





SUBSTITUTION OF ANCHOR CURRENCY: CHALLENGES FOR TRADE BETWEEN IRAN AND ITS MAJOR TRADING PARTNERS

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Abstract. The aim of the paper is to find out whether euro is a convenient substitution for U.S. dollar as an anchor currency for Iranian rial and whether this replacement would affect Iran's international trade positively. We explore these effects via Optimum Currency Area (OCA) theories using generalized least square from 2000 to 2018. Based on OCA index, euro would be a good substitution for U.S. dollar as an anchor for Iranian rial. In addition, gravity model and Generalized Method of Moments estimation confirm that substitution of U.S. dollar by euro would improve bilateral trade between Iran and its major trade partners especially the European Economic and Monetary Union (EMU). Furthermore, we confirm that a basket containing main currencies (euro, U.S. dollar, yuan, Russian ruble) would be more efficient than a single currency anchor however euro should be prominent in the basket. Such a change of anchor could positively contribute to reduction of transaction costs, diversification of external risk, rise of mutual trade exchanges between Iran and the EMU or the EU and consequent economic growth of trade partners. The paper contributes to the existing literature by comprehensive methodological approach how to identify an appropriate anchor currency.

Keywords: euro anchor, currency basket, international trade, OCA theory.

JEL Classification: F10, F31, O24.

Introduction

Major parts of Iran's foreign exchange earnings come from exports of oil and gas, oil products and petrochemicals, which are priced and traded in U.S. dollars in international markets. However sanctions against Iran during 2010–2013 and re-imposed sanctions against Iran in

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2018 have put much limitations on Iran's oil exports and thus the exchange earnings. The sanctions during 2010–2013 implemented oil embargo and froze Central Bank assets within the EU. It also barred companies from insuring Iranian oil shipments (Cordesman et al., 2011; Jamali et al., 2017).

Re-imposing of sanctions against Iran caused decrease in Iran's crude oil exports from 1,850,000 barrels per day in 2018 to 599,000 barrels per day in 2019 (68% decline). In addition, embargos against Iran affect Iran and its major trade partners directly since Iran's trade with other countries is based on U.S. dollar especially for exporting oil to other countries. Meanwhile, as Iran pegs its money to U.S. dollar, not only the trade volume but also the value of Iranian currency, rial, fluctuated and destabilized Iran's foreign exchange market during sanction period.

To decrease the role of U.S. dollar in Iran's economy, if not implemented completely, Iran has been trying to substitute a new currency anchor, particularly euro or providing a basket of the main currencies such as euro, Chinese yuan, Russian ruble should help to solve financial problems and euro as an anchor might be an efficient option to replace the U.S. currency.

Currency anchor is a main currency such as U.S. dollar or euro to which a small open economy pegs its currency and applies it as a reserve currency, invoice currency (Xu, 2011) and nominal anchor to reduce and stabilize domestic inflation via curbing inflation expectations directly through its constraint on the value of local currency. Currently, Iran pursues a new exchange policy to switch from U.S. dollar to euro due to its financial transactions, economic instability, exchange rate volatilities and the imposed U.S. sanctions. Therefore, it is necessary to assess the role of another currency as an anchor to provide economic stability. Euro, as a candidate, can implement Iran's anchor currency which is typically determined by structural factors such as the direction of trade flows (Sriyana & Afandi, 2020). This new policy would stabilize the economy and would decrease effects of exchange rate volatilities. Meanwhile, applying euro as a new anchor for Iran might help this country to promote its trade with trade partners and to decrease the effects of U.S. sanctions.

According to the discussion raised in this section, we conclude that pegging Iranian rial to U.S. dollar not only decreased trade between Iran and its trade partners but also caused fluctuation in value of Iranian rial. Therefore, the main objective of this study is to consider the possibility of switching from U.S. dollar to euro as an anchor and its effects on Iran's trade, given the fact that there exists a gap in the related literature.

Hence, to investigate this possibility the theory of Optimum Currency Areas (OCA) introduced by Mundell (1961) was applied. Then, we study the effect of new anchor on Iran and its major trade partner's trade by applying gravity model and GMM approach. Although many studies applied gravity model to consider major determinants of bilateral trade but in this paper the OCA index is added to the model to research the effect of currency anchor on Iran and its major trade partners' bilateral trade.

The remaining of the paper is structured as it follows. Section 1 reviews theoretical background, the OCA literature, and recent contributions linked to the topic. The methodology of research is presented in section 2. Section 3 describes empirical results and discusses achieved findings. Final section concludes and summarizes main findings and relevant remarks.

1. Theoretical background and related literature

Countries decide to peg to another currency to enhance lower and more predictable rate of inflation and prevent exchange rate fluctuations as uncertainty affects the terms of trade. A currency anchor is the major currency which movements against other major currencies are largely shared by another (the anchored) currency (McCauley, 1999). Countries have different reasons for pegging to the dollar and here we classified them in three groups. The first reason for pegging countries' currency to U.S. dollar is related to mainly export based income paid in dollars in e.g. oil-rich countries in the Middle East including Iran, Jordan, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. Small economies which major parts of their external revenues come from tourist sector usually also peg their currencies to U.S. dollar e.g. Caribbean islands like Aruba, Bahamas, Barbados, and Bermuda. Second reason for pegging currency to U.S. dollar is to benefit from country's manufacturing and export-driven economy for example in case of China and Japan. Third reason is that countries need to ensure that the value of their currency remains relatively stable in global economy and fixing to U.S. dollar stabilizes the economies and makes them less volatile (Kueh, 2002; Plumper & Neumayer, 2011).

Iran is not alone in its effort to establish an alternative to trading oil and other commodities in dollars. In the past, Russia also expressed interest in establishing a Russian stock exchange which would allow oil, gas, and other goods to be paid for in rubles in 2006 (Urbanovsky, 2015). However, this is not a new phenomenon that a country decides to change the exchange rate anchor as Russia put an end to its dollar peg in 2004 and opted to move towards a euro alignment.

To assess the possibility of substituting U.S. dollar by euro can be performed via the theory of Optimum Currency Areas (OCA) introduced by Mundell (1961) and developed by McKinnon (1963), Kenen (1969) and others. However, during the first half of 1970s the number of studies about OCA decreased due to lack of practical examples of monetary unification but the theory attracts the economists' attention again in the 1990s in the birth of the European Monetary Union (Broz, 2005).

