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Abstract

This paper investigates the relationship between inflation in and a set of domestic and external factors to provide an assessment of the determinants of inflation dynamics in Egypt. The analysis adopts ordinary least squares (OLS) and quantile regression based on monthly data for headlines and core inflation from 2005 to 2024. A nonlinear auto regressive distributed lag (NARDL) is conducted to explore the asymmetric impacts for determinants in the short run and the long run. Finally, the paper uses forecast analysis within multivariate models to explore the future path of inflation after different shocks in explanatory variables. The results demonstrate that the main significant variables that help explain inflationary pressures are monetary financing, banking sector financing to the government, and the volatility of the exchange rate. There is also an asymmetric effect for exchange rate changes in the short run, where depreciations result in significant increases in inflation. Furthermore, the interest rate tool of monetary policy becomes ineffective at high levels of inflation. This has critical policy implications, shedding light on the role of unconventional monetary policy tools like forward guidance, asset purchases, and term funding facilities in curbing inflation. Priorities for policymaking should include reducing budget deficits, as ensuring a sustainable path of the fiscal deficit would curb the rising inflation. Finally, given the significance of monetary financing and banking sector financing to the government in explaining inflationary pressures, effective implementation of inflation targeting as a framework for monetary policy can contribute to stabilizing inflation rates, as it implies freedom from fiscal dominance and limiting excessive monetary growth.

Keywords: inflation, fiscal dominance, exchange rate, monetary growth, domestic determinants, external determinants, forecasting and simulation

JEL Classifications: E31, E37, E52, E58, E63

ملخص

تبحث هذه الورقة في العلاقة بين التضـــخم في مصرـــ ومجموعة من العوامل الداخلية والخارجية بهدف تقديم تقييم لمحددات ديناميكيات التضـخم في مصرـ. يعتمد التحليل على المربعات الصـغرى العادية (OLS) والانحدار الكمي اسـتنادًا إلى البيانات الشـهرية للعناوين الرئيســـية والتضـــخم الأســـاسي من عام 2005 إلى عام 2024. تم إجراء تأخر توزيع انحداري تلقائي غير خطي (NARDL) لاستكشاف التأثيرات غير المتماثلة للمحددات في الأمد القريب والبعيد. وأخيرا، يستخدم البحث تحليل التوقعات ضمن نماذج متعددة المتغيرات لاسـتكشـاف المسـار المسـتقبلي للتضـخم بعد الصـدمات المختلفة في المتغيرات التفسـيرية. وأظهرت النتائج أن المتغيرات الرئيسية الهامة التي تساعد في تفسير الضغوط التضخمية هي التمويل النقدي، وتمويل القطاع المصرفي للحكومة، وتقلب سعر الصرف. وهناك أيضا تأثير غير متماثل لتغيرات أسعار الصرف في الأمد القريب، حيث تؤدي الانخفاضات إلى زيادات كبيرة في التضخم. علاوة على ذلك، تصبح أداة سعر الفائدة في السياسة النقدية غير فعالة عند مستويات التضخم المرتفعة. وهذا له آثار سياسية حاسمة، إذ يسلط الضوء على دور أدوات السياسة النقدية غير التقليدية مثل التوجيه المستقبلي، وشراء الأصول، وتسهيلات التمويل لأجل محدد في الحد من التضخم. وينبغي أن تشمل أولويات صنع السياسات خفض عجز الموازنة، لأن ضمان مسار مستدام للعجز المالي من شأنه أن يحد من ارتفاع التضـخم. وأخيرا، ونظرا لأهمية التمويل النقدي وتمويل القطاع المصرـفي بالنسـبة للحكومة في تفسـير الضـغوط التضـخمية، فإن التنفيذ الفعال لاسـتهداف التضـخم كإطار للسـياسـة النقدية يمكن أن يسـهم في اسـتقرار معدلات التضـخم، لأنه يعني التحرر من الهيمنة المالية والحد من النمو النقدي المفرط.

1. Introduction

This paper investigates the relationship between headline and core inflation[1] in Egypt since 2003 and a set of domestic and external factors to present a comprehensive assessment of the determinants affecting the inflation rate and their relative importance in explaining inflation dynamics. In light of the growing consensus in the literature that low and stable inflation is critical for promoting sound economic performance, sustainable economic growth, and efficient allocation of resources (Bernanke and Mishkin,1997; Ball and Romer, 2003), it is vital to understand what has caused inflation to design evidence-based policies that would help stabilize inflation rates and ensure a sustainable path for inflation targeting as a framework for monetary policy.

Egypt experienced a decline in inflation from 1996 to 2003, in line with worldwide trends of low and stable inflation since the mid-1990s due to the move towards flexible exchange rate arrangements and the increase in adoption of inflation targeting as a framework for monetary policy. However, the floatation of the Egyptian pound in 2003 led to a sharp peak, at 18% in 2004. From 2005 to 2007 it returned to single digits, but an increase in international commodity prices led to another inflation peak at 23.6% in August 2008. In July 2017 the country's inflation rate had reached 33% and in June 2023 it was 41% following further depreciations in the Egyptian pound in 2016 and 2022 respectively.

Such developments of inflation in Egypt indicated that there have been waves of accelerating inflation in varying time periods, attributed to world commodity prices, global shocks, supply chain disruptions and exchange rate pass through effects. The motivation of this research is to look deeper into these determinants and analyze the weights of the different drivers in explaining inflation dynamics to help achieve a low and stable inflation path.

The paper is structured as follows. Section one below presents previous literature on the determinants of inflation with special emphasis on empirical literature conducted for the Egyptian economy. Section two provides background information and stylized facts about inflation dynamics in Egypt and the relationship between headline and core inflation and each of the determinants identified in literature. Section three presents the empirical methodology framework and model specification. Section four discusses the main findings and their policy implications.

[1] Headline inflation is defined as the percentage change in consumer price index which constitutes a representative basket of consumer goods and services including volatile commodities such as energy and food, while core inflation is adjusted to remove those volatile components.

2. Literature review

The literature on the determinants of inflation is abundant. Historically, numerous research papers focused on the impact of monetary variables, namely money supply and interest rates, on inflation rates. This dates back to Friedman's work (1970) on the quantity theory of money and Taylor's work (1993) on the impact of central banks' policy interest rates on costs of borrowing and spending levels. Numerous studies have focused on the impact of monetary variables on inflation in Egypt specifically. For example, Helmy (2010) found that the rate of growth of money supply explains the bulk of inflation in Egypt. Arbatli and Moriyama (2011) showed that the interest rate channel of monetary policy is relatively weak in Egypt and that high inertia in the policy rate causes interest rates to be pro-cyclical, leading to magnified economic fluctuations. They concluded that supply shocks and inflation expectations primarily determine inflation in Egypt. Hosny's findings (2013) showed that exchange rate depreciation and supply-side bottle necks help explain inflation dynamics in the short run but in the long run money supply and global commodity prices play a larger role. Similarly, El Baz (2014) showed that the inflation rate responds positively to shocks in the inflation rate itself and also to domestic liquidity, output gap, exchange rate depreciation, and world food prices. Sharaf (2015) supported the adoption of inflation targeting as a framework for monetary policy to enhance the credibility of monetary policy and reduce inflation uncertainty. Mohieldin, M. et al. (2024) provide further discussion on the importance of adopting inflation targeting framework as part of economic policy reform, especially after the conclusion of the IMF program in November 2026.

A significant strand of literature focused on the fiscal determinants of inflation and how considerable government spending, fiscal deficit, and high levels of domestic public debt could trigger demand-pull inflation. The fiscal theory of price level emerged from this literature, positing that fiscal policy and the level of government debt primarily determine prices. This contradicts the monetarist view that money supply is the primary determinant of inflation (Sims, 1994 and Woodford 1994). Helmy (2009) and Moriyama (2011) focused on the role of fiscal policies in determining inflation in Egypt. Mariyoma's findings indicate that fiscal consolidation is a key variable to reduce inflation inertia. Similarly, Hashem (2017) found evidence of the prevalence of fiscal dominance in Egypt. The study shows that fiscal shocks, particularly budget deficits, significantly impact the consumer price index. This finding underscores the interplay between fiscal policy and inflation, where high levels of public debt and budget deficits undermine the effectiveness of monetary policy in curbing inflation.

In this context, institutional factors tend to play a significant role in mitigating the impact of fiscal policy on inflation. There is empirical evidence that adopting a fiscal rule prior to inflation targeting as a monetary policy framework tends to constrain money growth to accommodate budget deficits and hence improves inflation outcomes (Dahan and Strawczynski 2013; and Badinger and Reuter 2017). Similarly, other institutional factors attributed to central bank

independence improve inflation performance (Berger et al. 2001; and Klomp and de Haan 2010). Mohieldin and Kouchouk (2003) recommended using the inflation rate, rather than the exchange rate, as an anchor for its monetary policy. Their exchange rate misalignment index found substantial misalignment in Egypt's exchange rate. Youssef (2007) showed the importance of developing sound fiscal, financial, and monetary institutions as a prerequisite for inflation targeting in Egypt, emphasizing the importance of central bank independence to ensure a successful implementation. Similarly, Al-Mashat (2008) noted consolidating the fiscal position and improving the macroeconomic database as areas for improvement for effective implementation of inflation targeting. Abdelraouf, El-Abbadi, and Noureldin (2019) showed that structural and institutional factors, specifically excessive monetary growth and increase in relative price variability, drove rising inflation in Egypt.

Other research work focused on the impact of wages and other cost determinants on inflationary pressures. In this strand the Philips curve framework has been a key tool for analyzing the relationship between unemployment, wage inflation, and overall price inflation. This framework posits an inverse relationship between unemployment and inflation, suggesting that low unemployment leads to higher inflation as labor markets tighten, driving up wage demands and subsequently production costs. These higher costs are often passed on to consumers, resulting in increased prices and thus driving inflation. This wage-price spiral underscores the role of labor market conditions in influencing inflationary pressures. In Egypt, Ali (2011) found that the slope of the Phillips Curve has flattened, denoting the increased importance of other inflation determinants rather than the output gap.

Over the past two decades and particularly after global shocks including the COVID-19 pandemic, inflation dynamics have changed across countries over time even as they rise to unprecedented levels worldwide. Most research on these dynamics has focused on the relative importance of external vs. domestic factors for determining inflation. Studies undertaken in developing countries generally attribute inflation to external factors like global supply chain pressures and world commodity and oil prices. Kia (2006) explained that in small open economies inflation is a function of both internal and external factors especially in the short run while in the long run internal factors, in particular fiscal policies, are more dominant in explaining inflation dynamics. Dees et al. (2007) found evidence that global inflation has a significant impact on domestic inflation. The sensitivity of domestic inflation to global cyclical conditions implies that domestic monetary policy should take into account the impact of such factors to ensure its effectiveness. Similarly, Kia and Sotomoyar (2020) examined the impact of both internal and external factors on inflation in two emerging economies: Egypt and Mexico. Their results show that in both countries both internal and external factors affect the price level in the long run. Further, in both countries, money supply, interest rates, government spending, fiscal deficit, and public debt were the main domestic variables affecting inflation. The external factors significant in the long run included the United States' interest rate and price level. Nachega et al. (2024) also found evidence that the exchange

rate, output gap, and global prices of oil, food, and fertilizers are important long-term determinants of inflation in Gambia.

