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Asymmetric Impact of Real Effective Exchange Rate Changes on Domestic Output Revisited: Evidence from Egypt

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Asymmetric Impact of Real Effective Exchange Rate Changes on Domestic Output Revisited: Evidence from Egypt

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Abstract

The Egyptian pound has undergone substantial devaluations over the past five years. The Central Bank of Egypt aimed through these currency devaluations to stimulate domestic output. In this paper, we investigate the asymmetric impact of the real effective exchange rate (REER) on Egypt's real domestic output from 1960 to 2020 using a Nonlinear Autoregressive Distributed Lag (NARDL) model. The analyses account for the various channels via which the REER would affect domestic output. Results show evidence of a long-run asymmetry in the output effect of REER changes in which only real currency depreciations have a contractionary impact on output, while the REER has no impact on output in the short run. The Egyptian monetary authority cannot rely on domestic currency depreciation as a policy instrument to boost domestic output.

Keywords: Asymmetric effects; Domestic output; Egypt; ARDL; Real effective exchange rate.

JEL classification: E63; F31; F41; F62.

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1. Introduction

The real effective exchange rate (REER), defined as an average of the bilateral real exchange rates between a country and each of its trading partners, weighted by the respective trade shares of each partner, is a core measure of the trade capabilities and competitiveness of a country's exports in the international markets. Currency depreciations or devaluations are an essential part of the economic adjustment and stability programs proposed by the International Monetary Fund (IMF) that have been employed to enhance the competitiveness of several developing countries in the global market (Edwards, 1986). A reduction in the REER of a country means that its imports are getting more expensive, while exports are becoming cheaper, which would promote its trade balance and hence boost domestic output .

Theoretically, the impact of real currency changes on domestic production could be positive or negative and remains an empirical exercise. It has been shown that the output impact of currency changes is country-specific and depends on the model specification, estimation techniques, and the period under investigation (Bahmani-Oskooee & Miteza, 2003).

In Egypt, the response of macro variables to the REER changes had gained growing attention among academics and policymakers since the beginning of the 1990s when the Egyptian government launched the Economic Reform and Structural Adjustment Program (ERSAP), after which Egypt has witnessed multiple changes in its exchange rate system.

In November 2016, the Egyptian monetary authorities devalued the Egyptian pound by about half of its external value. A second substantial devaluation took place in March 2022, by which the Egyptian pound lost almost 18% of its external value. These consequent devaluations were intended to boost domestic production and mitigate the adverse repercussions of the covid-19 pandemic on the Egyptian economy and the global inflationary pressures caused by the Russian-Ukrainian conflict.

The main objective of this study is to investigate the short-run and long-run impact of the REER on Egypt's real GDP during the period 1960-2020, using the nonlinear autoregressive distributed lag (NARDL) approach of Shin et al. (2014) to isolate real currency depreciations from appreciations and account for the potential asymmetry in this impact.

We contribute to the extant literature in several ways. First, in this study, we use the REER instead of the real bilateral rate against the US dollar to measure the real external value of the Egyptian currency. Egypt trades with many countries with different currencies, and using the REER is expected to be a more accurate external competitiveness indicator. Second, previous studies mostly assumed that currency appreciations or depreciations have a linear effect on output. However, recent theoretical and empirical research indicates that the adjustment behavior of most economic variables involves significant nonlinearities (asymmetries), so in this study, we hypothesize that the REER changes have an asymmetric effect on the Egyptian domestic output. Third, to the best of the authors' knowledge and to date, the current study is the first that examines the potential asymmetric impact of real exchange rate changes on domestic output in Egypt over a long-time span ranging from 1969 to 2020 while controlling for the potential structural breaks in that relationship and the various channels through which the REER can affect domestic output.

Empirical related literature is mostly dominated by studies that assume that domestic output responds symmetrically to changes in the exchange rate. Recently, the potential asymmetric impact of exchange rate changes on domestic output has received growing attention to separate currency appreciations from depreciation (see, for example, the findings of Bahmani-Oskooee & Mohammadian (2018); Bahmani-Oskooee & Arize (2020) and Nusair (2021). The findings of these studies generally supported the asymmetric hypothesis, both in the short-run and long-run, which indicates that currency appreciation has a different impact on a country's output than currency depreciation.

The current study's findings show evidence for a long-run asymmetry in the output effect of REER changes in which real currency appreciation has no impact on domestic output, while real currency depreciations have a statistically significant contractionary impact.

The rest of the paper is organized as follows: Section 2 briefly reviews the related theoretical and empirical literature. Section 3 presents the data and the empirical methodology. Section 4 presents the results, and Section 5 concludes the paper.

2. Theoretical Background and Empirical Literature

The macroeconomic impact of the exchange rate has received growing attention in the economics literature since the work of Alexander (1952). The focus of early research was on the Aggregate Demand (AD) and Aggregate Supply (AS) model to examine the impact of currency devaluation or depreciation on output (Cooper, 1971; Wijnbergen, 2007).

