MUCH ADO ABOUT THE EGYPTIAN POUND: EXCHANGE RATE MISALIGNMENT AND THE PATH TOWARDS EQUILIBRIUM

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Abstract

This paper estimates Egypt's equilibrium real exchange rate and exchange rate misalignment based on economic fundamentals over the period 2001Q3-2017Q3. Focusing on the more recent period, we find that the Egyptian pound was undervalued by about 22.3 percent in 2017Q1 due to overshooting its equilibrium value after floating the currency in 2016Q4. The currency undervaluation then declined to 18.5 percent in 2017Q3 driven by an increase in the real effective exchange rate due to a surge in domestic inflation. With regard to the determinants of the equilibrium real exchange rate, we find the productivity differential (vis-à-vis Egypt's trade partners) and trade openness to be the most significant factors. We also provide projections for the equilibrium real exchange rate and exchange rate misalignment until 2020Q4, which reveal that the exchange rate undervaluation will be dissipating fast due to high inflation. If the nominal exchange rate stabilizes at its level in 2017Q3 (17.73 pounds per US dollar), the currency will be overvalued by 13.1 percent in 2020Q4. Given the uncertainty surrounding the projections, a forecast combination approach is also presented. Finally, the paper highlights the implications of the empirical findings for the conduct of monetary policy in Egypt.

الملخص

تقدر هذه الورقة البحثية سعر الصرف الحقيقي التوازني واختلال سعر الصرف في مصر استنادا إلى المؤشرات الاقتصادية، وذلك خلال الفترة الممتدة من الربع الثالث من عام 2001 حتى الربع الثالث من عام 2017. وبالتركيز على الفترة الأخيرة، نجد أن الجنيه المصري كان مقوما بأقل من قيمته الحقيقية بنحو 22.3% في الربع الأول من عام 2017 بسبب الانخفاض المفرط عن قيمته التوازنية بعد التعويم في الربع الرابع من عام 2016. ثم تراجع هذا التقويم بأقل من القيمة العادلة للجنيه إلى 18.5% في الربع الثالث من عام 2017 مدفوعا بارتفاع سعر الصرف الفعلي الحقيقي بسبب الارتفاع الحاد في معدل التضخم المحلي. وفيما يتعلق بالمحددات الاقتصادية لسعر الصرف الحقيقي التوازني، نجد أن فرق معدل الإنتاجية (بين مصر وشركائها التجاريين) والانفتاح الاقتصادي هما أهم المحددات. كذلك تقدم الورقة توقعات مستقبلية لسعر الصرف الحقيقي التوازني واختلال سعر الصرف حتى الربع الرابع من عام 2020، والتي تكشف أن التقويم بأقل من القيمة العادلة لسعر الصرف سوف يتلاشى سريعا بسبب ارتفاع التضخم. وإذا استقر سعر الصرف الاسمي عند مستواه في الربع الثالث من عام 2017 (17.73 جنيها مقابل الدولار الأمريكي)، ستكون العملة مغالى في قيمتها بنسبة 13.1% في الربع الأخير من عام 2020. ونظرا لعدم اليقين المحيط بالتوقعات، تناقش الورقة أيضا منهج الجمع بين التنبؤات (forecast combination approach). وأخيرا، تلقي الورقة الضوء على دلالات نتائج البحث فيما يتعلق بإدارة السياسة النقدية في مصر.

Keywords: equilibrium real exchange rate; exchange rate misalignment; economic fundamentals; cointegration; structural break.

JEL classification: C22; C51; E37.

1. INTRODUCTION

An economy's real exchange rate plays an important role in resource allocation as it determines the relative price of tradable and nontradable goods. It also guides the consumption and investment decisions of economic agents. Exchange rate misalignment occurs when the real exchange rate becomes disassociated from its equilibrium value. This may arise due to an economic shock with a significantly destabilizing effect, frictions in the foreign exchange market that prohibit efficient price discovery, or a policy intervention such as supporting a currency peg. Regardless of its cause, the misalignment results in misallocation of resources between the tradable and nontradable sectors, and tends to create an unsustainable balance of payments position, possibly leading to a currency crisis.

A voluminous literature has documented the drastic impact of prolonged exchange rate misalignment, in particular currency overvaluation. Extensive empirical evidence indicates its overall negative effect on growth, export performance and the general outward orientation of the economy. In addition, it has been a triggering factor for balance of payments and currency crises in developing countries, which necessitated substantial economic adjustment in the aftermath of these crises.

Against the backdrop of the currency crisis that Egypt experienced during 2016, and given the aforementioned implications of exchange rate misalignment, this paper aims to estimate Egypt's equilibrium real exchange rate and exchange rate misalignment over the period 2001Q3-2017Q3. To our knowledge, this is the first attempt to estimate the intensity and duration of exchange rate misalignment during the currency crisis of 2016, and it marks the first contribution of this paper.

The crisis led to a sizable exchange rate devaluation when the Central Bank of Egypt (CBE) announced the adoption of a floating exchange rate regime, concurrently with launching a wide-raging economic reform program in agreement with the International Monetary Fund (IMF) to rein in the fiscal deficit and revive economic competitiveness. Our attempt to estimate the exchange rate misalignment is a bid to provide deeper understanding of how the crisis emerged and unraveled, and also to offer lessons for the future conduct of monetary policy in Egypt.

In addition to estimating the historical exchange rate misalignment, we also show how the current misalignment is likely to evolve over the medium term (specifically over the period 2017Q4-2020Q4), which marks the second contribution of this paper. Offering an outlook for

the future path of the equilibrium real exchange rate constitutes a departure from earlier studies on the Egyptian economy in which the future outlook was disregarded. We chart out the course of the equilibrium real exchange rate using the latest IMF projections of the economic fundamentals for Egypt and its main trade partners.

Estimating the equilibrium real exchange rate and exchange rate misalignment has been the subject of a large literature adeptly summarized in Edwards (1994), Williamson (1994) and Hinkle and Montiel (1999). There are generally two strands in this literature: the so-called "behavioral" approach based on Edwards (1989b), and the "fundamentals" approach of Williamson (1985). This nomenclature is rather confusing since the two approaches involve the use of economic fundamentals to estimate the equilibrium real exchange rate, and their primary difference pertains to the role ascribed to current account sustainability in the analysis.1 A third but less widespread method, known as the "external sustainability" approach, is outlined in IMF (2006) and it links the equilibrium real exchange rate to a sustainable net foreign assets position.

Both the fundamentals approach of Williamson (1985) and the external sustainability approach discussed in IMF (2006) require an assumption about the level of some exogenous variable that is consistent with the simultaneous attainment of internal and external balance.2 This exogenous variable is the level of capital inflows in the case of Williamson (1985), and the economy's net foreign assets in the external sustainability approach. This has been a point of criticism of both methods since the resulting estimate of exchange rate misalignment is highly sensitive with regard to this assumption.

The approach adopted in this paper to estimate the equilibrium real exchange rate is based on the behavioral approach of Edwards (1989b), and its extensions in Elbadawi (1994), Baffes, Elbadawi, and O'Connell (1999), Edwards and Savastano (2000), and Edwards (1994) among others. The appeal of this method relates to its strong theoretical foundations, which we discuss in detail in the body of the paper, in addition to its suitability in a developing economy context as emphasized by Clark and MacDonald (1998). This largely explains why it has been applied extensively in the context of developing countries. For the objectives of this paper, the Edwards (1989b) model offers three distinct advantages. First, it explicitly highlights the interaction

[1] Specifically, the method of Williamson (1985) is based on general equilibrium simulation models in which the equilibrium real exchange rate is estimated to be the level that makes the present and future current account balance sustainable. Clark and MacDonald (1998) and Edwards and Savastano (2000) provide excellent accounts of the merits and limitations of each approach.

[2] Internal balance refers to equilibrium in the labor market and the market for nontradable goods, while external balance is attainted when the economy is intertemporally solvent, that is when the current and projected current account deficits (surpluses) match the economy's net foreign assets (liabilities).

between exchange rate misalignment and changing economic fundamentals, which deepens our understanding of the confluence of factors behind Egypt's recent currency crisis. Second, it circumvents the need to make ad hoc assumptions about some exogenous variable (e.g. the level of capital inflows, or net foreign assets) that is consistent with internal and external balance. Third, and quite importantly for our objectives, it allows for constructing projections of the equilibrium real exchange rate and exchange rate misalignment based on forecasts of the fundamentals.

Our empirical results show that right before the floatation of the Egyptian pound on 3 November 2016, the real exchange rate was overvalued by 24 percent in 2016Q3. The floatation of the currency led to a significant depreciation in which the currency lost about 32 percent of its value in real terms, which led to a reversal from overvaluation to undervaluation of 14.7 percent in 2016Q4. The undervaluation increased further to 22.3 percent in 2017Q1 before retreating to 18.5 percent by 2017Q3. This was caused by exchange rate overshooting which is consistent with the predictions of the Dornbusch (1976) model. It is also consistent with the exchange rate behavior during the preceding currency crisis of 2002-2003, in which successive devaluations were effected to correct for exchange rate misalignment at the time.

According to our projections for 2017Q4-2020Q4, the current exchange rate undervaluation is expected to disappear rapidly. Since Egypt's inflation is projected to remain high (relative to trade partners), the real effective exchange rate will witness a gradual increase, reaching the equilibrium level by 2019Q1, at which time the undervaluation would cease to exist. Starting 2019Q2, the misalignment will switch sign to indicate currency overvaluation. Our projections show that if the nominal exchange rate stabilizes at its level in 2017Q3 (i.e. 17.73 pounds per US dollar), the currency will be overvalued by 13.1 percent in 2020Q4. If, on the other hand, the nominal exchange rate tracks its projected equilibrium path, we expect to see some nominal depreciation. Specifically, the exchange rate for the US dollar is expected to reach 20.05 pounds per US dollar by 2020Q4.

The projections are of course subject to a margin of uncertainty, which is further amplified by a potential structural break given the adoption of a new exchange rate regime. Sensitivity analysis undertaken by combining forecasts from different vintages of estimation around 2016Q4 (the time of the regime change) shows that the projected nominal exchange rate may be in the range of 18.21 to 18.83 pounds per US dollar by the end of 2020 if less weight is placed on the 2017Q3 data in estimation. The wide range in the projections is reflective of the

fact that it is an inherently difficult task to accurately measure exchange rate misalignment around times of a regime change.

The rest of the paper is organized as follows: Section 2 provides the theoretical background and discusses the set of economic fundamentals considered for the estimation of the equilibrium real exchange rate. Section 3 provides a brief overview of exchange rate developments in Egypt during the period of study, while Section 4 outlines the econometric methodology. Section 5 presents the empirical results for the in-sample analysis, and Section 6 provides the medium-term projections. Section 7 concludes the paper and highlights policy implications for the future conduct of monetary policy in Egypt.

2. THEORETICAL FRAMEWORK

In this section, we discuss the theoretical framework for analyzing the determinants of the equilibrium real exchange rate, starting with a review of the definitions of the nominal and real effective exchange rates, followed by a discussion of the concept of the equilibrium real exchange rate, and how to estimate it.

2.1. The Nominal and Real Effective Exchange Rates

Both the nominal effective exchange rate (NEER) and the real effective exchange rate (REER) are calculated from observed data. The NEER is a weighted average of bilateral nominal exchange rates for the local currency against the currencies of the main trade partners. For the n most significant trade partners, the NEER at time t is defined as

$$NEER_t = 100 * \prod_{i=1}^{n} (E_{it})^{w_i} \quad (1)$$

where E_{it} denotes the time t bilateral exchange rate index, quoted as units of the foreign currency of partner country i per one unit of the local currency, normalized to equal 1 for some base year. The weight w_i is the trade share of country i in Egypt's total trade. An increase (decrease) in the NEER means the currency is appreciating (depreciating) against the currencies of Egypt's main trade partners. It is a useful measure for countries with a history of pegging the exchange rate to a particular anchor currency, as the NEER would then capture movements in the anchor currency against other major currencies.

