Can increasing interest rates manage inflation in Egypt without triggering a recession? New insights from Structural Equation Modeling (SEM)

هل يُمكن لرفع أسعار الفائدة إدارة التضخم في مصر دون التسبب في ركود اقتصادي؟ رؤية جديدة من نمذجة المعادلات الهيكلية (SEM)

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Abstract

This study sought to determine whether raising interest rates can effectively address the inflation problem in Egypt without causing a recession. This was done using structural equation modeling (SEM) over the period (1991-2024) to evaluate the direct and indirect effects of monetary policy on inflation and economic growth. The results showed that a 1% increase in the interest rate on deposits at central banks leads to an increase in lending rates by 0.73%, liquidity by 16.4%, and asset prices by 11.7%, but reduces private sector credit by -0.98%. Higher lending rates significantly reduce inflation by -3.4%, supporting the Keynesian theory, while higher asset prices slightly boost inflation by 0.045%. Asset prices and private credit positively affect GDP growth. The model demonstrates strong explanatory power ($R^2 = 0.983$), which confirms the effectiveness of raising interest rates in curbing inflation but highlights the need to set criteria to avoid deflation. Excessive credit, this study attempts to clarify a vision for achieving a balance between controlling inflation and growth through targeted monetary measures.

Keywords: Interest Rates, Inflation, Recession, Economic Growth, Monetary Policy, Structural Equation Modeling (SEM).

المستخلص

سعت هذه الدراسة إلى معرفة ما إذا كان رفع أسعار الفائدة يمكن أن يعالج مشكلة التضخم في مصر بفعالية دون التسبب في ركود، وذلك باستخدام نمذجة المعادلات الهيكلية (SEM) خلال الفترة (1991: 2024)، لتقييم الآثار المباشرة وغير المباشرة للسياسة النقدية على التضخم والنمو الاقتصادي، وتوصلت النتائج إلى أن زيادة 1% في معدل الفائدة على الودائع لدى البنوك المركزية تؤدي إلى رفع أسعار الإقراض بنسبة (0.73٪) والسيولة بنسبة (16.4٪) وأسعار الأصول بنسبة (11.7٪)، لكنها تُقلل من

ائتمان القطاع الخاص بنسبة (-0.98٪)، تؤدي أسعار الإقراض المرتفعة إلى خفض التضخم بشكل كبير وذلك بنسبة (-3.4٪)، مما يدعم النظرية الكينزية، في حين أن ارتفاع أسعار الأصول يعزز التضخم بشكل طفيف وذلك بنسبة (0.045٪)، تؤثر أسعار الأصول والائتمان الخاص إيجابياً على نمو الناتج المحلي الإجمالي، يوضح النموذج قوة تفسيرية قوية ($R^2 = 0.983$)، مما يؤكد فعالية رفع أسعار الفائدة في كبح التضخم ولكنه يسلط الضوء على الحاجة إلى وضع معايير لتجنب الانكماش المفرط في الائتمان الممنوح للقطاع الخاص، تُحاول هذه الدراسة توضيح رؤية حول تحقيق التوازن بين ضبط التضخم والنمو من خلال تدابير نقدية مُستهدفة.

الكلمات المفتاحية: أسعار الفائدة، التضخم، الركود، النمو الاقتصادي، السياسة النقدية، نمذجة المعادلات الهيكلية.

Introduction:

The global economy has faced significant challenges in recent years, particularly in the aftermath of the COVID-19 pandemic. Inflationary pressures have surged, prompting central banks worldwide to raise interest rates to stabilize prices. However, the aggressive tightening of monetary policy has raised concerns about the potential for a global recession. Subsequently, the examination of inflation dynamics and the identification of its underlying causes continues to be a subject of significant discourse among economists. On one side, the long run correlation between anticipated inflation and nominal interest rates, as articulated by the Fisher equation, is regarded as a fundamental principle in economic theory. On the other hand, central banks that adopt inflation targeting strategies adhere to the principles of Keynesian frameworks, both traditional and contemporary, which highlight a short run inverse relationship between interest rates and inflation, where causality flows from interest rates to inflation.

Recent investigations of the Neo-Fisherian Hypothesis advocate that a sustained rise in interest rates may result in heightened inflation, not only in the long run as suggested by Fisher hypothesis but also in the short run. Exploring this ongoing debate could offer essential insights for central banks in enhancing the effectiveness of their monetary policy (Azizirad, 2022). This paper aims to investigate the function of interest rates in achieving a careful balance between managing inflation and mitigating the risks of recession. The remaining of the paper include the following sections:

1. Stylized Facts about Egyptian Economy
2. Research Problem
3. Research Objectives
4. Research Hypothesis
5. Research Importance
6. Theoretical Framework and Historical Review
7. Literature Review
8. Methodology
9. Empirical Results
10. Conclusion

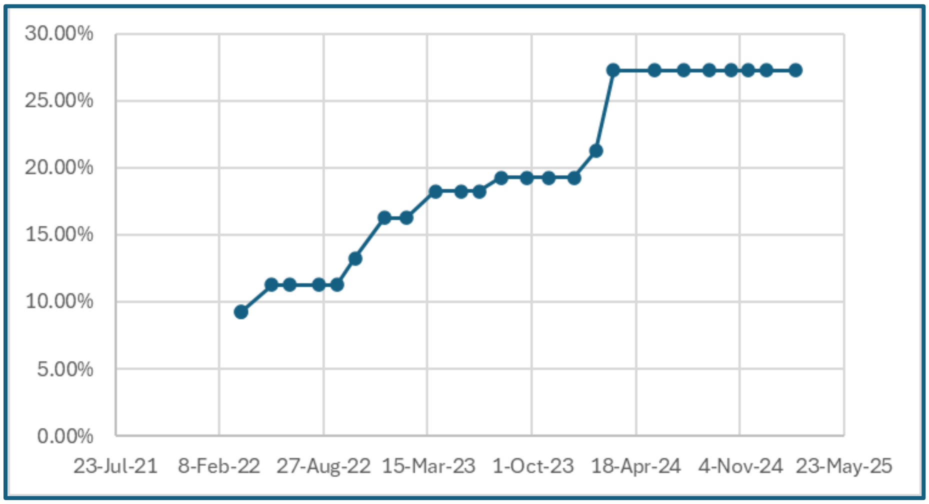
Following, we explore these sections in more detail.

