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Abstract

Egypt is an emerging economy that has been going through a series of monetary reforms since the 1990s. Previous studies examined the effects of monetary policy with the assumption of a symmetric impact on the macroeconomic aggregates. We add to this line of literature with a recent investigation of both the symmetric and asymmetric effects of monetary policy on output and inflation in Egypt. This paper utilized the interest rate as the monetary policy instrument and retrieved quarterly data covering the period from 2007Q3 to 2019Q3. We apply both the linear and non-linear Auto-regressive Distributed Lag (ARDL) model. In addition, the paper employs an F-bounds test for cointegration and derives the dynamic multiplier to visualize the asymmetric effects. Despite a significant long-run impact on both macroeconomic variables, there is evidence for asymmetric effects on inflation, but not on output. We conclude with policy implications reflecting on Egypt's plans of implementing an inflation-targeting (IT) regime.

JEL Classification: E5

Keywords: asymmetric policy, cointegration, interest rate, inflation, non-linear ARDL (NARDL), monetary policy

ملخص

اقتصاد مصر اقتصاد ناشئ يمر بسلسلة من الإصلاحات النقدية منذ التسعينيات. بحثت دراسات سابقة آثار السياسة النقدية بافتراض وجود تأثير متماثل على مجاميع الاقتصاد الكلي. نضيف إلى هذا الخط من الأدبيات مع التحقيق الأخير في كل من الآثار المتماثلة وغير المتماثلة للسياسة النقدية على الناتج والتضخم في مصر. استخدمت هذه الورقة سعر الفائدة كأداة للسياسة النقدية واسترجعت البيانات الفصلية التي تغطي الفترة من Q32007 إلى Q32019. نقوم بتطبيق كل من طراز Lag Distributed Lag (ARDL) الخطي وغير الخطي. بالإضافة إلى ذلك، تستخدم الورقة اختبار F-bounds للتكامل المشترك وتستمد المضاعف الديناميكي لتصور التأثيرات غير المتماثلة. وعلى الرغم من التأثير الكبير الطويل الأجل على كلا المتغيرين من متغيرات الاقتصاد الكلي، هناك أدلة على وجود آثار غير متماثلة على التضخم، ولكن ليس على الناتج. نختتم بتداعيات السياسة التي تنعكس على خطط مصر لتنفيذ نظام استهداف التضخم (IT).

Introduction

Until the Great Depression, it was believed that monetary policy has symmetrical effects. More recent literature started to acknowledge the possible asymmetry of the effects of monetary policy on the economy. Theoretically, it is suggested that negative (expansionary) policy shocks have a lower impact on output relative to positive (contractionary) policy shocks. This asymmetry has been highlighted since the times of the Great Depression; Keynes's idea of the *liquidity trap*. Later, multiple other incidences put the effectiveness of expansionary monetary policy into question. Friedman also mentioned an analogy comparing monetary policy to a string that you can "pull" but not "push".

What led to this theoretical assumption are several events during which expansionary monetary policy was implemented to lift the economy out of a slump, but was proven ineffective. One example is the time following the Second World War in the US. Another incident is when the Federal Reserve was trying to mitigate the recession during 1990 - 1992. Also, the same concerns were raised in the case of Japan, which Krugman (2000) regarded as a real-life example of a Keynesian liquidity trap. Similarly for Italy, the post-World War II period witnessed the weakness of the expansionary monetary measures, in addition to the 1960s period where the easing measures failed to increase credit (Florio, 2004).

Previous research found robust evidence of asymmetry between the effects of tight and easy monetary policies. Most evidence concluded that an easy monetary policy expands the economy less than a tight policy contracts the economy. The proposed theories are loss of confidence, credit constraints, and rigid prices in times of recession (Morgan, 1993). As Egypt is moving towards adopting the inflation-targeting regime, it is important to have a thorough understanding of the monetary policy's impact on the economy.

After taking account of the literature, we found a shortage of studies on Egypt's monetary policy using recent data from the last 10 years. In addition, testing for the asymmetric effects of monetary policy has not been investigated enough in the context of emerging economies in general and the Egyptian context in particular.

In this paper, we attempt to empirically investigate the following questions in the Egyptian context:

1) Do Monetary Policy shocks have an asymmetric effect on output and inflation?
2) Do Monetary Policy shocks have a long-term effect on output and inflation?

We answer these questions by applying both the auto-regressive distributed lag (ARDL) model and the nonlinear auto-regressive distributed lag (NARDL) introduced by Shin *et al*. (2014). We follow the 2-stage approach as per Morgan (1992) and apply both the linear and non-linear specifications of ARDL. Moreover, we test for cointegration to investigate the long-term relationship in both the linear and non-linear models. In addition to the Wald test, we derive the dynamic multipliers graph for asymmetry based on our NARDL estimations. From the results, we expect to understand the dynamics of the monetary policy in Egypt and learn whether the agreed view on asymmetry in the literature applies in the Egyptian context.

Literature Review

An overview of Monetary Policy in Egypt

The literature documents Egypt's monetary reforms that started in 1990 with economic reform and structural adjustment program (ERSAP). In 1991, the Central Bank of Egypt (CBE) liberalized the interest rates and eliminated interest rate and credit ceilings. 2003 marked the first floatation of the Egyptian pound which was followed by a banking sector reform in 2004. As a consequence of the currency floatation, the inflation rates spiked which led the CBE to consider price stability as a primary objective. This meant a move towards an inflation-targeting (IT) regime which required further reforms. The reform they started with was the introduction of an interest rate corridor in June 2005 (Moursi, El Mosallamy and Zakaria, 2007; Al-Mashat and Billmeier, 2008; Shokr, Abdul Karim, and Zaidi, 2019).