In sum, the literature demonstrates that the determinants of inflation are multifaceted, involving a combination of monetary, fiscal, and cost-related factors. Research findings emphasized the importance of monetary variables and fiscal variables, while recent studies highlight the growing significance of global factors, particularly in the wake of the COVID-19 pandemic. This study adopts a holistic approach to study inflation dynamics in Egypt by combining all determinants in the analysis. Understanding these determinants is essential for formulating effective monetary and fiscal policies to manage inflation and ensure economic stability. In addition, this work attempts to quantify the impact of exchange rate misalignment on inflation dynamics.

3. Inflation in Egypt

This section provides an overview of the major trends in inflation in Egypt throughout the period from 2005 to 2024 and how the various inflation determinants can help explain the path of inflation. In addition, it looks into a disaggregated analysis of the consumer price index (CPI) components to have a better understanding of inflation dynamics.

3.1. Stylized facts

Egypt started to implement an economic reform and structural adjustment program with the World Bank and the International Monetary Fund (IMF) in the 1990s to improve fiscal and monetary policy. The outcomes of this program were a decline in the inflation rate from 20% in 1990/1991 to 4.1% in 1997/1998 and a significant decrease in the budget deficit to gross domestic product ratio, from 18.2% to 1%. However, due to a series of external and domestic shocks, including the Asian crisis, Luxor incidents, September 11th attacks, and the deterioration of oil prices, macroeconomic indicators started to deteriorate sharply. The monetary authorities then embarked on significant devaluations in 2001 and 2002 respectively in response to these shocks before realizing that the attempts to officially support the Egyptian pound were counterproductive and therefore announcing the floatation of the Egyptian pound in January 2003.

The unavailability of dollars at the official rate and the widening gap between the parallel market rate and the official rate largely drove the abandonment of the managed peg system and the introduction of a flexible exchange rate system. The floatation was thus expected to redirect the flows of hard currency from various sources to the banking system rather than the black market. After the floatation, the pound lost 50% of its value and hence inflation increased to 18% in 2004. Inflation then fell back to single digits soon in 2005 before increasing again in 2006 due to price liberalization and the impact of bird flu on food prices (Youssef, 2007).

Figure (1) shows the domestic and external drivers of inflation from January 2005 to July 2024. Starting with domestic determinants, mainly monetary and banks' financing to the government, Figure (1.1) shows that during periods of 2016-2017, and mid-2022 to early 2023, increases in Central Bank of Egypt (CBE) financing to the government coincide with rises in inflation. This suggests that higher levels of monetary financing were associated with a higher inflation rate. However, this relationship is not consistent throughout the period of the analysis, indicating that other factors might also influence these dynamics, and other empirical tools are required to determine the direction and significance of this relationship. Similarly, there appears to be a positive association between the banks' financing to the government (as a proxy for fiscal deficit/government debt) and inflation.[2] After a time lag inflation increased, especially during the period from 2020 to 2022, showing that the impact of fiscal and monetary policies—particularly excessive government borrowing—led to structural imbalance in the economy. Inflation then rises, if not instantly: it accumulates and appears after a lag.

As for the relationship between output gap and inflation, the graph shows that periods with hiking inflation in July 2008, November 2017, and September 2023 were associated with high percentages of output gap. During these periods, the growth of aggregate demand outpaced the productive capacities measured by aggregate supply, resulting in high levels of inflation.

Moving to external determinants, Figure (1.2) shows that the period between January 2008 and June 2009 witnessed rising inflation, peaking at 23.6% in August 2008 due to the increase in international commodity prices, especially food prices. This period also witnessed an increase in inflation among Egypt's trade partners. The next significant increase in inflation rates was in the period between November 2016 and May 2018. CBE announced it was adopting a flexible exchange rate regime as part of the macroeconomic reform program supported by the IMF Extended Fund Facility (EFF) in November 2016, Bank and the pound depreciated by more than 50%, spurring inflation to reach almost 33% in July 2017. As the announced flexible exchange rate regime did not hold in the face of subsequent shocks, namely COVID-19 and the war in Ukraine, in October 2022, CBE announced once more the adoption of a flexible exchange rate regime as part of its macroeconomic reform program under the second 2022 EFF. The pound again lost more than 50% of its value, causing another spike in inflation, this time to a record 41% in June 2023. As shown in Figure (1.2), a significant parallel market developed in January 2023 that fueled further inflation. CBE again announced its commitment to a flexible exchange rate in March 2024. The pound depreciated again, allowing for a reunification of the exchange rate.

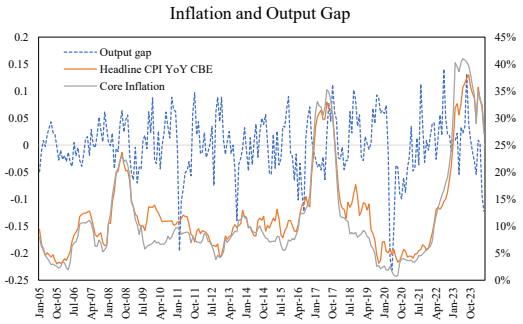
[2] CBE financing to the government is a proxy for monetary financing of public debt and is calculated from the CBE balance sheet as the summation of securities and credit facilities representing claims on the government. Bank financing to the government is a proxy for fiscal deficit as it denotes total borrowing of the government from the banks; it is calculated as the summation of securities and credit facilities owed by the government that is extracted from the banking sector survey.

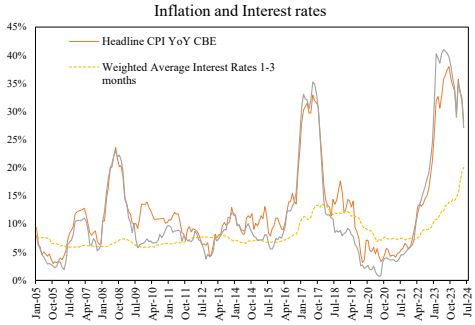
Finally, for the response of monetary policy to the inflation dynamics through the interest rate channel, Figure (1.1) shows that the CBE raised interest rates to curb rising inflation that resulted from repercussions of the global financial crisis in 2008–2009, where the inflation rate reached 23.6% in August 2008, primarily due to rising international commodity prices, especially food. Post-crisis recovery from 2010 to 2016 saw both inflation and interest rates stabilize, with a slight downward trend in inflation initially. Recovery efforts and relatively stable global economic conditions supported this stabilization, allowing interest rates to remain at moderate levels to support economic recovery without igniting inflation. The period from 2016 to 2018 saw significant economic reforms, including the floatation of the Egyptian pound in 2016, which led to a sharp depreciation and subsequent inflation spike, peaking at 33% in July 2017. Correspondingly, interest rates increased to counteract the inflationary pressures from the devaluation.

The COVID-19 pandemic in 2020 resulted in a temporary decline in both inflation and interest rates due to reduced economic activity and demand. Interest rates were lowered to support economic activity during the downturn. However, inflation and rising interest rates returned in 2021, reaching new highs by 2022–2023, reflecting post-pandemic economic recovery, supply chain disruptions, and geopolitical tensions affecting food and energy supply, reflected also in increases in trade partners' inflation. Core inflation's very high levels, exceeding headline inflation, indicate that price increases were entrenched, structural, and attributable to more than volatile commodity prices. Consequently, the CBE raised interest rates to manage the rising inflation. Another sharp increase in inflation began in October 2022 when the CBE allowed the Egyptian pound to depreciate due to foreign currency shortages, leading to an inflation surge that reached 41% in June 2023. Interest rates were subsequently increased to curb the resulting inflationary pressures. This context implies that CBE took adaptive measures to stabilize the economy amidst fluctuating global and local economic conditions.

Figure 1. Headline and core inflation: determinants

Figure 1.1. Domestic determinants





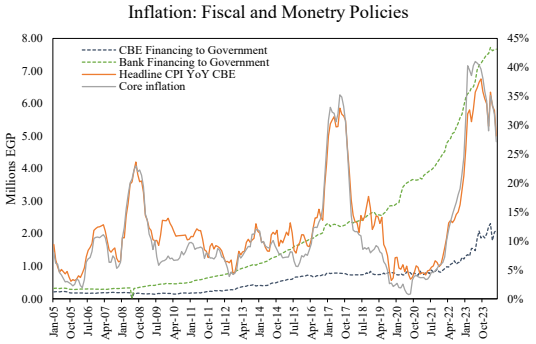
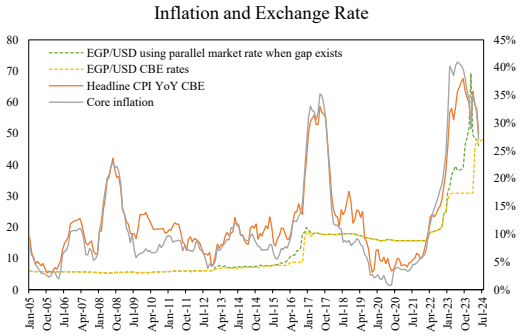
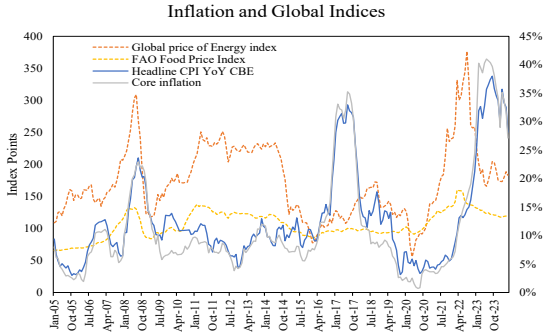
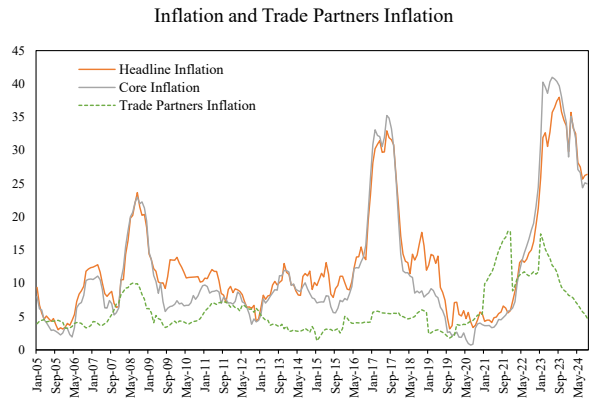


