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Asymmetric Effects of Monetary Policy Shocks on Output Growth: Evidence from Nonlinear ARDL and Hatemi-J Causality Tests



Abstract *Previous studies relied on asymmetric or a linear approach while considering the output response of monetary policy shocks. However, empirical results based on the symmetric approach tend to have masked the true effects of monetary policy shocks. The present study, therefore, aims to probe the asymmetric impact of monetary policy shocks on the output growth of selected developing economies. The empirical results indicate significant evidence of asymmetric effect both in the short run and in the long in almost all countries. Furthermore, compared to contractionary monetary policy, the findings indicate that expansionary monetary policy shocks have a more profound impact on output growth. The asymmetry between monetary policy shocks and output response tends to have implications for the effectiveness of the economic policy, in particular in developing economies. Thus, it is recommended to consider these asymmetries while evaluating the impact of monetary policy on economic growth.*

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Introduction

A robust relationship between monetary policy and domestic economic activity has been established by many theoretical and empirical research studies. According to the Keynesian perspective, monetary policy positively affects the domestic investment and output via a reduction in policy rates which reduces the user cost of capital and enhances the liquidity Keynes (, 1932, pp. 137). However, a revolutionary paper by Lucas (1972) indicates that the monetary policy can be effective in affecting the investment and

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output to the extent that it is unanticipated while the anticipated monetary policy tends to be neutral and does not affect domestic economic activity. The seminal work by Lucas motivated many researchers to revisit the nexus between monetary policy and major economic activities [Bernake and Blinder 1992; Bernake and Boivin 2003; Bernake et al. 2005; Uhlig 2005; Forni and Gambetti 2010]. Many of the studies have come up in support of the traditional Keynesian conjecture that an expansionary monetary policy increases domestic output while a contractionary monetary policy dwindles the domestic output.

The Keynesian literature does not dwell upon the asymmetries in implementing monetary policy. Yet, there may be a possibility that asymmetry may emerge even if a monetary shock is anticipated or unanticipated Barro (1977), Mishkin (1982), Frydman and Rappoport (1987). Likewise, asymmetry in the relationship between monetary policy and output may also arise due to various phases of business cycles Weise (1999); Garcia and Schaller (2002), Lo and Piger (2005). According to Ravn and Sola (2006), the size of monetary shock is also important, i.e., small vs large monetary shocks may also be translated into asymmetric effects on output. According to Cover (1992), the asymmetry may also arise due to the type of monetary policy shock (contractionary versus expansionary shock). According to Ravn et al. (1999), contractionary monetary policy changes may have a more profound effect than the expansionary monetary policy in case, the assumption of sticky nominal wages is supposed to hold. On the other hand, an expansionary monetary policy is supposed to expand aggregate demand along the vertical portion of the aggregate supply curve, leaving the real economy unchanged, at least in the short run. Thus, a contractionary or monetary policy is likely to dwindle the real economy as it moves the demand curve along the positively sloped segment of the supply curve, while the expansionary monetary policy will not affect real output.

Many of the studies report that the asymmetry between monetary policy and domestic output is related to economic conditions and the state of the economy. In particular, in periods of recessions, considerable effects on output have been observed than those found during expansions (Aye and Gupta, 2012; Weise, 1999; Garcia and Schaller, 2002 and Lo and Piger, 2005).

The asymmetries between monetary policy and output established in the literature tend to have implications for the effectiveness of monetary policy and the costs concerning the change in the nominal demand. The empirical evidence regarding the positive and negative monetary policy tends to show mixed findings. Cover (1992) and some other researchers like DeLong and Summers (1988) and Morgan (1993) support the proposition of asymmetric effects related to the positive and negative monetary shocks. Thoma (1994) shows that a negative monetary policy has more profound effects than a positive monetary policy. Tan and Habibullah (2007) confirmed the business cycle and monetary policy asymmetry for ASEAN economies. Florio and Milano (2004) reported the asymmetry effect for expansionary and contractionary monetary policy in the case of the US, Japan, and Italy. Rhee. And Rich (1995) show an asymmetric effect in the case of the US.

Similarly, Karras, G. (1996), Cover (1992), and Ball and Mankiw (1994) show the evidence of asymmetric effects with regards to the monetary policy. However, Ravn and Sola (1996) indicate the symmetric effects in the case of both the positive and negative monetary policy shocks. The empirical research studies are related in general to

developed economies, particularly to the United States, Japan, and other European economies.

However, empirical research on the asymmetric effect related to developing economies is limited. For example, Edilean & Marcelo (2009) investigated the monetary policy asymmetry for Brazil, Zakir, N., & Malik, W. S. (2013) examined for Pakistan, Aye and Gupta, 2012 studied India. Similarly, Ulke, V. & Berument (2015), and Mamdouh, A.. (2018), examined the asymmetry effect for Turkey, Egypt, and Nigeria, respectively. In almost all of the studies, the asymmetric effect of monetary policy has been confirmed.

However, these studies tend to have some limitations. First, in terms of asymmetry, these studies tend to be varied, as some studies have examined the asymmetric effect of monetary policy in the context of business cycles, while others have investigated the impact of monetary policy asymmetry in terms of positive and negative monetary shocks, while the empirical results tend to be country-specific and in some cases sensitive to estimation approaches. Thus the empirical results across countries may not be comparable. Since developing economies are characterized by money market and good market rigidities, while investors and entrepreneurs tend to differ in terms of their risk-loving and risk-averse behavior. Thus it is expected that monetary policy may have a different impact on output in the case of both expansionary and contractionary monetary policy.

The present study thus contributes to the existing literature in a number of ways. First, to get comparable results concerning the monetary policy shocks, the present study examines both the symmetric and the asymmetric effect of monetary policy shocks on the domestic output of the selected developing economies separately. Secondly, besides the long-run effect, the present study also examines the asymmetric effect of monetary policy shocks on the economic growth of the selected developing economies. Finally, and most importantly, the present study is innovative in the sense that it investigates the asymmetric causality (Hatemi-J causality) between monetary policy and domestic output to reach selected developing economies separately. The empirical results come up in support of asymmetric effect both in the short run and in the long run in the case of almost all developing economies. While the empirical show evidence of Hatemi-J causality in the case of many selected economies.

The rest of the study is structured in a way that section 2 deals with models and methods, Section 3 is related to results estimation, while section 4 is about the conclusion of the study.

Models and Methods

To examine the impact of monetary policy on economic growth following Garcia and Schaller (2002), Karras (1996) and Hayford (2005), we model the relationship between monetary policy and economic growth as below

$$\ln GDP_t = \gamma + \delta \ln RIR_t + \varepsilon_t \quad (1)$$

In the given model, GDP represents the gross domestic product or output growth for developing countries, and RIR denotes the real interest rate, which indicates monetary policy for selected developing countries. The variable RIR has been defined in a way that an increase in real interest rate shows the contractionary monetary policy. Thus, an increase in RIR is supposed to reduce the gross domestic product.