Awad (2010) explores the case of Egypt as an emerging market newly introducing the Inflation-Targeting (IT) regime. They assess the efficiency of monetary targeting in Egypt by testing the relationship between money and prices, the stability of the velocity of circulation, and the stability of the demand for money function. Their results point out that it is inefficient, and affirm the necessity of adopting the IT regime instead once the pre-requisites are fulfilled. The following were mentioned as preconditions before adopting an IT regime: (1) Central Bank

Independence, (2) Commitment to price stability and transparency about the inflation target, and finally, (3) Proper inflation forecasting and projections. This last requirement is the most relevant to our study; since a proper projection requires an understanding of the monetary policy transmission mechanism. This makes the question of asymmetry a very relevant topic to be explored. In the remainder of this section, we summarize some of the most cited empirical findings on Egypt's monetary policy.

Previous Empirical Research on Egypt's Monetary Policy

In their article, Moursi, El Mosallamy, and Zakaria (2007) evaluate the effect of policy shocks on both policy and non-policy variables (inflation and GDP). They apply a VAR methodology in which they included 3 policy variables (total bank reserves, nonborrowed reserves, and the 3-month deposit rate) and 3 non-policy variables (real GDP, GDP deflator, and CPI). Their analysis focused on Egypt from 1985 to 2005, using monthly data. They provide evidence supporting the long-run neutrality of money, as the results provided no evidence of real effects on output. They concluded that during 2001-2006 the Central bank of Egypt (CBE) focused more on reducing the variations in interest rates over stabilizing inflation.

Al-Mashat and Billmeier (2008) examine the monetary transmission mechanism in Egypt from 1996 to 2005. They evaluate the channels in a VAR model using monthly data on economic activity, price level, the monetary policy stance, and exchange rate. They used the interest rate (3-month deposit rate) similar to Moursi, El Mosallamy, and Zakaria (2007). They reflect on Egypt's intention to apply an inflation-targeting regime and concluded that the interest channel was underdeveloped, but it seemed to be strengthening since 2005. In addition, the results provided evidence of a strong exchange rate channel.

Hachicha and Lee (2009) explore the interest rate channel by imposing contemporaneous and long-run restrictions using the SVAR model on monthly data from 1976 to 2006. Their evidence points to a weak interest rate channel in the short run, however, seemed to be more important in the long run.

Abdel-Baki (2010) investigates the monetary policy transmission to the real economy following the banking reforms. They apply an SVAR methodology to monthly data from 1990 to 2009. They tested the impact of both interest rate (short-term interest rate) and the foreign exchange rate (real effective exchange rate) on both output and inflation. The results showed evidence of the interest rate having significant effects on output, but not on inflation, and the opposite for the exchange rate. They concluded that both transmission channels did improve after the banking reforms. To elaborate further on the results, they added that it is logical to find the exchange rate having a bigger impact on inflation than domestic output, given the high level of imports in the Egyptian economy during that time.

Awad (2011) studies the monetary transmission mechanism (MTM) in the Egyptian economy to answer questions regarding monetary policy independence, the impact of foreign shocks on Egypt's real GDP and price level, and the dominant monetary transmission mechanism channels. They apply the structural VAR method to quarterly data from 1995Q1 to 2007Q4. The monetary policy stance was measured by: the short-term nominal interest rate, non-borrowed reserves, and the ratio of non-borrowed reserves to total reserves. The findings of this study showed that the CBE does not apply an independent monetary policy as they are following a sterilized intervention policy; they found that the Central Bank's reaction is influenced by the foreign exchange rate and the Federal Funds rate of the US, as both explains the high levels of variation in the domestic short-term nominal interest rate. Further, they found foreign economic shocks to have a dominant impact on Egypt's real GDP, while domestic economic shocks have a dominant impact on domestic inflation. In addition, the interest channel seemed to be dominant where it had a significant impact on both real GDP growth and inflation in Egypt.

Finally, Shokr, Abdul Karim, and Zaidi (2019) examined the effects of monetary policy on three macroeconomic variables; output, inflation, and exchange rate in Egypt. They apply a non-recursive structural vector-autoregression (SVAR) model with a block exogeneity approach to quarterly data from the CBE, the International Financial Statistics, and Data Stream for the period 1991Q1 to 2011Q4. These results provided evidence that monetary policy has a significant impact on output, inflation, and exchange rate. The results were consistent using two different instruments, interest rate, and money supply, as a monetary policy measure.

Monetary Policy Asymmetry

In an attempt to explain the asymmetric effects of monetary policy, four theories were proposed:

1) *Private sector's expectations:*

During recessions, pessimism seems to be prevailing and this discourages spending and investment, thus, lower interest rates may not be enough to create an incentive to do otherwise. It is suggested that the asymmetry occurs due to pessimism being more intense in a recession relative to optimism in booming times. This theory relates expectations to the concept of the marginal efficiency of capital and inflation expectations; when lower inflation is expected, it lowers the schedule of the marginal efficiency of capital, and hence, lowers economic activity. The opposite occurs in the case of an expectation of higher inflation; it raises the schedule of the marginal efficiency of capital, and thus, increases economic activity.

