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Effectiveness of Monetary Policy in Kenya

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Abstract
Despite the central financial role, Kenya plays in the East-African economies, Cheng (2006) notes that, there is scanty information to validate the monetary policy effectiveness. The article aims to unravel the kind of monetary policy Kenya pursues and identify the effective policy instruments and their effects. Quarterly time series data covering the years 2000 (2000:1) to 2014 (2014:1) were used. The empirical results reveal that; - interest rates have no significant long-run or short-run effects on both output and inflation; real money demand and reserves have short-run, but no long run effects; asset prices, deposit rates and lending rates have no short run but have long run effects. The exchange rate and domestic credit have both short run and long run effects even though domestic credit has no significant long run effects on inflation.
Keywords: Kenya's monetary policy, ARDL Model, Impulse Responses, Variance Decomposition

1 Introduction

The proposition that, policy interventions influence macroeconomic behavior is a leading line of thought amongst the practitioners and researchers (Cheng, Kevin 2006). For any economic prosperity, price stability is a key determinant. Central banks via monetary policy, therefore play a pivotal role in the development of well-functioning markets in any economy through their intermediate role. Swanepoel, Jan (2004) noted, monetary policy serves the overriding objective of macroeconomic policy. Monetary policy has a wider appeal by policy makers mainly due to its shorter implementation lag, countercyclical and easily reversible properties, and more predictable impact.

In line with IMF recommendations, Kenya's conservative monetary policy mainly focuses on keeping both interest rates and inflation low, in line with the main goal of is maintaining a stable price level. A central question, therefore, is whether the Kenyan monetary policy truly has any significant influence on inflation and interest rates. Several studies have examined this question in light of developed and emerging economies, but have come to different conclusions, creating confusion especially for developing markets like Kenya in determining the effects of the monetary policy. For developed markets like the USA, many studies establish a substantial and significant policy effect, whereas many more are of contrary opinion. The resultant ambiguity and non-consensus puts central banks in an awkward position while determining their long-term policy impacts.

Notwithstanding the prominence of Kenya's financial role in East-African economies, Cheng (2006) notes that there is minimal research done to investigate Kenya's monetary policy impact. The impact is crucial for any meaningful design, management, and implementation of monetary policy. The paper therefore, focuses in detail, on a country specific study rather than generalizations experienced in cross-country analysis. The findings will hopefully, sprout out the unique empirical analysis on the monetary policy effects in Kenya. Secondly, the paper will make use of several techniques, including ARDL and impulse response to analyze the murky relationship of monetary policy and other economic variables, with a view of empirically shedding some light on their effects on nominal exchange rate, prices, interest rates, and output.

2 History of Kenyan Monetary Policy

Kenya's economy through the famous Sessional Paper No. 1 of 1986 turned its back on its post-Independence *dirigisme*, and set herself towards economic liberalism mainly due to the sequence of events that accelerated the reform pace. The turning point for the Kenyan economy appears to be the early 1990s. After the general hardening of donor attitudes and a standoff with the IMF in 1992 which lent to a substantial tightening of the external budget supplement, prompting government to quickly institute fiscal controls, elimination of *de jure* capital controls and agree to the floating exchange rate. This regime change resulted into monetary policy conventionally anchored around a broad-money, with a functional operating target been the reserve money. The Central Bank of Kenya (CBK) mainly uses the quantity-based monetary aggregates M3 as "the principal intermediate target", with operating instrument been the volume of reserve money, to conduct her monetary policy.

The IMF has supported Kenya in developing infrastructure, institutional and statistical reforms, data collection, and analytical capabilities with a view of moving towards adoption of inflation targeting policies that ensure low and sustained inflation levels. This calls for a regime shift from a money-growth to inflation targeting in Kenya. Developing economies, however, struggle adopting a "fully flexible" exchange rate regime; the theoretical condition for "strict IT", with many preferring "de-facto managed-floating" exchange rate, or implementing "flexible IT", with interventions in the forex market to moderate the volatility (Berganza, Juan &

Carmen Broto, 2012).

Laurens and others (2015) classifies Kenyan's current monetary regime as "Monetary Targeting with Floating and Free Floating Regime", while the immediate former CBK governor, Professor Njuguna Ndung'u in a book chapter (Adam, Christopher and others, 2010) associated with him notes that:

> ***"****In terms of structure and conduct, the Kenyan monetary regime is, at present, a hybrid. The authorities publish an explicit inflation target but concerns about the level and volatility of the exchange rate remain ever-present and the debate on the extent to which monetary policy can, and should be used to address concerns about external competitiveness is active. ... Thus while, for the moment, the Kenyan authorities have stopped short of implementing a full-fledged formal inflation-targeting structure there are pressures to move decisively in this direction". (p.162)*

3 Theory

Ever since Bretton Woods system collapse, the monetary regime choice, more so in emerging and developing economies, has been regularly evaluated (Mohanty, Biswajit & NR Bhanumurthy, 2014). The high inflation episodes of the 1970s and 1980s lead many countries to pay great attention on the exchange rate regime credibility facets plus its contribution in realizing lower inflation. Generally, in theoretical literature low inflation is easily attained in a stable exchange rate environment. However, with the existence of the impossibility trillema, the stable regime can easily turn inflationary under a capital account openness (Mohanty & Bhanumurthy, 2014). Before Argentina's currency board collapse (2002 crises), it had been widely accepted that countries adopt either free floats or hard pegs i.e., 'bipolar view' or 'corner solution'. However, after Argentina experience, the hard peg was discarded, and as a result, the majority of the developing and emerging countries adopted flexible exchange rate regimes, though not pure float regime shift. Due to "fear of float", many prefer a "constrained float" were they regularly intervene resulting in a "de facto" fixed regime of some sort. Many studies have observed that, "the official or de jure exchange rate regime as reported by the country's monetary authorities may be different from the actual or de facto exchange rate regime based on the actual behavior of exchange rates". This is due to the realization that, severe appreciation or depreciation is more harmful in developing and emerging economies mainly due to capacity and institutional constraints. Mengesha & Holmes (2013) investigated the monetary transmission mechanism for Eritrea and established that the official exchange and rate interest rate are both inoperative. However, the domestic credit and the black exchange rate were effective, an indication that the Eritrea bank can control inflation via reserve requirement ratio manipulation.

