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The Taylor Rule in Egypt: Is it Optimal? Is there Equilibrium Determinacy?

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Abstract We investigate Egypt's Taylor rule (interest rate targeting) between 1976 and 2019 by including the main economic variables in its reaction function. Using the Taylor principle, we investigate Egypt’s monetary policy optimality. To this end, we conduct the generalized method of moments (GMM) estimation procedure with different Taylor rule specifications to deal with potential endogeneity among variables. Our GMM estimates reveal that the partial adjustment coefficient is of considerable magnitude, indicating the explanatory power of policy inertia on many total variations in the current values of the nominal interest rate in Egypt. Furthermore, the inflation gap coefficient violates the Taylor principle, making the policy procyclical and inflation "spiral" and inducing divergence from the long-run equilibrium. Therefore, Egypt's Taylor rule, and thus monetary policy, reflects the indeterminacy of equilibrium and is a passive and destabilizing policy. Besides, the output gap coefficient was unexpectedly found to be insignificant.

Keywords: Monetary policy, Taylor rule, Taylor principle, Determinacy, Kapetanios test, Structural breaks

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I. Introduction

As a component of economic stability, monetary stability occurs through stabilizing the general level of prices (stabilizing inflation rates and lowering them by controlling monetary and credit expansion). Monetary stability is considered a milestone factor that strengthens economic and social resilience and improves living standards (Ascari and Sbordone, 2014; Bordo, 2018; Ocampo, 2008; Orphanides, 2007; Schinasi, 2003). Many studies, including Christiano et al.

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(2005); Smets and Wouters (2007); and Woodford (2003), investigated how monetary policy impacts macroeconomic stability. Economists agree that high and volatile inflation rates distort relative prices, discourage savings and investment plans, impede economic growth, and deepen social imbalances and political instability. Consequently, achieving such stability represents monetary policy's primary medium- and long-term goal.

Furthermore, Bordo (2018) emphasized the connection between monetary policy and financial stability through credit-driven asset price booms and busts. For example, prolonged periods of low inflation and rates triggered rising financial imbalances; that is, low-interest rates and inflation was conducive to generating bank credit-fueled asset price booms and busts (Borio and Lowe, 2002). Ocampo (2008) argued that due to the significant rise in inflation rates, most countries, whether developed or developing, have sought to reduce these rates and maintain their stability. As a result, there has been a shift in economic policy directions to occupy financial and price stability. In this context, central banks try using their tools to curb inflation rates. One of the key instruments under the central bank's control is the nominal interest rates.

Motivated by higher inflation rates, monetary instability, and their negative effects on the Egyptian economy during the study period (1976-2019), this study focuses on evaluating the effectiveness of the Taylor rule as a main policy intermediate goal for monetary policy to stabilize long-run inflation as the ultimate goal of monetary policy. The interest rate has been identified as the primary tool under the central bank's control in the context of the Taylor rule.

The interest rate is considered a representative of the relative scarcity of domestic financial assets (Berument, 2007). Under Irving Fisher's perspective, the nominal short-term interest rate, i_t, (as a dependent variable) relates to the expected inflation rate, π_{t+1}, (as an independent variable or predictor, measured by the percentage change in the consumer price index, CPI), under what is referred to as the "Fisher effect." That is, inflation is added to the real interest rate, obtaining the nominal rate with the so-called "inflation premium." The nominal interest rate changes point by point with the inflation rate, contracting the inflationary pressures by reducing the aggregate demand and compensating creditors (lenders) for the decline in the purchasing power of their loanable funds due to inflation risk. Thus, the real interest rate remains constant over time (Cochrane, 2018; Conrad and Eife, 2012; Fama, 1975; Mishkin, 1992; Orphanides, 2007). We can express the Fisher equation as

$$i_t = r_t + E_t(\pi_{t+1}), \tag{1}$$

where r_t is the real short-term interest rate at time t and $E(\cdot)$ denotes the expectation operator, referring to the expectation of inflation (π) at time $t+1$ conditional on available information at time t. Here, the estimated parameter of the expected inflation rate should be positive, indicating the assumed positive causal relationship between the expected inflation rate as an independent variable and the nominal interest rate as a dependent one. The idea that the central bank's interest rate can vary due to temporary and permanent monetary policy activities creates an information challenge. Private agents must use nominal interest rate shifts to distinguish between temporary and permanent policy actions. Temporary policy actions are (i) departures from the interest rate rule in response to various temporary inflation shocks and/or (ii) monetary authorities' imperfect control over interest rates. In this respect, shifts in the central bank's inflation target are deemed permanent policy actions (Dossche and Everaert, 2005).

Glasner (2017) distinguished two types of monetary policy rules for governing the conduct of the monetary system: (1) price rules that target money value (i.e., purchasing power) in terms of a real commodity or a price index. In this case, the price level is the target, while the quantity of money is the instrument, and (2) quantity rules target the quantity of money in circulation. Taylor (1993) designed the so-called "Taylor rule" as a rule-of-thumb benchmark for policymakers, making interest rate decisions, particularly the short-term interbank lending rate, in a less discretionary manner.[1] The Taylor rule shows how the monetary policy can execute a stabilization strategy without losing concentration on the long-term price stabilization objective. This rule, that is, "the interest rate reaction function[2] or the interest rate feedback rule," assumes the central bank adjusts its main policy instrument, the short-term policy rate, in response to changes in gaps between actual and target performance on each of the monetary policy's dual goals (i.e., the gap between actual and target inflation rate, and the gap between actual and target real output). The Taylor rule can be expressed as

$$i_t = 2 + \pi_t + 0.5(\pi_t - 2) + 0.5y_t, \tag{2}$$

where i refers to the nominal policy interest rate as the key instrument target for monetary policy; π indicates the inflation rate; and y represents the deviations of real GDP from its target or potential level (i.e., the output gap or detrended GDP). It indicates the difference between the actual real GDP and the potential "trend"[3] real GDP. In equation (2), the policy interest rate, in nominal terms, rises if the inflation rate increases above the chosen target of 2% or if the real GDP rises above its potential. Furthermore, Taylor assumes that the natural real interbank rate is 2%.[4] It is worth emphasizing that the previous specification's parameters

1) Discretion refers to the flexibility of monetary policy actions in each period in response to short-run economic developments.

2) Clarida et al. (1998) argued that the major central banks use the short-term interest rate as the main operating instrument of monetary policy.

3) Estimates of "unobserved, latent, or not directly observed" variables, such as potential output level, trend growth rate of potential output, and natural interest rate, are imprecisely estimated [see Holston et al. (2017), Orphanides and Williams (2007), and Laubach and Williams (2003)]. Justiniano et al. (2013) focused on potential output rather than efficient output because the former is a more natural monetary policy benchmark. Furthermore, because monetary policy is long-run neutral, it has no effect on the steady-state gap between actual and efficient output.

were set according to the Federal Reserve's capabilities and the performance of the US economy over 1984-1992, which may not necessarily fit all economies and may not fit the same economy at all times.

Taylor (2017) ascertains that a rule-based monetary policy would improve the national macroeconomic performance and reinforce global economic stability. He attributes the 2008 global financial crisis as a departure from a previously successful policy rule. Before the crisis, excessively low-interest rates began over the period 2003-2005 in the United States, compared to the 1980s and 1990s). Taylor (2017) proposed that interest rate rules be bounded for the "rule-space" approach to performing better; policymakers should rely on money growth rules outside of these bounds. If interest rates reach the lower bound, central banks should rely on a policy rule that maintains constant money growth. Taylor (1997) recommended that interest rate rules should be complemented with money supply rules in case of prolonged inflation or hyperinflation.

Yellen (1996) emphasizes that the mechanical use of the Taylor rule is impractical, suggesting adopting flexible rules. Similarly, Taylor (2017, 1993) assessed his rules' ability to be easily adjusted by policymakers. For example, central bankers can easily modify the rule if the equilibrium interest rate falls. Similarly, McCallum (1987, 1988) proposed that the monetary authorities set one or more monetary rules as targets while allowing monetary policymakers some discretion to adjust their chosen instruments to achieve the final target(s) rigorously. Subsequently, equation (2) can be modified as follows (Ascari and Sbordone, 2014; Cardoso and Galal, 2006; Castro, 2011):

$$i_t^* = \overline{r} + \pi^* + \beta\ (\pi_t - \pi^*) + \gamma\ (y_t - y^*) \tag{3}$$

where i^* stands for the monetary policy instrument (the nominal short-term interest rate); $\overline{r}$ is the equilibrium (natural) *real* interest rate; π denotes the actual inflation rate; while π^* indicates its target. y refers to the actual output, while y^* represents its potential value. The parameters β and γ indicate the responsiveness of the interest rate to deviations of inflation and output from their targets, respectively. These two parameters reflect the degree of the monetary policymakers' preferences for inflation and output, respectively. Clarida et al. (2000) affirm that such policy rules give quite accurate descriptions of the behavior of prominent central banks worldwide, at least recently. Fagan et al. (2013) modified this rule by adding the lagged values of interest rates to capture the effect of past interest rates on the contemporary ones, reflecting the adaptive expectation hypothesis. Furthermore, they incorporate the exogenous shocks to monetary policy

4) Clarida et al. (1998) and Castro (2011) assume that the average value of the real interest rate can be used as its long-run equilibrium values. For further reading, see Holston et al. (2017), Tanaka et al. (2021), and Wang and Kwan (2021).

due to, for instance, stochastic shifts in unemployment, social costs that are related to frustrating private agents' expectations about the central bank policy, changes in oil prices, and shocks to financial asset prices (Ball, 1995; Chari et al., 1998; Christiano et al., 1999).

To the best of the authors' knowledge, this is the first empirical study analyzing the relationship between various monetary policy targeting instruments (regimes) and their ultimate goals in Egypt over a long period. This is especially after the 2011 revolution, which was followed by widespread political, economic, and thus monetary instability. Even the most recent study, for example, Shokr et al. (2019), does not consider the monetary policy stance after the 2011 revolution, attributing this to the political instability of the time. Furthermore, previous studies have failed to account for the consequences of the Central Bank of Egypt's (CBE) decision to float the Egyptian pound in November 2016. Furthermore, no study has addressed the potential endogeneity issue between macroeconomic variables. They have not yet examined the adoption of various monetary policy regimes and their impact on the final goals in Egypt during the period under consideration. Most prior studies conducted worldwide have been carried out over relatively short periods, which do not provide a clear picture of the impact of targeting the nominal interest rate on the ultimate goals of monetary policy over time. More importantly, the vast majority of empirical evidence gathered from both developed and developing countries yields somewhat mixed and inconsistent results. Some thought the Taylor rule applied to developing countries, whereas others did not. Similarly, some discovered that the Taylor principle holds, while others did not.