Theoretically, currency devaluation/depreciation could affect output through two counteracting forces. Firstly, on the one hand, devaluation/depreciation could increase aggregate output through its impact on AD via improved international competitiveness and hence the boosting of exports. Currency devaluations/depreciations are, in this case, expansionary (Bahmani-Oskooee et al., 2018). This traditional viewpoint requires that the Marshall-Lerner condition be met, which states that the sum of the price elasticity of demand on imports and exports must be larger than unity. On the other hand, by redistributing income from workers who have a high marginal propensity to consume (MPC) to capital owners with a low MPC, currency devaluations/depreciations would reduce aggregate consumption and AD, resulting in a contractionary effect on output, as noted by Alexander (1952). Also, local importers will speed their purchases as a foreshadowing to subsequent devaluations, worrying that they will have to pay more for products in national currency terms later. At the same time, foreign importers hold off on making purchases for the devaluation country's exports in the hopes of getting them cheaper. In both cases, contractionary devaluation will come true because net exports are falling, reflecting the idea of the self-fulfilling prophecy. This is also known as the impact of physical lags, according to Thirlwall (1980). Secondly, currency devaluation/depreciation could hurt domestic output because of its effect on AS. Devaluations/depreciations would raise the cost of imports and imported inputs, so manufacturing costs will rise, resulting in contractionary effects. Countries that rely extensively on imported materials for production will face increased production costs, leading to a drop in AS, followed by a contractionary effect on domestic output (Krugman & Taylor, 1978).

To sum up, on theoretical grounds, the final effect of a devaluation/depreciation on domestic output is apriori indeterminate. The effect could be contractionary or expansionary, depending on the magnitude of the shifts in the AD and AS (Gylfason & Radetzki, 1991).

It has been shown that the effects of devaluation on domestic production are country-specific and are sensitive to model specification and the estimation technique (Bahmani-Oskooee & Miteza, 2003). Panel and cross-sectional analyses of the nexus between the exchange rate and domestic output were used in early studies due to the lack of long time-series data for most countries (Bahmani-Oskooee et al., 2018). Since the seminal work of Bahmani-Oskooee & Miteza (2003), a large amount of data for many individual countries has been accessible, and researchers have taken advantage of it by using time-series analysis to avoid the aggregation bias inherent in panel studies.

Empirical time-series evidence on the impact of currency changes on domestic output is inconclusive. While some studies found an expansionary output effect for currency devaluation/depreciation (Bahmani-Oskooee & Rhee, 1997; Gylfason & Schmid, 1983; Ratha, 2010), other studies found devaluation/depreciation contractionary (An et al., 2014; Shahbaz et al., 2012), and a third group of studies found a neutral effect for currency changes on domestic output (Ayen, 2014; Bahmani-Oskooee, 1998; Upadhyaya & Upadhyay, 1999). For example (Gylfason & Schmid, 1983) presented a basic macroeconomic model wherein devaluation affects real income and production via the supply side's cost of imported inputs and the demand side's exports, imports, and expenditures. They focused on ten industrial and developing countries and found that in most cases, demand impacts outweigh cost effects, confirming the traditional view that devaluation has positive real effects in these nations. Using quarterly data from 1971 to 1994, Bahmani-Oskooee & Rhee (1997) found real devaluation of the local currency in Korea expansionary, and Narayan & Narayan (2007) found similar evidence for Fiji. Ratha (2010) found that the rupee depreciation in India is expansionary. Shahbaz et al. (2012) found that the effect of real devaluation on economic growth is contractionary in Pakistan.

An et al. (2014) analyzed the effects of real exchange rate changes on real output growth for 16 Latin American, Asian, and non-G3 developed countries using quarterly data from 1973 to 2012. The authors found that contractionary devaluation is not contingent upon the type of economy or the exchange rate regime; it may happen in developed and developing countries. Ayen (2014) found that currency devaluations are observed to be contractionary in the long run but neutral in the short run in Ethiopia.

Bahmani-Oskooee (1998) investigated the impact of devaluations of nominal effective exchange rate on the output of selected least developed countries that involved Egypt from 1973 to 1988. The results indicated that devaluations in most countries have no long-term effect on output. Upadhyaya & Upadhyay (1999) examined the impact of devaluation on the output of six developing Asian countries and found that in general, a devaluation has no impact on output over any length of time — short-run, intermediate run, or long run.

The aforementioned empirical literature is mostly dominated by studies that assume that domestic output responds symmetrically to changes in the exchange rate. As a result, linear models are used, such as the ARDL model or Engle-Granger, Johansen cointegration procedure. According to recent theoretical and empirical investigations, most economic variables have significant nonlinearities and asymmetries in their adjustment behavior. Changes in the exchange rate especially may have an asymmetric effect on output, given the considerable evidence of asymmetric responses of import and export prices to changes in exchange rates. Also, it has been shown that asymmetry analysis which involves the use of nonlinear (asymmetric) models, generates far more significant and accurate results than linear (symmetric) models (Bahmani-Oskooee & Arize, 2020). For example, Bahmani-Oskooee & Mohammadian (2017) found that the failure of previous studies to find significant long-term effects for the yen depreciation on the Japanese domestic production is due to the assumption of a linear adjustment mechanism or symmetric effects of exchange rate changes. The authors revisited the impact of exchange changes on domestic output using a nonlinear ARDL approach and found that changes in Japan's exchange rate have asymmetric effects on domestic production.

