The Impact of Exchange Rate Volatility on Armenia's Export to Euro Area Countries

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ABSTRACT

This paper empirically investigates the impact of exchange rate volatility on Armenia's exports to Euro area countries for the period of 2007 Q1 to 2018 Q2. The exchange rate volatility is calculated with the moving standard deviation of the bilateral real exchange rate. Time series data is used for the analysis. An Autoregressive Distributed Lag (ARDL) model is applied for exploring the relationship between exchange rate volatility and export. Estimation results indicate that there exists a negative relationship between exchange rate uncertainty and export flows. A one percent increase in exchange rate volatility in this quarter is predicted to decrease export by 2.8 percentage. The negative relationship between exchange rate uncertainty and export is explained in terms of the risk-aversion of producers. It is expected that risk-averse producers reduce their export flows to foreign countries during the high exchange rate volatility.

Keywords: Exchange Rate Volatility, Export, ARDL model, Armenia

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1. Introduction

After the breakdown of the Bretton-Woods agreement, the fluctuations of the exchange rate started to dramatically influence international trade. These movements led policymakers and researchers to explore the influence of exchange rate fluctuations on the volume of international trade. Also, flexible exchange rates were substituted with fixed exchange rates which caused a significant increase in the volatility of different currencies. Many studies investigated the impact of exchange rate uncertainty on the international export flows. In the meantime, the theoretical question concerning whether exchange rate volatility influences positively or negatively to exports has not finally been explored, even though there have been numerous researches conducted on this topic. Various academic studies have arrived at a final conclusion for the presence of a negative relationship between exports and exchange rate volatility. In this context, the negative relationship is often explained by the risk aversion of exporters. The risk aversion of exporters presumes a decrease in export volume or an elimination from the exporting market during the high volatility of the exchange rate (Yuksel, Kuzey, & Sevinc, 2012).

This academic paper is going to investigate the impact of exchange rate volatility on Armenia's export flows. The essence of the topic is its influence on the economy's essential and attributive macroeconomic indicators. Such an indicator is the trade balance from the Balance of Payments Accounts which has a very crucial impact on the economy's Gross Domestic Product (GDP). Export is considered as one of the underlying components of the country's trade balance. Hence, export has a crucial role in the formation of GDP, and as a result, it is quite important to examine the impact of policy variables such as the exchange rate on the export flows. Also, various policy implications can be derived from analyzing the influence of exchange rate volatility on the country's export. Being familiar with the possible effects of exchange rate

uncertainty may allow the central bank to intervene in the market with its monetary policy instruments and reduce or prevent the possible negative consequences.

In addition, the contrasting views among the academic investigations present an interesting research question "How does exchange rate volatility affect Armenia's export to Euro area 19 countries". There are numerous academic articles conducted for different countries examining the effect of exchange rate uncertainty on export flows. Many of them are about China's economy. One of the reasons may be that China's exchange rate was pegged to the U.S. dollar for at least three years starting from 2003 to 2006 and then it was pegged with other East and West European currencies (Euro, Pound sterling). These changing financial strategies caused high fluctuations in China's exchange rate relative to other currencies. At the same time, those changes affected different important macroeconomic indicators of China. This interesting phenomenon might be one of the incentives for scholars to conduct research based on China's economy. This also motivates me to conduct research in this field as AMD/EUR exchange rate is quite volatile (see Figure 1 in Appendix).

2. Literature Review

In general, there are two directions of research for examining and exploring the possible response of exports to exchange rate changes. First is to consider the exchange rate *fluctuations* (appreciation or depreciation) and its impact on the export flows. The second method is to analyze the *volatility* of the exchange rate and determine its effect on export flows (desired direction of this paper). Analytical review of the literature about these two directions may provide a path for finding and selecting the right methodology for obtaining complete results.