Pontines, Victor & Reza Siregar (2012) demonstrated that, the flexibility of exchange rate movements is significantly higher on currency depreciation than appreciation for the emerging countries that adopted inflation targeting as they "tend to adopt a form of asymmetrical exchange rate behavior, wherein appreciation pressures are restrained more substantially than depreciation pressures". The impossibility trillema of Mundell predict that a stable exchange rate combined with an open capital account may result to a lack of monetary policy control and higher inflation. Mohanty & Bhanumurthy (2014) however, observed that the stability of exchange rate is critical in order to manage inflation mainly because of reduced pressures on domestic inflation via a "policy discipline effect – restricting money supply growth", and a "credibility effect – inducing higher money demand and reduced velocity of money".

Mishra, Ankita & Vinod Mishra (2012) established the existence of trade-off between exchange rate stabilization and output gap stabilization in flexible domestic CPI targeting and inflation targeting. Misati, Nyamongo & Mwangi (2013) established that both food and oil prices play a significant role in several measures of inflation, with food prices been more important in explaining the "overall non-fuel non-food inflation" while the effect of oil prices on inflation remained more persistent.

Beckworth, David, Kenneth Moon & Holland Toles (2012) estimated the monetary policy shock effects on interest rates and observed that, "it can strongly influence long-term interest rates, but only when the Federal Reserve has inflation-fighting credibility and is able to firmly anchor inflationary expectations". Monetary policy, is commonly used in many economies for short-run fluctuation stabilization. However, its effectiveness has been of constant interest for researchers. Alam, Rafayet (2015) established that the policy rate may not be effective in managing short-run fluctuations, for Bangladesh economy, they were not statistically significant.

Arin, Kerim & Timur Gur (2009) suggested that Turkey is better off with money-based targeting as opposed to exchange rate targeting; "the exchange rate does not have the traditional hump-shaped effect that money supply has on output". They further observed longer-lasting effects from monetary innovations, while exchange rate depreciation only had transitory improvements on the current account. Cheng (2006) examined the Kenyan monetary policy and observed that, "an exogenous increase in the short-term interest rate tends to be followed by a decline in prices and appreciation in the nominal exchange rate, but has an insignificant impact on output. Moreover, the variations in the short-term interest rate account for significant fluctuations in the nominal exchange rate and prices, while accounting little for output fluctuations". Alam, Rafayet (2015) established that, an unexpected positive change in the interest rate supersedes exchange rate appreciation, the decrease in output

and an increase in the price 'the price puzzle'.

Durevall and Ndung'u (1997) found that both money supply and interest rates have short-term effects, while foreign prices, trade and exchange rates have long-term effects on prices. Cheng (2006) observed a strong link using Kenya data between policy and nominal variables but "a weak transmission mechanism from monetary policy stance to real variables, an indication of a slew of structural problems in the financial market", including a weak legal framework and inadequate financial infrastructure. Arias, Caldara & Rubio-Ramirez (2015) imposed sign and zero restrictions only - agnostic in Uhlig's sense - in SVAR to identify monetary policy shocks, and established that a shock leads to a reduced output, which they interpreted to mean that, "contractionary effects of monetary policy shocks do not hinge on questionable exclusion restrictions". Reschreiter, Andreas (2011) found that, a shift to inflation targeting reduces the volatility but increases the interest rate deviation persistence, an indication that the choice of the monetary policy regime can influence the long run interest rate stochastic properties. Monetary policy is a key policy instrument especially for developing the country's development framework. In literature, there exist various implementation procedures for monetary policy instruments, and even though they vary within countries; they have some generic standards that can be relied on (Mengesha, Lula & Mark Holmes 2013).

The VAR model is widely used in investigating the monetary policy shock effects on other macroeconomic variables. Noticeable research that used VAR (Beckworth, Moon & Toles, 2012; Arin & Gur, 2009; Bernanke and Blinder, 1992; Cheng, 2006; and Ndung'u, 2000). SVAR (Alam, 2015; Arias, Caldara & Rubio-Ramirez, 2015; Misati, Nyamongo & Mwangi, 2013; Pontines & Siregar, 2012); IV-GMM (Mishra & Mishra, 2012); VECM (Mengesha & Holmes, 2013); ARDL cointegration approach (Mohanty, Biswajit & NR Bhanumurthy, 2014; Huseynov & Jamilov, 2012); OLS (Berganza & Broto, 2012). Generally, the most preferred method is VAR models and its variations (SVAR & VECM) while ARDL is gaining momentum in cases where variables are of different integration order.

4 Data

The article employed quarterly time series data covering the years 2000 (2000:1) to the first quarter of 2014 (2014:1; 57 observations). The variables include exchange rates (ER, KES/USD); Price level (CPI); Output (GDP, "measured in KES and deflated by the consumer price index"). Money supply (M, "M3 and deflated by the CPI"); Reserves (R, "bank reserves and deflated by the CPI"); trade balance (TB, "measured in KES, deflated by the US CPI"); Interest rate (r, "91 day T-bills rate"). Other variables include bank deposit rates, average bank lending rates, domestic credit, Federal Fund's rate (Fed) and oil commodity price index (Oil). The main source of data is official statistics of the IMF, the CBK and Kenya National Bureau of Statistics, as these sources contain the most reliable and detailed collection of data for the Kenyan economy. Several lag selection criterions were used to choose lag length.

