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Examining the nexus between exchange rate volatility and export performance: Empirical evidence from the Egyptian experience

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Abstract: This paper investigates the relationship between exchange rate volatility and export performance of the Egyptian economy for the period (1980-2016). Moving average standard deviation and conditional standard deviation from GARCH model are used to generate two different measures of exchange rate volatility. The co-integration results indicate the existence of a unique long-run relationship between the real value of non-petroleum exports (as well as the volume of total exports) and the GARCH measure of exchange rate volatility. Using a Vector Error Correction Model, it is found that the volatility of the real effective exchange rate has a significant negative effect on real exports, whereas the effect of the level of real effective exchange rate itself, is not found to be statistically significant. Relevant policy implications are derived from these results.

JEL Classifications: C13, C22, F31, F41

Keywords: Exchange rate volatility, export, Egypt, GARCH model, error-correction model

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1. Introduction

One of the main policy challenges for an economy is the maintenance of a stable and competitive exchange rate to promote economic growth and development. Real exchange rate is a key economic variable that reflects movements in relative prices of currencies. It represents an important link between the domestic economy and the rest of the world. This raises concerns about any potential or future exchange rate fluctuations in the real exchange rate, especially if such fluctuations are significant and/or persistent that can harm a country's economic performance (Fischer, 2001; Bahmani-Oskooee, Iqbal, & Salam, 2016). Exchange rate stability is therefore, a major monetary policy target. In particular, the impact of real exchange rate volatility, perceived as a key economic indicator has a critical interest for policymakers.

The relationship between the real exchange rate volatility and export flows is relatively a recent area of research in the economic literature. An extensive body of the literature indicates the detrimental effects of exchange rate fluctuations on international trade. The chief argument is that exchange rate volatility imposes high costs on risk-averse traders, and consequently lessens foreign trade (Arize, Osang, & Slottje, 2000). When exchange rate movements are not anticipated, economic agents tend to shift from risky activities to less risky activities, which reduces international trade and leads to an inefficient allocation of resources. It is believed that the adverse effects are more harmful for emerging

economies that are characterized by both underdeveloped capital markets and mismanaged macroeconomic policies (Chit, 2008; Chit, Rizov, & Willenbockel, 2010). However, some theoretical presumptions suggest that the relationship between exchange rate volatility and trade can be positive since the latter can increase the probability of making large profits to exporting firms. Given the knowledge they can gain through international trade transactions, exporters can expect the future exchange rate movements and hence, equip themselves with hedging tools, finance their investments with local capital and adjust their factor inputs in response to these movements (Chit, 2008; Hondroyannis et al., 2008).

The attention of studying exchange rate volatility and its link to foreign trade is still lacking for the Egyptian economy, which has witnessed different shifts in the conduct of monetary and exchange rate policies over the past three decades. In particular, it was the prominent feature of monetary policy up to 2003 to officially peg or manage the Egyptian pound against the US dollar. At the end of January 2003, the official exchange rate shifted to a free float (Moursi & Mossallamy 2010; Ahmed, 2012). Despite the floatation of the Egyptian pound, it was still questionable whether the Central Bank of Egypt (CBE) kept on maintaining exchange rate stability as one of its key objectives. Mixed conclusions can be driven from the literature on this point (see Moursi, El Mossallamy, & Zakareya, 2007; Al-Mashat & Billmeier, 2008; Moursi & El Mossallamy, 2010). In November 2016, the CBE has announced its liberalization of the Egyptian pound. This highlights the significance of studying the nexus between real exchange rate volatility and export performance for the case of Egypt in an attempt to reach relevant policy implications. As expressed in Calvo & Reinhart (2000), most of the developing countries characterized by floating exchange rates face more volatility than those which adopt fixed exchange rates.

The present study sets out to empirically investigate if real exchange rate volatility is having any possible negative impact on the export performance in Egypt and hence, is organized besides the introduction and the conclusion, into five main sections. Section 2 provides an explanation of the broad measures to estimate exchange rate volatility in the literature and describes the methodology used in this paper. Section 3 presents a summary of the main literature dealing with the relationship between exchange rate volatility and export performance. Section 4 gives an overview about the historical background of the exchange rate policy in Egypt. Section 5 discusses the estimation technique and presents the empirical results.

2. Measuring exchange rate volatility

A country's exchange rate can be a bilateral rate, such as the Egyptian pounds per dollar for Egypt, or a multilateral rate where, the Egyptian pound is expressed in terms of a weighted average of Egypt's bilateral exchange rates against its main trading partners. A broader measure of the value of a certain country's currency would be the real effective exchange rate (REER). Generally speaking, it can be defined as a weighted average of a country's nominal exchange rate against its major trading partners (also known as the nominal effective exchange rate, NEER) adjusted for price changes.

Thus, a more preferable mathematical expression of the REER is the following:

$$REER = \prod_{i=1}^n BRER_{ijt}^{w_i}, \quad (1)$$

Where $BRER_{ijt}$ is the bilateral real exchange rate of country j with the trading partner i at time t (Weerasekera, 1992; Fleissig & Grennes, 1994).

Therefore, to be able to generate this measure, the researcher needs to identify the trading partners to be included and their weights in the calculation. The selection of trading partners should be done in a way that ensures the inclusion of countries, which represent a high proportion of total trade. For the sake of calculating the REER index for the Egyptian economy between 1980 and 2016, we use data for the top 20 trading partners of Egypt and depend on the average share of each partner in foreign trade during the same period.

As noted by Isard (2007) that the focus on the REER index instead of just using the nominal or real exchange rate recognizes the fact that each country has its multiple trading partners and hence, we consider it to be a more consistent measure for analyzing the volatility of the exchange rate and its impact on export flows of the Egyptian economy. Furthermore, REER indices have the advantage of better reflecting the price of competitiveness of an economy's exports with the international world (Vieira & MacDonald, 2016).