In many different countries, the government and industry market sector are concerned about the severe consequences of currency appreciation/depreciation impact on the entire country's export volume. However, many academic journals and articles contradict to each other about

the possible effect of exchange rate fluctuations on aggregate export flows. For instance, Dekle, Jeong, and Ryoo (2007) analyzed the effects of the exchange rate changes on export by using macroeconomic and firm-level data. According to authors, exchange rate fluctuations affected the aggregate export (macroeconomic) of seven industrialized countries; Canada, France, Germany, Italy, Japan, U.K., and the U.S., for the period 1982-1997 very slightly. This negligible response of export to exchange rate fluctuations is referred to as the exchange rate "disconnect puzzle" (Obstfeld & Rogoff, 2000). In another article, Colacelli (2009) raised the following questions "Do exports expand after depreciation? If so, by how much? And do they react differently to such fluctuations depending on the type of the exported good?" According to the author, there is a sectoral differential between homogeneous and differentiated sectors of the production. This indicates that some sectors of the economy which are similar in the production of a particular good respond to exchange rate changes differently than the sectors which produce differentiated goods. The author concludes that based on the type of good produced and exported the fluctuation of the currency may differently impact on the export of that good. Also, another article conducted by Berman, Martin, and Mayer (2012) analyzed a heterogeneous reaction of exporters to real exchange rate changes. This article used French firm-level data set with destination-specific export values during the period 1995-2005. According to the authors, high productive firms respond to exchange rate depreciation by increasing their prices and by decreasing their export volume. They explain this decrease in the volume of exports by stating that aggregate exports are mainly produced by high productive firms, by those that increase their prices during currency depreciation.

In addition to these scholarly articles where authors found relatively slight response of aggregate export to currency fluctuations, Liu Lu and Zhou (2013, p. 3) uncovered a negative statistically significant effect of a currency appreciation on export flows by conducting a difference-in-differences estimation. They examined China's export with its main trading

partners after and before China's exchange rate reform in July 2005. Authors uncovered that "a 1% currency appreciation is to cause total exports to fall by 1.61%. Taking into account that China exported to US $1,904 trillion worth of goods in 2011, a 1% currency appreciation means a $30.65 billion decrease in Chinese exports to the U.S., a significant number, which may justify the concerns by government officials and exporters." Worth mentioning that they found no trade deflection by Chinese exporters after the currency appreciation.

Furthermore, another research direction of investigating the response of exports from the exchange rate changes is to analyze the exchange rate *volatility* impact on export flows. There are various academic articles based on this topic ranging from the early 1970s to 2000s.

In general, many studies concluded that exchange rate uncertainty has a negative impact on the level of export flows. To the proof of this, Clark (1973, pp. 304-305) investigated an early model, according to which a firm produces and exports one homogeneous good to a single foreign country. According to the model, the market operates under perfectly competitive conditions, and there are no imported inputs for the production process. Also, the payments for exports are received in foreign currency and those earnings are sold in the forward exchange market. Thus, under these conditions, the uncertainty in the exchange rate has a very crucial role in future sales. Hence, the high volatility of the exchange rate may negatively impact on the profits of the exporting firm. Therefore, for a risk level reduction, risk-averse firms decrease their volume of production which consequently leads to the reduction of exports to the foreign market. In line with this straightforward model number of other authors such as Baron (1976); Hooper and Kohlhagen (1978), suggested a very similar conclusion that exchange rate uncertainty negatively affects export flows. However, this model is too simplified and contains many restrictions; hence, these results are driven from a bunch of unrealistic assumptions. Moreover, it has been argued that the negative relationship between exchange rate uncertainty and export flows is explained in terms of risk aversion. In this context, producers who are

sensitive to the overall risk of exchange rate volatility are affected more than those who are less sensitive. Thus, the volatility of the exchange rate does not significantly affect a risk-neutral company's choice. However, De Grauwe (1988) developed a model in his paper where he found that *high* risk-averse producers export more when the exchange rate risk is high. This outcome is explained by the increase in the expected marginal utility of export revenue. The author concludes that high risk-averse producers increase their exports during the high exchange rate risk in order to avoid the possibility of losing revenue. On the other hand, low risk-averse (risk-neutral) producers decrease their exports during high volatility of exchange rate.