1. Stylized Facts about Egyptian Economy

In response to escalating inflation rates, which peaked at 8.5% in March 2022, the U.S. Federal Reserve abandoned its quantitative easing (QE) measures that had been in place for nearly 14 years and shifted towards quantitative tightening (QT) to reach its inflation target of 2%. A primary tool utilized in this monetary contraction has been the increase of the Fed Fund Rate, which rose from 0.25% in March 2022 to 5.5% by September 2023. This series of fund rate rises has been justified by the robust performance of the American economy, marked by low and stable unemployment rates fluctuating between 3.6% in March 2022 and 3.8% in September 2023, alongside a consistent real GDP growth rate that varied from 3.2% in the third quarter of 2022 to 2.1% in the third quarter of 2023. This policy shift has already contributed to a reduction in inflation in the US, decreasing from 8.5% in March 2022 to 3.6% in September 2023.

Many countries around the world, including Egypt, have mirrored the Federal Reserve's actions by increasing interest rates to mitigate inflationary pressures. That is, the Central Bank of Egypt (CBE) gradually raised interest rates from 9.75% in March 2022 to 19.75% in August 2023, and further to 27.25% in March 2024 and staying there until February 2025, as shown in figure (1).

Figure (1): The Egyptian Central Bank Policy Rates



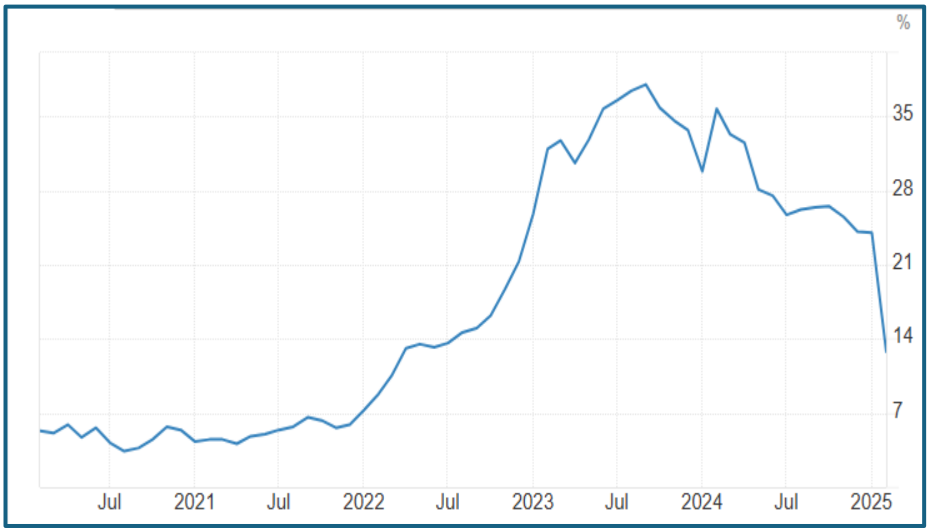
Source: Central Bank of Egypt (Daily Interbank Rates & Volumes Historical Data)

Figure (2): The Growth rates in Egypt

Source: https://tradingeconomics.com/egypt/gdp-growth-annual

Meanwhile, the growth rate during the same period declined from 8.3% in January 2022 to 5.4% in the third quarter of fiscal year 2021/22, then continued to decline to 3.2% in the fourth quarter of the same year. At the beginning of fiscal year 2022/23, it rose slightly to 4.4% in the first quarter of the year before declining again to 3.9% in the second quarter. This indicates a general downward trend, as shown in the figure (2). As for the inflation rate, as clearly seen from figure (3), we find that the general trend is almost steadily rising, rising from 16.2% in October 2022 to 37.4% in August 2023, then it turned to be 29.8% in January 2024 before hiking again to 35.7% and finally it fell steadily to approach 12.25% in February 2025.

Figure (3) Inflation rates in Egypt



Source: https://tradingeconomics.com/egypt/inflation-cpi

2. Research Problem:

From the above illustration and given the stylized facts about the Egyptian economy, we notice that rising interest rate was escorted by decreasing growth rates with delayed response of the inflation rates which trigger the question about the extent to which the monetary policy makers in Egypt can go in rising the interest rates to mitigate the inflationary pressure without causing economic recession.

3. Research Objectives:

The objective of the paper lies exclusively in the answer to the following questions:

a) Will raising interest rates effectively combat inflation in Egypt?

b) What are the anticipated effects of raising interest rates on economic activity of the Egyptian economy?

4. Research Hypothesis:

Based on the research problem, in an effort to achieve the objectives of the study we are going to test the following hypothesis:

a) The rise in interest rate by the central bank accommodates inflation in Egypt.
b) The increases of interest rate by the central bank are detrimental to the Egyptian economy's output.

5. Research Importance:

With the end of the COVID-19 pandemic and economic recovery from its effects, inflation rates began to rise. Despite rising interest rates, fears increased regarding a global economic recession or even stagflation. Therefore, the study's significance lies in understanding the nature of the relationship between interest rates, inflation, and the growth in Egypt. This will guide policymakers in determining the best strategies to manage inflation and avoid recession by using key monetary policy tools, specifically the interest rate.

6. Theoretical Framework and Historical Review:

As the U.S. Federal Reserve initiated its strategy to mitigate inflation in March 2022, the discourse centered on the potential outcomes of a "hard landing" versus a "soft landing." What do these concepts entail? and what insights can be gleaned from the examination of U.S. monetary history regarding the feasibility of attaining a soft landing in the context of the inflationary trends that emerged in March 2022? Typically, when the Federal Reserve seeks to address existing or emerging inflation, it tightens monetary policy by increasing the federal funds rate, which represents the overnight lending rate for bank reserves. This measure subsequently results in a rise in other interest rates across the economy due to financial arbitrage. Additionally, it often leads to a decline in stock prices and is likely to result in an appreciation of the exchange rate.