Previous studies in the literature have either used the variance and/or standard deviation of the real exchange rate to measure its volatility or resort to employing GARCH family models to achieve the same purpose. Both the variance and standard deviations measures are criticized on the basis of not taking into consideration information on the stochastic process by which the series of exchange rate is generated. Moreover, these measures represent unconditional measures of exchange rate volatility. Accordingly, and since the contribution by Engle (1982), both the Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models have been the prominent and essential tools in measuring exchange rate volatility. Moreover, GARCH family models are more capable of capturing fat tails and volatility clustering that characterize financial time series such as exchange rate (Rey, 2006; Ramzan, Ramzan, & Zahid, 2012). McKenzie (1999) and Hondroyannis et al. (2008) point to the effect of using different volatility measures in investigating the relationship between exchange rate volatility and international trade. It is argued that using GARCH-based volatility measures tend to give more consistent and significant results than using other specifications.

In this paper, we do our own REER calculations then employ both a 12 month moving standard deviation of the exchange rate series and GARCH family models to capture the volatility of the exchange rate series in Egypt during our sample period. The details of calculating both measures of volatility are explained in Section 5.

3. Exchange rate volatility and export performance

A large and growing body of economic literature deals with the possible effects of exchange rate uncertainty on export flows. There is no clear consensus in the empirical literature about the direction of the relationship and the effects vary between positive, negative, mixed or no effects at all. De Grauwe (1988) is one of the early studies that distinguish between substitution and income effects of an increase in exchange rate risk based on the degree of risk aversion of economic agents. He argues that in case of risk

averse exporters, the income effect can dominate the substitution effect of exchange rate risk, which in turn would encourage more exporting activities.

Fountas & Bredin (1998) use a sample of quarterly data that span from 1979:Q2 to 1993:Q3 on the economy of Ireland to estimate short-run and long-run relationship between Ireland's real exports to the UK and exchange rate volatility measured by the moving standard deviation of the growth rate of Irish exchange rate. Using co-integration and VECM models, their results indicate a statistically insignificant relationship in the long-run and a negative effect of exchange rate volatility on real exports in the short-run.

In an attempt to distinguish among different effects of exchange rate volatility on aggregate exports performance in different country groups, Sauer & Bohara (2001) use both fixed and random effects panel data models for 22 industrialized and 69 developing countries over the period (1973-1993). Their estimation incorporates three different measures of real effective exchange rate volatility; conditional variance of an ARCH model, moving standard error of the estimate from an AR process and moving standard error of the estimate from a trend model of logged real effective exchange rate series. Interestingly, it is found that the effect varies by country groups such that developing Latin American and African countries are adversely affected by exchange rate volatility while Asian LDCs and OECD countries are not. Doganlar (2002) examines the effect of exchange rate volatility on real exports of five Asian counties (Turkey, South Korea, Malaysia, Indonesia and Pakistan) and implement the Engle-Granger econometric procedure using quarterly data over the period (1980-1996). A volatility measure of four and eight-quarter moving standard deviation implies an adverse effect of exchange rate uncertainty on real exports in the five Asian countries.

Baaka, Al-Mahmood, & Vixathep (2007) investigate the effect of the bilateral exchange rate volatility in four East Asian countries (Hong Kong, South Korea, Singapore, and Thailand) on export volumes to Japan and the U.S. economies. Exchange rate volatility is measured by the standard deviation of the monthly exchange rate. Using quarterly data for the period between 1981 and 2004 and applying the Johansen co-integration approach, the results indicate a significant negative long-run relationship between exchange rate volatility and exports to both Japan and the U.S. with the exception of Hong Kong. Carrying out co-integration and VECM econometric techniques, Onafowra & Owoye (2008) test both the short-run and long-run relationship between Nigeria's exchange rate volatility and exports to the U.S. economy where the latter is measured by GARCH model approach. The empirical examination employed quarterly data from 1980 to 2001 and shows that there is a negative and statistically significant impact of exchange rate volatility on exports of the Nigerian economy to the U.S. and confirms the existence of a unique co-integration relationship in the long-run.

In their trial to study the nexus between exchange rate uncertainty and exports, Rahman & Serletis (2009) apply a dynamic multivariate framework in which they accommodate multivariate GARCH-in Mean errors into an open economy SVAR model. Their application use aggregate level data for the U.S. economy for the period between 1973:M1 and 2007:M1 and findings imply the existence of a statistically significant and negative effect of exchange rate uncertainty on U.S. exports. Hayakawa & Kimura (2009) employ a gravity equation approach to test the relationship between exchange rate volatility and international trade using bilateral trade values among 60 countries between 1992 and 2005. The estimation then incorporates a dummy variable for the East Asian region to compare the effect in this specific region relative to other regions. Exchange rate volatility is measured by both GARCH model and the standard deviation of the first-difference of the

monthly natural logarithm of bilateral real exchange rates. The estimation results indicate that intra-East Asian trade is more discouraged by exchange rate volatility than other regions.

For the sake of examining the impact of exchange rate volatility on export performance, Hall et al. (2010) distinguish between the relationship in ten emerging market economies (between 1980:Q1 and 2006:Q4) and eleven developing countries (between 1980:Q1 and 2005:Q4) using both fixed effects first difference GMM estimator and time-varying-coefficient estimation techniques. Their study measures real effective exchange rate volatility by both GARCH model approach and the log of the eight-quarter moving standard deviation. While the findings suggest a significant negative relationship only in the eleven developing countries between exchange rate volatility and exports, the same cannot be concluded for the ten emerging economies. Usman & Aliyu (2010) assess the quantitative impact between non-oil exports and both the naira and US dollar exchange rate (as a proxy of trading partners' exchange rate) volatility in Nigeria using quarterly data during the period (1986-2006). Their volatility measures are based on calculating the standard deviation of each series from the average nominal exchange rate. By employing the Johansen co-integration approach, it is found that while the naira exchange rate volatility discourages non-oil exports, the US dollar exchange rate volatility promotes them.