The findings of this paper show that policy inertia explains a significant portion of the CBE's monetary policy. This study reveals that, even though the inflation gap coefficient is positive and statistically significant, it is insufficient to infer active monetary policy. Furthermore, the output gap is statistically insignificant, indicating that the CBE does not respond to variations in output.

Section 2 discusses the background of the Egyptian economy and its monetary policy. Section 3 presents the literature on the Taylor rule. Section 4 presents the theoretical framework for equilibrium determinacy and the Taylor principle. Section 5 outlines the data and variables, besides the GMM estimation and its results. Finally, Section 6 ends our paper.

II. Background of the Egyptian Economy and Its Monetary Policy

As one of the developing countries, Egypt is characterized by some features expressed as follows according to Bhandari and Frankel (2017) and Frankel (2010), among others: In comparison to industrialized countries, developing countries have less developed fiscal and financial institutions, the monetary transmission mechanism usually functions poorly, in part, due to oligopolistic banks, and they have fewer credible monetary institutions because of a prolonged history of price instability and hyperinflation. Furthermore, without a well-functioning fiscal framework, these countries historically relied on seigniorage as a source of government financing and central banks' accommodation of government debt (monetization of fiscal deficit). Goods markets are frequently more vulnerable to global shocks. According to Hausmann et al. (2006), real exchange rate fluctuations in developing economies are three times greater than in developed economies.

Between 1975 and 1981, the average total deficit in Egypt was around 23%, financed through the banking system. As a consequence, liquidity expanded, and prices rose steadily. Generally, public enterprises suffered from over-employment, poor technology, and unprofessional management and were organized as monopolies without incentive to improve efficiency. Its deficits continued to be financed from the budget or by borrowing from public sector banks at low-interest rates. They also face little repercussions if they default on their payments, putting a strain on the financial system (Ikram, 2007, pp. 45-48).

The economic crisis during the 1980s triggered President Mubarak's administration, eventually and specifically in 1991, to implement the so-called "economic reform and structural adjustment program (ERSAP)" to correct the imbalances in the government budget and the balance of payments. In implementing the ERSAP, Egypt implemented a contractionary monetary policy by increasing the nominal interest rates to achieve positive real interest rates (Ikram, 2007, pp. 62-64). As a result, inflation rates came down due to the implementation of the ERSAP policies, except in the aftermath of the Egyptian currency floating in January 2003, the global financial crisis of 2008, and after the November 2016 floating exchange rate. Furthermore, between 1990 and 1997, the budget deficit as a percentage of GDP fell dramatically, from around 18.2% to less than 1%. Egypt has faced challenges in pursuing long-term economic growth but has made significant progress. Except for 1991 and 1993, and in the aftermath of the 2008 global financial crisis and the 2011 revolution, the economic growth rate has been above 3% since 1983.

Between July 2004 and March 2005, Egypt's money and financial markets have seen successful developments. The CBE has taken two phases to do this. Phase I (2004-2008) included the privatization of large state-owned banks that accounted for 80% of commercial banks' deposits in the Egyptian economy, settlement of non-performing loans, the reorganization of large public banks, and the development of the private sector credit policies. Phase II (2009-2011) aimed to improve access to finance, modernize prudential oversight, and boost competitiveness. Comprehensive risk-reduction and structural-impediment-removal efforts were critical in ensuring good financial intermediation [see Elshamy (2012), Hosny (2014), and Youssef (2007)]. At the end of the 1996 stabilization program, the CBE was preoccupied with attaining numerous objectives simultaneously, some of which were incompatible. These goals included achieving significant economic growth while maintaining price stability and a stable exchange rate. The variety of goals considering mounting capital mobility inflows made conducting an autonomous monetary policy nearly tricky, and the measurement of the monetary policy stance throughout that time (1996-2005) was obscured (Al-Mashat and Billmeier, 2008; Elshamy, 2012).

The 2011 revolution and its consequences undermine the production process, putting pressure on the exchange rate. As a reaction, the CBE used foreign exchange reserves to defend the local Egyptian currency by intervening in the foreign exchange market. Consequently, foreign exchange reserves have experienced a significant decrease twice. The first critical reduction was when they decreased from US$18.12 billion in 1999 to US$13.12 billion in 2000, a decrease of 38.11%, to maintain the exchange rate's stability, which resulted in curbing its collapse where it only decreased by 2.4%. The second considerable reduction occurred after the revolution of 2011 and the subsequent political and economic turmoil. Foreign exchange reserves fell 65.4% between 2010 and 2012, from US$33.61 billion in 2010 to US$11.63 billion in 2012. This procedure was designed to protect the Egyptian currency (taking the exchange rate as a nominal anchor for monetary policy). Because of that intervention, the exchange rate was relatively stable, keeping its price at around 6 pounds/US$, an increase of only 7.8%. Simultaneously, the economic growth rate severely declined from 5.15% in 2010 to 1.67% in 2011.

Under the collapse of the Egyptian's foreign exchange—which comes from rentier activities,[5] and the significant rise in the US dollar exchange rate vis-à-vis the Egyptian pound in the black market—which ranged around 18 pounds/US$, culminating in imported inflation of around 30% in 2017—the CBE was forced, in November 2016, to float its currency and set an indicative price equal to 13 pounds/US$, provided that the banking system is free to set the exchange rate using the interbank mechanism. As a result, the value of the Egyptian currency depreciated by almost 50% against the US dollar. This decision coincided with another one taken by the CBE to raise the overnight deposit and lending interest rates by 3%, reaching 14.75% and 15.75%, respectively, (Maher and Zhao, 2021) in the context of "leaning against the wind" policy when depreciating exchange rate is accompanied by rising interest rates. Egyptian economic growth slowed from an average rate of 8.8% during the first sub-period under the so-called "Open-Door" (i.e., *Infitah*) policy of 1974 to 6.2% and 4.3% during the 1980s and 1990s, respectively, from 1976 to 2019. The Egyptian revolution and its consequences have significantly impacted economic growth, which has slowed to an average rate of 3.6%. Simultaneously, as we illustrated before, implementing the ERSAP policies succeeded in bringing inflation rates down from double-digit to single-digit.

The law governing the CBE's operations states unequivocally that its primary goal is to achieve monetary stability. The CBE liberalized its interest rates on loans and deposits while implementing the ERSAP. It also relied on some instruments to conduct monetary policy, such

5) According to Maher and Zhao (2021), these rentier activities include Suez Canal revenues, Egyptian tourism revenues, remittances from Egyptian workers, particularly those from the Gulf countries, and net direct investment inflows. Following the Egyptian revolution in 2011, all sources of foreign exchange revenue saw a significant decline, with the exception of Suez Canal revenues and worker remittances.

as open market operations (OMO), the CBE's discount rate, interest rates on Treasury bills and government securities, reserve requirements, and repo and reverse repo operations. In 2005, the Egyptian monetary authorities changed the monetary policy instrument from banks' excess reserves, which was the monetary policy instrument from 1996 to 2005, to the overnight nominal interest rate in interbank transactions to manage inflation in the short-run. Additionally, the interest rate, represented by the discount rate, has been chosen as an intermediate target of Egyptian monetary policy (Al-Mashat, 2008; Elshamy, 2012; Hosny, 2014; Shokr et al., 2019).

III. Literature Review

The Taylor rule still receives a significant research interest. Kim and Shi (2018) empirically examine the Taylor rule and the determinants of the interest rates in China from 1987 to 2013 using ordered probit estimation. They estimate the Central Bank of China's behavioral equation that models its decision-making process. Their results suggest that the PBC's policy decisions should be viewed as responses to price volatility and money supply growth. Likewise, Lee et al. (2015) indicate that the Taylor rule can be employed versatilely to explain the monetary policy in the United States over the last 40 years. Fatás et al. (2007) discuss the choice of monetary target to determine whether central banks should use the money growth rate, the exchange rate, the inflation rate, or something else as a monetary policy target.

Similarly, Taylor (1999) argued that the preference for one monetary policy rule depends on whether the chosen rule delivers a good economic performance, compared to other rules, regarding some criteria, such as the variability of the output gap and inflation. Taylor advocates using the interest rate as a monetary policy rule. Similarly, Schabert (2009) discovered that in practice, short-term interest rate targets (e.g., the Taylor rule) serve primarily as an operating target.

Fagan et al. (2013) used the dynamic stochastic general equilibrium model for 1984-2007 to assess the effects of conducting monetary policy based on the Taylor rule. They concluded that this rule reduces inflation fluctuations significantly, albeit at the expense of interest rate fluctuations. Svensson (2017) elucidates that tightening monetary policy with a higher monetary policy interest rate may benefit the economy by lowering real debt growth and the likelihood of a financial crisis. Nonetheless, it weakens the economy by increasing unemployment and decreasing inflation. Contrarily, more recently, Abu Asab and Cuestas (2021) applied Johansen (1988, 1991) cointegration test to examine the relationships among variables eventually for Jordon from 1995 to 2011. Their findings point out that the interest rate pass-through is weak and slow. Moreover, it experienced a substantial lag for a full equilibrium adjustment. With weak and slow interest rate pass-through and the asymmetric reaction[6] in the loanable funds market, using inflation targeting to achieve price stability in the Jordanian economy will not produce the desired results.

However, Belongia and Ireland (2015) use the structural vector autoregressive (SVAR) model. They state that the money supply (or monetary aggregates) significantly impact economic performance in addition to the effects of short-term interest rates and conventional models that focus on them (the Taylor rule). They propose that monetary policymakers consider money growth an intermediate goal because money continues to have a strong relationship with economic activity. They ascertain that central banks can use monetary aggregates to target the NGDP, offering a method for them to execute a nominal GDP target that is not based on the Taylor rule. Furthermore, they ensure that the monetary policy strategy should not focus solely on targeting interest rates. Similarly, Cordero (2008) concluded that the real exchange rate targeting, which means that monetary authorities adjust the nominal exchange rate to maintain the actual real exchange rate to its target, effectively stimulates economic growth. Still, the macroeconomic policy trilemma reduces stabilization effectiveness using the OMOs.