2) *Inflation Expectations and the Term Structure of Interest Rates:*

As spending decisions depend on long-term interest rates, affecting the long-term interest rate is a sign of an effective monetary policy. The long-term interest rate will fluctuate based on two factors: the short-term rate and inflation expectations. The theory explains the asymmetric effects through this co-movement between short and long-term rates; expansionary monetary policy is ineffective in lowering long-term rates because of higher inflation expectations. At the same time, a contractionary policy is more effective as a lower price level is expected, hence, long-term rates increase.

3) *Asymmetric Price Adjustment:*

As mentioned in Karras (1996b), given a convex aggregate supply curve, positive shocks will be targeted at aggregate demand and will have different effects on the price level and output relative to negative shocks (even if it is the same size). With the assumption of sticky prices, a positive shock is expected to be met with a price adjustment, while a price adjustment following a negative shock is less likely due to the cost of adjustment and the positive inflation trend. Based on this it is predicted that the falling price level become more rigid as the inflation rate is higher.

4) *Credit Market Imperfections:*

The fourth explanation for asymmetry is through the credit view. Two channels can explain this asymmetry: the lending channel and the balance sheet channel. First, is the lending channel; a contractionary policy is followed by a reduction in the supply of credit, so firms will have to cut their investments and hence the output is lowered further than an expansion, wherein case of an easing policy, it is harder to push more people to invest by just reducing interest rates. Second, is the balance sheet channel; due to higher interest rates (contractionary monetary policy), this lowers the firms' net worth, hence, the lending banks will ask for larger premiums, discouraging further investments to be made.

In the remainder of this section, we summarize some empirical studies that investigated a similar question in the context of other emerging economies (EMEs).

Empirical studies on Asymmetry in EMEs

In their article, Khundrakpam (2017) analyzed the asymmetric effects of monetary policy on aggregate demand, its components (investment, government consumption, and private consumption), and inflation. They segregate anticipated and unanticipated monetary policy shocks similar to previous studies using a 2-step OLS approach, such as in Cover (1992), Morgan (1993), Ravn and Sola (2004). They apply a Taylor rule type, using OLS on quarterly data from 1996–97Q1 to 2013–14Q3, in the Indian context. They do find evidence in support of unanticipated shocks asymmetry on private consumption only, whereas the effect on investment is symmetric, while there is no significant response from government consumption. As for inflation, they also find that the impact of unanticipated shocks is symmetric.

Kilinc and Tunc (2019) examined the asymmetric effects of monetary policy on Turkey for the period from 2006Q1 to 2017Q4 using a Markov Switching Model. They found evidence of asymmetry, where the monetary policy seems to have a bigger impact during contractionary periods, while it has a weaker impact during expansionary periods.

Olayiwola (2019) investigated the asymmetric effects of monetary policy on both output and inflation in Nigeria. They applied the NARDL methodology to the period from 1986Q1 to 2016Q4. The study found evidence supporting an asymmetric impact of monetary policy shocks in both the short- and long- run, on both output and prices. More specifically, they found that negative shocks have a more significant impact on output than positive shocks, in the short run. However, it does not have a significant impact on prices. In the long run, they find significant effects on both output and prices, where positive shocks showed to be more significant.

As Egypt is moving towards adopting the inflation-targeting regime, it is important to have a thorough understanding of the monetary policy's impact on the economy. After taking account of the literature (and mentioning a few in this paper), it seems that there is a scarcity of studies on Egypt’s monetary policy for the last 10 years. In addition to the shortage of studies on monetary policy asymmetry in emerging economies, in general, and Egypt’s economy in specific. We now follow with our analysis attempting to answer our previously mentioned research questions. From the results, we expect to understand the dynamics of the monetary policy in Egypt and learn whether the agreed view on asymmetry in the literature applies in the Egyptian context. The following section details the data and methods we used in our study.

Data and Methods

To test for the effects of monetary policy on both inflation and output, this paper employed both the ARDL and NARDL methodologies. We begin our analysis by testing for the stationarity of the included variables. We found all variables to be integrated in order of I(0) or I(1) to be fit for the chosen models. Hence, using the ARDL methodology seems to fit due to the differing levels of integration (Shin *et al*., 2014). A summary of the sample data sources and stationarity results are provided in table 3 in the appendix. We find the NARDL model suitable for this investigation unlike other asymmetric models, as the NARDL approach does not have a convergence problem, the integration order of the variables can be a mix of I(0) and I(1), and most importantly, it helps avoid the endogeneity problem.

Our sample focuses on Egypt from 2007Q3 to 2019Q3. Data were retrieved from the Economist’s Intelligence Unit (EIU) and IMF International Financial Statistics database. We were able to acquire quarterly data for Discount rate, Consumer Price index (CPI), and Real Gross Domestic Production (GDP). We chose the interest rate as the monetary policy instrument given that Egypt has had an interest-based policy since 2005. The policy instrument chosen was the discount rate as per previous studies (Moursi, Mosallamy and Zakareya, 2007; Awad, 2011; Shokr, Abdul Karim, and Zaidi, 2019).

Model Specification: The 2-stage procedure

Given that the purpose of this study is to test for the non-linear effect of monetary policy, applying the VAR methodology as most commonly used in the literature is not a suitable method for this type of question. However, to control for the feedback between policy and our macroeconomic variables (GDP and inflation) we apply the 2-stage procedure as in Morgan (1993).