5 Empirical Results

5.1 VAR/Impulses evaluation of monetary Policy in Kenya

The VAR model approach constitutes a useful tool to capture the interdependence and the evolution between the multiple time series with complex feedback linkages. Variance decomposition (on VAR model results) were further, applied to track the specific shocks influence and the responses of selected variables over time. VAR models were used to examine the response to shocks. We used the Choleski decomposition of the variance–covariance matrix to identify structural shocks.

We describe the Kenyan economy by the following VAR model;-

$$Z(L)Y_t = B(L)X_t + \varepsilon_t$$

were Z and B are nxn and nxk matrix of coefficients respectively; X_t is a $kx1$ vector of exogenous foreign variables; Y_t is a $nx1$ vector of endogenous Kenya variables; ε_t is a vector of innovations.

The reduced corresponding VAR model is;-

$$Y_t = AY_t + BX_t + \varepsilon_t = A_1 Y_{t-1} + ...A_p Y_{t-p} + BX_t + \varepsilon_t$$

Throughout this paper, Y takes the value $Y_t' = [Z_t \quad GDP_t \quad CPI_t]$, where Z_t takes values: (ER, M, IR, Repo, CBKR, Deposit, Lending, Credit and NSE Index) each at a time, while X takes any of the following variables or even none; $X_t' = [TB_t \quad Oil_t \quad Fed_t]$. We considered different Wald causal orderings, with the higher-ordered variable considered to have contemporaneous effects on lower-ordered variables, whereas lower-ordered variables affect higher-ordered variables with a lag only. The first ordering: $Y_t' = [Repo_t \quad RGDP_t \quad CPI_t]$ which implies that, when the repo-rate is a policy variable (target variable),

we test the effects of one SD shock on it. The other eight (8) orderings are as discussed below. In all estimation, we use the log levels of all variables. The shocks to the various models and IRF results are as reported in figures 1, 2 and 3. The horizontal line values represent time lapsed after shock in quarters, while vertical denotes the deviation from the baseline level of the variable in response to given policy variable shock, and the dotted lines represent 95-percent confidence intervals.

Innovations on Repo Rate

The CBK uses Repo rate to manage the bank's liquidity. We establish short run evidence using the following macroeconomic variables $Y_t' = [Repo_t \quad RGDP_t \quad CPI_t]$ and US fed rate $X' = [fed]$ as exogenous variable. The impulse response (impact) is displayed in fig 1A, with one standard deviation on repo rate shock defined as "an exogenous, unexpected, temporary rise in the repo rate at t=0, on real output, prices and the repo rate". The real output response to innovations on the repo rate is first negative then becomes positive after three quarters, but statistically insignificant in both cases. Similarly, the price (CPI) responded positively to repo shocks for the first three quarters then turned negative thereafter but statistically insignificant in both cases as well. The effect of repo rate shock on output and price therefore seems to be negligible and insignificant, given that 95% confidence band includes the horizontal axis, hence the impact may not be statistically distinguishable from zero; hence, no evidence that the monetary policy via repo rate is effective.

Innovations on Money Supply (M3)

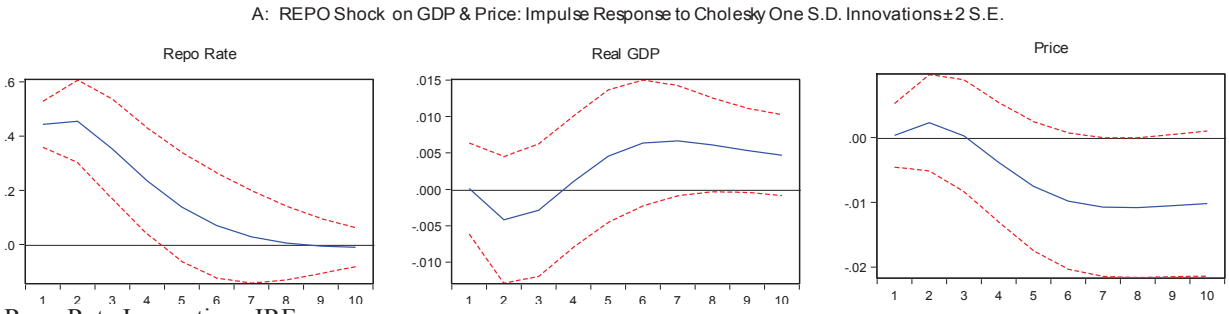
The CBK principal intermediate target been the money supply (M3), we extend our analysis by using M3 as policy variable. We establish short run evidence using the following macroeconomic variables $Y_t' = [RM3_t \quad RGDP_t \quad CPI_t]$ with no exogenous variables. The impulse response (impact) is as displayed in fig 1B, with one standard deviation on demand money shock. The real output response to innovations on the real money demand is positive and statistically significant for the first three quarters, an indication that, real monetary demand shock influence on real output is significant. Conversely, the price (CPI) responded negatively and statistically significant to money demand shocks in the first four quarters. Therefore, the real money demand shock has a significant impact on output and inflation in Kenya; this is evidence that the real money demand may be effective.