In addition, Yuksel, Kuzey, and Sevinc (2012) found a negative relationship between Turkish aggregate exports and exchange rate volatility by applying a simple OLS regression. However, they conclude that the relationship is not significant at the level of 5%. Another study conducted by Thuy and Thuy analyzed Vietnam's aggregate export data with its main trading partners for exploring the impact of exchange rate uncertainty on the export flows. Authors apply autoregressive distributed lag (ARDL) bounds testing approach for examining level relationships between effective exchange rate volatility and exports. They found that exchange rate uncertainty has a statistically significant and negative impact on the export volume in the long run (Thuy & Thuy, 2019)[1]. Other studies such as Chowdhury (1993) and Arize (1995) also found a negative relationship between exchange rate uncertainty and export flows by employing Cointegration and ECM model. Also, Barseghyan and Hambardzumyan (2017) found a negative relationship between export and exchange rate volatility by analyzing Armenia's aggregate export data to Russian Federation, the main trading partner of Armenia. Surprisingly, authors found that the relative prices between the two countries positively impact

[1] See also Arize and Malindretos (2014) for similar methodology and results.

on the export flows. The positive impact of relative prices is found in some other studies as well.

Moreover, Lastrapes and Koray (1990) examined a negative relationship between exchange rate volatility and trade variables by employing a Vector Autoregressive Model (VAR). According to the author, the relationship between volatility and trade variables were quite small in comparison with other variables in the model. Another academic article examined the impact of short-term volatility of the real effective exchange rates of industrial countries on the import flows. The authors Kenen and Rodrik (1986, p. 314) derived three critical conclusions about the circumstances of this effect "First, the volatility of real exchange rates has not diminished as markets have gained experience with floating exchange rates. Second, exposure to short-term volatility has differed among countries. Third, the volatility of real exchange rates appears to depress the volume of international trade". On the other hand, McKenzie and Brooks (1997) uncovered surprising results by using an ARCH model for examining the monthly German-US trade flows for the period 1973 to 1992. They found that there is a significant positive relationship between exchange rate volatility and trade flows.

Many articles in different countries have investigated the effect of exchange rate uncertainty on export flows. The outcomes of those investigations confirm that the impact of exchange rate uncertainty on export flows can be either positive or negative depending on the type of data and period employed by the researchers. Summary of the methodologies, data types and period used by different studies are demonstrated in Table 1.

The remainder of the paper is organized as follows: Section 3 with its subsections presents the model, methodology, data and data sources, formula for exchange rate volatility and reports the main empirical results. Section 4 includes the findings of the paper with the conclusion.

Table 1: Summary of the literature review

Study	Data type	Period	Method.	Impact of Volatility
Lastrapes & Koray (1990)	Bilateral	73-87 (monthly)	VAR	Negative
Chowdhury (1993)	Aggregate	73-90 (quarterly)	Cointegration, ECM	Negative
Arize (1995)	Aggregate	73-91 (quarterly)	Cointegration, ECM	Negative
McKenzie & Brooks (1997)	Bilateral	73-92 (monthly)	ARCH	Positive
Yuksel, Kuzey & Sevinc (2012)	Aggregate	03-10 (monthly)	OLS	Negative (not significant)
Arize & Malindretos (2014)	Aggregate	80-10 (quarterly)	ARDL	Negative
Barseghyan & Hambardzumyan (2017)	Bilateral	07-16 (monthly)	Cointegration, ECM	Negative
V. Thuy & D. Thuy (2019)	Aggregate	00-14 (quarterly)	ARDL	Negative

