Journal of Money and Economy
Vol. 17, No. 1, Winter 2022
pp. 89-114
DOI: 10.29252/jme.17.1.89

Original Research Article

Exchange Rate Pass-Through on Non-Oil Trade Balance in Iran

Reza Mohseni* **Vahid Mahin Ranjbar†**

Received: 22 Jan 2022 Approved: 31 Aug 2022

This article investigates the relationship between the exchange rate and non-oil trade balance in Iran between 1981 and 2014. A structural vector auto-regression model is built. The results indicated that the increasing effect of the real effective exchange rate worsens the non-oil trade balance in the short term. In contrast, the increasing effect of the real effective exchange rate improves the non-oil trade balance in the long term. In addition, the increase in the effective real exchange rate has two effects: the price effect can overcome the quantity effect leading to the deterioration of the non-oil trade balance in the short term. However, the quantity effect overcame the price effect and improved the non-oil trade balance in the long term. On the other hand, the J-curve and S-curve phenomena were confirmed.

Keywords: Real effective exchange rate, non-oil trade balance, structural vector auto-regression (SVAR) method, J curve, S curve.
JEL Classification: C22, E6, F14, F31.

1 Introduction

The experiences of East Asian countries in the 1990s indicated that expanding exports could be one of the most significant and effective strategies to achieve economic growth in developing countries. The reason is that moving towards industrialization and expanding production to an efficient scale is possible only by increasing exports in the lack of vast domestic markets for consumer goods. The success rate of any country depends on the relative competitiveness of the products.

The exchange rate is one of the critical factors determining countries' trade balance. In this regard, the phrase "exchange rate pass-through (ERPT)" on

* Assistant Professor, Member of Department of Economics, Faculty of Economics and Political Science, Shahid Beheshti University, Tehran, Iran; re_mohseni@sbu.ac.ir (Corresponding Author)
† Department of Economics, Raja University, Qazvin, Iran; vahidmranjbar@yahoo.com

trade balance indicates the elasticity of trade balance relative to the exchange rate; the exchange rate pass-through to trade balance will be complete if in response to a 1% change in the exchange rate the trade balance changes by 1%, and it will be incomplete if the response of trade balance to exchange rate fluctuations is less than 1%. Thus, the exchange rate pass-through on export price occurs when exporters increase or decrease the price of their export goods in response to a decrease or increase in the exchange rate. Such a response by exporters to exchange rate fluctuations adjusts the initial effects of exchange rate fluctuations on real exports because with the increase or decrease of the exchange rate, real exports increase or decrease. Thus, the real quantity of exports decreases or increases and moderates the initial effects of exchange rate fluctuations by increasing or decreasing export prices. If exporters preserve or increase their market share in the target markets, the exchange rate effect on export price in domestic currency becomes zero. In such cases the real export rate will increase due to increased competitiveness in global markets, the competitiveness of exports in global markets remains stable, and real exports are unchanged if the exchange rate pass-through is complete (Vigfussan et al., 2007).

Section 2 reviews the relevant literature in theoretical foundations and empirical studies in this study. Section 3 mentions the data, model, estimation, and analysis. Finally, the conclusion is presented in Section 4.

2 Review of Literature

2.1 Theoretical Foundation

The effect of exchange rate fluctuations on a trade balance is studied from the Keynesian point of view based on elasticity and absorption approaches.

2.1.1 Absorption Approach

This method is the current account imbalance as the difference between domestic production and real domestic expenditure, and the function of national income is considered as follows:

$$Y=C+I+G+X-M \qquad (1)$$

In Eq. 1, the real domestic absorption is defined as the sum of consumption expenditures, investment, and government expenditures. Thus, we have A = C + I + G. Therefore, the national income equation is expressed as follows:

[DOI: 10.52547/jme.17.1.89]

$$CA=X-M=Y-A \quad (2)$$

Based on Eq. 2, the current account represents the difference between production and real domestic absorption. Current account surplus means that domestic production is higher than real domestic expenditure. By differentiating from the above equation, we have:

$$\partial CA = \partial Y - \partial A \quad (3)$$

Eq. 3 indicates that the effect of national currency devaluation on the current account is dependent on its effect on national income. Assuming the absence of full employment, if national currency devaluation increases domestic income relative to real domestic expenditure, the national currency devaluation improves the current account balance. On the contrary, the current account faces a deficit if national currency devaluation increases the real domestic absorption relative to the domestic production and income.

In other words, the policy of increasing the exchange rate improves the balance of payments only if implementing this policy widens the gap between domestic absorption and production. If this difference fails to intensify, the balance of payments will not improve. A pervasive case of this issue is a partial or slow production response to the above-mentioned policy due to structural bottlenecks.

In other words, production fails to increase, and the balance of payments will not improve significantly if the absorption level remains constant. Thus, how the national currency devaluation affects the income and real domestic absorption is the main framework of the absorption method in analyzing the current account balance (Hacker & Kim, 2010).

2.1.2 Elasticity Approach

According to the elasticity method, proposed by Marshall Lerner and developed by Robinson (1947), Bickerdike (1920), and Metzler (1948), supplying domestic export goods and foreign imported goods is entirely elastic, and any changes in demand size cannot have any effects on prices. Such assumptions indicate that domestic and foreign prices are constant and exchange rate fluctuations cause fluctuations in relative prices.