Innovations on Reserves

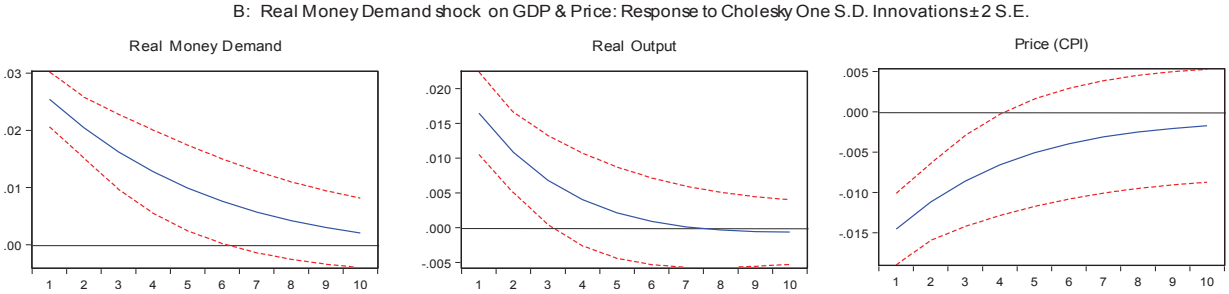
The CBK operating instrument been the volume of reserve money, we extend our analysis by using reserves as policy variable. We establish short run evidence using the following macroeconomic variables $Y_t' = [R_t \quad RGDP_t \quad CPI_t]$ with no exogenous variable. The impulse response (impact) displayed in fig 1C, with one SD on reserve shock. The real output response to innovations on the reserves is statistically significant and positive for the first three quarters, an indication that, the reserve shock impact on real output is significant. Conversely, the price (CPI) responded negatively and statistically significant to reserve shocks in the first five quarters. Therefore, the reserve shock impact on output and price level is significant in Kenya, an indication that, CBK can manipulate inflation and output using the reserve requirement ratio; this is evidence that the reserves may be effective.

Innovations on CBK Rate

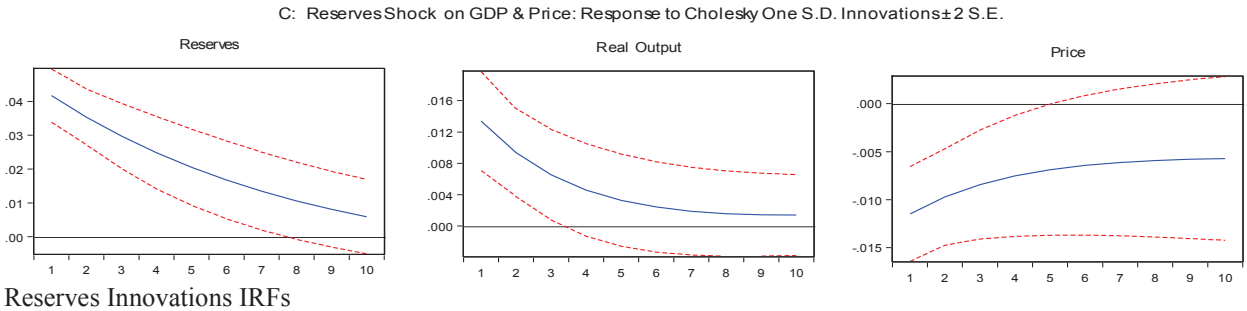
We establish the short run evidence for the CBK rate shock effects via the following macroeconomic variables; $Y_t' = [CBKR_t \quad RGDP_t \quad CPI_t]$ with US fed rate $X' = [fed]$ as exogenous variable. The impulse response (impact) is as displayed in fig 1D, with one standard deviation on central bank rate (CBKR) shock. The real output response to innovations on the CBK rate is first negative, then positive, but statistically insignificant. Similarly, the price (CPI) responded positively to CBK rate shocks for the first four quarters then became negative but statistically insignificant in both cases as well. The CBK rate shock effect on real output and price therefore appears to be insignificant, given that 95% confidence band includes the "zero" horizontal axis, hence the impact may not be statistically distinguishable from zero; a sign that, the CBK rate is ineffective.