Equation (1) provides long-run coefficient estimates. To obtain the result for the short run, we re-write eq. (1) as an error correction model suggested by Pesaran, Shin, and Smith (2001):

$$\Delta \text{LnGDP}_t = \gamma_0 + \sum_{k=1}^{n1} \gamma_k \Delta \text{LnGDP}_{t-k} + \sum_{k=0}^{n2} \delta_k \Delta \text{LnRIR}_{t-k} + \beta_0 \text{LnGDP}_{t-1} + \beta_1 \text{LnRIR}_{t-1} + \omega_t \quad (2)$$

In equation 2, the summation symbols indicate the error correction dynamics, while the second portion of the equation shows the long-run relationship among the variables. Similarly, γ_0 is drift, and ω is the error term. Thus, we use the ARDL bound test approach to estimate equation two by OLS. The F test is used to check the existence of cointegration. The null hypothesis for bound test i.e., $H_0: \beta_0 = \beta_1 = 0$, indicates no cointegration, whereas the alternative hypothesis is that $H_1: \beta_0 \neq 0, \beta_1 \neq 0$. If the cointegration exists, we move to error correction representation, thus, we can estimate an error correction model through the following equations.

$$\Delta \text{LnGDP}_t = \gamma_0 + \sum_{k=1}^{n1} \gamma_k \Delta \text{LnGDP}_{t-k} + \sum_{k=0}^{n2} \delta_k \Delta \text{LnRIR}_{t-k} + \tau \text{ECM}_{t-1} + \xi_t \quad (3)$$

In model (3), we assumed that all explanatory variables tend to have an asymmetric impact on the dependent variable. The meaning of symmetric assumption is that if a decrease in interest rate increases the output, then an increase in interest must lower it.

Now the question that arises here is, how valid is this assumption. This may not be true all the time. Some studies suggest that during the recession, interest rates have a greater effect on output Garcia and Schaller (2002). Producers could have different expectations about interest rate changes. Changes in their expectation tend to have a differential effect in the case of negative and positive shocks (Cover 1992). According to Karras (1996), positive monetary shocks have a statistically zero effect during recessions. In the same way, Hayford (2005) finds that during recession and expansion, positive shocks have a greater effect than negative shocks on output growth.

To deal with the limitation inherent in the symmetric approach to cointegration, we follow the approach applied by Granger and Yoon (2002). This approach investigates the "hidden cointegration" between the components of the series. It is helpful in the sense that it may allow checking for the evidence of long-run cointegration between the positive and negative sub-components of a series even though there may not be any linear cointegration between the aggregate level series. In other words, the asymmetric approach is preferable in the sense that it not only allows to examine the response of output fluctuations to changes in interest rate, rather it shows the impact of positive and negative shocks separately on output fluctuations. According to Granger and Yoon, the nonlinear adjustment mechanism to long-run equilibrium can be easily reduced to a linear one without any loss of information. Both the data series are supposed to have hidden cointegration if both positive and negative series are cointegrated. This type of nonlinear cointegration is important to be examined in particular when the ordinary linear cointegration approach is unable to identify this hidden cointegrating relationship. For instance, if there are two random walk series Z_t and Y_t

$$Z_t = Z_{t-1} + \mu_t = z_0 + \sum_{i=1}^t \mu_i \quad (3)$$

$$Y_t = Y_{t-1} + \Upsilon_t = Y_0 + \sum_{i=1}^t \Upsilon_i \quad (4)$$

where $t = 1, 2, \dots, T$ and Z_0, Y_0 are initial values, μ_i and Υ_i denote mean zero white noise disturbance terms. "If the two series, i.e., Y_t and Z_t are cointegrated by one vector, the two series are deemed to have a standard or linear cointegration. However, if both series tend to move in an asymmetric way, then the two series are expected to have the possibility of a hidden cointegration. According to Granger and Yoon (2002), both positive and negative shocks can be defined in the following way:

$$\begin{aligned} \mu_i^+ &= \max(\mu_i, 0), \mu_i^- = \min(\mu_i, 0), \Upsilon_i^+ = \max(\Upsilon_i, 0), \Upsilon_i^- = \min(\Upsilon_i, 0), \\ \mu_i &= \mu_i^+ + \mu_i^- \text{ and } \Upsilon_i = \Upsilon_i^+ + \Upsilon_i^- \end{aligned} \quad (5)$$

Hence

$$\begin{aligned} Z_t &= Z_{t-1} + \mu_t = z_0 + \sum_{i=1}^t \mu_i^+ + \sum_{i=1}^t \mu_i^- \text{ and } Y_t = Y_{t-1} + \Upsilon_t \\ &= Y_0 + \sum_{i=1}^t \Upsilon_i^+ + \sum_{i=1}^t \Upsilon_i^- \end{aligned} \quad (6)$$

To simplify the notations,

$$Z_i^+ = \sum_{t=1}^i \mu_t^+, \quad Z_i^- = \sum_{t=1}^i \mu_t^-, \quad Y_i^+ = \sum_{t=1}^i \Upsilon_t^+, \quad Y_i^- = \sum_{t=1}^i \Upsilon_t^- \quad (7)$$

Thus

$$Z_t = z_0 + Z_t^+ + Z_t^- \text{ and } Y_t = y_0 + Y_t^+ + Y_t^- \quad (8)$$

subsequently

$$\Delta Z_t^+ = \mu_t^+, \quad \Delta Z_t^- = \mu_t^-, \quad \Delta Y_t^+ = \Upsilon_t^+, \quad \Delta Y_t^- = \Upsilon_t^-$$

To obtain the series of both positive and negative movements i.e., ΔZ_t^+ and ΔZ_t^- , we calculate the first difference of the series as $\Delta Z_t = Z_t - Z_{t-1}$. Finally, both these positive and negative values are transformed into a cumulative sum of positive (negative) changes as $Z_t^+ = \sum \Delta Z_t^+$ and $Z_t^- = \sum \Delta Z_t^-$. The same procedure is pursued for the other series as follows: $Y_t^+ = \sum \Delta Y_t^+$ and $Y_t^- = \sum \Delta Y_t^-$. The hidden cointegration is supposed to exist between the series Z and Y if their components are cointegrated. Finally, for the sake of simplicity, we replace the series Z_t with our actual independent variable, i.e., the real interest rate variable while Z_t^+ and Z_t^- are replaced with notation RIR^+ and RIR^- respectively. Both RIR^+ and RIR^- are the increase and decrease of the real interest rate as shown below:

$$\begin{aligned} RIR_t^+ &= \sum_{j=1}^t \Delta \ln RIR_j^+ = \sum_{j=1}^t \max(\Delta \ln RIR_j, 0) \\ RIR_t^- &= \sum_{j=1}^t \Delta \ln RIR_j^- = \sum_{j=1}^t \min(\Delta \ln RIR_j, 0) \end{aligned}$$

Now our next model is a nonlinear model in which we interchange $LnRIR_t$ with RIR_t^+ and RIR_t^- variables. Henc, our model is as follows:

$$\Delta LnGDP_t = \gamma_0 + \sum_{k=1}^{n1} \gamma_k \Delta LnGDP + \sum_{k=0}^{n2} \delta_k \Delta LnRIR_{t-k} + \sum_{k=0}^{n3} \delta_k \Delta LnRIR_{t-k}^+ + \sum_{k=0}^{n4} \delta_k \Delta LnRIR_{t-k}^- + \beta_0 LnGDP_{t-1} + \beta_1 LnRIR_{t-1} + \beta_2 LnRIR_{t-1}^+ + \beta_3 LnRIR_{t-1}^- + \omega_t \quad (9)$$

