INFLATION DYNAMICS IN EGYPT: STRUCTURAL DETERMINANTS VERSUS TRANSITORY SHOCKS

Nadine Abdelraouf* Hoda El-Abbadi** Diaa Noureldin***

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* Egyptian Center for Economic Studies. E-mail address: nabdelraouf@eces.org.eg.

** Egyptian Center for Economic Studies. E-mail address: helabbadi@eces.org.eg.

*** Corresponding author. Department of Economics, American University in Cairo, AUC Avenue, P.O. Box 74, New Cairo 11835, Egypt. E-mail address: diaa.noureldin@aucegypt.edu.

Abstract

This paper studies recent inflation dynamics in Egypt with the objective of assessing whether there are structural factors behind the trend rise in inflation since 2003. Specifically, we uncover the role of two significant determinants of long-run inflation dynamics, namely excessive monetary growth and a rise in the intensity of relative price variability. These two variables are shown to play a key role in explaining inflation developments over the period January 2000 to October 2018 after controlling for the impact of exchange rate devaluations, energy price liberalization, adverse supply-side shocks and movements in international commodity prices. While the latter group of variables was influential in triggering inflation waves over the short to medium term, our empirical results show that excessive monetary growth and increased variability in relative prices are the main drivers behind the trend rise in inflation. The policy implications of our findings point to the immediate need to curb excess money growth in the economy, and also the pertinence of treating the issue of price liberalization using a holistic long-run plan as opposed to the historically-adopted piecemeal approach.

ملخص

تناقش هذه الدراسة ديناميكيات التضخم في مصر للوقوف على المحددات الهيكلية وراء ارتفاع معدلات التضخم منذ عام 2003. توضح الورقة دور محددين مهمين لديناميكيات التضخم على المدى الطويل، وهما النمو المفرط في المعروض النقدي وارتفاع تقلبات الأسعار النسبية؛ فوفقا للدراسة لعب هذان المتغيران دورا رئيسيا في تحديد تطورات التضخم خلال الفترة من يناير 2000 إلى أكتوبر 2018 بعد تثبيت تأثير تخفيض سعر الصرف وتحرير أسعار الطاقة والصدمات السلبية في جانب العرض وتحركات أسعار السلع الدولية. وبينما كان لمجموعة المتغيرات الأخيرة تأثيرها في إحداث موجات تضخمية في الأجلين القصير إلى المتوسط، تشير النتائج التطبيقية إلى أن النمو المفرط في المعروض النقدي وتزايد معدل التغير في الأسعار النسبية كانا المحركين الرئيسيين لارتفاع التضخم. وعلى جانب مدلولات السياسات، تشير نتائج الدراسة إلى ضرورة الحد من النمو المفرط في المعروض النقدي في الاقتصاد، والتعامل مع تحرير الأسعار من خلال خطة شاملة طويلة الأجل بدلا من النهج المجتزأ الذي كان يتم اللجوء إليه في السابق.

Keywords: inflation; structural determinants; relative price variability; excessive monetary growth; autoregressive distributed lag model.

JEL classification: C22; E31; E58.

1. Introduction

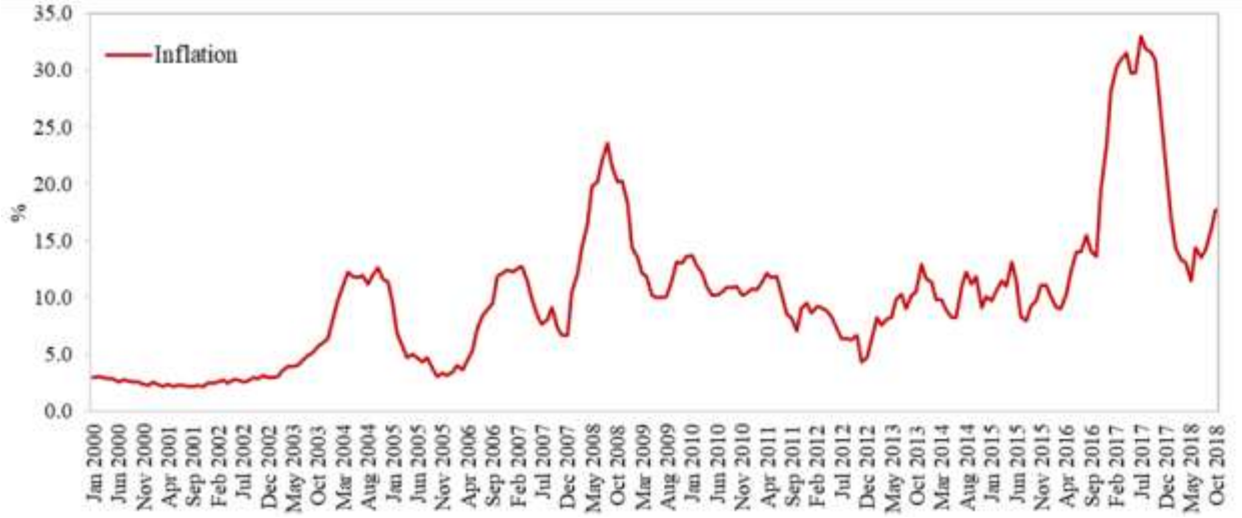
One premise that is not subject to much controversy in economics is that low and stable inflation is a desirable economic outcome. There is a growing consensus that low and stable inflation promotes long-term growth and efficiency (Bernanke and Mishkin (1997)). Equally, a voluminous literature has documented the damaging effects of high inflation. A high inflation environment discourages savings and productive investments, which adversely affects long-term growth (Pindyck and Solimano (1993), and Barro (2013)). High inflation tends to reduce the information signals in prices, which distorts the efficient allocation of resources in the economy (Ball and Romer (2003)). In addition, high inflation tends to be accompanied by high inflation volatility and uncertainty, thus affecting the efficiency of economic decisions.

Some studies have also documented the impact of high inflation on financial market development. The theoretical models of Choi, Smith, and Boyd (1996) and Huybens and Smith (1999) show that high inflation increases the cost of financial intermediation, thus hindering financial deepening and innovation. Boyd, Levine, and Smith (2001) report extensive evidence that high inflation has a negative impact on both banking sector development and equity market activity. This is another channel through which inflation can distort resource allocation and impact growth in the long run. In addition, when inflation in an economy significantly exceeds that of its trading partners, real exchange rate appreciation is bound to take place, which gradually erodes the competitiveness of the export sector and places pressure on the current account balance.

Since the mid-1990s, the world has witnessed the so-called "great moderation" as many developed and developing countries experienced low and stable rates of inflation. This has been accompanied by a gradual move towards flexible exchange rate arrangements, with inflation targeting emerging as the monetary policy regime of choice in many advanced economies. In line with the great moderation, Egypt has witnessed a notable decline in inflation since 1996, which lasted for a few years. However, since 2003, there has been a gradual rise both in the rate of inflation and its volatility. This was manifested in recurring inflation waves, the triggers of which varied from strong exchange rate devaluations to sector-specific supply-side shocks, including episodes of partial price liberalization where the administered prices of energy-related goods increased significantly.

It is hard to miss the fact that inflation in Egypt has been on an upward trend in recent years as shown in Figure 1, which raises questions about the existence of structural and institutional factors that underlie the persistent rise in trend inflation since 2003. The objective of this paper is to answer this question by studying inflation dynamics over the period January 2000 - October 2018, with the aim of identifying such structural and institutional determinants while controlling for other shocks that only had a transitory impact on inflation.

Figure 1. Inflation Developments in Egypt (January 2000 - October 2018)

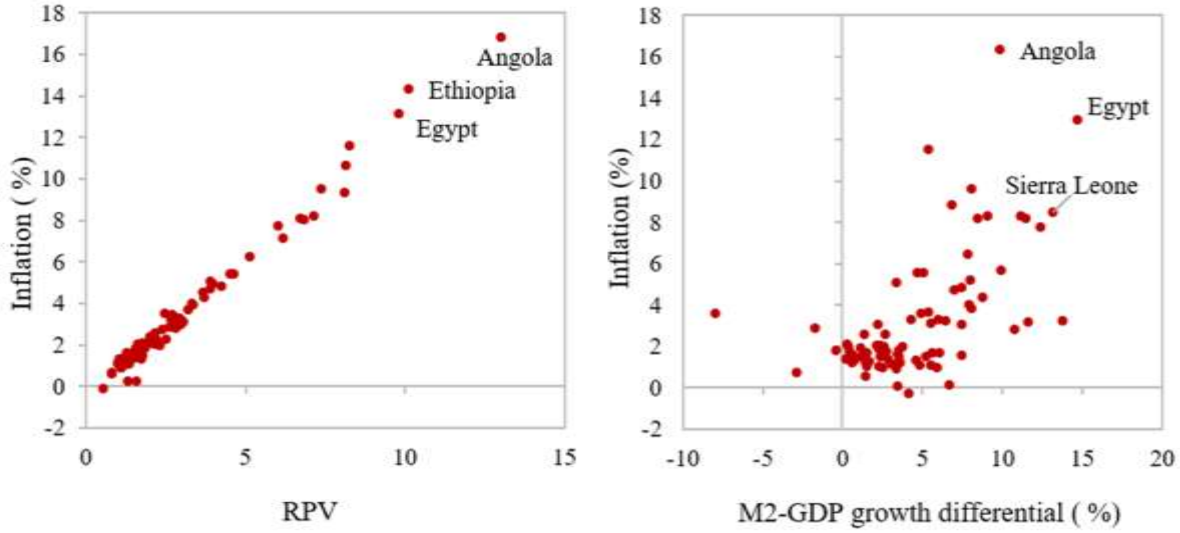


Source: Authors' calculations based on Egypt's data from the IMF International Financial Statistics database.
Notes: This graph shows headline (year-on-year) inflation over the period January 2000 - October 2018.