First-stage

Equation 2 presents the specification for the first step in the procedure:

$$\boldsymbol{IR = C + \sum_{i=1}^{i=n} \beta_1 IR_{t-i} + \sum_{i=0}^{i=n} \beta_2 GDP\_GR_{t-i} + \sum_{i=0}^{i=n} \beta_3 inflation_{t-i} + trend + u_t} \quad \textbf{(2)}$$

Where we regress the interest rate on its lags (IR), current and lagged inflation ($inflation_{t-i}$), and output growth (GDP_GR_{t-i}), in addition to a constant (C) and a trend ($trend$). We take the residuals from this model and use it in the second step as a measure of Monetary Policy shock which we will denote as MP.

Second-stage

We apply both linear and non-linear Auto-regressive Distributed Lag (ARDL) models and carry out a cointegration test to investigate the relationship in the long run. Equation 3 shows the model specification for the second step in the procedure, using the linear ARDL specification:

$$\boldsymbol{y = C + \sum_{i=1}^{i=n} \beta_1 \Delta y_{t-i} + \sum_{i=0}^{i=n} \beta_2 \Delta MP_{t-i} + \beta_4 y_{t-1} + \beta_5 MP_{t-1} + trend + u_t} \quad \textbf{(3)}$$

Equation 4 shows the non-linear ARDL specification:

$$\boldsymbol{\Delta y = C + \sum_{i=1}^{i=n} \beta_1 \Delta y_{t-i} + \sum_{i=0}^{i=n} \beta_2 \Delta MP^{+}{}_{t-i} + \sum_{i=0}^{i=n} \beta_3 \Delta MP^{-}{}_{t-i} + \beta_4 y_{t-1} + \beta_5 MP^{+}{}_{t-1} + \beta_6 MP^{-}{}_{t-1} + trend + u_t} \quad \textbf{(4)}$$

Where, y stands for Inflation rate and GDP growth rate, MP^{+} and MP^{-} are the positive and negative monetary shocks, respectively. The Δ refers to the first difference of variables. The *n* is the chosen optimum lag length for the variables based on the Akaike information criterion (AIC).

We do not include other control variables and suffice with the autoregressive lags as control. In addition, we controlled for major outliers (positive and negative) by adding dummies. Finally, all models are estimated with robust standard errors, and all diagnostics and stability tests are checked and added in the appendix (Table 4).

After estimating equation 4, we carry a Wald test on the coefficients of both positive and negative shocks at the first difference to test if they are statistically equal (no short-run asymmetry) versus the alternative hypothesis of inequality (evidence of short-run asymmetry). We do the same for the long-run coefficients ($-\beta_5/\beta_4$ and $-\beta_6/\beta_4$) to test if the asymmetry stands in the long run. For both models, we carry a bounds cointegration test (Pesaran *et al*., 2001) and if found to be cointegrated, we estimate the error correction term (ECT) and calculate the adjustment period. We find this method of cointegration testing fit for our data as it can be used with a mixture of I(0) and I(1) data, it is simple to implement and the variables can be assigned different lag lengths. We report the empirical results in the following section.

Results

In this section, we discuss the four models: models 1 and 2 are estimates of the effects of interest rate on output and inflation using the ARDL methodology, while models 3 and 4 are estimates of the same effects but allow for non-linearity; using the NARDL model. Tables 1 and 2 present a summary of the results, more detailed results are included in the appendix in tables 5 and 6, and table 4 shows diagnostic tests and the F-bounds test results. Before moving forward to the interpretation of the results, it should be noted that for the asymmetric parameters, a negative coefficient for the negative shock (positive shock) indicates that an expansionary (contractionary) shock increases (decreases) the dependent variable. On the other hand, a positive coefficient for the negative shock (positive shock) indicates that an expansionary (contractionary) shock decreases (increases) the dependent variable.

Model 1: Interest rate and Output

The coefficients of the differenced lags of the interest rate report the impact of a monetary policy shock in the short run. The results showed only the current and the first three lags to be significant. There is an immediate impact that seems to dissipate over the following three quarters. In other words, following a positive (negative) policy shock, output decreases (increases) in the current quarter, however, the effect over the subsequent quarter dissipates, and the GDP growth increases (decreases). The long-run coefficient reported in table 1 indicates that there is a significant long-run relationship between output growth and interest rate. The long-run multiplier between interest rate and output growth is 4.76. The coefficient's sign indicates that it is a negative relationship, meaning that every 1% increase in the interest rate (contractionary monetary policy) will reduce the output growth in the long run by 4.76%, while the opposite holds in the case of an expansionary policy.

Table 4 (appendix) shows all diagnostics in addition to the F-bounds test results on cointegration. From the F-bounds test we concluded that the null hypothesis of no levels relationship is rejected; meaning that there is a cointegrating relationship between interest rate and output. We run the ECM to estimate the error correction term (ECT) and calculate the period of adjustment to equilibrium. In table 1, we present the error correction term (ECT); it shows a negative sign and the value is between 0 and -1. Therefore, it indicates a stable model that converges to equilibrium. The coefficient is equal to -0.474799, hence, the speed of adjustment to the long-run equilibrium from one period to the next one is equal to 47.5%. The magnitude of this coefficient implies that 47% of any disequilibrium between GDP growth and interest rate is corrected within one period (one quarter). In other words, output goes back to equilibrium following a monetary policy shock after about 6 months (half a year).