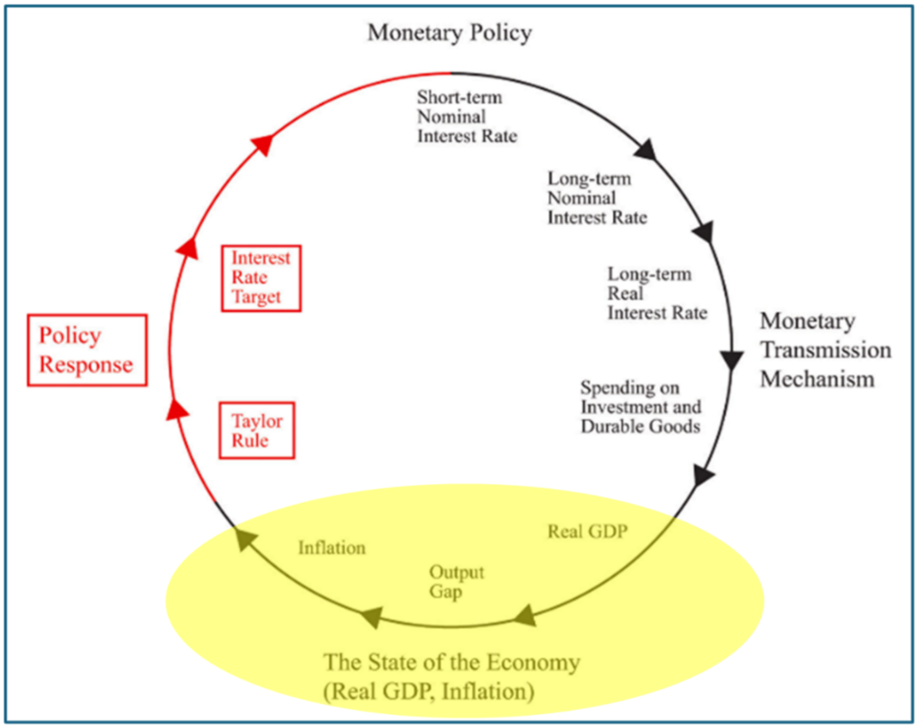
Higher interest rates inherently raise the cost of borrowing, which subsequently reduces aggregate demand, especially in sectors such as housing and automobiles. The primary objective of this approach is to decelerate the growth of aggregate demand, thereby alleviating some of the inflationary pressures within the economy. If the Federal Open Market Committee (FOMC) can successfully manage this momentum without overreaching, it may facilitate a "soft landing," characterized by either stabilization or a reduction in inflation, accompanied by minimal recessionary effects. Conversely, excessive tightening could lead to a recession, often referred to as a "hard landing," while insufficient monetary tightening may not adequately address the inflationary challenges (Blinder, 2023).

In the past decade, monetary policy in advanced economies has functioned within a context of historically low nominal interest rates and persistent disinflationary trends, which have often resulted in interest rates remaining significantly below the targets set by central banks. This phenomenon has been largely influenced by a long-term decline in the global equilibrium real interest rate, which has constrained the ability of monetary policy to reduce official interest rates during economic downturns without approaching the effective lower bound on nominal rates. The persistent and global nature of these developments has led to a widespread reevaluation of, on the one hand, the frequency and severity of economic downturns and, on the other hand, the effectiveness of the available monetary policy tools and alternative monetary policy frameworks in achieving satisfactory macroeconomic stability (Bank et al., 2021; Coenen et al., 2021).

Since Milton Friedman famously stated, "Inflation is always and everywhere a monetary phenomenon," economists and monetary policymakers have attempted to identify the monetary tool or mechanism capable of reducing inflation and achieving its targeted level. In the aftermath of the global financial crisis in 2008, the U.S. Federal Reserve pursued an unconventional monetary policy known as "quantitative easing (QE)." Key components of QE included: lowering the interest rate to very low levels, even near zero, and increasing the size of the central bank's balance sheet by purchasing distressed asset-backed securities, such as mortgages, from banks and expanding holdings of government bonds. This policy succeeded in propelling the U.S. and global economies out of the recession resulting from the global financial crisis.

The monetary transmission mechanism indicates that an increase in real interest rates leads to a decline in consumer spending, which subsequently results in a decrease in real output. In the very short term, this decline in spending directly correlates with a drop in real output due to the rigidity of prices. As output contracts, the output gap within the economy widens, this widening output gap is likely to exert downward pressure on the inflation rate. Certain firms may respond to these shifting economic conditions by adjusting their prices swiftly. However, it is not accurate to assert that the overall price level remains completely fixed for extended periods. Nonetheless, some firms may maintain their prices for several months despite changes in the economic landscape (Cooper & John, 2012).

Figure (4) Feedback and feedforward between interest rate, inflation and output



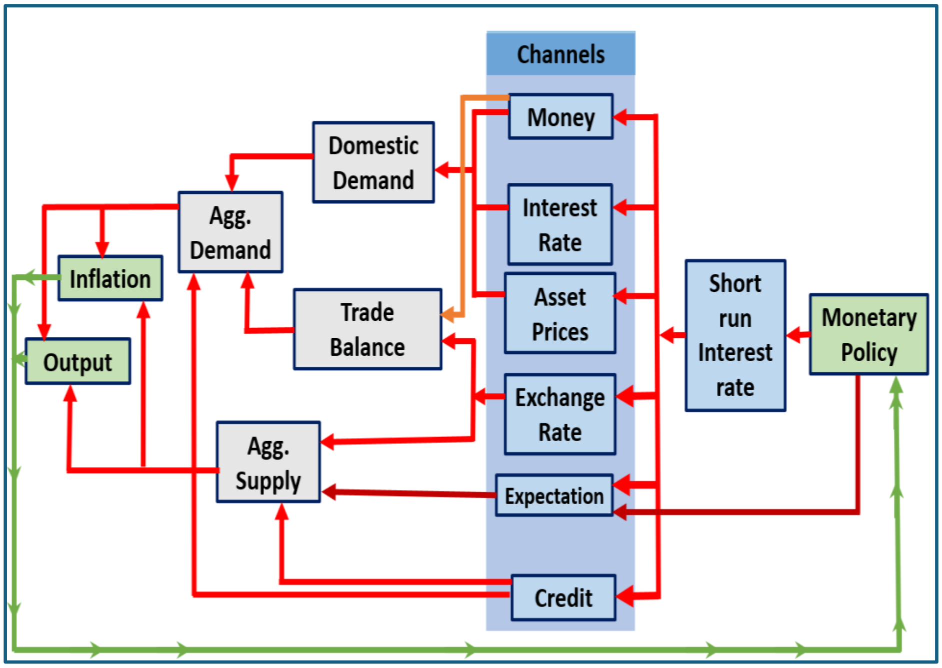
Source: (Cooper & John, 2013)

Consequently, the process of price adjustment across the economy is gradual, potentially taking months or even years for all firms to realign their prices. This process can be depicted in a loop between interest rate, inflation and output, as shown in figure (4).

Besides, central banks establish the nominal interest rate with the aim of managing inflation and stabilizing economic output. In monetary frameworks, monetary policy influences output directly through the wealth effect, within these frameworks, the central bank's reaction to output fluctuations can lead to real indeterminacy, even when the Taylor principle is upheld. The conditions for determinacy are contingent upon the interest rate elasticity of output, indicating that the Taylor principle is neither a necessary nor a sufficient condition for determinacy. This stands in sharp contrast to the New Keynesian model, where a sufficiently robust policy response to either inflation or output typically guarantees determinacy (Platonov, 2024).