Specifically, our work sheds light on two salient features of the Egyptian economy that we argue have been instrumental in driving inflation dynamics in recent years. The first is intense variability in relative prices, and the second is excessive growth in the money supply. In comparison to a large cross section of countries, Egypt appears in the top ranks with regard to these two variables as shown in Figure 2. Using scatter plots of inflation against relative price variability (henceforth RPV) and the differential between nominal money supply growth and real GDP growth (henceforth the M2-GDP growth differential) for 84 countries, two preliminary conclusions emerge: Both variables show strong correlation with inflation, and

Egypt appears as one of the outlier countries in both charts showing excessive levels of RPV and monetary growth.[1]

Figure 2. Relative Price Variability and Excessive Monetary Growth: Cross-Country Evidence



Source: Authors' calculations based on data from the IMF International Financial Statistics database, IMF Consumer Price Index database, and the World Bank World Development Indicators database.
Notes: The scatter plots use annual averages for 84 countries over the period 2011-2018 for the left panel, and 2011-2017 for the right panel due to unavailability of money supply growth data for some countries in 2018. The choice of 2011 as starting point for the cross-country data is due to lack of data on most countries in the IMF Consumer Price Index database prior to 2011. The 12 CPI components used to calculate the RPV measure as per the IMF classification are: Alcoholic beverages, tobacco, and narcotics; Clothing and footwear; Communication; Education; Food and non-alcoholic beverages; Furnishings, household equipment and routine household maintenance; Health; Housing, water, electricity, gas and other fuels; Miscellaneous goods and services; Recreation and culture; Restaurants and hotels; and Transport.

It is undoubtedly the case that other factors have been at play during the last two decades which acted as a catalyst for the increase in inflation. For instance, Egypt has witnessed successive devaluations in the earlier part of the sample during 2002-2003, and also a significant devaluation in November 2016 accompanied by a policy announcement to float the currency. In addition, the prices of energy-related goods and other goods with administered prices have been hiked a few times, coupled with sector-specific supply-side shocks. However, and as shown in the empirical analysis, these factors only had a transitory impact on inflation and the trend rise in inflation is largely driven by intense RPV and excessive monetary growth.

[1] In Section 4.1, we present the methodology used to compute RPV. See also the appendix for a full list of countries included in Figure 2.

Our labeling of RPV and excess money growth as structural and institutional features, respectively, warrants some discussion. In our view, these two variables are a manifestation of certain structural rigidities and institutional disorder in the economy. Theoretical models and empirical evidence show that excessive RPV occurs in times of economic transition during which price liberalization takes place. In those instances, RPV tends to increase, especially if the economy had a large share of administered prices prior to the transition. Accordingly, a rigorous adjustment in relative prices takes place as the free-market price mechanism replaces centralized planning as the means of allocating resources in the economy. In addition, RPV can also be influenced by structural features such as general nominal rigidity, the extent of domestic market competition, and prolonged exchange rate misalignment. On the other hand, excessive monetary growth typically reflects some form of fiscal dominance, where there is a low degree of central bank independence and strong incentives to create unanticipated inflation. In the empirical analysis section of the paper, we use these two variables as proxies for changes in the underlying structural rigidities and institutional setup which impact long run inflation outcomes.[2]

A large literature has documented the strong association between inflation and the variability in relative prices. Large adjustments in relative prices tend to occur in a high inflation environment. However, RPV itself is a realization of both the structural features of the economy as well as the tendency to distort price signals through administered prices. Historically and until this day, administered prices are prevalent in Egypt. The government sector enjoys a heavy presence in the economy, and various goods and services are offered by public entities at administered prices which are not necessarily at par with market-based prices, and are often kept unchanged for prolonged periods of time.[3] The historical predominance of administered pricing is a product of the socialist era in the 1960s, and was maintained since the economic liberalization in 1974 to protect the poor from the adverse effects of inflation. However, over the years, and due to the piecemeal approach to price liberalization, this has led to severe distortions in the structure of relative prices in Egypt.

[2] Our study does not delve into the determinants of the variation in RPV or excess monetary growth overtime. While this is an important subject, its consideration will detract from the main focus of the paper, so we elect to leave these questions for future research.

[3] Administered prices in Egypt feature prominently in the following sectors: Energy (fuel and natural gas), household utilities (electricity and water), public education and health services, public transportation, and housing that is subject to the so-called "Old Rent Law".

In addition to its effects on inflation, RPV impacts resource allocation, the level of employment and output, as well as the informational role of prices in the economy (Hayek (1945), Alchian (1969), and Fischer (1981)). Keynes (1924) emphasizes the extent that RPV can negatively affect specialization in the economy, while Ball and Romer (2003) argue that relative prices are the tools which enable the "invisible hand" to guide efficient resource allocation. As RPV increases, the reliability of the information signals transmitted by prices diminishes in importance and, in response, search activities increase. This, in turn, leads to more time and resources being consumed in decision making (Blejer and Leiderman (1980), Ball and Romer (2003), and Tommasi (1994)).[4]

With regard to excessive monetary growth, both theoretical and empirical work has shown that fiscal dominance plays a primary role in such an outcome. In Egypt's recent history, there is a notably high correlation between the government's budget deficit and excessive monetary growth, which points to the potential prevalence of a monetary policy regime that is accommodative of the fiscal policy stance at the expense of high and volatile inflation. The significant effect of excessive monetary growth on the rise in trend inflation is not disconnected from important considerations regarding the conduct of monetary policy in Egypt. Historically, it has generally been difficult to ascertain the nature of Egypt's monetary policy regime. Given prolonged periods with a fixed exchange rate, the latter has become a *de facto* nominal anchor. However, an inconsistent mix of fiscal and monetary policies has led to two severe currency crises in 2002-2003 and 2015-2016. In the aftermath of both crises, the Central Bank of Egypt announced the floatation of the currency only to be followed by periods of uncharacteristically low exchange rate volatility.

Our findings offer a number of policy recommendations, which we summarize at the end of the paper. However, the main message is that our results offer a counter-narrative to the current mainstream economic view that the recurring inflation waves in Egypt are attributed to shocks such as exchange rate devaluations or energy price shocks. We show that there are more

[4] Noureldin (2009) examined the impact of RPV on inflation in Egypt during the period 2000-2007, and documented the existence of a significant positive association between mean inflation and RPV, and also a positive correlation between RPV and inflation uncertainty.

fundamental forces shaping the trend rise in inflation, specifically the increased variability in relative prices due to the lack of free-market pricing in various sectors, and excessive monetary growth that is possibly driven by the fiscal policy stance. This points to the immediate need for structural and institutional reforms to address the root causes of Egypt's high inflation.

The rest of the paper is organized as follows: Section (2) sets out the theoretical background with a selective literature review, and Section (3) presents the econometric methodology. Section (4) presents the data with preliminary descriptive analysis of inflation dynamics and the evolution of the key variables of the study, and then discusses the model estimation results. Concluding remarks and policy implications follow in Section (5).

2. Theoretical Background

The literature on inflation dynamics is too expansive to be fully covered in this paper. In addition, modern theoretical advances and related applied work is largely dominated by research on advanced economies, where studies on the U.S. economy capture the lion's share.[5] Therefore, we focus on two streams in the literature that relate to the focus of this paper, mainly addressing the structural factors and institutional design issues pertaining to the variability in relative prices and excessive monetary growth.