One limitation of the NEER is that it does not control for the price level differentials between the local economy and the economies of the trade partners. These differentials capture an important dimension of how economic competitiveness evolves over time. The REER, which addresses this shortcoming, is computed as

$$REER_t = 100 * \prod_{i=1}^{n} \left(E_{it} \frac{P_t^{(d)}}{P_t^{(i)}} \right)^{w_i} \quad (2)$$

where the price level at time t is denoted by $P_t^{(d)}$ for the domestic economy, and by $P_t^{(i)}$ for partner country i. Both price series have the same base year as E_{it}.

The REER is a long-established measure of external competitiveness; see Edwards (1989a), Cottani, Cavallo, and Khan (1990), and Ghura and Grennes (1993), among others. It takes into account changes in nominal exchange rates as well as Egypt's inflation differential vis-à-vis its main trade partners. An increase (decrease) in the REER means the currency is witnessing a *real* appreciation (depreciation) against the currencies of Egypt's main trade partners. The REER captures currency movements in real terms since the price level differentials between Egypt and its trade partners have been accounted for. A rise in the REER generally indicates a decline in export competitiveness.

2.2. The Real Effective Exchange Rate (REER) as the Relative Price of Nontradable and Tradable Goods

In theoretical macroeconomic models, the REER is often defined as the relative price of nontradables to tradables. Nontradables are those goods that cannot be traded in international markets and must be consumed within the domestic economy (e.g. real estate and financial services), while tradable goods can be traded in international markets (e.g. agricultural and manufactured products). This view of the REER is instructive for our purposes as it lends another perspective to understand exchange rate developments in Egypt during the period of study.

Let Y_t denote the REER at time t. Formally, we have

$$Y_t = \frac{P_t^{(N)}}{P_t^{(T)}} \tag{3}$$

where $P_t^{(N)}$ is the price of the nontradable good, and $P_t^{(T)}$ is the price of the tradable good. An increase in Y_t induces a disproportionate allocation of resources to the nontradables sector relative to the tradables sector, resulting in a general loss of external competitiveness. Edwards (1989b) argues that this definition of the real exchange rate is appropriate for developing countries whose exports are subject to the *law of one price* in international markets. The law of one price applies only to tradables and it dictates that

$$\tilde{P}_t^{(T)} = E_t P_t^{(T)},$$

where $\tilde{P}_t^{(T)}$ is the price of tradables in foreign markets, and E_t is the *nominal* exchange rate defined as units of the foreign currency per one unit of the local currency, where we assume one trade partner for simplicity.

In logarithms, this relationship can be expressed as

$$\tilde{p}_t^{(T)} = e_t + p_t^{(T)},$$

where the lower-case variables denote the natural logarithm of their upper-case counterparts. Considering the REER definition in (2), and assuming one trade partner, the logarithm of the REER can be expressed as

$$y_t = e_t + p_t - \tilde{p}_t,$$

where p_t and $\tilde{p}_t$ denote the general price level in the domestic economy and for the trade partner, respectively. Assuming p_t and $\tilde{p}_t$ can be decomposed into the prices of tradables and nontradables, we have $p_t = (1-\alpha)p_t^{(T)} + \alpha p_t^{(N)}$ and $\tilde{p}_t = (1-\alpha)\tilde{p}_t^{(T)} + \alpha\tilde{p}_t^{(N)}$, where α is the share of the nontradables sector in GDP.[3] Then we can write the last equation as

$$y_t = \left(e_t + p_t^{(T)} - \tilde{p}_t^{(T)}\right) + \alpha\left[\left(p_t^{(N)} - p_t^{(T)}\right) - \left(\tilde{p}_t^{(N)} - \tilde{p}_t^{(T)}\right)\right].$$

Assuming the law of one price holds, which is a reasonable assumption for Egypt's exports, then the first term vanishes, and noting that the term $\left(\tilde{p}_t^{(N)} - \tilde{p}_t^{(T)}\right)$ is of limited variation as the ratio of the price of nontradables to tradables in foreign markets tends to be

[3] We assume the share of the nontradables sector in GDP is the same in the domestic and foreign economies. It is straightforward to show that the subsequent result still holds if this assumption is relaxed.

stable, especially since we consider a trade-weighted average of the major currencies when calculating the REER. Thus we have

$$y_t \approx p_t^{(N)} - p_t^{(T)}$$

which establishes the equivalence of the definition in (3) to that given in (2).

2.3. The Equilibrium Real Exchange Rate (ERER) and Exchange Rate Misalignment

Nurkse (1945) was among the first economists to discuss the concept of the equilibrium real exchange rate (ERER), which he defined as the real exchange rate value that simultaneously achieves internal and external balance. Edwards (1989b) utilized this concept to outline a coherent methodology to estimate the ERER using observed economic fundamentals. The model of Edwards (1989b), hereinafter referred to as the Edwards model, along with its extensions in Elbadawi (1994), Baffes, Elbadawi and O'Connell (1999) and Edwards and Savastano (2000), have been a workhorse for a large body of applied research on exchange rate misalignment.

Although the models of Obstfeld and Rogoff (1995a), Montiel (1999) and Lane and Milesi-Ferretti (2004) are constructed differently compared to the Edwards model, since the former models have micro foundations with a representative agent that maximizes intertemporal utility, they still share the common feature that they give rise to a single reduced-form equation for the ERER as a function of economic fundamentals.

In this paper, we utilize the Edwards model to estimate Egypt's ERER and use it to obtain a measure of the historical exchange rate misalignment. The single equation that arises from the Edwards model is of the form:

$$Y_t = \beta' X_t + \varepsilon_t \tag{4}$$

where Y_t denotes the observed REER, X_t denotes the vector of economic fundamentals, and β is a vector of unknown parameters. The error term ε_t is assumed to be *iid* with mean zero and variance σ^2. Let $\tilde{Y}_t$ denote the unobserved ERER. To estimate $\tilde{Y}_t$, the vector of parameters β is to be estimated as a first step. Subsequently, the long run values of X_t are used to construct the ERER.[4] Letting $\tilde{X}_t$ denote the long run values of the fundamentals, the ERER is obtained using $\tilde{Y}_t = \hat{\beta}' \tilde{X}_t$.

[4] The long run values of the fundamentals refer to their permanent components when cyclical variation is ignored; see Edwards (1989b), Elbadawi (1994), and Baffes, Elbadawi and O'Connell (1999). In the empirical literature, they are typically obtained using some filtering method, e.g. the Hodrick-Prescott filter.

This conception of the ERER is centered on having the level of the real exchange rate consistent with the long run values of the economic fundamentals, therefore cointegration is an appropriate econometric modelling framework to capture this equilibrium mechanism. Indeed, one can interpret β as a cointegrating vector and expect ε_t in (4), or the linear combination $Y_t - \beta' X_t$, to be stationary. This is discussed in further detail in Section (4).

We now turn to the economic fundamentals that have been discussed in the theoretical literature, and employed in empirical studies of the ERER and exchange rate misalignment. Based on the extant literature, with particular emphasis on the literature focusing on developing countries, we consider the following six determinants of the ERER: the productivity differential, government consumption, investment, terms of trade, net foreign assets and trade openness.

The **productivity differential** captures the impact of economic development on the ERER. Countries that grow faster than their trade partners tend to experience an appreciation of the real exchange rate, primarily due to a disproportionate increase in the price of nontradables which leads to a gradual loss of competitiveness. This is known as the Balassa-Samuelson effect in recognition of the seminal contributions of Balassa (1964) and Samuelson (1964).

Both studies highlight the shortcomings of the purchasing power parity theory of the exchange rate, and argue that productivity growth differentials between the tradables and nontradables sectors can change relative prices in the economy, thereby inducing movements in the real exchange rate. Consider an economy with a sector for tradables and another for nontradables, where wages are determined by productivity in the tradables sector. Suppose there is a productivity increase in the tradables sector which leads to a rise in wages. This will not affect the price level in the tradables sector assuming the law of one price holds. However, the increase in wages in the tradables sector will exert upward pressure on wages in the nontradables sector. If there is no matching productivity increase in the latter, the rising wage level will lead to a price increase for nontradables relative to tradables causing a real appreciation. Indeed, in the empirical literature, the productivity differential is found to have a positive impact on the real exchange rate.

The Balassa-Samuelson effect identifies supply-side factors as determinants of the ERER. As argued by Froot and Rogoff (1995), and as demonstrated in Lane and Milesi-Ferretti (2004) and Ostry (1994), demand side factors such as an increase in **government consumption** may

also influence relative prices, which in turn affects the ERER. An increase in government consumption typically induces a real appreciation since higher government spending tends to be more heavily concentrated in nontradables, which increases their relative price.

Also related to demand-side factors is **investment**. The effect of an increase in total investment is ambiguous as it depends on the composition of the new investment and the associated demand it induces for nontradables versus tradables. If it generates a disproportionate demand for nontradables, this increases the price of nontradables relative to tradables which leads to a real appreciation. As indicated in Brixiova, Égert, and Essid (2014), the effect on the real exchange rate also partly depends on the differential impact of the new investment on the supply-side capacity in the two sectors.

A country's **terms of trade**, defined as the unit price of exports relative to the unit price of imports, is another important determinant of the ERER. The impact of the terms of trade on the ERER is not known a priori due to the presence of income and substitution effects given a change in the terms of trade (see Edwards (1989b) for a discussion). On the one hand, a decline in the terms of trade triggers a negative income effect with falling purchasing power shrinking the demand for nontradables, which lowers their relative price. On the other hand, the substitution effect shifts consumption from tradables to nontradables thereby increasing their relative price. Empirical evidence for developing economies suggests that the income effect is generally dominant, thus a deterioration in the terms of trade tends to be associated with real depreciation and vice versa.

Given the connection between the real exchange rate and external balance, the economy's stock of **net foreign assets** is another determinant of the ERER. A country with positive net foreign assets can sustain trade deficits since the latter can be covered by the returns on net foreign assets, and vice versa. A decline in net foreign assets indicates that an adjustment to the trade balance is needed to ensure sustainable servicing of foreign liabilities and this adjustment is typically induced by a nominal depreciation (see Obstfeld and Rogoff (1995b)). In their theoretical model, Lane and Milesi-Ferretti (2004) illustrate that a deterioration in a country's net foreign assets position tends to be associated with real depreciation. They also show cross-country evidence supporting the prediction of their model.

Finally, **trade openness** is also a significant determinant of the ERER over the medium term. Often accompanied by trade liberalization, trade openness lowers the cost of imports, which shifts demand from nontradables to tradables. This in turn leads to a decline in the price of nontradables causing a real depreciation. Obstfeld and Rogoff (1995a) and Hau (2002) also

show that closed economies are subject to greater real exchange rate volatility. Since a closed economy is subject to higher overall price rigidity, given the large size of the nontradables sector, this results in excessive volatility of the real exchange rate as the economy adjusts to recurring shocks.

Changes in the economic fundamentals induce movements in the ERER, but these changes are expected to occur in a gradual fashion, since cyclical variation and transitory noise in these variables are ignored when constructing the ERER series as indicated above. Generally, an increase in the ERER is an indication that the economic fundamentals are changing in a way that supports a real appreciation of the currency. This could be due to a surge in government spending, an increase in investment that unevenly affects the demand for nontradables, or a significant buildup of net foreign assets. On the other hand, an increase in trade openness is expected to lead to a lower ERER (i.e. a depreciated real exchange rate) to be consistent with the demand shift from nontradables to tradables. Once the ERER is estimated, it can be compared to the observed REER to gauge the extent of misalignment. If the REER is higher (lower) than the ERER, then the currency is considered overvalued (undervalued). The observed REER may of course deviate from the ERER, however it is severe and prolonged misalignment that imparts drastic effects on the economy.

The economic effects of exchange rate misalignment have been well documented in the literature. One notable impact is on economic growth as demonstrated in Cottani, Cavallo, and Khan (1990), Dollar (1992), Fischer (1993), Ghura and Grennes (1993), Easterly, Loayza, and Montiel (1997), and Razin and Collins (1999). Dollar (1992) finds that a high level of exchange rate misalignment is associated with lower growth. Fischer (1993) and Easterly, Loayza, and Montiel (1997) use the foreign exchange black market premium to gauge the exchange rate disconnect from its equilibrium value, and find that it is associated with lower growth. Razin and Collins (1999) document evidence of nonlinearity in the impact of exchange rate misalignment on growth: only high levels of overvaluation hurt growth, while moderate to high undervaluation seems conducive to higher growth.