Eq. (9) is a new error correction model. We can estimate this model by using the ARDL approach. Shin et al. (2014) indicate that the Pesaran et al. (2001) approach to bound testing is also applicable to this model (9). Our model will not remain linear because we have two new time series variables in our model i.e. RIR^+ and RIR^- , which makes the adjustment process to be nonlinear. Hence, it becomes a nonlinear ARDL model. After estimating (9) and if co-integration is established between variables, we can infer the four kinds of asymmetry. To begin with, short-run asymmetry is built up in case $\hat{\delta}_k^+ \neq \hat{\delta}_k^-$ for all k. Secondly, long-run asymmetry is built up in case $\hat{\beta}_2^+ \neq \hat{\beta}_2^-$. Finally, the dynamic multipliers pattern captures the adjustment asymmetry, while again, we estimated the ECM for asymmetric effects of the real interest rate. The ECM model for nonlinear ARDL is as follows:

$$\Delta LnGDP_t = \gamma_0 + \sum_{k=1}^{n1} \gamma_k \Delta LnGDP + \sum_{k=0}^{n2} \delta_k \Delta LnRIR_{t-k} + \sum_{k=0}^{n3} \delta_k \Delta LnRIR_{t-k}^+ + \sum_{k=0}^{n4} \delta_k \Delta LnRIR_{t-k}^- + \tau ECM_{t-1} + \varpi_t \quad (10)$$

We apply the Wald test for the concreteness of our results. However, adjustment asymmetry is judged by dynamic movements. As per time-series studies, if we use non-stationary data or non-stationary variables for estimation, then our results will be spurious. To avoid this problem, we use different techniques to make our variables stationary. But the use of stationary variables provides short-run information from the data and eliminates the long-run information. Hence, there must be a technique through which one can compute whether there exists a long-run relationship among variables or not. Most studies adopt Engle and Granger (1987) and Johansen- Juselius (1990) for cointegration or long-run analysis. However, to apply these approaches, variables must be integrated of the same order. The above-mentioned models are not suitable for small data sets. ARDL model incorporates all the problems of these tests. In the case of ARDL, we can use mixed variables that are stationary at level I (0) or stationary at I (1) first difference (Pesaran et al.,2001). ARDL test has many desirable properties. One of them is that we can check the long-run relationship or existence of cointegration without the concern that the series is stationary at the level or first difference. ARDL also incorporates the problem of endogeneity since the focused variables need not be exogenous. This approach is best for both small and large samples. The First step of the ARDL approach is the estimation of the bound test; the bound test is used to calculate the long-run relationship among the variables by using the F test, with two sets, upper and lower. The critical region is given in the form of lower bound I (0) and upper bound I (1) given by Pesaran et al. (2001). If the value of F. STAT exceeds the upper bound, then the null hypothesis of no cointegration is rejected. If the value of F STAT is smaller than the lower bound, it means no existence of cointegration or no long-run relationship.

On the other hand, if the value of F STAT lies between the upper and lower bound, then the result will be inconclusive.

For the selection of the lag length model, we can use SBC and AIC criteria. The SBC is renowned as a parsimonious model, which selects minimum lag length, whereas AIC is identified for the selection of maximum lags. The second step is the estimation of the long-run relationship using ARDL based on AIC and SBC. If the model shows a long-run relationship between the variables, then there is an error correction representation. If the value of ECM is negative and significant, it leads to a long-run relationship among the variables. It also justifies the speed of adjustment of divergence from the preceding year. To confirm the robustness of the results, stability tests are used. For the stability of the model, CUSUM and CUSUMSQ techniques introduced by Brown et al. (1975) are used in this study. If the plots of the data lie between the upper and lower bound at the 5 percent level of significance, it means that our model is structurally stable (Ilyas et al. 2010) and vice versa. We also apply the Wald test for the long-run and short-run results to test for the joint significance of variables.

The main focus of the study is on the asymmetric effects of interest rate on GDP growth for a selected sample of developing countries; while, for comparison, we also estimate the symmetric effects of the real interest rate. We apply nonlinear ARDL by replacing the variable $LnRIR_t$ (interest rate) with RIR^+ and RIR_t^- variable. For non-linearity, we generate RIR^+ and RIR_t^- variables by using the Nonlinear ARDL model (Shin et al., 2014). According to Pesaran et al. (2001), the bound test is the same for linear and nonlinear ARDL; we should handle both variables (RIR^+ and RIR_t^-) as one variable and use the same critical value of F.STAT as for $LnRIR_t$ in linear ARDL. We apply Wald-S for short symmetry and Wald-L for long-run symmetry in the nonlinear model.

We have selected ten (10) developing countries, which are part of this research. The annual data which is gathered from these ten developing countries covers the duration from the year 1980-to 2019. The data collected from WDI involve the real interest rate as a representation of "monetary policy". While the growth rate of real output (GDP) is used for "economic activity." The selection of period and countries were based on data availability.

Empirical Results

To examine the impact of monetary policy shocks on the economic growth of selected developing economies such as Pakistan, India, Egypt, Kenya, the Philippines, Sri Lanka, Nigeria, Ukraine, Vietnam, and Bangladesh, we use both the linear and nonlinear ARDL approaches to see the symmetric and asymmetric impact of monetary policy (real interest rate) on GDP growth. To confirm the long-run cointegration relationship, we have used the bound test cointegration approach presented in Tables 1 through 10. Furthermore, we have presented the results based on the linear and nonlinear ARDL model. The estimates for the linear ARDL model are given in part 1 of each table, while results for the nonlinear ARDL model are provided in part 2. There are three panels in each segment of the table. The short-run coefficients are provided in Panel A, the long-run coefficients are provided in Panel B, and the diagnostic statistics of the estimation process are provided in Panel C.

Table 1. Empirical Results for Pakistan

Linear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
Δ GDP Pak				-0.75*(-3.63)			
Δ RIR Pak			0.14(1.6)				
Panel B: Long run results							
Constant	RIR Pak						
3.59*(6.58)			-0.82*(-3.90)				
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	
6.23	0.21	-0.72*(-3.82)	0.37	S	S	0.27	
Nonlinear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
Δ GDP Pak				-0.82*(-3.90)			
Δ RIR+ Pak			0.15(1.71)				
Δ RIR- Pak			0.16(1.72)				
Panel B: Long run results							
Constant	RIR+ Pakistan			RIR-Pakistan			
4.84*(5.13)		0.21(1.64)		0.22(1.64)			
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald
3.86	0.20	-0.72*(-3.75)	0.58	S	S	0.24	0.24
Asymmetric causality test							
Null Hypothesis		Fisher Statistic	P-Value	Decision			
RIR- Pakistan \neq GDP- Pak		4.475*	0.023	Fail to Accept			
GDP- Pakistan \neq RIR- Pak		3.003**	0.070	Fail to Accept			
RIR+ Pakistan \neq GDP- Pak		3.103**	0.065	Fail to Accept			
GDP- Pakistan \neq RIR+ Pak		4.271*	0.027	Fail to Accept			
RIR- Pakistan \neq GDP+ Pak		1.515	0.241	Accept			
GDP+ Pakistan \neq RIR- Pak		0.954	0.400	Accept			
RIR+ Pakistan \neq GDP+ Pak		1.087	0.354	Accept			
GDP+ Pakistan \neq RIR+ Pak		0.560	0.578	Accept			

*shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bond for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77, respectively. LM is the Lagrange multiplier test of residual serial correlation. It is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical value at 5% (1%) significance is 3.84(6.63). Number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol " \neq " indicates no causality.