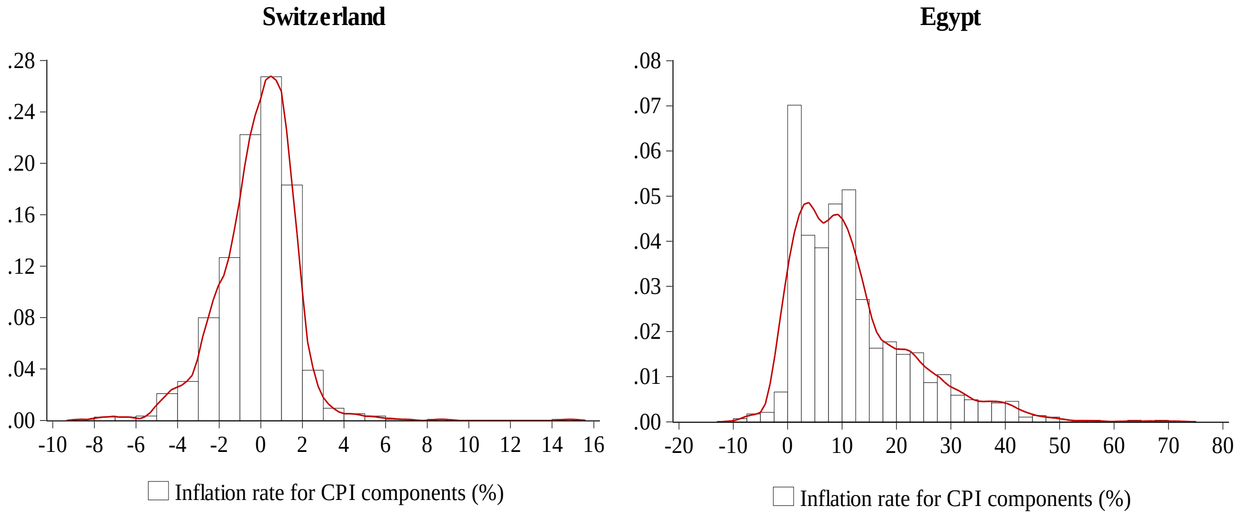
2.1. Relative Price Variability

Generally, RPV denotes the intensity with which relative prices change in the economy. Given a price index (e.g., the consumer price index (CPI)), RPV can be quantified by the dispersion of the cross section distribution of price changes of price index components. For the CPI, Figure 3 shows the cross section distribution for the individual inflation rates of the CPI components for Egypt and Switzerland, the latter being used as a benchmark for comparison. Comparing the two countries, it is clear that the distribution in the case of Egypt shows larger dispersion. Departure from normality is also evident with high positive skewness for Egypt, where a few

[5] See, for instance, the special issue of the Journal of Money, Credit, and Banking (Volume 39, Issue 2, 2007) covering the conference on "Quantitative Evidence on Price Determination" held in 2005 and co-sponsored by the Federal Reserve Board.

commodity groups in the right tail of the distribution show inflation rates reaching as high as 70 percent.

Figure 3. The Cross Section Distribution of Price Changes



Source: Authors' calculations based on data for Egypt and Switzerland from the IMF Consumer Price Index database.
Notes: This graph shows the frequency distribution of the individual (annualized) inflation rates of the 12 CPI components for Egypt and Switzerland over the period January 2011 - December 2018. The choice of 2011 as starting point is for consistency with the presentation in Figure 2. The red curves in the left and right panels represent the kernel density estimates of the frequency distribution. The 12 CPI components used to calculate the RPV measure as per the IMF classification are: Alcoholic beverages, tobacco, and narcotics; Clothing and footwear; Communication; Education; Food and non-alcoholic beverages; Furnishings, household equipment and routine household maintenance; Health; Housing, water, electricity, gas and other fuels; Miscellaneous goods and services; Recreation and culture; Restaurants and hotels; and Transport.

As noted by Ball and Mankiw (1995), an asymmetric distribution of individual price changes that is skewed to the right will lead to higher inflation when the variance of the cross section distribution increases, which indicates that a few commodity groups with higher-than-average rates of price changes are pushing the mean rate of inflation upwards. Also, note that the majority of the CPI components have positive rates of inflation (right panel of Figure 3). This is a manifestation of the well-documented phenomenon of downward price rigidity observed in many economies where prices have a tendency to rise rather than fall.

There is a broad stream of literature focusing on the structural features that lead to the variation in the intensity of RPV over time and across countries. We focus, in particular, on the theoretical models addressing nominal rigidities and the pricing behavior of firms. Subsequently, the role of administered prices as a source of price stickiness is reviewed, which paves the way to a discussion of the role of economic transition in elevating the intensity of

RPV. Other determinants of RPV are reviewed, namely domestic competition and the effect of prolonged exchange rate misalignment. We then review the literature on the informational role of prices and the welfare costs of excessive RPV and follow with a discussion of the joint dynamics of RPV and inflation.

2.1.1. Nominal Rigidities, Pricing Behavior and Relative Price Variability

A primary assumption in new Keynesian macroeconomic models is the non-neutrality of the impact of nominal shocks on the structure of relative prices due to the presence of nominal rigidities. If all firms react synchronously to nominal shocks, the structure of relative prices would remain unchanged. However, due to the existence of nominal rigidities, price changes occur infrequently and are not synchronous across firms, which in turn increases RPV. One class of models explaining nominal rigidity assumes that firms alter their prices by allowing their real price to vary between bounds which depend on the state of the economy. The presence of "menu costs" is a central tenet in these models, e.g., Barro (1972), Sheshinski and Weiss (1977, 1983), and Mankiw (1985). The theory stipulates that, due to menu costs, firms keep their nominal prices fixed for some time and do not respond to shocks instantaneously. As the firm's real price declines and approaches a certain boundary, the firm responds by adjusting its nominal price (Sheshinski and Weiss (1977)). Adjustments occur at a higher frequency when the shocks are of large magnitude thereby increasing RPV (Sheshinski and Weiss (1977, 1983), and Danziger (1987)).

Other studies (e.g., Ball and Mankiw (1994), and Mankiw and Reis (2002)) relate price rigidity to the costly search for information by consumers and producers. The focus here is on the role of information costs in addition to adjustment costs as impediments to instantaneous price flexibility. Other explanations of nominal rigidity include the presence of explicit and implicit contracts, cost-based pricing, and pricing thresholds that can prevent firms from changing prices; see Dias *et al.* (2011) for a discussion.

2.1.2. The Role of Administered Prices

The previously discussed models assume that firms set prices freely. Another stream of literature focuses on administered prices as the source of price rigidity. In economies with a high share of administered prices, the necessary adjustment of relative prices following a nominal shock tends to increase the dispersion of relative price changes. However, only a few studies attempt to incorporate the two types of prices (i.e. administered prices and market-determined ones) in one model with the notable exception of Cukierman and Leiderman (1984). In their model, they show that RPV in the free segment increases when price changes in the administered segment diverge from the money growth path. On the other hand, when price changes in the administered segment are at par with money growth, RPV in the free market segment is minimized. A significant policy implication of their findings is that the government should adopt a gradual approach for adjusting administered prices, with frequent increases slightly above overall inflation. This gradual approach tends to minimize the increases in RPV compared to the case of less frequent but large increases (Wozniak (1998)).

With the historical presence of a high share of administered prices, deregulation and price liberalization induce large relative price adjustments. Accordingly, RPV is likely to be exacerbated during periods of economic transition, which significantly affects inflation dynamics. Coorey, Mecagni, and Offerdal (1996) provide supporting evidence based on the experiences of Central and Eastern European economies. Rother (2000) explains how the distribution of price changes becomes asymmetric during periods of transition due to the differential speed of adjustment among different sectors. Specifically, there is slow adjustment in the prices of capital-intensive sectors. Another factor is the Balassa-Samuelson effect which induces an increase in the price of nontradables relative to the price of tradables given differential productivity gains. Wozniak (1998) studies the experience of Poland where high RPV resulted from price liberalization, removal of subsidies and the unification of different exchange rates. Also, Pujol and Griffiths (1996) focus on Poland's transition and emphasize the central role of RPV in inflation dynamics during the transition. They further conclude that reducing inflation during transition is best achieved by reducing money supply growth and implementing structural reforms at the institutional and sectoral levels.

2.1.3. Other Influences on Relative Price Variability

Other possible factors that might influence the intensity of RPV in an economy relate to market competition. Using intramarket price data, Domberger (1987) and Lach and Tsiddon (1992) find a strong positive relationship between "within industry" RPV and inflation. Moreover, Caucutt, Ghosh, and Kelton (1998) show that the relationship between inflation and RPV varies significantly across industries based on variation in the level of market concentration. Domberger (1987), Slade (1991) and Beaulieu and Mattey (1999) find evidence that the strength of the relationship between inflation and RPV is inversely related to industry concentration. Later, Bakhshi (2002) confirms that greater competition implies a stronger relationship between unanticipated inflation and RPV, showing that firms' pricing tends to respond to changes in the aggregate price level, as market competition improves.

Another factor that may influence RPV in the economy is the exchange rate and, in particular, exchange rate misalignment, which occurs as the real effective exchange rate (REER) becomes disconnected from its equilibrium value. Being a proxy for the relative price of nontradables to tradables, the REER and its dynamics play an important role in relative price adjustment, and its misalignment induces price distortions in the economy.[6] As argued by Friedman (1953), the flexibility of the exchange rate facilitates the needed relative price adjustment when a real shock hits the economy. Apart from exchange rate misalignment, the exchange rate regime itself could impact RPV through its role in anchoring inflation expectations. For instance, Cukierman and Wachtel (1979) show that inflation uncertainty, due to unanchored inflation expectations, increases RPV.