The main point in the elasticity method is that the national currency devaluation has two effects on the current account balance: price and quantity. In price effect, the export goods become cheaper in foreign currency, and the imported goods become more expensive in national currency when the national currency devaluates. Thus, the price effect worsens the current account balance of the country. In quantity effect, the quantity of exports

[DOI: 10.52547/jme.17.1.89]

increases when domestic goods become cheaper from the perspective of foreigners, while the volume of imports decreases when the imported goods become more expensive in terms of national currency. Therefore, the quantity effect leads to an improvement in the current account balance. Assuming an elastic supply curve for export of domestic goods, and import of foreign goods, an increase in the exchange rate (national currency devaluation) improves the current account balance if the sum of absolute values of export and import elasticities relative to the exchange rate is higher than one. This condition is known as the Marshall Lerner condition. It states that the national currency devaluation will lead to the dominance of quantity effect on price effect when the above-mentioned condition is established. Thus, the national currency devaluation will increase the export size and decrease the import. As a result, the trade balance will improve (Hacker & Kim, 2010). In the elasticity approach, two effects can be deduced such as the Marshall Lerner condition and the J curve, as is briefly explained below:

Marshall Lerner

The traditional economic theory states that the positive effects of currency devaluation depend on import and export elasticities. If the sum of such elasticities is higher than one, the trade balance is expected to improve after the currency devaluation. Such an issue has been raised under the Marshal Lerner conditions. Most countries which devaluate their national currency face a trade deficit, which in this case the demand elasticity for export and import should be higher than that of the Marshall Lerner condition. The devaluation policy improves trade balance because the demand elasticity for exports should be so high to overcome the decline in imports (due to currency devaluation) and the initial trade balance deficit. In most Third World countries facing trade deficits, the devaluation policy fails to improve their trade balance.

Based on the Marshall Lerner, if the elasticities of exports supply and imports demand of the home country are infinite, the effect of national currency devaluation on the trade balance is as follows:

$$\frac{\partial \mathrm{TB}}{\partial \mathrm{ER}} = \mathrm{M}(\eta_{\mathrm{X}} + \eta_{\mathrm{M}} - 1) \tag{4}$$

In Eq. 4, the trade balance improves with national currency devaluation if the total absolute value of the elasticities of export and import demand is higher than one ($|\eta_{\mathrm{X}}| + |\eta_{\mathrm{M}}| > 1$)).

[DOI: 10.52547/jme.17.1.89]

On the other hand, when the supply elasticities of exports and imports are less than infinite, the effect of national currency devaluation on trade balance is calculated as follows:

$$\frac{\partial TB}{\partial ER} = \frac{\varepsilon_X(\eta_X - 1)}{\varepsilon_X + \varepsilon_M} + \frac{\eta_M(\varepsilon_M + 1)}{\eta_X + \eta_M} \qquad (5)$$

In Eq. 5, ER represents the exchange rate, TB indicates the trade balance, and ε_X andε_M represent the elasticity of exports and imports in the home country, respectively. In addition, and $\eta_M$and η_X represent the elasticities of domestic demand and domestic demand in the home country (Pilbeam, 2006).

Bahmani-Oskooee (1985) argued that the trade balance worsens in some countries having the Marshall Lerner condition. In addition, a trade policy should focus on short-term dynamics affecting the time path of the trade balance.

J curve

Economic policymakers often use the devaluation policy as a tool for increasing the net exports of a country. It is worth noting that this theory is applied in an economy with full liquidity and lack of stickiness because, in such an environment, the economic agents immediately change their purchasing behaviors to adapt to exchange rate fluctuations. However, it takes time for exchange rate fluctuations to adapt to the behavioral patterns of economic agents in a real world. Accordingly, the J-curve or the theory of short-term trade balance adjustments states that an increase in the real exchange rate (policy of devaluation) in the long term improves trade balance after a short period of decline. (Bahmani-Oskooee, 1985).

Numerous opinions have been presented for justifying this phenomenon. Magee (1973) first offered such an interpretation and interpreted this phenomenon as follows. In the real devaluation of the national currency, the volume of exports and imports will not change very much because import and export contracts are often signed for the next few months. However, a real devaluation will make the pre-determined level of imports more expensive with the national currency. Thus, the value of imports increases while the value and volume of exports have no significant change. As a result, the trade balance will deteriorate rapidly after the real weakening of the currency. However, both producers and consumers react more quickly over time and prices begin to adjust based on the relative price of domestic goods. Thus, the trade balance improves and the trade balance response shows a J-shaped curve over time (Bahmani-Oskooee & Hegerty, 2010).

[DOI: 10.52547/jme.17.1.89]

The hypothesis which is implicitly considered in this regard is that the elasticities are low enough in the short term and high enough in the long term, or that the Marshall-Lerner condition is established in the long term. The J-shaped curve takes more than six months. However, if the exchange rate pass-through to domestic import prices takes time, the initial deterioration of the current account fails to occur all at once, but rather gradually.

S-curve

A new approach used in the international economics literature to study the dynamic adjustment of trade balance relative to the deterioration of the domestic value (exchange rate increase) is the s-curve proposed by Backus et al. (1994). According to Backus et al. (1994), the trade balance is not only affected by exchange rate fluctuations in the past but is also correlated with future fluctuations.

One of these two equations, implying the J-curve, is positive and indicates that lower prices due to the national currency devaluation are likely to improve the trade balance. On the other hand, this similarity is reversed when it improves with the trade balance. Thus, the trade deficit may devaluate the national currency (negative correlation relationship) while a trade surplus can strengthen the national currency (positive correlation relationship). Accordingly, the two above-mentioned equations lead to the phenomenon of the S curve in a country that relies on the official devaluation of the national currency (Backus et al., 1994).

In general, the J-curve should be observed after the national currency devaluation, but there should also be a contrasting relation between trade balance and real exchange rate before the national currency devaluation to establish the S-curve (Bahmani-Oskooee & Hagerti, 2010).

The S-curve indicates the dynamic relationship between trade balance and real exchange rate. The trade balance is positively correlated with the movement of the real exchange rate (J curve) but is negatively correlated with the current and future fluctuations. The S-curve, unlike the J-curve which is based on regression analysis, has no need for regression analysis and is based merely on the cross-correlation coefficient between real exchange rate and trade balance. Backus et al (1994) stated that such a cross-correlation between the current and future value, real value, and past values of the trade balance is negative and that there is a positive correlation between the current values of real exchange rate and the future value of the trade balance.