Figure 1.2. External determinants



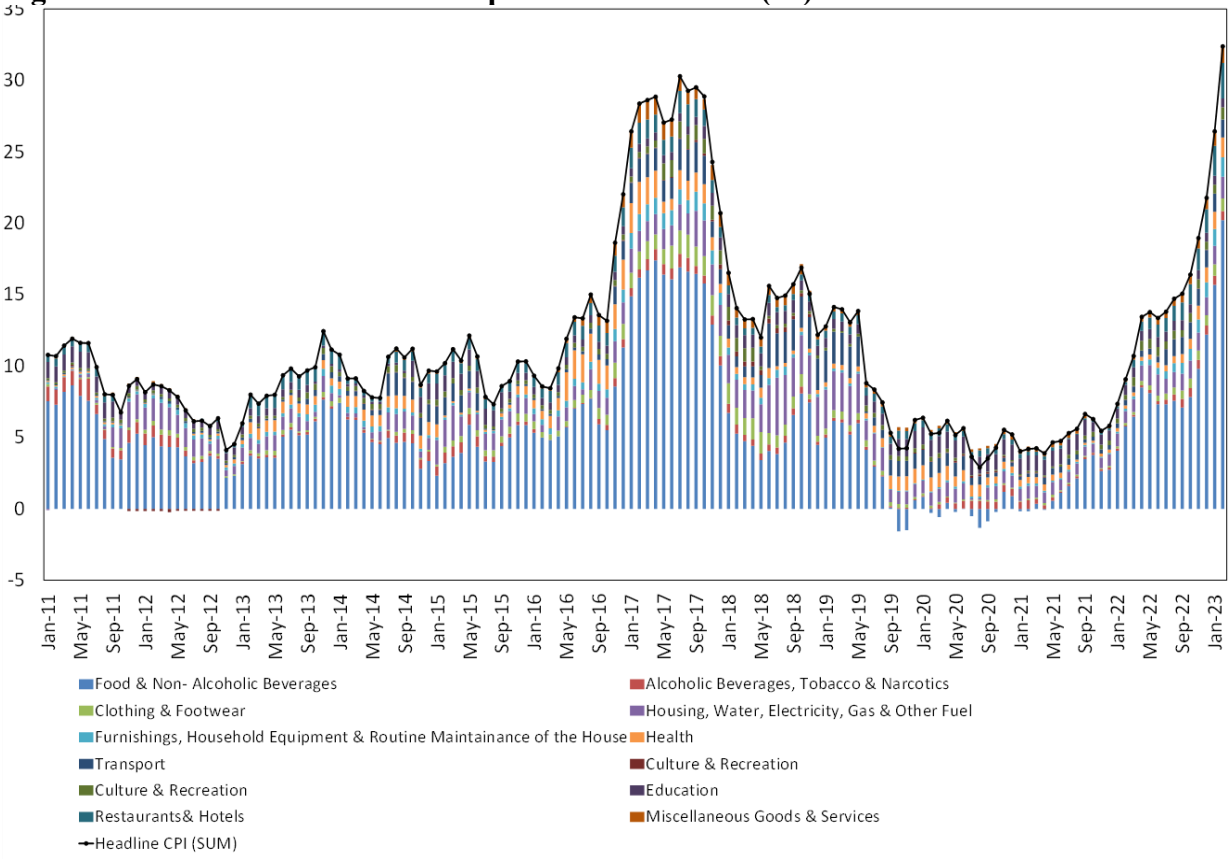




3.2. Disaggregated lens on inflation

The previous section on inflation determinants showed the major trends in the inflation rate and how the inflation dynamics respond to various determinants. This section attempts to dig deeper into the main components of CPI, their relative weights. and how they contribute to inflation. Figure (2) shows that food and non-alcoholic beverages represent the major contributions to inflation, constituting on average 33% of the total CPI basket. The combined impact of housing, water, electricity and other fuel follows, constituting 19% of the CPI basket.

Figure 2. Contributions of CPI components to inflation (%)



A deeper investigation into the relationship between food and non-alcoholic beverages on one hand and housing, water, electricity and other fuel on the other and global prices through Egypt's trade balance shows the heavy weight of imported foods in the overall food basket. These include wheat, maize, animal & vegetable fats, and lastly, meat and offals. These represent 27%, 25%, 17%, and 13% of the total volume of imports on average respectively. Figure (3) plots the food & non-alcoholic beverages component of the CPI against subcomponents in the FAO Prices Index to show their correlation. It is evident that the food component increased sharply throughout the period from 2016 to 2018 due to the exchange rate passthrough effect despite the relative stability in the trend of world cereal, meat, and oil prices.

Figure 3. Disaggregated analysis: CPI components & FAO index commodities

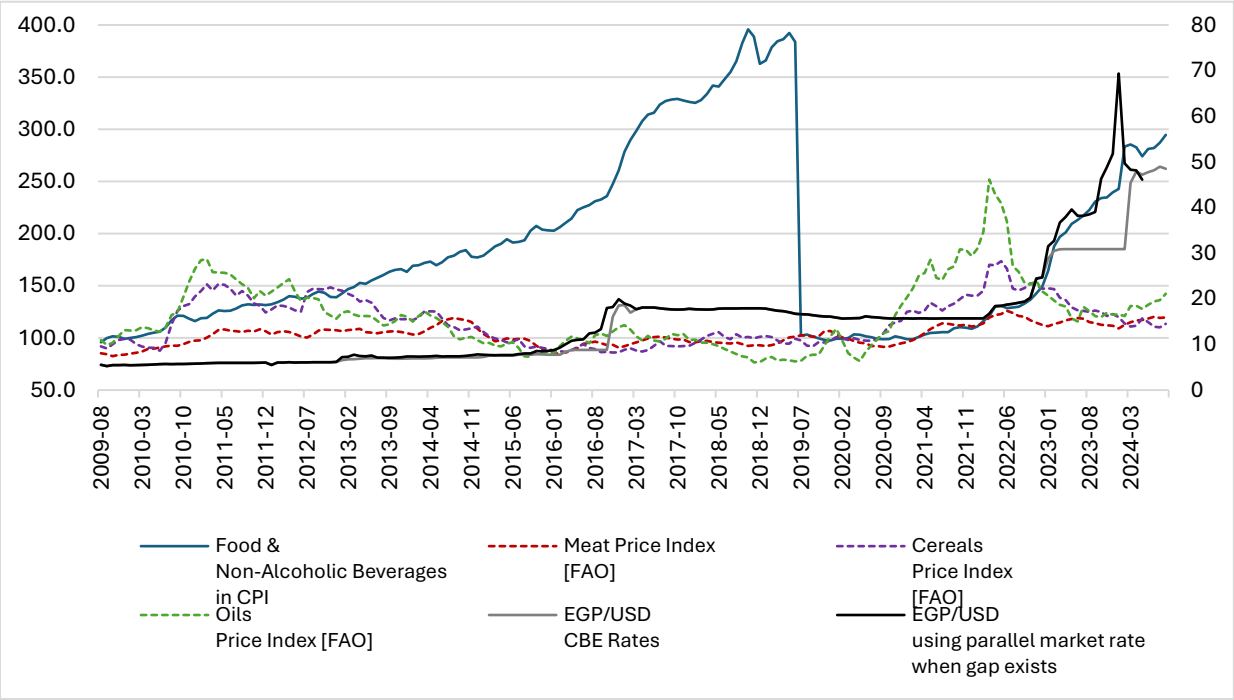
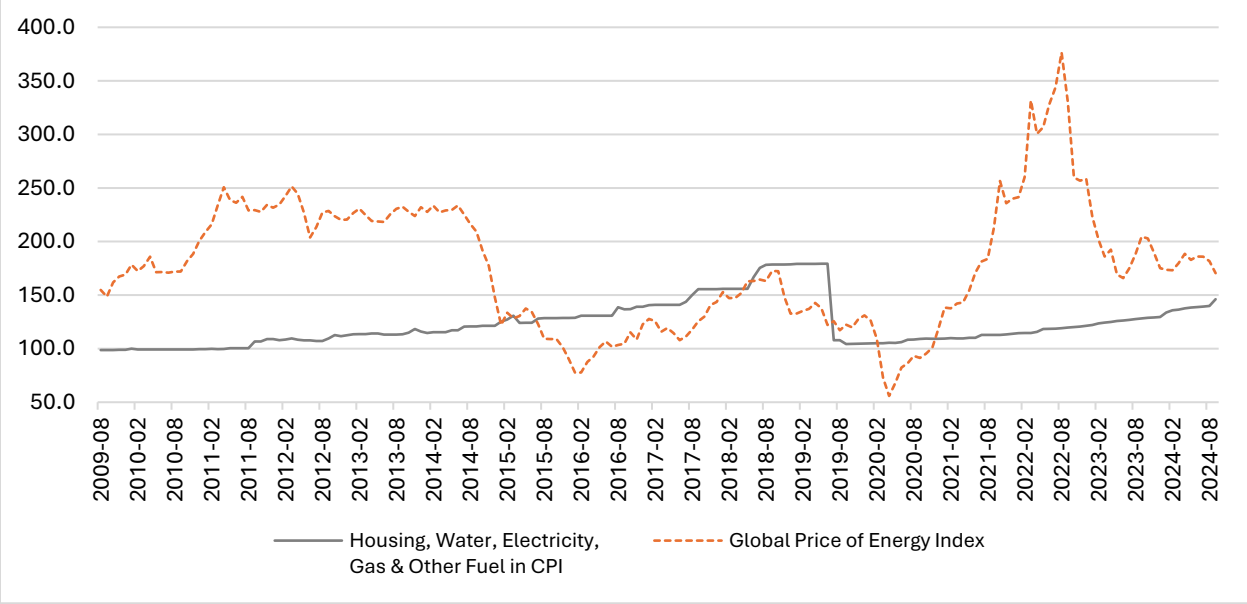


Figure (4) plots the housing, water, electricity, gas & other fuel component in the CPI against the global prices of energy index to demonstrate their correlation. The correlation seems low. Energy prices in Egypt are administered, which limits the domestic price response to international price fluctuations.

Figure 4. Disaggregated analysis: CPI components & global energy prices index



4. Empirical methodology: model specification and results

Three types of econometric modeling were conducted to explore the main determinants of inflation in Egypt. Firstly, we estimated ordinary least squares (OLS) and quantile regression based on monthly data from January 2005 to September 2024. Second, a nonlinear auto regressive distributed lag (NARDL) was conducted to explore the asymmetric impacts for determinants over the short run and the long run. Third, we explored impulse response functions based on a local projection model with different scenarios of shocks in the main determinants.