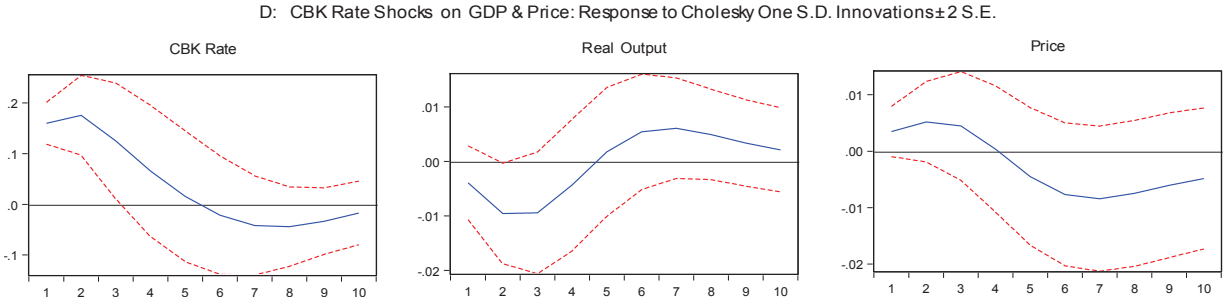
Repo Rate Innovations IRFs



Real Money Demand Innovations IRFs



Reserves Innovations IRFs



CBK Rates Innovations IRFs

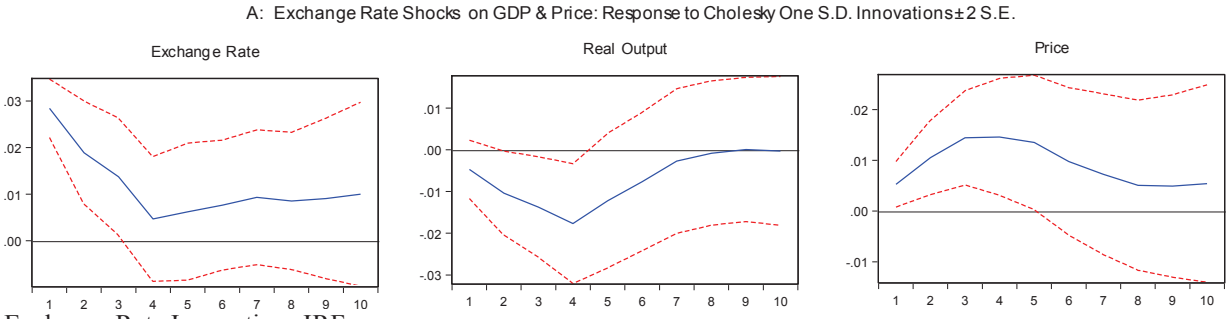
Figure 1 Monetary policy shock innovations IRFs

Innovations on Exchange Rate

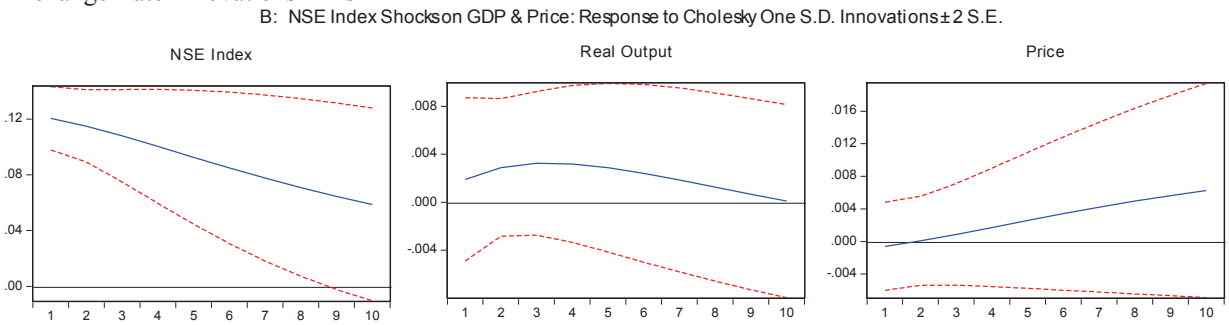
We establish the short run evidence for exchange rate shock effects using the following macroeconomic variables; $Y_t' = [ER_t \quad RGDP_t \quad CPI_t]$ with remittances and oil price index $X' = [Remittances \quad oil]$ as exogenous variable. The impulse response (impact) is as displayed in fig 2A, with one standard deviation on exchange rate shock. The real output response to exchange rate innovations is negative and statistically significant after the second quarter and for only two quarters. An indication that, exchange rate shocks have a significant effect on real output. Price on the hand responded positively and statistically significant to exchange rate shocks for the first five quarters. This implies that, an exchange rate depreciation (appreciation) increases (decreases) price level and decreases (increases) real output. This is an indication that CBK can manipulate inflation via exchange rate, an indication that this channel is effective.

Innovations on Asset prices

We establish the short run evidence for NSE index effects via the following on macroeconomic variables $Y_t' = [NSE_t \quad RGDP_t \quad CPI_t]$. The impulse response (impact) is as displayed in fig 2B, with one standard deviation on NSE index shock. The real output response to innovations on the NSE is positive but statistically insignificant. Similarly, the price (CPI) responded positively but statistically insignificant as well to asset price shocks. The effect of the asset price shocks on output and price is therefore statistically insignificant; a sign that the asset channel is ineffective.



Exchange Rate Innovations IRFs

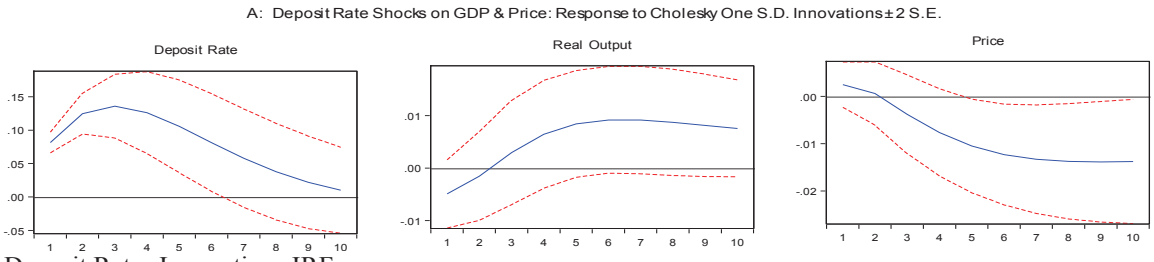


Asset Prices Innovations IRFs

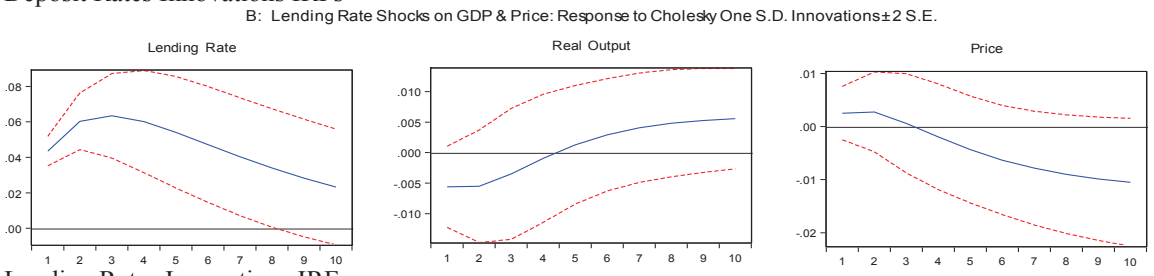
Figure 2 Exchange Rate & Asset Prices Innovations IRFs