Table 2. Empirical Results for India

Linear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
ΔGDP India				0.11(0.68)			
ΔRIR India			-0.42*(-3.06)				
Panel B: Long run results							
Constant	RIR India						
0.39*(0.23)	-0.39*(-2.89)						
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	
10.88	1.19	-1.05*(-4.56)	0.002	S	S	0.50	
Nonlinear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
ΔGDP India		0.54(2.08)			0.42(1.98)		
ΔRIR+ India	0.42(1.00)			1.39*(6.03)			
ΔRIR-India	-1.39*(-4.44)			1.39*(3.94)			
Panel B: Long run results							
Constant	RIR+ India				RIR- India		
-0.94(-0.54)	-1.59*(-4.52)				-2.82*(-4.80)		
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald
7.97	0.46	-1.48*(-4.63)	1.35	S	S	0.58	3.11*
Asymmetric causality test							
Null Hypothesis			Fisher Statistic	P-Value	Decision		
RIR- India ≠> GDP- India			1.447	0.256	Accept		
GDP- India ≠> RIR- India			2.118	0.144	Accept		
RIR+ India ≠> GDP- India			2.930**	0.074	Fail to Accept		
GDP- India ≠> RIR+ India			1.022	0.376	Accept		
RIR- India ≠> GDP+ India			0.275	0.761	Accept		
GDP+ India ≠> RIR- India			8.375*	0.002	Fail to Accept		
RIR+ India ≠> GDP+ India			1.434	0.259	Accept		
GDP+ India ≠> RIR+ India			0.796	0.463	Accept		

**shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bond for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77 respectively. LM is the Lagrange multiplier test of residual serial correlation. It is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical values at 5% (1%) significance is 3.84(6.63). The number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol "≠>" indicates no causality.*

Table-1 and Table-2 indicate both the symmetric and asymmetric effect of monetary policy on economic growth in Pakistan and India, respectively. Both short-run and long-run results have been presented in panels A and B, which are based on the linear ARDL approach. The results indicate that in the case of Pakistan, as per the linear ARDL

model, monetary policy shocks have an insignificant impact on economic growth in the short run. However, monetary policy has a significant impact on economic growth in the long run. The long-run coefficient indicates that a 1 percent increase in the real interest rate causes output to decline by 82 percent. While, in the case of India, as per the linear ARDL approach, monetary policy (real interest rate) has a negative and significant impact on economic growth both in the short run and in the long run, which indicates that a contractionary monetary policy has a significantly negative impact on economic growth in case of India. The results in the case of both Pakistan and India are in line with the theory. An increase in real interest tends to discourage domestic investment, which in turn is supposed to affect economic growth negatively.

In the case of the nonlinear results, we find evidence of asymmetric effect in the case of both Pakistan and India. However, the impact of both positive and negative monetary policy shocks are insignificant in the short run as well as in the long run in the case of Pakistan. However, in the case of India, the impact of both positive and negative monetary policy shocks are significant in the short run and the long run as well. In the case of India, compared to contractionary monetary policy (positive shock in interest rate), expansionary monetary policy (negative shock in interest rate) has a more profound impact on economic growth both in the short run as well as in the long run. However, in the case of Pakistan, negative monetary shock outweighs positive monetary shock. However, in the long-run positive monetary shock has a larger impact on economic growth. Table-3 provides the results related to Egypt as presented. The results are based on the linear approach to cointegration. It shows that there is no impact of the monetary shock on GDP growth both in the short run and long run as well. In terms of magnitude, the impact of monetary policy shock is small both in the short run as well as in the long run, as indicated by the coefficient of 0.001 and 0.002 respect.

Table 3. Empirical Results for Egypt

Linear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
ΔGDP Egypt		0.36(1.97)	0.53*(2.86)			0.25(1.52)	
ΔRIR Egypt			0.001(0.03)				
Panel B: Long run results							
	Constant			RIR Egypt			
	4.50*(13.02)			0.002(0.03)			
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	
7.24	0.52	-0.77*(-3.98)	0.57	S	S	0.45	
Nonlinear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
ΔGDP Egypt				-0.48*(-3.86)			
ΔRIR+ Egypt	-0.12(-1.40)		0.10(0.95)	-0.23(-1.94)		0.26*(2.96)	
ΔRIR- Egypt	-0.17(-1.95)		-0.05(-0.53)	-0.32*(-2.14)		-0.65*(-4.52)	
Panel B: Long run results							
	Constant		RIR+ Egypt		RIR- Egypt		
	1.80(0.99)		-0.25(-1.35)		-0.12(-0.88)		

Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald
6.32	1.06	-0.48*(-3.86)	0.50	S	US	0.59	4.02*
Asymmetric causality test							
Null Hypothesis			Fisher Statistic	P-Value	Decision		
RIR- Egypt \neq > GDP- Egypt			1.262	0.302	Accept		
GDP- Egypt \neq > RIR- Egypt			2.329	0.120	Accept		
RIR+ Egypt \neq > GDP- Egypt			0.806	0.459	Accept		
GDP- Egypt \neq > RIR+ Egypt			4.547*	0.022	Fail to Accept		
RIR- Egypt \neq > GDP+ Egypt			3.705*	0.041	Fail to Accept		
GDP+ Egypt \neq > RIR- Egypt			1.605	0.223	Accept		
RIR+ Egypt \neq > GDP+ Egypt			2.240	0.130	Accept		
GDP+ Egypt \neq > RIR+ Egypt			2.723**	0.087	Fail to Accept		

*shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bounds for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77, respectively. LM is the Lagrange multiplier test of residual serial correlation. It is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical values at 5% (1%) significance is 3.84(6.63). The number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol " \neq " indicates no causality.

Table-3 in Panel A and B also presents results based on asymmetric cointegration. It shows that both positive and negative shocks have an insignificant effect on economic growth in the short run. However, at longer lags, at least one coefficient of both positive and negative monetary shocks becomes significant. In the long run, we have evidence of the asymmetric effect as both positive and negative monetary shocks hurt economic growth. However, the long-run effect is insignificant. In terms of magnitude, the positive monetary shock dominates the negative monetary shock, as evidenced by the coefficient of -0.25 and -0.12, respectively.

Table 4. Empirical Results for Kenya

Linear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
Δ GDP Ken					-0.52*(-2.68)		
Δ RIR Ken			0.008(0.13)				
Panel B: Long run results							
	Constant			RIR Ken			
	3.75*(2.85)			0.01(0.13)			
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	
4.46	0.56	-0.52*(-2.68)	0.03	S	S	0.20	
Nonlinear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
Δ GDP Ken					0.48*(2.48)		

Δ RIR+ Ken									-0.02(-0.51)
Δ RIR- Ken									-0.10(-1.79)
Panel B: Long run results									
	Constant			RIR+ Ken					RIR-Ken
	1.16*(2.27)			-0.01(-0.52)					-0.07*(-2.15)
Panel C: Diagnostic results									
	F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald	
	7.61	0.87	-1.46*(-4.90)	0.05	S	US	0.44	14.62*	
Asymmetric causality test									
Null Hypothesis			Fisher Statistic		P-Value		Decision		
RIR- Ken \neq > GDP- Ken			7.649*		0.003		Fail to Accept		
GDP- Ken \neq > RIR- Ken			0.570		0.573		Accept		
RIR+ Ken \neq > GDP- Ken			3.252**		0.057		Fail to Accept		
GDP- Ken \neq > RIR+ Ken			0.655		0.529		Accept		
RIR- Ken \neq > GDP+ Ken			3.654*		0.042		Fail to Accept		
GDP+ Ken \neq > RIR- Ken			3.949*		0.034		Fail to Accept		
RIR+ Ken \neq > GDP+ Ken			0.412		0.667		Accept		
GDP+ Ken \neq > RIR+ Ken			2.020		0.156		Accept		

*shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bounds for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77, respectively. LM is the Lagrange multiplier test of residual serial correlation. It is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical value at 5% (1%) significance is 3.84(6.63). The number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol " \neq " indicates no causality.