The conflict between three policy objectives is referred to as the policy trilemma. These objectives are capital mobility (capital control), pegged exchange rate, and monetary autonomy. In such a case, policymakers must select and trace two of the three simultaneously, but not all three due to the potential conflict.[7] In this respect, capital inflows wreak havoc on domestic monetary policies without well-developed and well-functioning financial markets. As capital inflows increase, the central bank is more inclined to buy excess foreign exchange on the market, resulting in monetary expansion and inflation. If the central bank does not intervene in the foreign exchange market, the effect might be a nominal appreciation of the local currency, a deteriorating checking account, and lower profitability (Granville and Mallick, 2010).

Ghosh et al. (2016) investigated the case in which monetary policymakers in emerging market economies target two policy instruments (i.e., the policy interest rate and the exchange rate). They discover that both policy instruments are frequently used and argue that using foreign exchange intervention improves welfare under both regimes. Furthermore, they suggest adding exchange rate targeting with an inflation targeting framework since this is more likely to assist central banks in emerging market economies in maintaining low inflation. They do not observe any contradiction between stabilizing the exchange rate around its equilibrium value and achieving the inflation target.

6) Because of the asymmetric reaction of the money market, banks are more hesitant to reduce their loan interest rates, but they are quick to raise them.

7) For further information about the trilemma, see Fischer (2001), Ono (2021), Rose (2011), and Obstfeld et al. (2005).

IV. Determinacy and the Taylor Principle

In the Taylor rule, the output gap's parameter is expected to be positive, indicating that when the output falls under (above) its potential, the economy will stabilize by lowering (raising) interest rates. In the same vein, the inflation gap's parameter is expected to be greater than 1; if so, this will be consistent with the "Taylor principle" and determinacy of equilibrium (Eusepi and Preston, 2018; Gabaix, 2020; Nikolsko-Rzhevskyy, et al., 2021). The determinacy of equilibrium (i.e., a unique stable solution) indicates the great sensitivity of the nominal interest rate to the changes in inflation, especially changes in the expected inflation. In other words, the inflation parameter in the Taylor rule must be greater than 1 to aggressively influence the nominal interest rate and aggregate demand, preventing inflation rates from spiraling and causing convergence back to the steady-state (the long-run equilibrium). In this regard, Orphanides (2007) ascertained that a robust reaction to inflation is associated with good stabilization performance. The Taylor principle holds if the inflation parameter in the Taylor rule is greater than 1. According to Eusepi and Preston (2018) and Lubik and Schorfheide (2004), this is an example of "active monetary policy," in which the monetary authorities raise the real interest rate in response to changes in the inflation gap (the cyclical or transitory component of inflation). In contrast, if the inflation parameter in the Taylor rule is less than 1, the Taylor principle is violated, or the reaction function does not hold (a destabilizing policy rule). In such a case, we can refer to it as "passive monetary policy," because the real interest rate falls in response to rising inflation.

In this respect, Clarida et al. (1999) attributed the high volatility of inflation to monetary policy's failure to match the Taylor principle. Therefore, in the context of adopting the Taylor rule, indeterminacy (i.e., multiple stable solutions) can arise if monetary policymakers do not raise nominal interest rates aggressively enough in response to increased inflation to reduce inflationary pressures. The result is negative real interest rates and making monetary policy procyclical rather than countercyclical (Bullard and Mitra, 2007; Lubik and Schorfheide, 2004). Bullard and Mitra (2007) found that monetary policy inertia mitigates the indeterminacy of equilibrium in monetary policy rules and enhances the learnability of rational expectation equilibrium. According to their study, we need two conditions to match determinate equilibrium: (1) fulfilling the Taylor principle; and (2) ensuring that the degree of inertia, reflected by the parameter of the lagged nominal interest rate, is large enough. If the latter condition is not fulfilled, the central bank may violate determinacy. They emphasize that when inertia equals zero, the magnitude of the coefficients on both inflation and the output gap, which is supposed to be associated with determinate equilibria, should be relatively small. Their conclusions are consistent with those of Rotemberg and Woodford (1999) who detected that large values of policy inertia tend to be compatible with the determinacy of equilibrium.

Table 1. *Empirical Estimates of the Coefficients of Inflation and Output Gaps*

The conducted study	Estimated coefficient on the inflation gap	Estimated coefficient on the output gap
Driffill and Rotondi (2007)	2.14	0.83
Ball (1999) for the US.	1.50	1.00
Clarida et al. (1998) for some advanced economies: (the US, Germany, Japan, England, France, and Italy)	0.48 : 2.20	-0.07 : 0.88
Clarida et al. (1999) for the US.	0.83 : 2.15	0.27 : 0.93
Peersman and Smets (1999) for Germany	1.30	0.28
Taylor (1999) for the US during (1954-1997), using two sub-samples	0.81 : 1.53	0.25 : 0.77
Clarida et al. (2000)	1.15	0.93
Rudebusch (2005)	0.33	1.29
Nikolsko-Rzhevskyy et al. (2014)	0.49	0.47
Taylor and Wieland (2012)	2.00	0.52
Christiano et al. (2005)	1.58	0.45
Smets and Wouters (2007)	1.04	0.26
Boehm and House (2019)	1.00	0.61
Tetlow (2015) for two sub-samples	0.44 : 0.53	0.33 : 1.17
Peters (2016) for Mexico, South Africa, Indonesia, and Thailand	0.81 : 1.38	0.01 : 0.52
Kim and Shi (2018) for China	0.165 : 0.171	-0.008 : -0.004
Sims and Wu (2019)	1.50	0.00
Debortoli et al. (2019)	0.50	1.50

Table 1 manifests some studies' estimates of the estimated coefficients on both the inflation gap and the output gap in the context of the Taylor rule. In short, as shown in Table 1, there is a relatively wide array of different estimates for both parameters. This diversity is attributable to differences between countries (and, of course, the economic structural shocks that every country faces) and differences between periods within the same country.

Overall, motivated by the lack of research on investigating whether the Taylor rule is determinate in the Egyptian economy, our study aims to explore this issue. Moreover, it estimates the relationship between interest rate targeting and monetary policy objectives (such as long-run inflation and output).

V. Research Methodology

A. Study period and data collection

Our research spans the years 1976 to 2019. Our justification for this period is that, before 1975, the Egyptian economy experienced two notable events that significantly impacted our analysis. The first element was the October 1973 Arab-Israeli war. The second was the socialist economic policies implemented in Egypt during President Nasser's political regime. Besides, this study is subject to data limitations. Starting in October 1974, the Egyptian economy adopted the Open-Door policy. Such a policy retreated from the socialist orientation of the Egyptian economy, opening it to both the private and external sectors to play a dominant role in the national economy. Furthermore, because 2020 is the year COVID-19 disease began, the economic data and the conducted economic policies are different from the period before COVID-19. Therefore, our analysis covers the period 1976-2019 since it featured consistent economic policies. This study uses data from the World Bank's world development indicators (WDI) and the database of the CBE. Our variables set consists of nominal short-term lending interest rate (i); its one-year lagged value (i_{t-1}); inflation gap (π); differenced output gap (Δy); logarithm money supply ($log\ M2$); differenced logarithm nominal exchange rate ($\Delta log\ EX$); the intercept proxied by the equilibrium real interest rate (β_0). Δ refers to the first-difference operator. Later on, we will define all of them.

1. Constructing the output and inflation gaps

The output and inflation gaps are unobservable variables, meaning they should be constructed or estimated. In this context, we use the two-sided Hodrick-Prescott (HP) filter proposed by Hodrick and Prescott (1997). It divides the series into the long-run trend component (e.g., as a measure of potential output or inflation trend) and the transitory or cyclical component (as a measure of the output gap and inflation gap). The HP filter is widely used in the literature [see, for example, Juhro et al. (2021), Debortoli et al. (2019), Bhandari and Frankel (2014, 2017), Kim and Shi (2018), Caporale et al. (2018), Florio (2018), Mayandy and Middleditch (2022)] to eliminate trend movements (detrending) in the cyclical component to construct the gaps.

The smoothness parameter, λ, should be adjusted according to the data frequency. For quarterly data, as used in Hodrick and Prescott (1997), λ is set to 1600, but Ravn and Uhlig (2002) propose to adjust it to accommodate the frequency of data used. Accordingly, in our study, which uses annual data, we adjust λ to be 6.25 (= $1600/4^4$), based on the criterion, $\lambda_A = (k)^n \lambda_Q$ where λ_A signifies the annual data's smoothness parameter, λ_Q denotes that parameter on the quarterly data, k is the ratio of the observations' number per annum. The output gap is the percentage difference between logarithmic real GDP and potential output. It can be expressed as shown in equation (4) (Bhandari and Frankel, 2014; Billmeier, 2009; Creamer and Botha, 2017; Galí, 2002; Judd and Rudebusch, 1998; Kawamoto et al., 2017)

$$\text{Output gap} = \frac{Actual\ real\ output - Potential\ output}{Potential\ output} \times 100. \tag{4}$$

When the actual real output outmatched potential output, the economy experiences a positive output gap, stimulating inflationary pressures. Contrarily, when the actual real output is less than the potential output, the economy experiences a negative output gap, exacerbating contractionary pressures (Blanchard, 2017; Claus, 2000; Gordon, 2012, p. 67; Orphanides and van Norden, 2005).

However, the inflation gap is the difference between the actual inflation rates and their trend or expected value in the long-run (Fuhrer, 2010). When the current inflation outmatched the inflation target of its potential values, the economy witnesses inflationary pressures. To compute the inflation gap, we use equation (5) (Billmeier, 2009; Cogley et al., 2010; Cogley and Sbordone, 2008; Galí, 2002; Hwu and Kim, 2019; Morley et al., 2015)

$$\text{Inflation gap} = \frac{Actual\ inflation - Anticipated\ inflation}{Anticipated\ inflation} \times 100. \qquad (5)$$

In what follows, we plot the variables used in estimating the Taylor rule in Egypt over the study period, as shown in Figure 1.

