for i=1, 2,…,

The moving average representation is used to obtain both the forecast error variance decomposition and the impulse response functions. The variance decomposition shows the proportion of the unanticipated changes that is attributable to its own innovation and to shocks to other variables in the system.

Accumulated impulse response analysis

Sometimes interest centres on the accumulated effect over several or more periods of a shock in one variable. This may be the case in cases of undulating responses where one would like to gander at the net effect over some period. In that case, accumulated impulse response analysis may be required. Accumulated impulse response measure accumulated effect over several or more periods of a shock in one variable. This effect may be determined by summing up the MA coefficient matrices. For example the total accumulated effects for all the MA coefficient matrices such that $\psi_\infty = \sum_{i=0}^{\infty} \Phi_i$. This is sometimes called the matrix of total multipliers.

In terms of a finite period, one would compute accumulated responses over h periods, of a unit shock in the j-th variable of the system. This would be equivalent to $\psi_h = \sum_{i=0}^{h} \Phi_i$ (Lutkepohl, 2006). In essence the accumulated effects are the cumulative sums of the (generalised) impulse responses. This paper employs this measure to amplify cumulative differences of effects of different variables in the system. Some information that can be obtained from impulse responses is about persistence of shocks in a system.

Next is a discussion of some measures of persistence.

The asymmetric case 1

Linear models are said to be too restrictive because they have a symmetry property which implies that shocks occurring in a recession are just as persistent and indeed equally damaging as shocks occurring in an expansion. Linear models therefore, may not adequately capture asymmetries that may exist in business cycle fluctuations. Indeed univariate nonlinear models have found evidence that persistence varies over the business cycle and, in particular they find that recessionary shocks are less persistent than are expansionary shocks (Koop et al, 1996). It follows from this that the most appropriate methodology for capturing the asymmetric effects of recessions and economic booms on inflation would involve a nonlinear model.

Computation of impulse responses with nonlinear models is cumbersome and hard to implement as well as to interpret. Due to the said cumbersomeness, this paper decomposes the variable GDP into negative and positive changes as illustrated below. This decomposition means that the resultant model is no longer nonlinear.

$$\Delta GD\,\mathrm{P}_t^{+} = \begin{cases} \Delta GDP_t \;\; if \;\; \Delta GDP_t > 0 \\ 0 \qquad otherwise \end{cases}$$

$$\Delta GD\,\mathrm{P}_t^{-} = \begin{cases} \Delta GDP_t \;\; if \;\; \Delta GDP_t < 0 \\ 0 \qquad otherwise \end{cases} \qquad (1.5)$$

Where, GDP_t is the rate of change of log of GDP.

This model may be rationalized in terms of the hysteresis hypothesis (Hamilton, 1994). To this extent, the most preferable VAR is nonlinear in nature but owing to the difficulty of interpretation inherent in nonlinear specifications, this paper treats the so transformed nonlinear GDP variable in a linear set up. Such a development permits analysis and interpretation of impulse responses in the same way as in linear models. This thinking has been applied by Hamilton (1996) as well as by Jimenez-Rodriquez and Sanchez (2005) in analysis of oil shocks on the macroeconomy and many others. The discussion of the net specification below is hatched from similar arguments as with the asymmetric case. However the thinking is that it is the greatest recessions and booms occurring in a period that will really matter.

The asymmetric case 2 (the net specification)

In an attempt to estimate the effects of oil prices on the macro economy of USA, Hamilton employed a net transformation. In our case it is assumed that both GDP increases and decreases may have effects on inflation. This paper therefore extends Hamilton (1996) nonlinear transformation to the case of recessions and booms values as follows:

$$NGDPI_t = \max\{0, \Delta GD\,\mathrm{P}_t - \max\{\Delta GD\,\mathrm{P}_{t-1}, \Delta GD\,\mathrm{P}_{t-2}, \Delta GD\,\mathrm{P}_{t-3}, \Delta GD\,\mathrm{P}_{t-4}\}\}$$
$$NGDPd_t = \min\{0, \Delta GD\,\mathrm{P}_t - \min\{\Delta GD\,\mathrm{P}_{t-1}, \Delta GD\,\mathrm{P}_{t-2}, \Delta GD\,\mathrm{P}_{t-3}, \Delta GD\,\mathrm{P}_{t-4}\}\} \quad .. \ (1.6)$$

Where $NGDPI_t$ is the net GDP increase and NGDPd is the net GDP decrease. The NGDPI is the amount by which the log of GDP in quarter t, (GDP_t) exceeds the maximum value over the previous four quarters and zero otherwise. The $GDPD_t$ is the amount by which the log of GDP in quarter t falls below the minimum value over the previous four quarters. Similarly, the generated variables are then treated as linear and are used in a linear VAR set up where impulse responses are computed and interpreted as in a linear setup.

Empirical application

The three models considered here are outlined as follows;

$$y_t = c + \sum_{i=1}^{2} \Phi_i y_{t-i} + \varepsilon_t \qquad (1.7)$$

where for the first model y = (Inflation, M_2 , exchange rate (MK/US$), interest rate, GDP). This is named the linear model.

The second model is y= (Inflation, M_2, exchange rate (MK/US$), interest rate, GDP+, GDP-) and this is named the asymmetric model. The third case has y = (Inflation, M_2, exchange rate (MK/US$), interest rate, NGDPI, NGDPD) and this is named the net specification model which is also asymmetric in practice.

Data

This paper is based on data for the Malawi economy obtained from the Reserve Bank of Malawi, the International Financial Statistics (IFS) webpage as well as the Malawi National Statistical Office (NSO) bulletins. Analysis has been conducted in Microfit 4.1.1 and STATA 8. The series comprises of data on quarterly inflation, real GDP, real exchange rates, real interest rates and broad money supply. All variables are seasonally adjusted. The dataset is one of the longest involved in such studies in Malawi spanning the period 1970 through 2000s hence a total of 140 observations.