[DOI: 10.52547/jme.17.1.89]

2.2 Review of Empirical Evidence

A large number of studies have been conducted on the trade balance and exchange rates. Lopes and Sequeira (2014) examined the presence of the S model to show the relationship between the dynamics of trade balance and real exchange rate. The trade balance is positively correlated with the movement of the real exchange rate but is negatively correlated with current and future fluctuations. They studied ten Central and Eastern European countries between 1992-2008 and found that the S model as well in the trade of Slovenia, Czech Republic, Hungary, but weaker in Latvia, Poland, Romania and Slovakia, Byrne et al. (2010) used the annual data of 1980-2004 and confirmed the asymmetric response to exchange rate fluctuations on the price of imported foods of 14 emerging economies such as Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, India, Indonesia, Malaysia, Mexico, Pakistan, the Philippines, Thailand, and Venezuela with a PMGE model which uses the ARDL model. Then, they estimated separate equations for Asian and Latin American countries. The findings confirmed the presence of asymmetry in both groups. However, asymmetric exchange rate changes were more observed in Asian countries. Bahmani-Oskooee and Artarana (2011) examined the dynamics of the relationship between trade and trade balance in an S-curve in Switzerland and trading partners using quarterly data during 1980 - 2005. The results indicated the presence of an S-curve for 12 of the 17 Swiss partners. Soleimani and Chua (2013) examined the presence of the S-curve between Malaysia and its three major trading partners, including China, Japan, and Singapore, during 1974-2009. The results confirmed the presence of a pattern in small industries and the industries engaged in the production of intermediate goods. Ono and Baack (2014) examined the presence of the J and S curves in the bilateral relationship of trade between Japan and China, the United States, South Korea, as well as oil exporters to Japan from 1980 to 2008. Based on the results, the trade between Japan with other countries had an S-curve in the last two periods. In addition, the results indicated that the S phenomenon was available in the bilateral relationship between Japan and oil-exporting countries to Japan but was not observed in the bilateral relationship with the United States and Korea.

3 Method, Data, Model Presentation, Estimation, and Analysis

The vector auto-regression model is considered one of the methods for evaluating the effect of exchange rate shocks on non-oil trade. The present study used the SVAR structural vector auto-regression model. In order to

[DOI: 10.52547/jme.17.1.89]

explain the above-mentioned model more precisely, the vector auto-regression model was first estimated. Then, the response functions based on structural constraints were specified with the help of structural constraints. Finally, the effects related to the impulses of the variables within the model on non-oil trade balance were evaluated using the impulse response functions. The general model of vector auto-regression is shown in the following equation.

$$A\varepsilon_t = BU_t$$

In the above-mentioned equation, $\varepsilon_t$and U_t are the disturbance term vectors of reduced form (ε_t) and structural disturbance terms (U_t), respectively, where both ε_t and $U_t$are vectors with dimensions (K * 1) and A and B are matrices with dimensions (K * K). According to Blanchard and Quah (1989), Mosconi and Giannini (1992) and Sims (1986), the simultaneous correlation between variables can be expressed by two inverted square matrices A and B. In this equation, the variables should have a stationary condition; otherwise, the impulse response functions are not converted. In order to determine the optimal lag rate P, different lag criteria such as Akaike information criterion (AIC), Schwarz -Bayesian (SBC), and Hannan-Quinn (HQ) can be used. Normally, there is no guarantee that the optimal number of lags is equal to these methods. In addition, none of the above-mentioned criteria alone are complete. In addition to the optimal lag criteria to evaluate the specified models in terms of appropriate statistical features, some control and diagnostic tests are performed after estimating the models.

The Lagrange coefficient test can evaluate the autocorrelation of model residuals and the normality test of model residuals. After examining these steps, the relationship between the desired variables is analyzed using the impulse response functions.

3.1 Data

The vector auto-regression model includes the global GDP, the global money supply, real effective exchange rate, interest rate, GDP, currency in circulation, and non-oil trade balance. The data were annual and covered the period 1981-2014. The statistics of the desired variables were extracted from the database of the Central Bank, World Bank, International Science Foundation (IFS), and World Development Indicators (WDI). The variables used in the model were non-oil trade balance logarithm (LTB), global GDP logarithm (LY_w), global supply of money logarithm (LMS_w), real effective exchange rate logarithm ($LREER$), GDP logarithm ($LREER$), supply of money logarithm (LMS_d), and interest rate logarithm (LIR_d).

3.2 Unit Root Test

To avoid spurious regressions, any empirical work on times series data requires testing for the existence of unit roots. This section performs unit root tests for stationarity on the levels and the first differences of all variables. In this regard, Augmented Dickey-Fuller and Philips-Perron tests were used for the unit root test of the model variables. Our results clearly show that all variables have unit roots at level (they are I (1)), but their first differences are stationary under both tests. Hence, we have concluded that these variables are integrated of order 1 Tests were performed for all variables at the significance level of 5 percent.[1]

3.3 Selecting the Optimal Lag and Model Stability

The optimal lag should be determined after determining the stationary of the model variables. The present study used Akaike, Schwarz, and Hannan- Quinn criteria to find the optimal lag length. As shown in table 1, the Schwarz criterion is considered for the lag length model, and the lag is equal to 1.

Table 1
Specifying the optimal lag length of the model

Lag	Akaike	Schwarz	Hannan- Quinn
0	-4.5362	-4.2124	-4.4306
1	-17.8994	**-15.3090	-17.0550
2	**-19.7717	-14.9147	**-18.1885

Source: Research finding

In order to analyze vector auto-regression models, the stability conditions of the model should be evaluated before analyzing the impulse response functions. The condition for model stability is that the inverse root of the characteristic polynomial for the estimated model lag is placed within a unit circle.