Incorporating a conditional variance estimate from a GARCH model to investigate the effect of exchange rate volatility on Turkish exports, Demirhan & Demirhan (2015) apply the Johansen co-integration technique using data between February 2001 and January 2010. It is concluded that increases in exchange rate volatility causes a decline of real exports in Turkey. Such results are inconsistent with the findings of Altintas, Cetin, & Oz (2011) who find positive effect of exchange rate volatility on Turkish aggregate exports when they employ quarterly data between 1993 and 2009. Moving average of standard deviation of real effective exchange rate is used as a proxy of exchange rate volatility and it is found to significantly and positively affect export performance in Turkey within a co-integration and VECM framework.

Using a group of ARCH models under different assumption, Wong (2016) explores the impact of bilateral exchange rate volatility on both total real and sectoral real exports to Singapore, China, Japan, the USA and Korea. The Johansen co-integration and dynamic OLS estimator are used with data spanning from January 2010 to March 2015. The findings suggest a mixed positive and negative effects of exchange rate volatility on exports that vary between the short-run and long-run and between total real exports and its sub-categories as well. Bahmani-Oskooee, Iqbal, & Salam (2016) employ autoregressive distributed lag (ARDL) approach using bilateral trade data for the Pakistani economy with Japan during the period (1980-2014) to assess the impact of exchange rate volatility on 43 exported commodities to Japan and 60 imported commodities from Japan. For each year, the standard deviation of 12 monthly real exchange rates is used as a measure of bilateral real exchange rate volatility. Their empirical findings show mixed positive and negative effects in the long-run and are only significant for four exporting industries and seven importing industries. Pino, Tas, & Sharma (2016) utilize an ARDL model to validate the relationship between the volatility of real effective exchange rate and export flows between six Asian countries and the rest of the world using three measure of exchange rate volatility (namely, an ARCH model, a GARCH model and a moving average standard deviation). Their estimation is based on quarterly data and covers the period between 1974

and 2011. With the exception of Singapore, empirical results indicate that an increase in exchange rate volatility is harmful for exports.

Using quarterly data between 1999 and 2013 for the economy of Pakistan, the Alam, Ahmed, & Shahbaz (2017) examine the effect of real effective exchange rate volatility on real exports of the food sector, textile sector, manufactured commodities other than textile and all other commodities sector to main trading partners. The estimation technique used is the co-integration and VEC models. Out of 20 long-run models, 13 models support a statistically significant and positive link between exchange rate volatility and sectoral exports.

4. Historical overview of the exchange rate policy in Egypt

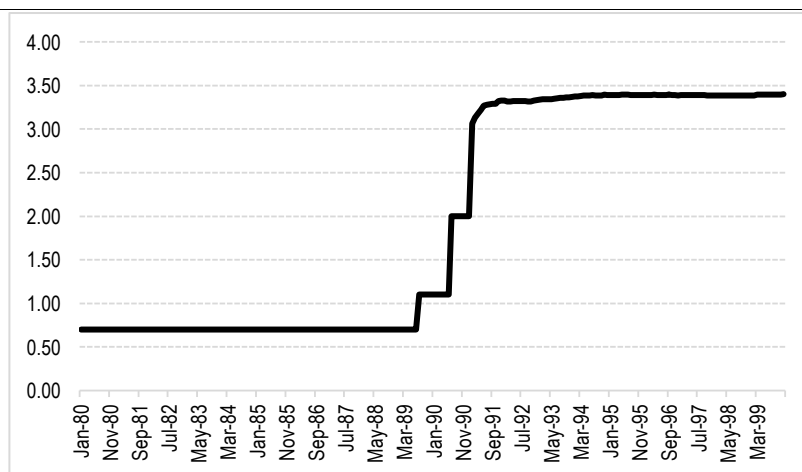
Prior to the official implementation of the Economic Reform and Structural Adjustment Program (ERSAP) in 1991, the Egyptian economy has been through several measures to switch from a fixed parity to a flexible peg regime and from multiple rates to a unified rate. Abdel-Khalek (2001) sums up the Egyptian overall experience of exchange rate regimes until 1991 as one of repeated failed trials to establish a unified exchange rate. The launch of the ERSAP implied aggressive measures to tighten both the monetary and fiscal policies and liberalize the exchange rate. In February 1991, the old pegged exchange rate was abandoned and replaced by a dual flexible peg system (Al-Shawarby, 1999). The dual exchange rate consisted of a primary and secondary markets that were merged then in October 1991. This represented a new phase in the exchange rate management in Egypt (Hosni, 2015). The ERSAP was successful in bringing inflation rate down to 2-4 percent and achieving an average growth rate of 5 percent during the mid-1990s. However, it resulted in an overvalued real exchange rate. The appreciation of the Egyptian pound led to a current account deficit that was problematic given the inability of the economy to attract private capital flows (Hassan, 2003).

Toward the late 1990s, the Egyptian economy has started to show many signals of serious economic troubles. In addition to the appreciation of the real exchange rate, which was negatively affecting the level of competitiveness of the Egyptian economy, Egypt was hit by a succession of both internal and external shocks in 1997. The East Asian crisis, the Luxor tragedy and the decline in oil international price led to a deterioration in Egypt's external position triggered mainly by an outflow of capital and a decline in tourism receipts in addition to a widening current account deficit (Handy, 2001; Panizza, 2001). Figure (1) captures these main changes in the Egyptian exchange rate policy as reflected by the sharp turning point of the nominal exchange rate with the implementation of the ERSAP and till the end of the nineties.