2.1.4. The Welfare Costs of Excessive Relative Price Variability

The variability in relative prices driven by nominal rigidities is a key dynamic by which inflation leads to welfare losses. According to Fischer (1981), "inflation is associated with relative price variability that is unrelated to relative scarcities and hence leads to misallocations of resources." As RPV increases, the allocative signs of prices diminish in importance and, in

[6] For a recent study of exchange rate misalignment in Egypt, see Noureldin (2018).

response, search activities increase consuming more time and resources (Blejer and Leiderman (1980)). Benabou (1992) and Diamond (1993) study the welfare effects of RPV in the context of consumer search and imperfect information about aggregate inflation. The two studies show that price variability decreases firms' profits, which in turn shrinks the number of firms in equilibrium, thereby creating a more complex search process.

Tommasi (1994) and Ball and Romer (2003) assume that the firm's price plays an additional role as a signal for future prices. High inflation tends to increase the noise in the price relative to the intended information signal. In a repeated-purchase setting, each buyer chooses a seller according to the relative price after a costly search. An increase in real price instability lowers the value of this information leading to reduced consumer welfare and inefficient resource allocation. In addition, as prices become less informative, consumer demand becomes less price elastic and thus, firms exploit this by raising their markups. As indicated in the surveyed literature, this nexus between inflation and the structure of relative prices is considered a primary channel through which inflation negatively affects the real economy.

2.1.5. The Nexus between Inflation and Relative Price Variability

The literature on the nexus between inflation and RPV is rather inconclusive with regard to the nature of association as well as the direction of causality between the two variables. Fischer (1981) and Ball and Mankiw (1994, 1995) establish the impact of RPV on inflation by emphasizing the impact of the asymmetric distribution of individual price changes, positive trend inflation and downward nominal rigidities. The asymmetric distribution of price changes (see the right panel of Figure 3) coupled with asymmetric supply shocks indicate that higher dispersion in the distribution (i.e. higher RPV) leads to higher inflation.

On the other hand, Sheshinski and Weiss (1977) and Parks (1978) argue that inflation causes RPV. This class of models stipulates that due to the costs associated with changing prices, price adjustments occur in a discrete fashion. The central assumption in these models is that firms incur a fixed cost each time they change their prices in response to aggregate shocks. Given that these costs are fixed; firms change prices only at certain boundaries which may vary across sectors. Therefore, under the presence of "menu costs", RPV becomes more intense as inflation increases.

Cukierman and Wachtel (1979), among others, argue that the positive association between inflation and RPV is induced by exogenous common factors such as unanticipated money growth. Another example of common factors that affect both variables are major supply shocks hitting specific sectors, such as shocks to oil and food prices, which lead to an increase in both inflation and RPV.

2.2. Excessive Monetary Growth: Incentives and Institutional Design

In this subsection, we discuss the institutional design and incentive mechanisms which may cause money growth in the economy to exceed the optimal growth rate that is consistent with low and stable inflation. There is consensus in macroeconomics that money is neutral in the long run in the sense that it can only affect nominal variables (e.g., the price level) but not real variables (e.g., the level of output or unemployment).

The link between money growth and long-run inflation outcomes is well-documented starting from the earlier work of Irving Fisher on the quantity theory of money, which essentially states that the supply of money in the economy will directly determine the price level, given that the demand for money is stable. This view was challenged during the 1970s due to empirical evidence showing that the demand for money relationship became too unstable. However, it is hardly contested that a sustained rise in inflation cannot materialize without excessive growth in the money supply. This, in turn, raises questions about the underlying reasons for excessive monetary growth, which we discuss next.

2.2.1. Fiscal Dominance and the Fiscal Theory of the Price Level

Fiscal dominance refers to the hegemony of the fiscal authority over the central bank, in which the latter either monetizes the budget deficit through seigniorage, or allows its balance sheet to expand by increasing its holdings of government debt. Fiscal dominance tends to be more prevalent in the absence of fiscal rules, or when there is a low degree of central bank independence.

Fiscal rules impose limits on certain fiscal aggregates with the objective of ensuring long term fiscal responsibility and debt sustainability. Such rules pertain to government spending, the overall budget (e.g., a balanced-budget rule), or the level of public debt.[7] In general, fiscal rules tend to impose fiscal discipline and improve budgetary outcomes (Dahan and Strawczynski (2013), and Badinger and Reuter (2017)). They also lower the degree of fiscal dominance, and insulate the central bank from political pressure to monetize the budget deficit, thereby contributing to *de facto* central bank independence. Empirical evidence shows that *de facto* central bank independence lowers both the level and volatility of inflation (Berger, de Haan, and Eijffinger (2001) and Klomp and de Haan (2010)).

In an influential paper, Sargent and Wallace (1981) discuss what they termed "unpleasant monetarist arithmetic". Their model is not disconnected from the idea of fiscal dominance and at its heart lies the quantity theory of money. In their model, they show that an increase in the budget deficit is bound to be accompanied by monetary expansion to finance the deficit. In the long run, the result is higher inflation and an increase in the price level.

During the 1990s, a series of contributions led to the development of what is known as the fiscal theory of the price level; see Leeper (1991), Sims (1994), and Woodford (1994). In these models, it is the quantity of government debt that matters. A key equilibrium relationship in this literature has the government nominal debt divided by the price level on the left hand side, and the discounted sum of future government budget surpluses on the right hand side. Accordingly, if the right hand side is taken as given, a contemporary increase in government debt is bound to be matched by an increase in the price level. This tends to happen as an equilibrating mechanism, where inflation expectations become self-fulfilling causing a rise in the rate of inflation to reduce the real balance of public debt and place it on a sustainable path. This can occur even in the presence of a tight monetary policy by the central bank.

[7] For country-specific fiscal rules, see the fiscal rules dataset of the IMF available at https://www.imf.org/external/datamapper/fiscalrules/map/map.htm.

2.2.2. Gains from Surprise Inflation

Inflation, due to excess money growth, not only results in welfare losses but also creates additional institutional costs since high and uncontrolled inflation erodes the credibility of the central bank due to its inability to fulfill the mandate of price stability. It also comes at significant social costs which are certainly well perceived by any government. However, these costs tend to be relatively obscure for two reasons: (i) they tend to be realized with a lag, and (ii) it is possible for the central bank to claim that excess money growth occurred due to an unanticipated shock, e.g., a sudden shift in money demand. On the other hand, monetary expansion is quite likely to boost real output in the short run if unanticipated by economic agents. This asymmetry between the costs and benefits of excessive money growth often creates a strong incentive for this stance.

The policymaker's objective is often a benign one such as boosting output and reducing unemployment in a recession. However, the long term effects are certainly negative and, more often than not, they exceed the short term gains. This is what caused institutions around the world to evolve accordingly by introducing fiscal rules to enforce fiscal discipline, and promoting central bank independence to insulate the latter from political pressure. However, the magnitude of short term real output gains that can result from surprise inflation depends, to a large extent, on the structural features of the economy. Cottarelli, Griffiths, and Moghadam (1998) discuss how features such as lack of trade openness, underdeveloped domestic financial markets, and the presence of strong nominal rigidities (e.g., in the form of administered pricing) can boost the realized short term output gains from surprise inflation, and therefore such features strengthen the incentive for excessive monetary expansion.

3. Econometric Methodology

For the empirical analysis, we use the autoregressive distributed lag (ARDL) model of Pesaran and Shin (1999) and Pesaran, Shin, and Smith (2001). The model has the following specification:

$$y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} y_{t-i} + \sum_{j=0}^{q} \beta_j{}' X_{t-j} + \gamma' Z_t + \varepsilon_t, \quad (1)$$

where y_t is the rate of inflation (*INF*), X_t is a vector of explanatory dynamic variables, Z_t is a vector of exogenous static variables that appear only contemporaneously in (1), and ε_t is a mean-zero uncorrelated error term. The specification in (1) is an ARDL(*p*,*q*) model. The dynamic explanatory variables included in the model are relative price variability (*RPV*), changes in the nominal exchange rate for the US dollar (*NER*) and the differential between nominal money supply growth and real GDP growth (*M2GDP*). For the static explanatory variables, we include variables that capture supply-side shocks such as shocks to energy prices due to adjustments in the administered prices of petroleum products and electricity (*ENERGY*), local supply-side shocks affecting food prices (*SUPPLY*), and price shocks due to changes in international commodity prices (*PRIMCOM*).

For modeling time series dynamics, the ARDL model offers a number of advantages over vector autoregressive (VAR) models. Most importantly, the study of cointegration in a VAR model requires that integrated variables be of the same order, which may not necessarily be the case. Unit root tests often give different conclusions regarding the stationarity of a given time series. This is particularly the case with short time series that are subject to structural breaks. Therefore, it is often difficult in practice to ascertain the level of integration of the variables included in the model with a reasonable degree of accuracy. The ARDL model allows for a mix of I(0) and I(1) variables, as well as fractionally-integrated series. Therefore, it is most suitable when the unit root tests are inconclusive. However, it is important to note that it does not allow for I(2) variables to be included in the model.