Rodrik (2008) argues that currency undervaluation boosts economic growth in developing countries. This is achieved through the tradables sector, in particular the industrial sector, which tends to have a larger size relative to the nontradables sector in developing economies with undervalued currencies. The link between currency misalignment and the overall level of economic openness is also emphasized in Dollar (1992) and Sachs and Warner (1995).

In addition to its long term impact on growth and economic openness, exchange rate misalignment has been a culprit in many currency crises. In a seminal paper, Krugman (1979) outlines the anatomy of how, under a fixed exchange rate regime, a balance-of-payments crisis manifested in falling international reserves may lead to a full-fledged currency crisis where a speculative attack on the domestic currency results in a significant devaluation.[5] Empirically, Frankel and Rose (1996), and Kaminsky and Reinhart (1999) find currency overvaluation to be a significant predictor of currency crashes.

While the causes for exchange rate misalignment have varied historically across countries, there is strong evidence that adopting inflexible exchange rate regimes, particularly a fixed exchange rate, is a significant contributing factor (see, for example, Coudert and Couharde (2009) and Holtemöller and Mallick (2013)). Under a fixed exchange rate regime, the real exchange rate tends to witness appreciation, particularly if inflation in the home economy significantly exceeds that in the economies of the trade partners.

2.4. Previous Studies of Exchange Rate Misalignment in Egypt

We conclude our review of the theoretical and empirical literature by summarizing earlier studies of the ERER and exchange rate misalignment in Egypt. The majority of previous studies on Egypt utilized the Edwards model, or variants thereof, with very few exceptions. Mongardini (1998) studied Egypt's ERER and exchange rate misalignment following Egypt's economic reform and structural adjustment program that was launched in 1991. His findings indicate that the significant devaluation in the currency at the program's inception led to overshooting, with the real exchange rate approaching its equilibrium only after 1993. He concluded that the subsequent real appreciation of the currency was a result of an improvement in Egypt's economic fundamentals, in particular the improvement in the net foreign assets position due to the Paris Club debt forgiveness initiative.

The study of Mohieldin and Kouchouk (2003) examined the historical misalignment in Egypt's real exchange rate during the period 1970-2001 and concluded the existence of significant misalignment around times of turmoil, which eventually led to a sizable adjustment in the nominal exchange rate. They found that an unsustainable mix of fiscal and monetary policies was the main reason for the misalignment. This policy mix was incompatible with the

[5] A subsequent literature of "second generation" currency-crisis models emerged which typically assumes the existence of multiple equilibria, whereby a speculative attack on the currency can be triggered due to an expectation of a future deterioration in economic fundamentals, which gives rise to a self-fulfilling crisis. See Rangvid (2001) for a review.

fixed exchange rate regime that was adopted during most of this period. With regard to the economic fundamentals, they find government consumption, investment and the terms of trade to be significant determinants of the ERER.

Hosni (2015) estimated Egypt's ERER during the period 1974-2012, and calculated the degree of misalignment. With regard to her findings for the latter part of this period, she concluded that the currency was overvalued during 2009-2012. Her study corroborates the significance of the following economic fundamentals: the productivity differential, government consumption, investment and trade openness. Also, Hosni and Rofael (2015) analyzed the exchange rate misalignment between 1999 and 2012, and concluded that the exchange rate was overvalued during 2001-2003 and 2008-2012, and undervalued in the interim period.

Other papers that focused on Egypt in cross-country studies of exchange rate misalignment include Drine and Rault (2003) and Brixiova, Égert, and Essid (2014). Drine and Rault (2003) showed that government consumption and the level of trade openness are significant determinants of the ERER for seven countries in the MENA region including Egypt. With a focus on Egypt, Morocco and Tunisia, Brixiova, Égert, and Essid (2014) found the Egyptian currency to be overvalued from mid-1990s to the mid-2000s, with the real exchange rate approaching equilibrium during 2006-2007. In their study, net foreign assets, trade openness and the terms of trade were found to be significant determinants of the ERER.

3. Recent Exchange Rate Developments in Egypt

In this section, we document Egypt's exchange rate developments during the period of study, which is 2001Q3-2017Q3. To construct the NEER and REER indices, we use data for the following six trade partners: the EU (29.7 percent), US (7.8 percent), China (6.9 percent), Turkey (3.8 percent), Russia (3.0 percent), and the UK (2.5 percent), with the average trade share over the period 2006-2015 reported in brackets.[6] These countries combined represent 53.6 percent of Egypt's total trade.

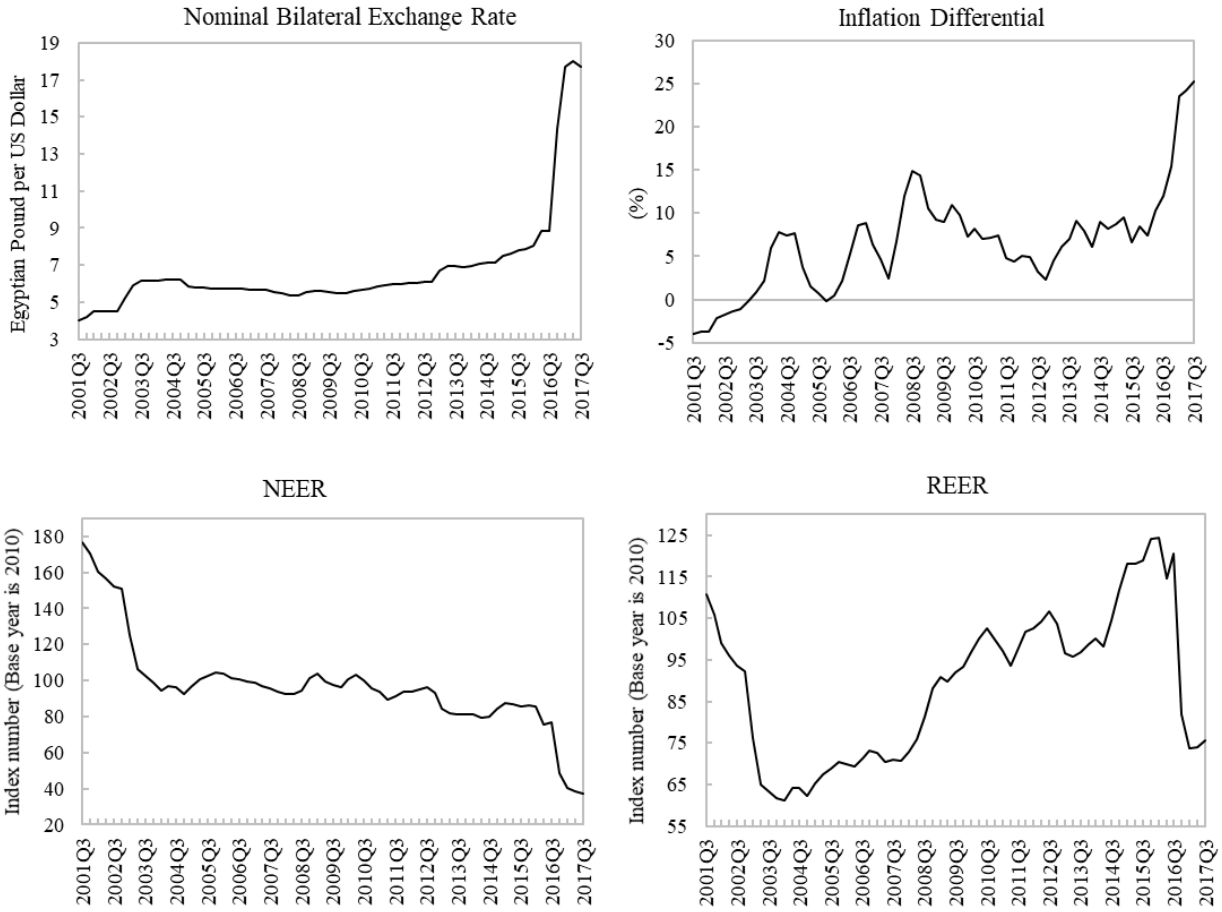
Figure 1 includes the historical nominal exchange rate for the US dollar over the entire sample period (top left panel), Egypt's inflation differential with its trade partners using the trade-weighted average inflation for the trade partners (top right panel), the NEER (bottom left panel) and the REER (bottom right panel). During the period 2001Q3-2004Q4, the nominal

[6] The trade share for country i is defined as the sum of Egypt's exports and imports with country i divided by Egypt's total trade. The trade shares have been normalized to sum to 100. Further details about the data sources used to construct the NEER and REER indices is provided in Section (5.1).

exchange rate against the US dollar depreciated by more than 50 percent from 0.25 dollars per pound (4.04 pounds per dollar) to 0.16 dollars per pound (6.22 pounds per dollar). This was due to a series of successive devaluations to counter pressure on the exchange rate due to mild overvaluation at the time (see Mohieldin and Kouchouk (2003) and Hosni and Rofael (2015)). Afterwards, the Egyptian pound gradually strengthened to 0.19 dollars per pound (5.35 pounds per dollar) by 2008Q3 before gradually losing ground to the US dollar, witnessing a sharp depreciation after it was floated in 2016Q4. Since the floatation, the nominal exchange rate reached 0.055 dollars per pound (18.03 pounds per dollar) in 2017Q2 before appreciating slightly in 2017Q3 recording 0.056 dollars per pound (17.73 pounds per dollar); see the top left panel of Figure 1.

As shown in the bottom left panel, the NEER shows a similar trend signaling that the Egyptian pound witnessed a general depreciating trend against the currencies of all six trade partners. Recall that the NEER and REER series are constructed such that an increase means appreciation. However, two distinct time periods showed different behavior. The first period is 2005Q1-2008Q3 in which the pound appreciated slightly against the US dollar, however the NEER remained almost flat over the same period since the US dollar had weakened against the currencies of the other trade partners, namely the EU, China, Turkey and Russia. The second period is 2013Q1-2016Q3 when the Egyptian pound witnessed moderate gradual depreciation against the US dollar, while the NEER showed a slight appreciation. This was due to the US dollar strengthening significantly against the euro, the Turkish lira and the Russian ruble.

Figure 1. Exchange Rate and Inflation Developments



Notes: The plotted series are based on data from the following sources: Central Bank of Egypt, the IMF International Financial Statistics database, and Trade Map. The NEER and REER are both index numbers with base year 2010.

Figure 1 also shows developments in the REER in the bottom right panel. Generally, changes in the REER reflect changes in nominal bilateral exchange rates, variation in Egypt's inflation differential with its trade partners, or a combination of the two. During 2001Q3-2003Q4, the REER declined indicating a real depreciation in the currency and an improvement in external competitiveness. This was due to the successive devaluations in the Egyptian pound against the US dollar and other major currencies. Starting 2004, the REER started to increase signifying real appreciation, and indicating that the competitiveness gains from the 2001-2003 devaluations were being eroded. The increase in the REER during this period was due to the rising rate of inflation in Egypt relative to its trade partners (see the top right panel), and a nominal appreciation in the Egyptian pound during the period 2005Q1-2008Q3.[7]

[7] As we show later on, this real appreciation was in fact supported by improving economic fundamentals, and therefore did not cause exchange rate misalignment.