Figure 1. Plots of the Taylor rule's main variables

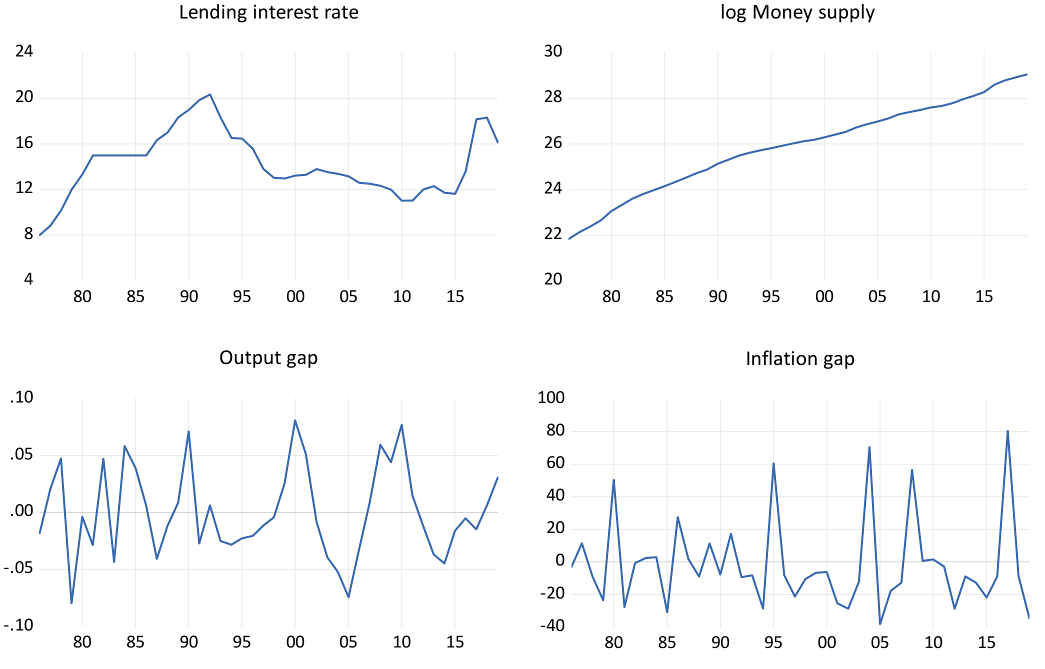
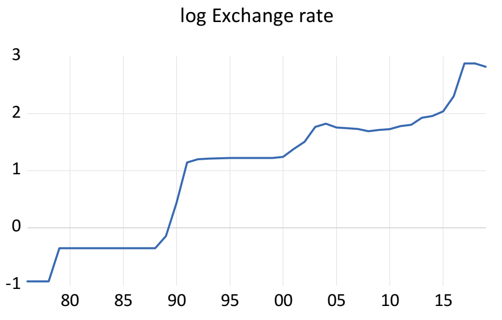


Figure 1. Continued



Source: The authors' calculations based on the WDI database.

2. Multicollinearity

The pairwise correlation matrix and the variance inflation factor (VIF) are employed to ensure multicollinearity among the regressors, as depicted in Figure 1. Wooldridge (2020, 92) and Kennedy (2008, 199) suggested that a pairwise Pearson correlation coefficient greater than 0.8 and a VIF greater than 10 indicate severe multicollinearity. Some studies, like Marcoulides and Raykov (2019), propose that a VIF greater than 5 indicates severe multicollinearity issues. As shown in Table 2, a strong linear correlation does not exist among the explanatory variables.

Table 2. *Matrix of Correlations and VIF for the Taylor Rule's Regressors*

Regressors	i_{t-1}	π	Δy	$log\ M2$	$\Delta\ log\ EX$	VIF
Lagged nominal interest rate (i_{t-1})	1.000					1.02
Inflation gap (π)	-0.025	1.000				1.09
Output gap (Δy)	0.020	0.143	1.000			1.22
M2 money supply ($log\ M2$)	0.055	-0.027	0.014	1.000		1.00
Nominal exchange rate ($\Delta\ log\ EX$)	0.099	0.177	-0.365	-0.006	1.000	1.25

B. Unit root tests

To proceed with the GMM technique, we must satisfy the stationarity assumption.[8] It denotes that a variable, say x, should not exhibit non-stationarity (e.g., autoregressive unit roots, unconditional heteroskedasticity, or deterministic trends). To handle non-stationarity, i.e., those variables that are integrated of order 1, $I(1)$, if it exists, we must use some transformations, such as including growth rates of x, the logarithm, or the first-difference (Creamer and Botha, 2017; Mátyás,

8) To describe a particular time series as stationary, we mean that its values converge to its long run average value, and that its properties (e.g., the mean, variance, and co-variance) are not changing in response to the change in the time trend only. The opposite situation indicates non-stationarity (Verbeek, 2017, ch. 8).

et al., 1999; Ogaki, 1993). According to Frankel (2017) and Wintoki et al., 2012), taking the first-difference, for example, prevents x from being influenced by its long-run trend. Furthermore, first-differencing eliminates any potential bias caused by time-invariant unobserved heterogeneity. In this respect, for the GMM and IVs to be consistent, we must ensure that all of our main variables, control variables, and instruments are stationary, i.e., integrated in levels or $I(0)$ (Clarida et al., 1998; Ege Yazgan and Yilmazkuday, 2007; Han, 2012; Hansen, 1982). To this end, we used a battery from the unit root test. As discussed, unit root testing ensures that variables follow a random walk, preventing spurious correlations and misleading regressions (Granger and Newbold, 1974; Phillips, 1988). We begin with conventional unit root tests (without considering structural breaks), such as the augmented Dickey-Fuller (ADF) test of Dickey and Fuller)1981), the Phillips-Perron (PP) unit root test of Phillips and Perron)1988), and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test of Kwiatkowski et al. (1992). It is important to note that, unlike the null hypothesis of the ADF and PP tests, the null hypothesis (H_0) of the KPSS test states that the series does not have a unit root (i.e., stationary). Table 3 indicates a conflict among the three tests concerning whether the series is stationary.

Table 3. *The ADF, PP, and KPSS Unit Root Tests*

Series	ADF test-statistics		PP test-statistics		KPSS test-statistics			k	Result I(d)
	Level	*1st difference*	*Level*	*1st difference*	*Level*	*1st difference*	*5% critical values*		
i	−2.2307	−3.5004**	−2.4046	−2.9148*	0.2037 A	0.2107 A	0.463	2	Contr.
π	−8.1128***	−11.0390***	−11.418***	−27.804***	0.0302 A	0.0283 A	0.463	1	Stat., I(0)
y	−3.6288***	−4.8708***	−4.8340***	−16.1267***	0.0306 A	0.0302 A	0.463	1	Stat., I(0)
log M2	−3.1722	−2.0693	−3.6134**	−3.3301*	0.4060	0.3153	0.146	1	Contr.
log EX	−0.3192	−3.8530***	−0.9016	−3.8208***	2.1010	0.0580 A	0.463	1	Non, I(1)

Note:
- ***, **, and * denote the 1%, 5%, and 10% levels of significance, respectively.
- We used the modified Akaike information criterion (MAIC) to assign the number of lags needed to perform the ADF unit root test. We used the MAIC criterion since in all of the unit root tests studied, and it has led to significant size improvements over typical information criteria, such as the Akaike information criterion and Bayesian information criterion (Cavaliere et al., 2015; Ng and Perron, 2001). The maximum number of lags is determined based on Schwert's (1989) criterion given by $l = \{4(T/100)^{1/4}\}$. This formula gave a maximum lag length of 3 lags. Claus (2000) proposes that maximum lag length should be set to equal to three times the seasonal frequency of the data sample size. In our study, we use annual data. Thus, it will also be three lags as a maximum.
- For performing the PP and KPSS unit root tests, we used a nonparametric Bartlett kernel function and the Newey-West fixed bandwidth. The PP test takes the heteroscedasticity and autocorrelation into account.
- ^{A} indicates that the series is stationary based on the KPSS test.
- Concerning the significance of both constant and time trend, the results are as follows: The constant is significant only for the interest rate (i), its *first lag,* and *log* (*M2*). This trend is significant only for *log* (*M2*).
- K is the lag length determined based on the MAIC criterion.
- The KPSS test's critical values are obtained from the Lagrange Multiplier (LM) test-statistics.
- *Non*: Nonstationary series and need to be differenced. *Stat.*: Stationary series. *Contr.*: There is a conflict between the three tests concerning whether the series is stationary or not. Integration order, *I*(d).

1. The Kapetanios unit root test with structural breaks

All unit root tests shown above have low power if structural breaks exist in the data generation process. They could lead to us making incorrect and biased conclusions about time series stationarity. Furthermore, structural breaks may result in spurious cointegration and misleading estimations. When the first differenced series residuals have a significant and negative moving average component, some of these tests, particularly the PP test, suffer from severe size distortions. Furthermore, small-sample size distortions have a significant impact on these tests (Choi, 2015, pp. 28-29; Culver and Papell, 1997; Gregory et al., 1996; Montañés, et al., 2005; Ng and Perron, 2001; Perron and Ng, 1996; Schwert, 1989; Shrestha and Bhatta, 2018).

We perform the Kapetanios' (2005) unit root test considering the structural breaks. It examines the stationarity in the intercept and/or trend when there are up to five unknown or data-dependent structural breaks. Stated differently, by minimizing the sum of squared residuals, this test endogenously determines the structural break dates and estimates the position of the structural break. According to Kapetanios' (2005) notation, this test has the following formula:

$$y_t = \alpha_0 + \alpha_1 t + \rho y_{t-1} + \sum_{i=1}^{k} \lambda_i \Delta y_{t-i} + \sum_{i=1}^{m} \phi_i DU_{i,t} + \sum_{i=1}^{m} \gamma_i DT_{i,t} + \epsilon_t \tag{6}$$

The parameters α_0 and α_1 indicate the intercept and trend, respectively; the parameter of the autoregressive term of order 1, AR(1), is denoted by ρ; $DU_{i,t}$ refers to the break dummy variable of the intercept, whereas $DT_{i,t}$ is the break dummy variable of the time trend. This test checks the unit roots under the null hypothesis of a unit root or non-stationarity with m structural breaks; that is H_0: $\rho = 1$. The break dummies of the intercept and time trend, $DU_{i,t}$ and $DT_{i,t}$, can be expressed as

$$DU_{i,t} = 1 \text{ if } (t > T_{b,i}) \text{ 0 otherwise, and } DT_{i,t} = (t - T_{b,i}) \text{ if } (t > T_{b,i}) \text{ 0 otherwise.}$$

$T_{b,i}$ denotes the structural break date specified by the test. Kapetanios (2005) stated that the test's power decreases when the number of breaks grows. Therefore, and due to our small-sample size, we allow for only two structural breaks. Table 4 displays the Kapetanios test results, revealing the discrepancy between its results and those of the conventional unit root tests. At the 5% significance level, the Kapetanios test reveals that some of our variables are stationary at the level I(0), while others are integrated of order one, I(1), around two structural breaks. Put differently. Our variables are a mix of level and first-difference stationary variables.