The ARDL model also offers several advantages. First, being a single-equation model, the ARDL specification enables us to focus on the variable of interest, which lends itself to a straightforward interpretation of the results. Second, the lags of the dependent variable and the explanatory variables can differ in length which offers flexibility in modelling and also avoids overfitting. Third, the existence of a cointegrating relationship between the variables can be tested using the Bounds Test outlined in Pesaran and Shin (1999) and Pesaran *et al.* (2001). The Bounds Test also has the advantage of being straightforward to apply in practice compared to the Johansen cointegration test, since the latter requires certain assumptions about the existence of trends in the data and in the cointegrating relationship itself. The findings from the Johansen test tend to be sensitive to such assumptions.

Specifically, we run the following regression:

$$INF_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} INF_{t-i} + \sum_{i=0}^{q_1} \beta_{1i} RPV_{t-i} + \sum_{i=0}^{q_2} \beta_{2i} NER_{t-i} + \sum_{i=0}^{q_3} \beta_{3i} M2GDP_{t-i} + \gamma_1 ENERGY_t + \gamma_2 SUPPLY_t + \gamma_3 PRIMCOM_t + \varepsilon_t. \quad (2)$$

We allow the dynamic regressors to have different lag structures denoted by p and q_i, $i = 1,2,3$. For the choice of the lags (p, q_1, q_2, q_3), we use the Schwarz information criterion (SIC) given its well-known property of consistent model selection in finite-dimensional models; see Shao (1997). The Bounds Test is then conducted via the regression:

$$\Delta INF_t = \tilde{\alpha}_0 + \sum_{i=1}^{p} \tilde{\alpha}_{1i} \Delta INF_{t-i} + \sum_{i=0}^{q_1} \tilde{\beta}_{1i} \Delta RPV_{t-i} + \sum_{i=0}^{q_2} \tilde{\beta}_{2i} \Delta NER_{t-i} + \sum_{i=0}^{q_3} \tilde{\beta}_{3i} \Delta M2GDP_{t-i} + \tilde{\gamma}_1 ENERGY_t + \tilde{\gamma}_2 SUPPLY_t + \tilde{\gamma}_3 PRIMCOM_t + \delta_0 INF_{t-1} + \delta_1 RPV_{t-1} + \delta_2 NER_{t-1} + \delta_3 M2GDP_{t-1} + \eta_t, \quad (3)$$

The Bounds Test for cointegration is an F-test of the null hypothesis $H_0: \delta_0 = \delta_1 = \delta_2 = \delta_3 = 0$. Rejecting the null implies the existence of a long run relationship among the variables. The distribution of the test is nonstandard and also depends on the cointegration rank of the system. Pesaran *et al.* (2001) provide lower and upper bounds on the critical values where the lower bounds are based on the assumption that all variables are I(0), and the upper bounds are obtained assuming all the variables are I(1). If the test statistic is smaller than the lower bound, the null hypothesis of no cointegration is maintained, and if it exceeds the upper bound, the null hypothesis is rejected. If the test statistic lies in between the two bounds, the test is inconclusive.

If evidence of cointegration is found, an error correction model (ECM) can be estimated by including an ECM term in (3), and its coefficient would be the speed of adjustment parameter. In this case, the ECM term would be the lagged residual ($\hat{\xi}_{t-1}$) from the following long run regression:

$$INF_t = \varphi_0 + \varphi_1 RPV_t + \varphi_2 NER_t + \varphi_3 M2GDP_t + \varphi_4 ENERGY_t + \varphi_5 SUPPLY_t + \varphi_6 PRIMCOM_t + \xi_t, \quad (4)$$

The coefficients in (4) are the long run response coefficients in the cointegrating relationship.

4. Empirical Results

4.1. Data Sources and the Measurement of Relative Price Variability

We use monthly data for the period January 2000 - October 2018. Annual inflation rates at the monthly frequency were computed using data on the CPI from the IMF International Financial Statistics database.[8] Data on the detailed components of the CPI used to compute *RPV* is obtained from Egypt's Central Authority for Public Mobilization and Statistics (CAPMAS). Due to data discontinuity, we split the data into two sample periods differing in the disaggregation levels of the components of the CPI. For the period January 2000 - December 2006, 31 components of the CPI are used to compute RPV, while we use more disaggregated data for the period January 2007 - October 2018 comprising 55 components. Weights used to calculate RPV are based on the Household Income, Expenditure, and Consumption Survey (HIECS) of 1995/1996, 2004/2005 and 2008/2009.

For changes in the nominal exchange rate, we use monthly data on the EGP/USD exchange rate from the IMF International Financial Statistics database. For the period January

[8] The reason for using the CPI data from the IMF International Financial Statistics database is its temporal consistency. When using CAPMAS data, we found an inexplicable upward level shift in inflation in January 2004, and a downward shift in January 2005. As mentioned in the IMF Egypt Country Report No. 05/177, the official statistics show this level shift due to a change in index composition that took place in 2004.

2013 - November 2016, in which significant activity took place at the parallel market exchange rate, the average monthly exchange rate of the parallel market was used based on daily data from Bloomberg and Reuters. For excess money growth, we use the difference between money supply growth and real GDP growth.[9] Dummy variables were used to capture the shocks due to energy price liberalization and other supply-side shocks as documented below in Figure 4.[10] Finally, international commodity prices were obtained from the IMF Primary Commodity Prices database.

In line with Theil (1967), Parks (1978) and Blejer and Leiderman (1982), among others, we construct a measure of RPV using disaggregated price data for the components of the CPI and their respective weights. The RPV measure for month t is defined as the square root of the weighted sum of squared deviations of the individual components' rate of inflation from overall inflation:

$$RPV_t = \sqrt{\sum_{i=1}^{n} w_{i,t}(\pi_{i,t} - \bar{\pi}_{i,t})}^2$$

where $w_{i,t}$ is the weight of the i^{th} component of the CPI at month t, and $\pi_{i,t}$ is its year-on-year rate of inflation computed as

$$\pi_{i,t} = 100 * \left(\frac{P_{i,t} - P_{i,t-12}}{P_{i,t-12}}\right)$$

with $P_{i,t}$ being the price index of the i^{th} component, and $\bar{\pi}_{i,t}$ is the overall rate of inflation given by

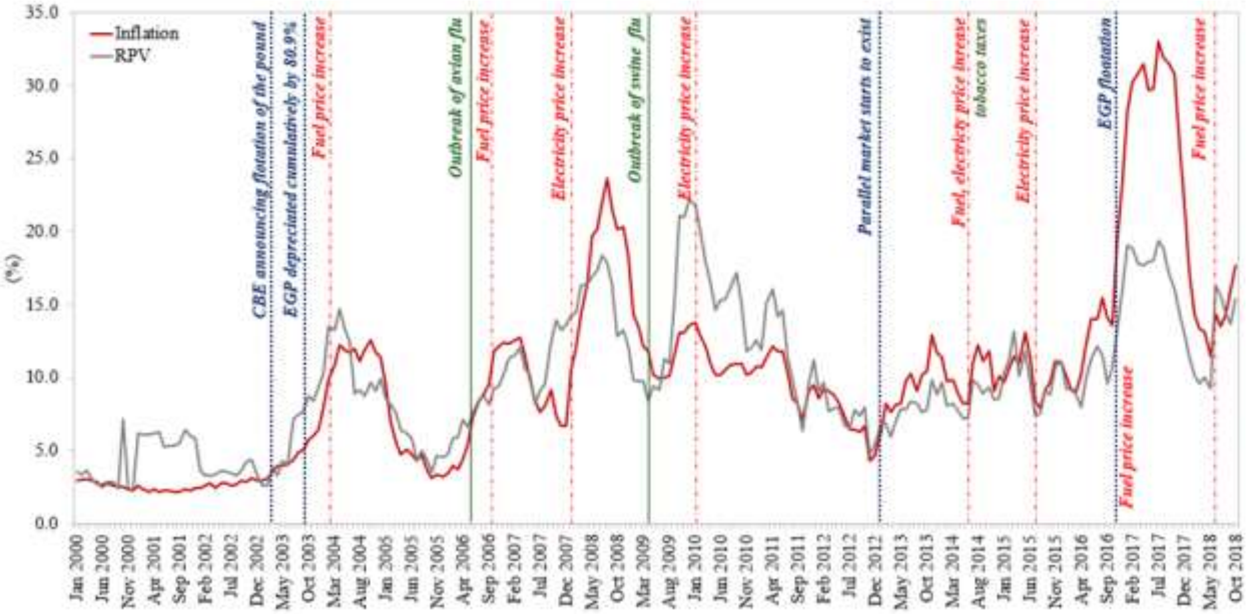
$$\bar{\pi}_{i,t} = \sum_{i=1}^{n} w_{i,t}\,\pi_{i,t}.$$

[9] Due to the lack of real sector data at the monthly frequency, quarterly data was used and interpolated using a cubic spline function.

[10] During the period of study, several adjustments in the prices of domestic energy-related prices took place. Also, two significant supply-side shocks affected domestic food prices in January 2006 (the avian flu virus) and April 2009 (the swine flu virus).