Innovations on Bank Lending rates, Deposit rates and Credit

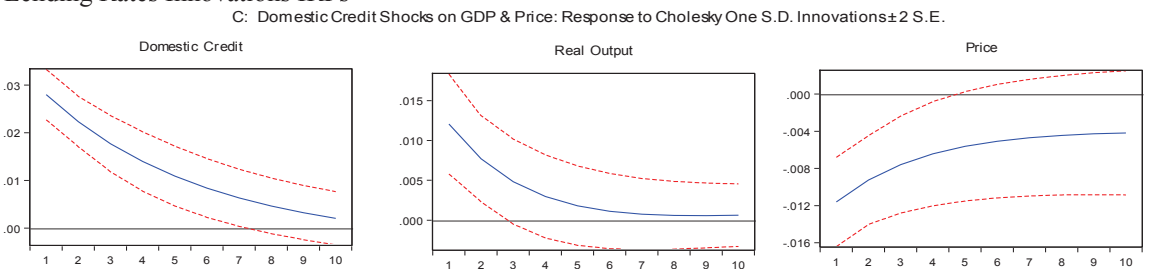
Many empirical and theoretical research works have established a relevant and efficient bank-lending channel via deposit and lending rates for developing economies (Huseynov & Jamilov, 2012 and Adam, 2008). We establish the short run evidence via the following on macroeconomic variable $Y_t' = [R_t \quad RGDP_t \quad CPI_t]$, where R is either deposits, lending rates or domestic credit. The impulse responses (impact) are as displayed in fig 3 with one standard deviation on R shock.



Deposit Rates Innovations IRFs



Lending Rates Innovations IRFs



Domestic Credit Innovations IRFs

Figure 3 Bank Lending rates, Deposit rates and Credit Innovations IRFs

The real output response to innovations on the deposit rate is negative in the first two quarters then became positive but statistically insignificant in both cases. The price (CPI) on the other hand responded positively to deposit rate shocks for the first two quarters then became negative but statistically insignificant in both cases as well. The lending rates shock behaves similar to deposit rates. Therefore, both lending and deposit rate shock effect on output and price is therefore statistically insignificant. The real output response to innovations on the domestic credit is statistically significant and positive for the first three quarters. The price (CPI) on the other hand responded negatively and statistically significant to credit shocks for the first four quarters. The credit shock impact on output and price is therefore statistically significant; a sign that the credit channel may be effective in Kenya.

Variance Decomposition

Table 1 shows that, the variation in prices and GDP are largely due to their own shock as opposed to been influenced by shock from other variables. This is because, 100% of the variation in prices and GDP in the first quarter are as the result of their own shocks. However, the real money demand, reserves, repo rate and CBK rate shocks, on the fourth quarter, separately each explains 0.361%, 0.527%, 2.026% and 11.345% of the variations of GDP; while after the tenth quarter, they each explain 2.363%, 2.488%, 14.408% and 19.254% respectively of GDP variation. Similarly, 1.889%, 0.154%, 1.803% and 0.767% of price variation are explained by real money demand, reserves, repo rate and CBK rate shocks separately after the fourth quarter respectively, while the same variables explain 9.621%, 0.586%, 24.993% and 20.506% of price variations after the tenth quarter. Therefore, CBK rate explains more of GDP variation while Repo rate explains price variation better. Further, the exchange rate, NSE index, deposit rate, lending rate and domestic credit shock, separately each explains 10.02%, 1.157%, 6.933%, 0.089% and 1.248% of the variations of GDP in the fourth quarter, while after the tenth quarter, they each explain 9.504%, 1.784%, 24.09%, 4.893% and 4.758% respectively of GDP variations. Similarly, 10.748%, 0.396%, 9.122%, 0.962% and 0.797% of price variations are respectively explained by exchange rate, NSE index, deposit rate, lending rate and domestic credit shocks separately after the fourth quarter, while same variables explains 8.719%, 4.609%, 34.69%, 13.44% and 3.015% of price variations after the tenth quarter. Therefore, deposit rate explains both GDP and price variations better than the other variables. Based on variance decomposition; interest based instruments (repo, deposit and lending rates) explains GDP and inflation variations better than other macroeconomic variables.

5.2 ARDL evaluation of monetary Policy in Kenya

5.2.1 Theory and Methodology

We further employ the ARDL to estimate the long-run equation, given its flexibility of application when the variables are either "mutually co-integrated" or are of different integration order, that is, $I(1)$ or $I(0)$, but not appropriate when integrated at order two ($I(2)$) or higher (Pesaran & Pesaran, 2009). However, the ARDL model is applicable given all variables as reported in the table 2 are $I(1)$ or $I(0)$. Laurenceson & Chai (2003) noted "ARDL takes sufficient numbers of lags to capture the data generating process in a general-to-specific modeling framework". Moreover, according to Banerjee and others (1993), ARDL is easily convertible to ECM, via a simple linear transformation. The ECM integrates the long-run equilibrium with the short run dynamics without losing long-run information. Similar to the short-run analysis in 5.1 above, we model the ARDL in a similar way, with equation R1 taking the form;

$$CPI_t = \alpha + \beta GDP_t + \delta \,\mathrm{Re}\, po_t + \sum_{j=1}^{n} \varphi_{1,j} \Delta GDP_{t-j} + \sum_{j=1}^{n} \varphi_{2,n} \Delta \,\mathrm{Re}\, po_{t-j} + \varepsilon_t$$

5.2.2 Results of ARDL Regression

This part examines the long-run behavior of the monetary policy using the ARDL regression technique. The cointegration test via bound testing, as shown in the summary table 3 indicates all regressions are cointegrated, with an exception of assets (NSE index) regression. Further, the adjustment (ECT(-1)) coefficient is negative and statistically significant for all regression equations, an indication that any short-term disequilibrium in the last period is corrected in the current period.