OCA literature focuses on inter-relationships among members of a potential OCA in terms of the volume of trade, the similarity of business cycles and shocks, the system of risk-sharing through fiscal transfers (Frankel & Rose, 1998), export structure dissimilarity and relative size of the economies (Bayoumi & Eichengreen, 1997; Frydrych & Burian, 2017). The OCA theory evaluates the possibility of implementing a common currency between the pair of the countries based on the structural features of the economies (Horvath & Komarek, 2002) by calculating OCA index through an estimation of a regression equation and prediction the variability of the exchange rate (Bayoumi & Eichengreen, 1997; Cincibuch & Vavra, 2001; Devereux & Lane, 2003; Frydrych & Burian, 2017). In this regression model based on OCA theory, bilateral deviation of the currency exchange rate regresses on selected exogenous variables including the GDP cycles symmetry, intensity of mutual trade relations and size of the economies and the aim is to minimize the sum of the squares of the residuals. Lower OCA index indicates that it is suitable for the economy to join a monetary union or it shows that the given exchange rate is a suitable anchor. In the case of selecting between one anchor and several currencies in the basket, the minimum deviation of the exchange rate

or OCA index can be the guideline (Bénassy-Quéré & Lahrière-Révil, 1998; Barseghyan & Baghdasaryan, 2019). Fischer (2016), Baran and Witzany (2018), and Thanarerk (2016) re-consider an anchor currencies after the global financial crisis on the basis of OCA approach from the global point of view and in South Asian countries respectively.

While pegging currency to an individual currency is a transparent and explicit commitment to mimic the rate of inflation of the reference currency but there are some disadvantages, too. One inconvenience is that a currency peg does not ensure stability of the country's effective exchange rate. For example, suppose that Iran trades with the EMU, China and Russia but pegs its currency to euro only and if euro appreciates or depreciates relatively to other currencies therefore Iran also faces currency appreciation or depreciation (Fратиanni et al., 1998). Thus, selecting a basket could solve this problem. However, what should be the share of euro in this basket? To answer this question we follow the methodology introduced by Frankel and Wei (1994) which enables us to estimate weights of the basket currencies or test whether other exchange rate arrangements fit basket currencies.

2. Data and research methodology

Annual and monthly data for Iran, the EMU, China, Russia, and the U.S., over the 2000–2018 period are used in the analytical part of this research. All data are collected from World Development Indicators (WDI, 2020) database, however exchange rate and bilateral trade data were gathered from several sources, i.e. from the World Development Indicators database of the World Bank, United Nations Conference on Trade and Development (UNCTAD, 2020) database Central Bank of Iran (CBI, 2020) and Pacific Exchange Rate Service (Sauder, 2020).

Based on the traditional literature on OCA, to fix exchange rate to another country's currency, several conditions are required, which make the adjustment of the exchange rate either inefficient or unnecessary to stabilize output: (1) most shocks to real output are common to both countries; (2) foreign trade represents a large share of GDP; (3) the other country is an important trade partner; (4) specific shocks can be adjusted by factor of mobility, real wage flexibility and/or fiscal federalism (Mundell, 1961; McKinnon, 1963; Kenen, 1969). By following Bayoumi and Eichengreen (1997) we investigate whether the conditions are fulfilled for Iran and whether the exchange rate variability is explicable by traditional OCA criteria. Therefore, we estimate the following equation by applying euro, yuan, ruble, dollar because the EMU, China, Russia, and the U.S. are major trade partners for Iran and their currencies are among important fully convertible world currencies.

$$SDS_{ij,t} = \alpha_0 + \alpha_1 SDY_{ij,t} + \alpha_2 RGL_{ij,t} + \alpha_3 RSIZ_{ij,t} + u_{ij,t}, \quad (1)$$

where SDS_{ij} shows bilateral exchange rate volatility between Iran and other countries. $SDS_{ij,t}$ is the standard variation of the monthly log-variations of bilateral, nominal exchange rates during 2000:1–2018:12. S_{ij} is quarterly nominal exchange rate of currency i against currency j . $SDY_{ij,t}$ represents standard deviation of the differences in year-on-year log variations of real output between i and j . $RGL_{ij,t}$ is the ratio of Iran and country j 's intra-industry trade to total i 's bilateral trade with all four countries. $RSIZ_{ij,t}$ is the ratio of current dollar GDPs in i and j . It is expected that $a_1 > 0$, $a_2 < 0$ and $a_3 > 0$. Since asymmetric shocks proxied by high SDY_{ij} or low RGL_{ij} are incentives for exchange-rate flexibility, whereas a small size com-

pared to the potential anchor partner (low $RSIZ_{ij}$) should lead to more stability. Therefore, it is expected that SDY_{ij} and $RSIZ_{ij}$ have positive effect on SDS_{ij} . High deviation in GDP of Iran and other countries' GDP in our sample indicates the asymmetry of business cycles or dissimilarity in their output cycles affects exchange rate volatility negatively (Bénassy-Quéré & Lahrèche-Révil, 1998; Frydrych & Burian, 2017). It reveals the fact that business cycle synchronization would decrease exchange rate volatility that means the higher symmetry of business cycles, the lower standard variation of bilateral exchange rates is. The coefficient on the relative Grubel and Llyod index (RGL_{ij}) is expected to have a negative effect on bilateral exchange rate volatility since the more the volume of intra-industry trade, the less bilateral exchange rate volatility due to similarity in trade structure as a channel of transferring external shocks to the country. Based on OCA theory $RSIZ_{ij,t}$ should have positive effect on SDS_{ij} since a small country has more incentive than a big one to peg its currency.

In order to assess the variability of the exchange rates that would fit the OCA theory like Bayoumi and Eichengreen (1997), we apply Eq. (1) to calculate OCA index to assess the variability of the exchange rates that would fit the OCA theory and to select the appropriate peg for Iran. Indeed, the OCA index represents the predicted value of the exchange rate variability. We compute the ratio of the OCA index against euro, yuan and ruble over the corresponding index against the dollar. These exchange rates should be preferred to the dollar if this ratio is lower than one. Lower value of OCA index indicates lower risk of the nominal exchange rate volatility, which decreases the potential risk to the trade of the Iran economy with its trade partners. Consequently, the exchange rate which proposed lower OCA index is a good candidate as a peg.

As one of main determinants of exchange rate volatility in Iran is imposing of sanction then to investigate this effect we augment the model by including a dummy variable ($DUM_{10:13}$) into the Eq. (2):

$$SDS_{ij,t} = \alpha_0 + \alpha_1 SDY_{ij,t} + \alpha_2 RGL_{ij,t} + \alpha_3 RSIZ_{ij,t} + \alpha_4 DUM_{10:13} + u_{ij,t}, \quad (2)$$

where $DUM_{10:13} = 1$ for the years 2010–2013 and 0 otherwise to consider the effect of imposing of sanctions on Iran during this period. Dummy was not applied in 2018 when sanctions were re-imposed as the impact of sanctions would appear only in the following years and our data ends in 2018.