Regardless of the implemented monetary policy framework, central bankers seek to understand how alterations in monetary policy tools such as the interest rate influence inflation and economic output, as well as the timing and magnitude of these effects. Traditionally, the transmission of monetary policy impacts is conceptualized through either money or credit channels, often referred to as the money versus credit perspective. In the money view, variations in the nominal money supply directly influence spending. Conversely, in the credit view, open market operations lead to fluctuations in interest rates, which subsequently affect spending. Additionally, certain models suggest that credit rationing and the financial accelerator may further influence output and prices. Most theoretical frameworks incorporate some degree of nominal price or wage rigidity to establish the proposed connections between money supply, interest rates, and economic output (Al-Mashat & Billmeier, 2008; M. H. R. Davoodi et al., 2013; Gedikli, 2017)

Figure (5): Chanels of the relationships between interest rates, inflation and output.



Source: (Al-Mashat & Billmeier, 2008; H. R. Davoodi et al., 2013; Gedikli, 2017)

In other words, the impact of altering the interest rate on both inflation and output may differ in both direction and magnitude depending on the channel by which that effect flows from the central bank policy rates into inflation and output. Figure (5) summarizes those direct and indirect relationships.

To sum up, an increase in interest rates results in a slow decline in the inflation rate within the economy. However, this contractionary monetary policy leads to diminished economic activity and, over time, a reduction in inflation. A pertinent example is the US monetary policy in the early 1980s. At the beginning of that decade, inflation exceeded 10 percent. To combat this inflation, the Federal Reserve, led by Chairman Paul Volcker, implemented a contractionary monetary policy that significantly raised real interest rates. The immediate consequence was a deep recession, while the eventual outcome aligned with the model's predictions, resulting in lower inflation rates.

7. Literature Review:

Recently, with inflation rates remaining high despite interest rate hikes, fears of a global recession or even stagflation have intensified. Numerous studies have addressed this issue. Some of these studies attempted to track the episodes of economic recession in previous decades to anticipate and deduce what might occur in the present. Other studies attempted to construct models to foresee or predict what might happen in the future, while others sought to develop solutions to avoid or alleviate the possible recession due to rising interest rates.

For instance, Azizirad (2022) attempted to answer the question of whether raising the interest rate leads to an increase or decrease in inflation. Starting from a New Keynesian macroeconomic model, he estimated a liquidity-enhanced empirical model for interest rates and inflation using both time-varying structural vector autoregression and a system of latent variables and found that raising interest rates has a short-term negative impact on inflation regardless of its duration. This finding contradicts the Neo-Fisherian Hypothesis' prediction of a positive inflationary response in the short term to a permanent shift in interest rates. At the same time, inflation and the nominal interest rate move in the same direction in the long run. He also found that the short run and long run interactions of macroeconomic variables including inflation, interest rates, and growth have changed over the decades from the 1950s to 2016.

Additionally, Coenen et al. (2021) examined the effectiveness of monetary policy and macroeconomic stabilization in a low-interest-rate context, where the effective lower bound (ELB) on nominal interest rates poses a significant limitation. Utilizing the European Central Bank's New Area-Wide Model (NAWM II) for the euro area, they advocate that neglecting the ELB through targeted policy measures results in considerable persistent negative biases in inflation and economic activity falling short of desired levels, alongside increased macroeconomic instability. The findings indicate that these adverse effects can be somewhat alleviated by employing a combination of unconventional monetary policy tools, specifically interest-rate forward guidance and large-scale asset purchases. However, the success of forward guidance is contingent upon its credibility, which may be bolstered by asset purchases. Additionally, the research highlights that alternative monetary policy approaches, particularly make-up strategies such as price-level targeting and average-inflation targeting, can prove to be very effective.

Moreover, Guénette et al. (2022) examined the circumstances surrounding the previous global recessionary periods from 1970 to 2022 in an attempt to extrapolate the causes of recession and the possibilities of its current occurrence. They observed five episodes of global recession over the past fifty years. These recessions were characterized by decline in the growth rate in the year prior to the recession, which is currently happening since the beginning of 2022 (as occurred before previous recessions), asset prices globally have fallen, and investor and consumer confidence has corroded. Furthermore, each recession was accompanied by a sharp economic contraction in several major economies. Additionally, they argue that despite lower growth rates and the effort to combat persistent inflation, most countries in the world currently have engaged in monetary tightening combined with the reduction of fiscal support. This has made these economies suffer from the most violent episodes of monetary and financial tightening in the past fifty years.

Also, Cochrane (2022) argues that the current inflation stems from a fiscal shock, and that the Federal Reserve has been slow to respond to this shock. This shock consists of an increase in the US public debt of $2 trillion between 2021 and 2022, most of which are short-term loans. The US money supply has also increased by $3 trillion in the same period. He attributed that to the monetary and financial authorities believe that this quantitative easing (QE) will not produce inflationary effects as had occurred during the quantitative easing (QE) that followed the global financial crisis, which was accompanied by stable inflation rates, especially since the rate of recovery of the American economy after the COVID crisis was unprecedented in previous recessionary periods.

To determine why the Federal Reserve has been slow to respond to this shock, and whether this slowness is stimulating more inflation, Cochrane (2022) suggests a simple model that includes the Federal Reserve's moderate expectations and its slow reaction, and the traditional views that inflation will rise without rapid increases in interest rates. According to this model, if expectations are forward-looking, then the Federal Reserve is right, and inflation will eventually fade without a period of high real interest rates. Also, in the case of financial deflation, the Federal Reserve can reduce inflation now, but only by increasing inflation later. If the Federal Reserve wants to reduce inflation permanently by raising interest rates, this must be accompanied by fiscal support to drive higher debt costs and achieve windfall gains for bondholders.

Responding to Cochrane (2022), Bianchi and Melosi (2019) advocate that significant fiscal imbalance generates inflationary pressures, which in turn prompt monetary tightening, increased debt accumulation, and further inflationary strain. Consequently, the economy may enter a cycle characterized by rising inflation, reduced output, and additional debt growth. A coordinated approach aimed at mitigating the debt incurred during a major recession can yield improved macroeconomic results by distinguishing long-term fiscal sustainability from the immediate need for fiscal stabilization. This approach can also help prevent situations where the central bank faces limitations due to the zero lower bound.

Two years later, Bianchi et al. (2023) developed new general equilibrium models with partially unfunded debt to propose a fiscal theory of persistent inflation. In response to economic cycle shocks, the monetary authority tries to control inflation, while the fiscal authority works to stabilize public debt. However, the central bank absorbs unfunded fiscal shocks, causing continuous movements in output inflation and real interest rates. Based on proposed model, they found that fiscal-policy-caused inflation is the largest part of inflation dynamics. After the COVID virus pandemic, it was confirmed that the unfunded fiscal shocks work to support economic recovery but also cause a continuous increase in inflation.