The variables are constructed as follows; real GDP is the chain-weighted measure of gross domestic product where the base year changes every two years such that the average prices for the year 2000 and 2001 are used to measure real growth from 2001 and 2002. The real GDP and its modifications proxy demand shocks but can also proxy supply shocks. Inflation is the rate of change of prices where the price index is the Consumer Price Index (CPI), money supply is the M2 and proxies the role of monetary policy, real interest rate is nominal interest rate (the treasury bills rate) less inflation while real exchange rate is the nominal exchange rate times domestic CPI divided by the United States CPI, and is the variable through which international prices impact Malawi's economy and it is also a proxy of supply shocks. It is these variables that are then used in levels or changes to fit the VAR on which the impulse responses, error variance decomposition functions and all other computations are based.

EMPIRICAL RESULTS AND DISCUSSION

Here empirical results starting with the descriptive nature of the results to the model results are presented.

Unit root tests

It is important in multivariate analysis to run regressions with similar orders of integration to avoid getting spurious

results. In respect to this caveat, this paper presents results from unit root tests implemented via the Augmented Granger Dickey Fuller tests as shown. Table 1 shows results from Augmented Dickey Fuller tests. According to this test all the variables namely consumer price index (CPI), broad money supply (M2), gross domestic product (GDP), exchange rate (EXR), real interest rate (IRR) in levels are not stationary as their corresponding AGDF statistics are larger than -3.4455 the critical AGDF statistic for the trended regression thereby failing to reject the null hypothesis of unit root. The conclusion is the same even if a non-trended regression is employed. In order to ascertain stationarity, the same AGDF tests are applied on the rates of change for the same variables.

Table 2 shows unit root tests on the rates of change of the variables tested. From the Table 2, the change in CPI (inflation) together with the rest of the variables suggest a rejection of the unit root process (implying that the changes are stationary) as their AGDF statistics are all smaller than the critical value of -3.445 for the trended regression and again smaller than -2.8842 a critical value for the non-trended regression. This finding renders these variables suitable for meaningful regression analysis.

Table 1. Unit root tests on level variables.

Variable	AGDF Statistic	LAG
CPI	-1.76	ADF(6)[trended]
GDP	-1.59	DF[trended]
EXR	-0.82	ADF(2)[trended]
M2	-1.704	ADF(12)[trended]
IRR	-1.843	DF[trended]

The critical values for the non-trended ADF regression here is -2.8842 while for the trended regression is -3.4455. Trended means the AGDF regression includes a trend otherwise it does not. Selection of statistics is done with reference to AIC and SBC.

Table 2. Unit root tests for variables in changes.

Variable	AGDF Statistic	LAG
ΔCPI	-4.24	ADF(5)
ΔGDP	-4.525	ADF(3)
ΔEXR	-7.74	DF
ΔM2	-5.3699	ADF(3)
ΔIRR	-10.28	DF

The critical values for the non-trended ADF regression here is -2.8842 while for the trended regression is -3.4455. Trended means the AGDF regression includes a trend otherwise it does not. Selection of statistics is done with reference to AIC and SBC.

Empirical tests

Following the results from the unit root analysis this paper has set up and analyzed a vector auto regression model of variables in changes. This is permissible because none of them follows a unit root process. Next is a description of results from all the three models considered in this paper. A detailed discussion is centred on the net specification as it has turned to be our preferred model based on likelihood ratio tests and Akaike Information Criterion where a model with the largest values of these is chosen. For convenience, this paper uses the term 'standard VAR for the model where GDP enters only as change in GDP in the VAR; asymmetric VAR for the model where GDP enters as GDP- and GDP+; nonlinear VAR for the model where GDP enters as NGDPI and NGDPD where these are as defined in the methodology section above.

Standard VAR (Linear in GDP)

Below are results from a standard vector autoregressive model. Here recessions are treated in the same way as economic booms.

Results from the standard VAR analysis are shown in Table 3. From this Table 3, one notes that inflation seems to be influenced positively by its past levels, past levels of money supply, negatively by GDP in the past two quarters and positively by exchange rate changes in the previous quarter. It is also shown that the period 1970-1993 was associated with lower levels of inflation while1991-2004 was a high inflation regime as evidenced by the dummy variable D70 (defined such that 1991-2004 = 1) which is marginally significant. This dummy

Table 3. Results from the Linear VAR.

Dependent variable (Inflation)	Coefficient	Standard error
INFLATION(-1)	0.21315**	0.091726
INFLATION(-2)	-0.21705**	0.089222
ΔM2(-1)	0.11022***	0.038783
ΔM2(-2)	0.16229***	0.038285
ΔGDP(-1)	-0.00455	0.019567
ΔGDP(-2)	-0.040279**	0.019663
ΔEXR(-1)	0.12369**	0.058319
ΔEXR(-2)	0.042418	0.060119
ΔIRR(-1)	0.036008	0.041983
ΔIRR(-2)	-0.023487	0.042168
D70	1.5025*	0.83215
CONSTANT	2.0241***	0.83215
ADJ RSQ	0.37491	
Serial corr Chi-sq	CHSQ(4)= 7.0421[0.134]	
Heteroskedasticity chi-sq	CHSQ(1)= 2.6034[0.107]	
Normality	CHSQ(2)= 2.2302[0.110]	
AIC=-397.3; EQUATION LR-STATISTIC=385.3		

Note: *, **, *** means significant at 10, 5 and 1% respectively.

Table 4. Summary of Granger causality results from the three models.