The variability of exchange rates between i and j (SDS_{ij}) is measured as the standard variation of the monthly log-variations of bilateral, nominal exchange rates. $LogS_{ij}$ is quarterly nominal exchange rate of currency i against currency j and SD denoted standard deviation during 2000:1–2018:12.

$$SDS_{ij,t} = SD \left(LogS_{ij,t} - LogS_{ij,t-1} \right), j = \text{euro, yuan, ruble, dollar}, \quad (3)$$

The asymmetry of business cycles between i and j (SDY_{ij}) is the standard deviation of the differences in year-on-year log variations of real output between i and j :

$$SDY_{ij,t} = SD \left(\log \frac{RGDP_{i,t}}{RGDP_{i,t-1}} - \log \frac{RGDP_{j,t}}{RGDP_{j,t-1}} \right), j = \text{EMU, China, Russia, U.S.}, \quad (4)$$

where $RGDP_i$ and $RGDP_j$ stand for Iran and country's j GDP at constant prices, respec-

tively. $RGDP_{i,t-1}$ is Iran's GDP at constant prices in $t-1$ and $RGDP_{j,t-1}$ is country's j GDP at constant prices in $t-1$. SD is the standard deviation operator. The relative size of i compared to j ($RSIZE_{ij}$) is the ratio of current dollar GDPs in i and j :

$$RSIZE_{ij,t} = \frac{SIZE_{i,t}}{SIZE_{j,t}}, j = \text{EMU, China, Russia, U.S.}, \tag{5}$$

where $SIZE_{i,t}$ is Iran's GDP in current dollars and $SIZE_{j,t}$ is country's j GDP in current dollars.

Sectorial asymmetries are proxied by the share of intra-industry flows in bilateral trade. The share of intra-industry trade is measured through a relative Grubel and Lloyd index (RGL_{ij}) quantifying the importance of intra-industry trade in ij bilateral trade in comparison to in i 's external trade with all four countries:

$$RGL_{ij,t} = 100 \frac{GL_{ij,t}}{GL_{iw,t}}, w = \text{sum of EMU, China, Russia, U.S.}, \tag{6}$$

where $RGL_{ij,t}$ is bilateral trade of Iran and country j and $GL_{iw,t}$ is the sum of Iran's and all four countries' bilateral trade. The following index of intra-industry trade would be applied in order to calculate the Grubel and Lloyd index:

$$GL^k_{ij,t} = 1 - \frac{\sum_{k=1}^n |X_{ij,t}^k - M_{ij,t}^k|}{\sum_{k=1}^n (X_{ij,t}^k + M_{ij,t}^k)}, \tag{7}$$

where $GL^k_{ij,t}$, $X_{ij,t}^k$ and $M_{ij,t}^k$ represent intra-industry trade, exports and imports respectively between countries i and j in industry k . By construction, this indicator displays the trade imbalance as a part of inter-industry trade flows and trade overlap representing intra-industry trade.

Nevertheless it is questionable whether a basket containing all these currencies could be preferred to a single currency. We follow approach by Frankel and Wei (1994) who suggest an idea that a simple ordinary least squares (OLS) regression analysis on the monthly exchange rates against a numeraire currency will uncover the weights in the basket. In other words, the volatility of the Iranian currency against the numeraire can be explained by the volatility of one or several potential anchor currencies. The estimation then takes the following form:

$$e_{i,t} = \alpha_i + \sum_1^N \beta_{ij} e_{j,t} + u_{i,t}, \tag{8}$$

where the logged change rates of the monthly bilateral exchange rates of Iranian currency and other currencies in the basket are expressed by e_i and e_j respectively, while N denotes the number of different currencies in the basket, here it is 4. The β coefficients indicate the weight of the respective currency in the currency basket (Freitag, 2010). If β reached a value close to unity the respective currency basket was shown to be pegged to this currency. If β was close to zero there was no exchange rate stabilization against that (Freitag, 2010). To regress the exchange rates of four currencies on the Iranian rial, we rewrite the Eq. (8) as bellow:

$$e_{i,t} = \alpha_i + \beta_1 e_{USD,t} + \beta_2 e_{EUR,t} + \beta_3 e_{CNY,t} + \beta_4 e_{RUB,t} + u_{i,t}, \tag{9}$$

where $e_{i,t}$, $e_{USD,t}$, $e_{EUR,t}$, $e_{CNY,t}$ and $e_{RUB,t}$ are the logged change rates of the monthly bilat-

eral exchange rates of Iranian rial, U.S. dollar, euro, Chinese yuan and Russian ruble in the basket, respectively. To define the value of each currency which is mentioned as the problem of numeraire, Frankel and Wei (1995, 1994) and Ohno (1999) used the special drawing rights (SDR), Eichengreen (2006) applied Swiss franc and Frankel and Wei (2007) used gold as a numeraire. In this study we apply three numeraires to ensure the robustness of our results, i.e. Swiss franc, SDR and gold by considering official and unofficial Iranian currency.

The last question in this study is whether substitution of U.S. dollar by euro as a currency anchor for Iranian rial develops trade between Iran and major trading partners especially economic relations with the EMU during re-imposing of sanctions by the United States. In order to reply to this question, gravity model is chosen to quantify the Iran’s bilateral trade with its major trade partners including China, European Union, United Arab Emirates, India, Turkey, South Korea, Switzerland, Singapore, Japan, Brazil, Russia, Afghanistan, and Malaysia. The general gravity model applied in bilateral trade has the following form:

$$EX_{ij} = A \frac{GDP_i GDP_j}{DIS_{ij}}, \tag{10}$$

where A is a constant term, EX_{ij} is the trade flow from origin country i to the destination country j , GDP_i and GDP_j is gross domestic product of country i and j , respectively. GDP indicates the economic size of two countries. DIS_{ij} is the distance between two countries i and j and shows the geographical distance between two capital cities. The gravity model applied in this paper is an augmented model of Krugman et al. (2010) by adding population of original and target countries and OCA index. The number of population is a proxy for size of market. OCA index is the predicted value of bilateral exchange rate volatility between Iran and other countries including the EMU, China, Russia, and the U.S. Eq. (2). The study adopted and applied the econometric specification of the dynamic panel gravity model (Nguyen, 2010; Wondesen & Mersha, 2019).