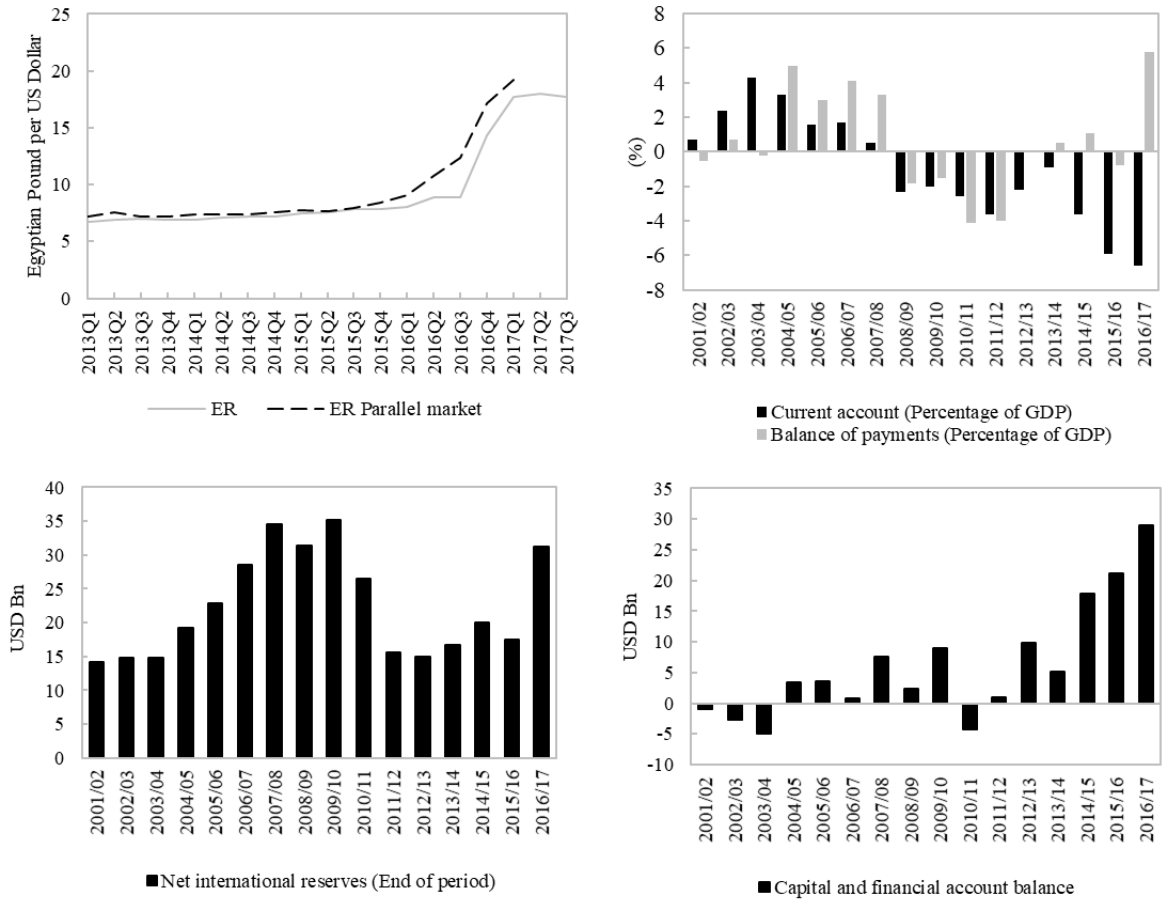
As the inflation differential between Egypt and its trade partners declined with the economic downturn in Egypt starting 2011, coupled with a gradual nominal depreciation of the pound, the REER went down slightly before witnessing a significant increase since the beginning of 2014. During 2014Q1-2015Q4, the currencies of most of Egypt's trade partners witnessed a strong retreat against the US dollar.[8] Since the Egyptian pound witnessed only a mild depreciation against the US dollar (around 13 percent during this period), this meant a significant rise in the REER as the Egyptian pound was appreciating in real terms against other major currencies, which resulted in a loss of external competitiveness. In addition, Egypt's inflation recorded an average of 9.8 percent compared to weighted-average rate of inflation at about 1.7 percent for Egypt's main trade partners, which further amplified the rise in the REER.

As the REER showed significant appreciation during this period, and as it became strongly detached from its equilibrium level as we show later in the empirical analysis, a parallel currency market started to emerge, which gradually acquired an increasing share of foreign exchange transactions. The parallel market exchange rate premium increased considerably during the summer months of 2016 amid a drying up of foreign exchange liquidity (see the top left panel of Figure 2).[9] The liquidity squeeze was in large part due to the decline in tourism revenue after the crash of a Russian passenger plane over Sinai in October 2015. In addition, and as the parallel market premium increased, workers' remittances flowing into the banking sector declined giving way to informal channels for the transfer of funds to Egypt. By the end of the summer of 2016, the majority of foreign exchange transactions in Egypt were conducted at the parallel market rate.

[8] The cumulative depreciation against the US dollar during 2014Q1-2015Q4 amounted to 25.1 percent for the euro, 4.4 percent for the Chinese yuan, 31.1 percent for the Turkish lira, 88.5 percent for the Russian ruble and 8.9 percent for the Sterling pound.

[9] In 2016Q1, the official and parallel market rates were 8.02 and 9.06 pound per US dollar, respectively. By 2016Q3, the official and parallel market rates recorded 8.86 and 12.39 pound per US dollar.

Figure 2. Egypt's Balance of Payments Developments



Notes: The source for the data on the balance of payments and net international reserves is the Central Bank of Egypt. For the parallel market exchange rate (ER), quarterly averages are computed based on daily data from Bloomberg and Reuters.

Against the background of a general deterioration in external accounts starting FY 2010/2011 (see the top right panel of Figure 2), and the exchange rate becoming significantly overvalued since the beginning of 2015, the attempt to defend the currency peg led to a decline in international reserves. Reserves went down from a peak level of USD 35.2 billion in FY 2009/2010 to USD 17.6 billion in FY 2015/2016 (see the bottom left panel of Figure 2). A further reduction in net international reserves could have happened had it not been for a surge in capital and financial inflows (see the bottom right panel of Figure 2), which were primarily in the form of government-to-government grants and short-term loans. On 11 August 2016, the Egyptian authorities signed a staff-level agreement with the IMF to obtain a three-year Extended Fund Facility (EFF) for USD 12 billion. The agreement stipulated a series of economic reforms, which paved the way for the floatation of the pound on 3 November 2016.

Right before the floatation, the parallel market exchange rate was quite volatile from day to day due to the presence of intense speculation. After the floatation, banks were allowed to

set their exchange rates based on their own sources and uses of foreign exchange. The official market rates became increasingly aligned with quoted rates in the parallel market leading to a gradual disappearance of the latter. The floatation of the currency, and the concurrent defensive hike in interest rates attracted significant financial flows to Egypt in the form of carry trade (see the bottom right panel of Figure 2), which led to a significant improvement in the balance of payments in 2016/2017 despite the continued current account deficit (see the top right panel of Figure 2).

The adoption of a floating exchange rate was one of the fundamental pillars of the EFF agreement with the IMF. It marks a significant departure from the policy of pegging the exchange rate to the US dollar as an anchor currency, which lasted for most of Egypt's recent history. The EFF agreement also included other reforms such as the removal of subsidies on energy products and publicly-provided utilities (e.g. electricity, water and transportation) through gradual price increases. The enactment of these measures coupled with the pass-through effect due to the floatation led to an unprecedented surge in the annual rate of inflation, which exceeded 30 percent during the early months of 2017.

Although it resulted primarily from a supply-side shock, the surge in inflation was exacerbated by two factors: First, there was ample liquidity in the economy prior to the devaluation. During the period 2012Q1-2016Q4, money supply grew annually at 17.05 percent at a time when real GDP growth averaged only 3.54 percent. Second, shifting from one monetary policy regime to another meant absence of a nominal anchor for inflation expectations. We revisit the second factor in further detail in the concluding remarks in Section 7.

4. Econometric Methodology

The basic premise of the Edwards model is a tight connection between a country's ERER and its economic fundamentals over the medium term. The model's theoretical predictions, as well as extensive empirical evidence for various countries, indicate that a significant level of exchange rate misalignment is unsustainable. In such a case, a correction is bound to occur to bring the actual exchange rate closer to its equilibrium level. The mildness or severity of this correction depends on a multitude of factors, prime amongst them is the degree of misalignment, which dictates the extent of adjustment needed to restore internal and external balance.

Given this premise, cointegration is a natural modelling framework to estimate the ERER. The concept of cointegration is credited to Engle and Granger (1987), with subsequent seminal contributions by Johansen (1988, 1991). Before testing for cointegration, one must test for the nonstationary of the variables employed in the model. Afterwards, and following the Engle and Granger (1987) method, the long run regression is estimated by ordinary least squares. The long run regression is given by:

$$Y_t = \beta_0 + \beta_1 PD_t + \beta_2 INV_t + \beta_3 GOV_t + \beta_4 TOT_t + \beta_5 NFA_t + \beta_6 OPEN_t + \varepsilon_t, \quad (5)$$

where ε_t is *iid* with mean 0 and variance σ_ε^2. The economic fundamentals on the right-hand-side of (5) are the productivity differential (PD_t), the share of investment in GDP (INV_t), the share of government consumption in GDP (GOV_t), terms of trade (TOT_t), the ratio of net foreign assets to GDP (NFA_t), and trade openness ($OPEN_t$). Equation (5) can also be written as $Y_t = \beta' X_t + \varepsilon_t$, where X_t is the vector of economic fundamentals, and β is the cointegration vector. The residuals from (5) are given by $\hat{\varepsilon}_t = Y_t - \hat{\beta}' X_t$. For a cointegration relationship to exist, the residuals $\hat{\varepsilon}_t$ must be integrated of a lower order, which is tested for using the Augmented Dickey-Fuller (ADF) test or alternative tests. If found stationary, an error correction model (ECM) is then specified for the short run dynamics as follows:

$$\begin{aligned} \Delta Y_t = \delta_0 + \gamma \hat{\varepsilon}_{t-1} + \delta_1 \Delta PD_t + \delta_2 \Delta INV_t + \delta_3 \Delta GOV_t + \delta_4 \Delta TOT_t + \delta_5 \Delta NFA_t \\ + \delta_6 \Delta OPEN_t + \eta_t, \end{aligned} \quad (6)$$

where Δ denotes the first-difference operator, and η_t is assumed *iid* with mean 0 and variance σ_η^2. The term $\gamma \hat{\varepsilon}_{t-1}$ is the error correction term, and γ captures the speed of adjustment to past disequilibria, i.e. previous misalignment.

Once the cointegration vector β is estimated, the ERER is constructed using the long run values of the fundamentals, which are denoted by $\tilde{X}_t$. These are extracted from the original series using some filtering method (e.g. Hodrick-Prescott filter) to separate out the transitory movements in the fundamentals and extract their permanent components. The ERER, denoted by Y_t^*, is then constructed as

$$Y_t^* = \hat{\beta}' \tilde{X}_t,$$

with the exchange rate misalignment at time t (as a percentage of the ERER) given by

$$M_t = 100 \left(\frac{Y_t - Y_t^*}{Y_t^*} \right).$$

Johansen (1988, 1991) developed an alternative method which is capable of finding more than one cointegration relationship, if existing. Define $Z_t = (Y_t, X_t')'$ as the vector containing all the variables including the dependent variable Y_t. A VAR model for the first differences can be specified as follows:

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{i=1}^{p} \Phi_i \, \Delta Z_{t-i} + u_t.$$

If the variables in Z_t are cointegrated, then Π is a reduced-rank matrix. In such a case, it can be written as $\Pi = \alpha\beta'$, where β is the cointegration vector (or matrix containing the cointegration vectors if there is more than one), while α is the vector (or matrix in case of more than one cointegrating relationship), which includes the speed of adjustment parameters. The method then proceeds with testing for the order of cointegration using the rank and trace tests outlined in Johansen (1988, 1991).

While the Johansen method is deemed superior to that of Engle and Granger (1987) in terms of the power properties of the cointegration test, it is often problematic in application when it indicates the presence of more than one cointegration relationship without a clear theoretical interpretation for each one. In addition, the Johansen method involves fitting a VAR model as a first step, and therefore suffers from the curse of dimensionality problem when dealing with a large number of variables and a relatively short time series.[10]

5. Empirical Results

5.1. Data Sources

The data sample used in the construction of the REER and in estimating the model parameters is for the period 2001Q3-2017Q3. The choice of the start of the sample period is dictated by the lack of quarterly fiscal data before that date. The trade partners used in the analysis are the EU (29.7 percent), US (7.8 percent), China (6.9 percent), Turkey (3.8 percent), Russia (3.0 percent), and the UK (2.5 percent), with the trade shares over the period 2006-2015 reported in brackets. Combined, these countries represented 53.6 percent of Egypt's total trade, and the shares have been normalized to sum to 100. The data for the trade shares are obtained from Trade Map (www.trademap.org). The bilateral exchange rate data and consumer price indices

[10] In the empirical analysis, we employ the two methods and show that the results of the Johansen method are difficult to interpret since they suggest more than one cointegration relationship, however, the coefficient signs and magnitudes cannot be reconciled with economic theory or corresponding findings from the literature. We discuss this in detail in Section 5.3.

used in the construction of the REER are obtained from the IMF International Financial Statistics and OECD online databases.