Furthermore, reviewing the quantitative tightening policies adopted by the US Federal reserve from November 3, 2021, until July 2023, in addition to the views of economists and experts, Kakulia and Chikobava (2023) concluded that companies and dealers in financial markets considered these policies a very serious sign for the emergence of expectations of another dangerous wave of economic contraction. These expectations were fueled by raising the interest rate on federal funds eleven consecutive times by the Fed from March 2022 until July 2023 despite the declaration of not considering raising the interest rate made by its chairman Jerome Powell in March 2023, which raises doubts about the strength of the American economy, and whether it can withstand the anti-inflation drug called “monetary tightening” or not. Based on that fear, most economists predicted that tightening monetary policy is likely to lead to a global recession.

Analogously, Schrager and Riedl (2023) argued the US inflation rate was pushed too high through excessive stimulus spending, tariffs, and pro-union regulations. With Congress and the President continuing to make inflation worse, and continuous stimulation to the demand side may ultimately weaken the economy forcing the Federal Reserve to press harder on the brakes of the economy, and thus risk recession. Accordingly, they presented a set of recommendations to enhance economic growth in the face of the looming recession at a relatively low cost to taxpayers such as eliminating old stimulus rules, adopting supply-side policies to encourage investment, opening trade, encouraging work, and formulating a legislative proposal to stimulate the low-cost supply side.

Likewise, Schäfer and Semmler (2024) demonstrates that energy, commodities, and food have been the primary contributors to inflation. Consequently, the central banks' strategy of reducing labor demand through substantial interest rate increases appears misguided. They contend that the current policies are unlikely to fulfill all their intended goals of curbing inflation, stabilizing financial markets, and promoting growth. That is, if interest rates remain elevated while external factors exert a lasting influence, particularly in smaller emerging economies, it will be challenging to address inflation through high-interest rate policies and national management of the price- and wage-Phillips curve. The significant adverse effects of interest rate increases heighten the risk of underinvestment and particularly undermine the bargaining power of vulnerable labor groups. Therefore, alternative strategies are necessary to manage and control inflation, such as increased investment in sectors facing supply chain disruptions and a substantial expansion of investments in renewable energy.

Driven by the persistent inflation and the sluggish output, White (2024) advocate that the central banks should consider elevating their target inflation rates. He argues that increased inflation leads to elevated tax burdens on monetary holdings and non-indexed savings, resulting in financial detriment for households and a decline in their real income levels. The primary justifications for the central banks to elevate its inflation, namely, that higher inflation enhances the functioning of a sticky-price economy or that it helps maintain a buffer above the zero lower bound on nominal interest rates—are based on anticipated benefits from increased inflation that are unlikely to surpass the associated losses. The argument that low inflation hampers real GDP growth is not supported by historical data from periods of low inflation. Furthermore, the rationale for raising the inflation target to provide the central banks with "more ammunition" to combat recessions fails to consider more effective and less expensive strategies for implementing counter-recessionary monetary policy, particularly through quantitative easing.

From the above demonstration, we found that most of the studies that questioned whether raised interest rate harms the output or not concentrated on the US economy, may be this is the case because the US economy was and still the locomotive to the world economy and the economic history indicates that most of the global recessions in the last decades started there. Also, and to the best of our knowledge, most of the research in case of Egypt investigated the relationship between interest rate, exchange rate and inflation such as (Ahmed & Abdelsalam, 2017; Helmy, 2022; Mohamed Youssef et al., 2022; Omran & Bilan, 2021) except Omar and Yousri (2024) who estimated two binary models, one include interest rate and output where the other one include interest rate and inflation, to find a significant long-run impact of interest rate on both inflation and output with evidence of asymmetric influences on inflation, but not on output. Therefore, our paper fills that gap in two ways, first by investigating the possible simultaneous impact of the raised interest rate on output and inflation within a comprehensive model, secondly by including direct and indirect relations (as discussed in the next section) to determine the channels by which the impact is pathing through, finally by investigating the data of the Egyptian economy which was not tested (to the best of my knowledge) that way.

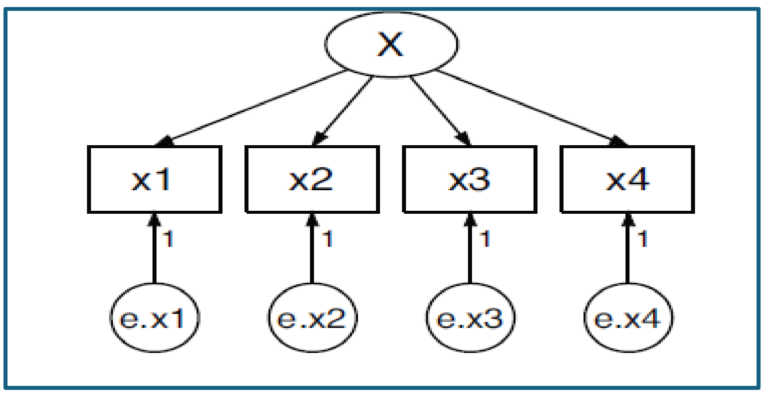
8. Methodology:

A. Structural equation modeling (SEM)

Structural equation modeling (SEM) offers a framework for understanding causal relationships between variables and clarifying their respective impacts on overall performance. As a powerful analytical technique, SEM combines factor analysis with multiple regression analysis to investigate the relationships between different variables. This method reflects our daily evaluations, where we consider how factors like posture, confidence, and communication abilities collectively affect results such as interview performance. SEM is a valuable tool for analyzing complex and multifaceted constructions that may be affected by measurement error. Its strength lies in its capacity to map out a network of interconnected variables. Unlike traditional approaches that usually concentrate on one independent variable along with several predictors, SEM reveals insights into causal relationships among observed variables, acknowledging that correlation does not imply causation (Stein et al., 2012; Westland, 2015).

In structural equation modeling, it is common to represent models using a path diagram such as:

Figure (6): An example SEM



Source: (Cain, 2021).

As shown in figure (6) the SEM chart consists of boxes representing variables that are directly observed in the dataset and circles denote unobserved variables, referred to as latent variables. Arrows, referred to as paths, that link certain boxes and circles. An arrow pointing from one variable to another indicates that the first variable influences the second. Specifically, if $X \rightarrow x_1$, it implies that the value of β_1 should be added to the linear equation for x_1, where β_1 is termed the path coefficient.