Recently, the potential asymmetric impact of exchange rate changes on domestic output has received growing attention to separate currency appreciations from depreciation (see, for example, the findings of Bahmani-Oskooee & Mohammadian (2016) for Australia, Bahmani-Oskooee & Mohammadian (2017) for Japan, Bahmani-Oskooee & Mohammadian (2018) for Turkey, Bahmani-Oskooee & Arize (2020) for selected African countries, and Nusair (2021) for a group of Asian countries. The findings of these studies generally supported the asymmetric hypothesis, both in the short-run and long-run, which indicates that currency appreciation has a different impact on a country's output than currency depreciation. For instance, in a recent cross-country study, using annual data over the period 1973 to 2018, Nusair (2021) employed the NARDL model to investigate the asymmetric impacts of real exchange rates on domestic output in seven Asian nations, including Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, and Thailand. The author found evidence of asymmetries in the effects of real exchange changes on the domestic output of all the examined countries in both the short-run and long run. Currency appreciations and depreciations were contractionary in most cases.

Empirical evidence on the exchange rate- domestic output nexus in Egypt is very limited with few studies. For instance, in an earlier study, using a VAR model and annual data from 1982 to 2004, El-Ramly & Abdel-Haleim (2008) found a short-run contractionary effect for currency devaluation on output lasts four years before the devaluation's intended positive impact begins to appear. The previous research on the impact of the exchange rate on the Egyptian output ignored asymmetry in the effects of changes in REER on domestic output.

Accordingly, this study will answer the central question: Do the Egyptian REER changes have an asymmetric effect on domestic production? This is the first research for Egypt that we are aware of.

3. Data and methods

To uncover whether the REER changes have symmetric or asymmetric effects on domestic output, we use the linear (symmetric) ARDL model of Pesaran et al. (2001), then employ the nonlinear (asymmetric) NARDL model of Shin et al. (2014) to isolate currency depreciation from appreciations. The analyses cover the period 1960 to 2020, and the data is drawn from the World Development Indicators. The variables covered by the analyses include the gross domestic product (GDP), the real effective exchange rate (REER), the money supply (M) as a proxy for the monetary policy, government spending (G) as a proxy for the fiscal policy, and the global oil price which is converted to local currency units using the official nominal exchange rate. The global oil price is included in the analyses to capture the aggregate supply channel through which the REER could affect domestic output. For more details on how the REER is constructed see Darvas (2021). All the variables are expressed in local currency units and were converted to real terms using the GDP deflator. All variables are expressed in natural logarithmic form.

Insert Figure 1 here

Figure 1 plots the real GDP and the REER over the study period and suggests a positive correlation between the two variables. This was also supported by a positive correlation coefficient of 0.196 between the two variables. This positive correlation indicates that real depreciation is contractionary in its effect on domestic output.

Following most of the earlier related studies, such as Bahmani-Oskooee & Arize (2020); Bahmani-Oskooee & Mohammadian (2017); Nusair (2021), we use the model in Equation (1) to estimate the impact of the REER on domestic output within a multivariate approach that captures other variables that affect domestic output.

As discussed earlier in the literature section, the model in Equation (1) captures the AD and AS channels through which the REER could affect domestic output. The changes in government spending (as a proxy of the fiscal policy) and money supply (as a proxy of the monetary policy) capture the AD channel. The price of oil captures the AS channel.

$$GDP_t = \gamma_0 + \gamma_1 \, REER_t + \gamma_2 \, G_t + \gamma_3 \, M_t + \gamma_4 \, P_t^{oil} + u_t \qquad (1)$$

Where GDP is the real gross domestic product, $REER_t$ is the real effective exchange rate, M_t is the real money supply, used as a proxy for the monetary policy, G_t is the real government spending, used as a proxy for the fiscal policy, P_t^{oil} is the real price of oil, u_t is the standard random error term.

The analysis typically starts with checking the order of integration of all the variables to ensure a non-spurious estimation and that none of the variables is integrated of an order greater than one I(1); otherwise, the bounds test for cointegration will not be valid. In this regards, the paper uses two standard unit root tests, the Phillips- Perron (PP) test, and the Augmented Dickey-Fuller (ADF) test. Two versions of both tests are used; one version allows for a constant, and a second allows for a constant and a deterministic trend.