$$\begin{aligned} LEX_{ij,t} = & \beta_1 + \beta_2 LEX_{ij,t-1} + \beta_3 LGDP_{i,t} \times LGDP_{j,t} + \beta_4 LPOP_{i,t} \times \\ & LPOP_{j,t} + \beta_5 DIS_{ij} + \beta_6 OCA_K + U_{ijt}, \quad k = EMU, \text{ China, Russia, U.S.}, \end{aligned} \tag{11}$$

where $LEX_{ij,t}$ is log of exports from country i to country j (Iran and its major trade partners) at time t . $LEX_{ij,t-1}$ denotes lagged value of $LEX_{ij,t}$ at time $t-1$. $LGDP_{i,t} \times LGDP_{j,t}$ is the product of (log of) GDPs of Iran and its major trade partners. $LPOP_{i,t} \times LPOP_{j,t}$ is also the product of (log of) the exporter’s (importer’s) population. DIS_{ij} shows geographical distance between Iran and each of its major trade partners which is a proxy for transportation costs in trade flows. OCA stands for OCA index and we consider $OCA_{US,t}$, $OCA_{EMU,t}$, $OCA_{CHINA,t}$ and $OCA_{RUSSIA,t}$ to assess the effect of substituting other currencies for U.S. dollar on Iran and its major trade partners bilateral trade. U_{ijt} is the error term and shows residuals in time t in country i and it is a random variable that has well defined probabilistic properties.

In addition, we contribute to find out the relationship between exchange rate volatility and international trade through assessing the effect of the OCA index and misalignment on international trade and by exploring whether this index affects trade relations. As fluctuation in bilateral exchange rate is used as a proxy for financial risk and affects relative prices and purchasing power parity and it would result in lower bilateral trade, the sign of the estimated

coefficient should be negative. Indeed, an increase in bilateral exchange rate volatility increases risks and transaction costs while these changes reduce the incentives to trade.

We applied Eq. (1) and Eq. (2) by applying panel data approach in four cases by considering official and unofficial exchange rates and dummy variables for sanctions during 2010–2013. The Wald test and LR test are also used to test serial correlation and heteroscedasticity, respectively. Then Feasible Generalized Least Squares (FGLS) method has been applied to remove the heteroskedastic problem. To consider the exchange rate basket, we apply the SDR, the Swiss franc and gold to solve the numeraire problem and in three cases for official and unofficial Iranian currency.

To investigate the effect of OCA index on Iran and its major trade partners gravity model Eq. (11) has been estimated by applying the Generalized Method of Moments (GMM) approach to consider the endogeneity of the explanatory variables in eight cases (four different OCA indices) and considering official and unofficial exchange rate. In addition, Arellano-Bond autocorrelation test and Sargan test were applied to consider autocorrelation and goodness of instruments for all cases (Arellano & Bond, 1991; Arellano & Bover, 1995; Blundell & Bond, 1998). For data processing and analysis STATA 14 software was applied.

3. Research results and discussion

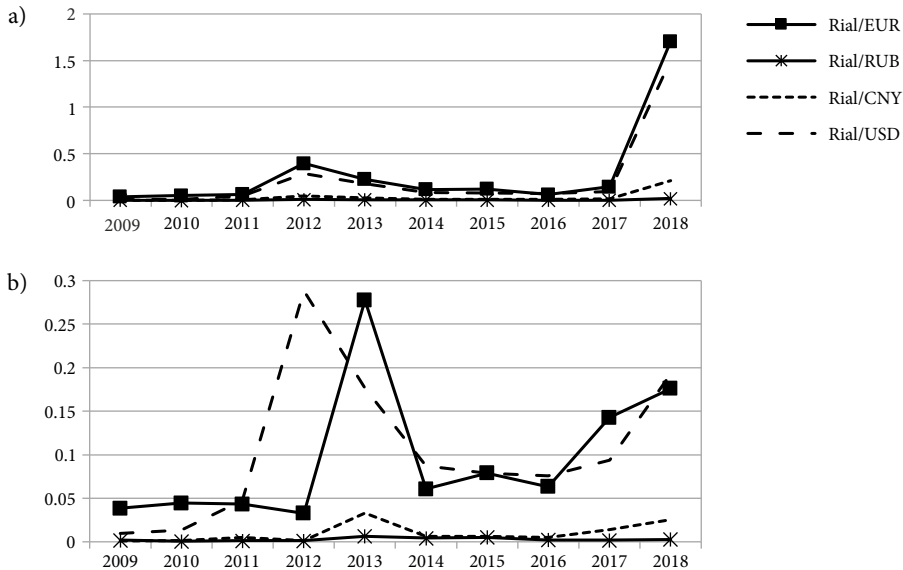
Monthly data over 2000–2018 period were used to estimate Eq. (1) and (11) for Iran, the EMU, China, Russia, and the U.S. regarding their data availability. All the series in Eq. (1) and (11) are stationary at their levels except for GDP of Iran and its major trade partners ($LGDP_{i,t} \times LGDP_{j,t}$). This variable appears to contain a unit root in its level but it is stationary in its first difference, i.e., I (1) (for more see Table 1).

In this section, we firstly estimate the bilateral exchange rate volatility model Eq. (1) and Eq. (2) to calculate the OCA index. Then, the basket currencies model Eq. (9) is estimated to consider the share of euro in Iran exchange rate basket. Finally, to evaluate the effect of

Table 1. Unit root test by LLC test (source: own research)

Variable	<i>t</i> statistics	Prob.	Variable	<i>t</i> statistics	Prob.
$SDS_{ij,t}^*$	-1.961	0.024	$OCA_{US,t}^*$	-12.523	0.000
$SDS_{ij,t}^{**}$	-2.425	0.007	$OCA_{US,t}^{**}$	-11.252	0.000
$RGL_{ij,t}$	-1.612	0.053	$OCA_{EMU,t}^*$	-10.732	0.000
$SDY_{ij,t}^*$	-2.334	0.009	$OCA_{EMU,t}^{**}$	-8.205	0.000
$RSIZ_{ij,t}$	-5.302	0.000	$OCA_{China,t}^*$	-2.910	0.002
$LEX_{ij,t-1}$	-4.991	0.000	$OCA_{China,t}^{**}$	-16.381	0.000
$LGDP_{i,t} \times LGDP_{j,t}$	0.916	1.384	$OCA_{Russia,t}^*$	-1.939	0.026
$D(LGDP_{i,t} \times LGDP_{j,t})$	-8.492	0.000	$OCA_{Russia,t}^{**}$	-10.583	0.000
$LPOP_{i,t} \times LPOP_{j,t}$	-10.456	0.000	-	-	-

Note: * Official exchange rate, ** Unofficial exchange rate, *D* is the first difference of the variable.



Note: Volatility means average of the standard deviations of the change in the logarithm of the exchange rate.

Figure 1. Exchange rate volatility based on monthly data: a – unofficial, b – versus official rates (source: own elaboration based on CBI, 2020 and Sauder, 2020)

new anchor on Iran and its major trade partners the gravity model is estimated by applying GMM approach.