Model 2: Interest rate and Inflation

The short-run effect is reported by the coefficients of the differenced lags of the interest rate. We find only the second lag to be significant, which means that inflation responds to monetary policy shocks with a lag of two quarters. The lagged response shows a negative sign, in other words, following a contractionary policy shock, inflation responds by decreasing in the second quarter. The long-run coefficient reported in table 1 indicates that there is no significant long-run relationship between inflation and interest rate. According to the F-bounds test result shown in table 4 (appendix), the null hypothesis of no levels relationship is not rejected; meaning that there is no cointegrating relationship between interest rate and inflation. Therefore, we do not proceed with ECM estimation as it would be irrelevant in this case.

Table 1 – ARDL Models Results

	(1)	(2)
y	ΔGDP_GR	ΔINFLATION
Sample (adjusted for lags)	2010Q2 2019Q3 (38 obs.)	2009Q3 - 2019Q3 (41 obs.)
LR Coefficient	-4.767606** (1.813823)	-6.689406 (11.95534)
ECT	-0.474799*** (0.071432)	- -
Adjusted R-squared	0.931983	0.891561
Adjustment period (in years)[1]	0.53	-
Note: ***, ** and * denote 1, 5 and 10% levels of significance respectively, while values in () are standard errors.		

Model 3: Interest rate and Output

The coefficients of the differenced lags of both positive and negative interest rate shocks report the impact of a monetary policy shock in the short run. For positive changes, the results showed only the first and the second lags to be significant; following a contractionary policy, the effect is lagged by one quarter, and the GDP growth increases. While for the negative changes, both the first and third lags were significant. In other words, following an expansionary policy, the effect is lagged by one quarter, and the GDP growth decreases. All coefficients showed a positive sign in the short run, which is consistent with the positive short-run coefficients from the ARDL results.

The long-run coefficients for positive and negative shocks, reported in table 2, indicate that there is a significant long-run relationship between output growth and both positive and negative shocks. The long-run multiplier between positive changes and output growth is 2.49. The coefficient's sign indicates that it is a negative relationship, meaning that every 1% increase in the interest rate (contractionary monetary policy) will reduce output growth in the long run by 2.49%. On the other hand, the long-run multiplier between negative changes and output growth is 2.51. The coefficient's sign indicates that it is a negative relationship, meaning that every 1% decrease in the interest rate (expansionary monetary policy) will increase output growth in the long run by 2.51%.

[1] We calculate the adjustment period as follows: we divide 100 by the adjustment percentage per quarter (Error correction term x 100), and then divide it by 4 (for example (100/54)/4 = 0.463 years).

From the F-bounds test (table 4 in the appendix) we concluded that the null hypothesis of no levels relationship is rejected; meaning that there is a cointegrating relationship between interest rate and output. We run the ECM to estimate the error correction term (ECT) and calculate the period of adjustment to equilibrium. Hence, in table 2, we present the error correction term (ECT) which is negative and between 0 and -1, indicating a stable model that converges to equilibrium. It shows a significant coefficient of -0.527; the magnitude of this coefficient implies that 52.7% of any disequilibrium between GDP growth and interest rate is corrected within one period (one quarter). In other words, output goes back to equilibrium following a monetary policy shock after about 6 months. This is also consistent with the cointegration and error-correction term results shown in the previous ARDL estimation.

Finally, we carry a Wald-test for asymmetry and find evidence of short-run asymmetry where the contractionary shocks (positive shocks) have a larger impact on output. However, there is no evidence of asymmetry in the long run. Even though the long-run coefficients are different, the Wald test indicates that this difference is not statistically significant. We also include the dynamic multiplier graph in the appendix (Figure 1), to further visualize the symmetric impact, and it confirms that there is no statistically significant difference between the impacts of positive versus negative shocks. Therefore, we can conclude that the monetary policy's impact on Egypt's GDP growth is symmetric for the period under study.

Model 4: Interest rate and Inflation

The short-run effect is reported by the coefficients of the differenced lags of both positive and negative interest rate changes. After segregating the positive and negative effects, the impact in the short-run is now significant where the second lag of a positive shock seems to have the only significant effect on inflation. In other words, following a contractionary shock (positive shock), the effect is lagged by one quarter, and the GDP growth increases. On the other hand, an expansionary policy seems to have no significant effect on inflation, in the short run.

The long-run coefficients for positive and negative shocks, reported in table 2, indicate that there is a significant long-run relationship between inflation and both positive and negative shocks. The long-run multiplier between positive changes and inflation is 11.14. The coefficient's sign indicates that it is a negative relationship, meaning that every 1% increase in the interest rate (contractionary monetary policy) will reduce inflation in the long run by 11.14%. On the other hand, the long-run multiplier between negative changes and inflation is 12.17. The coefficient's sign indicates that it is a negative relationship, meaning that every 1% decrease in the interest rate (expansionary monetary policy) will increase inflation in the long run by 12.17%. From the F-bounds test (table 4 in the appendix) we concluded that the null hypothesis of no levels relationship is not rejected; meaning that there is no cointegrating relationship between interest rate and inflation.