After determining the order of integration of the time series, cointegration between the variables is tested using the bounds test for cointegration within an NARDL unrestricted error correction model. If cointegration exists between the variables, the analysis proceeds by estimating the long-run and short-run asymmetric impact of the REER on real GDP through the decomposition of the changes in the REER into positive changes, REER_t^+, and negative changes, REER_t^- as in equations (2) and (3). Where the $REER_t^+$ and $REER_t^-$ are the partial sums of the positive and negative changes in the $REER$, respectively:

$$REER_t^+ = \sum_{i=1}^{t} \Delta REER_t^+ = \sum_{i=1}^{t} \max(REER_i, 0) \quad (2)$$

$$REER_t^- = \sum_{i=1}^{t} \Delta REER_t^- = \sum_{i=1}^{t} \min(REER_i, 0) \quad (3)$$

An NARDL approach proposed by Shin et al. (2014) is utilized to examine the existence of an asymmetric long-run equilibrium relationship between the REER and domestic output as in equation (4). The merit of the NARDL model, in contrast to the linear (symmetric) ARDL model, is that it permits the estimation of the asymmetric REER impact in both the short-run and the long run.

$$\Delta\, GDP_t = \omega_1 + \sum_{i=1}^{p} \theta_{1i} \Delta GDP_{t-i} + \sum_{i=1}^{q} \theta_{2i} \Delta\, REER_{t-i} + \sum_{i=1}^{r} \theta_{3i} \Delta G_{t-i} + \sum_{i=1}^{s} \theta_{4i} \Delta M_{t-i} + \sum_{i=1}^{m} \theta_{5i} \Delta P_{t-1}^{oil} + \sum_{i=1}^{l} \theta_{6i} \Delta REER_{t-i}^{+} + \sum_{i=1}^{v} \theta_{7i} \Delta REER_{t-i}^{-} + \tau_1\, GDP_{t-1} + \tau_2\, REER_{t-1} + \tau_3\, G_{t-1} + \tau_4\, M_{t-1} + \tau_5 P_{t-1}^{oil} + \tau_6 REER_{t-1}^{+} + \tau_7 REER_{t-1}^{-} + \varepsilon_t \quad (4)$$

In which Δ is a first difference operator, and the rest of the variables are as defined before. $\mathrm{p, q, r, s, m, l, v}$ are the optimal lag order which are determined based on an information criterion.

The bounds test approach for cointegration uses an F-test for the joint significance of the coefficients of the lagged level variables (H_0: $\tau_1 = \tau_2 = \tau_3 = \tau_4 = \tau_5 = \tau_6 = \tau_7 = 0$). Cointegration between the variables is established if the F- statistic exceeds the upper bound critical values. The F-statistics does not follow the standard F distribution, and Pesaran et al. (2001) provided the lower and upper bound critical values for it.

The merit of the bounds testing approach over other cointegration tests is being relatively more robust in small samples, and not sensitive to the order of integration of the variables of interest, yet none of the time series should be integrated of an order greater than one. Also, the bounds testing approach allows an efficient simultaneous estimation of the short- and long-run relationships between the variables of interest; and yields unbiased estimates and valid -statistics, even in the presence of endogenous regressors. It also account for the existence of structural breaks in the time series.

To estimate the short run asymmetric impact of the REER on domestic output, we need to formulate the NARDL model in equation (4) in the form of an error correction model as in equation (5).

$$\Delta\, GDP_t = \omega_1 + \sum_{i=1}^{p} \theta_{1i} \Delta GDP_{t-i} + \sum_{i=1}^{q} \theta_{2i} \Delta\, REER_{t-i} + \sum_{i=1}^{r} \theta_{3i} \Delta G_{t-i} + \sum_{i=1}^{s} \theta_{4i} \Delta M_{t-i} + \sum_{i=1}^{m} \theta_{5i} \Delta P_{t-1}^{oil} + \sum_{i=1}^{l} \theta_{6i} \Delta REER_{t-i}^{+} + \sum_{i=1}^{v} \theta_{7i} \Delta REER_{t-i}^{-} + +\emptyset ECT_{t-1} + \varepsilon_t \quad (5)$$

The coefficient of the error-correction term $\emptyset$, reflects the speed of adjustment of the variables to their long-run equilibrium, following any shock. This coefficient measures the portion of the last period disequilibrium that is corrected for in the current period. Dynamic stability requires this coefficient to be negative and less than unity.

The short-run and long-run asymmetric impact of the REER on real GDP is also examined by deriving the cumulative dynamic multiplier, which measures the percentage point change in real GDP resulting from a one percent change in $REER_{t-1}^{+}$ and $REER_{t-1}^{-}$. Given the long period covered by the current study, about 60 years, it is crucial to test for structural breaks and control for it, in case they exist, in the analyses. In this regard, we utilize a multiple structural breakpoints test of Bai & Perron (2003). As suggested by Bai & Perron

(2003), the number of statistically significant breaks, m, is determined endogenously by a sequential algorithm where the first breakpoint is identified, the sample is stratified into two sub-samples, and a test is conducted to test the null hypothesis of one regime against the alternative two regimes. Then the null hypothesis of a two-regime model is tested against the alternative hypothesis of a three-regime model. The same procedure is implemented for each sub-sample until the regimes are reached and the null hypothesis is not rejected for this at the 5% significance level. We control for the potential structural breaks that the multiple structural breakpoints test identifies by including time dummy variables corresponding to each of the time breaks.