[1] The results are available on request (not reported).

[DOI: 10.52547/jme.17.1.89]

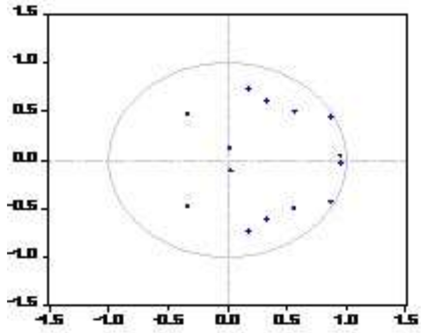

Figure 1. Convergence of the Model
Source: Research finding

Model estimation by SVAR structural vector auto-regression method in the short term

After selecting the variables, estimating the model, and ensuring the model stability, a vector auto-regression model was estimated by designing a structural equations system, where the dependent variables were obtained as an explicit function of exogenous lagged and constant intervals. In these models, structural form residuals should be used instead of reduced-form residuals to evaluate and interpret the shock effect of a variable on the model variables. For this purpose, the structural constraints should be applied to the matrix of structural coefficients for converting the shocks of the reduced-form model to the structural shocks and extracting the disturbance components of the structural model from the residuals of the reduced model as discussed below.

Short-term constraints

As mentioned, identifying the SVAR model means that constraints should be applied to matrices A and B to obtain structural coefficients and analyze the results. Based on the Sims (1986) approach in VAR models, the parameters of the structural model from the standard model cannot be estimated for identifying the constraints in the SVAR model about the quantity of applied constraints since the number of structural model parameters is higher than the number of standard model parameters (solved form model in concurrent equations) without applying the recognition constraints. In the SVAR model, such detection constraints are applied to the structural coefficient matrix. The SVAR models require the application of $\frac{n(n-1)}{2}$ constraints on the relationships

[DOI: 10.52547/jme.17.1.89]

between regression residuals and perturbation terms of structural equation. The exchange rate is one of the key variables of Iran's macroeconomic model. The presence of this variable is appropriate at least for two following reasons. First, when the monetary authorities attempt to offset the current effects of external impulses on the economy. The exchange rate plays a critical role in measuring the monetary policy. Second, domestic monetary policy shocks are reflected in exchange rate fluctuations (Cologni and Manera, 2008).

Exchange rate fluctuations indicate the strength and weakness of the currency in each country against foreign currencies. Currency devaluation from its equilibrium and preventing the exchange rate deviation from the equilibrium quantity decreases perturbation in other domestic prices while increases welfare and efficiency. Observations indicate the emergence of some problems such as negative effects on economic growth due to the dominance of the floating exchange rate system and the resulting exchange rate fluctuations for South Africa, Iran, etc.

However, no negative effects are observed in many other countries, especially developed countries. Such a duality-making fluctuation in the exchange rate plays a significant effect on critical economic variables such as interest rates (Madura, 2000). For this purpose, the interest rate can be entered into the model in terms of the exchange rate to examine its impulses.

Another reason which has been studied about the exchange rate in this study is the money of supply in the world, the shock of which can be studied in the exchange rate because the fluctuations in the money of supply in a country can affect the price of domestic products depending on the recessionary or inflationary conditions of the country. Such a change in the price of products results in changing the quantity of exports in that country. In this case, a third country can increase the exports of its products by changing its exchange rate. In the present study, the supply of money in the world was included in the exchange rate equation.

Adopting appropriate exchange rate policies in developing countries has always been controversial. Debates focus on the extent of exchange rate fluctuations while facing internal and external shocks. Exchange rate fluctuations play an essential role in the country's economic performance including the evaluation of the effect of exchange rate fluctuations on the growth of production and demand (Agenor, 1991) GDP is one of the most significant economic variables indicating a high sensitivity to exchange rate developments. If the exchange rate is not adjusted in proportion to the world inside and outside the economy, it will slow down the economy growth (Samanta, 2006). Therefore, the exchange rate affects GDP. Since the money

[DOI: 10.52547/jme.17.1.89]

supply and national income in the world is a part of the research variables and this study attempted to measure the shock of external factors on its variables in the short term and estimate in its analysis, these two variables or one of them can be applied in each of the internal variables. In banking systems, using the interest rates has been considered as an effective monetary policy tool. The interest rate as a price in the financial market is considered as one of the critical economic variables. Bank interest rates are considered as the capital cost from the investor's point of view and as the opportunity cost of money from the depositor's point of view. Thus, the forces in the capital market determine the equilibrium interest rate.

However, GDP is considered one of the most essential factors which can affect interest rates. Changes in GDP affect household consumption and such effectiveness on consumption can affect investment. In addition, the effectiveness of investment will have a direct effect on the interest rates of deposits. Thus, the shock related to GDP can be applied in relation to interest rates. Exchange rate fluctuations affect the real sector of the economy by creating uncertainty in the future prices of goods and services. Economic agents base their decisions on production, investment, and consumption on the information provided by the pricing system.

Unreliable and unpredictable prices due to exchange rate uncertainty increase the interest rates and decrease the investment. Based on Fisher's theory, when the volume of money in an economy increases, prices increase which means inflation. Changes in the quantity of inflation in the society affect monetary variables, especially interest rates on deposits (Miller & Benjamin, 2005). In general, the quantity of money in circulation in the Iranian economy affects the interest rates and such effectiveness is performed through the inflation channel.

Arize (1995) considers the GDP of countries as an appropriate variable which stimulates the foreign demand effective in the growth of exports. In recessions or inflations, adopting expansionary or contractionary monetary policies is expected to be on the central bank's agenda. However, money loses its exogenous role, especially when there is inflation or recession, and is always affected by domestic prices and output growth.