Variable	Linear ∆GDP (Model 1)	Asymmetric specification(GDP +, GDP-) (Model 2)	NET specification (NGDPI, NGDPD) (Model 3)
INFLATION	0.001***	0.001***	0.000***
NGDPI			0.034**
NGDPD			0.045**
∆EXR	0.029**	0.023**	0.003***
∆IRR	0.317	0.445	0.331
∆M2	0.000***	0.000***	0.000***
∆GDP	0.068*		
∆GDP+		0.396	
∆GDP-		0.000***	

The null hypothesis is that variables are non- causal in the system.
Key *, **, *** signify statistical significance at 10% 5%, and 1% respectively; the numbers are P-values.

roughly reflects macroeconomic policies before and after the introduction of multiparty politics in Malawi. The model does not suffer from serial correlation as well as heteroskedasticity as evidenced by the insignificant chi-square values resulting from the tests. Explicit test for the presence of ARCH effects failed to reject the no arch effect hypothesis and the results suggest absence of volatility clustering in the inflation variable. The test had a resultant Lagrange multiplier with a chi-sq (1) value of CHSQ(1) = 0.25438 and a p-value of 0.614 suggesting that the null hypothesis of absence of ARCH effects could not be rejected.

Likelihood ratio tests

This part of the paper presents in advance a summary of Granger causality (GC) results from the three models discussed herein. Typically GC is applied following implementation of a chosen VAR.

The Table 4 presents results from different specification. The second column shows results from standard linear model where only changes in GDP are included, the third column shows results from an asymmetric model while the fourth column shows results from the nonlinear net specification. These results show that in the linear model, past values of inflation (inflation inertia), changes in exchange rates and changes in money supply are not negligible in the system of equations for the five variables while changes in GDP aremarginally non-negligible.

In the asymmetric case, the same variables as before are 'causal' in the system while GDP- (recessions) are also highly 'causal' but economic booms (GDP+) are quite negligible which seems counterintuitive until one considers that Malawi's GDP has a greater component of agriculture such that since people are dependent on domestically produced food, any decrease in supply of food say due to poor rainfall, is quickly felt and pushes the prices up quite quickly. However an increase in agricultural commodity supply, may affect prices downward, but not as much as they are pushed up by scarcity. Prices seem to be sticky downwards. The latter results for GDP changes are supportive of the differential behaviour that booms and recessions have on the economy. In the net specification model where NGDPI is a boom and NGDP is a recession as defined previously, all the variables which were significant before are also significant and on top of that, recessions and booms are also significant implying that they have a causal relationship in the system of equations comprising the six variables.

The contribution of the latter findings to the hypotheses is that it is now clear from the asymmetric and net specifications that booms and recessions have an effect in the system though it is not yet known whether they are different statistically. And from all the models, it is evident that money supply changes, inflation rates, exchange rates and changes in GDP are important (causal) in the system. The real interest rates seem non-causal in the system possibly because since the financial markets are underdeveloped in Malawi, the effect of interest rates on the money supply and demand and hence prices, which is often through loans is almost ignorable.

The VAR results as they appear above may not have much to say in terms of policy purposes. An analysis of impulse responses as a result of shocks to error terms of these policy variables however may be more useful. In this regard, this study proceeds by presenting results from the Generalized Impulse Response analysis (GIR). The oscillating nature of the responses is not very novel and several other authors have attributed this to the

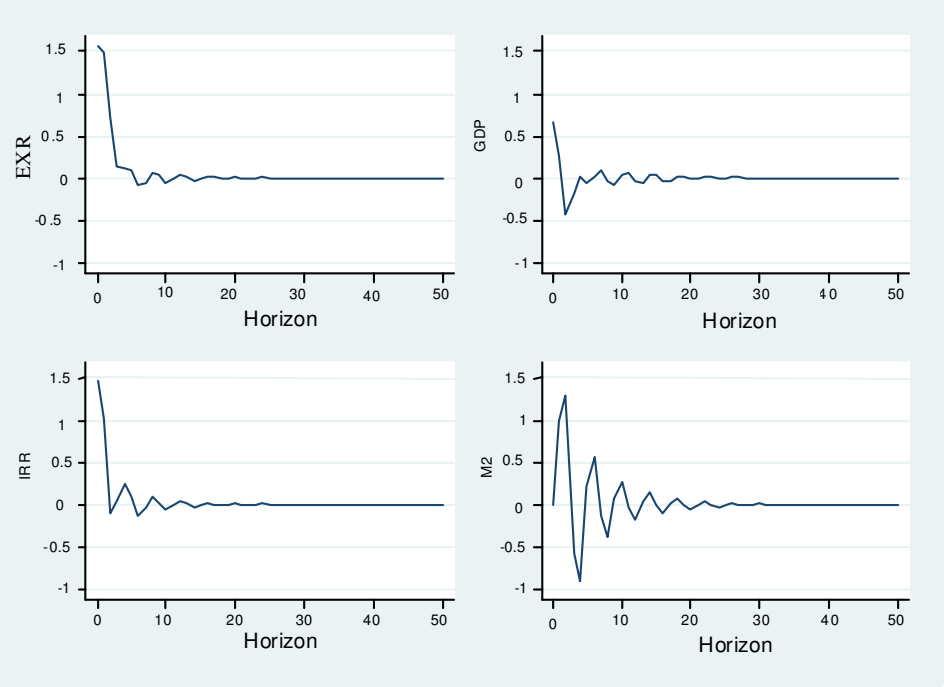

Figure 2. Generalised Impulse response graphs of inflation following shocks in different variables.