The same path diagram utilized to illustrate the model can also be employed to present the results of estimation, with estimated coefficients displayed along the paths (Mueller & Hancock, 2018; Whittaker & Schumacker, 2022). Consequently, the above SEM chart corresponds to the equations:

$$x_1 = \alpha_1 + \beta_1 X + e.x_1$$

$$x_2 = \alpha_2 + \beta_2 X + e.x_2$$

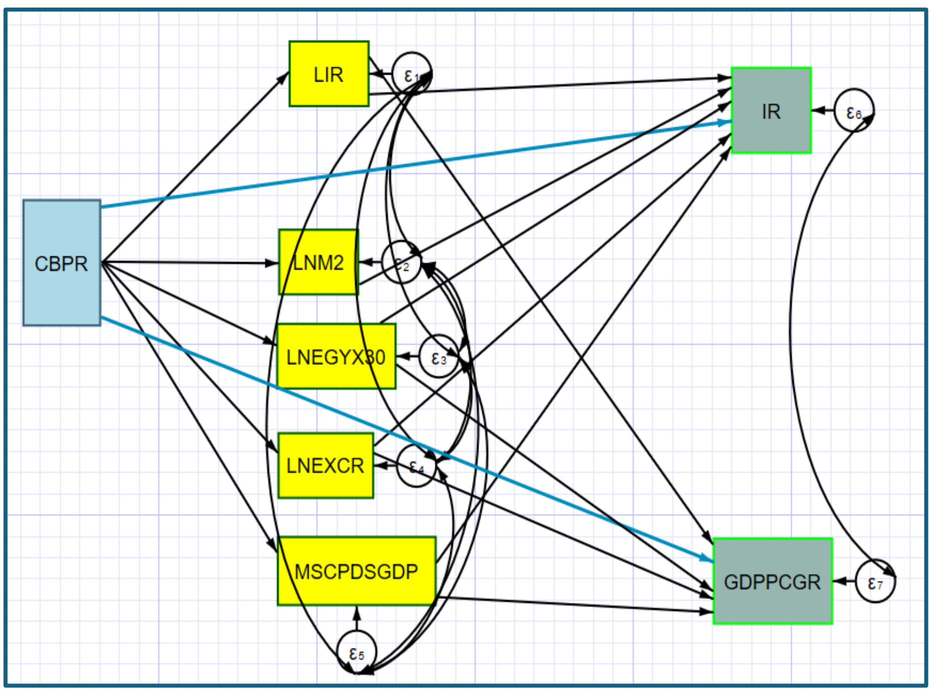
$$x_3 = \alpha_3 + \beta_3 X + e.x_3$$

$$x_4 = \alpha_4 + \beta_4 X + e.x_4$$

B. The empirical model

Based on the work done by Al-Mashat and Billmeier (2008), H. R. Davoodi et al. (2013) and (Gedikli, 2017) we depict the structural direct and indirect relationships between interest rate, inflation and output as:

Figure (7): the SEM of interest rate, inflation and output relationships



Source: This SEM was built by the authors using STATA 17.

Where:

CBPR	:	Central bank policy rate (%)
LIR	:	Lending interest rate to the private sector (%)

LNM2	:	Natural logarithm of Broad money as a proxy for liquidity
LNEGYX30	:	Natural logarithm of the EGX 30 index as a proxy for asset prices
LNEXCR	:	Natural logarithm of the exchange rate (EGP to US$).
MSCPDSGDP	:	Monetary sector credit to private sector as % of GDP
GDPPCGR	:	GDP per capita annual growth rate (%) as a proxy for output.
IR	:	Inflation rate calculated by consumer prices (annual %)

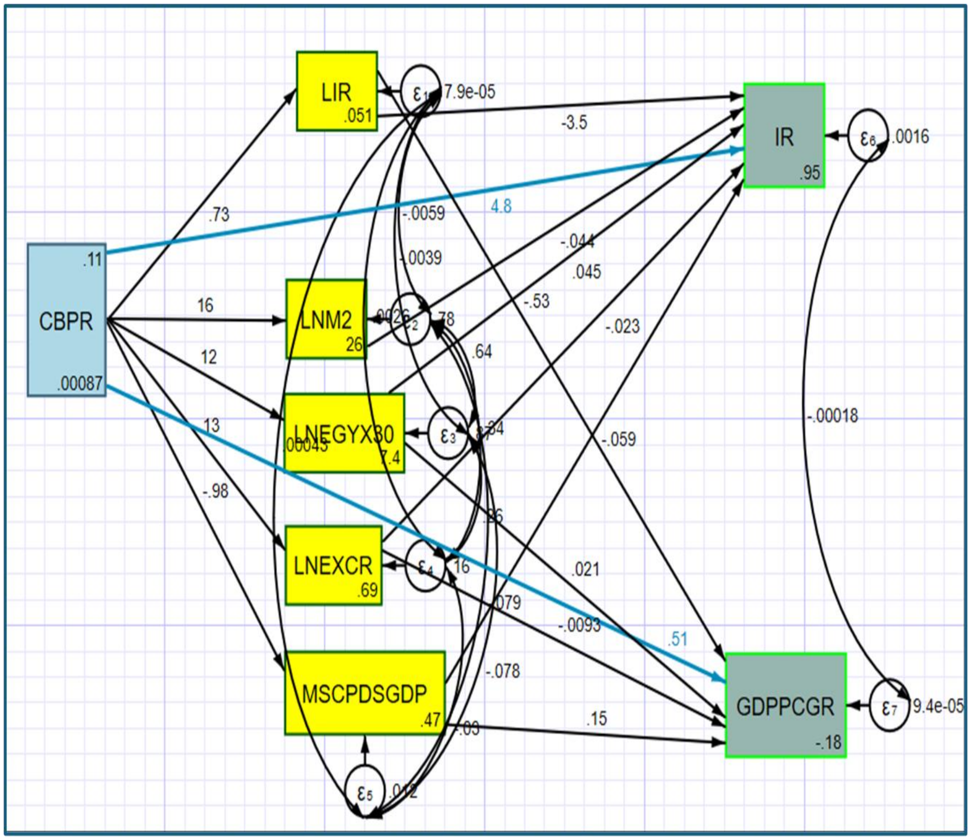
C. Data

The data for each of the above illustrated variables were collected for the Egyptian economy from 1991 to 2024. All data were obtained from the World Bank World Development Indicators (WDI) database (https://databank.worldbank.org/source/world-development-indicators) except the central bank policy rate was obtained from the Egyptian Central Bank (ECB) and the EGYX30 Egyptian Exchange (https://www.egx.com.eg/en/Indices.aspx)

9. The Results:

After building the structure equation model, as illustrated in figure (7), we estimate simultaneously the regression equations represented by the boxes and the arrows of that SEM model. Accordingly, the path coefficient for each relationship is written above the arrow representing the magnitude and the sign of this relationship, as shown in figure (8). Viewing the results, we find that the estimated path coefficients show positive relationships flow from the central bank policy rate to lending interest rate, quantity of money, assets price and exchange rate. Whereas the impact of the central bank policy rate on monetary credit on the private sector is negative. On the other hand, the inflation rate is negatively affected by lending interest rate, liquidity, exchange rate and monetary credit on the private sector, and positively by asset prices and policy rates. Moreover, the output is negatively influenced by the lending interest rates and the exchange rate. But it was affected positively by the other variables.