Furthermore, speculative behavior occurs in inflationary conditions. The following equation shows the money demand equation that any change in variables has an effect on the money market:

$$m_t = \beta_0 + \beta_1 y_t + \beta_2 r_t - \beta_3 p_t$$

where m_t represents nominal monetary balance, p_t indicates the price level, y_t indicates product level, and r_t shows the interest rate. Parameters $\beta_1$and $\beta_2$measure income elasticity and opportunity cost of money, respectively. Further, McCarthy (2006) indicated that exchange rate fluctuations may be responded by monetary policy. Thus, the exchange rate is one of the factors affecting the money supply. It is believed that the central bank should respond optimally to exchange rate fluctuations since exchange rate fluctuations affect inflation through the channels other than supply and demand impulses. Therefore, the exchange rate is required in the equation of money volume. Based on Taylor's equation, the interest rate as a monetary policy tool is a function of inflation and the output gap, which can affect the currency in circulation, but some studies remove the interest rates from the model due to its small share in the quantity of money supply.

Iran's foreign trade is known for its single-product export and strong dependency on foreign exchange earnings from oil exports. Since the emergence of oil in Iran until today, the share of exports for this product in total exports has been increasing. However, the expansion of non-oil exports is an undeniable necessity due to fluctuations and uncertainty in the realization of oil revenues (Jian, 2007). The proposed policies referred to stimulating foreign demand for domestic goods and services. Thus, the foreign demand should be stimulated for increasing non-oil exports. Stimulating demand in the domestic economy is possible by increasing liquidity. Increasing the external demand is a good option for eliminating the recession. The non-oil export function (XNO) is considered in relation to the non-oil trade balance as follows.

$$XNO = f(P, e)$$

where P and e represent the domestic price level and the exchange rate, respectively. Exports are expected to reduce as domestic prices increase while other conditions remain stable. On the other hand, exports are expected to increase if the exchange rate increases since it leads to a reduction in foreign demand for exporting domestic goods and services (Balassa, 1990).

The stability of the domestic market and the foreign exchange market provides conditions for stable exports and the continuation of stimulating foreign demand. In order to advance the research objectives of the non-oil trade balance in the equation related to the non-oil trade balance, the factors such as Iran's money of supply, nominal domestic interest rate, Iran's GDP,

[DOI: 10.52547/jme.17.1.89]

global money of supply and world GDP were included. The shocks of such variables were entered into the model because in their related analysis, which is a part of the research objectives, this study aimed to recognize the percentage of the mentioned non-oil trade balance in the above- mentioned factors.

The short-term dynamics of the model is described based on seven equations through a set of additional constraints on some of the matrix B coefficients. The symbols used are $U^{ltb}, U^{lmsd}, U^{lird}, U^{lyd}, U^{lreer}, U^{lmsw}, U^{lyw}$, which are related to the reduced form transaction error terms and the unexpected movements of the all variables in the system.

$\varepsilon^{\text{ltb}}, \varepsilon^{\text{lmsd}}, \varepsilon^{\text{lird}}, \varepsilon^{\text{lyd}}, \varepsilon^{\text{lreer}}, \varepsilon^{\text{lmsw}}, \varepsilon^{\text{lyw}}$ refer to the structural disorders which indicate the impulses of the global GDP, global money of supply, real effective exchange rate, Iran's GDP, domestic interest rate, Iran's money of supply and non-oil trade balance. The matrix of the model is presented in the following equation as follows.

$$\begin{pmatrix} \varepsilon^{lyw} \\ \varepsilon^{lmsw} \\ \varepsilon^{lreer} \\ \varepsilon^{lyd} \\ \varepsilon^{lird} \\ \varepsilon^{lmsd} \\ \varepsilon^{ltb} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{32} & b_{33} & 0 & b_{35} & b_{36} & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & 0 & 0 & 0 \\ b_{51} & b_{52} & b_{53} & 0 & b_{55} & b_{56} & 0 \\ b_{61} & 0 & b_{63} & b_{64} & b_{65} & b_{66} & 0 \\ b_{71} & b_{72} & b_{73} & b_{74} & b_{75} & b_{76} & b_{77} \end{pmatrix} * \begin{pmatrix} U^{lyw} \\ U^{lmsw} \\ U^{lreer} \\ U^{lyd} \\ U^{lird} \\ U^{lmsd} \\ U^{ltb} \end{pmatrix}$$

3.6 Analysis of Variance of Prediction Error in SVAR Model in the Short Term

The analysis of variance for the prediction error measures the relative strength of the Granger causal chain or the degree of exogenous variables out of sample. Thus, the analysis of variance can be called Granger causality out of sample. Table 2 indicates the results related to the analysis of variance for the non-oil trade balance prediction error in the model. As shown, the impulses show 40% of non-oil trade balance during the short period of momentum in the first period, while this percentage decreases in later periods. The second impulse has the highest effect on the interest rate on deposits, indicating about 17% in the first period and its quantity reaches about an average of 8%, while the third impulse is related to the world GDP and the global money supply explaining about 16% of GDP. The rest of the impulses affects the non-oil trade balance below 10%.

[DOI: 10.52547/jme.17.1.89]

Table 2
Results obtained from the analysis of variance for prediction error

Period	shock 1	shock 2	shock 3	shock 4	shock 5	shock 6	shock 7
1	16.151	16.153	0.550	2.426	16.969	7.047	40.70
2	19.141	24.660	1.400	10.04	13.662	5.210	25.88
3	26.184	27.570	1.332	12.925	10.184	3.895	17.90
9	23.027	34.655	2.204	12.880	8.150	3.954	15.12
10	23.011	34.854	2.258	12.829	8.0407	3.971	15.02

Source: Research finding

3.7 Impulse Response Function in SVAR Model in the Short Term

Impulse response functions indicate the dynamic behavior of the model variables at the time of a unit impulse to each of the variables over time. These impulses are selected as much as a standard deviation which is why they are called as impulse. The origin of the coordinates or the starting point of the response variable refers to the values related to the steady state of the device without the presence of impulse. The dynamic response of the device to the unit impulse applied by each of the device variables is determined by using the impulse response functions.