Over the period January 2000 - October 2018, four inflation waves occurred as shown in Figure 4. The first wave occurred between July 2003 and March 2005 where inflation peaked at 12.6 percent in October 2004. The successive exchange rate devaluations during 2001-2003 as well as the announcement of the floatation of the Egyptian pound by the Central Bank of Egypt triggered this wave. The second wave occurred between March 2006 and September 2007 where inflation reached 12.8 percent in March 2007. The two main drivers during this wave were the outbreak of the avian flu virus and a surge in international commodity prices. The avian flu virus led to a disruption in the local food market, and the food and beverages group was one of the main groups driving inflation during this period.

Figure 4. Inflation and Relative Price Variability (January 2000 - October 2018)

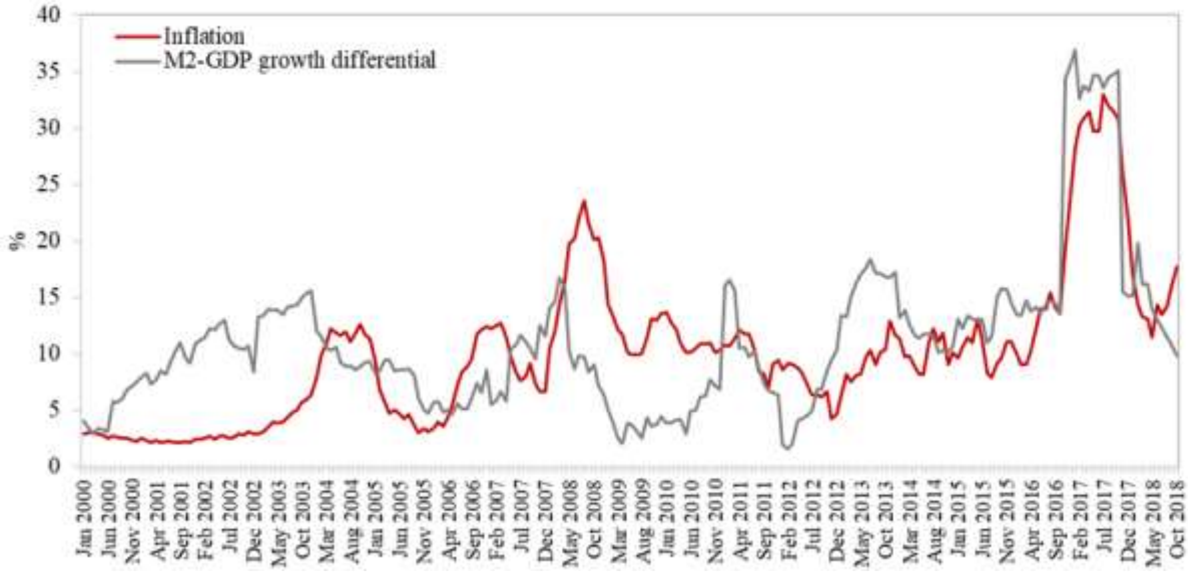


Source: Authors' calculations based on the IMF International Financial Statistics database, and CAPMAS disaggregated CPI data for RPV.
Notes: This graph shows headline (year-on-year) inflation and RPV during the period January 2000 - October 2018. The time series of RPV is calculated using CAMPAS data to obtain a longer time series starting in January 2000, in addition to the availability of CPI components at a more disaggregated level. The vertical lines mark the dates of different inflationary shocks.

The third wave occurred between January 2008 and June 2009 reaching a peak inflation rate of 23.6 percent in August 2008. This was due to the increase in international commodity prices, specifically food prices. The fourth wave occurred between November 2016 and May 2018 where inflation reached a record high of 33 percent in July 2017. This wave was driven by the strong devaluation in the Egyptian pound after the Central Bank of Egypt announced its floatation as part of a loan agreement with the International Monetary Fund. Inflation was in fact creeping up before the official devaluation due to the emergence of a parallel exchange market at which most transactions were taking place. During this period, the response of inflation to the exchange rate devaluation intensified due to ample liquidity in the economy, where money supply growth reached 17.05 percent while on average GDP grew at 3.54 percent between 2012Q1 and 2016Q4 (Noureldin (2018)). Figure 4 also shows the tight positive association between RPV and inflation.

As previously shown in the right panel of Figure 2, Egypt had the highest rate of excess money growth among the sampled countries over the period 2011-2017. Figure 5 further confirms the close association between excess money growth and inflation over the period January 2000 - October 2018.

Figure 5. M2-GDP Growth Differential and Inflation (January 2000 - October 2018)



Source: Authors' calculations based on data from the IMF International Financial Statistics database, Egypt's Ministry of Planning, Monitoring and Administrative reform, and the Central Bank of Egypt.
Notes: This graph shows the historical evolution of M2-GDP growth differential and overall inflation over the period January 2000 - October 2018.

4.2. Unit Root Tests

In Table 1, we report the results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests for the presence of a unit root for both the levels and first differences of the variables employed in the study. The results indicate that none of the variables are I(2), and there is possibly a mix of I(0) and I(1) variables; see, for instance, the results for *INF* according to the ADF test including intercept and trend, and for the *NER* according to the Phillips-Perron test. The mixed evidence suggests that the use of the ARDL model is appropriate for this data set.

Table 1. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Unit Root Tests

	Intercept (no trend)		Intercept and trend	
	(Levels)	*(First differences)*	*(Levels)*	*(First differences)*
		ADF Unit Root Test		
INF	-1.261	-8.802***	-3.843**	-8.807***
RPV	-2.563	-14.202***	-2.977	-14.170***
NER	-1.581	-6.597***	-1.950	-6.613***
M2GDP	-1.557	-3.279**	-1.825	-5.994***
		PP Unit Root Test		
INF	-2.362	-9.644***	-3.198*	-9.622***
RPV	-2.724*	-14.182***	-3.085	-14.148***
NER	-3.120**	-11.622***	-3.152*	-11.595***
M2GDP	-2.320	-3.465***	-2.414	-3.473**

Notes: These are *t*-statistics from the ADF (upper panel) and PP (lower panel) unit root tests. For the ADF test, the Schwarz information criterion (SIC) is used for lag selection. For the PP test, automatic bandwidth selection is applied using the Newey-West bandwidth selection. *** marks statistical significance at the 1 percent level of significance, ** marks statistical significance at the 5 percent level of significance, and * marks statistical significance at the 10 percent level of significance.

4.3. ARDL Model Estimation Results

In Table 2, we report the parameter estimates for the ARDL regression with inflation as the dependent variable. The chosen lag structure according to the SIC is (p, q_1, q_2, q_3) = (3,1,2,2) for the variables *INF*, *RPV*, *NER* and *M2GDP*, respectively, according to the regression in (2). The chosen lag structure minimizes the SIC at a value of 2.852. All of the coefficients have the expected sign. In the group of dynamic regressors, the first lags of *RPV* and *M2GDP* have a positive and statistically significant impact on inflation.[11] The first lag of *NER* is insignificant while its second and third lags are significant. For the group of static regressors (energy shocks, supply-side shocks and changes in international commodity prices), their coefficients also have the right sign, but are statistically significant only for energy shocks and changes in international commodity prices (marginally significant at the 10 percent level). This is consistent with the observed increase in inflation subsequent to increases in the prices of gasoline and other energy-related products over the course of our sample; see Figure 4. It is also consistent with the increase in inflation during the so-called “commodity super cycle” extending from 2005 to 2014, in which international commodity prices significantly exceeded their historical average save for the drop in 2008-2009 in the aftermath of the financial crisis.

Table 2. Parameter Estimates of the ARDL Model

	Coefficient Estimates	**Standard Error**	***t*-Statistic**	***p*-value**
$Constant$	-0.6215^{***}	0.2245	-2.7679	0.0062
INF_{t-1}	1.0754^{***}	0.0574	18.7496	0.0000
INF_{t-2}	-0.0636	0.0807	-0.7891	0.4309
INF_{t-3}	-0.1159^{**}	0.0503	-2.3035	0.0222
RPV_t	0.4112^{***}	0.0422	9.7558	0.0000
RPV_{t-1}	-0.3057^{***}	0.0461	-6.6350	0.0000
NER_t	0.0140	0.0184	0.7630	0.4463
NER_{t-1}	0.0850^{***}	0.0277	3.0688	0.0024
NER_{t-2}	-0.0880^{***}	0.0185	-4.7523	0.0000
$M2GDP_t$	2.2424^{***}	0.7260	3.0885	0.0023
$M2GDP_{t-1}$	-4.6396^{***}	1.4653	-3.1663	0.0018
$M2GDP_{t-2}$	2.4391^{***}	0.7549	3.2312	0.0014
$ENERGY_t$	1.3533^{***}	0.3881	3.4868	0.0006
$SUPPLY_t$	0.7367	0.6274	1.1742	0.2416
$PRIMCOM_t$	0.0062^{*}	0.0033	1.8848	0.0609

Notes: Sample period used for estimation is January 2000 - October 2018. The dependent variable is INF_t. *** marks statistical significance at the 1 percent level of significance, ** marks statistical significance at the 5 percent level of significance, and * marks statistical significance at the 10 percent level of significance.