The long-run regression results from R1, R2 and R3 shows that both price and real GDP as not significantly influenced by Repo rate, real money demand and reserves shock, as their coefficients are statistically insignificant. Therefore, monetary shocks have no long-run effects in Kenya, as expected in theory. The long-run regression results from R4 indicates that exchange rate has a negative and significant influence on both inflation and real GDP. The results from R5 reveals deposit rates significantly and negatively affects both the real GDP and inflation while R6 indicates, lending rates as only significantly affecting inflation (negatively) but not GDP. Domestic credit (R7) on the hand has no long-run impact on inflation, but it significantly affects real GDP positively, while asset prices (R8) positively and significantly affects both inflation and real GDP in the long run.

6 Conclusion

The study investigated the Kenyan transmission channels based on the ARDL model, variance decomposition and impulse responses. The empirical investigation reveals that, interest rates have no significant impact (short run or long run) on both output and inflation. The real money demand and reserves have the short-run but no long run influence on both inflation and output. Asset prices have no short run effects, but affects both prices and inflation in the long run. The bank-lending channel (deposit rates, lending rates and domestic credit) has mixed results, with both deposit and lending rates having no significant short run effects on output and inflation while domestic credit has; in the long-run deposit rate influences both output and inflation, lending rates only influences inflation, while domestic credit influences output, but not inflation. Exchange rate channel appears to be effective, with both short run and long run influence on inflation and output. Based on variance decomposition; interest based instruments (repo, deposit and lending rates) explains GDP and inflation variations better than other macroeconomic variables.

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Appendix

Table 1 Variance Decomposition

Real GDP Variance Decomposition			Real GDP Variance Decomposition			Real GDP Variance Decomposition			
Period	Real GDP	Price	Period	Real GDP	Price	Period	Real GDP	Price	Deposit Rate
1	100.0000	0.000000	1	100.0000	0.000000	1	100.0000	0.000000	0.000000
4	93.00021	4.973652	4	68.70776	19.94710	4	84.34519	10.23585	2.831373	6.932779
8	78.31785	9.892076	8	61.10705	20.49951	8	78.39347	11.18789	8.104414	20.70770
10	73.80899	11.78385	10	59.29785	21.44767	10	76.25446	10.70218	10.20817	24.08966
Price Variance Decomposition			Price Variance Decomposition			Price Variance Decomposition			
1	0.000000	100.0000	1	0.000000	100.0000	1	0.000000	100.0000	0.000000	0.000000
4	2.469691	95.72745	4	25.28724	73.94608	4	7.766673	3.081276	87.79650	9.122223
8	10.58388	69.19406	8	43.76780	37.82197	8	18.41024	16.96113	53.66185	29.37701
10	12.15390	62.85346	10	47.18221	32.31208	10	20.50571	20.93734	44.37219	34.69047
Real GDP Variance Decomposition			Real GDP Variance Decomposition			Real GDP Variance Decomposition			
Period	Real GDP	Price	Money Demand			Period	Exchange	Real GDP	Price	Lending Rate
1	100.0000	0.000000	0.000000	Real GDP	Price	1	Rate 100.0000	0.000000	0.000000
4	98.94856	0.690107	0.361329	100.0000	0.000000	4	0.000000	96.72548	3.185317	0.089200
8	95.87384	2.533012	1.593153	84.36044	5.622531	8	0.017087	87.69019	9.641736	2.668075
10	94.09066	3.546726	2.362617	74.83433	14.75274	10	0.412982	82.56040	12.54643	4.893171
Price Variance Decomposition			10	74.07968	16.41627	Price Variance Decomposition	9.504047			
1	0.000000	100.0000	0.000000	Price Variance Decomposition		1	0.000000	100.0000	0.000000
4	0.522704	97.58873	1.888562	0.000000	100.0000	4	0.000000	0.576080	97.46211	0.961814
8	2.363705	90.68334	6.942957	2.465638	86.78607	8	0.748291	1.76192	79.55861	8.679465
10	3.447742	86.93093	9.621326	29.93884	59.61002	10	0.451145	5.80497	70.75510	13.43994
			10	43.84058	47.44045	8.718970				
Real GDP Variance Decomposition			Real GDP Variance Decomposition			Real GDP Variance Decomposition			
Period	Real GDP	Prices	Reserves	Real GDP	Price	NSE Index	Real GDP	Price	Credit
1	100.0000	0.000000	0.000000	100.0000	0.000000	0.000000	100.0000	0.000000	0.000000
4	98.78705	0.686099	0.526856	96.79315	2.049584	1.147266	98.51070	0.241109	1.248192
8	94.71054	3.421523	1.867938	90.88795	7.225963	1.886086	94.21921	1.992885	3.787908
10	92.17290	5.338964	2.488135	88.51254	9.703558	1.780898	91.66006	3.581414	4.758531
Price Variance Decomposition			Price Variance Decomposition			Price Variance Decomposition			
1	0.000000	100.0000	0.000000	0.000000	100.0000	0.000000	0.000000	100.0000	0.000000
4	1.866266	97.97939	0.134345	1.058013	98.54640	0.394589	1.650328	97.55218	0.797495
8	5.550013	93.99290	0.457085	1.996722	95.20246	2.880817	5.126510	92.51084	2.362650
10	7.123119	92.29136	0.585517	2.072918	93.31813	4.608952	6.666352	90.31826	3.015384