Figure (8): The SEM estimated path coefficients



Source: This SEM was built by the authors using STATA 17.

Table (1) illustrates the detailed path coefficients along with its significancy levels for every possible path of the relationship between central bank policy rate, inflation and output. The first part of the table shows the structural link going from the Central Bank policy rate to the mediatory variables while the second and the third sections illustrate the structural links from those mediators to both inflation and output.

Table (1): The estimated SEM path coefficients

	Coefficient	Satorra-Bentler std. err.	z	P>|z|	[95% conf.	interval]
Structural						
LIR						
CBRP	.7309116	.0524991	13.92	0.000	.6280153	.8338079
_cons	.0508473	.0061382	8.28	0.000	.0388166	.062878
LNM2						
CBRP	16.42405	4.103555	4.00	0.000	8.381232	24.46687
_cons	26.18183	.5514292	47.48	0.000	25.10105	27.26261
LNEGYX30						
CBRP	11.71429	3.070325	3.82	0.000	5.696566	17.73202
_cons	7.353604	.4524441	16.25	0.000	6.46683	8.240378
LNEXCR						
CBRP	13.19331	2.006392	6.58	0.000	9.260853	17.12576
_cons	.6861933	.2666347	2.57	0.010	.163599	1.208788
MSCPDSGDP						
CBRP	-.9827136	.4668822	-2.10	0.035	-1.897786	-.0676414
_cons	.4707893	.0655996	7.18	0.000	.3422165	.5993621
IR						
LIR	-3.492709	1.86668	-1.87	0.061	-7.151335	.1659169
LNM2	-.0439417	.0690434	-0.64	0.524	-.1792643	.091381
LNEGYX30	.044888	.0141929	3.16	0.002	.0170704	.0727055
LNEXCR	-.0226733	.0894369	-0.25	0.800	-.1979663	.1526197
MSCPDSGDP	-.0591833	.1874066	-0.32	0.752	-.4264935	.308127
CBRP	4.835367	1.621877	2.98	0.003	1.656546	8.014187
_cons	.9500181	1.827183	0.52	0.603	-2.631196	4.531232
GDPPCGR						
LIR	-.5301002	.3526653	-1.50	0.133	-1.221311	.161111
LNEGYX30	.0206251	.0026076	7.91	0.000	.0155143	.0257358
LNEXCR	-.0092534	.0058565	-1.58	0.114	-.0207319	.002225
MSCPDSGDP	.1510366	.0319266	4.73	0.000	.0884617	.2136115
CBRP	.5132995	.3018804	1.70	0.089	-.0783753	1.104974
_cons	-.1773792	.0427619	-4.15	0.000	-.261191	-.0935674

Source: This SEM was built by the authors using STATA 17.

From table (1), the results confirm that the policy rate is a significant determinant to all mediatory variables and all path coefficients are properly signed. That is, at 1% significance level, an increase of 1% in the central bank policy rate brings about 0.73% increase in the lending interest rate, 16.4% rise in the liquidity, 11.7% increase in assets prices, 13.19% increase in the exchange rate (i.e. the price of the US dollar in terms of Egyptian pounds. But, however, a 1% increase in the policy rate decreases the amount of credit available to the private sector by 0.98% at 5% significance level.

Consequently, this impact of central bank policy rate on the above mediatory variables is transmitted into the inflation rate only through the lending interest rate and assets prices. That is, the path coefficients, illustrated in the second section of table (1), indicate that every 1% rise in the lending interest rate pushes down the inflation rate by 3.4% at a significant level of 10%. The plausible explanation is that the higher lending interest rate increases the cost of borrowing funds which causes a reduction in both consumption and investment which in turn decreases the aggregate demand and at the end mitigates the inflationary pressure. Conversely, at one percent significance level, a 1% increase in assets prices increases the inflation by 0.045%. This result supports the Mundell (1963) and Tobin (1965) point of view, known as "Mundell-Tobin effect MT-E", which predicts that higher inflation forces central bank to increase interest rate, both higher inflation and nominal return induce investors to lower their cash balances in favor of increased real capital formation and nominal assets which increases the demand for those assets pushing up its prices.

From the output side, the GDP per capita growth rate is significantly and positively impacted by both assets prices and the credit available to the private sector. That is, a one percent increase in the assets prices and credit availability causes 0.02% and 0.15% in the GDP growth rate respectively. On the other hand, the direct path running from the policy rate to inflation rate shows a very significant positive impact of 4.84% for every 1% increase in the policy rate. In the meantime, it has a slightly positive effect on the GDP growth rate (at ten percent significancy level) of 0.51.

According to the goodness of fit tests, the proposed SEM has good fitting properties. That is, the probability of the Satorra and Bentler (1994) Satorra-

Bentler scaled statistic is 0.9401, while the p-value of the normal-theory statistic is 0.9515. With a 0.01 significance level, we fail to reject the null hypothesis, indicating good fit using either the normal-theory statistic or the Satorra-Bentler scaled statistic.

LR test of model vs. saturated:	chi2(1) = 0.00	Prob > chi2 = 0.9515
Satorra-Bentler scaled test:	chi2(1) = 0.01	Prob > chi2 = 0.9401

Moreover, when the path coefficients were estimated, as shown in table (1), the standard errors are robust to nonnormality when computing test statistics and confidence intervals for each of these path coefficients. Additionally, numerous goodness-of-fit statistics are derived from the model's chi-squared statistics, table (2) provides adjusted versions of all these statistics as well. Specifically, the RMSEA, CFI, and TLI goodness-of-fit statistics that were computed using the Satorra-Bentler scaled chi-squared statistics are like those based on the normal-theory statistic. Based upon the goodness-of-fit statistics reported in table (2), our model be found to fit well (Pituch & Stevens, 2016).

Table (2): The estimated SEM path coefficients

Fit statistic	Value	Description
Likelihood ratio		
chi2_ms(1)	0.004	model vs. saturated
p > chi2	0.952	
chi2_bs(28)	287.428	baseline vs. saturated
p > chi2	0.000	
Population error		
RMSEA	0.000	Root mean squared error of approximation
90% CI, lower bound	0.000	
upper bound	.	
pclose	0.953	Probability RMSEA <= 0.05
Information criteria		
AIC	-453.886	Akaike's information criterion
BIC	-407.331	Bayesian information criterion
Baseline comparison		
CFI	1.000	Comparative fit index
TLI	1.108	Tucker-Lewis index
Size of residuals		
SRMR	0.000	Standardized root mean squared residual
CD	0.983	Coefficient of determination

Source: Calculated by the authors using STATA 17.