Table-4 reports the result of linear and nonlinear ARDL for Kenya. The results of the linear model indicate that both in the short run as well as in the long run, there is no impact of monetary policy shock on economic growth, as the t-ratios are insignificant. As far as the asymmetric effect of monetary policy shock on economic growth is concerned, the findings indicate that monetary policy does not have an impact on economic growth in the short run, but in the long run, both positive monetary and negative monetary shocks have a significant impact on the economic growth of Kenya. In terms of signs, the results indicate that both a decrease and increase in the interest rates tend to decrease the GDP growth. However, the impact of expansionary monetary policy dominates the impact of contractionary monetary policy. The coefficient of both positive and negative interest rates are -0.01 and -0.07, respectively. The outcome shows evidence of the asymmetric effect in the case of Nigeria.

Table 5. Empirical Results for Philippines

Linear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
Δ GDP Phi					-0.47*(-2.60)		
Δ RIR Phi				0.13(0.91)			

Panel B: Long run results

Constant	RIR Phi
3.40(1.85)	0.28(0.78)

Panel C: Diagnostic results

F	LM	ECM	RESET	CSM	CSM2	Adj R2
6.05	0.98	-0.47*(-2.60)	0.86	US	S	0.26

Nonlinear ARDL model estimates

Panel A: Short-run results

Lags	0	1	2	3	4	5	6
Δ GDP Phi				-0.95*(-5.48)			
Δ RIR+ Phi				0.001(0.01)			
Δ RIR-Phi				0.30*(2.57)			

Panel B: Long run results

Constant	RIR+ Phi	RIR- Phi
4.24*(4.13)	0.44*(2.96)	0.32*(2.29)

Panel C: Diagnostic results

F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald
8.99	0.21	-0.95*(-5.48)	1.12	S	S	0.46	2.57

Asymmetric causality test

Null Hypothesis	Fisher Statistic	P-Value	Decision
RIR- Phi \neq GDP- Phi	0.303	0.741	Accept
GDP- Phi \neq RIR- Phi	0.363	0.699	Accept
RIR+ Phi \neq GDP- Phi	0.836	0.446	Accept
GDP- Phi \neq RIR+ Phi	6.914*	0.004	Fail to Accept
RIR- Phi \neq GDP+ Phi	1.771	0.193	Accept
GDP+ Phi \neq RIR- Phi	0.265	0.769	Accept
RIR+ Phi \neq GDP+ Phi	1.524	0.239	Accept
GDP+ Phi \neq RIR+ Phi	0.587	0.564	Accept

*shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bond for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77, respectively. LM is the Lagrange multiplier test of residual serial correlation. It is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical values at 5% (1%) significance is 3.84(6.63). The number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol " \neq " indicates no causality.

Table-5 presents empirical findings based on the symmetric and asymmetric approach to cointegration. The results show that in the case of the Philippines, the independent variable (interest rate) has no major effect on the dependent variable (GDP growth) in the linear model, both in the short and long term through monetary policy (interest rate) is theoretically regarded as a significant indicator that is expected to have a profound effect on economic growth. Since a fall in the real interest rate tends to stimulate investment spending, which in turn tends to boost up economic growth. In the case of nonlinear results, the results show that in the short run, an increase in interest rate does not have any significant impact on economic growth. However, a decrease in

interest rate tends to boost economic growth. However, in the long run, both positive and negative monetary policy shocks have a significantly positive impact on economic growth, thus supporting the asymmetric effect in the case of the Philippines. The coefficient of positive real interest rate is 0.44, and that of negative interest rate is 0.32 indicating that the impact of contractionary monetary policy is larger than the expansionary monetary policy, which corroborates the evidence in favor of the asymmetric effect concerning the monetary policy and economic growth nexus.

Table 6. Empirical Results for Sri Lanka

Linear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
$\Delta RIRLK$				-0.21*(-2.28)			
Panel B: Long run results							
	Constant			RIRLK			
	7.10*(8.80)			-0.51*(-2.71)			
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	
13.88	0.37	-0.86*(-4.84)	0.07	S	S	0.47	
Nonlinear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
$\Delta RIR+LK$					-0.29(-1.58)		
$\Delta RIR-LK$					-0.19(-1.84)		
Panel B: Long run results							
	Constant		RIR+LK		AIR-LK		
	4.99*(6.73)		-0.57*(-2.50)		-0.56*(-2.46)		
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald
7.96	0.34	-0.87*(-4.54)	0.03	S	S	0.42	0.13
Asymmetric causality test							
Null Hypothesis		Fisher Statistic		P-Value		Decision	
RIR- LK \neq > GDP- LK		1.797		0.189		Accept	
GDP- LK \neq > RIR- LK		1.792		0.190		Accept	
RIR+ LK \neq > GDP- LK		1.908		0.172		Accept	
GDP- LK \neq > RIR+ LK		0.645		0.534		Accept	
RIR- LK \neq > GDP+ LK		0.685		0.514		Accept	
GDP+ LK \neq > RIR- LK		1.081		0.356		Accept	
RIR+ LK \neq > GDP+ LK		0.392		0.680		Accept	
GDP+ LK \neq > RIR+ LK		2.285		0.125		Accept	

*shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bounds for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77 respectively. LM is the Lagrange multiplier test of residual serial correlation. It is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical value at 5% (1%) significance is

3.84(6.63). number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol " \neq " indicates no causality.

Table 7. Empirical Results for Nigeria

Linear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
Δ RIRNGA			0.03(0.57)				
Panel B: Long run results							
	Constant			RIRNGA			
	3.90*(3.50)			0.06(0.61)			
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	
5.85	3.23	-0.59*(-3.32)	1.28	S	S	0.25	
Nonlinear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
Δ GDPNGA			-0.36(-1.37)	-0.29(-1.01)		-0.72*(-2.67)	
Δ RIR+NGA	0.17(1.20)		0.13(0.80)	-0.22(-1.71)			
Δ RIR-NGA	-0.03(-0.21)		-0.26(-1.27)	0.19(1.11)		-0.38*(-2.45)	
Panel B: Long run results							
	Constant		RIR+NGA		RIR-NGA		
	56.22(0.88)		2.00(0.92)		2.43(0.91)		
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald
2.92	4.75*	-0.22*(-0.95)	0.54	S	S	0.36	1.17
Asymmetric causality test							
Null Hypothesis			Fisher Statistic	P-Value	Decision		
RIR- Nigeria \neq GDP- NGA			2.914**	0.075	Fail to Accept		
GDP- Nigeria \neq RIR- NGA			1.434	0.259	Accept		
RIR+ Nigeria \neq GDP- NGA			2.726**	0.087	Fail to Accept		
GDP- Nigeria \neq RIR+ NGA			2.106	0.145	Accept		
RIR- Nigeria \neq GDP+ NGA			0.564	0.576	Accept		
GDP+ Nigeria \neq RIR- NGA			2.819**	0.081	Fail to Accept		
RIR+ Nigeria \neq GDP+ NGA			0.551	0.584	Accept		
GDP+ Nigeria \neq RIR+ NGA			1.510	0.242	Accept		

*shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bond for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77 respectively. LM is the Lagrange multiplier test of residual serial correlation. It is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical values at 5% (1%) significance is 3.84(6.63). number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol " \neq " indicates no causality.