3. Empirical Investigation

3.1. Model Specification

According to the literature review, many studies investigated long-run equilibrium export demand function for exploring the response of export to exchange rate volatility. However, there is not a one fixed model that is followed by all studies conducted in this field. Many studies including Chowdhury (1993), Arize and Malindretos (1998), Arize (1995), Kenen and Rodrik (1986) used the following benchmark model in their studies:

$$\ln X_{it} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln P_{it} + \beta_3 V_{it} + \varepsilon_{it} \quad (1)$$

where X_{it} denotes the logarithm of the real export value to country i at time t, Y_{it} denotes the logarithm of the real income of foreign country i at time t, P_{it} is the logarithm of the relative prices which is a measure of competitiveness, V_{it} is the volatility of the exchange rate with country i at time t, and ε_{it} is the error term. All variables are expressed in a log-linear

relationship. The former allows the dependent variable to respond proportionally to independent variables. The expected signs of the coefficients are as follows: real income of the foreign country is assumed to have a positive impact on the export level of the domestic country because according to gravity theory of international economics, the higher is the real GDP of a partner country the higher is the export to that country ($\beta_1 > 0$). Relative prices are assumed to have a negative effect on export level because the higher is the price in domestic country the less is the export to the foreign country ($\beta_2 < 0$). The impact of volatility on the export level is ambiguous, therefore the sign of the coefficient can be either negative or positive ($\beta_3 < 0, \beta_3 > 0$).

3.2. Methodology

Many studies employed a simple OLS regression for exploring the relationship between the export demand function and the exchange rate volatility. More recent studies mostly use different models including VAR, Co-Integration; ECM, ARDL, ARCH (see Table 1) for investigating the relationship between the variables. Authors Thuy and Thuy (2019) employed an ARDL model in their paper for examining the relationship between export demand function and exchange rate volatility and uncovered a significant negative relationship between export flows and exchange rate volatility. Also, another study conducted by Arize and Malindretos (2014) again used an ARDL model and found a negative relationship between export and exchange rate volatility. Based on these studies, this paper will follow the same methodology and will apply an ARDL model for estimating the relationship between exchange rate volatility and export. In addition, an ARDL model is a non-complicated and easily interpretable model which allows to include lags of explanatory variables as well as lags of the dependent variable in the model. This can further help to explain the relationship between volatility and export

flows. The optimal lags of the variables are selected based on the Bayesian Information Criterion (BIC).

3.3. Exchange Rate Volatility Measurement

All variables in the model are directly observable from macroeconomic data besides the exchange rate volatility. In general, exchange rate volatility is the risk associated with the unexpected fluctuations of the exchange rate. The volatility tends to be low when the exchange rate is spread over a small range of values, and it tends to be high when the exchange rate fluctuates dramatically (see Figure 2 in Appendix). The literature provides numerous methods for deriving the exchange rate volatility. According to studies Chowdhury (1993), Lastrapes and Koray (1990), Kenen and Rodrik (1986), and many others, the method of calculation of the exchange rate volatility is as follows:

$$V_t = \left[\frac{1}{m}\sum_{i=1}^{m}(\log E_{t+i-1} - \log E_{t+i-2})^2\right]^{\frac{1}{2}} \quad (2)$$

where m is the order of moving average (m=4)[2], t is the time and E is the real exchange rate. This formula applies a moving sample standard deviation of the real exchange rate.

3.4. Data and Data Sources

The data frequency is quarterly and ranges from 2007 Q1 to 2018 Q2 including 46 observations. The aggregate export from Armenia to Euro area 19 countries (see Table 6 in the Appendix for the list of Euro area 19 countries) and Armenia's Consumer Price Index are derived from the International Monetary Fund's (IMF) International Financial Statistics.

[2] The order of moving average is taken out from the literature. Also, m=4 allows to have relatively more sample size.