Also, we calculated the residual matrices to confirm the appropriateness of our SEM. Both normalized and standardized residuals seek to modify the residuals in a similar manner. While normalized residuals are consistently valid, they do not conform to a standard normal distribution. In contrast, standardized residuals adhere to a standard normal distribution when they can be computed; if not, they will be represented as missing values. When both types can be computed (indicating their appropriateness), normalized residuals will typically be slightly smaller than their standardized counterparts. As shown in table (3), both normalized and standardized residuals were calculated and are almost zero indicating the appropriateness of the model. Therefore, it was reported that there are no modification indices to report.

Table (3): The SEM residual matrices

Residuals of observed variables

Mean residuals

	LIR	LNM2	LNEGYX30	LNEXCR	MSCPDSGDP	IR	GDPPCGR	CBRP
raw	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000
normalized	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000
standardized	.	-0.000	-0.000	-0.000	-0.000	-0.000	.	0.000

Covariance residuals

	LIR	LNM2	LNEGYX30	LNEXCR	MSCPDSGDP	IR	GDPPCGR	CBRP
LIR	0.000							
LNM2	0.000	-0.000						
LNEGYX30	0.000	-0.000	-0.000					
LNEXCR	0.000	-0.000	-0.000	-0.000				
MSCPDSGDP	-0.000	-0.000	-0.000	-0.000	0.000			
IR	0.000	-0.000	-0.000	-0.000	-0.000	0.000		
GDPPCGR	-0.000	0.000	-0.000	-0.000	0.000	-0.000	-0.000	
CBRP	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000

Normalized covariance residuals

	LIR	LNM2	LNEGYX30	LNEXCR	MSCPDSGDP	IR	GDPPCGR	CBRP
LIR	0.000							
LNM2	0.000	-0.000						
LNEGYX30	0.000	-0.000	-0.000					
LNEXCR	0.000	-0.000	-0.000	-0.000				
MSCPDSGDP	-0.000	-0.000	-0.000	-0.000	0.000			
IR	0.000	-0.001	-0.000	-0.000	-0.000	0.001		
GDPPCGR	-0.000	0.003	-0.000	-0.000	0.000	-0.002	-0.000	
CBRP	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000

Standardized covariance residuals

	LIR	LNM2	LNEGYX30	LNEXCR	MSCPDSGDP	IR	GDPPCGR	CBRP
LIR	0.000							
LNM2	0.000	-0.000						
LNEGYX30	0.000	-0.000	-0.000					
LNEXCR	0.000	-0.000	-0.000	-0.000				
MSCPDSGDP	-0.000	-0.000	-0.000	-0.000	0.000			
IR	0.000	-0.003	-0.000	-0.000	-0.000	0.002		
GDPPCGR	-0.000	0.025	-0.000	-0.000	0.000	-0.011	-0.000	
CBRP	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000

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. estat mindices
(no modification indices to report, all MI values less than 3.841458820694123)
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Source: Calculated by the authors using STATA 17.

Finally, the determination coefficient (R-squared) for the overall SEM is 0.983, which represents significant explanatory power, and it ranges from 0.07 to 0.85 as illustrated in table (4).

Table (3): The R-squared for the estimated

Equation-level goodness of fit

Dependent variables	Fitted	Variance Predicted	Residual	R-squared	mc	mc2
Observed						
LIR	.0005423	.0004635	.0000788	.8547815	.9245439	.8547815
LNM2	1.010091	.2340593	.7760316	.231721	.4813741	.231721
LNEGYX30	.9846235	.1190686	.8655549	.1209281	.3477472	.1209281
LNEXCR	.31374	.1510333	.1627067	.4813964	.6938274	.4813964
MSCPDSGDP	.0127272	.000838	.0118893	.0658394	.2565919	.0658394
IR	.0055556	.0040053	.0015503	.7209491	.8490872	.7209491
GDPPCGR	.0002706	.0001763	.0000942	.6516923	.8072746	.6516923
Overall				.9829148		

mc = Correlation between dependent variable and its prediction.
mc2 = mc^2 is the Bentler-Raykov squared multiple correlation coefficient.

Source: Calculated by the authors using STATA 17.

10.Conclusion and recommendation:

The paper examines whether raising interest rates can effectively combat inflation in Egypt without causing a recession. This question arises amid global inflationary pressures post-COVID-19, where central banks, including Egypt's, have tightened monetary policy. The Central Bank of Egypt (CBE) raised policy rates from 9.75% in March 2022 to 27.25% by March 2024. While inflation initially rose (peaking at 37.4% in August 2023 before declining to 12.25% by February 2025), economic growth slowed from 8.3% in early 2022 to 3.9% in mid-2023. This trade-off between inflation control and growth sustainability forms the core research problem.

The paper also discusses transmission channels (e.g., credit, exchange rates, asset prices) through which monetary policy affects inflation and output. We employed the Structural Equation Modeling (SEM) to analyze direct and indirect relationships between interest rates, inflation, and output in Egypt (1991–2024). Our key findings are:

1) A 1% increase in CBPR raises lending rates by 0.73%, liquidity by 16.4%, and asset prices by 11.7%, but reduces private sector credit by 0.98%.
2) Higher lending rates significantly reduce inflation (-3.4% per 1% increase), supporting the Keynesian view.
3) Asset price increases mildly boost inflation (0.045% per 1% rise), aligning with the Mundell-Tobin effect.
4) Asset prices and private credit positively impact GDP growth (0.02% and 0.15% per 1% increase, respectively).
5) The CBPR's direct effect on growth is marginally positive (0.51%), suggesting limited recessionary risk from policy rate hikes.
6) The CBPR has a strong direct inflationary effect (4.84% per 1% rise), possibly due to expectations or exchange rate pass-through.

The SEM model demonstrates strong explanatory power ($R^2 = 0.983$) and robustness, with fit indices (RMSEA, CFI, TLI) confirming validity. Residual analysis further supports the model's reliability.

Consequently, our policy implications and recommendations to the Egyptian policy makers includes:

1. Central bank policy rate hikes are effective but must be calibrated to avoid excessive credit contraction.
2. Supporting asset markets and private credit can mitigate recession risks.
3. Policymakers should consider indirect channels (e.g., exchange rates, liquidity) to balance inflation and growth.

To sum up, we conclude that while interest rate increases can manage inflation in Egypt, their design must account for multi-channel transmission effects to prevent economic downturns. The SEM approach provides a nuanced understanding of these dynamics, offering a roadmap for targeted monetary policy.

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