Table-6 and Table-7 indicate the result related to Sri Lanka and Nigeria, respectively, which indicate the impact of monetary policy on economic growth in both of the

economies. As per the linear ARDL model, in the case of Sri Lanka, the results are in line with the theory as the interest rates carry a significant and negative sign in the short run as well as in the long run. Whereas, in the case of Nigeria, the findings indicate no significant impact of monetary policy shock on economic growth both in the short run as well as in the long run. However, in the case of the nonlinear results, the findings indicate that in the case of Sri Lank, there is no impact of both positive and negative monetary policy in the short run. However, in the long run, both positive and negative interest rates tend to have output-reducing effects. When we examine the asymmetric effect of monetary policy (interest rate) on national output, in the case of Nigeria, the findings indicate that in the short-run, positive interest rate (contractionary monetary policy) does not have any effect on economic growth, but negative shocks depend on previous lags and tend to impact the economic growth negatively. While, in the long run, the results are different as there is no significant impact of interest rate on GDP growth. However, the result confirms the asymmetric effects.

Table 8. Empirical Results for Ukraine

Linear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
$\Delta RIRUKR$			0.005(0.09)				
Panel B: Long run results							
Constant				RIRUKR			
0.79(0.47)				0.21*(3.93)			
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	
9.19	0.64	-0.64*(-4.14)	0.014	S	S	0.35	
Nonlinear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
$\Delta RIR+UKR$					-0.08(-0.88)		
$\Delta RIR-UKR$					0.13*(2.13)		
Panel B: Long run results							
Constant				RIR+UKR			
-5.10(-0.94)				0.18*(3.36)			
					AIR-UKR		
					0.19*(2.10)		
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald
5.79	0.97	-0.68*(-4.11)	0.07	S	S	0.33	1.83
Asymmetric causality test							
Null Hypothesis			Fisher Statistic	P-Value	Decision		
RIR- Ukraine $\neq >$ GDP- UKR			1.800	0.188	Accept		
GDP- Ukraine $\neq >$ RIR- UKR			0.073	0.929	Accept		
RIR+ Ukraine $\neq >$ GDP- UKR			1.300	0.292	Accept		
GDP- Ukraine $\neq >$ RIR+ UKR			1.582	0.228	Accept		
RIR- Ukraine $\neq >$ GDP+ UKR			1.961	0.164	Accept		
GDP+ Ukraine $\neq >$ RIR- UKR			2.507	0.104	Accept		
RIR+ Ukraine $\neq >$ GDP+ UKR			1.633	0.218	Accept		

GDP+ Ukraine \neq > RIR+ UKR	1.560	0.232	Accept
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**shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bond for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77 respectively. LM is the Lagrange multiplier test of residual serial correlation. It is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical values at 5% (1%) significance is 3.84(6.63). number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol " \neq " indicates no causality.*

Table 9. Empirical Results for Vietnam

Linear ARDL model estimates								
Panel A: Short-run results								
Lags	0	1	2	3	4	5	6	
Δ GDPVNM			0.29(1.63)					
Δ RIRVNM			0.05(1.30)					
Panel B: Long run results								
	Constant			RIRVNM				
	6.41*(12.89)			0.11(1.31)				
Panel C: Diagnostic results								
F	LM	ECM	RESET	CSM	CSM2	Adj R2		
6.91	0.58	-0.48*(-3.12)	0.05	S	S	0.29		
Nonlinear ARDL model estimates								
Panel A: Short-run results								
Lags	0	1	2	3	4	5	6	
Δ GDPVNM	0.58*(2.72)		0.14(0.85)			0.34(2.06)		
Δ RIR+VNM			0.05(1.24)					
Δ RIR-VNM			0.07(1.89)					
Panel B: Long run results								
	Constant		RIR+VNM		RIR-VNM			
	8.07*(16.92)		0.06(1.19)		0.09(1.89)			
Panel C: Diagnostic results								
F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald	
4.16	1.64	-0.75*(-3.56)	2.88	S	S	0.24	2.91	
Asymmetric causality test								
Null Hypothesis			Fisher Statistic		P-Value	Decision		
RIR- Vietnam \neq > GDP- VNM			1.228		0.312	Accept		
GDP- Vietnam \neq > RIR- VNM			0.595		0.560	Accept		
RIR+ Vietnam \neq > GDP- VNM			1.371		0.274	Accept		
GDP- Vietnam \neq > RIR+ VNM			0.372		0.693	Accept		
RIR- Vietnam \neq > GDP+ VNM			1.768		0.193	Accept		
GDP+ Vietnam \neq > RIR- VNM			2.099		0.146	Accept		
RIR+ Vietnam \neq > GDP+VNM			1.469		0.251	Accept		
GDP+ Vietnam \neq > RIR+VNM			0.337		0.717	Accept		

**shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bond for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77 respectively. LM is the Lagrange multiplier test of residual serial correlation. It*

is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical values at 5% (1%) significance is 3.84(6.63). number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol " \neq " indicates no causality.

Results for Ukraine and Vietnam are reported in Table-8 and Table-9, respectively. In the case of the results based on the asymmetric approach, it shows that in the short run, the results are insignificant, while in the long run, the interest rate has a positive and significant impact on domestic GDP. It shows that, unlike expectations, the increasing interest rate has an output-enhancing effect on economic growth in the case of Ukraine. On the other hand, in the nonlinear model, a positive interest rate has an insignificance effect, while a negative interest rate has a positive effect in the short run. While in the long run, both positive and negative interest rates have a positive impact on economic growth. Thus, the results point to the fact that there is evidence of the asymmetric effect in the case of Ukraine. The results based on symmetric effects related to Vietnam are reported in Table-9, which shows that there is no significant impact of the monetary policy on economic growth both in the short run and the long run as well. However, in the case of the nonlinear ARDL, it doesn't show any significant impact on economic growth, i.e., the impact of both positive and negative interest is insignificant. However, we still have evidence of asymmetric effect in the case of Vietnam.

Table 10. Empirical Results for Bangladesh

Linear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
Δ GDP Bang				0.68*(4.50)			
Δ RIR Bang				-0.07(-1.61)			
Panel B: Long run results							
	Constant				RIR Bang		
	7.51*(6.20)				-0.24(-1.58)		
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	
1.60	1.19	-0.31*(-2.03)	7.43*	US	S	0.04	
Nonlinear ARDL model estimates							
Panel A: Short-run results							
Lags	0	1	2	3	4	5	6
Δ GDP Bang				-0.51*(-3.32)			
Δ RIR+ Bang				-0.32*(-2.90)			
Δ RIR-Bang				0.17*(2.30)			
Panel B: Long run results							
	Constant		RIR+ Bang		RIR-Bang		
	-0.84(-0.36)		-0.62*(-2.58)		-0.49*(-2.98)		
Panel C: Diagnostic results							
F	LM	ECM	RESET	CSM	CSM2	Adj R2	L-Wald
1.68	0.03	-0.51*(-3.42)	2.78	S	S	0.70	4.42*
Asymmetric causality test							
Null Hypothesis			Fisher Statistic	P-Value		Decision	
RIR- Bang \neq GDP- Bang			0.953	0.400		Accept	

GDP- Bang \neq > RIR- Bang	0.978	0.391	Accept
RIR+ Bang \neq > GDP- Bang	0.658	0.527	Accept
GDP- Bang \neq > RIR+ Bang	0.731	0.492	Accept
RIR- Bang \neq > GDP+ Bang	0.229	0.796	Accept
GDP+ Bang \neq > RIR- Bang	0.554	0.582	Accept
RIR+ Bang \neq > GDP+ Bang	0.426	0.657	Accept
GDP+ Bang \neq > RIR+ Bang	1.289	0.295	Accept

**shows significance at 5% and ** shows significance at 10%. Abbreviation n.e.s refers to not elsewhere specified. The critical values for upper and lower bond for 5% and 10% are 3.23 to 4.35 and 2.72 and 3.77 respectively. LM is the Lagrange multiplier test of residual serial correlation. It is chi-square distributed with one degree of freedom. Ramsey RESET test for functional form. It is also chi-square distributed with one degree of freedom. Its critical values at 5% (1%) significance is 3.84(6.63). number inside the parenthesis is next to the coefficients are the absolute values of t-ratios. The symbol " \neq " indicates no causality.*

Finally, Table-10 presents the result for Bangladesh, where the results indicate that in the case of the linear ARDL model, there is no effect of monetary policy (interest rate) on GDP growth both in the short run and long run. While in the case of the nonlinear model, the short-run results show that a positive interest rate has a negative and significant on economic growth, while a negative interest rate has a positive and significant impact in the case of Bangladesh. Thus the results indicate that in the case of the nonlinear ARDL model, a negative impact of both the positive and negative interest rate was observed in the long run; thus, the results support the asymmetric effect.