Consumer Price Index of Euro area 19 countries is derived from the Organization for Economic Co-operation and Development (OECD). Bilateral nominal exchange rate (AMD/EUR) and export price index are collected from Central Bank of Armenia (CBA). The real GDP of Euro area 19 countries as a measure of real foreign income, is collected from Eurostat. For obtaining the real export indicator, Armenia's export to Euro area countries is deflated by the export price index. The relative prices as a measure of competitiveness are calculated by dividing Armenia's CPI to the Euro area's CPI (both expressed in the same currency). The real exchange rate for obtaining volatility is calculated by the product of the nominal exchange rate and the ratio of CPI of Euro area countries to CPI of Armenia. The exchange rate volatility is calculated by equation (2). The logarithm of real export, relative prices and real GDP have been seasonally adjusted before using in the estimations. Also, the log of real export, real GDP, relative prices and volatility have been detrended with the Hodrick-Prescott filter. Summary statistics of original data is presented in Table 2.

Table 2: Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
ln X	46	17.9684	0.18012	17.50229	18.3848
ln Y	46	28.5279	0.03179	28.47696	28.6025
ln P	46	6.20176	0.06561	6.09559	6.39194
V	46	0.04229	0.02439	0.00485	0.10344

3.5. Empirical Results

For obtaining unbiased and consistent results with time series dataset usually the assumption of stationarity should be satisfied. For that reason, Dicky-Fuller unit root tests are employed for checking the stationarity of each time series (see Table 3). The results presented in Table 3 indicate that all variables are stationary. Particularly, the dependent variable ln X is I(0), while all other variables are trend stationary.

Table 3: Dicky-Fuller unit root tests

Variable	Level
ln X	-4.260***
ln Y	-3.123**
ln P	-5.370***
V	-2.587**

** and *** indicate 5% and 1% level of significance, respectively. The null hypothesis of the test is that there is a unit root.

Also, for conducting a Dicky-Fuller unit root tests the constant term for ln X, and V is suppressed[3]. For the construction of an ARDL model and optimal lag length selection, Bayesian Information Criterion (BIC) is used. After lag length selection and appropriate model diagnostics, an ARDL (1,0,0,0)[4] model is selected. The results are presented in Table 4.

Table 4: ARDL (1,0,0,0) model

Dependent variable ln X	Coefficient	Standard Errors
$\ln X_{t-1}$	0.2118	0.1524
ln Y	8.2479**	3.6919
ln P	-0.0779	0.3921
V	-2.7935**	1.2482
Constant	-0.0023	0.0187
Log-likelihood	32.303	
AIC	-1.21	
BIC	-1.01	

** and *** indicate 5% and 1% level of significance, respectively.

The signs of the coefficients match the expectations. The estimated coefficient of the volatility is around -2.8 percent, indicating that the exchange rate volatility has a negative impact on the export flows from Armenia to Euro area countries. A one percent increase in the exchange rate

[3] The constant term for Dicky-Fuller unit root test is restricted according to Principles of Econometrics (2012). The variables have zero mean and the errors are serially independent when regressed on their first lags. In addition, the optimal lags for Dicky-Fuller unit root tests are selected based on Bayesian Information Criterion.
[4] Optimal lag lengths are selected with EViews statistical software based on Bayesian Information Criterion.

volatility is expected to cause around 2.8 percentage decrease in exports to Euro area countries. This result is in line with many studies including Barseghyan and Hambardzumyan (2017), Lastrapes and Koray (1990), Chowdhury (1993), Thuy and Thuy (2019), Arize and Malindretos (2014) where authors also found a negative relationship between exchange rate volatility and export flows. According to an ARDL model, the estimated equation of the export demand function is as follows:

$$\ln X_t = -0.0023 + 0.211 \ln X_{t-1} + 8.247 \ln Y_t - 0.077 \ln P_t - 2.793 V_t \qquad (3)$$

the estimation output suggests that volatility and real GDP are statistically significant variables. Surprisingly, the positive relationship between the real GDP of Euro area countries and Armenia's export is quite strong. A one percent increase in the real GDP of Euro area countries is predicted to increase the exports of Armenia by about 8.5%. This indicates that an increase in the real income of Euro area countries dramatically increases the export flows of Armenia. However, we should account the fact that our data frequency is quarterly and a 1% increase in the real GDP of Euro area countries for one quarter is very high compared to reality. The average quarterly growth rate of the real GDP of Euro area countries in 2018 was only 0.46% (Eurostat, 2019).