With regard to the model’s diagnostic checks, the residuals are free from serial correlation according to the LM test statistic, which returned a p-value of 0.308. The Breusch-Pagan-Godfrey heteroscedasticity test returned a p-value of 0.120 indicating homoscedastic errors. The null hypothesis of normality of the error term in (2) is also not rejected at the 5 percent level of significance according to the Jarque-Bera test statistic which returned a p-value of 0.078. The Bounds Test of Pesaran and Shin (1999) and Pesaran *et al.* (2001) returned an F-

[11] In the group of dynamic regressors, we also included a measure of the output gap computed using the Hodrick-Prescott (HP) filter to estimate potential GDP. However, this variable proved insignificant at all lags and was excluded from the final specification to avoid overfitting. This could potentially be due to the limitations of the HP filter and also the dubious quality of the real sector data in Egypt.

statistic of 6.21 which exceeds the I(1) upper bound value of 4.66 at the 1 percent level of significance. This confirms the existence of a stable long run relation between the variables. In Table 3, we report the results of the long-run regression in (4).

Table 3. Parameter Estimates of the Long Run Cointegrating Relationship

	Coefficient Estimates	**Standard Error**	***t*-Statistic**	***p*-value**
$Constant$	-5.9709^{***}	2.0820	-2.8680	0.0046
RPV_t	1.0136^{***}	0.1469	6.8998	0.0000
NER_t	0.1058	0.0704	1.5018	0.1347
$M2GDP_t$	0.4025^{**}	0.1557	2.5853	0.0104
$ENERGY_t$	13.0012^{***}	4.4909	2.8950	0.0042
$SUPPLY_t$	7.0779	6.0966	1.1610	0.2470
$PRIMCOM_t$	0.0596^{*}	0.0353	1.6919	0.0922

Notes: Sample period used for estimation is January 2000 - October 2018. The dependent variable is INF_t. *** marks statistical significance at the 1 percent level of significance, ** marks statistical significance at the 5 percent level of significance, and * marks statistical significance at the 10 percent level of significance.

In the long run cointegrating relationship, we find that both *RPV* and *M2GDP* are significant determinants of inflation over the long term. This finding strongly supports our hypothesis about the role of excessive monetary growth in increasing trend inflation over the last few years. It also highlights the role of intense *RPV* as a contributor to high inflation in the long run. Interestingly, the *NER* is insignificant in the long-run regression despite its significance in the ARDL specification. The fact that the *NER* is insignificant in the long-run regression is consistent with our hypothesis that it only has a transitory effect on inflation. We also find that *ENERGY* has a significant coefficient indicating that the rise in trend inflation during the period of study is partly due to price liberalization after a long period of stale prices for energy-related products. While the supply-side shocks *(SUPPLY)* variable has an insignificant coefficient, changes in the international prices of primary commodities is significant but only at the 10 percent level of significance. Note that all coefficients in the long run cointegrating relationship have the correct sign.

The coefficient of the ECM term in the equation for short term dynamics is -0.1004 and is statistically significant with a p-value of 0.0000.[12] The small magnitude of the coefficient of the ECM term suggests a slow correction for past equilibria, which is consistent with the strong persistence of inflation after an inflationary shock. Typically, it takes inflation a rather long period to return to pre-shock levels as it corrects only 10 percent of the disequilibrium from

[12] This regression is not reported in the interest of brevity, but is available from the authors upon request.

the previous month. The half-life measure for this coefficient is around 6.5 months, which means it takes this period of time for half of the disequilibrium to be removed from the system assuming no further shocks occur in the interim.

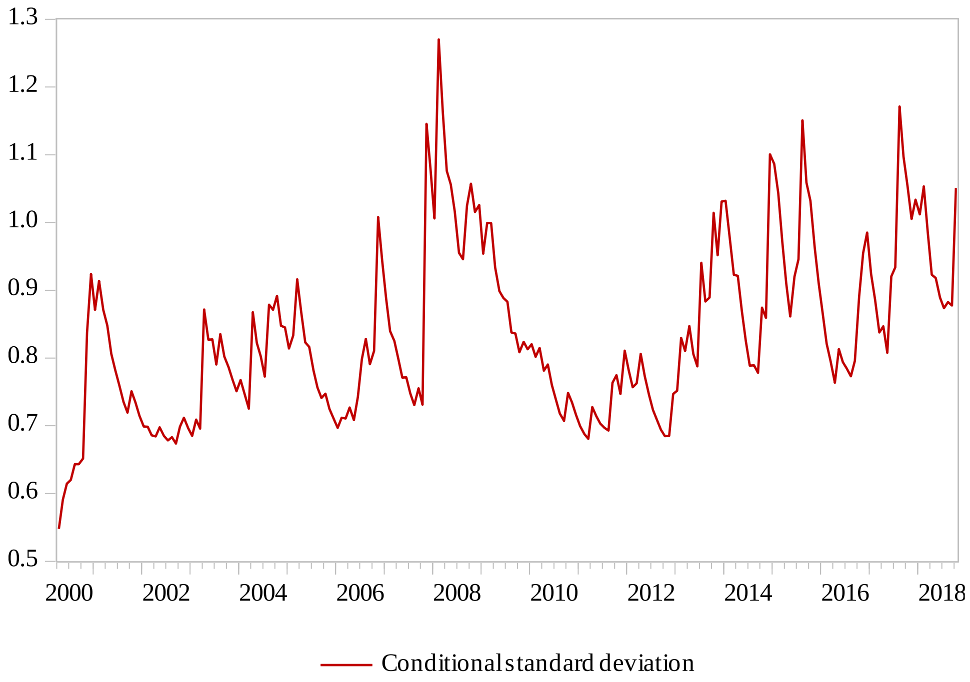
The key finding from the estimation results of the long run cointegrating relationship and the short run dynamics confirms our hypothesis that long run inflation outcomes are determined primarily by excessive monetary growth and not cumulative depreciation in the value of the currency. Depreciation matters only in the short run dynamics and, in our view, is also a result of inflation induced by excess money growth. With high inflation relative to Egypt's trade partners, the REER starts appreciating and currency misalignment increases gradually as long as the nominal exchange rate is fixed. As currency misalignment (in that case on the overvaluation side) becomes untenable, a significant nominal devaluation takes place which drives the short run inflation dynamics. The results also point to the centrality of relative price adjustment in inflation dynamics.

4.4. Inflation Uncertainty

It is instructive to shed some light on the level of uncertainty accompanying the high levels of inflation in Egypt. In the absence of surveys of inflation expectations, which are regularly conducted in many economies, changes in the level of inflation uncertainty overtime can be captured by the temporal evolution in the variance of the error term in equation (2). Introducing autoregressive conditional heteroscedasticity (ARCH) in his seminal paper, Engle (1982), and later on Bollerslev (1986) with the generalized ARCH (GARCH), show how to estimate the latent conditional variance.

We start by running the ARCH test of Engle (1982) using the squared residuals from the regression in (2). The p-value from the Engle (1982) ARCH test is 0.049 which rejects the null hypothesis of conditionally homoscedastic errors. With evidence of an ARCH effect in the residuals, we move on to estimating a plain vanilla GARCH (1,1) model. The results indicate that the ARCH coefficient is significant with a p-value of 0.079 and the GARCH coefficient is significant with a p-value of 0.000. Figure 6 shows estimates of the conditional standard deviation. An increasing trend in the level of inflation uncertainty over the sample period is indicated by the rising trend in the graph. This finding is consistent with Cukierman (1983) who argues that variability in money supply growth is what drives the strong association between inflation, RPV and increased inflation uncertainty.

Figure 6. GARCH-Based Measure of Inflation Uncertainty (January 2000 - October 2018)



4.5. Forecast Performance Evaluation

An important measure of success for an econometric model is its forecasting performance out of sample. We assess the model's predictive ability over the period January 2010 - October 2018 by computing different criteria for forecast evaluation through comparing our model to the following benchmarks: (i) AR(1), (ii) ARMA(1,1), (iii) VAR(4) and (iv) VECM(4). In fitting the AR and ARMA models, the simplest specification is used. Regarding the VAR and VECM models, the SIC is used for choosing the appropriate number of lags, which is 4 lags for both models.[13] For forecast evaluation, we use the following criteria: (i) root mean squared error (*RMSE*), (ii) mean absolute error (*MAE*), and (iii) the Theil inequality (*U*) coefficient. The formulas for the criteria are as follows:

[13] For the VECM(4) model, we assume the existence of two cointegrating relationships as concluded by the Johansen cointegration test.

$$RMSE = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^f - Y_t)^2} \quad , \qquad MAE = \frac{1}{T}\sum_{t=1}^{T}\left|Y_t^f - Y_t\right|,$$

$$U = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^f - Y_t\right)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^f\right)^2} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t)^2}},$$

where Y_t^f is the forecasted value of the observed value Y_t, forecasted at time $t-1$, and T is the total number of observations in the out-of-sample period. In all criteria, the lower the value of the criterion, the better the forecast performance of the respective model.