Due to the persistent pressures on the Egyptian pound during late 1990s and in an attempt to prevent extra drainage of the foreign reserves, the government has moved gradually to a more flexible exchange rate in late 2000. A series of devaluations started in June 2000 when the Egyptian pound recorded the rate of L.E. 3.69 per USD. In January 2001, the exchange rate was set to crawl within a band of ± 1 percent around the central rate. The band was then widened to ± 3 percent in August 2001 (Hussein & Nos'hy, 2000; Khodeir, 2012). At the end of 2002, the Egyptian economy was facing a real economic predicament; low level of international reserves, high levels of both current account and budget deficits, an excessively overvalued exchange rate. The government was in a situation to choose between two alternatives to maintain an active monetary policy; the first was to impose restrictions on the capital market while keeping the exchange rate peg

and the second was to allow the domestic currency to freely float while keeping an open capital market (Hassan, 2003). In January 2003, the Egyptian pound was announced to float against the US dollar. This shift in the exchange rate system was intended to correct for the overvaluation of domestic currency, achieve price stability and improve the competitiveness of the economy. Since then, the exchange rate ceased to be the nominal anchor of monetary policy in Egypt (Galal, 2003; Sharaf, 2015).

FIGURE 1. MONTHLY NOMINAL EXCHANGE RATE OF THE EGYPTIAN POUND (1980-1999)



Source: Authors' calculations.

Note: The exchange rate is calculated as the units of the domestic currency (LE) per one unit of the foreign currency (USD).

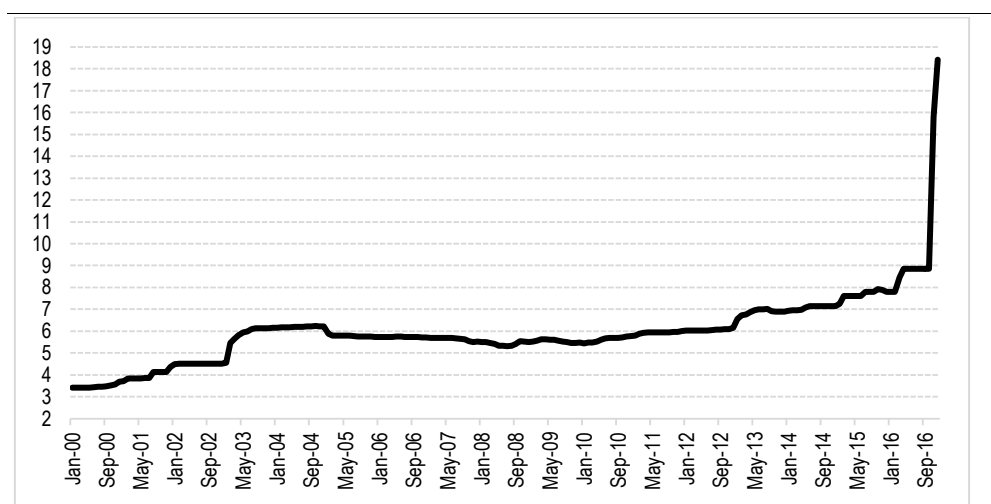
High inflation rates, a by-product of abandoning the exchange rate anchor, which came at the end of January 2003, led the CBE to adopt a new monetary policy framework that makes the price stability and low rates of inflation its main objective (Moursi, El Mossallamy, & Zakareya, 2007; Noureldin, 2008). In virtue of the Law of the Central Bank, the Banking Sector and Money No. 88 for 2003, the CBE should work on realizing price stability as the overriding objective of its monetary policy. Accordingly, since June 2005, the CBE has taken serious steps, on both the institutional and operational sides, to develop its monetary policy framework with the intention of adopting inflation targeting over the medium term. Such framework leaned on using the overnight interest rate on interbank transactions (known as the interest rate corridor system) as an operational target for the monetary policy instead of banks' excess reserves (Central Bank of Egypt, 2005/2006; Al-Mashat, 2008).

The Egyptian pound exchange rate was influenced by the global financial crisis and its spillovers in 2008, which led to a decline in the external demand for the Egyptian goods and services and an outflow of capital (Selim, 2012). Consequently, between 2008 and 2012, the nominal exchange rate witnessed a decline in its value reaching a rate of L.E. 6.056 per USD in 2012 from a rate of L.E. 5.433 per USD in 2008 (a depreciation of about 11 percent). However, the nominal exchange rate depreciated by only 2 percent between 2008 and 2009 due to the CBE intervention in the foreign exchange market to

ease the downward pressure on the Egyptian pound. Net international reserves at the CBE decreased by USD 3.3 billion between June 2008 and June 2009 from a level of USD 34.6 billion to USD 31.3 billion, respectively (Central Bank of Egypt, 2008, 2009).

On January 25, 2011, the Egyptian economy witnessed a political uprising, which caused a decline in tourism receipts and an outflow of capital. Together, these factors led to a downgrade of Egypt's international credit rating and a 42 percent decline in its international reserves between 2011 and 2012 (Hosni, 2015). Moreover, the CBE has adopted a number of measures in 2015 and 2016 with the aim to curb the parallel foreign exchange market, avoid US dollar speculations and raise confidence in the Egyptian economy. In February 2015, imposed ceilings on foreign currency deposits and withdrawals were removed. In November 2016, the CBE has liberalized the pound exchange rate and made it possible that banks can freely trade and quote at any exchange rate. These last measures were mainly intended to eliminate shortages in the foreign exchange and push FX trading towards formal banking channels (Central Bank of Egypt, 2015, 2016; Central Bank of Egypt, Economic Review, 2015, 2016). Figure (2) shows the different phases that the Egyptian exchange rate has passed by since the beginning of the nineties and till the end of 2016.

FIGURE 2. MONTHLY NOMINAL EXCHANGE RATE OF THE EGYPTIAN POUND (2000-2016)



Source: Authors' calculations

Note: The exchange rates are calculated as the units of the domestic currency (LE) per one unit of the foreign currency (USD).