4.1. Variable motivation and data sources

The variables utilized in the analysis are in line with the empirical literature that investigated domestic and external determinants of inflation (Kia, 2006; Kia and Sotomoyar, 2020; Nachega et al., 2024). For domestic determinants, the variables reflect the fiscal and monetary financing in addition to interest rates and the output gap. While external factors reflect trade and financial linkages by relying on trade partners' inflation, exchange rates and global indices prices as proxies. The sources of data utilized in the analysis are CBE balance sheet and banking survey data for CBE and bank finance variables, as explained above. Main trade partners' inflation rates were calculated based on the World Bank database, and energy prices were measured by the IMF Energy Index. CBE time series data was used for headline, core inflation, interest rate, and official exchange rate. Haver Analytics and the Bloomberg database were used for the parallel market exchange rate. The output gap was calculated based on the industrial production index data by using the Hodrick-Prescott Filtering method. The researchers account for structural breaks by adding dummies for the 2011 revolution, the 2016 exchange rate devaluation, and the 2020 COVID-19 pandemic. Table (1) summarizes all data sources and variable definitions.

Table 1. Data sources and variable definitions

Variable	Source	Definition
Headline Inflation	CBE time series data	The percentage change in the consumer price index which constitutes a representative basket of consumer goods and services including volatile commodities such as energy and food.
Core Inflation	CBE time series data	The percentage change in consumer price index adjusted to remove volatile components in the basket.
Global food price index	World Bank database	Value represents the benchmark prices which are representative of the global market. They are determined by the largest exporter of a given commodity. Prices are period averages in nominal U.S. dollars.
Main trade partners	World Bank database	Inflation based on main trade partners.
Energy price index	IMF Energy Index	Indices that are commonly used to calculate prices for oil, natural gas and electricity transactions
Interest rate	CBE time series data	Weighted Average Interest Rates 1-3 months.
Exchange rate level	CBE	Number of Egyptian pounds equivalent to one US dollar.
industrial production index	Ministry of planning. Economic Development and International Cooperation	The industrial production index (IPI) measures levels of production and capacity in the manufacturing, mining, electric, and gas industries, relative to a base year.
Bank financing to the government	CBE	It is a proxy for fiscal deficit as it denotes total borrowing of the government from the banks; it is calculated as the summation of securities and credit facilities owed by the government that is extracted from the banking sector survey.
CBE financing to the government.	CBE	It is a proxy for monetary financing of public debt and is calculated from the CBE balance sheet as the summation of securities and credit facilities representing claims on the government.

4.2. Methodology

The study utilized Autoregressive Distributed Lag Model (ARDL) which can be used regardless of the integration level as it can include time series integrated of order zero or one (Engle and Granger, 1987; Hassler and Wolters, 2006). However, Nonlinear effect might cite that positive changes have different effects than negative effects which are known as asymmetric effect of the relationship. To explore this asymmetric effect over positive and negative changes, we utilize the following modeling equation which can be formulated based on (Shin et al., 2014):

$$Y_t = \beta^+ w_t + \beta^- w_t + u_t \quad (1)$$

$$\Delta w_t = v_t$$

$$w_t^+ = \sum_{j=1}^{t} \Delta w_j^+ - \sum_{j=1}^{t} \max(\Delta w_j, 0), \; w_t^- = \sum_{j=1}^{t} \Delta w_j^- - \sum_{j=1}^{t} \min(\Delta w_j, 0) \quad (2)$$

where w_t^+ denotes positive changes and w_t^- is negative changes.

Additionally, the study adopted also the Quantile regression which is introduced by Koenker and Basset (1978), and it estimates the relation over the whole distribution.

$$Q_{y|w}(\tau) = \inf\{b | F_{y|w}(b) \geq \tau\} = x' \gamma(\tau) \quad (3)$$

Where, y as a dependent variable and W as a regressor, $Q_{y|x}(\tau)$ is the conditional quantile for the relation, and $0 < \tau < 1$, $\gamma(\tau)$ is the coefficient for the relationship. The coefficients might be extracted by the following equation:

$$\hat{\gamma}(\tau) = \arg min_{\gamma(\tau)} \sum_{i=1}^{n} \rho_\tau(y_i - w' \gamma(\tau)) \quad (4)$$

Where ε_i refers to the error component.

4.3. OLS results and quantile regression

OLS estimations and the quantile regression reveal that inflation in Egypt has been highly persistent. The first and the twelfth lags have significant effects. The main determinants of inflation in Egypt are exchange rate movements, monetary financing, and banks' financing to the government.

Annex Table A1 demonstrates the results of the OLS and quantile regressions. These can be summarized as follows:

- Monetary financing significantly increases inflation: If central bank financing rises by 1%, inflation will increase by 3.88%.

- Banks' finance significantly increases inflation: If banks' finance increases by 1%, inflation will increase by 9%. Moreover, quantile regression shows that banking finance is significant over the low and high quantiles.
- The output gap does not have a significant effect on inflation. However, quantile regression (with a quantile 90%) implies that the business cycle has a significant effect on inflation in Egypt, which implies that the pass-through of real side to prices is considerable during periods of high inflation, greater than in periods of mean or low levels of inflation.
- Energy prices do not have a significant effect on inflation in Egypt. This could be because energy prices in Egypt are administered and do not reflect global energy prices. However, quantile regression shows it is significantly positive, with quantiles over 90%.
- Trade partners' inflation rates have a significant positive effect on inflation in Egypt and the quantile regression shows that trade partners' inflation rates have a significant positive effect over the quantile sets, ranging from 10% to 90%,
- The effect of changes in monetary policy is insignificant. However, quantile regression reveals that it has a negative effect only over the quantile set 10%. This indicates that monetary policy can only play a significant role when inflation is low (Table A3).

Given the significance of monetary financing in shaping inflation dynamics, the effective implementation of inflation targeting is a key factor in stabilizing inflation as it entails consolidating the fiscal position, freedom from fiscal dominance, and limiting excessive monetary growth. It would also ensure that the CBE looks ahead and tightens monetary policy before inflation becomes too intense, which is an important factor as the model shows that the interest rate channel is effective only at low levels of inflation.

4.4. The non-linear long run effect

We conducted linear and non-linear cointegration analysis for the main determinants of inflation in Egypt. Unit root test (Table 2) shows some variables, such as inflation, exchange rate, monetary policy, monetary financing, and global price index, are stationary in first difference. In contrast other variables such as domestic output gap, bank finance to the government, and energy prices, are stationary in level. This indicates that the NARDL approach is a suitable modeling technique for data analysis. NARDL supplies the analysis over both the short run and the long run time horizons, and it is useful as a non-linear approach because an asymmetric impact on inflation is likely. Table (A4) demonstrates that there is a nonlinear cointegration relationship between the variables throughout the study period.

Table (A5) shows that considering the nonlinear effect of monetary financing indicates that monetary financing has an asymmetric effect on inflation as the effect of negative shocks have stronger effect than positive shocks. This implies that when monetary financing decreases, inflation also decreases. This suggests it is an effective policy tool for curbing inflation. The same

table also indicates that the exchange rate has an asymmetric effect on inflation in Egypt: negative changes have no significant impact, but positive changes have considerable impacts. This might reflect behavior of producers who immediately increase prices if there is news about an exchange rate depreciation but who do not cut prices in cases of exchange rate appreciation. Changes in interest rates also have an asymmetric effect on inflation. When the interest rate is decreased, inflation significantly responds positively but if the interest rate increased, inflation does not significantly respond. Furthermore, Table (A5) shows that increases in inflation in main trade partners cause an increase in domestic inflation but decreases in trading partner inflation rates have no effect.

4.5. Short-run cointegration effect

Changes in the time lag, changes in banks' financing to the government, changes in monetary financing, changes in the exchange rate, changes in main trade partners' inflation, and global energy prices primarily determine the short-run impact of inflation. Table (A6) shows that the cointegration vector is equal to -0.13 with a significant probability. This indicates that the model is stable and goes back to the equilibrium point following any deviations. Changes in inflation lag with the first round have a positive significant effect on inflation in the short run. Changes in monetary financing and banks' financing to the government have a significant effect in the case of both positive and negative changes. In line with OLS regression results, there is an asymmetric effect in exchange rate changes over the short run: Only depreciations cause inflation to increase significantly while appreciations do not have considerable impact.

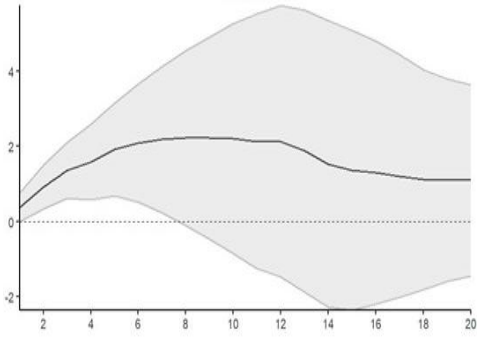
Furthermore, increases in the interest rate do not have significant impact on inflation in the short run, contracting monetary literature. Considerable impact on inflation from monetary policy only emerges over time. Finally, main trade partners' inflation and global energy prices have an asymmetric effect on inflation in Egypt as only trade partners' inflation increases boost domestic inflation.

4.6. Impulse response function to shocks by local projection model

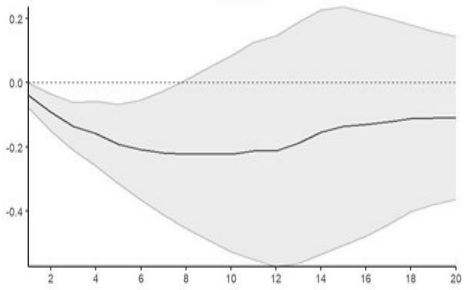
Impulse response functions emphasize the asymmetric effect of exchange rate movements and nonlinearity of the effect of exchange rate depreciation on inflation in Egypt. We have three scenarios for exchange rate shocks, illustrated in Figure (5). The first scenario is a 1% increase in the exchange rate of EGP/USD. Inflation rises 2% after 12 months and 1.5% after 24 months. In contrast, in the second scenario, with a 1% appreciation, inflation in Egypt falls by only 0.2% after 12 months and only 0.1% after 24 months. The third scenario is a stronger depreciation. A 10% deprecation in the value of Egyptian pound causes inflation to increase by around 4% after 12 months and about 2% after 24 months, confirming the nonlinearity in the effect of exchange rate movements on inflation.