Finally, we carry a Wald test for asymmetry and found evidence of short- and long-run asymmetry. In the short-run, only the positive shocks seem to have a significant impact on inflation; contractionary policy is more significant than expansionary policy. For the long-run relationship, there is an asymmetric effect where expansionary policy (negative shocks) seems to have a more pronounced effect on inflation in the long run. We also include the dynamic multiplier graph in the appendix (Figure 1), to further visualize the asymmetric impact, and it shows that there is a statistically significant difference between the impacts of positive versus negative shocks. Hence, we conclude that the monetary policy's impact on Egypt's inflation is asymmetric for the period under study.

Table 2 – NARDL Models Results

	(3)	(4)
y	ΔGDP_GR	ΔINFLATION
Sample (adjusted for lags)	2010Q1 - 2019Q3 (39 obs.)	2010Q1 2019Q3 (39 obs.)
LR Coefficient (pos)	-2.491757**	-11.140050*
	(1.160087)	
LR Coefficient (neg)	-2.515210**	-12.174604*
	(1.133207)	
ECT	-0.526755***	-
	(0.110572)	-
Adjusted R-squared	0.909689	0.896026
SR Symmetry - Wald test (F)	3.817988*	-
LR Symmetry - Wald test (F)	0.059308	3.726944*
Adjustment period (in years)[2]	0.48	-
Note: ***, ** and * denote 1, 5 and 10% levels of significance respectively, while values in () are standard errors.		

[2] We calculate the adjustment period as follows: we divide 100 by the adjustment percentage per quarter (Error correction term x 100), and then divide it by 4 (for example (100/54)/4 = 0.463 years).

Discussion and Conclusion

In our analysis, we aimed to answer two questions regarding monetary policy in Egypt:

1) Do Monetary Policy shocks have an asymmetric effect on output and inflation?
2) Do Monetary Policy shocks have a long-term effect on output and inflation?

To answer the first question for output, we find the effects to be asymmetric in the short-run but not in the long run (figure 1 in the appendix). In the short run, the coefficients of the positive shocks showed significantly higher effects relative to the negative shocks. This result is consistent with the hypothesis in Florio (2004). However, in the long run, the coefficients of both negative and positive shocks are not significantly different; hence, the policy impact, in the long run, is symmetric.

For inflation, we find the effects to be asymmetric both in the short-run and in the long run (figure 1 in the appendix). In the short run, the coefficients of the positive shocks showed significantly higher effects relative to the negative shocks. This result is consistent with Florio (2004). However, in the long run, the negative shocks (expansionary) seem to have a bigger impact relative to the positive (contractionary) shocks. These results contradict the presented theoretical and empirical literature in Florio (2004), as it is theorized that expansionary policy would be less effective, but according to the results from this paper, this theory does not seem to hold up in the Egyptian context on the long-run. A similar conclusion was reached by Khundrakpam (2017) in the Indian context; they found that the expansionary policy has a bigger impact than the contractionary policy on inflation.

To answer the second question for output, we found evidence of a significant cointegrated relationship between GDP growth and interest rate shocks. The short-run coefficients indicate that there is an immediate response to monetary policy shocks under the assumption of a symmetric effect. However, in the non-linear model, under the assumption of asymmetry, there is a lag in the response by one quarter to interest rate shocks. For inflation, the linear model showed no long-run impact, however, when allowing for non-linearity using the NARDL method, the long-run impact showed significant coefficients. The short-run coefficients indicate that there is a lag in the response of inflation to an interest rate shock by two quarters. This was consistent in both the linear and non-linear models' results.

Looking back at previous studies, these conclusions are in line with Awad (2011) and Shokr, Abdul Karim, and Zaidi (2019); both found a significant impact on output growth and inflation. Hachicha and Lee (2009) also report that monetary policy transmission is more significant in the long run than in the short run. This can explain the inconsistencies we found in the short run with regards to the direction of the relationship for GDP, and the insignificant impact found for inflation. Similar to Abdel-Baki (2010), we find a significant effect on GDP; however, we also find a significant impact on inflation. Even though the latter finding might contradict Abdel-Baki (2010), as well as the reported findings in Moursi, El Mosallamy, and Zakaria (2007), it supports their claim that the interest rate channel is becoming stronger. The significant effects in our results provide evidence supporting this conclusion for the more recent years that were not included in their sample.

A potential extension of the current paper would be replicating the study with other interest rates such as the Treasury bill rate or lending rate, to check the robustness of the results. Also, given the consensus in the literature that the exchange rate channel is a stronger channel than the interest rate (Abdel-Baki, 2010; Al-Mashat and Billmeier, 2008), we suggest replicating the study to test for asymmetries in the exchange rate channel. Further, due to the unavailability of data, we did not include the 2020-2021 pandemic period; however, it would add more insights into the discussion by evaluating how the recession during that time impacted Egypt's plans toward an inflation-targeting regime. Finally, we could check the robustness of these results further, by applying other methodologies that allow for non-linearity such as the Markov Switching method applied in Kilinc and Tunc (2019).

So far, there has been a scarcity of studies on Egypt’s monetary policy for the last 10 years, in addition to the shortage of studies on monetary policy asymmetry in emerging economies, in general, and Egypt’s economy in specific. This paper attempted to fill this gap by investigating the asymmetric effects of the monetary policy shocks on both output and inflation in Egypt. We investigated the period between 2007Q3 to 2019Q3 by employing both linear and non-linear ARDL methodology. To control for the feedback between policy and our macroeconomic variables (GDP and inflation), we applied the 2-stage procedure as per Morgan (1993).