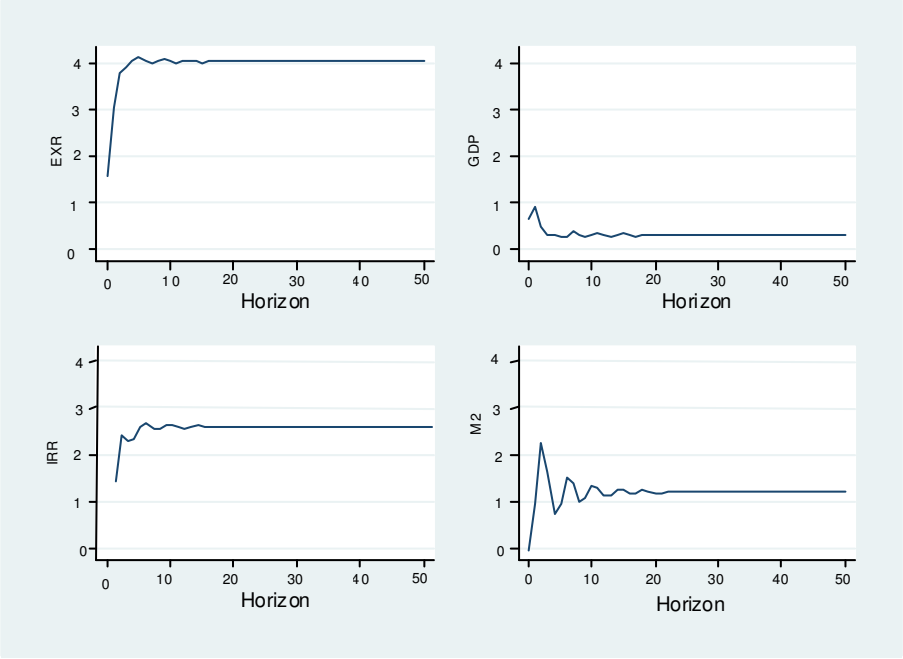

Figure 3. Graphs showing cumulative impulse responses of inflation following shock in the other variables.

underdevelopment nature of financial markets in developing countries and this seems plausible in Malawi where money markets are in their infantile stages such that any external shock could generate ups and downs in the economy as agents try to adjust to the shock.

The graphs in Figures 2 and 3 above, show inflation responses to different shocks. Figure 2 shows that inflation increases following a depreciation (more Malawi

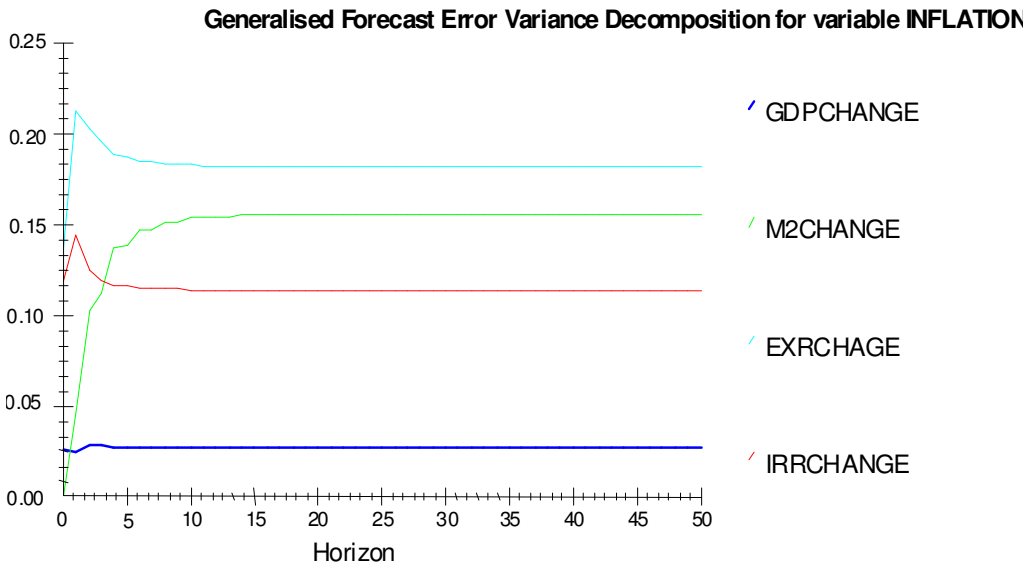

Figure 4. Forecast error variance decomposition for variable INFLATION.

Kwacha/US$) and an increase in money supply. This is consistent with theory because an increase in money supply (say due to donor aid, grants, or increases in credit in an economy) directly impacts on prices positively if the supply is not paralleled by output growth and , on the other hand, a depreciation generates (among other things) foreign demand for domestically produced goods. This puts pressure on domestic prices resulting to a hike in prices which may very well be inflationary.

Economic boom seems to increase inflation initially but tends to decrease it at later stages. This may happen if the first stages of booms is characterised by incomes rising more than output leading to too much money chasing too few goods. Thereafter, inflation may decrease as enough goods get produced in the economy. Figure 4 in particular summarises the cumulative effect of such shocks on inflation and it can be seen that cumulatively, depreciations, money supply increases as well as interest rate increases are inflationary while output increases are marginally inflationary. And this is on the whole not novel. Normally an increase in the real interest rates reduces investment demand in a closed economy and so should be associated with less inflation, however in a small open economy model such as the present one, it is possible that an increase in real interest rates makes it attractive place for foreign investments and such generated investment demand imposes pressure on domestic prices thus creating some inflation.

Figure 4 shows graphs for forecast error variance decomposition. It shows that innovations in exchange rate, money supply and interest rates are major sources of variation in the inflation innovations while innovations in GDP account for a smaller part of the innovations in inflation. In essence, Figures 2 through 4 point to the fact that indeed variation in inflation could be attributable to variation in changes in exchange rates, interest rates, GDP and money supply. The results presented in the aforementioned Tables and Figures 2 through 4 suggest a rejection of the null hypothesis that the regressors in inflation model are zero.

The asymmetric VAR

Impulse responses from asymmetric VAR

Figure 5 present the responses of inflation to shocks in the regressors. On the whole the results are not very different from the linear model since the effect of increasing money supply and depreciation is an increase in inflation due to the reasons discussed earlier. Further, a recession calls for an increase in inflation than a reduction. There is instability until after twenty quarters. In general all shocks seem to persist until after twenty quarters. A recession (GDP-) has a smaller initial impact on inflation but it is more persistent. On the other hand booms (GDP+) have larger impacts initially on inflation but the impact dies out in subsequent quarters and indeed is less persistent compared to recessions which have longer durations. This finding points to different policies which could be used to control inflation or its effects in the presence of a boom or a recession.