Figure 5. Exchange rate pass-through to inflation

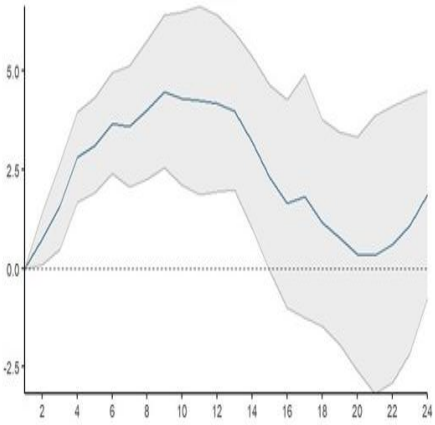
A. Depreciation shock



B. Appreciation shock



C. Larger depreciation shock



Source: estimated by authors.

Note: The gray shaded area represents the 95 percent confidence interval of the estimated pass-through coefficients.

5. Forecast within multivariate model

This section illustrates a forecast model for the inflation rate which we used to test the impact of various scenarios on the inflation rate path. Based on the existence of a cointegration relationship between augmented variables, we can estimate a vector error correction model (VECM) which can be written as follows:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \gamma_2 \Delta Y_{t-2} + \varepsilon_t$$

where Y_t implies endogenous variables.

After estimating the VECM, we can capture unconditional forecasts based on historical data. Then, conditional forecast can be established based on the assumption of a specific scenario. We explore different scenarios for the exchange rate like moderate depreciation and appreciation, exogenous shocks, and increases in monetary financing and banks' financing to the government, below.

Estimations were conducted for the period from 2005m01 to 2023m06. We used the period 2023m07 to 2024m09 for forecast evaluation. Finally, we conducted out-of-sample forecast beyond the available data for the period 2024m10 to 2026m09 under different policy scenarios. Based on Figure (6) and evaluation criteria for in-sample forecasts, we can deduce that the model has an acceptable prediction power.

Figure 6. In-sample forecast for some variables for the period 2023m07 to 2024m07

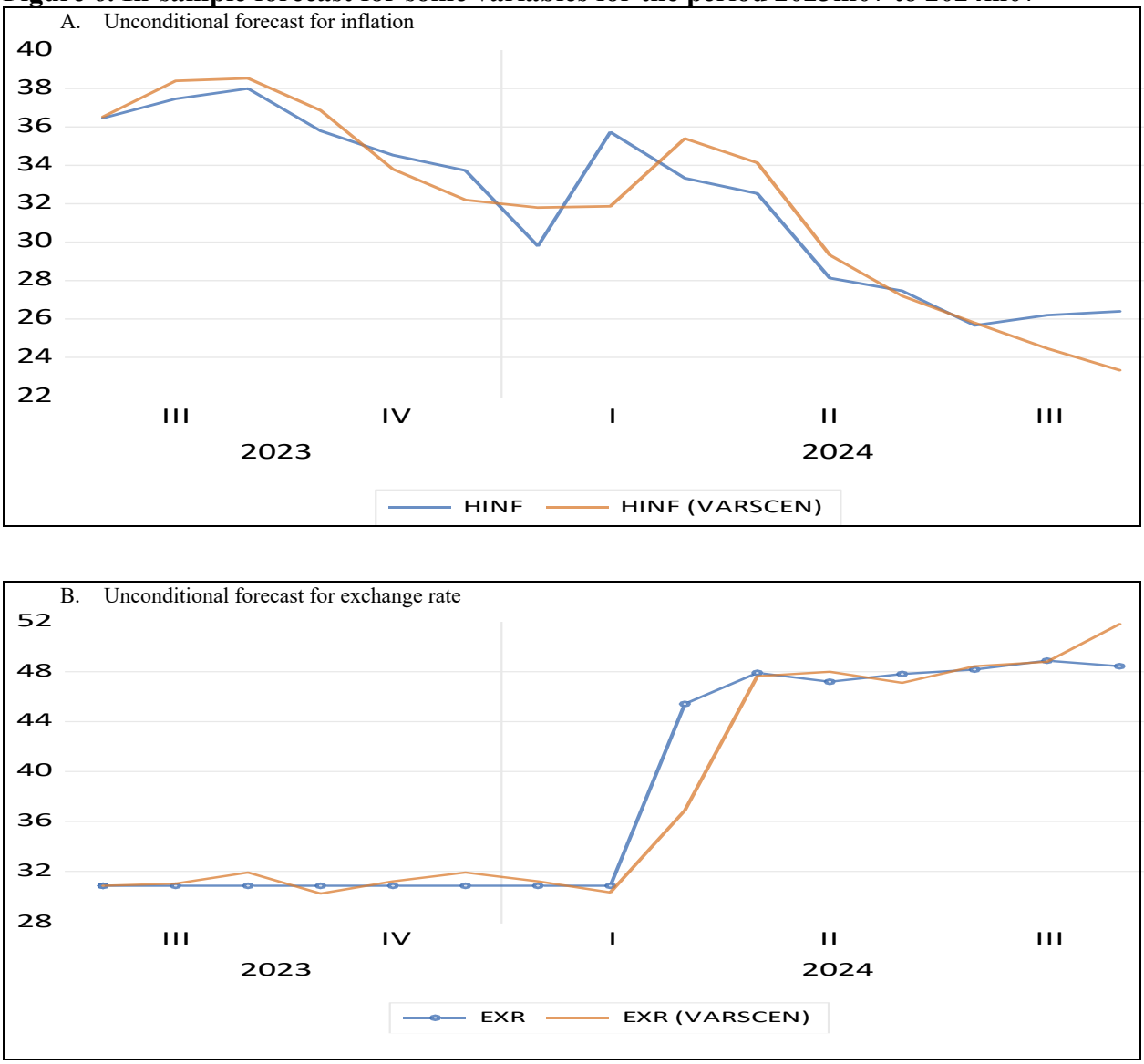
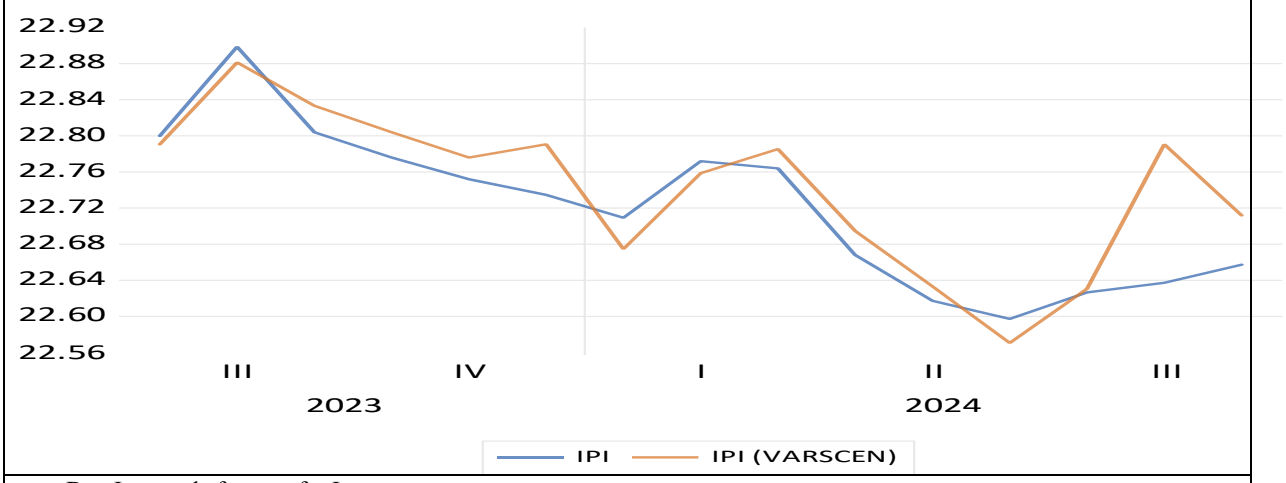
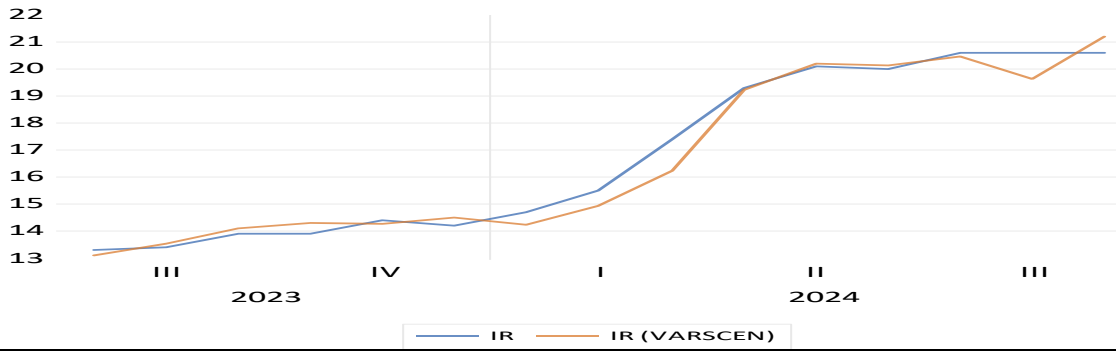


Figure 6. In-sample forecast for some variables for the period 2023m07 to 2024m07 (Continued)