For the above empirical estimates to be valid and meaningful, we need to establish cointegration among variables. The F-state values are given in Table-1 through Table-10. Given the new critical value of the F-test (4.15 at 10% significance level) from Narayan 2005), the variables are cointegrated in most optimum models since our calculated F-statistic values are greater than its critical value. Thus, the results indicate evidence of cointegration among variables indicating that the estimates are valid. The long-run relationship can also be established using an alternative method given in the literature. Using the normalized long-run coefficients for equation-2, we generate the error term and denote it by ECT. We then replace the lagged level variables in Equation-3 by ECTt-1 and estimate each model using the same optimum lags. The ECM-1 term indicates a significantly negative coefficient in the case of all the selected economies. The negative value of the ECM term indicates that it not only supports cointegration but it also indicates the convergence towards long-run equilibrium values as the lagged error-correction term, ECTt-1 carries a significantly negative coefficient in the case of selected economies.

Other diagnostic statistics are given in Table-1 to Table-10. To test the presence of autocorrelation, we apply the Lagrange Multiplier (LM) test, which is distributed as χ^2 with one degree of freedom. Given its critical value of 3.84 at the 5% level of significance, none of the optimum models suffer from serial correlation since none of the LM statistics is significant. The same is true of the RESET statistic. It is used to test for misspecification of the models. It also is distributed as χ^2 with one degree of freedom. It indicates that none of the optimum models are miss-specified. In line with the literature

and following Bahmani-Oskooee, Economidou, and Goswami (2005), we also apply the CUSUM test denoted by CUS and CUSUMSQ test denoted by CUS2 to determine the stability of all short-run and long-run coefficient estimates. Stable coefficients are marked by 'S' and unstable ones by 'US.' Again, it appears that almost all models are stable. Finally, the size of adjusted R2 is reported to measure the goodness of fit of each optimum model.

Asymmetric Causality Analysis

The results concerning asymmetric causality are given in Panel-D in Table -1 through Table-10. These tests hypothesize the same way as does the Hacker and Hatemi-j (2006) causality test, which means that the H_0 hypothesis is rejected if the test statistic is greater than the critical value at the significance level of 0.05. The results indicate significant evidence of asymmetric causality in the case of many economies. In the case of Pakistan, the results show a bidirectional Granger causality between negative RIR shocks and negative GDP as well as between positive RIR shocks and negative GDP. While we found that there is no Granger causality between negative RIR shocks and positive GDP and between positive RIR with positive GDP. Thus the findings support the evidence of asymmetric causality in the case of Pakistan. In the case of India, the findings support the evidence of unidirectional causality between positive shocks of RIR and negative GDP and between positive GDP with negative RIR. While the rest of the variables have no causal relationship. Thus, the findings support evidence of asymmetric causality in the case of India.

In the case of Egypt, the results indicate the unidirectional causality between negative GDP and positive RIR, as well as between negative RIR and positive GDP. Furthermore, the findings also indicate a unidirectional causality between positive GDP with positive RIR. While the other variables have no causal relationship. Yet, the findings support the evidence of asymmetry in causality concerning Egypt. In the case of Kenya, the estimated result gives evidence about unidirectional causality between negative RIR shocks and negative GDP. While we also find unidirectional causality among positive RIR shocks and negative GDP. Additionally, the findings indicate bidirectional causality between negative shocks of RIR and positive GDP. Hence, the findings suggest evidence of asymmetric effect causality in the case of Kenya.

Likewise, the findings suggest evidence of asymmetric causality in the case of the Philippines and Nigeria. For example, in the case of the Philippines, the estimated results revealed unidirectional causality in the case of negative GDP and positive RIR. While other variables have no causal relation between each other. In the case of Nigeria, the causality tests indicate evidence of unidirectional causality from negative RIR shocks to negative GDP, and from positive shocks of RIR to negative GDP. Likewise, unidirectional causality from positive GDP to negative RIR shocks was reported. However, in the case of Sri Lanka, Ukraine, Vietnam, and Bangladesh, the estimated results do not show any evidence of asymmetric causality between variables as reflected in the insignificant p-values.

This study investigates the asymmetric effect of monetary policy shocks on output growth in Nigeria using the asymmetric ARDL model and Hatemi-J causality over the period 1981Q1–2018Q4. Given that most studies simply assumed a linear relationship in considering the effect of monetary policy shocks on output growth and causality between the variables. This study contributes immensely to the bulk of literature by

moving out of the linear to an account t for the asymmetric or nonlinear effects of monetary policy shocks on output growth in Nigeria and the causality thereof. To avoid spurious estimates, we tested for the stationarity properties of the data using the newly developed single structural break unit root test by Lee and Strazicich (2013). The result of the unit root test indicates that all the variables became stationary at first difference. This study investigates the asymmetric effect of monetary policy shocks on output growth in Nigeria using the asymmetric ARDL model and Hatemi-J causality over the period 1981Q1–2018Q4. Given that most studies simply assumed a linear relationship in considering the effect of monetary policy shocks on output growth and causality between the variables. This study contributes immensely to the bulk of literature by moving out of the linear to an account t for the asymmetric or nonlinear effects of monetary policy shocks on output growth in Nigeria and the causality thereof. To avoid spurious estimates, we tested for the stationarity properties of the data using the newly developed single structural break unit root test by Lee and Strazicich (2013). The result of the unit root test indicates that all the variables became stationary at first difference. This study investigates the asymmetric effect of monetary policy shocks on output growth in Nigeria using the asymmetric ARDL model and Hatemi-J causality over the period 1981Q1–2018Q4. Given that most studies simply assumed a linear relationship in considering the effect of monetary policy shocks on output growth and causality between the variables. This study contributes immensely to the bulk of literature by moving out of the linear ARDL approach to account for the asymmetric or nonlinear effects of monetary policy shocks on output growth in Nigeria and the causality thereof. To avoid spurious estimates, we tested for the stationarity properties of the data using the newly developed single structural break unit root test by Lee and Strazicich (2013). The result of the unit root test indicates that all the variables became stationary at first difference.

Conclusion

The present study aims to consider the asymmetric impact of monetary policy shocks on output growth of selected developing economies while relying on a nonlinear ARDL approach. Previous studies, in general, have relied on the symmetric approach while considering the output response of monetary policy. The present study contributes to the literature by introducing the asymmetric effect or nonlinear effect of positive and negative monetary policy shocks on output growth in developing economies. The empirical results indicate that in the case of the symmetric approach, at least one significant coefficient, either in the short run or in the long run, was observed in the case of Pakistan, India, Sri Lanka, and Ukraine. However, when we relied on nonlinear ARDL, the results indicate the evidence of asymmetric effect both in the short run as well as in the long run in the case of all the selected economies. As far as the effect of both positive and negative monetary shocks is concerned, the results indicate that expansionary monetary policy shock has a more profound impact on output growth which is in line with the findings of the previous studies. The findings are important from policy perspectives. As nonlinearity or asymmetry is the phenomenon that tend to exist between the monetary policy and output, and it may be caused by various reasons or assumptions related to the economy. In particular, the specific version of the asymmetry differs between competing theories, and it is often difficult to test the underlying assumptions directly on macroeconomic data. One of the challenges or difficulties that one has to face is that it is not clear that empirical tests of the

assumption at the firm or household level may necessarily carry over to the macro level. Nevertheless, these asymmetries that prevail in monetary policy shocks and output or other economic variables tend to have ramifications for the conduct and effectiveness of the economic policy.