A recession has to be avoided if possible because, its effects on the macro economy may stay for a longer period of time. At this juncture it could be argued that recessions are different from booms in terms of the impact they have on inflation. This finding then rejects the hypothesis that recessions and booms have similar

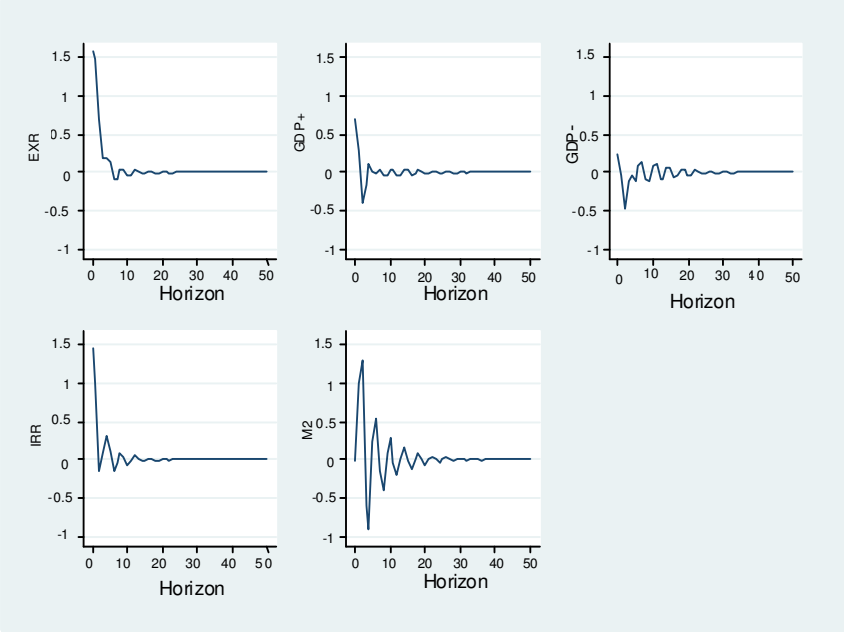

Figure 5. Generalized impulse responses of inflation to impulses in the named graphs.

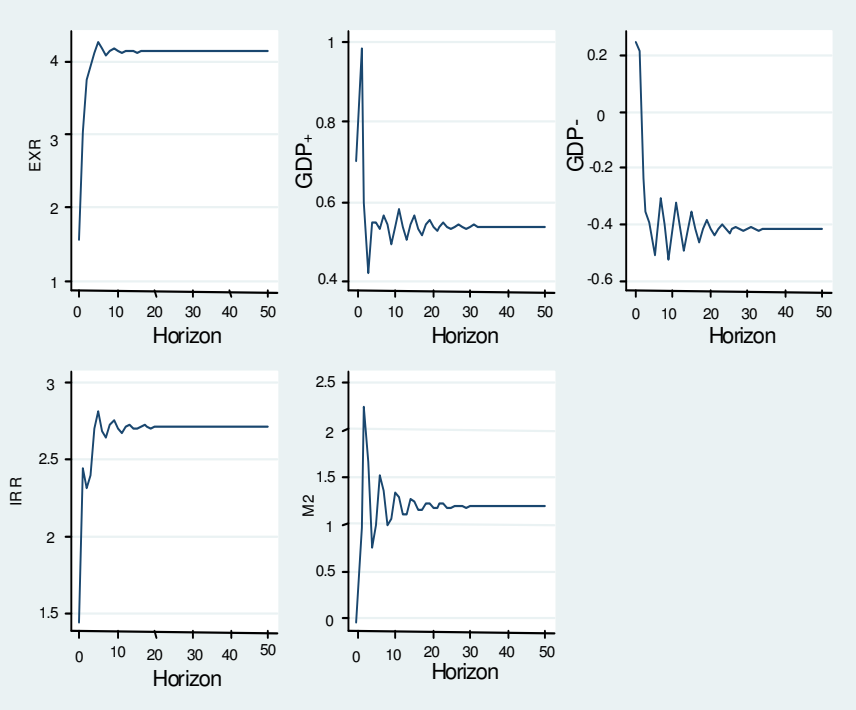

Figure 6. Cumulative generalized impulse responses of inflation to the impulses in the named variables (asymmetric case).

impacts on inflation. Figures 5 and 6 complement each other in showing the effects of shocks on various variables on inflation, and, more importantly, they show that recessions (GDP-) are overall, more inflationary than booms (GDP+) pointing to the thesis that booms should be treated differently from recessions. Figure 7 shows