Table 4. *The Kapetanios Unit Root Test with Structural Breaks*

Series	Test-statistics		5% critical values		Constant (C) or Trend (T) §	I(d)	Result	Break dates	
	Level	*1st difference*	Constant	Constant & Trend				1st break	2nd break
i	−5.4082**	−6.0199**	−5.096	−6.113	C, C	$I(0)$	Stat.	1990	2011
π	−6.6908**	−7.6930 **	−5.096	−6.113	C, C	$I(0)$	Stat.	1991	2001
y	−4.6167	−9.1778 **	−5.096	−6.113	C, C	$I(1)$	Non	1984	2011
log M2	−6.9938**	−4.8581	−5.096	−6.113	C & T, C & T	$I(0)$	Stat.	1989	2010
log EX	−4.3991	−7.4302**	−5.096	−6.113	C, C	$I(1)$	Non	2003	2011

Note.
- ** denotes the 5% level of significance.
- Critical values at the 5% significance level are provided by Kapetanios (2005, Table 1).
- We selected only two structural breaks for all variables due to our small-sample size.
- The trimming parameter was set to 0.15.
- For performing the Kapetanios (2005) unit root test, we use the MAIC criterion to assign the number of lags we need, as we did while performing the ADF. The maximum number of lags is determined on the Schwert's (1989) basis of Schwert's formula referred to previously and Claus (2000) proposition. Both propose a maximum lag length of 3 lags.
- We use the same number of lags for every variable as shown in conventional ADF, PP, KPSS unit root tests.
- Concerning the significance of both constant and time trend, the results are as follows: The constant is significant only for *LEND*, its *first lag*, and *log m2*. The trend is significant only for *log M2*.
- § The letter ordered first, in the notation (C, C), for example, refers to the significance of constant and trend terms for both levels and first the differences, respectively.
- I(d) denotes the integration order.
- *Non*: Nonstationary series at 5% significance level and needs to be differenced. *Stat.*: Stationary series at 5%.

Due to the non-stationarity of some variables in their level, following Juhro et al. (2021) and Mohanty and Klau (2005), we differenced our nonstationary variables were stationary before estimating their policy rule. Therefore, as an explanatory variable in our estimated Taylor rule, we incorporated both the nominal exchange rate (in its log-differenced value, denoted $\Delta logEX_t$) and the output gap (Δy) by subtracting its value in time $t-1$ from theirs in time t, denoted by the first-difference operator (Δ). Beckworth and Hendrickson (2020) argued that the different rules allow the central bank to avoid the difficulties of constructing unobservable series such as the output gap.

C. Econometric models specification

1. The Taylor rule model

In order to empirically estimate the relationship between interest rate targeting and the objectives of monetary policy in Egypt over the period under consideration, this study modifies Taylor's (1993) interest rate targeting rule, which was proposed and modified by Clarida et al. (1998, 2000), and followed by Eichenbaum et al. (2021), Ahmed et al. (2021), Castro (2011), Fagan et al. (2013), Ghosh et al. (2016), Schabert (2009), and Caporale et al. (2018). As a result, taking a dynamic form of the Taylor rule's inertial and forward-looking specification, this study constructs the interest rate regression equation (i.e., the policy reaction function), referred to as the "Fisher equation," illustrated previously in equation (1). The following specification is also known as the expectations-based Taylor rule because it takes into account "expected" inflation and "expected" output gap rather than their current values of the form

$$i_t^{*} = \beta_0 + \beta_1 \, i_{t-1} + \beta_2 \, (\pi_{t+1} - \pi^{*}) + \beta_3 \, \Delta \, (y_{t+1} - y^{*}) \\ + \beta_4 \, logM2_t + \beta_5 \, \Delta \, logEX_t + \varepsilon_t \tag{7}$$

where i^{*} stands for the nominal short-term interest rate (as the dependent variable). Following Castro (2011) and Shokr et al. (2019), we use the short-term nominal lending interest rate to construct the Taylor rule instead of the discount rate.[9] The lagged dependent variable reflects the monetary policy inertia or degree of nominal interest rate smoothing, i_{t-1}, which indicates the lagged nominal interest rate, incorporated to capture the set of past information of interest rate available at time $t-1$. It affects the expected future nominal interest rate, reflecting the market efficiency hypothesis discussed in Fama (1975) and Pelaez (1989). The interest rate inertia may also be included in the reaction functions to make the model dynamic (considering the time effect), even in the absence of true inertia, and deal with or correct serial correlation. It is also included as a robust model uncertainty since it is desirable under both learning dynamics and rational expectations, as argued by Eusepi and Preston (2018). In the above specification, Clarida et al. (1998), Castro (2011), Owusu (2020), Tetlow (2015), and Ascari and Sbordone (2014), *among others*, assume that the intercept β_0 is the equilibrium (natural) *real* interest rate, $\overline{r}$, proxied by the average value of the real "lending" interest rate, that it can be treated as its long-run equilibrium value. Based on our calculations using the Fischer equation of the *ex ante* real interest rate, β_0 is set approximately to 0.564. The parameter β_1 denotes the smoothing parameter, the partial adjustment (gradualism) coefficient, or the monetary policy inertia's coefficient. It ranges between $0 \leq \beta_1 < 1$, put differently, $\beta_1 \in [0,1]$. The case of $\beta_1 = 1$ is called a "derivative control" or "difference rule," while $\beta_1 > 1$ reflects super-inertial behavior (Orphanides and Williams, 2007; Woodford, 2003, p. 96). The number of delays (lags) in the Taylor rule equation is usually selected empirically, so that the error term is free of serial correlation (Castro, 2011).

The term $(y_{t+1} - y^{*})$ denotes the "expected" output gap, π_{t+1} denotes the forward-looking or "expected" inflation, and π^{*} indicates its long-term target or trend. The policy parameters, β_2 and β_3, indicate the responsiveness of interest rate to the deviations of "expected" inflation from its target (trend) and the deviations of output from its potential level, respectively. According to Clarida et al. (2000) and Dossche and Everaert (2005), the Fed raised nominal and real short-term interest rates in response to higher expected inflation when observed inflation

9) The Egyptian monetary authorities switched from banks' excess reserves to the overnight nominal interest rate on interbank transactions as a policy instrument in 2005. As a result, we will rely on the nominal lending interest rate (i) in both proxying for the nominal interest rate in both cases.

in time $t-1$ was greater than its target (π^*). Noteworthily, central banks with higher β_2 could react aggressively to inflation. By the same logic, central banks with higher β_3 could react aggressively to the cycle variable. We expect that β_2 will be positive because when inflation rates increase, monetary authority hikes interest rates to (1) curb inflation rates, (2) offset agents concerning decreasing their loanable funds' purchasing power. The error term e_t represents the monetary policy shock, which is assumed to follow the independently and identically distributed process [i.e., $e_t \sim i.i.d.\ N(0,\ \sigma_\epsilon^2)$]. It captures monetary policy implication error, unanticipated deviations from policy rules, or central banks' responses to changes in exogenous economic conditions. Generally, these shocks spread through changes in the money supply or interest rates.

In order to avoid specification errors and accurately identify monetary policy dynamics in emerging and developing countries, policymakers should consider monetary rules that include variables other than the principal macroeconomic variables originally included in the standard Taylor rule, such as the exchange rate or the money aggregates. As a result, we include the M2 monetary aggregate to show how the nominal interest rate reacts to changes in the money supply. Incorporating M2 has been extensively supported in the literature, for example, Clarida et al. (1999), Peters (2016), and Kim and Shi (2018). The M2 (β_4) parameter is expected to be negative, mirroring the reverse relationship between the domestic money supply and the price of domestic money supply (i.e., the nominal lending interest rate).

Additionally, external sector variables are manifested in our reaction function to capture the external or foreign effect on the domestic nominal interest rate. Accordingly, we incorporate the nominal exchange rate, *EX*. The literature, which is concerned with developed, developing, and emerging market economies, strongly supports this variable, like Eichenbaum et al. (2021), Caporale et al. (2018), Ghosh et al. (2016), Peters (2016), and Kim and Shi (2018), *among other things*. According to these studies, the exchange rate should be included in the Taylor rule because it provides accurate and timely information for inflation, improving the Taylor rule's performance and providing the central bank with a heads-up on expected inflationary conditions. In our dataset, the nominal exchange rate indicates the price of a unit of the US dollar in terms of the Egyptian pound. The nominal exchange rate (β_5) parameter should be positive, reflecting the positive relationship between the nominal exchange rate and the nominal lending interest rate. When the domestic currency depreciates (higher *EX*), the central bank responds by hiking the nominal interest rate, and *vice versa*.

2. GMM estimation of the Taylor rule

The relationships between economic growth, inflation, and interest rates are theoretically endogenous. Concerning endogeneity in the Taylor reaction function, Kim and Shi (2018), Rudebusch (2005), and Christiano et al. (1999) argue that the interest rate, the output gap, and inflation are highly persistent (possibly nonstationary variables) and highly autocorrelated (endogenous variables). Therefore, differentiating the influence of, for example, inflation in time t from its lagged influence in time $t - 1$ or earlier is not a trivial task. Additionally, the arguments of the policy rules are not exogenous (suffering from the endogeneity problem and reverse causation). Consequently, we should use a technique to distinguish those effects and handle such an issue. Unlike ordinary least squares (OLS) models, the GMM models and IV techniques can achieve this. Hansen (1982) first proposed the GMM estimation procedure for time series applications. This framework was first introduced into the context of monetary policy modeling by Clarida et al. (1998). It was followed by monetary policy writers like, *inter alia*, Schmidt-Hebbel and Tapia (2002), Galí et al. (2005), Mavroeidis (2005), Rudd and Whelan (2005, 2006), Surico (2007), and Bhandari and Frankel (2017). According to Clarida et al. (1998, 2000) and Galí and Gertler (1999), when the variables of interest are not predetermined at the decision-making time, GMM models are well-suited for estimating and analyzing central banks' reaction functions. Besides endogeneity, economic models commonly suffer from econometric problems like serial correlation and heteroskedasticity of residuals.