Egypt's data (GDP components and net foreign assets) are obtained from the Ministry of Planning and the Central Bank of Egypt. For the terms of trade, we constructed a *commodity terms of trade* index using global price indices available from the IMF World Economic Outlook (WEO) database. These include price indices for agricultural raw materials, cereals, fuel, meat, metals, sugar and vegetable oils. The corresponding shares for Egypt's exports and imports with regard to these commodity groups are obtained from Trade Map. For per capita GDP, which is used to construct the productivity differential, data for the trade partners are obtained from the IMF WEO database and Eurostat. The corresponding time series are plotted in Figure 4.

For variables available only at the annual frequency, cubic spline interpolation has been used to obtain the quarterly observations. Finally, seasonal adjustment for the variable *INV* has been applied to remove its strong seasonal pattern using the X-13 ARIMA-SEATS algorithm.[11]

5.2. Unit Root Tests

In Table 1, we report the results of the ADF test for the presence of a unit root, for both the levels and first differences of the variables employed in the study. These are: the real effective exchange rate (*REER*), the productivity differential (*PD*), the share of investment in GDP (*INV*), the share of government consumption in GDP (*GOV*), terms of trade (*TOT*), net foreign assets as a percentage of GDP (*NFA*), and trade openness (*OPEN*).

Table 1. Augmented Dickey-Fuller (ADF) Unit Root Test Results

	(Levels)	*(First differences)*
REER	-1.481	-5.818***
PD	-1.472	-3.728***
INV	-1.782	-11.423***
GOV	-0.083	-4.827***
TOT	-2.254	-4.599***
NFA	-1.309	-7.110***
OPEN	-1.647	-2.953**

Notes: All variables are in natural logarithm except for *NFA*. For the ADF test, the test specification assumed either an intercept, or intercept plus trend for some of the variables, and for lag selection the Schwarz information criterion was used. *** and ** mark statistical significance at the 1 and 5 percent levels of significance, respectively.

The results indicate that all of the variables are I(1), and are stationary in first differences. The null hypothesis of a unit root in first differences is uniformly rejected for all the variables

[11] See the U.S. Census Bureau manual (https://www.census.gov/ts/x13as/docX13AS.pdf) for details on the X-13 ARIMA-SEATS filter.

at the 1 percent level of significance, except for trade openness (*OPEN*) where the hypothesis is rejected at the 5 percent level of significance.

5.3. Estimation Results

In Table 2, we report the parameter estimates for the long run regression in (5). All of the estimated coefficients have the expected signs and are statistically significant at the 1 percent level of significance. The only exception is the coefficient on the terms of trade (*TOT*), which is not statistically significant. Generally, the model has a good fit with an R^2 of 0.88. The normality of the residuals is not rejected at the 1 percent level of significance using the Jarque-Bera, and Anderson and Darling (1952) tests, with the latter providing more power to detect misspecification in the tail of the distribution. The Ramsey RESET test was also carried out, and it indicates the appropriateness of the linear specification.

Table 2. Determinants of the Equilibrium Real Exchange Rate: Long-Run Estimates

	Coefficient Estimates	Standard Error	Standardized Coefficients
Constant	4.508***	0.651	
PD	0.342***	0.075	0.504
INV	0.323***	0.102	0.243
GOV	0.378***	0.098	0.211
TOT	0.189	0.175	0.071
NFA	0.002***	0.000	0.318
OPEN	-0.686***	0.101	-0.829

Notes: All variables are in natural logarithm except for *NFA*. For an estimated coefficient $\hat{\beta}$, the standardized coefficient is computed as $\hat{\beta}s_x s_y^{-1}$, where s_x and s_y respectively denote the standard deviation of the explanatory and the dependent variables. *** marks statistical significance at the 1 percent level of significance.

The signs of the coefficients are all consistent with economic theory, and their magnitude is comparable to the estimates found in the empirical literature for other developing economies. The interpretation of the estimates is straightforward. For instance, a 1 percent increase in the productivity differential (*PD*) in favor of Egypt leads to an increase (i.e. appreciation) in the REER by about 0.342 percent, whereas a 1 percent increase in trade openness (*OPEN*) lowers the REER by about 0.686 percent. The positive signs of the coefficients on *INV* and *GOV* indicate that an increase in investment and government consumption tends to be concentrated in the nontradables sector, which leads to a real appreciation.

With regard to net foreign assets (*NFA*), an improvement in the *NFA* position leads to a real appreciation since the economy can afford a relative deterioration in the current account, which would then be offset by the returns on the economy's net foreign assets. The terms of trade (*TOT*) has a positive, yet statistically insignificant coefficient, indicating that the income effect of terms of trade changes dominates the substitution effect. Despite the insignificance of

the *TOT* variable, we still include it in the model since it is found to be significant when using sub-samples that do not include the observations post the currency floatation.[12]

The last column reports the standardized coefficients to gauge the relative importance of each explanatory variable. Adjusted by the ratio of the standard deviations of the corresponding explanatory variable and the dependent variable, the standardized coefficients are normalized to correct for different levels of variability and the effect of units of measurement. They show that trade openness (*OPEN*) seems to be the most influential among all the economic fundamentals with a standardized coefficient of -0.829, indicating that a one standard deviation increase in trade openness (*OPEN*) lowers the REER by 0.829 standard deviations. The productivity differential (*PD*) and net foreign assets (*NFA*) come next with standardized coefficients of 0.504 and 0.318, respectively.

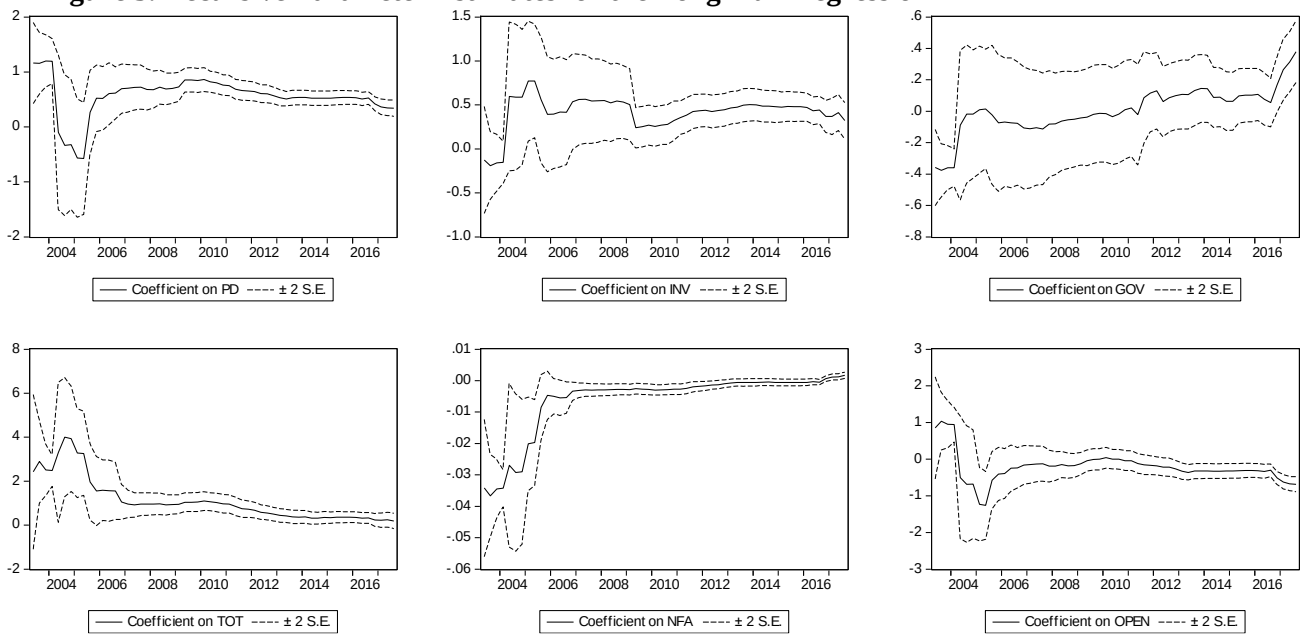
The investment-to-GDP ratio (*INV*) and the share of government consumption in GDP (*GOV*) are relatively less important in driving the variation in the observed REER in comparison to the productivity differential and trade openness. The terms of trade (*TOT*) appears as the least influential variable possibly due to Egypt's commodity export and import base being sufficiently diversified such that terms of trade shocks are relatively unimportant. However, it should be noted that the terms of trade variable is constructed only for commodities, which constitute the smaller share in Egypt's total exports and imports, representing 46.4 percent for the former and 36.2 percent for the latter as an average over the period 2006-2015.

With regard to the stability of the parameters of the long run regression, Figure 3 shows the recursive parameter estimates, which are estimated by increasing the sample size by one observation at a time. The results show that the estimated parameters were relatively stable once the sample size was large enough,[13] however there is evidence of a structural break in the parameter values starting 2016Q4, the quarter in which the fixed exchange rate regime was abandoned. This change is more pronounced for the coefficients on *PD* and *OPEN*, which happen to be the two most influential variables for the determination of the ERER. There is also a notable change in the value of the coefficient on *GOV*.

[12] Sub-sample analysis is undertaken in Section 6.2 to investigate the robustness of the projections to structural breaks in the parameter values.

[13] The only exception is the coefficient on government consumption (*GOV*) which shows a mild upward trend as the estimation window expands.

Figure 3. Recursive Parameter Estimates for the Long-Run Regression



Notes: Starting 2003Q2, the regression in (5) is recursively estimated by expanding the estimation window by one observation at a time. For each panel, the solid line is the recursively-estimated parameter value, and the dashed lines are confidence bands obtained using ±2 times the parameter standard error.

Visual inspection of Figure 3 indicates that this structural break is not transitory in nature. Rather, it reflects a sustained change in the value of the coefficients starting 2016Q4, which coincides with a fundamental regime change since currency floatation was adopted. In Section 6.2 we conduct sensitivity analysis to check the robustness of our projections to this structural break.

Following Engle and Granger (1987), we conduct the ADF unit root test for the residuals from the long run regression, which returns a *p*-value of 0.000 indicating strong rejection of the null hypothesis of a unit root. This confirms the existence of a long run equilibrium relationship between the real exchange rate and the economic fundamentals, with the parameter estimates reported in Table 2 constituting the cointegration vector.

According to the Engle and Granger (1987) two-step estimation procedure, the second step is the estimation of the error correction model for the short run dynamics. Table 3 reports the parameter estimates of the regression in (6). Here, only the productivity differential (*PD*) and trade openness (*OPEN*) are statistically significant at the 1 percent level of significance. Considering the standardized coefficients, *PD* and *OPEN* have the largest impact on changes in the REER.

Table 3. Error Correction Model Estimates

	Coefficient Estimates	Standard Error	Standardized Coefficients
Constant	-0.006	0.007	
ΔPD	0.862***	0.193	0.453
ΔINV	0.079	0.062	0.128
ΔGOV	0.028	0.061	0.052
ΔTOT	0.457	0.413	0.110
ΔNFA	0.000	0.001	0.047
ΔOPEN	-0.217***	0.081	-0.316
ECM term	-0.512***	0.108	-0.495

Notes: All variables are in natural logarithm except for *NFA*. For an estimated coefficient $\hat{\beta}$, the standardized coefficient is computed as $\hat{\beta} s_x s_y^{-1}$, where s_x and s_y respectively denote the standard deviation of the explanatory and the dependent variables. *** marks statistical significance at the 1 percent level of significance.

As for the coefficient of the ECM term, it also has the correct sign and is statistically significant at the 1 percent level of significance. The coefficient magnitude indicates a relatively fast speed of adjustment to past disequilibria, and this is primarily due to the high pass-through from the exchange rate to domestic inflation, which leads to fast appreciation in the REER after a significant devaluation. This behavior had been evident during the crisis of 2002-2003 and, more recently, during the crisis of 2016.