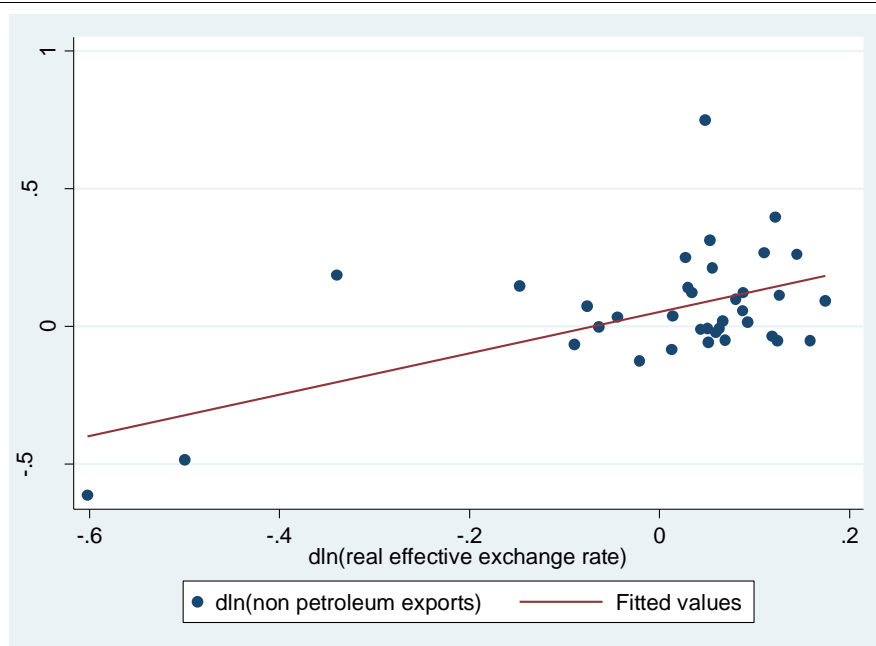
5. Data analysis, model estimation and results

Prior to the formal econometric examination of the relationship between exchange rate volatility and export performance, one should start first by giving a glance at the relationship from an unconditional perspective. This would allow us to expect what the conditional quantitative relationship be like and accordingly help in providing a better understanding to the nature of the econometric relationship.

In this regard, the first step would be to examine the visual relationship between exports' performance (as measured by the real value of non-petroleum exports) and the level of exchange rate itself measured by real effective exchange rate as shown in figure (3). Contrary to the expected, the graph shows a positive relationship between the two variables; indicating that an appreciation in the Egyptian pound would in fact lead to a higher value of exports, not to a lower one as should be anticipated by the basic theories of exchange rates.

This positive relationship could be explained by referring to the inherent characteristics of the import-oriented Egyptian economy. Particularly, Egypt is a net importer country with a high import component even of its exported commodities. A stronger currency as indicated by the higher exchange rate means a higher ability of importing the required materials for the commodities to be exported, and therefore, eventually a higher level of exports. Whether, this relationship is also affirmed through the more formal econometric technique, is a question that is answered below.

FIGURE 3. SCATTER PLOT OF NON- PETROLEUM EXPORTS AND REAL EFFECTIVE EXCHANGE RATE DURING THE PERIOD (1980-2016)

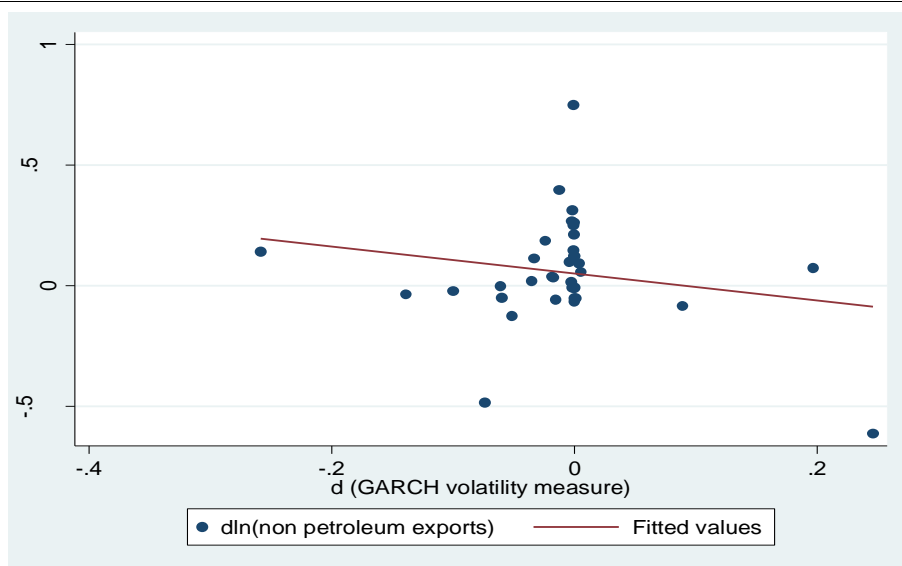


Source: Authors' calculations using STATA software

Note: The Real Effective Exchange Rate is calculated as the units of the foreign currency (USD) per one unit of the domestic currency (LE).