C. In-sample forecast for Industrial production



D. In-sample forecast for Interest rate

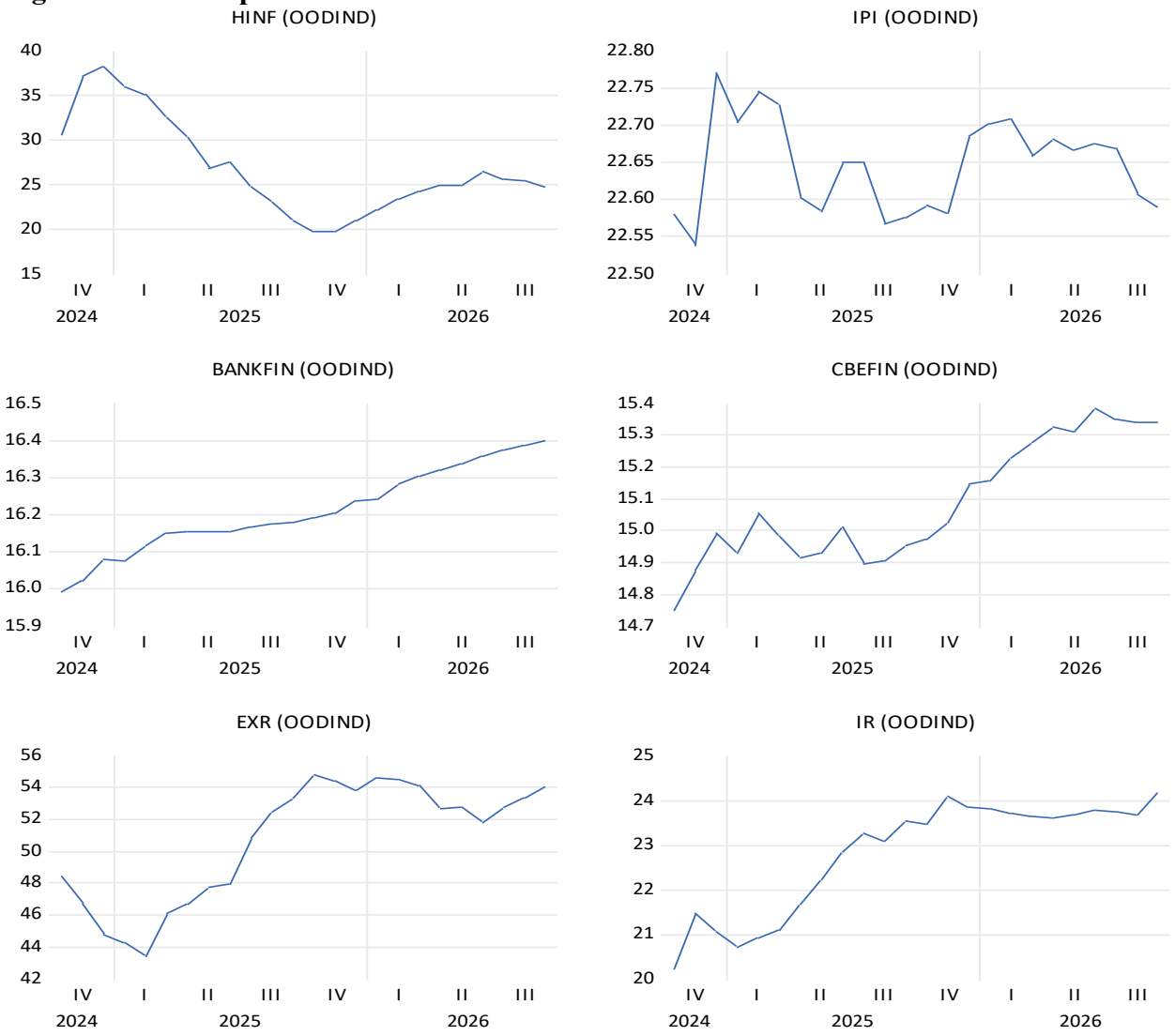


Source: Estimated by authors.

Note: HINF is actual headline inflation while HINF (VARSCEN) is predicted headline inflation; exr is actual exchange rate while exr (VARSCEN) is the predicted exchange rate; IR is the actual interest rate while IR(VARSCEN) is the predicted interest rate.

Moving to out-sample forecasts, we run multiple scenarios starting with an unconditional prediction, which is a function of the given historical data. Based on this scenario, inflation is expected to continue to increase during the coming two years, partially due to the depreciation in the value of Egyptian pound of the last few years. However, by the end of the first quarter in 2025, inflation is expected to decrease to around 20%. This will push monetary policy to keep interest rates at high levels, above 20%, which will in turn have a negative impact on industrial production.

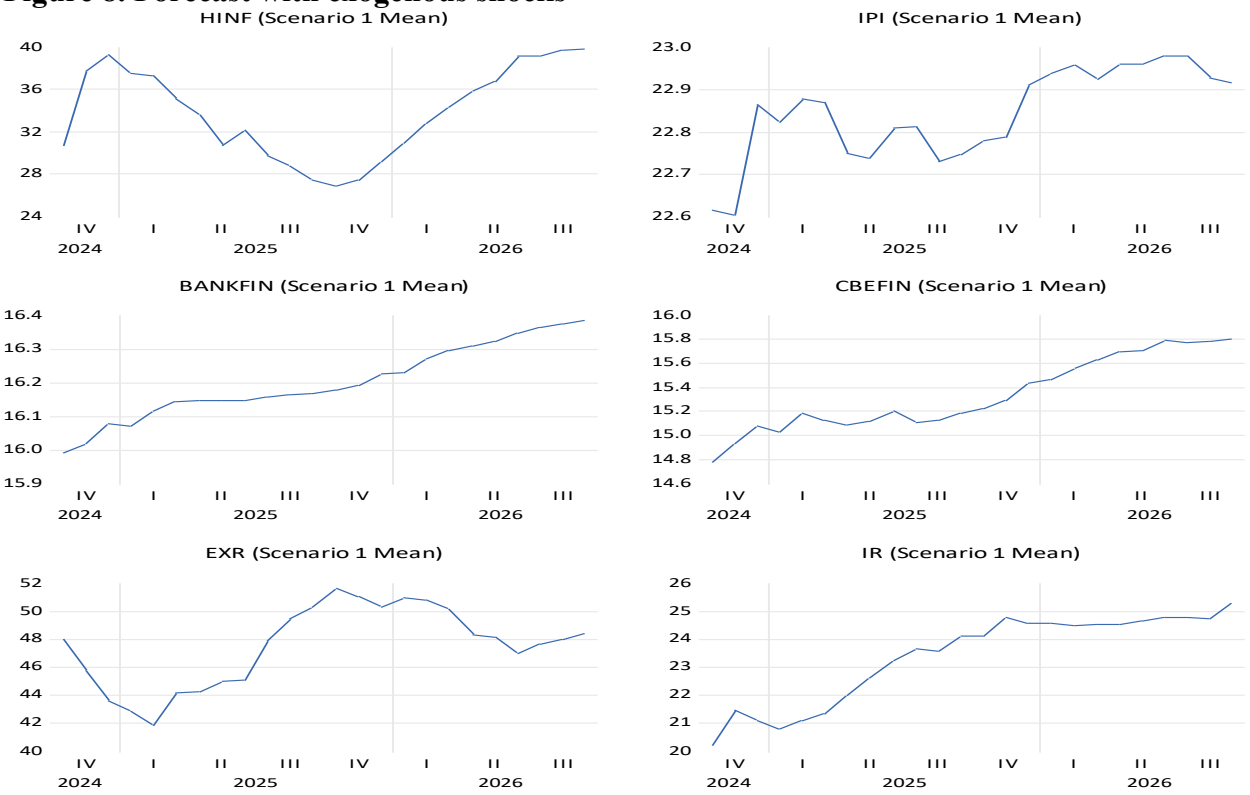
Figure 7. Out-sample forecast



Note: HINF(OODIND) is the predicted headline inflation; IPI((OODIND) is the predicted industrial production prediction; BANKFIN(OODIND) is the predicted banking finance; CBEFIN(OODIND) is the predicted CBE finance; exr (OODIND) is the predicted exchange rate; IR(OODIND)is the predicted interest rate.

The second scenario shows that assuming a 5%, increase in the exogenous shocks, inflation is expected to increase significantly to around 40% at end-2026. The CBE is expected to respond by raising interest rates further, which will in turn have a negative effect on industrial production. This implies that the effects of exogenous socks on domestic variables are persistent to the end of the period under study.

Figure 8. Forecast with exogenous shocks



The third scenario shown in Figure (9) gives warning signals about the high cost of exchange rate depreciation. If the value of the Egyptian pound depreciates by 5% for each year, the country would experience persistent hyperinflation exceeding 40% in 2026. Even more alarming is the fact that monetary policy would become ineffective, as CBE would be unable to cut inflation pressures, even if it raised interest rates by 10%.

Figure 9. Forecast with exchange rate shock

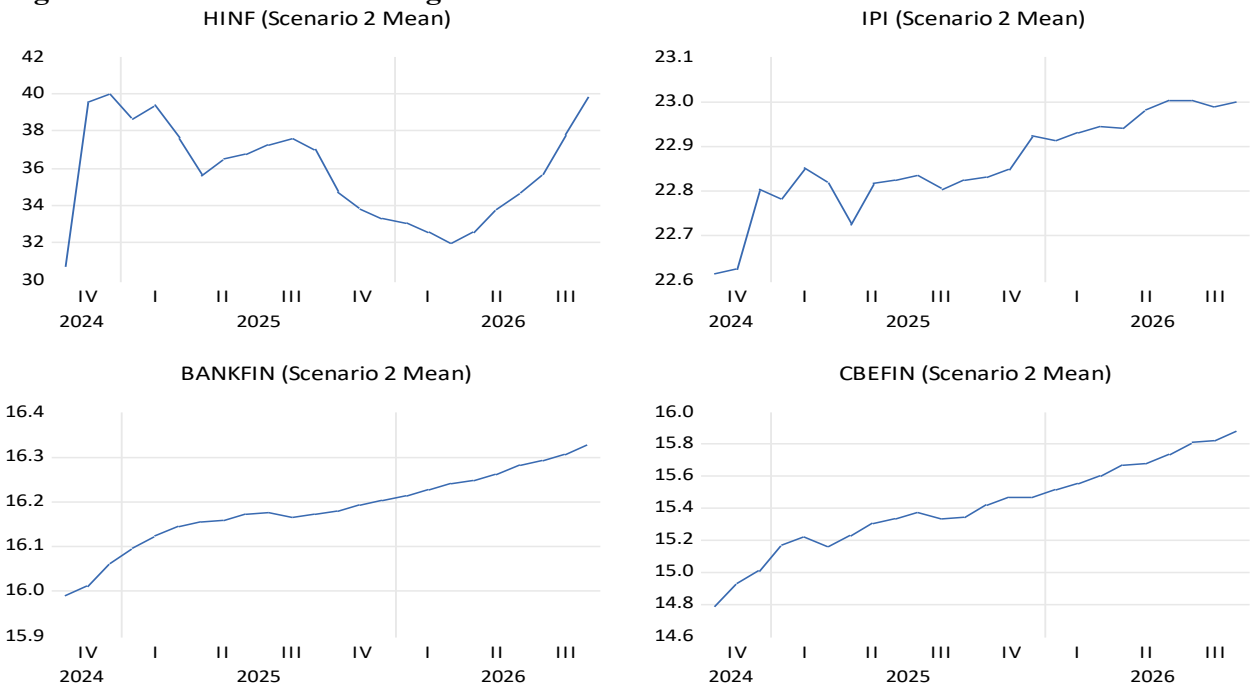
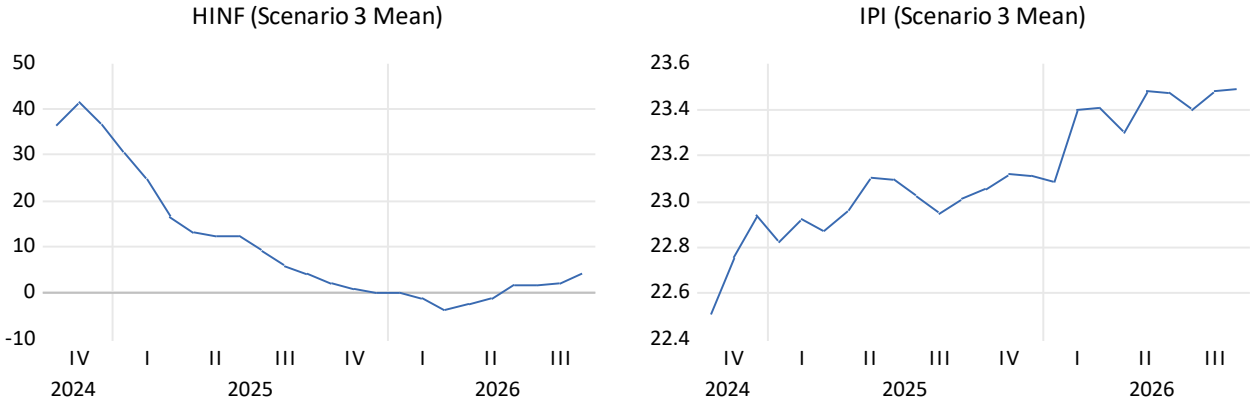


Figure (10) shows the impact of decreasing monetary financing to the government by 5% each year. As it shows, inflation decreases to reach 13% by mid-2025 and 4% in Sep 2026. This implies that limiting excessive monetary growth and decreasing the issuance of T-bills and bonds contributes greatly to curbing inflationary pressures.