[DOI: 10.52547/jme.17.1.89]

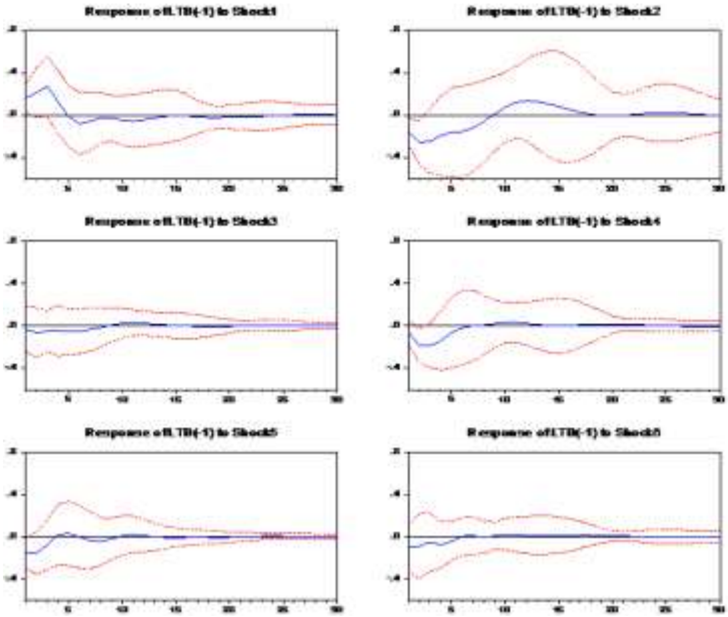

Figure 2. The Results Obtained From the Impulses to Non-Oil Trade Balance.
Source: Research finding

3.8 Shock Effect of Real Effective Exchange Rate on Non-Oil Trade Balance

Based on the chart below, whenever an impulse equal to a standard deviation from the real exchange rate affects the non-oil trade balance, the non-oil trade balance response is negative until the second period and becomes positive from the second period onwards until after several periods.

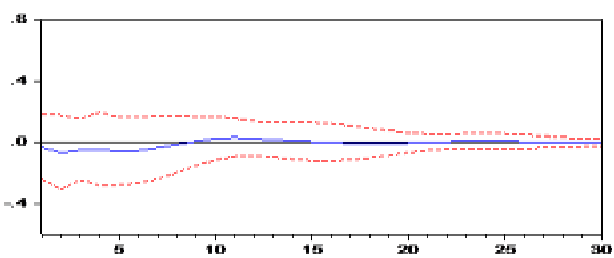

Figure 3. Shock Effect of Real Effective Exchange Rate on Non-Oil Trade Balance.
Source: Research finding

The important point is its J shape which is widely used in economic analysis. Here, it is necessary to analyze the J diagram between the real effective exchange rate and the non-oil trade balance.

3.9 Explaining the J Curve In Relation To Real Effective Exchange Rate and Non-Oil Trade Balance

In order to separate the short-term effects of real effective exchange rate changes from its long-term effects on non-oil trade balance and the J-curve test, the analysis of impulse response effects or real exchange rate shock effects on non-oil trade balance was used as a standard deviation. Therefore, SVAR test was used to obtain this phenomenon, where both short-term and long-term effects can be examined.

The test results indicate the presence of the J-curve. As shown, following the impulse of the real effective exchange rate by a standard deviation, the non-oil trade balance decreases to the second period and reached its lowest value in the second period, i.e., -0.07. From the second to the ninth period, this trend grows but it is negative. In the tenth period, the response of the oil trade balance to real effective exchange rate is positive and continues its positive trend, showing a shape like J, known as the J-curve phenomenon, indicating that the response of non-oil trade balance to exchange rate impulse is real and effective. In order to analyze such a phenomenon based on the theoretical issues, the deterioration of non-oil trade balance to the second chapter can be considered as real and effective due to the dependence of the domestic sector on imports, the lack of rapid and appropriate response of the domestic economy to changes due to the state structure of industries, adherence in terms of contracts signed by the government in the import sector, and the restriction of import laws, as well as the insensitivity of the non-oil export sector to exchange rate changes. Based on this curve, exchange rate fluctuations have two effects on non-oil trade balance, price effect, and quantitative effect. In general, the price effect outweighs the quantity value and causes the trade balance to deteriorate in the short term. Assuming that the condition of total export and import elasticities or the same condition of Marshall Lerner is met in the long term, the situation is reversed and the quantitative effect outweighs the price effect. In other words, it improves the trade balance. If the export and import volumes are initially adjusted slowly and import prices are relatively faster, exchange rate fluctuations will show a J-shaped trade balance over time, which is due to the stickiness of short-term import and export quantities in the short term (Krugman and Obstfeld, 2001).

Explaining the S-curve in relation to effective real exchange rate and non-oil trade balance

A cross-correlation function is often used for checking the presence or absence of an S-curve. A cross-correlation diagram is drawn between the two variables of effective real exchange rate and non-oil trade balance. For this purpose, the variables of real effective exchange rate and non-oil trade balance were de-trended using Hodrick Prescott filter and then their cross-correlation function was calculated.