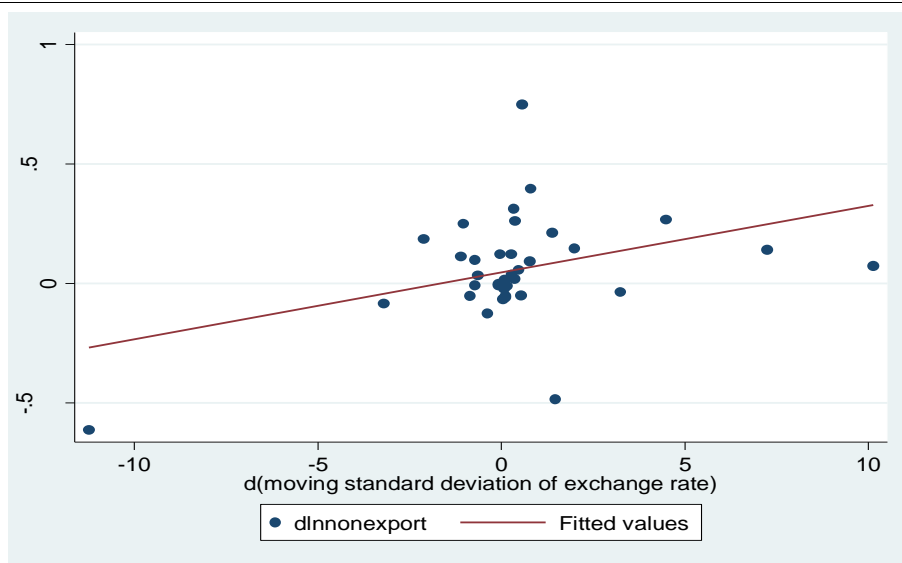
Both the theory and the intuition indicates that it is not enough to look at the level data to judge its relationship with the intended variable(s). Other factor that can contribute to the explanation of the relationship is the magnitude of the fluctuations. In particular, by observing the fluctuations in the level of the real effective exchange rate, as indicated by the different volatility measures, one would expect to reach useful insights.

FIGURE 4. SCATTER PLOT OF REAL VALUE OF NON- PETROLEUM EXPORTS AND GARCH VOLATILITY MEASURE DURING THE PERIOD (1980-2016)



Source: Authors' calculations using STATA Software

FIGURE 5. SCATTER PLOT OF REAL VALUE OF NON-PETROLEUM EXPORTS AND STANDARD DEVIATION VOLATILITY MEASURE DURING THE PERIOD (1980-2016)



Source: Authors' calculations using STATA Software

Figure (4) plots the relationship between the GARCH measure of exchange rate volatility and the real value of non-petroleum exports for Egypt during the period (1980-2016). The negative relationship is consistent with the historical evolution of the Egyptian exchange rates; particularly, the periods that witnessed stable exchange rate policy with higher degrees of certainty towards the perception of monetary policy in Egypt, are those which witnessed improvements in the trade balance via higher exports. This also emphasizes the great role that the fluctuations in the internal policies of a country have on its relationship with the external counterpart.

This same relationship was not sustained by using other measures of volatility. Specifically, by using the moving standard deviation of the exchange rate series, the relationship was reversed as is shown by Figure (5).

The relationship obtained with this measure of exchange rate volatility should be dealt with great caution due to the reasons mentioned in section II that are related to the validity of the methodology itself. In this regard, using of moving averages as a measure of volatility does not necessarily capture the fluctuations in the REER in an appropriate way. Further investigation of the unconditional measure of volatility is still required before we can reach any safe conclusion concerning its relationship with exports performance. The objective of plotting this relationship by the moving average measure, though, is first, to show that the conditional measures of volatility indeed provide a better approximation of the fluctuations in exchange rates compared to the unconditional ones and second, to confirm on the necessity of double checking the performance of the indicator used with the historical evidence of the relationship in question.

The objective of second part of this section is to provide a more formal quantitative assessment of the relationship by adopting an econometric technique to examine the conditional relationship between exchange rate volatility and exports performance in Egypt. It estimates the time-series relationship between annual exchange rate volatility and real non- petroleum exports in Egypt during the period (1980-2016). We start by introducing the model specification and the data used in the model. We then continue by explaining the steps of the econometric methodology, and finally presenting the main findings of the econometric model and the implications of the results.

5.1. Model specification and data description

The paper is following the underlying export equation adopted originally in (McKenzie, 1997), and later on by Raddatz (2008) and relates exports (the dependent variable) to real effective exchange rate, a measure of domestic economic activity, a measure of economic activity in trading partners, and a measure of the volatility of the real effective exchange rate. A general representation for the export model is given by the following equations, where two different measures of exchange rate volatility are examined:

$$EXP_{it} = \beta_0 + \beta_1 CONDVOL_{it} + \beta_2 REER_{it} + \beta_3 RGDP_{it} + \beta_4 FINCOME_{it} + u_{it} \quad (2)$$

$$EXP_{it} = \beta_0 + \beta_1 SDVOL_{it} + \beta_2 REER_{it} + \beta_3 RGDP_{it} + \beta_4 FINCOME_{it} + u_{it} \quad (3)$$

Where, EXP is the measure of exports, CONDVOL, is the conditional measure of exchange rate volatility, REER is the real effective exchange rate, RGDP is the measure of domestic activity, FINCOME is the measure of economic activity in trading partners, and SDVOL is the standard deviation measure of exchange rate volatility. The sources of the data are the World Bank Development Indicators (WDI), the International Financial Statistics (IFS), the Directory of Trade Statistics (DoTs), The Central Agency for Public Mobilization and Statistics in Egypt (CAPMAS). The measure of exports (EXP) used is the logarithm of the real value of non- petroleum exports; calculated as the residual of total value of the Egyptian exports after subtracting the value of petroleum exports. The real values were then calculated using the exports price index as a deflator. Using export price indices to deflate nominal value of exports is commonly agreed upon in the literature as explained by Mead (2014). In different versions of the model, the total volume of the Egyptian exports was also examined.

Real effective exchange rate (REER) was calculated using monthly data for nominal exchange rate, domestic consumer price index, a weighted average of foreign consumer price index and trade shares of the top 20 trading partners between 1980 and 2016. It is calculated as the units of the foreign currency (USD) per one unit of the domestic currency (LE).

Real Gross Domestic Product (RGDP, *in logarithms*) is used as a measure of domestic activity. To capture the economic activity of the trading partners, a trade weighted foreign income variable (FINCOME, *in logarithms*) was calculated to account for the income effect on exports. This measure was calculated following the methodology of Vieira & MacDonald (2016), and based on the export shares of the main 20 export partners for Egypt.