Some studies used the GMM estimator and the IV technique to estimate and analyze the Taylor rule like Clarida et al. (1998, 2000), Caporale et al. (2018), Eusepi and Preston (2018), Owusu (2020), and Bhandari and Frankel (2017), and Rudd and Whelan (2006, 2007), among others. To estimate the previous Taylor rule specification using the GMM procedure, we must first define the set of orthogonality conditions as

$$E_t = \{[i_t^* - \beta_0 - \beta_1 \, i_{t-1} - \beta_2 \, (\pi_{t+1} - \pi^*) - \beta_3 \, \Delta \, (y_{t+1} - y^*) - \beta_4 \, logM2_t - \beta_5 \, \Delta \, logEX_t], \, z_t\} = 0 \tag{8}$$

where E_t denotes the expected value, and z_t represents the instrument set. The term between [·] refers to the error term. Instrumental variables must be orthogonal to the error term. Namely, instrument exogeneity: corr $(z_t, \varepsilon_t) = 0$. In such a circumstance, we also test for the exogeneity condition, which is violated if $E[x_t, \varepsilon_t] \neq 0 \;\; \forall \;\; m$, where x_t is the independent variable and m denotes the number of independent variables. ε_t denotes the stochastic disturbance term. We consider the two-step feasible, efficient GMM (EGMM) estimator in the context of GMM. First, we compute the quadratic long-run covariance matrix of orthogonality conditions Λ. To that end, we used a consistent but inefficient GMM estimator. Second, we use Λ^{-1} as the weighting matrix to maximize the GMM objective function. In this step, the weighting matrix $W = \Lambda^{-1}$ is dealt with as a constant matrix. Therefore, the error terms in the estimate of Λ are the first-stage residuals defined by the first-step estimator. In contrast, the error terms in the orthogonality conditions are the second-step error terms.

To test whether an instrumental variable is correlated with the error term (the instrument orthogonality condition), we use the so-called "difference-in-Sargan test" of Sargan (1958, 1959). Its null hypothesis (H_0) states that all instruments are not correlated with the disturbance term (jointly valid); that is $z_t \perp \varepsilon_t$. Additionally, we used the Hansen *J* test. Roodman (2009), Hall (2005, pp. 45-46), and Hayashi (2000, pp. 227-228, 407) state that the Hansen *J* test of Hansen (1982) is considered an extension of the Sargan *C* test. The test statistic is Hansen's *J* statistic for the efficient GMM estimator is robust to heteroscedasticity and autocorrelation. In contrast, the test statistic is Sargan's *C* for the 2SLS estimator under conditional homoscedasticity.

The *J* statistic represents the value of the GMM objective function estimated using an EGMM estimator (Zivot and Wang, 2007, p. 789). It is testing for overidentifying restrictions or testing for endogenous instruments. Under the null hypothesis that the instruments are orthogonal to the error terms, the *J* statistic determines how close the sample meets the overidentification restrictions; that is, $E[z_t, \xi_t] = 0$, indicating that the overidentifying restrictions are valid. It converges to a χ^2 distribution with degrees of freedom equal to the number of overidentifying restrictions. Briefly, we must check the overidentification when $m > k$, where m denotes the number of instruments and k denotes the number of explanatory variables suspected to be endogenous. That is $J_T \xrightarrow{d} \chi^2_{m-k}$, where T denotes the sample size. Finding a solution to the equation system will then be impossible, implying that there is no unique or exact solution to the equation system. Furthermore, the weighted error sum will be positive, as is the case in GMM [see Stock and Watson (2020, ch. 12) and Kennedy (2008, ch. 9)].

3. The instrument set for the Taylor rule

In addition to the OLS estimation, we estimated four GMM models. Our instrument set will be shown below, based on a survey for the previously mentioned literature: Our instruments consist of one lag of the short-term nominal lending interest rate, one lag of the inflation gap,[10] one lag of the inflation gap, one lag of the differenced output gap, and one lag of logarithm the money supply (M2). Furthermore, three year-dummies (1990, 2011, and 2017) proposed by Kapetanios' (2005) unit root test are included. Some specific events (the structural change in monetary policy targeting), such as the 2011 Egyptian revolution and the hike in the short-term nominal lending interest rate as an accompanying procedure after floating the exchange rate by the end of 2017, are also included. The constant term is also included because it is orthogonal to any random variables, per Hong (2020). Secondly, for the *standard* and *augmented* Taylor rule[11] (i.e., without any forward-looking, backward-looking, but it includes the related control variables

10) Kennedy (2008, ch. 9) argued that the researchers can use some explanatory variables as their own instruments. According to Hong (2020), *we can use lagged values of the explanatory variables as instruments*. Yamani and Rakowski (2019) used the lagged values for the instruments set and, for robustness, they re-estimate their equations using the current values of the instruments.

11) Ahmed et al. (2021) estimated the same specification.

such as the money supply M2 and the nominal exchange rate), our instrument set consists of two lags of the short-term nominal lending interest rate, the current value of the inflation gap, one lag of the inflation gap, the current value of the differenced output gap, one lag of the differenced output gap, one lag of *log* M2, one lag of the differenced nominal exchange rate,[12] and the same three year-dummies, besides the constant term. Thirdly, for the *forward-looking* Taylor rule (i.e., with the expected values of both the inflation gap and the output gap and the related control variables such as M2 and the nominal exchange rate), our instrument set is the same as the standard-augmented model. Finally, for the *backward-looking* Taylor rule (i.e., with the lagged values of both the inflation gap and the output gap and the related control variables such as M2 and the nominal exchange rate), our instrument set consists of two lags of the short-term nominal lending interest rate, the current value of the inflation gap, the current value of the differenced output gap, one lag of *log* M2, one lag of the differenced nominal exchange rate, and the same three year-dummies, besides the constant term.

4. Discussion of the Taylor rule's GMM results

Table 5 reports the findings of both the OLS and GMM estimates. It exhibits five different specifications for the Taylor rule. We take the forward-looking GMM estimates (shown in the fifth column) as our benchmark. After that, we analyzed other estimates for comparison. Although, as previously demonstrated, the OLS estimates in our study are more likely to produce a spurious regression and thus a misleading inference, we report them for comparison. Our forward-looking GMM estimates indicate the inertial component (the partial adjustment coefficient) in the policy rule reaction function (captured by the lagged short-term nominal interest rate, i_{t-1}) is of considerable magnitude (almost $\beta_1 = 0.804$; *p-value* < 0.01), and it has a highly significant positive impact on the nominal interest rate at the 1% significance level. Holding all other explanatory variables constant, an increase in i_{t-1} by 1% is associated with an increase in i_t by approximately 0.80%. This result indicates that policy inertia can explain the high number of total variations in the current values of the nominal interest rate in Egypt.

This result is harmonious with the predominant strand of the literature. Based on an extended survey of the Taylor rule's literature, we found that the partial adjustment coefficient ranges from 0.73 to 0.92 (Caporale et al., 2018; Driffill and Rotondi, 2007; Kim and Shi, 2018; Rudebusch, 2002). In the same respect, Sims and Wu (2019) estimated the Taylor rule's smoothing parameter to be 0.8. Besides, Clarida et al. (1999) estimate this parameter for the US economy, using quarterly data, to a range between 0.68 and 0.79. Additionally, Clarida et al. (1998), for a list of some advanced economies (the US, Germany, Japan, England, France, and Italy), found that the inertia component ranges from 0.87 to 0.97, suggesting a sluggish adjustment in practice.

12) We include the lagged exchange rate, not the current exchange rate, within the instrument set, since the former is a legitimate candidate, but the latter is not, according to Clarida et al. (1998).

For the Egyptian economy, our estimates of the inertial policy rate are consistent with those of ShawarbyAl- and El Mossallamy (2019), Hosny (2014), and Selim (2012). However, they contradict those of Baaziz and Labidi (2014) and Abdelsalam (2018), who estimated the inertial component to be 0.374 and 0.187, respectively. The latter estimates ignore Egypt's large *de facto* partial gradualism and slow nominal interest rate adjustment.

On the one hand, because the partial adjustment coefficient is large and highly significant, interest rates should be highly predictable. Furthermore, it implies that the central bank adjusts its interest rate per the smoothing parameter. On the other hand, it could reflect an optimal policy when the private sector is adequately forward-looking (Mohanty and Klau, 2005; Orphanides and Williams, 2007).

Concerning our estimates of the inflation gap (π), we find that its estimated coefficient equals β_2 = 0.0146; *p-value* < 0.01. It has a highly significant positive impact on the nominal interest rate at the 1% significance level. Holding all other explanatory variables constant, if π increases by 1%, we expect i_t will hike by approximately 0.015%. Surprisingly, this result shows that the inflation gap's parameter is positive, as predicted by theory (the Fisher effect). However, it violates the Taylor principle, which states that β_2 should be greater than 1 because, according to our results, $\beta_2 < 1$. Therefore, this result is inconsistent with the determinacy of equilibrium, revealing the low sensitivity of the nominal interest rate to the changes in inflation, making the policy procyclical. This result also shows that inflation cannot properly influence the nominal interest rate, and then the aggregate demand—via the real interest rate—aggressively, making inflation to be *spiral* out of control by supporting a self-fulfilling increase in inflation, inducing divergence from the steady-state (the long-run equilibrium). As a result, during the study period, the Taylor rule reflects a poor stabilization performance (a destabilizing monetary policy) in the Egyptian economy. In such a case, we can refer to it as "passive monetary policy" because the *real*, rather than nominal, interest rate falls in response to the rising inflation gap. In other words, indeterminacy arises when the central bank fails to raise nominal interest rates aggressively enough (i.e., $\beta_2 < 1$, resulting in negative real interest rates and making monetary policy procyclical rather than countercyclical, exaggerating economic fluctuations). It is worth noting that Clarida et al. (1999) attribute high inflation volatility and instability to monetary policy's failure to match the Taylor principle.