It is necessary to measure the variability of exchange rates between i and j ($SDS_{ij,t}$) before estimating Eq. (1). Figure 1 illustrates $SDS_{ij,t}$ measured based on Eq. (3) by considering official and unofficial exchange rate, respectively during 2000:1–2018:12.

The variability of unofficial exchange rates between Iran and the EMU, China, Russia, and the U.S. (SDS_{ij}) fluctuated during the researched period while it has a summit in 2012 due to international sanctions imposed in 2010 which target Iran’s ability to sell crude oil on the world market and have made it more difficult for Iran’s Central Bank and other financial institutions to engage in transactions abroad. Therefore, it has caused significant damage to Iranian oil exports which went from 2.5 million dollars in 2011 to about 1 million dollars in 2013. As a result, Iran’s revenues from oil exports have seen a decline by 55% from their peak in 2011 and it had a negative effect on value of Iran’s rial. Although both official and unofficial exchange rates fluctuated in Iran, official rates fluctuates less as they are controlled by the government via exchange rate markets. In 2017 both exchange rates jumped when the U.S. announced its withdrawal.

The asymmetry of business cycles between i and j (SDY_{ij}) is measured on the basis of Eq. (4) as the standard deviation of the differences in year-on-year log variations of real output between i and j . High SDY_{ij} is an incentive for exchange-rate fluctuations therefore as Figure 2 shows especially in year 2017–2018 standard deviation of the differences in log variations of output between Iran and the EMU is lower than SDY of Iran and China, Russia, and the U.S. (see Figure 2).

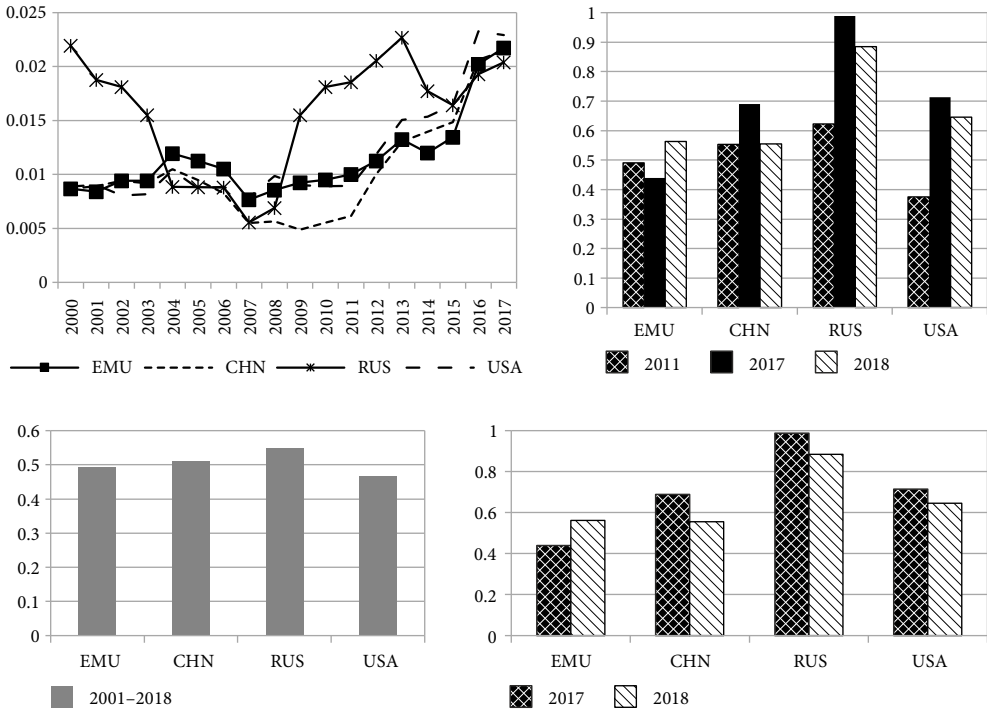


Figure 2. Business cycles asymmetry between Iran and each major trade partner (constant 2010 in USD) (source: own research based on WDI, 2020)

The relative size of i compared to j ($RSIZE_{ij}$) is measured on the basis of Eq. (5), i.e. the ratio of current dollar GDP in i and j . A small size compared to the potential anchor partner (low $RSIZE_{ij,t}$) should lead to higher stability. Therefore, based on Figure 3 the size of Iran is small relative to the EMU, the U.S., and China, respectively.

In this study, the sectorial asymmetries are proxied by the share of intra-industry flows in bilateral trade. Relative Grubel and Lloyd index (RGL_{ij}), which shows the share of intra-industry trade, is measured through a relative quantifying the importance of intra-industry trade in Iran and four countries (the EMU, China, Russia, the U.S.) bilateral trade in comparison to Iran's external trade with all four countries based on Eq. (6).

Based on Figure 4 the trend of RGL index for the EMU is diminishing during 2012–2015 when Iran faced other sanctions in 2012. However, its trend becomes increasing after signing the Joint Comprehensive Plan of Action by Iran and the P5+1 (i.e. China, France, Russia, the United Kingdom, the United States, plus Germany) world powers during 2015–2018 while it decreases for the U.S. after 2016.

To consider the effects of explanatory variables on $SDS_{ij,t}$ we estimate Eq. (1) and (2). Table 2 summarizes the empirical results for bilateral exchange rate volatility ($SDS_{ij,t}$) between Iran and other countries in question. The results are analyzed to show the effects of main determinants of bilateral official and unofficial exchange rate volatility based on OCA theory. Table 2 outlines estimation results in the case when official and unofficial exchange

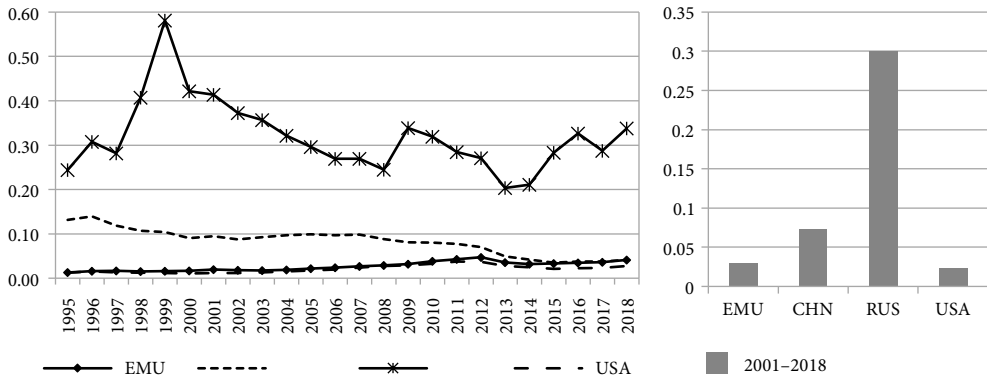


Figure 3. Relative size of *i* compared to other countries (source: own research based on WDI, 2020)