Two measures of exchange rate volatility were used- again following the methodology of Vieira & MacDonald (2016). Specifically, the first measure (CONDVOL) is the natural log of the first difference of the monthly real effective exchange rate, based on modeling each time series using an autoregressive structure and an ARCH-GARCH process for the conditional variance. The conditional volatility measure is the squared root of the conditional variance, and the annual volatility is then calculated as a monthly average to transform it in annual data.

A second measure of volatility (SDVOL) was calculated based on a 12 month moving standard deviation of the monthly logged first-differenced REER. After this monthly measure was calculated, we then transformed it to an annual frequency so that it can be used in the export model.

All variables used or calculated in the model depend on (Y2000) as a base year. Finally, we created two dummy variables to account for the background of the Egyptian economy and specifically the exchange rate policy (as was presented in section 4). The first one is (FLOAT) to model the floatation of the Egyptian pound in 2003, and it takes the value of one starting from the year of the floatation and till the end of the series. The second dummy (REV) was added to control for the Egyptian Revolution in 2011.

The recent floatation of the Egyptian pound in 2016 is beyond the time span of this model; however, it shall be accounted for in future work. Other dummy variables accounting for either the domestic or the global contexts - like the Economic Reform and Structural Adjustment Program in 1991 (ERSAP), or the Global Financial Crisis in 2008, were also examined in different model specifications.

5.2. The framework of time series analysis

The time series analysis of the relationship between Egyptian non-petroleum exports and exchange rate volatility was implemented by following a number of steps, which we shall present as follows.

5.2.1. The conditional exchange rate volatility measure

The paper adopts two measures of exchange rate volatility; a conditional measure and an unconditional one. The conditional measure refers to the one calculated using the ARCH/GARCH method, while the unconditional measure is that calculated by the conventional moving average standard deviation method.

In order to obtain our measure of conditional volatility, we first estimated an autoregressive model for REER using up to four lags, which we found to be AR(1). The next step was to use the Engle (1982) test for the detection of an ARCH effect in the selected model, with the null of no ARCH effect. After rejecting the null hypothesis, we proceeded by estimating an ARCH model to check for the autoregressive coefficients and the significance of the variance equation terms (ARCH/GARCH). Proceeding with testing for the significance of different ARCH models; specifically the Generalized ARCH (GARCH), the Threshold GARCH (T-GARCH), and the GARCH-in mean (MGARCH), our tests confirmed the significance of GARCH (1) model, and this was the one we used for calculating the conditional volatility measure. This manner of measuring volatility using the GARCH family measures is standard in the literature and has been used by Viera & MacDonald (2016); Raddatz (2008) and Wang (2002) among others.

5.2.2. Tests of stationarity

TABLE 1. AUGMENTED DICKY FULLER TEST RESULTS

UNIT ROOT TESTS AT:	AUGMENTED DICKY-FULLER TEST RESULTS
LEVEL VARIABLES	MODEL FORM: INTERCEPT AND TREND
ln EXP	-3.510028
ln X	-2.240692
ln REER	-3.120252
ln RGDP	-2.643148
ln FINCOME	-2.998897
ln CONDVOL	-1.336644
ln SDVOL	-2.960349
FIRST DIFFERENCE VARIABLES	MODEL FORM: INTERCEPT AND TREND
Δ EXP	-4.906681*
Δ X	-3.921858*
Δ REER	-6.627743*
Δ RGDP	-4.346925*
Δ FINCOME	-4.050678*
Δ CONVOL	-3.748314*
Δ SDVOL	-4.564768*

Source: E-views Output Results. * Denotes significance at the 5 percent level and the rejection of the null hypothesis of non-stationarity.

An Augmented Dicky Fuller Test (ADF) has been used to check for the stationarity of the dependent and the explanatory variables with the null hypothesis of a unit root. The null hypothesis was not rejected at the level data for all the variables; however it was rejected at the first difference. The results of the ADF test indicates a non-stationary level data, while the first difference yields an integrated variables of order one [i.e. I(1)]. Accordingly, we proceeded by using the Akaike and the Schwarz information criteria (at the level data) to choose the appropriate lag length, which was found to be two. The lag length is the same for both measures of volatility. Table (1) presents the results obtained by the ADF test Statistic.

5.2.3. Test of co-integration

With the necessary conditions of co-integration being met, the next step was testing for the existence of long-run relationship between the dependent and the explanatory variables using Johansen co-integration test. The results indicated the existence of a one unique relationship between the Egyptian non-petroleum exports and the other explanatory variables used in the model. This result obtained is the same for both measures of volatility. Table (2) shows the results of the co-integration test.

TABLE 2. JOHANSEN CO-INTEGRATION TEST RESULTS

HYPOTHESIZED NO. OF CE(S)	EIGENVALUE	TRACE STATISTIC	5% CRITICAL VALUE	1% CRITICAL VALUE
None **	0.714931	81.02054	59.46	66.52
At most 1	0.441233	38.34970	39.89	45.58
At most 2	0.220054	18.56092	24.31	29.75
At most 3	0.191988	10.11086	12.53	16.31
At most 4	0.080753	2.862803	3.84	6.51

Trace test indicates 1 cointegrating equation(s) at both 5% and 1% levels

Source: E-Views Output Results.

Note: * (**) - denotes rejection of the hypothesis at the 5% (1%) level.

5.2.4. Vector error correction model results

A VECM model was estimated to examine both the short and long-run relationship between the Egyptian non-petroleum exports and exchange rate volatility. In this regard, we estimated the two models underlying in equations (1) and (2) using the two different measures of volatility.