Table 5. *The GMM Estimates of the Taylor in the Egyptian Economy (1976-2019)*

Dependent variable: Short-term nominal lending interest rate (i)					
Estimated models	*Simple OLS model*	*Standard GMM model*	*Standard-Augmented GMM model*	*Forward-looking GMM model*	*Backward-looking GMM model*
i_{t-1}	0.8658 (0.0571)***	0.8366 (0.0463)***	0.8291 (0.0417)***	0.8042 (0.0426)***	0.7547 (0.0396)***
π	0.0163 (0.0059)***	0.0440 (0.0086)***	0.0103 (0.0032)***	0.0146 (0.0046)***	0.0264 (0.0032)***
Δy	−4.2075 (3.4678)	3.4640 (3.2009)	0.5689 (0.7774)	5.5276 (6.4304)	−7.9386 (3.5095)**
$log\ M2$			−0.1363 (0.0613)**	−0.1995 (0.0459)***	−0.1922 (0.0542)***
$\Delta\ log\ EX$			2.8411 (1.2896)**	3.8444 (1.6044)**	2.1934 (0.8853)**
β_0	3.7649 (1.4628)***	5.3245 (1.2422)***	10.5036 (1.9561)***	13.9284 (3.0650)***	15.1207 (2.2837)***
Diagnostic tests					
Adj. R-squared	0.8470	0.6711	0.8841	0.8034	0.7779
Hansen *J* statistic [*p-value*]		5.7343 [0.4536]	7.9199 [0.2440]	6.2361 [0.3973]	1.6350 [0.8025]
Sargan *C* statistic [*p-value*]		0.7344 [0.9470]	2.2663 [0.8112]	5.1428 [0.3987]	1.6350 [0.8025]
Wald test [*p-value*]	78.4807 [0.0000]	142.5291 [0.0000]	161.4353 [0.0000]	365.4197 [0.0000]	2202.287 [0.0000]
Autocorrelation (LM test)	11.2001 [0.0037]	The GMM estimates are robust to both Autocorrelation and Heteroscedasticity			
Heteroscedasticity (BPG test)	10.9484 [0.0120]				
Normality (JB test)	2.0495 [0.3588]	3.2476 [0.1972]	6.2960 [0.0429]	0.8313 [0.6599]	3.8450 [0.1462]

Notes.

- *Variables notation*: Nominal short-term lending interest rate (i) ; its one-year lagged value (i_{t-1}); inflation gap (π); differenced output gap (Δy); logarithm money supply ($log\ M2$); differenced logarithm nominal exchange rate ($\Delta \log EX$); the intercept proxied by equilibrium real interest rate (β_0) . Δ refers to the first-difference operator.
- ***, **, and * denote the 0.01, 0.05, and 0.10 levels of significance, respectively.
- Robust standard errors (SEs) of the estimated coefficients are (in parentheses), whereas *p-values* of the post-estimation diagnostic tests are [in square brackets].
- The Wald test for the OLS estimation tests the joint significance of the regressors with df = 39.
- We do not report autocorrelation and heteroscedasticity results for the GMM different estimates because, as previously stated, the GMM procedure is robust to autocorrelation and heteroscedasticity. Conversely, OLS estimates are not. However, we examined autocorrelation in GMM estimates using correlogram plots of residuals and squared residuals and found no evidence of autocorrelation. Correlogram plots are not reported but are upon request from the authors.
- Concerning the instruments set used for the GMM, we have mentioned them for every estimated model before.
- In the context of correcting the estimated SEs in the presence of autocorrelation and heteroscedasticity and for estimating the GMM long-run variance-covariance weighting matrix, we use the Newey-West heteroscedasticity and autocorrelation-consistent nonparametric estimators, advocated by Newey and West (1987) with the Bartlett kernel (weight) spectral density estimator and fixed bandwidth (roughly, lag length) (see Andersen and Sørensen (1996)).
- For the "forward-looking" model, the first-stage F-statistic (5, 35) = 7.59 with p-value = 0.0001, and Hausman $\chi^2(5)$ test statistic = 13.422 with p-value = 0.0197, indicating that the variables used in this study are endogenous.

In terms of the inflation gap, our forward- and backward-looking estimates are consistent with those of Hosny (2014) but contradict those of Selim (2012), who fails to account for the effects of both the 2011 revolution and the floating of the Egyptian pound's exchange rate in 2016. Despite the CBE's announcement that the primary goal of its monetary policy is to constrain inflation and target monetary stability, our estimates show that Egypt's monetary policy is not optimal and does not meet the Taylor principle, which is a dilemma. This demonstrates that the Egyptian monetary authorities follow the Taylor rule only in theory, not in practice and that they must address many issues that undermine the effectiveness of their monetary policy, including less developed fiscal and financial institutions, a poor monetary transmission mechanism, a long period of heavy reliance on seigniorage as a source of government financing, and monetization of fiscal deficits.

Our findings of the output gap (y) manifest that its estimated coefficient equals $\beta_3 = 5.528$; *p-value* > 0.1. This result is consistent with the theory, which assumes a positive parameter for the output gap (i.e., $\beta_3 > 0$), indicating that when the output falls under (above) its potential, the economy will be stabilized by lowering (raising) interest rates. This relationship remains insignificant, even at the 10% significance level. Even though this insignificant result is consistent with some empirical studies, like Clarida et al. (1999), who found that the output gap's parameter is not significantly different from zero, and Peters (2016), who discovered the same result for Indonesia and South Africa. Based on the magnitude of the estimated coefficients on both the inflation gap and the output gap, we can say that the CBE's monetary policy is known as the "output gap tilting rule" because it produces larger coefficients on the output gap than on the inflation gap (i.e., $\beta_2 < \beta_3$).[13] The insignificant coefficient on the output gap we found is supported by the estimates conducted by Hosny (2014) and Selim (2012).

Theoretically, as we referred to before, John B. Taylor (1993) proposed that the coefficients of the inflation gap (β_2) and the output gap (β_3) to be 1.5 and 0.5, respectively, fit the data well. Many empirical studies have investigated this proposition by comparing our results with the literature. For example, Cogley et al. (2010) found that the value of β_2 ranges between 1.56 and 1.78 across their sub-samples' estimations. Additionally, Judd and Rudebusch (1998) estimated β_3 to be equal to 0.99. Briefly, there is a wide array of different estimates for both parameters. This diversity can be attributed to differences between countries (and, of course, the economic structural shocks that every country faces) and differences between periods within the same country.

Concerning the effect of the control variables included in the Taylor rule, we observe that the M2 money supply is included significantly with the expected negative sign; its estimated coefficient approximately equals $\beta_4 = -0.199$; *p-value* < 0.01. This result is consistent with the theory that assumes that the money supply parameter is positive (i.e., $\beta_4 > 0$), reflecting

13) The opposite situation ($\beta_2 > \beta_3$) is called "inflation gap tilting rule." See Nikolsko-Rzhevskyy et al. (2021), for further readings.

the liquidity effect. That is, *all else being equal*, when the monetary authorities increase the money supply by 1%, the nominal interest rate will decrease by approximately 0.2% (in our estimations). Additionally, our estimates of β_4 are compatible with some empirical literature. For example, Peters (2016), *among other things*, reveals that countries like Mexico, South Africa, Indonesia, and Thailand prioritize variations in money growth while conducting their monetary policy. Besides, Kim and Shi (2018) ascertain this result for the Chinese economy.

Furthermore, our Taylor rule includes the nominal exchange rate as a control variable. We detected that the exchange rate had a statistically significant positive impact on Egypt's nominal interest rate variations during the study period. Its estimated coefficient is of relatively high magnitude, equals approximately β_5 = 3.844; *p-value* < 0.05. That is, *all else being equal*, when the exchange rate increases (depreciation of the domestic currency, the Egyptian pound) by 1%, the nominal interest rate will increase by approximately 3.84% (in our estimations).

This relatively large response of the nominal interest rate to exchange rate volatility reflects the critical role that the exchange rate plays in the Egyptian economy and the extent to which the CBE reacts to its movements. This could be demonstrated by periods when the CBE raised the nominal interest rate in response to positive nominal exchange rate movements (depreciation of the domestic currency, the Egyptian pound). For example, in 1990, the CBE increased the nominal interest rate in response to increases in the nominal exchange rate. Similarly, in November 2016, when the US dollar's exchange rate against the Egyptian pound increased significantly due to black market pressures—which ranged around 18 pounds/US$—the CBE leaned against the wind by raising the overnight deposit and lending interest rates by 3%, reaching 14.75% and 15.75%, respectively (Maher and Zhao, 2021). Additionally, according to Edwards (2006), this relatively large β_5 could be justified by the extended history of higher inflation in the Egyptian economy and the historically high volatility in *real* exchange rates.

Briefly, our current GMM estimates for the exchange rate are consistent with the theory that assumes that the parameter of the exchange rate is positive (i.e., $\beta_5 > 0$), indicating that the CBE (in our study) reacts with the pound's depreciation by raising the interest rate. Additionally, our findings align with empirical studies like Caballero and Krishnamurthy (2005) and Mohanty and Klau (2005). The latter study looked at the reaction function for many emerging market economies. Their results affirm ours, supporting Reinhart'sCalvo and (2002) "fear of floating" hypothesis.

Lastly, we report estimates for different models for comparison purposes. Regardless of the OLS estimates due to their shortcomings, our GMM estimates reveal that: the partial adjustment coefficient ranges from 0.755 to 0.837; the inflation gap coefficient ranges from 0.0103 to 0.044; the output gap coefficient ranges from −7.94 to 5.528; money supply coefficient ranges from −0.1995 to −0.1363; and exchange rate coefficient ranges from 2.193 to 3.844.

Compatible with both Lucas' (1976) critique of the backward-looking models and Clarida et al.'s (1999), whose results favor the forward-looking rule over the backward-looking one, our GMM estimates of the forward-looking policy rule are more reliable in reflecting the Egyptian monetary policy stance during the study period.

5.1. Diagnostic tests

Concerning the diagnostic tests of our different estimates, Table 5 also shows that, based on the adjusted R^2, our forward-looking GMM can account for roughly 80% of the total variation in the short-term nominal interest rate. Regarding the post-estimation diagnostic tests for our forward-looking GMM model, the Sargan *C* statistic = 5.1428; *p-value* > 0.1. Therefore, we fail to reject the null hypothesis that our instrument set satisfies the orthogonality condition, indicating that our instrument set is jointly valid (uncorrelated with the error term). Furthermore, the Hansen *J* statistic of overidentification restriction equals 6.236; *p-value* > 0.1. As a result, we cannot reject its null hypothesis, implying that our instruments are orthogonal to the error term, the overidentifying constraints are valid, and our estimated GMM models are well-specified. We use the Wald test to emphasize the significance of our explanatory variables and whether the estimated equation satisfies restrictions presupposed by economic and statistical theory. The joint Wald *F*-statistic = 365.42; *p-value* < 0.01. Therefore, we reject the null hypothesis that the coefficients of the explanatory variables are jointly restricted to zero. Our regression residuals are normally distributed since we fail to reject the null hypothesis of the Jarque-Bera (JB) test. Its test statistic equals 0.8313; *p-value* > 0.1. Additionally, as we emphasized before, the GMM models are robust to both autocorrelation and heteroscedasticity, but OLS models are not, as we can see from our estimates in Table 5.