The cross-correlation between real effective exchange rate and non-oil trade balance can be calculated using the following formula.

$$COR_k = \frac{\sum(REER_t - \overline{REER})(TB_{t+k} - \overline{TB})}{\sqrt{\sum(REER_t - \overline{REER})^2 (TB_{t+k} - \overline{TB})^2}}$$

where TB represents the non-oil trade balance, REER indicates the real effective exchange rate, $\overline{\text{TB}}$ and $\overline{\text{REER}}$ *indicate* the mean non-oil trade balance and the real effective exchange rate for all observations, respectively, in addition, k shows the number of lags. Figure 4 displays the S-curve in relation to effective real exchange rate and non-oil trade balance, known as the S-curve phenomenon.

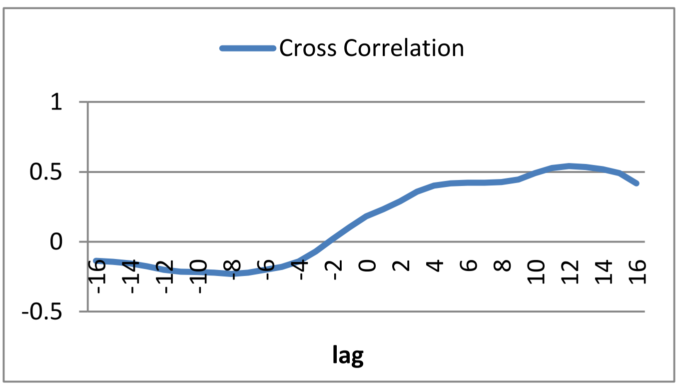

Figure 4. Cross-Correlation of Non-Oil Trade Balance and Real Effective Exchange Rates.
Source: Research finding

As displayed, the S-curve phenomenon can be verified for the Iranian economy in the studied period and the correlation between the current values of real effective exchange rate and the delayed values of trade balance is

[DOI: 10.52547/jme.17.1.89]

positive. In other words, an increase in the current values of a real effective exchange rate will improve the trade balance in the future. The increase in the balance of payments in the future is the result of the national currency devaluation at the present time, and an increase in the balance of payments in the past led to a decrease in the national currency, indicating a dynamic relationship between non-oil trade and real effective exchange rates. In other words, the non-oil trade balance is positively correlated with the real effective exchange rate movement (J curve), but is negatively correlated with current and future changes.

Ideally, the number obtained from the cross-correlation function in the presence of the S-curve has a positive sign for the lags greater than zero and a negative sign for the lags smaller than zero. Simultaneous cross-correlation (k = 0) can have a negative or positive sign. If this correlation is negative, there is a reason for the effect of Harberger, Larsen, and Metzler (Bahmani Oskooee and Ratha, 2007). As a result, the temporary deterioration of the exchange rate situation reduces the total savings and worsens the balance of payments status (Misztal, 2010).

3.5 Estimating the SVAR Structural Vector Auto-Regression Model in the Long Term

The structural auto-regression approach is used for using economic theories (mostly Chulsky) in the long term to obtain a non-recursive structure for the perturbation terms of the summarized form of the auto-regression model. The summarized form of the SVAR model is shown as follows:

$$\begin{pmatrix} \varepsilon^{lyw} \\ \varepsilon^{lmsw} \\ \varepsilon^{lreer} \\ \varepsilon^{lyd} \\ \varepsilon^{lird} \\ \varepsilon^{lmsd} \\ \varepsilon^{ltb} \end{pmatrix} = A(L) * \begin{pmatrix} U^{lyw} \\ U^{lmsw} \\ U^{lreer} \\ U^{lyd} \\ U^{lird} \\ U^{lmsd} \\ U^{ltb} \end{pmatrix}$$

The left side of the above system indicated the first-order difference of the dependent variables logarithm. To the right of A (L), the square matrix contains some polynomials in terms of the lag operator. An element of the matrix A (L), for example, $a_{ij}(L)$, represents the i-th response of the dependent variable to the j-th structural impulse.

[DOI: 10.52547/jme.17.1.89]

The vector $E' = [\varepsilon_1 \quad \varepsilon_2 \quad \varepsilon_3 \quad \varepsilon_4 \quad \varepsilon_5 \quad \varepsilon_6 \quad \varepsilon_7]$ includes structural perturbation terms which are different in each model. Perturbation terms are assumed to be serially unrelated and orthogonal to each other. In the Blanchard- Quah approach, structural impulses are identified by imposing some constraints on the long-term effects of impulses on some variables.

Long-term constraints

Theoretical expectations of matrix coefficient constraints are as follows. First, as stated in the short-term constraints, external shock in a small open economy is assumed to be exogenous in the short and long terms. In other words, this assumption leads to zero coefficients C_{13} ‘C_{14} ‘C_{15} ‘C_{16} ‘C_{17} ‘C_{23} ‘C_{24} ‘C_{25} ‘ C_{26} ‘C_{27}. In addition, according to monetary theories, money supply has no effect on GDP, so it is not included in the equation. As a result, its shock effect, i.e., C_{12} can be considered zero. Based on the studies on the real effective exchange rate and its effective factors in the Iranian economy, GDP is not one of the factors affecting the real effective exchange rate and is not included in the model. As a result, the shock related to C_{34}. is considered zero. The theories examined in the Iranian economy in the long-term show that non-oil trade balance has no effect on real effective exchange rate and cannot be included in the model. Thus, the shock of $C_{37}$is considered zero. The shock related to the global currency in circulation and Iran's GDP C_{42} can be considered zero with the theory that the GDP of each country originates from domestic factors whether in the short or long terms and external factors have no effect on GDP. The next shock which can be considered zero in Hessian matrix is the shock of currency in circulation on GDP C_{46} because the currency in circulation is not included in the GDP model and has no effect on this model based on the balance sheet of the central bank. The shocks of global currency in circulation and global GDP on deposit interest rate are considered zero because these two factors cannot play a significant role in the (nominal) interest rate model in the long term. Thus, the related shocks are considered zero as C_{51} and C_{52}, respectively. In determining the interest rate, the non-oil trade balance can have an effect in the long term, but the Granger causality test was used to test the hypothesis that non-oil trade balance is the cause of deposit interest rate. Based on to the test, the above-mentioned hypothesis was rejected. Thus, this claim can be rejected. As a result, its shock can be considered zero, i.e. C_{57} becomes zero. The quantity of money in circulation in the Iranian economy in the long run is affected by domestic factors and external factors such as GDP and global currency in circulation in the world have no effect on determining the quantity of currency in circulation in Iran and cannot enter the model. Thus, the coefficients of their shocks, i.e. C_{61} and