Table 4. Forecast Evaluation: ARDL Model versus Benchmarks

	ARDL	**AR(1)**	**ARMA(1,1)**	**VAR(4)**	**VECM(4)**
Root mean squared error (RMSE)	1.1225	1.6808	1.5956	1.4906	1.5060
Mean absolute error (MAE)	0.8663	1.1882	1.1592	1.1625	1.1613
Theil inequality (U) coefficient	0.0385	0.0579	0.0551	0.0514	0.0516

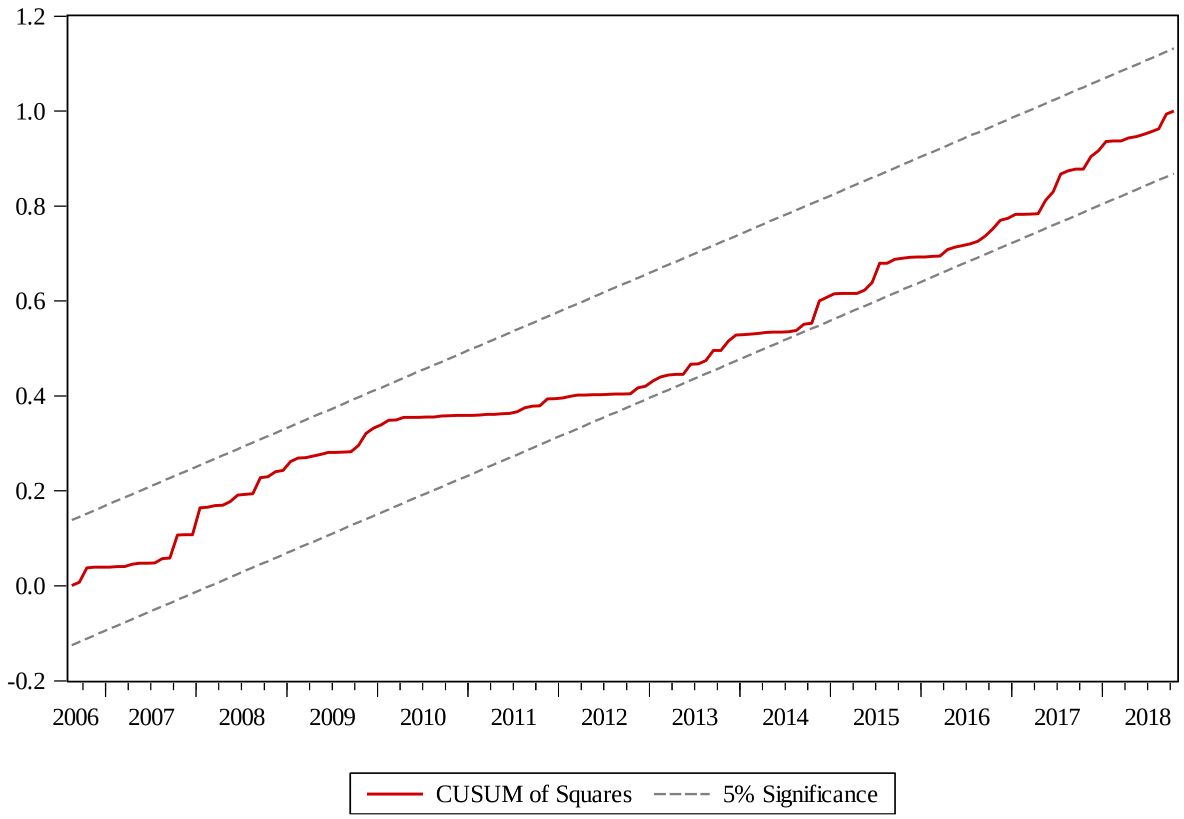
Notes: Sample period used for forecasting is January 2010 - October 2018. Rolling window estimation is employed. The VAR and VECM models included the following variables: *INF*, *RPV*, *NER* and *M2GDP*. In the VAR and VECM models, 4 lags were included as selected by the SIC.

Table 4 reports the forecast evaluation results where, in all criteria, the ARDL model shows superior predictive ability relative to all of the benchmark models as it provides a large reduction in the forecast errors. To assess the statistical significance of these improvements, we conduct the model confidence set (MCS) test of Hansen *et al.* (2011). The MCS is a procedure which selects the best set of forecasting models from a larger group of candidate models using the time series of forecast errors (e.g., mean squared error (MSE) or MAE)) for a given level of statistical significance. In this context, the MSE and MAE are interpreted as loss functions that the best forecasting model should minimize. At the 1 percent level of significance, the MCS only selected the ARDL model for both MSE and MAE losses. The fact that none of the benchmark models were included in the MCS shows that the ARDL model provides a distinct and clear advantage when it comes to forecasting inflation. Given that the out-of-sample period is January 2010 - October 2018, the superior predictive ability of the ARDL model is established over a long time period that witnessed different inflation waves with varying degrees of intensity.

4.6. Additional Robustness Checks

In this subsection, we consider some additional robustness checks. We start by examining the correctness of our specification given the lack of consensus in the literature on the direction of causality between mean inflation and RPV. To check whether there is causality in the opposite direction, we also estimate the ARDL model assuming RPV is the dependent variable with inflation appearing on the right hand side. The results indicate the following: First, the ARDL model optimal lag structure is (1,1,0,0) for the following variables (in respective order): *RPV*, *INF*, *NER* and *M2GDP*. Second, mean inflation and its first lag are statistically significant reflecting the strong association between mean inflation and RPV. Third, both *NER* and *M2GDP* are statistically insignificant in the model. Fourth, the Bounds Test indicates that the F-statistic is in the inconclusive range at the 5 percent level of significance, and rejects the null hypothesis of a long run relation at the 1 percent level of significance.[14]

Figure 7. Cumulative Sum (CUSUM) of Squares of Recursive Residuals Test



[14] We do not report these results in the interest of brevity, but they are available from the authors upon request.

The second robustness check concerns parameter stability. The cumulative sum (CUSUM) of squares of recursive residuals test statistic is shown in Figure 7. Since it never crosses the 5 percent critical values at any point, this is indicative of the absence of significant structural breaks in the regression. Finally, the model also passes the Ramsey RESET misspecification test for missing nonlinear effects using both $\widehat{INF_t}^2$ and $\widehat{INF_t}^3$ in the regression.

5. Concluding Remarks

The findings of our study indicate that while inflation has been partly driven by transitory factors in the short run, such as exchange rate devaluations and other supply-side shocks, the rising trend in inflation in recent years was primarily due to structural and institutional factors, namely intense relative price variability and excess money growth. The empirical robustness of the estimated model as well as its superior forecast performance lend further support to this conclusion.

The policy implications of our findings are centered on the immediate need to tackle the issue of price liberalization using a holistic long run plan, in addition to the pertinence of curbing excess money growth in the economy. With regard to the first dimension, Egypt needs a comprehensive plan for price liberalization as opposed to the historically-adopted piecemeal approach. With the prevalence of a distorted structure of relative prices due to the high incidence of administered prices in the economy, it is inevitable that relative price variability will remain a strong driver of inflation in the years to come. However, an adequately-designed strategy can ameliorate some of the negative impacts of price liberalization. This requires a study of the optimal sequencing of price increases, where it may be better to opt for continuous small increases above the rate of inflation (over a longer period of time) rather than the current practice of occasional large price increases.

In parallel, it is absolutely necessary to introduce fiscal rules in Egypt. Fiscal rules are part and parcel of an overall institutional setup that is needed to rid the system of fiscal dominance, enhance the independence of the central bank, and improve long-run inflation outcomes. In addition to fiscal rules, there is also need for an independent body to monitor and review fiscal operations and public finances within a medium-term framework.

Finally, the central bank needs to devise a strategy with a clear timeline for the adoption of full-fledged inflation targeting. With the announced floatation of the exchange rate in November 2016, it is high time for the central bank to enhance its communication with the public to introduce inflation targeting as an alternative monetary policy framework. The transition to inflation targeting will help anchor inflation expectations around the announced target, thereby leading to a gradual reduction in the rate of inflation as well as its volatility.

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Appendix

The list of countries used in cross-country comparisons:

Albania	Ecuador	Kenya	Poland
Angola	Egypt	South Korea	Portugal
Armenia	El Salvador	Latvia	Russian Federation
Aruba	Equatorial Guinea	Lesotho	Rwanda
Austria	Estonia	Liberia	Samoa
Bahrain	Ethiopia	Lithuania	Senegal
Belgium	Fiji	Luxembourg	Serbia
Botswana	Finland	Macedonia	Seychelles
Bulgaria	France	Malaysia	Sierra Leone
Burundi	Gabon	Mauritania	Slovak Republic
Cabo Verde	Georgia	Mauritius	Slovenia
Chile	Germany	Mexico	South Africa
China, P.R.: Hong Kong	Greece	Mongolia	Spain
Colombia	Honduras	Montenegro	Swaziland
Costa Rica	Hungary	Morocco	Switzerland
Cote d'Ivoire	Iceland	Namibia	Togo
Croatia	Ireland	Netherlands	Turkey
Cyprus	Israel	Nigeria	United Arab Emirates
Czech Republic	Italy	Norway	United Kingdom
Denmark	Japan	Oman	United States
Dominican Republic	Jordan	Paraguay	Uruguay