We also implemented the Johansen (1988, 1991) method by estimating a VAR model, which incorporated all the variables including the REER.[14] The analysis rendered the following results: the trace statistic indicated the presence of 4 cointegration relationships, while the maximum eigenvalue statistic suggested the presence of 3 cointegration relationships. This problem is also encountered in Hosni (2015), and the author chose to eliminate some variables from the model to address the problem. In addition to suggesting an inconceivably large number of cointegration relationships, the results of the Johansen method also reveal that the coefficients of the cointegrating vectors have uninterpretable signs and implausible magnitudes. Finally, the test for multivariate normality of the residuals is also rejected at conventional levels of significance returning a p-value of 0.003.[15]

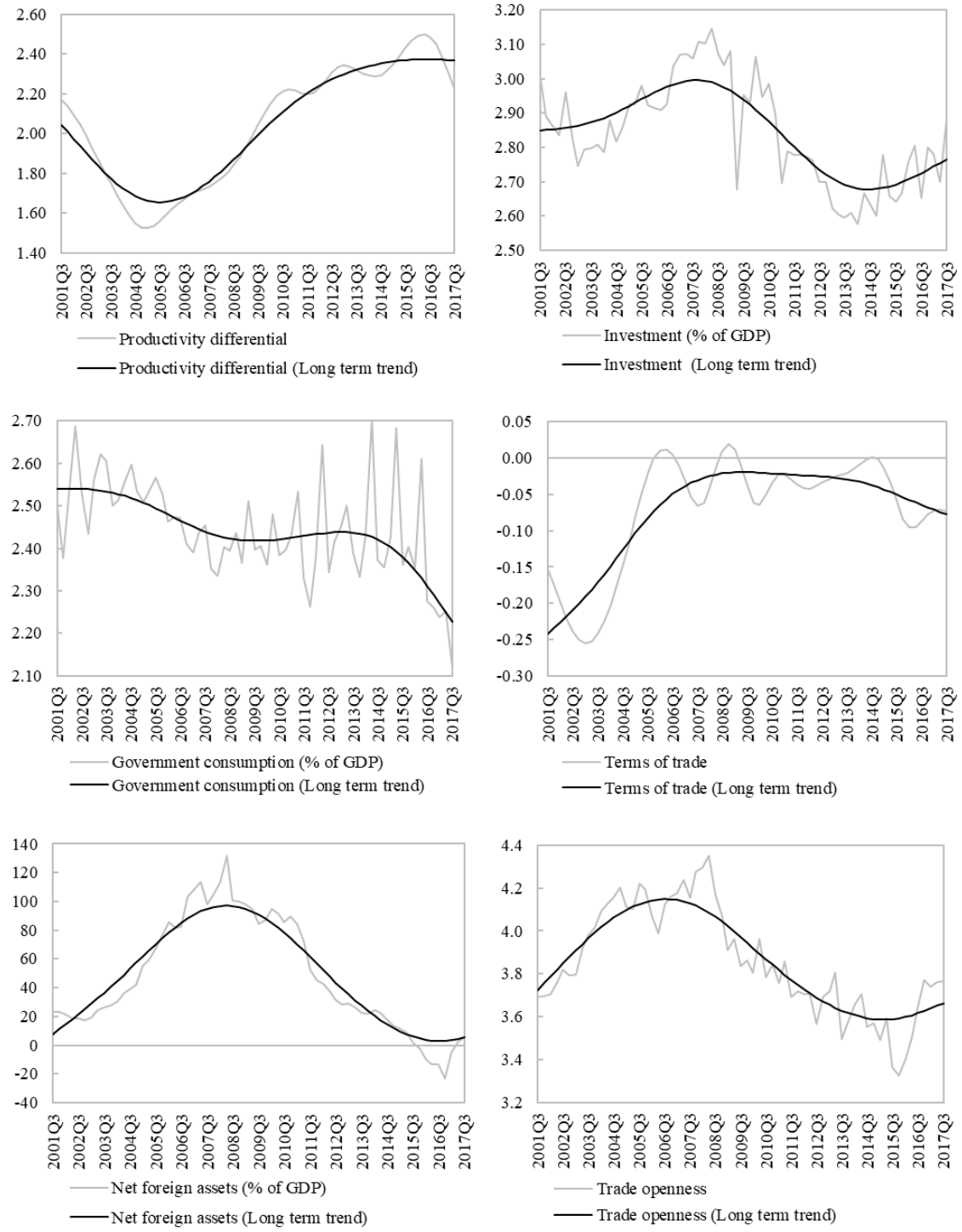
5.4. Constructing The Equilibrium Real Exchange Rate

As discussed in Section 4, we use the permanent (i.e. long run) component of the economic fundamentals to construct our estimate of the ERER. Figure 4 displays the time series for the economic fundamentals along with their permanent components.

[14] The Schwarz criterion suggested the inclusion of 4 lags in the VAR model.

[15] The detailed results are not reported in the interest of brevity, but are available from the author upon request.

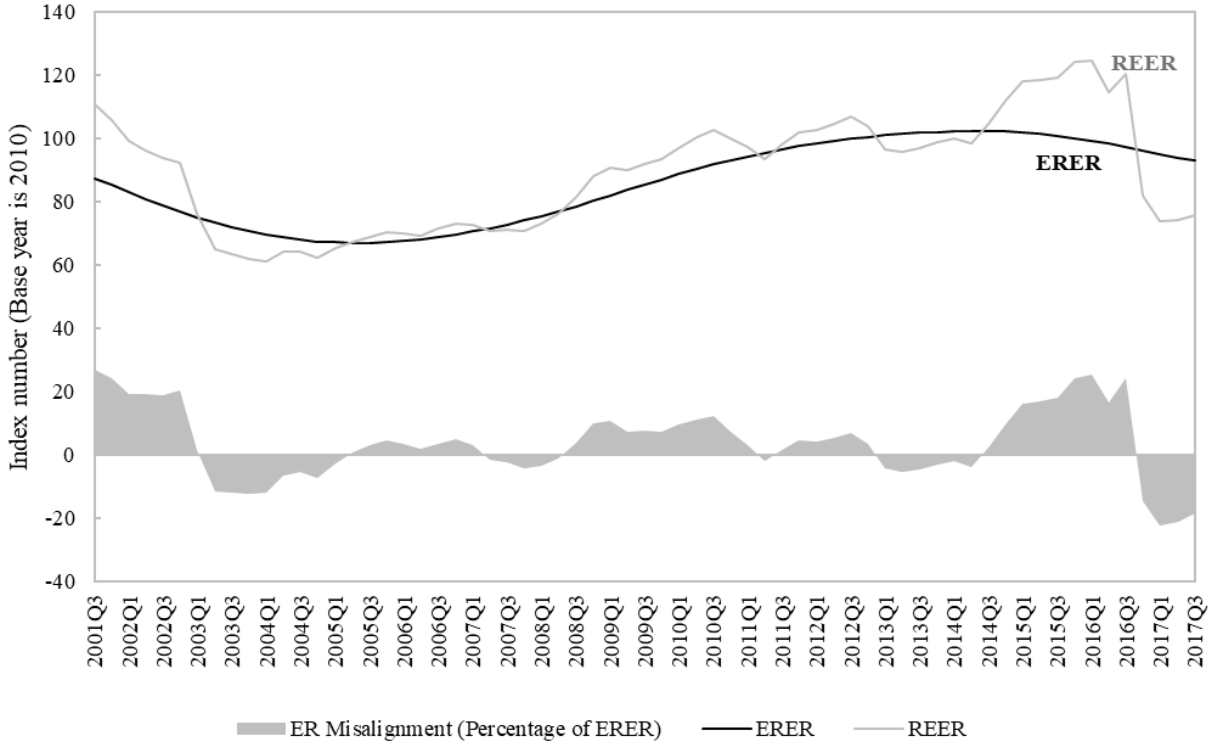
Figure 4. The Economic Fundamentals and Long Run Trends (Historical)



Notes: The figure plots the time series for the economic fundamentals over the sample period 2001Q3-2017Q3. All series are expressed in natural logarithm, except for *NFA*. For each panel, the grey line is the historical time series, and the black (smooth) line is the permanent component obtained using a Hodrick-Prescott filter.

The permanent components of the economic fundamentals are used along with the parameter estimates of the long run regression in Table 2 to construct the ERER series. Figure 5 displays the REER (grey line), the ERER (black smooth line) and the exchange rate misalignment as the area graph displayed around the horizontal axis.

Figure 5. The Equilibrium Real Exchange Rate and Misalignment (Historical)



Notes: The figure plots the time series for the real effective exchange rate (REER) as the grey line, the estimated equilibrium real exchange rate (ERER) as the smooth black line. The REER is an index number with a value equal to 100 in the base year 2010. The exchange rate (ER) misalignment is plotted as the area graph around the horizontal axis, and is computed as ((*REER* – *ERER*)/*ERER*)*100.

Figure 5 shows that the ERER has varied over time along with changes in the economic fundamentals. In general, the REER has tracked the ERER well, however there were periods during which the two variables became strongly disassociated. During 2001Q3-2002Q4, the exchange rate was significantly overvalued, that is the REER was significantly higher than the ERER. A strong nominal devaluation in 2003Q1 led to overshooting, which reversed the misalignment such that the exchange rate became undervalued. Based on the experience of many countries, exchange rate overshooting tends to happen whenever a significant adjustment in the exchange rate occurs.

By 2003Q2 the exchange rate was undervalued by 11.6 percent rising to 12.6 percent in 2003Q4 before the misalignment started to retreat. This gradual reduction in the misalignment was partly due to an increase in the REER because of the surge in inflation in Egypt (relative to trade partners) due to the pass-through effect, in addition to some nominal appreciation of the Egyptian pound against the US dollar starting 2005Q1.

From 2006Q1 onwards, the REER along with the ERER were appreciating, which indicates that the improving fundamentals of the Egyptian economy helped sustain real currency appreciation. The improvement in the fundamentals during this period is attributed to

strong economic growth relative to trade partners, an improvement in the terms of trade, and a significant increase in net foreign assets (see Figure 4).

After some mild undervaluation during 2013Q1-2014Q2, the situation drastically changed to strong overvaluation starting 2015Q1. This happened due to the dual effect of a REER appreciation and a decline in the equilibrium real exchange rate, with the latter occurring due to deteriorating fundamentals. On the one hand, the rise in the REER was due to: (i) most of Egypt's trade partners witnessing significant currency depreciations against the US dollar while the Egyptian pound remained strong as it was pegged to the US dollar,[16] and (ii) the rise in Egypt's inflation differential, particularly since 2016Q2 as it soared to double-digit figures (see Figure 1). On the other hand, the deterioration in the economic fundamentals was mainly due to a decline in the productivity differential, investment, terms of trade and net foreign assets (see Figure 4). Despite the increase in government consumption during this period, and the general decline in trade openness, their combined effect on the ERER was not sufficient to counter the impact of the other fundamentals, which acted to lower the ERER.

Although the correct policy response at the time was to let the Egyptian pound to depreciate to match the decline in the ERER and thereby avoid currency overvaluation, the monetary authority opted instead for defending the currency peg, which proved to be an untenable stance. In 2016Q3, right before the floatation, the Egyptian pound was overvalued by about 24 percent. With the floatation of the currency, exchange rate overshooting occurred resulting in the currency being undervalued in real terms by about 14.7 percent in 2016Q4, and increasing further to reach 22.3 percent undervaluation by 2017Q1, before showing a gradual decline. The decline in the misalignment more recently is due to the fast appreciation of the REER because of the surge in domestic inflation. Towards the end of the sample period in 2017Q3, the exchange rate was undervalued by 18.5 percent.