Moreover, the estimation shows that the first lag of the dependent variable, real export, positively affects the current export flows. A one percent increase in the real export of the previous quarter is predicted to increase the real export of current quarter by 0.2 percentage. However, the variable is not statistically significant at the level of 5%. As it was expected the relative prices between trading partners negatively affect the export flows. An increase in Armenian prices is predicted to cause a slight decrease in exports to foreign countries. However, again, the coefficient of the relative prices is not statistically significant at 5% level of significance.

In addition, the negative impact of the exchange rate volatility on export flows is mainly explained by the risk aversion of the producers (exporters). That is high exchange rate uncertainty causes risk-averse producers to decrease their exports to foreign countries for reducing the possibility of losing revenue.

3.6. Model Diagnostics

In this section, we will check the main assumptions of an ARDL model for having consistent and unbiased results. One of the essential assumptions for the distributed lag model is the serial correlation of the errors. To estimate the serial correlation of the errors we employ Breusch-Godfrey LM test. Another important assumption is the normal distribution of errors which we check with the Shapiro Wilk test. In addition, we employ the Breusch Pagan test for checking the constant variance of errors. All test results are presented in Table 5.

Table 5: Assumptions testing for distributed lag model

Test name	X^2 - Prob
LM: Breusch-Godfrey AR(1)	0.3285
Shapiro Wilk	0.9525
Breusch Pagan	0.3091
LM: ARCH(1)	0.2267

The results in Table 5 indicate that all assumptions of the model are satisfied. Specifically, the Breusch-Godfrey LM test for serial correlation suggests that there is not enough evidence to reject the null hypothesis of no serial correlation of errors. Thus, we can conclude that our errors are not serially correlated. The Shapiro Wilk test for normality indicates that there is not enough evidence to reject the null hypothesis of normally distributed errors. The Breusch Pagan test for constant variance (homoskedasticity) indicates that the residuals are homoscedastic.

Finally, the LM ARCH test suggests that the null hypothesis of no autoregressive conditional heteroscedasticity is not rejected. The results of the tests indicate that the model is consistent and provide unbiased estimators.

4. Conclusion

This paper investigates the impact of exchange rate volatility on Armenia's exports to Euro area countries for the period of 2007 Q1 to 2018 Q2. The exchange rate volatility is calculated with the moving standard deviation of the bilateral real exchange rate. We apply an Autoregressive Distributed Lag (ARDL) model to explore the relationship between exchange rate volatility and export demand function. Estimation results indicate that there exists a negative relationship between exchange rate uncertainty and export flows. A one percent increase in exchange rate volatility is predicted to decrease export by 2.8 percentage in the current quarter. Also, real foreign income has a strong positive relationship with the export. A one percent increase in the real GDP of Euro area countries is predicted to increase export by 8.2 percentage. The negative relationship between exchange rate uncertainty and export is explained in terms of the risk-aversion of producers. It is expected that risk-averse producers reduce their export flows to foreign countries during the high exchange rate volatility.