The results from the linear model provided evidence of a significant impact of monetary policy on output but not on inflation. However, when allowing for non-linearity in the model, the long-run effect on inflation was significant. The impact of monetary policy on output was found to be asymmetric in the short-run, but not in the long run. However, the main empirical finding from this paper is the asymmetric impact of monetary policy on inflation in the long run. This asymmetry needs to be acknowledged in Egypt's monetary policy setting, especially as they switch to an inflation-targeting regime. This makes a thorough understanding of the lags and asymmetry of the monetary policy's effect on the economy of high importance.

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Appendix

Table 3 – Data Sources

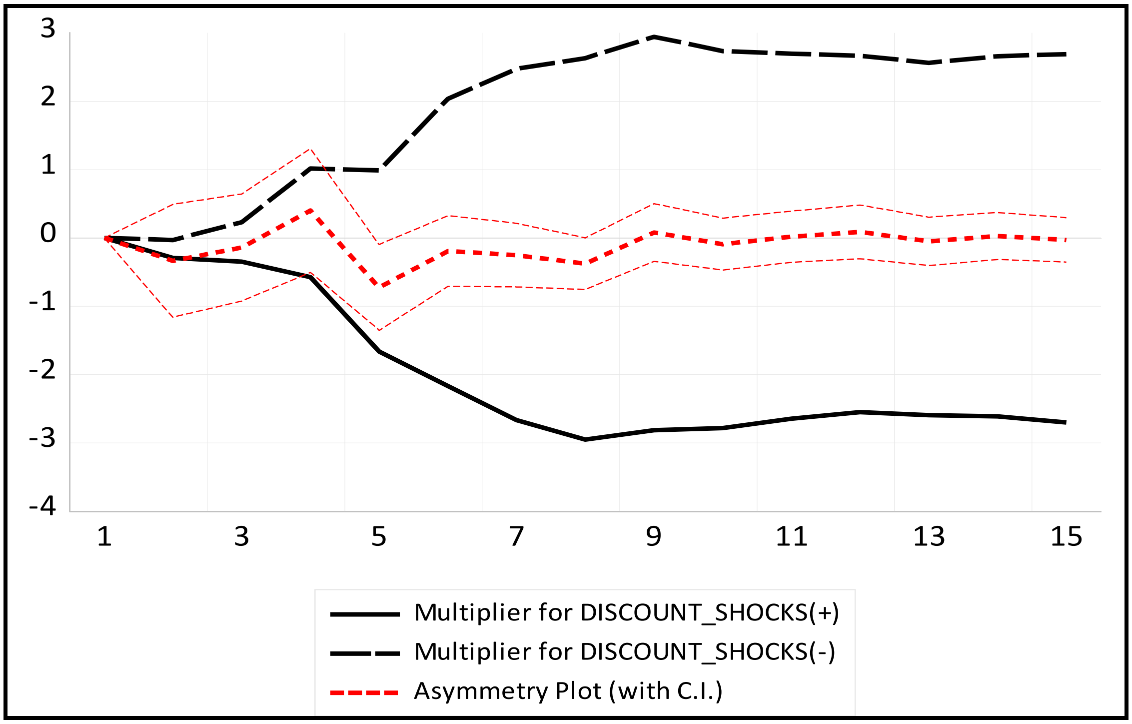
Data	Source	Frequency	Sample range	Stationarity	Transformation
Discount rate	IMF, International Financial Statistics	Quarterly	2004Q2 – 2019Q3	I(1)	*The 2-stage procedure: I(0)*
Inflation rate	Derived from Central Agency for Public Mobilization and Statistics	Quarterly	1993Q1 – 2021Q2	I(1)	-
GDP Growth	Derived from World Bank, World Development Indicators; Ministry of Planning	Quarterly	2007Q3 – 2021Q2	I(0)	-

Table 4 – Model Diagnostics

	ARDL		NARDL	
Diagnostics for model:	(1)	(2)	(3)	(4)
Serial Correlation LM test (chi2)	4.302572	1.082515	4.003120	2.212501
Breusch/Pagan heteroskedasticity test (chi2)	20.33090	10.44505	17.87047	15.85402
Jarque-Bera test on normality (chi2)	1.132238	0.670809	1.752574	0.283201
Bounds test (F_pss)	21.03853	1.256859	6.907112	2.139066
CUSUM and CUSUMsq	S	S	S	S