5.5. Exchange Rate Evolution Under a Flexible Exchange Rate Regime: A Counterfactual Scenario

In the previous subsection, we argued that the policy response to the exchange rate overvaluation during the period 2015Q1-2016Q3 was suboptimal. In this subsection, we present a counterfactual scenario to answer the following question: If the exchange rate was determined

[16] Between 2014Q1 and 2016Q4, the US dollar appreciated by 27 percent against the Euro, 11 percent against the Chinese Yuan, 48 percent against the Turkish Lira, 80 percent against the Russian Ruble and 32 percent against the Sterling. This meant that the Egyptian pound was significantly appreciating (in real terms) against the currencies of Egypt's main trade partners due to being pegged to the US dollar.

without intervention since the beginning of 2015, what would have been the path of the nominal exchange rate for the US dollar? Using the estimated ERER, we back out the equilibrium nominal exchange rate for the US dollar that would have prevailed over the period 2015-2016 if it were left to be determined by market forces. We focus on the period 2015-2016 since this is the period in which a parallel market for foreign exchange emerged and had become the predominant foreign exchange market before the floatation of the currency.

In Table 4, we show the evolution of the equilibrium nominal exchange rate for the US dollar, along with the official and parallel market rates. The figures clearly show that the overshooting of the exchange rate after the floatation could have been avoided had the exchange rate been determined more flexibly to reflect the changing economic fundamentals during this turbulent period. Specifically, the nominal exchange rate at the time should have been around 12.24 pounds per US dollar.

Unsurprisingly, the parallel market rate was actually tracking the rise in the equilibrium rate during this period, hence it was more reflective of the pound's fair value. However, the parallel market rate started to increase notably, exceeding its equilibrium value in 2016Q2. We conjecture that this occurred due to the emergence of huge speculative demand for foreign exchange amid a dearth of liquidity. It was also coupled with a growing state of anxiousness about an inevitable strong devaluation at some undetermined date. The delay in deciding to devalue or float the Egyptian pound was certainly a compounding factor. Between 2016Q2 and 2016Q4, the black market rate increased from 10.8 pounds per US dollar to 17.16 pounds per US dollar, which is an increase of 58.9 percent. This rendered any traded foreign currency quite a valuable asset with abnormal returns, which served to boost speculative demand for these currencies. Most likely, this has also hampered efficient price discovery post the floatation.

Table 4. Evolution of the Nominal Exchange Rate for the US Dollar (EGP per USD) under the Counterfactual Scenario

	Official rate	Equilibrium rate	Parallel market rate
2015Q1	7.49	8.69	7.74
2015Q2	7.61	8.87	7.67
2015Q3	7.81	9.22	7.96
2015Q4	7.87	9.76	8.46
2016Q1	8.02	10.06	9.06
2016Q2	8.86	10.32	10.80
2016Q3	8.86	10.98	12.39
2016Q4	14.36	12.24	17.16
2017Q1	17.72	13.76	19.23*
2017Q2	18.03	14.21	--
2017Q3	17.73	14.45	--

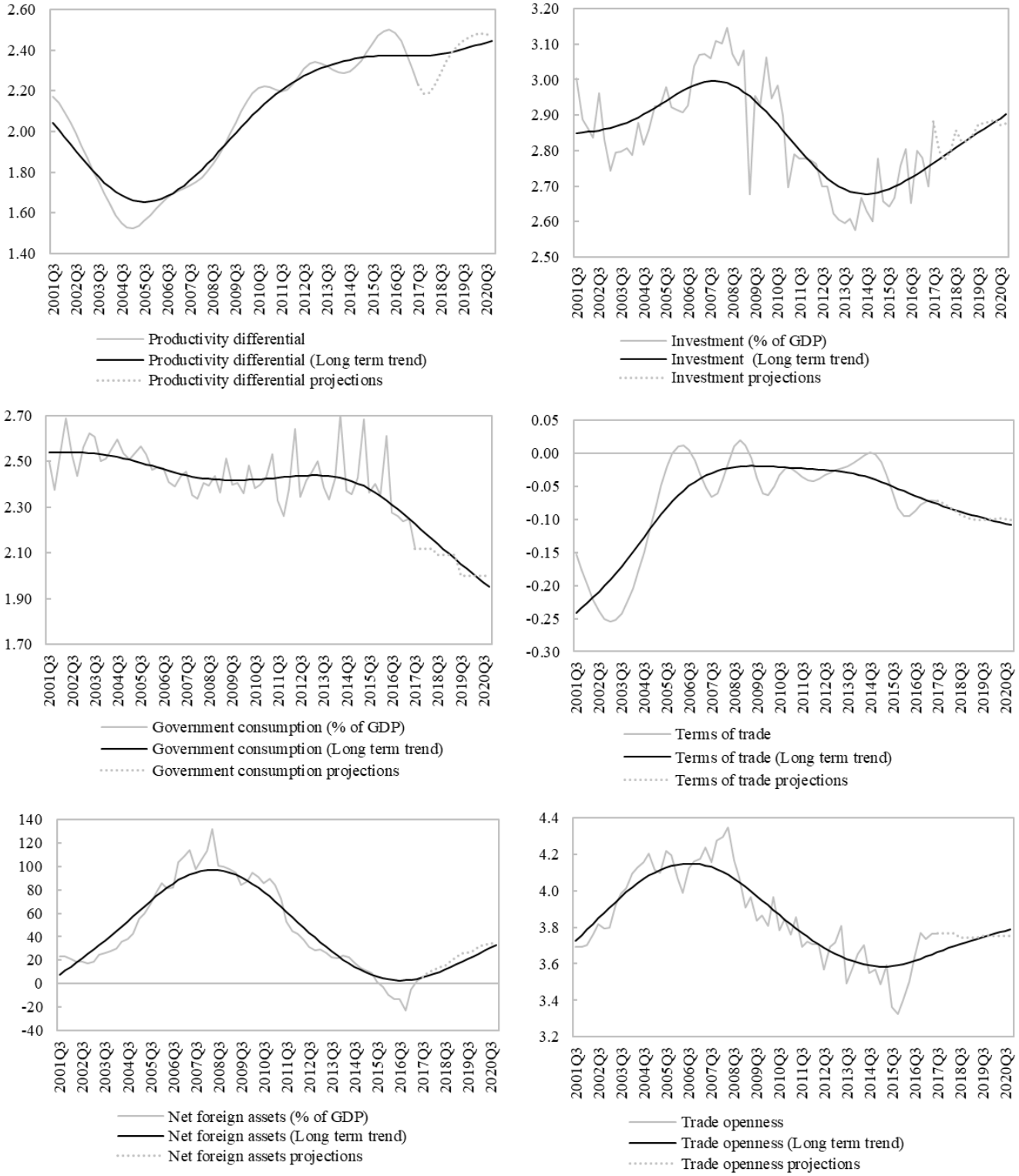
Notes: The equilibrium rate is based on the author's calculations given the estimated equilibrium real exchange rate (ERER). The sources for the official and parallel market rates are the Central Bank of Egypt and Bloomberg/Reuters, respectively.
* This is the average of the daily rates quoted in the parallel market from 1 January 2017 until 6 February 2017, the date after which the parallel market ceased to exist.

After the floatation of the currency in 2016Q4, the parallel market persisted for a while to test the monetary authority's resolve in committing to the new regime. The parallel market rates recorded new highs during that period with the exchange rate exceeding 20 pounds per US dollar at one point, however by early February 2017, the parallel market ceased to exist.

6. MEDIUM-TERM PROJECTIONS

In this section, we provide projections for the ERER until the end of 2020, along with the likely path for the evolution of the current misalignment, i.e. current undervaluation of the Egyptian pound. This is undertaken by constructing projections for the six economic fundamentals to obtain projections for the ERER. In addition, we also construct projections for the REER to show the likely path for exchange rate misalignment over the short to medium term. The source for Egypt's projections is the Egypt IMF Country Report No. 17/290 (September 2017). The projections for the trade partners are obtained from the IMF WEO database (October 2017 edition) and Eurostat. Figure 6 shows the projected fundamentals (dashed grey line) along with their long run values obtained using the Hodrick-Prescott filter.

Figure 6. The Economic Fundamentals and Long-Run Trends (Projections)

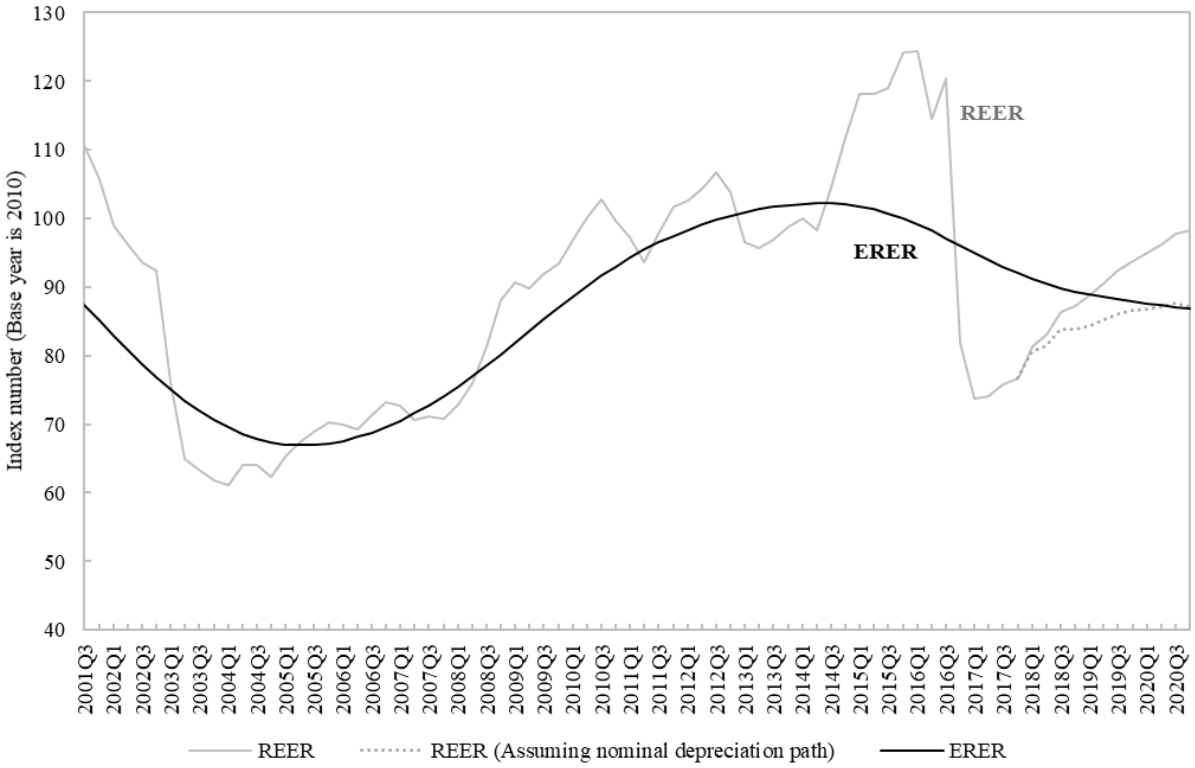


Notes: The figure plots the time series for the economic fundamentals over the sample period 2001Q3-2017Q3, in addition to projections until 2020Q4. All series are expressed in natural logarithm, except for *NFA*. For each panel, the grey line is the historical time series, and the black (smooth) line is the permanent component obtained using a Hodrick-Prescott filter.

6.1. Equilibrium Real Exchange Rate Projections for 2017Q4 - 2020Q4

As shown in Figure 7, the projections indicate that the REER will be subject to gradual appreciation since Egypt's inflation is expected to remain significantly above the rate of inflation in the trade partners until the end of the projections period in 2020Q4. This path is displayed by the solid grey line. Such evolution is based on the assumption that the nominal exchange rate for the US dollar remains at its 2017Q3 level, which is 17.73 pounds per US dollar, and given the IMF inflation projections for Egypt and its trade partners. Over the same period, the ERER is showing a decline, indicating that the equilibrium exchange rate will be more depreciated relative to its value in 2017Q3.

Figure 7. The Equilibrium Real Exchange Rate and Misalignment (Projections)



Notes: The figure plots the real effective exchange rate (REER) as the grey line, along with projections for the period 2017Q4-2020Q4. The continuation of the REER (solid grey line) assumes that the nominal exchange rate will remain at its 2017Q3 level (i.e. 17.73 pounds per US dollar), and assuming a path for inflation in Egypt and the trade partners based on the IMF projections. The dotted grey line is based on an alternative scenario in which the nominal exchange rate will be depreciating by one percent every quarter throughout the projections period. The estimated equilibrium real exchange rate (ERER) is plotted as the smooth black line. The REER is an index number with a value equal to 100 in the base year 2010.