Notes: This table contains summary of variance decomposition

Table 2 Unit roots Test Results

Series		At Level ADF	At Level PP	Conclusion	First Difference ADF	First Difference PP	Conclusion
Real Output	τ_t	-2.74	-3.04	Non Stationary	-6.44***	-6.44***	Stationary
	τ_u	-0.80	-0.83		-6.51***	-6.51***	
	τ	-2.89***	-2.71***		-5.98***	-5.95***	
CPI	τ_t	-4.41***	-2.63	Non Stationary	-5.80***	-5.81***	Stationary
	τ_u	-0.05	-0.09		-5.84***	-5.84***	
	τ	7.57	6.82		-3.72***	-3.69***	
Money M3	τ_t	-2.93	-2.93	Non Stationary	-6.23***	-6.16***	Stationary
	τ_u	1.36	1.35		-6.01***	-5.99***	
	τ	3.13	2.86		-5.21***	-5.14***	
Repo Rate	τ_t	-2.78	-2.53	Non Stationary	-6.08***	-6.08***	Stationary
	τ_u	-2.82*	-2.56		-6.12***	-6.13***	
	τ	-0.50	-0.55		-6.18***	-6.18***	
Reserves	τ_t	-2.77	-2.93	Non Stationary	-8.21***	-8.21***	Stationary
	τ_u	1.47	1.50		-7.56***	-7.54***	
	τ	2.70	2.67		-6.59***	-6.67***	
KES/USD	τ_t	-2.54	-2.47	Non Stationary	-7.13***	-8.16***	Stationary
	τ_u	-0.67	-0.48		-7.21***	-8.23***	
	τ	-2.25**	-3.29***		-7.06***	-7.05***	
Deposit Rates	τ_t	-2.75	-2.57	Non Stationary	-3.79**	-3.91**	Stationary
	τ_u	-2.64*	-2.43		-3.84***	-3.94***	
	τ	-0.40	0.03		-3.89***	-3.99***	
Lending Rates	τ_t	-2.30	-2.14	Non Stationary	-4.33***	-4.35***	Stationary
	τ_u	-2.49	-2.54		-4.15***	-4.21***	
	τ	0.14	0.45		-4.18***	-4.23***	
CBK Rate	τ_t	-2.69	-1.97	Non Stationary	-3.57**	-3.57**	Stationary
	τ_u	-2.67	-1.97		-3.64**	-3.63***	
	τ	-0.17	-0.06		-3.69***	-3.70***	
Domestic Credit	τ_t	-4.49***	-4.41***	Non Stationary	-6.80***	-6.82***	Stationary
	τ_u	3.87	3.08		-5.76***	-5.76***	
	τ	8.86	6.38		-0.22	-2.71***	
NSE Index	τ_t	-1.56	-2.01	Non Stationary	-6.01***	-6.07***	Stationary
	τ_u	-0.88	-1.20		-6.07***	-6.13***	
	τ	0.81	0.62		-6.03***	-6.14***	

*(**) *** denotes statistical significance at 10(5)1 percent level

τ_t, τ_u *and* τ indicates the model includes "intercept, trend & intercept, or none" respectively

Table 3 ARDL Results

	Repo rate R1		Money Demand R2		Reserves R3		Exchange Rate R4		Deposit Rate R5		Lending Rate R6		Domestic Credit R7		NSE Index R8	
	Price	Output	Price	Output	Price	Output	Price	Output	Output	Price	Output	Price	Output	Price	Output	Price
Price		-0.4184* (-8.199)		-0.345** (-3.007)		-0.541** (-2.785)		-0.574* (-38.49)	-0.462* (-32.52)		-0.4098* (-9.802)		-0.462* (-32.52)		-0.4098* (-9.802)	
Output	-2.3406* (-7.692)		-3.09*** (-1.963)		-0.1344 (-0.105)		-1.574* (-13.67)			-3.494 (-1.143)		-0.7066 (-1.482)		-3.494 (-1.143)		-0.7066 (-1.482)
Repo Rate	-0.1235 (-1.448)	-0.0520 (-1.858)														
Money (M3)			-0.941 (-0.841)	-0.222 (-1.533)												
Reserves					0.6567 (1.473)	0.0265 (0.191)										
Exchange (ER)							-0.385* (-4.29)	-0.1749* (-5.594)								
Deposit Rates									-0.15*** (-2.332)	-0.064** (-3.135)						
Lending rates											-0.949 (-0.5936)	-0.164* (-4.389)				
Domestic Credit													0.305** (2.626)	0.2467 (0.999)		
NSE Index															0.1196* (3.755)	0.0625* (4.894)
ECT	-0.290* (-5.522)	-0.983* (-6.795)	-0.099* (-5.054)	-0.661* (-4.667)	-0.358* (-5.285)	-0.869* (-5.159)	-0.215* (-5.511)	-1.711* (-5.017)	-0.434* (-4.133)	-1.483* (-5.885)	-0.136* (-5.098)	-1.272* (-4.916)	-0.337* (-7.095)	-0.478* (-6.493)	-0.567** (-2.744)	-1.65** (-3.081)
ARDL lags	12,12,12	12,12,12	9,12,12	12,9,12	12,12,12	10,10,12	6,8,11	11,12,10	12,12,12	12,12,12	12,12,12	10,12,12	11,12,7	12,11,7	12,11,12	10,12,12
ARDL Bounds Test	4.503*	7.559*	4.790*	4.085**	4.656*	5.118*	6.51*	4.721*	2.847***	5.772*	4.332*	4.394*	10.069*	8.432*	1.318	1.7256

Notes: * (**) *** represents 1% (5%) 10% confidence intervals, ( ) t statistics
All regression equations in this table have either Output or Price are the dependent variable