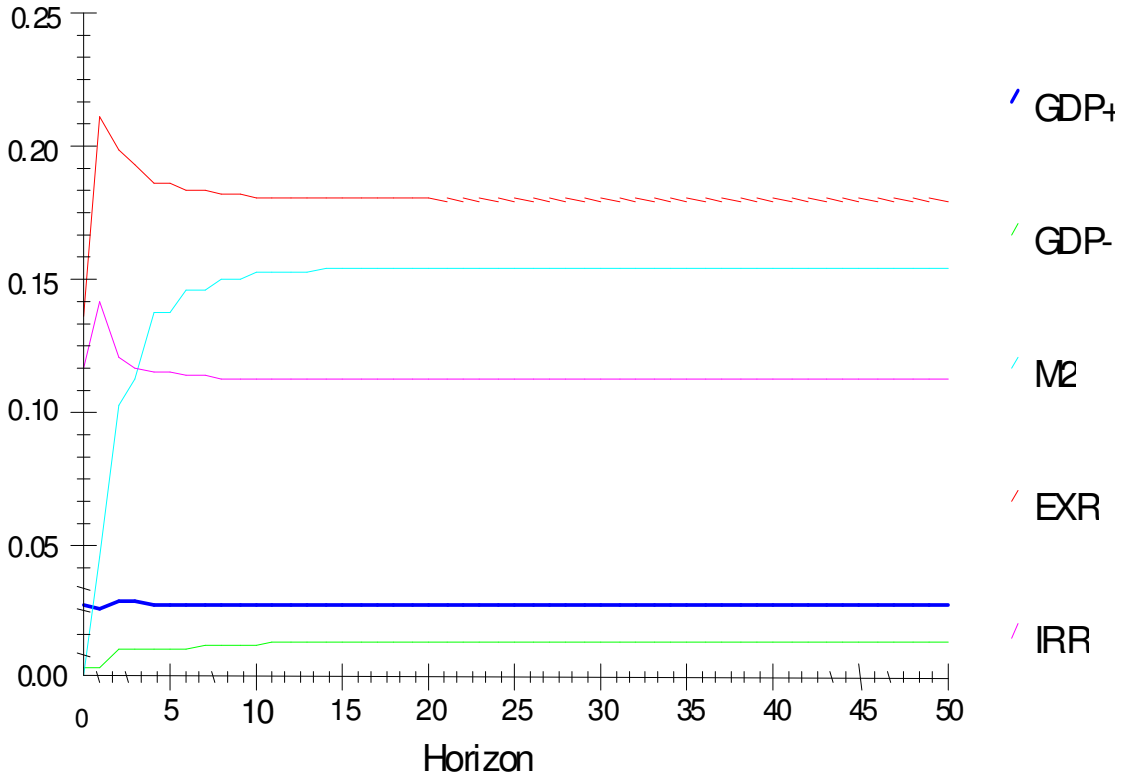

Figure 7. Generalized forecast error variance decomposition for variable INFLATION.

Table 5. Nonlinear inflation model (asymmetric).

	Coefficient	Standard error
Inflation(-1)	0.25837***	0.096276
Inflation(-2)	-0.21150**	0.097530
ΔM2(-1)	0.079676**	0.032997
ΔM2(-2)	0.12699***	0.033765
ΔNGDPI(-1)	-0.009235*	0.005506
ΔNGDPI(-2)	-0.003097	0.005685
ΔNGDPD(-1)	0.0033999***	0.0011416
ΔNGDPD(-2)	-0.009112	0.0011354
ΔEXRCHAGE(-1)	0.079676	0.059476
ΔEXRCHAGE(-2)	0.096420	0.061351
ΔIRRCHANGE(-1)	0.031808	0.042239
ΔIRRCHANGE(-2)	-0.032448	0.041597
D70	2.3100**	0.89130
Constant	1.9436***	0.63642
Adj. Rsq	0.39454	
Serial correlation	CHSQ(4)= 5.9223[0.205]	
Functional Form	CHSQ(1)= .39027[0.532]	
Normality	CHSQ(2)= 2.1302[0.100]	
Heterosckedasticity	CHSQ(1)= 2.8854[0.089]	
AIC=-396.03; EQUATION LR –TEST STATISTIC=-382.03		

that exchange rate interest rate and money supply are the major sources of inflation while booms are more inflationary than booms, though as we have seen earlier, recessions are more persistent.

Net specification (Asymmetric Case 2)

Based on model selection criteria, this paper chooses the net specification as a centre of discussion, recommendations and conclusion.

Table 5 presents results from a nonlinear model of inflation where GDP is replaced by net GDP increase (NGDPI) and net GDP decrease (NGDPD) as discussed. More focus is placed of this model as it is a model of choice here.

The Table 5 above shows that determinants of inflation are the past changes of inflation in the last two quarters, money supply in the last two quarters, recessions (net GDP decreases), booms (net GDP increases) and the period before 1993 was still associated with lower levels of inflation. A Wald test of asymmetric effects (that GDP decreases and increases impact differently on inflation) is computed to be 10.28 and is highly statistically significantly different from zero with a p-value of 0.001. This finding should remind researchers of the error committed when a standard symmetry is assumed for the effects of

Table 6. Granger causality results.

Equation	Excluded	Prob > chi2
Inflation	NGDPD	0.0071***
	NGDPI	0.1678
	m2change	0.0000***
	irrchange	0.5481
	Exchange	0.0119**
	ALL	0.0000***
NGDPI	inflation	0.1335
	NGDPD	0.7363
	∆m2	0.4420
	∆irr	0.9511
	∆exr	0.2677
	ALL	0.0640*
∆m2	Inflation	0.0258**
	NGDPD	0.8742
	NGDPI	0.4190
	∆irr	0.2367
	∆exr	0.1505
	ALL	0.0091***
∆irr	Inflation	0.0593*
	NGDPD	0.0984*
	NGDPI	0.0066***
	∆m2	0.6035
	∆exr	0.0112**
	ALL	0.0102**
∆exr	Inflation	0.0150**
	NGDPD	0.0374**
	NGDPI	0.7121
	∆m2	0.0651*
	∆irr	0.2475
	ALL	0.0188**

booms and recessions in the inflation determination model. From Table 6, it can be seen that past values of recessions (ngdpd) are causal in the inflation equation.

The net GDP decrease (NGDPD) granger causes inflation highly significantly but inflation does not granger cause NGDPD. This suggests that persistence of recessions will have an impact on the inflation regime of an economy. It is possible that recession effectively reduces the amount of goods available leading to increased prices. Changes in money supply (M2) highly significantly granger causes inflation and inflation is also seen to granger cause changes in money supply. One implication of this is that an increase in money supply stimulates demand which then pushes prices upwards in the quarters to come, but this inflation reduces the real value of money calling for relatively more extra funds to purchase items which were probably purchased at lower prices.

Real interest rates seem to be granger caused by inflation possibly because an increase in inflation may reduce deposits as people convert financial resources to other capital and inflation proof assets. This invites scarcity of money in banks so that real interest rate rises for the few people who might want loans. This is similar to the findings of Stock and Watson (2001) where it was found that the Federal Funds interest rate did not granger cause inflation but that inflation did granger cause real interest rates. This result could also follow from the familiar Fisher effect and the definition of real interest rates. There seems to be some independence between inflation and net increases in GDP in this dataset.

Table 7 is supplementary to the granger causality tests. Other than testing for non-causal relationships, the latter tests, aim to examine the net effect of the two lags for each variable. Only in the net specification does the net effect for ∆GDP turn to be significant at 10%. Changes in money supply and exchange rates however have proven to be non-ignorable regardless of the model chosen and regardless of the test considered.