The decline in the ERER, which places it on a depreciating path, is determined by three factors: (i) the decline in Egypt's productivity differential (*PD*), (ii) the decline in the share of government consumption in GDP (*GOV*) given the ongoing fiscal consolidation, and (iii) the projected increase in trade openness (*OPEN*) (see Figure 6). Recalling that *PD* and *OPEN* have the greatest effect on the ERER, their impact dominates that of the increase in investment (*INV*) and net foreign assets (*NFA*), which have an appreciating effect on the ERER.

Given the combined impact of an appreciating REER and a declining ERER, the exchange rate misalignment is bound to disappear by 2019Q1. At that point in time, the equilibrium nominal exchange rate is expected to be 17.70 pounds per US dollar. As the REER keeps appreciating, the currency is projected to be overvalued by around 13.1 percent by the end of 2020Q4. This occurs since the nominal exchange rate is assumed to remain at 17.73 pounds per US dollar, while the equilibrium value will be around 20.05 pounds per dollar by the end of 2020.

The assumption that the nominal exchange rate remains fixed at 17.73 pounds per US dollar is not innocuous. It implies that the exchange rate will not be allowed to respond to changing fundamentals, which, of course, should not be the case if the currency is truly floating. We now make an alternative assumption that the exchange rate will be depreciating in nominal terms by one percent every quarter starting from 2017Q4 until 2020Q4. This path is given by the dotted grey line in Figure 7. It shows that the REER appreciation path is now milder since two opposing forces will be at play: the high inflation differential will be pushing the REER to rise, while the nominal depreciation will be pushing it down. It is evident that the effect of the inflation differential will dominate. Under this one-percent-per-quarter nominal depreciation path, the exchange rate undervaluation will dissipate more slowly, and the nominal exchange rate will be approximately at its equilibrium level of 20.05 pounds per US dollar by 2020Q4.

It is worth emphasizing that the exchange rate values quoted in this analysis are subject to a considerable margin of uncertainty for two reasons. First, the exercise of estimating the ERER around times of significant economic adjustment, as in Egypt's case, is a challenging task. We already showed evidence of a structural break in the value of the long run parameters, which necessitates some sensitivity analysis to ascertain the robustness of the results. Second, the projected ERER is based on the projections of many variables for Egypt and its trade partners, therefore, it is somewhat sensitive to changes in the paths of the corresponding variables. Naturally, the margin of uncertainty is higher for the longer horizon.

6.2. Robustness Check: A Forecast Combination Approach

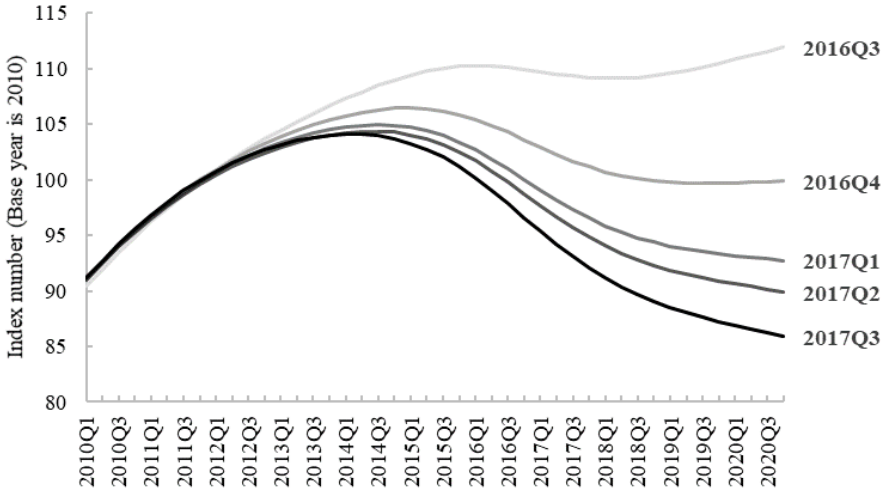
As indicated earlier, there is evidence of a structural break in the parameters of the long run regression. This presents a challenge since it occurs at the end of the sample period, and this is particularly relevant since we use the estimated parameters to construct future projections of the ERER. One way to address this challenge is to utilize various point estimates of the parameters to construct alternative forecast paths under each set of parameter values. This is based on the idea of forecast combinations which has been shown to provide robust results

when confronted with structural breaks (see, for example, Pesaran and Timmermann (2007) and Tian and Anderson (2014)).

To this end, we utilize different sets of parameter estimates before and after the regime change in 2016Q4. Specifically, we consider the period 2016Q3 to 2017Q3 for a total of five quarters. We then obtain parameter estimates from different samples that end in each respective quarter, and use it to construct projections for the period 2017Q4-2020Q4. The implied ERER path under each set of estimates is displayed in Figure 8, with the vintage reported next to each trajectory.

One can obtain projections of the ERER by averaging the five trajectories reported in Figure 8. As can be gleaned from the figure, the combined forecast will have a more appreciated level relative to the one based on the 2017Q3 vintage. Note that the latter was the basis for the analysis in Section 6.1. We combine the trajectories using both unweighted and weighted averaging schemes, the difference being that the latter gives relatively more weight to the recent vintages.[17] According to the combined projections path, the estimates show that the fair value for the Egyptian pound will be in the range of 18.21 to 18.83 pounds per US dollar in 2020Q4, where the lower and upper limits of this range correspond to the unweighted and weighted schemes, respectively.

Figure 8. Various Paths for the Equilibrium Real Exchange Rate



Notes: The figure plots various projections for the equilibrium real exchange rate (ERER) for various vintages of in-sample estimation of the long run parameters. The vintages correspond to the five quarters from 2016Q3 to 2017Q3.

[17] For the weighted average scheme, we use exponentially declining weights given by $w_j = \lambda^j \left(\sum_{j=1}^{m} \lambda^j\right)^{-1}$, where m is the number of vintage points employed, which is five quarters, and λ is the exponential decay parameter set equal to 0.75.

This exercise shows the sensitivity of the projections to the way we address the regime change of 2016Q4. This, in turn, invokes the question of whether recent data should be given less weight through averaging the estimates of different vintages. The answer to this question depends on one's view as to whether the break is a genuine one or if it is transitory in nature. While this is a matter of speculation since there is not enough observations post the break to undertake more extensive analysis, we conjecture that recent data should be given full weight when it comes to near-future projections of the ERER given that the new parameter values have rather persisted since the 2017Q1 vintage. The analysis in Section 6.1, in which the projected nominal exchange rate in 2020Q4 is 20.05 pounds per US dollar, is based on the most recent vintage (i.e. 2017Q3), which gives full weight to the most recent data.

7. CONCLUDING REMARKS

Although the floatation of the Egyptian pound led to overshooting, with the exchange rate becoming undervalued by about 22.3 percent right after the devaluation, this undervaluation is only temporary. The currency floatation sparked an unprecedented inflationary wave in Egypt, which is exerting upward pressure on the REER, signifying that the competitiveness gains from the devaluation are dissipating fast. Our estimates show that if the exchange rate is left to be determined by market forces, then the nominal exchange rate for the US dollar will have to depreciate from its 2017Q3 level of 17.73 pounds per US dollar. This paper has shown some likely paths for the real and nominal exchange rates under different sets of assumptions, which are suggestive and indicative of the underlying trends. The main conclusion from the analysis is that the change in Egypt's economic fundamentals in the last few years warrants a more depreciated, and hence more competitive, exchange rate to maintain internal and external balance.

The excessive overshooting of the exchange rate in the aftermath of the floatation is due in no small part to the delay in devaluing the Egyptian pound during the course of 2016, or even earlier during 2015. Given legitimate concerns at the time about the inflationary impact of the devaluation, postponing this move has inadvertently fueled speculative demand for foreign currencies. This has in turn contributed to exchange rate overshooting, which created an inflationary wave that surpassed expectations by a substantial margin.

Going forward, the recent crisis offers important lessons and also poses questions, which the policymakers must ponder if Egypt is to successfully devise a new framework for monetary policy. Since the emerging monetary policy framework is an inflation-targeting regime, a

natural question to consider is whether the institutional prerequisites for inflation targeting are in place.

Masson, Savastano, and Sharma (1997) and Mishkin (2004) emphasize that the scope for the conduct of independent monetary policy in developing countries is often hampered by the excessive reliance on the monetization of the budget deficit. This form of fiscal dominance makes it difficult, if not impossible, for the monetary authority to control inflation, and it tends to undermine the credibility of the monetary policy framework. An additional constraint that often exists is having shallow capital markets, which reduces the effectiveness of the monetary transmission mechanism from policy instruments to targets such as output and inflation.

The success of inflation targeting in Egypt not only necessitates the de facto independence of the monetary authority from fiscal pressure, but also requires continuous communication with the public to adequately anchor inflation expectations. The operationalization of inflation targeting goes well beyond the introduction of numerical inflation targets, as its success critically hinges upon the adoption of an information-intensive approach to monetary policy conduct, including enhanced transparency through continuous communication with the public, in addition to holding the monetary authority accountable if it fails to meet the announced inflation targets.

Convincing the public that the CBE's overriding objective is price stability is not an easy task, especially if there is skepticism about the absence of fiscal dominance. In contrast to an exchange rate peg, inflation targeting allows the monetary authority to smooth output fluctuations over the business cycle using its policy instruments. However, the commitment to a low and stable rate of inflation must be the overriding objective if conflict arises. Instating this notion in the public's mind takes effort and time, and it needs to be a central component of the monetary authority's drive to build its credibility with regard to preserving price stability.

This in turn hinges upon economic agents gradually shifting their focus from a long-established nominal anchor, which is the nominal exchange rate, to a new anchor which is the announced inflation target. Initially, this requires a true abandonment of the exchange rate peg. Currently, the observed exchange rate volatility appears artificially low, and this will not serve the CBE over the medium term to re-anchor expectations around its announced inflation target. It is natural to worry about the impact of exchange rate volatility on inflation, however, one must also acknowledge that the high pass-through from the exchange rate to inflation is largely due to the exchange rate having been a firmly-established nominal anchor for far too long.

Needless to say, bringing inflation down to single digits is needed before inflation targeting can be meaningfully adopted. Most developed economies have targets in the range of 2-3 percent annual inflation. Other countries (e.g. Brazil, India, Russia and Vietnam) chose targets in the range of 4-5 percent. Achieving inflation rates in this range in the near future is a challenge given the commitment of the Egyptian government to continue on a course of price liberalization for energy products and public utilities as government subsidies are removed. However, the adoption of a carefully-designed communication strategy could help a great deal in managing the course of monetary policy during this transition.

On the operational side, there are two important issues to consider. The first relates to the effectiveness of the policy tools at the disposal of the monetary authority to affect output and inflation outcomes. The second operational issue pertains to the availability of timely and accurate data, which enables policymakers to make the right decisions in real time. With regard to the second issue, there is no doubt that both the accuracy and timeliness of economic data could be improved, especially when it comes to the real sector. As for the monetary policy transmission mechanism, we believe that it is not very well understood in the case of Egypt given that the majority of the adult population is unbanked, and also given the existence of a large informal sector. This issue warrants further study.

The above points are not meant to discourage the CBE's move to inflation targeting. Adopting inflation targeting is a real opportunity to institute a successful and sustainable monetary policy regime in Egypt. Rather, they are intended to highlight some pertinent issues that are critical for the success of inflation targeting in Egypt. Needless to say, having a sustainable monetary policy framework in Egypt will not, on its own, solve all of Egypt's economic woes. The root causes of many of Egypt's economic problems relate to structural weaknesses. In particular, the alarmingly low rate of national savings, which indicates an insufficient rate of capital formation, places a binding constraint on the rate of growth of potential output. Complementary real-sector reforms are needed to encourage private saving and investment, with incentives to expand the economy's potential to export goods and services with high domestic value added. This is when the economy could really reap the fruits of an improved macroeconomic policy framework.

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