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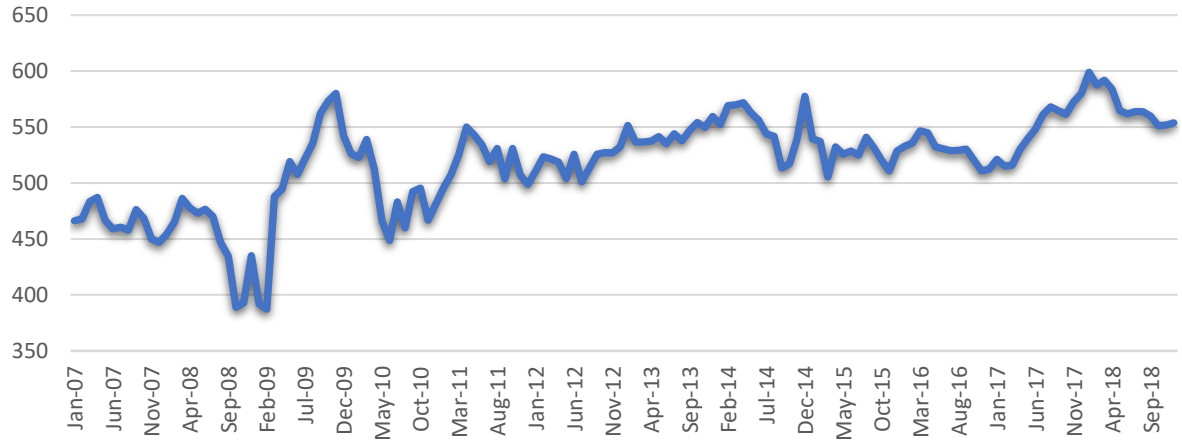
Appendix

Figure 1: AMD per EUR exchange rate from 2007 to 2018

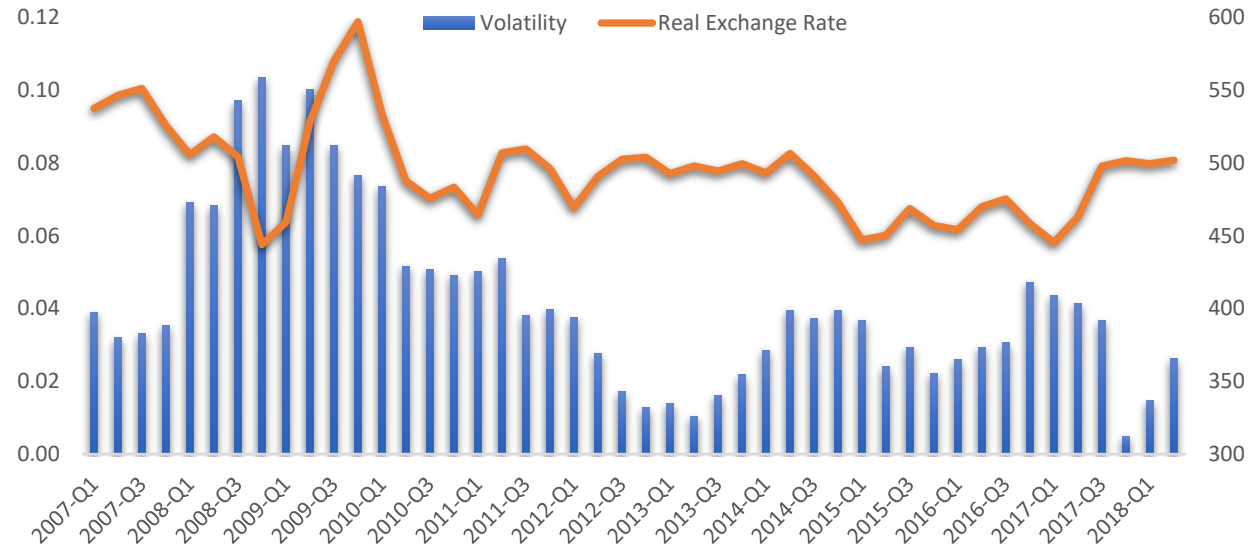


Source: Central Bank of Armenia

Table 6: List of Euro area countries

Euro area 19 countries					
Austria	Estonia	Germany	Italy	Luxembourg	Portugal
Belgium	Finland	Greece	Latvia	Malta	Slovakia
Cyprus	France	Ireland	Lithuania	Netherlands	Slovenia
Spain					

Figure 2: Real exchange rate and real exchange rate volatility from 2007 Q1 to 2018 Q2



The left axis presents the real exchange rate volatility and the right axis presents the real exchange rate. When the real exchange rate is stable, the volatility tends to be low. For example, during the period 2012 Q3 to 2014 Q1 the volatility is quite low as the real exchange rate is stable over that period.

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