Figure 8 shows that inflation increases more during recessions than during booms and is even more persistent during recessions signaling that there are reasons for governments to pull up socks in the wake of recessions, as the days following recessions are likely going to be inflationary. Inflation response in this case takes on alternating signs but the average is above zero signifying that a recession increases inflation doubtlessly. A rainfall failure may negatively impact agriculture leading to an economic recession. This economic recession may be associated with an increase in inflation immediately and in the years to come. Contrary to the case of a boom, a recession leads to an undisputable increase in inflation possibly resulting from a reduction in output demand resulting in increased price hikes. On average there is also an increase in money supply as governments try to dampen the effects of inflation. This increase in money supply may lead to an increase in future inflation. Exchange rate depreciation results from the fact that in the wake of a recession, imports may have to increase leading to an increase in demand for dollar which then leads to a depreciation of kwacha. The increased interest rates may be due to the increased demand for loans as money becomes scarce in the economy. Figure 9 shows that the cumulative effect of a recession is an increased inflation while the increase in inflation due to a boom, is relatively less. Figure 10 shows that NGDPD unlike NGDPI, accounts for a larger percentage of the forecast error variance in inflation.. Therefore, based on the latter model, the hypotheses that these regressors are zero in the inflation equation, and that recession and booms have symmetric effects on inflation can be rejected. According to empirical results suggested by VAR, impulse responses and error variance decomposition, the direct linkages between monetary policy and inflation appear to be strong. This may be cited as an argument

Table 7. Summary of Wald tests for joint significance of coefficients of the 2 lags of variables for all the models.

Dependent variable (inflation)	MODEL		
	Linear ∆GDP	Asymmetric specification(GDP+, GDP-)	NET specification (NGDPI, NGDPD)
INFLATION	0.973	0.763	0.701
NGDPI			0.110
NGDPD			0.067*
∆EXR	0.014**	0.017**	0.005***
∆IRR	0.826	0.832	0.991
∆M2	0.000***	0.000***	0.000***
∆GDP	0.168		
∆GDP+		0.903	
∆GDP-		0.170	

for inflation targeting regime in Malawi because for a successful inflation targeting regime, monetary policy instruments such as money, interest rates and exchange rates must contain strong and predictable information about the future path of inflation. From the findings it seems that there is evidence of the existence of a monetary transmission mechanism in the short run (when prices are sticky) where an increase in money supply may lead to a reduction in interest rates and an increase in income which in turn increases aggregate demand for goods and services and which may lead to some inflation.

Comparison with findings from Malawi's neighbours

These results are comparable to results from Malawi's nearest neighbours and trading partners. According to Akinboade et al. (2002), in South Africa the sources of inflation from a variance decomposition method we found to be innovations from past values of inflation which accounted for over 70%, effective exchange rates, and interest rates and real GDP had the least influence. This motivated the authors to conclude that a control of inflation could be achieved through the control of the South African Rand exchange rate among other policies. This is also similar to Malawi's case as unveiled in this paper though there are other sources as well.

In Tanzania, Laryea (2001) found that inflation was influenced greatly by money supply and output in the short run but that in the longer run inflation was also influenced by exchange rates. It did not escape their notice that to control inflation the Tanzanian government needed to adopt a contractionary monetary policy while encouraging improved food production as agriculture plays a greater role in the Tanzanian economy. These findings are consistent with the findings in this paper at least to the extent that this paper finds money supply, exchange rates and recessions inflation inducing factors.

Derevall and Ndung'u (2001) found that inflation was influenced by exchange rate movements, foreign prices, interest rates, terms of trade money supply food prices and inflation inertia (past values of inflation) in Kenya. Their conclusions were that inflation could be kept stable in Kenya via policies which bolstered exchange rate stabilization and those which sought to provide food to people in times of drought. This is similar in many respects to this paper's findings. In Zambia, inflation has been mainly due loose monetary policy and foreign debt (Terra, 1998). The uniqueness of this paper emanates from the fact that it goes beyond the standard analyses and shows that booms and busts do not have symmetric effects on the inflation regimes. This is very important for policy purposes and studies that have ignored this step could be incapable of prescribing policies that would ensure robust handling of inflation and impacts during\ recessions and booms in developing countries.

CONCLUSIONS AND RECOMMENDATIONS

This paper has addressed two major hypotheses, namely the past values of real exchange rates, inflation, real interest rates money supply and real GDP changes do not induce inflation both jointly and individually, and that economic booms and recessions induce inflation in equal proportions. Analysis has been done in terms of vector autoregressions by using three specifications, namely a linear model, asymmetric model and a net (nonlinear) specification (which is asymmetric as well) proposed in the literature of analysis of oil shocks on real activity. This paper finds evidence of nonlinear effects of GDP on today's inflation with GDP changes having different effects on inflation when they increase than when they decrease. The nonlinear (net) specification is in contrast with the linear VAR in which GDP changes are assumed to have symmetric impacts on inflation.

This paper is distinct from others in its methodology as

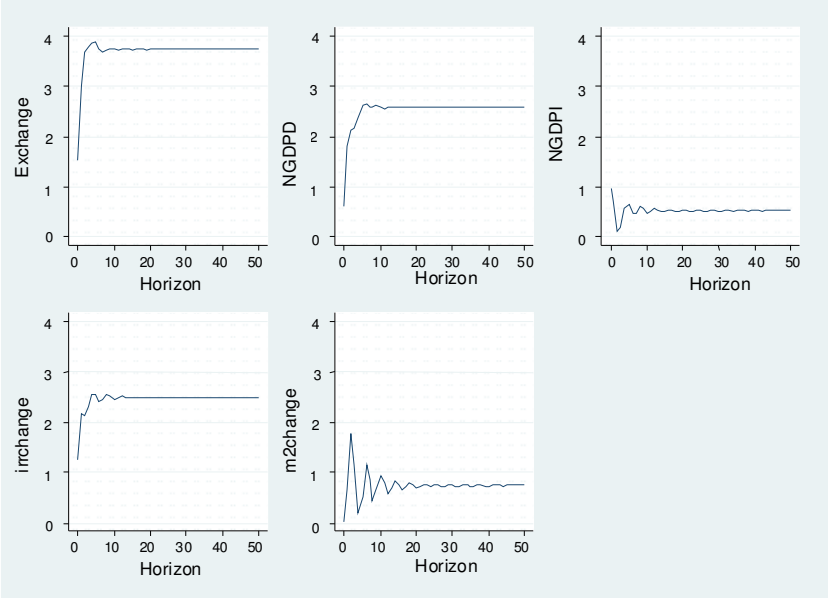

Figure 8. Generalized impulse responses of inflation to shocks in the other variables over years.