Figure 10. Forecast with exchange rate shock with more aggressive policy



Although the value of exchange rate would appreciate, inflation is still increasing (Figure (11)). This again highlights the asymmetrical impact of movements in the exchange rate, with appreciations having a limited impact on inflation. It also highlights the stickiness and rigidities of prices despite a mild appreciation of the exchange rate. For the appreciation to be effective in

stabilizing inflation, it must be significant and sustainable. If there is a 25% appreciation in the value of the Egyptian pound, inflation will reach zero or even disinflation in mid-2025.

Figure 11. Conditional forecast assuming appreciation exchange rate

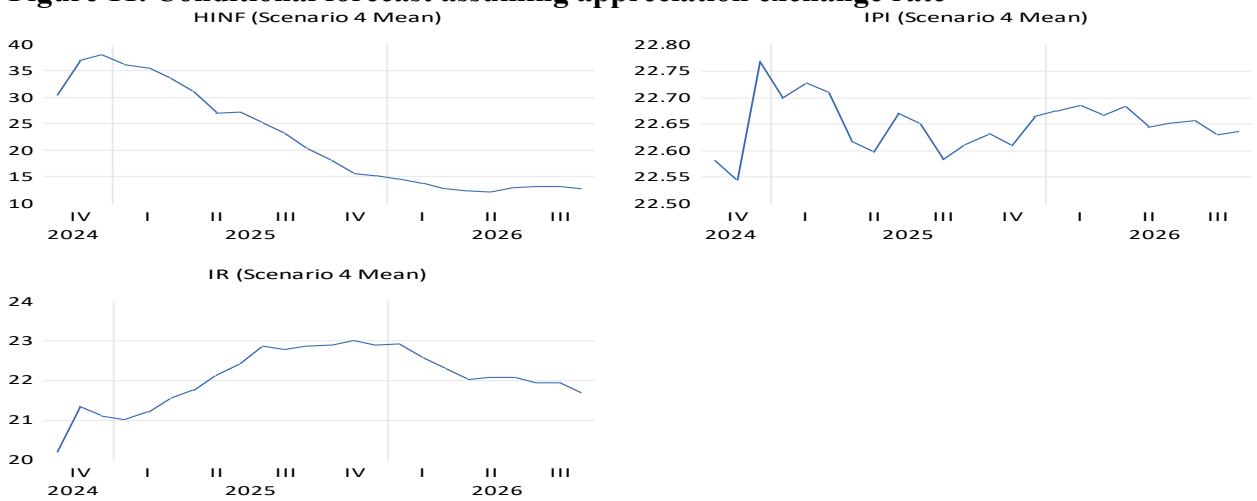
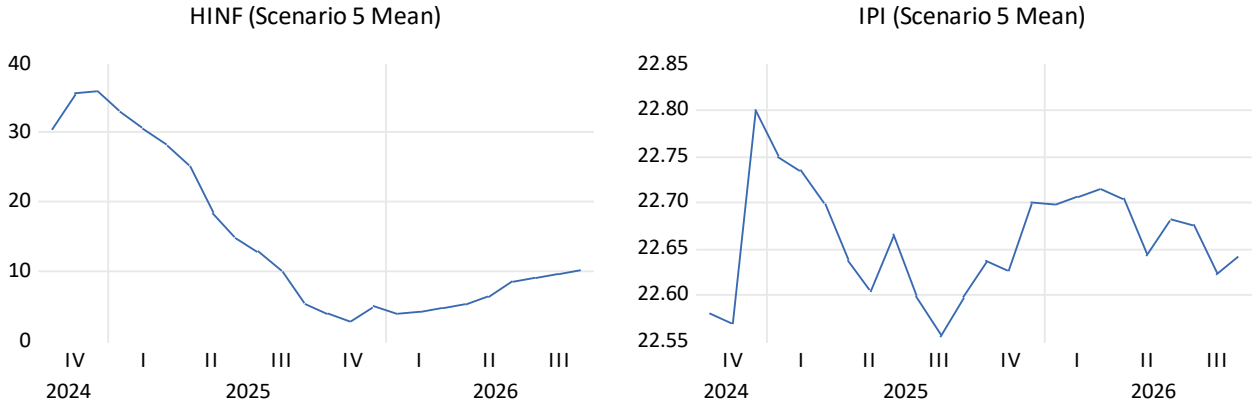
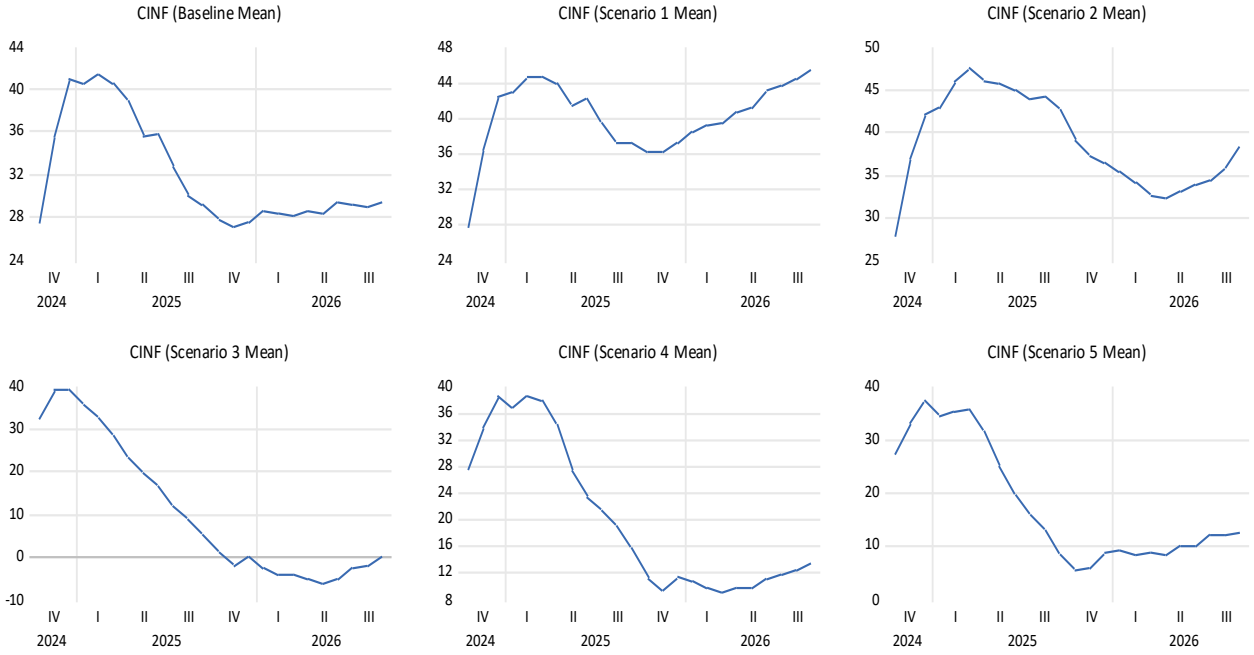


Figure 12. Forecast with more appreciation in exchange rate



To analyze the robustness of our analysis of the four scenarios, we conduct the same analysis using core inflation instead of headline inflation. Findings are aligned, showing that both exogenous shocks and exchange rate devaluations have significant effects on inflation. In addition, monetary policy has minimal capacity to stop inflationary pressures while consistent fiscal policy, through decreasing the amount of credit that the government depends on to manage cash flow shortages, is an important factor in reducing inflation. Furthermore, appreciation in the Egyptian pound is only likely to reduce inflation if it is considerable.

Figure 13. Forecast of core inflation under different scenarios



6. Conclusion and policy implications

This paper offers an empirical analysis of inflation determinants in Egypt. It demonstrates that both domestic and external factors explain the current high inflation rates. The main significant variables that help explain inflationary pressures are monetary financing, banking sector financing to the government, and the volatility of the exchange rate. Results also show that conventional monetary policy tools such as interest rates are not effective, in periods of high inflation, in curbing inflationary pressures. This finding provides insights as to the need to utilize unconventional monetary policy tools to curb inflation, especially in periods of crises and significant economic shocks. The CBE needs to examine how those tools can enhance inflation dynamics and predictability. This includes forward guidance to reduce uncertainty, asset purchases, and term funding facilities by providing low-cost, long-term funding to financial institutions and hence incentivizing banks to lend to businesses and households. The model findings that banks' financing to the government results in higher inflation provides further support; policies need to be directed towards tools that CBE can provide to the banks to encourage them to finance business and the household sector both to boost private sector–led growth and to stabilize inflation.

Priority areas for policymaking include reducing budget deficits, as ensuring a sustainable path of the fiscal deficit will help curb the rising inflation. Controlling the amount of money supply will also contribute to stabilizing the inflation rate. Furthermore, enacting the policies that would ensure increased foreign currency flows whether through foreign direct investment, remittances, and other channels of generating foreign currency will be crucial to avoid further depreciations in the exchange rate that tend to have significant inflationary effects. The utilized forecast model also

confirms these findings and shows the significant impact of exchange rate on inflationary pressures.

Given the significance of monetary financing and banking sector financing to the government in explaining inflationary pressures, it is worth noting that the effective implementation of inflation targeting as a framework for monetary policy would contribute greatly to stabilizing inflation rates. The adoption of a sound inflation targeting framework implies freedom from fiscal dominance and the willingness and ability of CBE not to target other nominal anchors like the exchange rate. It also implies limiting excessive monetary growth and adopting a future-looking approach by utilizing monetary policy instruments before inflation becomes so persistent and high. This is crucial, as the results showed that at high levels of inflation, monetary policy loses its effectiveness.