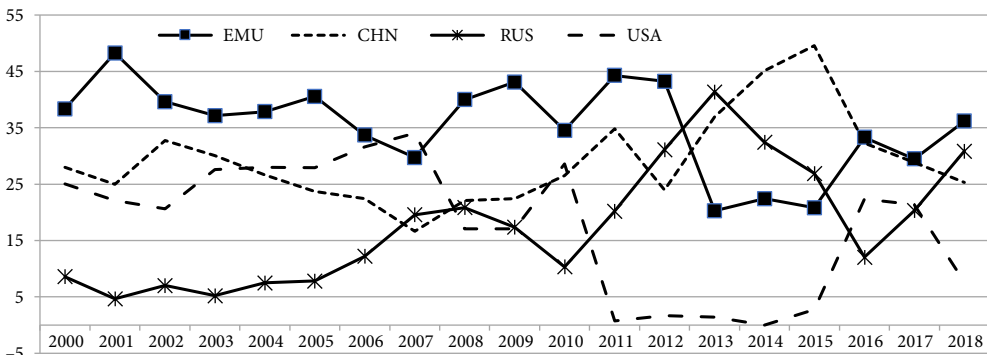


Figure 4. Relative Grubel and Lloyd index during 2000–2018 (source: own research based on UNCTAD, 2020)

rates are used as dependent variable. Applying the Leamer test and the relevant calculated statistic (F_{Leamer}) the results estimated by the panel data method are more consistent and more reliable than those obtained by pooled method. The Wald test as reported in Table 2 indicates that the model is fitted well in all cases and the LR test (homoscedasticity vs. heteroscedasticity) demonstrates that all cases have suffered from heteroscedasticity, consequently FGLS (Feasible Generalized Least Squares) method has been applied to remove the heteroskedastic problem.

The empirical results show that the signs of variable coefficients are consistent with theoretical expectations in all cases. Table 2 indicates that deviation in GDP of Iran and other countries' GDP in our sample (SDY_{ij}) has positive effect on exchange rate volatility but statistically it is not significant in all cases.

In addition, the relative Grubel and Lloyd index (RGL_{ij}) affects bilateral exchange rate volatility negatively. It reveals that the more the volume of intra-industry trade is, the less bilateral exchange rate volatility exists due to similarity in trade structure as a channel of transferring external shocks to the country. Higher intra-industry trade relationship leads

Table 2. Empirical results of bilateral exchange rate volatility model Eq. (1) and Eq. (2) (source: own research)

Variable	Official Exchange Rate		Unofficial Exchange Rate	
	Case 1	Case 2	Case 3	Case 4
Cons	-10.660 [0.000]***	-9.735 [0.000]***	-12.822 [0.000]***	-10.701 [0.000]***
$SDY_{ij,t}$	0.350 [0.796]	0.028 [0.930]	0.233 [0.578]	0.106 [0.795]
$RGL_{ij,t}$	-0.015 [0.001]***	-0.015 [0.001]***	-0.011 [0.046]**	-0.010*** [0.073]
$RSIZ_{ij,t}$	0.406 [0.000]***	0.371 [0.000]***	0.479 [0.000]***	0.401 [0.000]***
$DUM_{10:13}$	-	0.172 [0.209]	-	0.394 [0.023]**

Note: *** 1% significance level, ** 5% significance level, * 10% significance level, Leamer, Wald and LR tests are in Appendix (a).

to specialization in production, thereby it reduces the impact of industry-specific shocks on the two countries (Krugman, 1993; Kose & Yi, 2002), resulting in reduced bilateral exchange rate volatility. In addition, intra-industry trade relationship leads to higher synchronization through increased policy similarity (Frankel & Rose, 1998). Empirical results show that relative size of Iran to the potential anchor partner ($RSIZ_{ij,t}$) i.e. the EMU, China, Russia, and the U.S. has positive and statistically significant effect on $SDS_{ij,t}$ in all cases at the 1% level. It shows that a relatively small size leads to more stability.

The results for coefficients of dummy variable illustrate that sanctions against Iran have affected positively the bilateral exchange rate volatility during imposing sanction period 2010–2013 in both Cases (2) and (4) but the coefficient is statistically significant in Case (2). Such results imply that the sanction has increased Iran bilateral exchange rate fluctuations.

To select the appropriate peg for each country we use OCA indexes and compute the ratio of the OCA index against euro, yuan and ruble over the corresponding index against dollar. To measure OCA indexes in order to assess the variability of the exchange rates that would fit the OCA theory, we applied Case (1) and Case (3) following Bayoumi and Eichengreen (1997). Lower value of OCA index suggests that the countries are good candidates to be chosen as a peg. From the above regression equations we calculate OCA index, which is the predicted value of exchange rate variability. The lower the OCA index is, the higher is the benefit-cost ratio for monetary integration for the pair of the countries. The joint significance and satisfactory significance of Wald statistics of all of the regressions strongly support the idea that OCA indices have some explanatory power. Figure 5 captures OCA indices based on official and unofficial exchange rate (EX), respectively. As OCA index is lower than one in all cases especially for unofficial exchange rate, it is concluded that euro, yuan and ruble are preferred to U.S. dollar.

As OCA indices for all bilateral exchange rates between rial and euro, yuan and ruble are less than one, it can be asked whether a basket containing all these currencies and U.S. dollar could be preferred to a single currency or as OCA index for euro is significantly

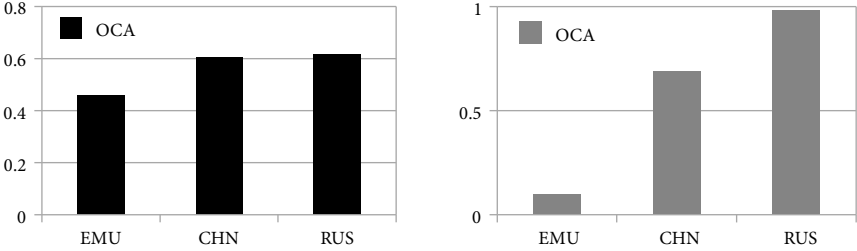


Figure 5. OCA indices based on unofficial (left) and official (right) exchange rates (source: own research)

lower than for other currencies whether the share of euro should be crucial in this basket. To estimate de facto weight of the basket currencies, we calculate the share of euro, yuan, ruble and U.S. dollar in the basket by following Frankel and Wei (1994) and estimating an ordinary least squares (OLS) regression analysis of the monthly exchange rates against a numeraire currency.