Figure 1 – Dynamic Multipliers

(a) Output-Interest rate



(b) Inflation-Interest rate

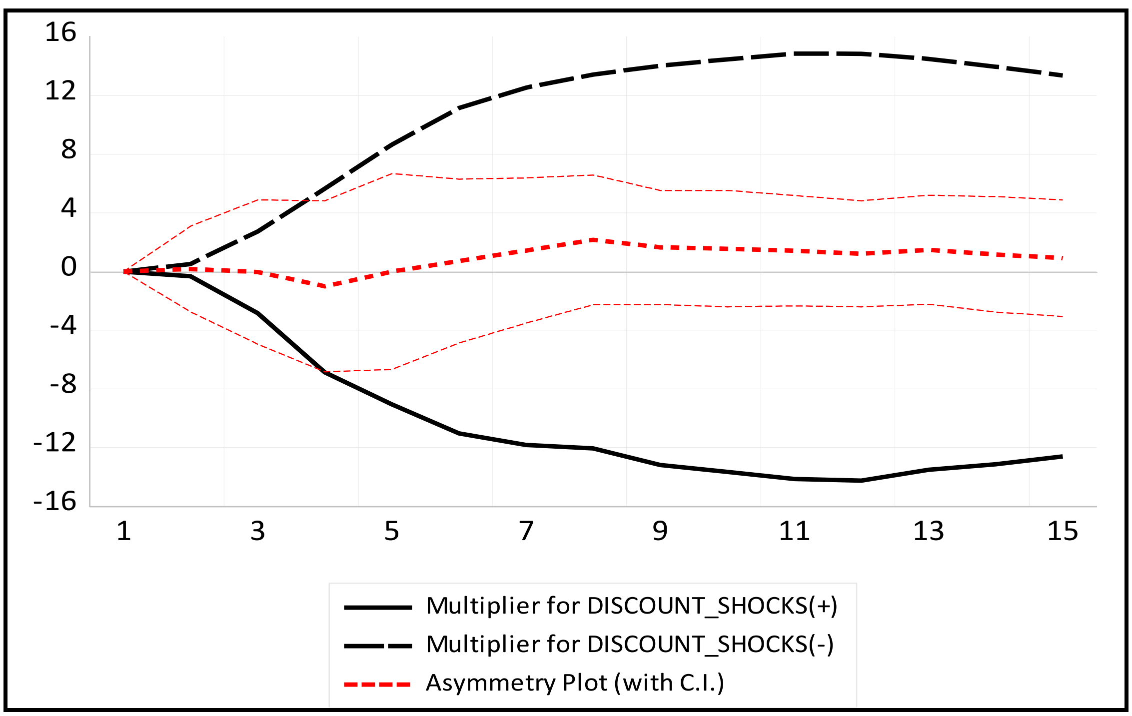


Table 5 – ARDL Results

	(1)	(2)
y	ΔGDP_GR	ΔINFLATION
Sample (adjusted for lags)	2010Q2 2019Q3 (38 obs.)	2009Q3 - 2019Q3 (41 obs.)
y(-1)	-0.474799*** (0.096048)	-0.109699 (0.071815)
MP(-1)	-2.263653*** (0.625202)	-0.733819 (1.328523)
Δy(-1)	-	0.520194*** (0.126736)
Δy(-4)	-0.241739*** (0.073255)	-0.398141*** (0.117151)
Δy(-5)	-0.144613* (0.070616)	0.432832*** (0.114494)
Δy(-6)	-0.162503** (0.059682)	-
ΔMP	-0.598879** (0.213408)	-
ΔMP (-1)	1.640379*** (0.476920)	-
ΔMP (-2)	1.021318** (0.397882)	-1.544180** (0.607877)
ΔMP (-3)	0.836582** (0.369908)	-
Constant	2.289642*** (0.390082)	0.849219 (1.031057)
LR Coefficient	-4.767606** (1.813823)	-6.689406 (11.95534)
ECT	-0.474799*** (0.071432)	-0.109699 (0.067987)
Adjusted R-squared	0.931983	0.891561
Adjustment period (in years)[3]	0.53	-
Note: ***, ** and * denote 1, 5 and 10% levels of significance respectively, while values in () are standard errors.		

[3] We calculate the adjustment period as follows: we divide 100 by the adjustment percentage per quarter (Error correction term x 100), and then divide it by 4 (for example (100/54)/4 = 0.463 years).

Table 6 – NARDL Results

	(3)	(4)
y	ΔGDP_GR	ΔINFLATION
Sample (adjusted for lags)	2010Q1 - 2019Q3 (39 obs.)	2010Q1 2019Q3 (39 obs.)
y(-1)	-0.526755*** (0.134479)	-0.164291** (0.071862)
MP_pos(-1)	-1.312546* (0.692866)	-1.836021*** (0.568369)
MP_neg(-1)	-1.324900* (0.702580)	-2.00017*** (0.57615)
Δy(-1)	-	0. 508846*** (0.122564)
Δy(-2)	0.224892** (0.103271)	-
Δy(-3)	0.235848** (0.086447)	-
Δy(-4)	-0.167378** (0.08730)	-0.376715*** (0.111779)
Δy(-5)	-	0.375010*** (0.111403)
ΔMP_pos	-	-
ΔMP_pos(-1)	1.108553* (0.517534)	-
ΔMP_pos(-2)	0.964606* (0.447915)	-1.345302** (0.12818)
ΔMP_pos(-3)	-	-
ΔMP_neg	-	-
ΔMP_neg(-1)	1.083726* (0.486538)	-
ΔMP_neg(-2)	-	-
ΔMP_neg(-3)	0.898028*** (0.313749)	-
Constant	2.733762*** (0.433182)	0.916098 (0.916635)
LR Coefficient (pos)	-2.491757**	-11.140050*

LR Coefficient (neg)	-2.515210**	-12.174604*
ECT	-0.526755***	-0.213882**
	(0.110572)	(0.080983)
Adjusted R-squared	0.909689	0.896026
SR Symmetry - Wald test (F)	3.817988*	-
LR Symmetry - Wald test (F)	0.059308	3.726944*
Adjustment period (in years)[4]	0.48	1.19
Note: ***, ** and * denote 1, 5 and 10% levels of significance respectively, while values in () are standard errors.		

[4] We calculate the adjustment period as follows: we divide 100 by the adjustment percentage per quarter (Error correction term x 100), and then divide it by 4 (for example (100/54)/4 = 0.463 years).