4. Results

Results of the ADF and PP unit root tests are reported in Table 1. According to the PP test, all the variables are non-stationary at level, while it is only the REER that is stationary at level at the 5% significance level according to the ADF test. More importantly, all the variables become stationary at their first difference across the two versions of the tests. This means that all the variables are integrated of order one I(1). This implies that none of the variables is integrated of an order greater than one, which would validate the bounds test approach for cointegration.

Insert Table 1 here

Insert Table 2 here

The Bai and Perron multiple breakpoint test is conducted with a maximum of five breaks and a trimming parameter of 0.15 to test the null hypothesis of L+1 versus L sequentially determined structural breaks. The results, presented in table 2, reveal the existence of one to four structural breaks clustered around major events that happened during the study period. These events correspond to the outbreak of the October war in 1973, the second oil price shock in 1980 and the open-door policy, the implementation of the Economic Reform and Structural Adjustment program (ERSAP) in consultation with the IMF, and the first gulf war in 1991 and the outbreak of the global financial crisis in 2007. Accordingly, we construct four dummy variables corresponding to these events and include them in the ARDL model. These dummy variables are, D73 with the value of one in 1973 to 1975 and zero otherwise, D79 with the value of one in 1979 to 1981, D90 with the value of one in 1990 to 1992 and zero otherwise, D2007 with the value of one in 2006 to 2008 and zero otherwise.

To estimate the ARDL and NARDL models, we impose a maximum of four lags on each first-differenced variable and use the SIC to select the optimum number of lags. The SIC selected an ARDL (3,2,2,0,0) and NARDL (3,2,2,0,0,0) models.

Insert Table 3 here

Table 3 presents the F-statistic of the cointegration bounds test along with the 95% critical bounds for both the symmetric and asymmetric ARDL models. The results reveal both a linear and a nonlinear long-run relationship, cointegration, between GDP, G, M, REER, and oil price since the F-statistics are greater than the upper bound of the critical value at the 5% significance level.

Insert Table 4 here

Table 4 presents the short-run and long-run coefficients of the estimated symmetric and asymmetric ARDL models. The estimated short run coefficients, presented in Panel (A) of Table 4 show that the REER and the price of oil have no impact on domestic output in the short run, while fiscal policy has a short run expansionary effect, and monetary policy has a short run contractionary effect as reflected by the negative sign of the sum of its short run coefficients. The results also show that coefficients of the structural breaks time dummies and are statistically significant at the 5% significance level, while the coefficient of is statistically significant at the 10% significance level in the linear ARDL model. This indicates the importance of controlling for the structural breaks in the analyses.

Estimates of the long-run coefficients, presented in Panel (B) in Table 4 reveal that while fiscal policy has a long run contractionary effect on domestic output, monetary policy has a statistically significant expansionary effect. The price of oil has a statistically significant positive long-run effect on domestic output. As for the effect of the REER, the estimated coefficient shows that REER has a statistically significant long-run positive effect on output, in which real depreciations are contractionary in their effect on output.

Results of the nonlinear ARDL model were in general qualitatively similar to that of the linear ARDL model in which fiscal policy has a statistically significant expansionary effect on domestic output, while monetary policy has a contractionary effect on domestic output in the short run. The REER and the oil price have no impact on domestic output in the short run. As for the long-run coefficients, results of the NARDL model reveal that the monetary (fiscal) policy has a statistically significant expansionary (contractionary) effect on domestic output; the price of oil has no statistically significant long-run effect on domestic output. As for the effect of the REER, results of the NARDL model show long-run asymmetry in the effect of currency appreciations and depreciations. In particular, real currency appreciations have no statistically significant impact on domestic output while real currency depreciations have a statistically significant contractionary impact on domestic output.

The estimated coefficient of the error-correction term has a statistically significant negative sign at the 1% significance level. It shows a high speed of convergence in the long-run dynamics of the variables. In the estimated symmetric ARDL (3,2,2,0,0) and the NARDL (3,2,2,0,0,0) models, 65% and 61% of last period's disequilibrium is corrected in the current period respectively. This means that following a shock, it takes about 1.5 years for GDP, G, M, REER, and Poil to restore their long-run equilibrium relationship.

Several diagnostic checks have been conducted to test the adequacy of the estimated ARDL and NARDL models. These include the Lagrange multiplier (LM) test of residual serial correlation, Ramsey's RESET test for specification error, Jarque-Bera's normality test based on the skewness and kurtosis of residuals and the Breusch-Pagan-Godfrey's heteroscedasticity test. Parameters stability diagnostics, including the cumulative sum of recursive residuals (CUSUM) test and the cumulative sum of squares of recursive residuals (CUSUM of squares) test, are also conducted. The results also show very high goodness of fit for the estimated ARDL and NARDL models as reflected by the very high R^2 and adjusted R^2.

Insert Figure 2 here

As evident in figure 2, the coefficients of the estimated linear and nonlinear ARDL models are stable at the 5% significance level. Also, the results of the diagnostic tests show that all the estimated models are free from serial correlation, heteroskedasticity, non-normality of the residuals, and specification error at the 5% significance level.