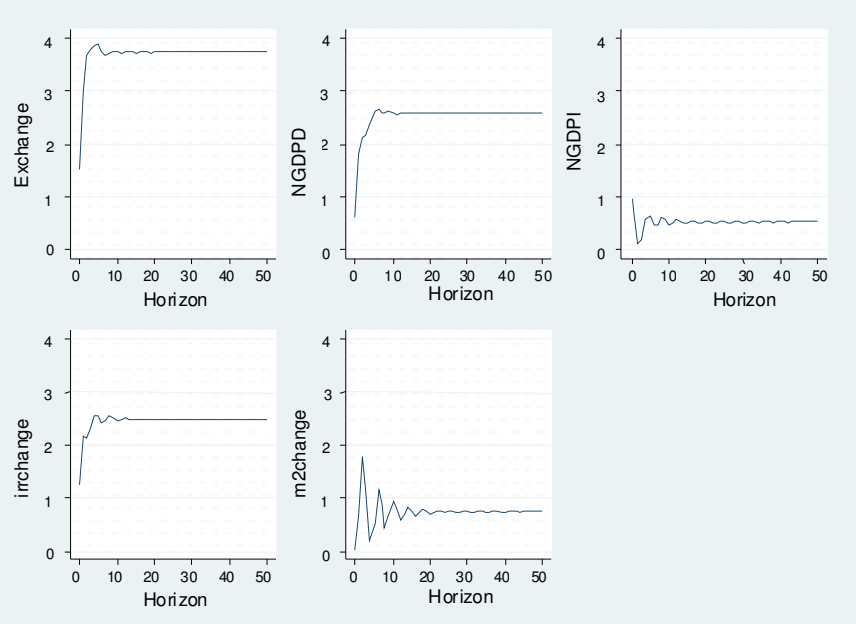

Figure 9. Cumulative Generalized impulse responses of inflation to impulses in the named variables.

it has used VAR with a nonlinear variable GDP based on the intuition that inflation may be induced asymmetrically by recessions and booms. Indeed it is found that recessions are more inflationary than economic booms. The distinction between the effects of booms and recessions on inflation is evident in generalized impulse response graphs and in graphs from their cumulative responses. It is clearly seen from those graphs that the effect of an economic boom is a reduction in rates of change of inflation while recession increase recession.

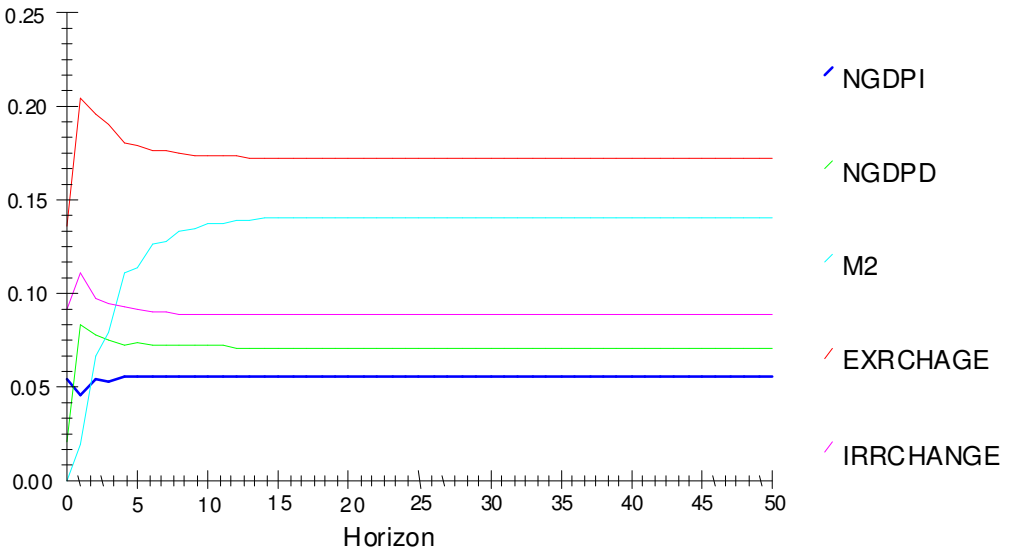

Figure 10. Forecast error variance decomposition graphs, where innovations in inflation are being decomposed.

Innovation accounting results via error variance decomposition analyses indicate that changes in exchange rates, interest rates, money supply, recessions and booms as well as past values of inflation are indeed the sources of inflation. Changes in money supply exchange rates, recessions and interest rates are further suggested to be the main sources of variation in inflation. This implies that if a recession is deemed greater relative to the previous slumps in the economy, it should be conceived that a period of enormous recession will follow and policy makers should not be taken unawares. On the other hand, if it is possible to control money supplies the better for inflation stability in the quarters to come.

Drawing from the findings, this paper concludes that for now in order to control inflation, agricultural production needs to be enhanced as it accounts for a greater proportion of Malawi's GDP (Malawi's economy is predominantly agro-based with agriculture accounting over 38% of the GDP, where tobacco, tea and sugarcane are among the major exports. Policies which would ensure availability of food in times of drought could also help to dampen price increases and thereby keeping inflation at bay.

As a way of building on this research, future researchers may have to consider including other measures of money supply and they may further have to consider treating inflation as a nonlinear variable to see if there could also be differential impacts between high inflation regimes and low inflation ones on the macroeconomy.

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