To solve the problem of numeraire, we apply the SDR (Frankel & Wei, 1994, 1995; Ohno, 1999), Swiss franc and gold (Eichengreen, 2006) by considering official and unofficial Iran currency. The R^2 values for all cases indicate that volatilities of these currencies against Swiss franc (Case 1), SDR (Case 2) and gold (Case 3) are strongly explained by the model. Based on Breusch-Pagan test for heteroskedasticity reported in Table 3 the model in all cases (for unofficial exchange rate) suffers from heteroskedasticity. Therefore we apply robust command in Stata to obtain unbiased standard errors of OLS coefficients and remove this problem. We estimate the composition of the Iran currency baskets during 2000:1–2018:12 by considering official and unofficial exchange rates.

Based on estimated results reported in Table 3 euro plays the major role in the currency basket by considering official exchange rate apart from Case (2) where euro takes rank as the second main exchange rate after ruble in Iranian basket. Yuan has dominant role by considering unofficial exchange rate basket in Case (2) and (3) while in Case (1) U.S. dollar plays more important role. In addition to higher value of the estimated coefficient, it is necessary to check the goodness of fit described by R^2 to consider overall variations of the regressor currencies in order to infer de facto degree of pegging (Baig, 2001). As reported in Table 3 R^2 is more than 0.90 in all cases except for Case (2) which is equal to 0.87 for unofficial exchange rate.

To assess the effect of OCA index on Iran and its major trade partners Eq. (11) has been estimated by applying the Generalized Method of Moments (GMM) approach to consider the endogeneity of the explanatory variables. The trade gravity model specified in Eq. (11) explains changes in bilateral trade flows between Iran and its major trade partners through changes in the explanatory variables. Table 4 reports the estimation results for eight cases of Eq. (11) where Cases 1–4 have been estimated for OCA based on Iran’s official rate of rial and Cases 5–8 have been estimated by applying Iran’s unofficial rate of rial, respectively. All estimates have been obtained by the Generalized Method of Moments (GMM) method. According to Arellano-Bond autocorrelation test, we cannot reject the null hypothesis on no autocorrelation of order 1 and no autocorrelation of order 2. Therefore, it is evident that the

Table 3. Empirical results of basket currencies model Eq. (9) (source: own research)

Variable	Case 1		Case 2		Case 3	
	Official EX	Unofficial EX	Official EX	Unofficial EX	Official EX	Unofficial EX
Cons	0.299 [0.194]	-0.940 [0.004]***	-14.580 [-0.32]	-1.250 [0.41]	-1.450 [0.007]***	-1.120 [0.000]***
$e_{US,t}$	0.133 [0.098]*	0.199 [0.062]*	0.005 [0.020]**	0.010 [0.976]	0.470 [0.000]***	0.120 [0.003]***
$e_{EMU,t}$	-0.246 [0.02]**	0.050 [0.740]	0.230 [0.000]***	0.012 [0.011]***	-0.440 [0.011]***	-0.130 [0.091]*
$e_{China,t}$	0.261 [0.051]**	-0.200 [0.186]	0.011 [0.904]	-0.300 [0.011]***	-0.005 [0.979]	-0.270 [0.016]***
$e_{Russia,t}$	0.197 [0.00]***	0.120 [0.072]*	-0.610 [0.450]**	-0.171 [0.619]	0.204 [0.043]**	0.231 [0.001]***
	$R^2 = 0.97$	$R^2 = 0.91$	$R^2 = 0.93$	$R^2 = 0.87$	$R^2 = 0.95$	$R^2 = 0.98$

Note: *** 1% significance level, ** 5% significance level, * 10% significance level, Breusch-Pagan test is in Appendix (b).

Arellano-Bond model assumptions are satisfied. The results of Sargan test statistics express that null hypothesis in all cases cannot be rejected which means that over-identifying restrictions are valid. Hence, the instrumental variables used in the model are strong.

Based on all eight cases reported in Table 4 the empirical results are rather consistent with theory as the signs of coefficients are in line with expectations. The coefficient of Iran's GDP and its major trade partners' GDP are significantly positive in all cases implying that Iran tends to trade more with larger economies and 1% increase of $LGDP_{i,t} \times LGDP_{j,t}$ will increase bilateral trade between them by 0.07% on average. The product of Iran and its major trade partners' market size ($LPOP_{i,t} \times LPOP_{j,t}$) in all cases except for Case (2), Case (3), and Case (7) have positive and statistically significant effects on Iran and its trade partner's bilateral trade. The coefficient of the distance variable (DIS_{ij}) in all cases except for Case (2) has been estimated significantly with a negative sign and this indicates that transportation costs decrease the bilateral trade flows between Iran and its trade partners.

The results for OCA indices demonstrate different effects of exchange rate volatility on Iran and its major partners' bilateral trade. $OCA_{US,t}$ and $OCA_{EMU,t}$ which are OCA indices based on dollar and euro, respectively, have negative effect on bilateral trade by considering both official and unofficial exchange rate in Iran. The similarity of result for dollar and euro indicates that euro is a good substitution for U.S. dollar. However, $OCA_{China,t}$ and $OCA_{Russia,t}$ for official exchange rate have positive effect on bilateral trade which is unexpected and indicates that Chinese yuan and Russian ruble are not suitable anchor currencies for rial since bilateral trade decreases by declining financial risk which is not appropriate. Both $OCA_{China,t}$ and $OCA_{Russia,t}$ have negative and statistically significant effect on bilateral trade by considering unofficial exchange rate. The implication is that any decrease in exchange rate volatility can create more trade opportunities for Iran and its major trade partners.

Table 4. Estimated results for Iran and its major trade partners' bilateral trade (2000–2018) (source: own research)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Cons	-8.03 [-6.26]**	-1.19 [-0.63]	-2.21 [-1.16]	-5.61 [-3.06]**	-5.84 [-4.35]**	-6.82 [-2.86]**	-1.47 [-0.85]	2.55 [1.24]
$LEX_{ij,t-1}$	0.61 [40.83]**	0.57 [42.89]**	0.59 [27.57]**	0.57 [39.15]**	0.60 [40.14]**	0.61 [35.7]**	0.56 [27.83]**	0.58 [22.76]**
$LGDP_{i,t} \times LGDP_{j,t}$	0.072 [10.98]**	0.08 [10.11]**	0.08 [8.89]**	0.09 [12.40]**	0.077 [8.64]**	0.07 [5.17]**	0.06 [8.94]**	0.07 [6.41]**
$LPOP_{i,t} \times LPOP_{j,t}$	0.02 [4.78]**	0.00 [0.20]	0.00 [0.71]	0.01 [2.08]**	0.02 [3.03]**	0.02 [1.86]**	0.01 [0.86]	-0.01 [-0.93]
DIS_{ij}	-7.38e-18 [-3.30]**	-1.69e-17 [-1.41]	-1.60e-17 [-3.20]**	-1.36e-17 [-2.40]**	-1.11e-17 [-2.17]**	-7.20e-18 [-2.74]**	-1.07e-18 [-1.98]**	-1.65e-18 [-2.27]**
$OCA_{US,t}$	-0.20 [-10.36]**	-	-	-	-0.21 [-8.24]**	-	-	-
$OCA_{EMU,t}$	-	-0.06 [-5.25]**	-	-	-	-0.16 [-9.03]**	-	-
$OCA_{China,t}$	-	-	0.43 [16.64]**	-	-	-	-0.68 [-11.80]**	-
$OCA_{Russia,t}$	-	-	-	0.45 [10.01]	-	-	-	-0.31 [-6.34]**