Insert Figure 3 here

Figure 3 depicts the dynamic asymmetric multiplier of the NARDL (3,2,2,0,0,0) model and reveals an apparent asymmetry in the long-run adjustment patterns following a shock to the REER. This finding is in line with the result of the asymmetric effects test presented in Table 5. The solid black line of the dynamic multiplier plots shows that a 1% increase in the REER has no impact on real GDP in the long run. Similarly, the black-dashed line of the dynamic multiplier plots reveals that a 1% decline in the REER decreases real GDP by 0.105% in the long run. Remarkably, the net effect of the REER (thick red-dashed line) is negative and converges to around 0.10% in the long run.

A NARDL asymmetric effects test is conducted to test symmetry in the effect of the REER on domestic output and it. The results show that the null hypothesis of symmetry in effect is rejected in the long run as the p-value of the chi-square statistic is less than the 5% significance level. This result is consistent with the long-run estimates of the NARDL model and the dynamic asymmetric multiplier.

5. Conclusion

This paper examined the short- and long-run impact of the REER on Egypt's real GDP over the period 1960 to 2020. To uncover whether real exchange rate changes have symmetric or asymmetric effects on domestic output, we used the nonlinear autoregressive distributed lag (NARDL) model of Shin et al. (2014) to isolate currency depreciation from appreciations. The multivariate analyses controlled for the different channels through which the REER can affect domestic output via including government spending (as a proxy of the fiscal policy) and money supply (as a proxy of the monetary policy) to capture the AD channel and the price of oil to capture the AS channel.

Results show that fiscal policy has an expansionary output effect in the short run, and monetary policy has a contractionary output effect. However, in the long run, fiscal policy has a contractionary effect on domestic output, while monetary policy has a statistically significant expansionary effect. This means that fiscal policy exercises a crowding-out effect in the long run, i.e., fiscal expansion crowds out other components of aggregate demand, including domestic investment and exports, which eventually dampens domestic output. The short-run contractionary effect of monetary expansion could be explained by the fact that increased money supply causes high inflation, lowers aggregate consumption, and dampens domestic output.

Results of the symmetric ARDL model show that real depreciation is contractionary. The policy implication is that the Egyptian monetary authorities cannot rely on domestic currency depreciation as a policy instrument to promote net exports and boost domestic output. However, the NARDL results show long-run asymmetry in the output effect of REER changes in which real currency appreciation has no statistically significant impact on domestic output, while real currency depreciations have a statistically significant contractionary impact on domestic output. The policy implication is that Egypt should maintain a strong Egyptian pound to stimulate domestic output. These results are similar to the findings of several earlier studies, such as Nusair (2021) for Malaysia, in which appreciations have no long-run effect on output depreciations are contractionary. Our results are also in line with those of Shahbaz et al. (2012), who found that the effect of real devaluation on economic growth is contractionary in Pakistan, and Ayen (2014), who found currency devaluations to be contractionary in the long run and neutral in the short run in Ethiopia.

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Appendix

List of Tables

Table 1. Results of ADF and PP unit root tests of the variables in level and first difference

	GDP		REER		G		M		Poil	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
Unit root tests of variables in levels										
Constant	-1.29 (0.62)	-1.41 (0.57)	-3.63*** (0.007)	-2.82* (0.06)	-2.23 (0.19)	-2.68* (0.08)	-1.37 (0.58)	-1.58 (0.48)	-1.80 (0.37)	-1.86 (0.34)
Constant & Trend	-1.59 (0.78)	-1.23 (0.89)	-4.29*** (0.006)	-3.11 (0.11)	-2.67 (0.25)	-2.45 (0.34)	-1.30 (0.87)	-1.12 (0.91)	-1.93 (0.62)	-1.93 (0.62)
Unit root tests of variables in first difference										
Constant	-4.58*** (0.00)	-4.59*** (0.00)	-5.88*** (0.00)	-5.66*** (0.00)	-5.95*** (0.00)	-5.98*** (0.00)	-4.99*** (0.00)	-4.97*** (0.00)	-6.65*** (0.00)	-6.60*** (0.00)
Constant & Trend	-4.73*** (0.00)	-4.74*** (0.00)	-55.83*** (0.00)	-5.79*** (0.00)	-6.26*** (0.00)	-6.26*** (0.00)	-5.11*** (0.00)	-5.04*** (0.00)	-6.68*** (0.00)	-6.63*** (0.00)

* , **, *** imply rejection of the null hypothesis at the 10%, 5%, and 1% significance level, respectively. Lag length is based on SIC. P-values are in parenthesis. The null hypothesis is that the series is non- stationary.