5.2. Impulse response functions (IRFs) for the Taylor rule in Egypt

The IRF represents the impact of ann exogenous positive one-unit innovation (shock) on a particular variable's standard error (SE) on endogenous variables' current and future values. Put differently. The IRF graph demonstrates how fast and how much the dependent variable responds to shocks caused by independent variables. Furthermore, it allows decision-makers to determine the relative importance of each variable in their decision rule. Studies like Lubik and Schorfheide (2004) use IRF under indeterminacy to discuss the association between forecast errors are fundamental shocks. Those plots could offer evidence for the coefficients' stability, indicating the models' validity for policy analysis and forecasting.

For Egypt, the left panel of the first row of IRF plots, plotted in Figure 2, exhibits the pass-through effect of the nominal lending interest rate (i) in itself, given by the impulse response of the interest rate to one standard deviation shock to itself. The plots show that the interest rate hikes in the first period, hits a peak, and then falls gradually after the second time horizon. Then, it slowly recovered, reaching its steady-state (pre-shock value) in the tenth time horizon. The monetary policy inertia derives from the initial increase in the interest rate; that is, increasing interest rates affect the expected future nominal interest rate, reflecting the market efficiency hypothesis discussed in Fama (1975) and Pelaez (1989).

The right panel of the first row of Figure 2 shows the pass-through effect of the inflation gap (π) on the nominal lending interest rate (i), which is given by the impulse response of the interest rate to one standard deviation shock to the inflation gap. The plots show that if the inflation gap is shocked, the interest rate initially rises slowly, but after one period lag, and then gradually falls after the second time horizon. Then, it slowly recovered, reaching its steady-state in the tenth time horizon. This shock dies out over time. We can observe that the relationship between the two variables is stable enough for forecasting and policy analysis. The pass-through effect of the output gap (y) on the nominal lending interest rate I is shown in the left panel of the second row of IRF plots, given by the interest rate's impulse response to a one standard deviation shock to the output gap. The plots show that if there is a shock to the output gap, the interest rate initially rises but falls after one period lag, then hits its peak in the third period and remains unchanged (stable) during this period. After the fourth period, it falls gradually, reaching its steady-state in the tenth time horizon. Interestingly, the output and inflation gaps return to their steady-state values, i.e., set to zero, as in Eusepi and Preston (2018). That full stabilization is represented by $[y_{t+1} = (\pi_{t+1} - \pi^{*}) = 0 \ \forall \ t]$.

Figure 2. IRF plots for the Taylor rule

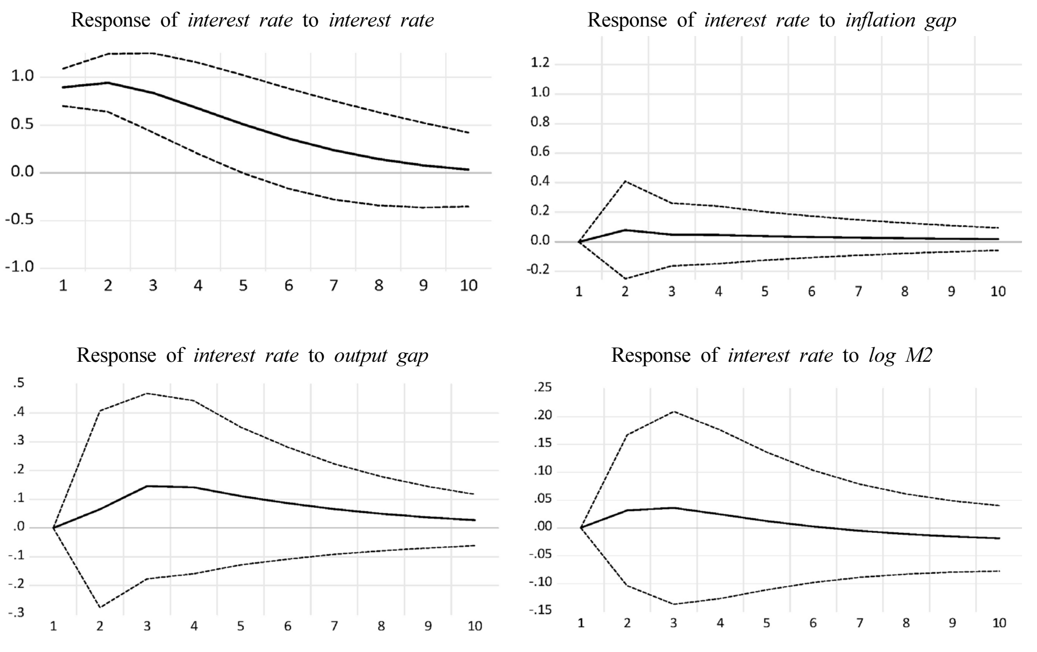
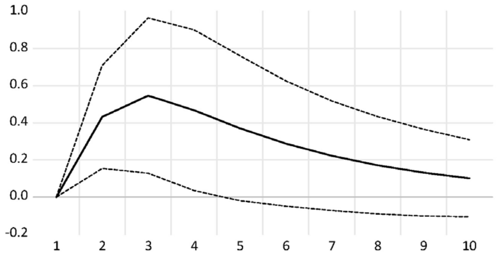


Figure 2. Continued

Response of *interest rate* to *log exchange rate*



Note. Figure 2 exhibits the response of the nominal interest rate to one standard deviation positive shock in a particular variable. The solid black lines denote the impulse responses, whereas the dashed black lines denote the 95% confidence intervals.

The right panel of the second row of IRF plots shows the pass-through effect of the M2 money supply (*M2*) on the nominal lending interest rate (*i*), which is given by the impulse response of the interest rate to one standard deviation shock to the money supply. The plots reveal that if we have a positive shock to the M2 money supply, the interest rate initially hikes slowly (this can be described as a "liquidity puzzle"). This effect occurs after one period lag and experiences slight stability during the second and third periods. Then, it falls gradually and slowly, reaching its steady-state in the sixth time horizon. From the seventh time horizon, the interest rate becomes negative, diverging from its steady-state.

The pass-through effect of the nominal exchange rate (EX) on the nominal lending interest rate (*i*) is shown in the left panel of the third row of IRF plots, which is given by the interest rate's impulse response to a one standard deviation shock to the exchange rate. The plots show that if the exchange rate is shocked, the interest rate will initially rise at a noticeable rate until the second period but then lag for one period. This acceleration will be slowed down in the third period, and then the interest rate begins to fall gradually and slowly toward its steady-state.

As can be seen from the IRF plots, the effect of the innovation (shock) begins from the first-time horizon (with a lag), not time zero (contemporaneously). This can be attributed to policy inertia, which prevented monetary policy (represented by the interest rate) from responding to inflationary pressures in real-time. The estimated Taylor rule, which includes a significant persistence, demonstrates this interaction. We have already mentioned this issue when discussing the constraints on monetary policy conduct.

VI. Concluding Remarks

During the study period, the Egyptian economy experienced many episodes of economic fluctuations and structural breaks. For example, the 1980s economic crisis prompted the Egyptian government to implement the ERSAP in 1991 to correct imbalances in the government budget and the balance of payments. The CBE liberalized the interest rates on loans and deposits under the ERSAP. Also, it implemented a contractionary monetary policy by raising nominal interest rates to achieve positive real interest rates. To manage inflation in the short-run, the CBE switched its monetary policy instrument from banks' excess reserves to the overnight nominal interest rate on interbank transactions in 2005. The 2011 revolution and its consequences also put pressure on the domestic currency's exchange rate, and the CBE reacted to foreign exchange reserves to defend the local Egyptian currency. Simultaneously, the CBE hiked the overnight deposit and lending interest rates by 3%.

We investigated the effectiveness of the nominal interest rate in achieving monetary stability in Egypt during the study period (1976-2019) in the context of the Taylor rule. Furthermore, we examined whether the Taylor principle is met in Egypt. To estimate the Taylor rule, motivated by avoiding the endogeneity problem among our main variables, we conducted the GMM technique. We estimated four different Taylor rule specifications using the GMM estimation technique and the OLS. Our GMM results show that the partial adjustment coefficient (the inertial component) has a large magnitude, indicating that policy inertia can explain a high number of the total variations in the current values of the nominal short-term interest rate in the Egyptian economy. As a result, Egypt's monetary policy reflects a sluggish adjustment in practice. Regarding the examination of the determinacy of equilibrium, the coefficient on the inflation gap is less than unity. Thus, it violates the Taylor principle, causing the monetary policy to be procyclical and inflation to self-fulfill. This finding suggests that Egypt's monetary policy induces divergence from the long-run equilibrium (a passive or destabilizing monetary policy), rendering the equilibrium indeterminate. As Clarida et al. (1999) noted, inflation's high volatility and instability is attributed to monetary policy's failure to satisfy the Taylor principle.

Additionally, we found that the output gap was insignificant, and this finding is consistent with the findings of some empirical studies, like Clarida et al. (1999) and Peters (2016). Furthermore, we found that the M2 money supply significantly negatively affected interest rates, mirroring the liquidity effect. Also, the nominal exchange rate is detected to significantly impact the nominal interest rate variations during the study period. That result is consistent with what had happened in Egypt in 1990 when the CBE reacted to the increases in the nominal exchange rate by raising its short-run nominal interest rate. The same thing was repeated in November 2016, when the CBE hiked the overnight deposit and lending interest rates to combat the US dollar's exchange rate increase against the Egyptian pound. This response agreed with the "fear of floating" hypothesis. Finally, our GMM estimates of the forward-looking policy rule are more reliable in reflecting the Egyptian monetary policy stance during the study period, which is consistent with both Lucas (1976) and Clarida et al.'s (1999) critique of backward-looking models.

We recommend that CBE's policymakers keep their conducted monetary policy in line with their *de jure* declared main objective (stabilizing inflation rates) by responding aggressively to the inflation movements.

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