Note: ** 5% significance level, * 10% significance level, Arellano-Bond test and Sargan test are in Appendix (c).

Conclusions

In this paper we tested the hypothesis in which euro is a good substitution for U.S. dollar as an anchor for Iranian rial. Accordingly, monthly data during 2000:1–2018:12 were applied to estimate the model based on OCA theory to select the appropriate peg for Iranian currency. Our findings suggest that euro, yuan and ruble are preferred to U.S. dollar. In addition, when considering a currency basket for pegging Iranian rial, we applied Swiss franc, the SDR and gold to solve the problem of numeraire for official and unofficial Iran currency. Empirical results indicate that euro is the dominant anchor currency for Iran in case of formal exchange rate. We confirm the hypothesis that euro should be prominent in the Iran's optimal real basket peg. It can be concluded that euro should be chosen as a monetary anchor, or at least as the main currency of basket pegs. These results imply that replacing of U.S. dollar by euro would contribute to the expansion of mutual trade between Iran and the EMU even the EU as a whole as also other EU countries beyond the euro area realize their external trade with Iran using mainly euro.

Consequently, trade relations between Iran and the EU could be enhanced and would guarantee appropriate diversification of territorial trade structure and external risks on both sides. As trade relations between Iran and the EU have been growing, replacing of dollar by euro would reduce transaction costs especially in this period of time when it is not possible

for Iran to export oil via U.S. dollar due to U.S. sanctions. Rise of mutual trade, reduction of transaction costs could positively impact economic growth of both partners. Furthermore, such a change of anchor currency should not be at the expense of external trade with other trading partners.

Empirical indicates that Iran's GDP and its major trade partners' GDP affect bilateral trade positively. It implies that Iran tends to trade more with larger economies. Additionally, the market size of Iran and its major trade partners have positive effects on Iran and its trade partner's bilateral trade. It shows the higher the population the higher the production and bilateral trade.

Based on empirical results, OCA indices based on dollar and euro, respectively, affect bilateral trade negatively on Iran and its major trade partners indicating that exchange rate volatility have negative affect on Iran's trade flows with its major partners. Therefore, the more decrease in exchange rate volatility, the more trade opportunities for Iran and its major trade partners. Additionally the similarity of result for dollar and euro proves that euro is a suitable substitution for U.S. dollar.

This research and applied methodology can be inspiring for other countries which are maintaining the status quo situation in anchoring or pegging of their currencies despite the fact that this is not by far any more the most convenient solution for their economies. Situation in the world financial markets is evolving in time, international positions of currencies and their countries are changing, too. Therefore, countries should regularly reconsider their anchors, exchange rate regimes, currency baskets in favour of maximization of their benefits from external trade and the approach provided in this paper could be a certain guideline. However, in future, to reduce limitations of the paper it would be useful to apply longer time series, to involve other indicators, e.g. openness of economies and to confirm the results with alternative methods to increase robustness of findings. Comparison and quantification of potential costs and benefits from introduction of euro as an anchor currency would be useful. Additionally, by applying longer time series it is possible to investigate the OCA theory and its effect on bilateral trade in long-term and short-term by using Pooled Mean Group (PMG) estimation or panel ARDL in future investigations.

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APPENDIX

Appendix (a)

Leamer, Wald and LR tests for bilateral exchange rate volatility model Eq. (1) and Eq. (2) (source: own research)

<i>Diagnostic Tests</i>	$F_{Leamer} = 6.94$ [0.004]	$F_{Leamer} = 8.19$ [0.001]	$F_{Leamer} = 5.66$ [0.001]	$F_{Leamer} = 7.28$ [0.003]
	Wald chi2 = 33.45 [0.000]	Wald chi2 = 35.75 [0.000]	Wald chi2 = 25.73 [0.000]	Wald chi2 = 32.76 [0.000]
	LR chi2 = 129.84 [0.000]	LR chi2 = 65.02 [0.000]	LR chi2 = 563.25 [0.000]	LR chi2 = 97.28 [0.000]

Appendix (b)

Breusch-Pagan test is in for basket currencies model Eq. (9) (source: own research)

Variable	Case 1		Case 2		Case 3	
	Official EX	Unofficial EX	Official EX	Unofficial EX	Official EX	Unofficial EX
Diagnostic Tests	BPchi2 = 0.13 [0.715]	BPchi2 = 4.91 [0.026]	BPchi2 = 0.26 [0.970]	BPchi2 = 3.29 [0.000]	BPchi2 = 0.39 [0.534]	BPchi2 = 5.398 [0.020]

Appendix (c)

Arellano-Bond test and Sargan test for Iran and its major trade partners' bilateral trade model (source: own research)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Arellano-Bond Test	Z1 = -1.98 (0.04)	Z1 = -1.359 (0.17)	Z1 = -1.90 (0.05)	Z1 = -1.88 (0.05)	Z1 = -2.01 (0.04)	Z1 = -2.04 (0.04)	Z1 = -1.96 (0.04)	Z1 = -2.06 (0.03)
	Z2 = -1.46 Prob = 0.14	Z2 = -0.90 Prob = 0.36	Z2 = -1.13 Prob = 0.25	Z2 = -1.16 Prob = 0.24	Z2 = -1.54 Prob = 0.12	Z2 = -1.47 Prob = 0.14	Z2 = -0.96 Prob = 0.33	Z2 = -0.77 Prob = 0.43
Sargan Test	chi2 = 24.35 Prob = 0.99	chi2 = 20.89 Prob = 0.99	chi2 = 24.34 Prob = 0.99	chi2 = 24.47 Prob = 0.99	chi2 = 24.16 Prob = 0.99	chi2 = 24.34 Prob = 0.99	chi2 = 23.37 Prob = 0.99	chi2 = 24.01 Prob = 0.99