References

- Abdelsalam, M. A. M. (2018). Asymmetric Effect of Monetary Policy in Emerging Countries: The Case of Egypt. *Applied Economics and Finance*, 5(4), 1-11.
- Aye, G. C., & Gupta, R. (2012). Are the effects of monetary policy asymmetric in India? evidence from a nonlinear Vector Autoregression Approach. *Trends in Applied Sciences Research*, 7(7), 565.
- Ball, L., & Mankiw, N. G. (1994). Asymmetric price adjustment and economic fluctuations. *The Economic Journal*, 104(423), 247-261.
- Barro, R. J. (1977). Long-term contracting, sticky prices, and monetary policy. *Journal of Monetary Economics*, 3(3), 305-316.
- Bernanke, B. S., & Boivin, J. (2003). Monetary policy in a data-rich environment. *Journal of Monetary Economics*, 50(3), 525-546.
- Bernanke, B. S., Boivin, J., & Elias, P. (2005). Measuring the effects of monetary policy: a factor-augmented vector autoregressive (FAVAR) approach. *The Quarterly journal of economics*, 120(1), 387-422.
- Bernanke, B., & Blinder, A. S. (1992). The federal funds rate and the transmission of monetary policy. *American Economic Review*, 82(4), 901-21.
- Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society: Series B (Methodological)*, 37(2), 149-163.
- Cover, J. P. (1992). Asymmetric effects of positive and negative money-supply shocks. *The Quarterly Journal of Economics*, 107(4), 1261-1282.
- De Long, J. B., Summers, L. H., Mankiw, N. G., & Romer, C. D. (1988). How does macroeconomic policy affect output?. *Brookings Papers on Economic Activity*, 1988(2), 433-494.
- Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251-276.
- Florio, A. (2004). The asymmetric effects of monetary policy. *Journal of Economic Surveys*, 18(3), 409-426.
- Forni, M., & Gambetti, L. (2010). The dynamic effects of monetary policy: A structural factor model approach. *Journal of Monetary Economics*, 57(2), 203-216.
- Frydman, R., & Rappoport, P. (1987). Is the distinction between anticipated and unanticipated money growth relevant in explaining aggregate output?. *The American Economic Review*, 77(4), 693-703.
- Garcia, R., & Schaller, H. (2002). Are the effects of monetary policy asymmetric?. *Economic Inquiry*, 40(1), 102-119.
- Granger, C. W., & Yoon, G. (2002). Hidden cointegration. *U of California, Economics Working Paper*, (2002-02).
- Hatemi-j, A. (2012). Asymmetric causality tests with an application. *Empirical Economics*, 43(1), 447-456.
- Hayford, M. D. (2005). Fiscal policy and national saving. *Applied Economics*, 37(9), 981-992.
- Hayford, M. D., & Malliaris, A. G. (2005). Recent monetary policy in the US: Risk management of asset bubbles. *The Journal of Economic Asymmetries*, 2(1), 25-39.
- Ilyas, S., Bhatti, H. N., Bhatti, I. A., Sheikh, M. A., & Ghauri, M. A. (2010). Bioleaching of metal ions from low-grade sulphide ore: Process optimization by using

- orthogonal experimental array design. *African Journal of Biotechnology*, 9(19), 2801-2810.
- Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52(2), 169-210.
- Johansen, S., & Juselius, K. (1990). *Some structural hypotheses in a multivariate cointegration analysis of the purchasing power parity and the uncovered interest parity for the UK* (No. 90-05).
- Karras, G. (1996). Are the output effects of monetary policy asymmetric? Evidence from a sample of European countries. *Oxford Bulletin of Economics and Statistics*, 58(2), 267-278.
- Lo, M. C., & Piger, J. (2005). Is the response of output to monetary policy asymmetric? Evidence from a regime-switching coefficients model. *Journal of Money, credit, and Banking*, 865-886.
- Lucas Jr, R. E. (1972). Expectations and the Neutrality of Money. *Journal of economic theory*, 4(2), 103-124.
- Mishkin, F. S. (1982). Does anticipated monetary policy matter? An econometric investigation. *Journal of Political Economy*, 90(1), 22-51.
- Morgan, D. P. (1993). Asymmetric effects of monetary policy. *Economic Review-Federal Reserve Bank of Kansas City*, 78, 21-21.
- Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, 16(3), 289-326.
- Psaradakis, Z., Ravn, M. O., & Sola, M. (2005). Markov switching causality and the money–output relationship. *Journal of Applied Econometrics*, 20(5), 665-683.
- Ravn, M. O., & Sola, M. (1996). A reconsideration of the empirical evidence on the asymmetric effects of money-supply shocks: Positive vs. negative or big vs. small?. *Available at SSRN 56134*.
- Ravn, M. O., & Sola, M. (2004). Asymmetric effects of monetary policy in the United States. *Review-Federal Reserve Bank of Saint Louis*, 86, 41-58.
- Rhee, W., & Rich, R. W. (1995). Inflation and the asymmetric effects of money on output fluctuations. *Journal of Macroeconomics*, 17(4), 683-702.
- Sawyer, M. (2006). Inflation targeting and central bank independence: we are all Keynesians now! or are we?. *Journal of Post Keynesian Economics*, 28(4), 639-652.
- Shin, H. J., Takasugi, S., Park, K. M., Choi, S. H., Jeong, Y. S., Kim, H. S., ... & Ahn, B. C. (2014, June). 50.1: Invited paper: Technological progress of panel design and compensation methods for large-size UHD OLED TVs. In *SID Symposium Digest of Technical Papers* (Vol. 45, No. 1, pp. 720-723).
- Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). *Modeling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework*. In *Festschrift in Honor of Peter Schmidt* (pp. 281-314). Springer, New York, NY.
- Tan, S. H., & Habibullah, M. S. (2007). Business cycles and monetary policy asymmetry: An investigation using Markov-switching models. *Physica A: Statistical Mechanics and its Applications*, 380, 297-306.
- Telatar, E., & Hasanov, M. (2006). The asymmetric effects of monetary shocks: the case of Turkey. *Applied Economics*, 38(18), 2199-2208.
- Thoma, M. A. (1994). Subsample instability and asymmetries in money-income causality. *Journal of econometrics*, 64(1), 279-306.

- Uhlig, H. (2005). What are the effects of monetary policy on output? Results from an agnostic identification procedure. *Journal of Monetary Economics*, 52(2), 381-419.
- Ülke, V., & Berument, M. H. (2016). Asymmetric effects of monetary policy shocks on economic performance: empirical evidence from Turkey. *Applied Economics Letters*, 23(5), 353-360.
- Weise, C. L. (1999). The asymmetric effects of monetary policy: A nonlinear vector autoregression approach. *Journal of Money, Credit, and Banking*, 85-108.
- Zakir, N., & Malik, W. S. (2013). Are the effects of monetary policy on output asymmetric in Pakistan?. *Economic Modelling*, 32, 1-9.