Table 2. Bai-Perron multiple breakpoint tests of L+1 versus L sequentially determined structural breaks

Variable	0 vs. 1	1 vs. 2	2 vs. 3	3 vs.4	4 vs.5	Number of breaks	Dates of breaks
GDP	192.56**	54.72**	65.94**	23.31**	0.00	4	1976; 1985;1995;2007
M	288.26**	70.65**	48.76**	16.99**	10.28	4	1972; 1981; 1990; 2003
G	126.30**	101.62**	25.53**	23.34**	0.00	4	1969; 1981;1997;2006
REER	57.87**	4.56				1	1991
Oil price	161.44**	52.49**	6.79			2	1974; 2003

Table 3: Results of the Cointegration bounds test

				95% Critical bounds	
Dependant variable	Explanatory variables	Specification	F-statistic	I(0)	I(1)
$\Delta(GDP)$	$G, M, REER, Poil$	ARDL (3,2,2,0,0)	12.09	3.32	4.33
$\Delta(GDP)$	$G, M, REER^{+} REER^{-}, Poil,$	NARDL (3,2,2,0,0,0)	11.31	3.08	4.15

The lower and upper bound critical values are obtained from (Pesaran et al., 2001).

Table 4: Estimated short run and long run parameters of the symmetric ARDL and asymmetric ARDL (NARDL) models

	ARDL (3,2,2,0,0)		NARDL (3,2,2,0,0,0)	
Panel (A)				
Short run coefficients				
$constant$	11.40***	1.26	11.77***	1.23
ΔGDP_{t-1}	0.20**	0.09	0.18**	0.09
ΔGDP_{t-2}	0.26***	0.08	0.26**	0.08
ΔG	0.04	0.03	0.03	0.03
ΔG_{t-1}	0.14***	0.03	0.17***	0.03
ΔM	0.05*	0.03	0.03	0.03
ΔM_{t-1}	-0.11***	0.03	-0.11***	0.03
D_{73}	-0.02**	0.009	-0.02**	0.00
D_{79}	0.017*	0.01	0.01	0.01
D_{90}	0.02**	0.009	0.02**	0.00
D_{2007}	0.01	0.008	0.01	0.008
ECT_{t-1}	-0.65***	0.07	-0.61***	0.06
Panel B				
Long run coefficients				
G	-0.07*	0.03	-0.14**	0.06
M	0.24***	0.01	0.25***	0.01
Poil	0.02*	0.01	0.017	0.01
REER	0.077***	0.02		
$REER^{+}$			-0.0001	0.05
$REER^{-}$			0.105***	0.02
Diagnostic tests				
A: Serial correlation	$\chi^2(2) = 2.55$ P value (0.27)		$\chi^2(2) = 2.28$ P value (0.31)	
B: Heteroskedasticity	$\chi^2(16) = 13.93$ P value (0.60)		$\chi^2(17) = 16.21$ P value (0.50)	
C: Functional form RESET test	F (1,40)=3.39 P value (0.07)		F (1,39)=0.59 P value (0.44)	
D: Normality	Jarque-Bera =2.78 P value (0.24)		Jarque-Bera = 1.93 P value (0.38)	
	R^2 =0.99 Adjusted R^2 =0.99		R^2 = 0.99 Adjusted R^2 =0.99	

A: Lagrange multiplier test of residual serial correlation.
B: based on the regression of squared residuals on squared fitted values.
C: Ramsey's RESET test using the square of the fitted values.
D: based on a test of skewness and kurtosis of residuals.

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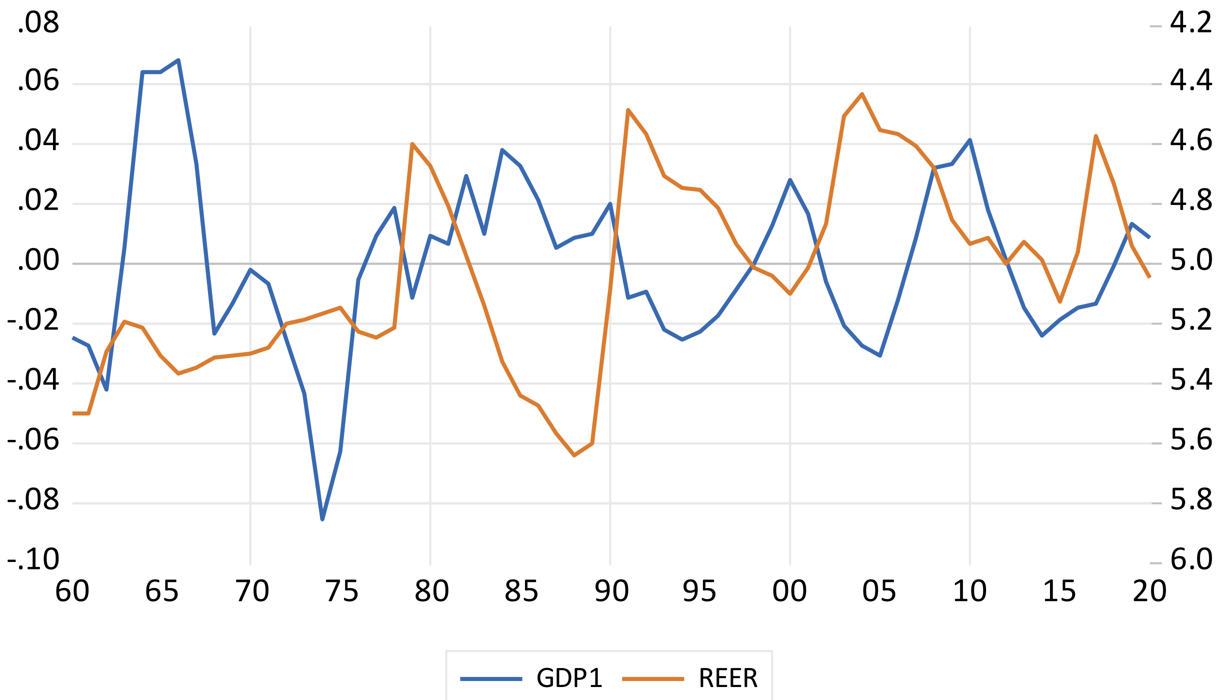
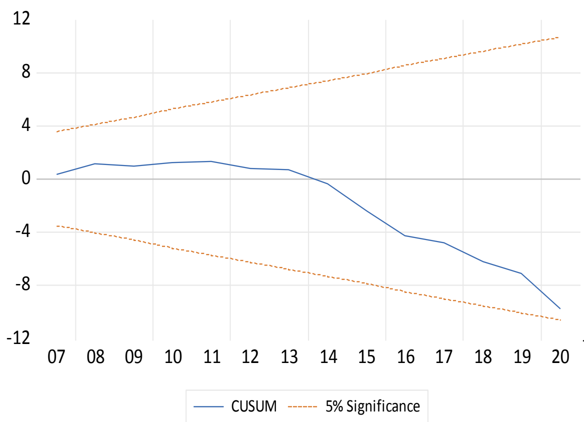
Figure 1. Real GDP and REER in Egypt over the period 1960-2020.