While one would expect that the two measures of volatility should yield similar -or comparable- results, this is not particularly the case for more than one reason. The first is related to the methodology; as was previously mentioned in the survey of literature, the ARCH/GARCH measures of volatility is the now more commonly used and agreed upon as a better tool of capturing the different dimensions of volatility. Therefore, it is expected to yield better results compared to the unconditional measures (Rey, 2006; Ramzan, Ramzan, & Zahid, 2012). The second reason is related to the Egyptian context, as was shown in the previous section, the moving average standard deviation of real effective exchange rate has been characterized by obvious outliers which renders the effectiveness and the consistency of the estimation. Unless these outliers are explained, adjusted or accounted for, the results would be dealt with great cautious.

For those reasons, we chose to present only the results obtained using the conditional measure of exchange rate volatility as it expected to yield better and reliable results. In this regard, Table (3) presents the results of the VECM estimated for one co-integrating equation at two lags using the GARCH measure of exchange rate volatility. The ECT(-1), which is the error correction term reflects the speed of adjustment and it is both negative and significant. It implies that nearly 26 percent of the disturbance or disequilibrium in the short-run will be corrected each year.

TABLE 3. RESULTS OF THE ESTIMATED VECM
USING THE GARCH MEASURE OF VOLATILITY

<i>DEPENDENT VARIABLE: REAL VALUE OF NON-PETROLEUM EXPORTS</i>	
ECT (-1)	-0.258719
	(0.10527)
	[-2.45763]
<i>EXPLANATORY VARIABLES</i>	
GARCH Volatility (CONDVOL)	-4.038179
	(0.67043)
	[-6.02330]
Real Effective Exchange rate (REER)	0.338384
	(0.29842)
	[1.13394]
Domestic income (RGDP)	0.587227
	(0.19843)
	[2.95933]
Weighted Trade Foreign Income (FINCOME)	1.726043
	(0.24638)
	[7.00561]

Source: E-Views Output Results.

The results indicate the existence of a significant negative relationship between real non-petroleum exports (EXP) and the GARCH measure of volatility (CONDVOL). This result is consistent with a wide array of studies that confirmed the existence of a negative relationship between the mentioned variables (e.g., Viera & MacDonald, 2016; Rey, 2006; Ramli & Podivinsky, 2011).

An important implication, is that the higher the volatility or the fluctuations of the exchange rate of the domestic economy, the higher is the level of uncertainty, and the lower is the demand for that economy's exports. This also supports the idea that the level of exchange rate in itself is not a sufficient tool to affect the value or the volume of exports; one should look beyond, to the volatility or the frequent changes in the exchange rate series.

Our results did not reach an affirmative relationship between the real value of non-petroleum exports (EXP) and the real effective exchange rate. The standard text-book relationship expects the effect to be negative; indicating that a higher value of the exchange rate (Egyptian Pound's appreciation) should induce lower demand for exports. However, the model found an insignificant relationship between the two variables.

This result does not contradict with the previous visual inspection of the two variables (see section 5) and could be explained by the exact context of the Egyptian economy

characterized by the high import component of the Egyptian imports. Therefore, an increase in exchange rate implies a higher cost of production and does not necessarily encourage exports. The final impact on exports is thus, not certain.

The link between non-petroleum exports and the two measures of economic activity; the domestic (RGDP), and the foreign (FINCOME) is as expected. Both relationships are positive and significant; indicating that a better economic activity whether inside the country or in the main trading partner countries will encourage a higher level of exports.

It is worth noting that all the previously mentioned results were also achieved by using the total volume of exports as the dependent variable instead of the real value of the non-petroleum ones. This further confirms and supports the results obtained.

6. Conclusions

In the presence of conflicting and ambiguous findings of prior studies, the purpose of this study was to examine the impact of exchange rate volatility on export performance in Egypt. Our main concern has been to investigate whether exchange rate volatility has affected trade flows, and particularly the value of non-petroleum exports of Egypt using annual data for the period (1980-2016). In order to analyze this, we built our own calculation of the real effective exchange rate over this period. Two measures of exchange rate volatility; moving average standard deviations and a GARCH measure of volatility. We show that the conditional measure provides better statistical results compared to the unconditional one.

The results based on the co-integration technique show that real exports are co-integrated with the relative price (real effective exchange rate, REER), Egyptian real GDP, trade weighted foreign income and exchange rate volatility. The direction of the relationship also indicates that the real value of non-petroleum exports (as well as the volume of total exports) are, in the long run, negatively correlated with exchange rate volatility. The short-run dynamics of the relationship is based on an error-correction model and implies that nearly 26 percent of the disturbance in the short-run will be corrected each year. The relationship between exports and both trade weighted foreign income and domestic real GDP are significant with appropriate positive signs, while the relationship with REER was not found to be statistically significant.

The main policy implications that can be drawn from this work are as follows: First; attempts to minimize exchange rate volatility can be considered a reasonable goal for Egyptian policy makers since reducing exchange rate volatility seems to have a relevant role in fostering export performance in the economy. Therefore, economic policy must not disregard the importance of preserving the real exchange rate stability as a source of export stability. The second point is related to the mismanagement of exchange rate policy in Egypt. Liberalizing the exchange rate in Egypt requires a careful design of other macroeconomic policies that would support such direction. If the economy is adopting inconsistent policies that cause exchange rate to fluctuate sharply, then government intervention would be important to avoid the negative economic effects of such volatility. The Egyptian government should work on some aspects to strengthen the value of the Egyptian pound relative to foreign trading partners. Furthermore, trade policies should be directed to support domestic exporters' international competitiveness and offer incentives that would help them better serve the international market.

Third, the negative impact of exchange rate volatility on export performance suggests that Egyptian exporters have a tendency of reducing their trade activities when the exchange rate becomes persistently volatile, which in turn is expected to affect export volume growth in an adverse way. This indeed was noticed several times with frequent changes in the domestic exchange rate regime.

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