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Table A1. OLS Regressions of inflation of Egypt and its determinants

Banal A. OLS Regressions of Headline Inflation of Egypt and Its Determinants						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
D(INF (t-2))	0.12(0.05)*	0.125 0.05)*	0.14(0.02)**	0.14(0.00)***	0.187(0.00)**	0.17(0.00)***
D(INF(t-12))	-0.35(0.00)***	-0.3(0.00)***	-0.35(0.00)***	-0.3(0.00)***	-0.30(0.00)**	-0.3(0.00)***
D(CBEFIN(-1))		3.88(0.04)**	4.35(0.03)**	3.80(0.02)**	4.96(0.01)**	4.9(0.01)**
BankFIN		9.3 (0.1)	11.43 (0.04)	11.19 (0.05)	10 (0.07)	11.1 (0.04)
D(EXR)			(0.19)(0.03)**	0.19(0.00)***	0.33(0.00)***	0.33(0.00)***
OG				0.79(0.472)	1.18(0.54)	1.5(0.45)
D(IR(-4))					-0.66(0.1)	-0.56(0.17)
D(tpinf)						8.8(0.04)**
D(energyinf)						0.012 (0.09)*
D11	0.019(0.19)	-0.059(0.76)	-0.07(0.27)	-0.071(0.27)	-0.07(0.27)	-0.07(0.27)
D16	-0.2(0.54)	-0.135(0.65)	-0.14(0.16)	-0.13(0.16)	-0.12(0.16)	-0.12(0.16)
D20	0.94(0.00)***	0.87(0.01)**	0.072(0.01)**	0.072(0.01)**	0.07(0.01)**	0.07(0.01)**
N	220	220	220	220	220	220
Log-Lokelihood	-417	-417.4	-415	-413	-412	-411
Banal B. OLS Regressions of Core Inflation of Egypt and Its Determinants						
D(INF (t-2))	0.20(0.00)***	0.2(0.00)***	0.22(0.00)	0.22(0.00)***	0.20(0.00)**	0.18(0.00)***
D(INF(t-12))	-0.2(0.00)***	-0.22(0.00)***	-0.26(0.00)***	-0.2(0.00)***	-0.27(0.00)**	-0.2(0.00)***
D(CBEFIN(-1))		4.1(0.03)**	0.034(0.9)**	0.08(0.9)	-0.15(0.93)	0.23(0.1)
BankFin		5.2 (0.26)	3.04 (0.02)	10.9 (0.1	10.8 (0.11)	11.1 (0.1)
D(EXR)			0.26)(0.00)***	0.26(0.00)***	0.26(0.01)**	0.22(0.03)**
OG				1.45(0.472)	2.26(0.1)	2.2(0.03)**
D(IR)					-0.95(0.01)**	-0.81(0.03)
D(tpinf)						0.28(0.00)**
D(energyinf)						0.005 (0.4)
D11	0.05(0.19)	-0.02(0.76)	0.04(0.27)	-0.05(0.78)	-0.08(0.27)	0.8(0.6)
D16	-0.27(0.34)	-0.19(0.65)	-0.26(0.16)	-0.29(0.32)	-0.33(0.16)	-0.36(0.16)
D20	0.81(0.02)**	0.7(0.04)**	0.072(0.06)**	0.61(0.00)***	0.93(0.01)**	0.98(0.00)***
N	220	220	220	220	220	220
Log-Lokelihood	-427	-417.4	-415	-417	-416	-418

*Probabilities in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

Table A2. Egypt: ADF Unit Root Tests

ADF Test Results	Level	First Difference
Inflation	-2.018	-10.826***
Core Inflation	-2.3	-8.63***
Global food price index	-2.57	-8.20***
Energy price index	-2.93**	-10.19***
TPinf	-1.96	-5.23***
Exchange rate level	3.31	-12.5***
Parallel exchange rate	-1.5	-2.04**
Output gap	-3.96***	-6.118***
Banking_Finance	-3.86**	-12.59***
CBE_Finance	-2.08	-18.5***
Monetary Policy	1.5	-5.3***

Table A3. Quantile regression for inflation determinants

Headline Inflation			Core Inflation		
Variable	**Quantile**	**Coefficient & Probability**	**Variable**	**Quantile**	**Coefficient & Probability**
BANKFIN	0.1	0.09 (0.00)***	D(CBIFinance)	0.1	5.86 (0.00)***
	0.5	0.005(0.6)	BanFinance	0.7	10.5(0.00)***
	0.9	0.148(0.00)***		0.8	15(0.02)**
D(EXR(-3))	0.3	0.3 (0.06)*	D(EXR(-3))	0.1	0.58 (0.06)*
	0.3	0.378 (0.00)***		0.7	0.67 (0.00)***
	0.4	0.341 (0.00)***	D(IR(-4))	0.1	-1.36 (0.00)***
	0.5	0.35(0.02)**		0.3	-1.11(0.00)***
	0.6	0.37 (0.02)**	OG(-1)	0.6	3.11 (0.00)***
D(IR(-4))	0.1	-1.046 (0.00)***		0.8	4.2 (0.03)**
	0.9	-0.58(0.288)	D(energyinf)	0.2	0.011 (0.1)
OG(-1)	0.1	-7.694 (0.00)***		0.9	0.04 (0.07)*
	0.9	6.9 (0.07)*	D(TPINF)	0.1	0.23 (0.00)***
D(energyinf)	0.2	0.011 (0.1)	D20	0.3	0.98 (0.04)**
	0.9	0.04 (0.07)*		0.4	1 (0.03)**
D(TPINF)	0.1	0.35 (0.00)***	D16	0.9	0.89 (0.09)*
	0.9	0.0296 (0.58)	D2011	0.9	0.9 (0.00)***
D20	0.1	1.6 (0.03)**			
	0.5	0.98 (0.00)**			

Table A4. Bounds test for cointegration in non-linear specification

Dependent variable: Δ(Annual inflation)	F-PSS[2]	95% lower Bound	95% upper Bound	99% lower Bound	99% upper Bound	Cointegration Result
NARDL with no imposed symmetry for food prices, exch. rate and the output gap	4.66	2.39	3.38	3.06	4.15	Yes
NARDL with imposed long-run symmetry for food prices[1]	4.298	2.27	3.28	2.88	3.99	Yes

Notes: 1. The exact specification of asymmetric model with imposed long-run symmetry imposed for global food prices is presented in Table A5. 2. F-PSS indicates the F-PSS statistic testing the null hypothesis of no cointegration.

Table A5. Long run nonlinear effect

Headline inflation		Core Inflation	
Variable	**Coefficient**	**Variable**	**Coefficient**
HINF(-1)*	-0.137 (0.00)***	CINF(-1)	-0.121 (0.00)***
@CUMDP(BANKFIN(-1))	-0.00016 (0.84)	@CUMDP(BANKFIN(-1))	-0.12 (0.00)**
@CUMDN(BANKFIN(-1))	0.00013 (0.05)*	@CUMDN(BANKFIN(-1))	0.000028 (0.00)***
@CUMDP(CBEFIN(-1))	0.0000733 (0.6)	@CUMDP(CBEFIN(-1))	-0.00072 (22)
@CUMDN(CBEFIN(-1))	0.000133 (0.00)***	@CUMDN(CBEFIN(-1))	0.00018 (26)
@CUMDP(EXR(-1))	0.319 (0.00)***	@CUMDP(EXR(-1))	0.26 (0.00)***
@CUMDN(EXR(-1))	0.145 (0.77)	@CUMDN(EXR(-1))	-0.28 (0.47)
@CUMDP(IR(-1))	-0.36 (0.22)	@CUMDP(IR(-1))	-1.1(0.00)***
@CUMDN(IR(-1))	-0.86 (0.01)**	@CUMDN(IR(-1))	0.1 (0.6)
@CUMDP(OG)	-0.025 (0.8)	@CUMDP(OG)	0.92 (0.5)
@CUMDN(OG)	0.827 (0.6)	@CUMDN(OG)	1.07 (0.52)
@CUMDP(TPINF)	0.2557 (0.00)***	@CUMDP(TPINF)	-0.0198 (0.82)
@CUMDN(TPINF)	-0.101 (0.2)	@CUMDN(TPINF)	0.189 (0.01)**
@CUMDP(energyinf)	0.01458 (0.00)***	@CUMDP(energyinf)	0.021 (0.00)***
@CUMDN(energyinf)	0.0016 (0.03)**	@CUMDN(energyinf)	-0.0002 (0.9)
D2016	6.03 (0.00)***	D2016	2.59 (0.02)**
D2020	-2.8 (0.01)**	D2011	-1.03 (0.07)*
F-statistic	6.62 (0.00)***	F-statistic	11.1 (0.00)***

Table A6. Short run nonlinear effect

Headline inflation		Core Inflation	
Variable	Coefficient	Variable	Coefficient
COINTEQ	-0.13 (0.00)***	COINTEQ	-0.132 (0.00)***
CUMDP(BANKFIN(-1))	0.00083 (0.00)***	CUMDP(BANKFIN(-1))	0.00054 (0.05)*
CUMDN(BANKFIN(-1))	-0.0003 (0.00) ***	CUMDN(BANKFIN(-1))	-0.00015 (0.23)
CUMDP(CBEFIN(-1))	-0.00083 (0.03)**	CUMDP(CBEFIN(-1))	-0.0007 (0.05)*
CUMDN(CBEFIN(-1))	0.00027 (0.00)***	CUMDN(CBEFIN(-1))	0.00002 (0.00)***
CUMDP(EXR)	0.376 (0.01)**	CUMDP(EXR)	0.31 (0.01)**
CUMDN(EXR)	1.189 (0.22)	CUMDN(EXR)	0.97 (0.2)
CUMDP(IR(-1))	1.02 (0.14)	CUMDP(IR(-1))	-0.23 (0.1)
CUMDN(IR(-1))	0.86 (0.2)	CUMDN(IR(-1))	0.91(0.2)
DCUMDP(TPINF)	0.32 (0.09)*	DCUMDP(TPINF)	0.36 (0.04)**
DCUMDN(TPINF)	-0.04 (0.2)	DCUMDN(TPINF)	0.062 (0.65)
DCUMDP(ENERGYINF)	0.029 (0.04)**	DCUMDP(ENERGYINF)	0.029 (0.04)**
DCUMDN(ENERGYINF)	0.01 (0.4)	DCUMDN(ENERGYINF)	0.01 (0.4)
D2016	0.91 (0.2)	D2016	0.116 (0.2)
D2011	-0.5 (0.01)**	D2011	-0.7 (0.03)**
F-statistic	4.085 (0.00)***	F-statistic	5.11 (0.00)***