Note: The blue line is the real GDP after removing the trend using the Hodrick-Prescott filter. The orange line is the REER. We used the Hodrick-Prescott filter to remove the trend in the real GDP.

Figure 2. ARDL (3,2,2,0,0) and NARDL NARDL (3,2,2,0,0,0) CUSUM stability plots

ARDL model



NARDL model

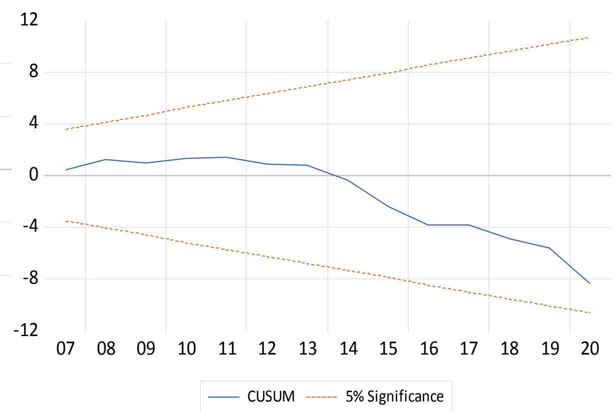
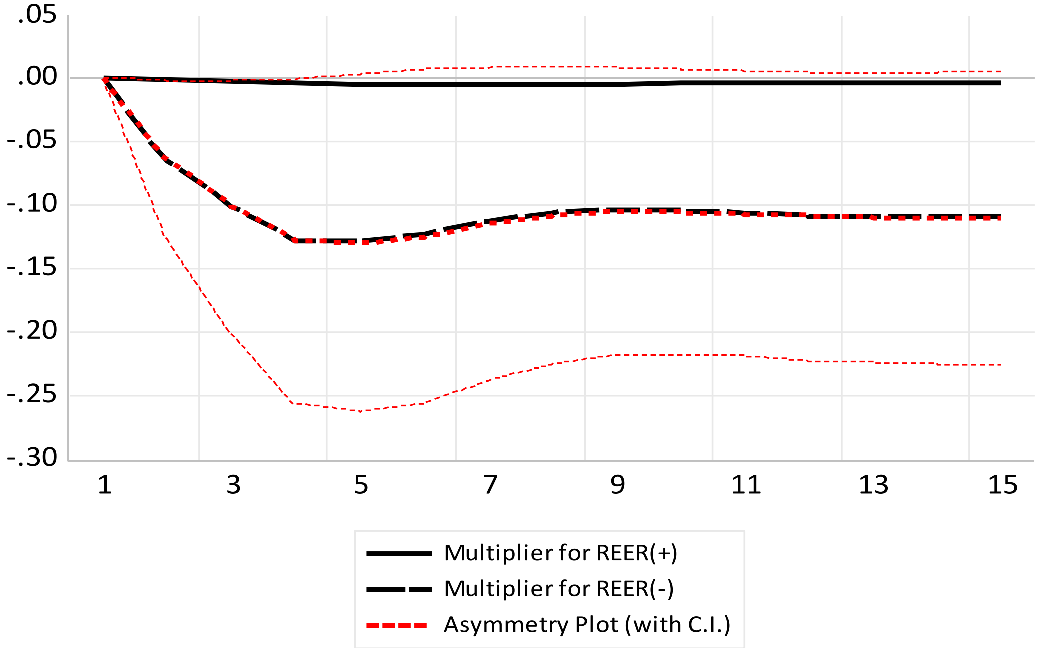


Figure 3. NARDL (3,2,2,0,0,0) dynamic asymmetric multiplier



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