C_{62} in Hessian matrix can be considered zero. Non-oil trade balance can indirectly affect the quantity of currency in circulation, as the theories of the Iranian economy show that the non-oil trade balance affects national income and national income affects the quantity of currency in circulation. However, the causality test was performed to prove this claim based on the studied period and the data of that test, indicating that the non-oil trade balance in the studied period cannot be the cause of Iran's currency in circulation. Thus, it can be removed from the currency in circulation model and its related shocks C_{67} can be considered zero.

Accordingly, the Hessian matrix related to the model is as follows.

$$\begin{pmatrix} \varepsilon^{lyw} \\ \varepsilon^{lmsw} \\ \varepsilon^{lreer} \\ \varepsilon^{lyd} \\ \varepsilon^{lird} \\ \varepsilon^{lmsd} \\ \varepsilon^{ltb} \end{pmatrix} = \begin{pmatrix} c_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ c_{21} & c_{22} & 0 & 0 & 0 & 0 & 0 \\ c_{31} & c_{32} & c_{33} & 0 & c_{35} & c_{36} & 0 \\ c_{41} & 0 & c_{43} & c_{44} & c_{45} & 0 & c_{47} \\ 0 & 0 & c_{53} & c_{54} & c_{55} & c_{56} & 0 \\ 0 & 0 & c_{63} & c_{64} & c_{65} & c_{66} & 0 \\ c_{71} & c_{72} & c_{73} & c_{74} & c_{75} & c_{76} & c_{77} \end{pmatrix} * \begin{pmatrix} U^{lyw} \\ U^{lmsw} \\ U^{lreer} \\ U^{lyd} \\ U^{lird} \\ U^{lmsd} \\ U^{ltb} \end{pmatrix}$$

Impulse response functions

After the limitations applied to the variables in the model and the model estimation using the SVAR structural vector auto-regression model in the long term, the impulse response functions of the variables can be studied to the non-oil commercial balance. As mentioned, in the model of global GDP, global currency in circulation, informal exchange rate, GDP, deposit interest rate, currency in circulation, and non-oil trade balance were present. In this section, the response of non-oil trade balance to the impulse of other variables in the model can be verified by using the impulse response functions in the long term. Figure 5 shows the results of the impulses from the model variables on non-oil trade balance in the long term.

[DOI: 10.52547/jme.17.1.89]

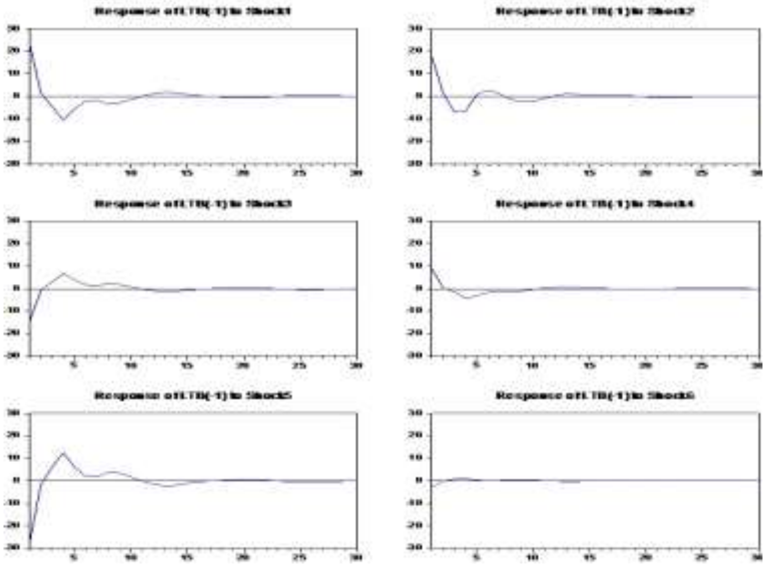

Figure 5. The Results of Impulses to Non-Oil Trade Balance in the Long Term.
Source: Research findings

The effect of real effective exchange rate shock on non-oil trade balance in the long term

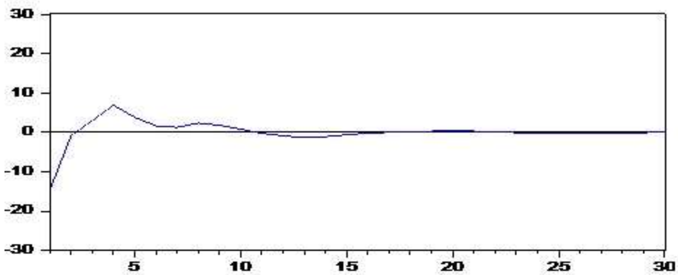

Figure 6. The Effect of Real Effective Exchange Rate Shock on Non-Oil Trade Balance in the Long Term.
Source: Research finding

Figure 6 displays the impulse on non-oil trade balance in the long term from the real effective exchange rate as a standard deviation. As shown, when there is an impulse from the real effective exchange rate on non-oil trade balance in the long term and oil is imported, the non-oil trade balance increases and continues until the fourth period, where it reaches its highest value, i.e., 7. After the fourth period, the shock gradually loses its impulse and the diagram is in a stable state.

4 Conclusion

The present study aimed to evaluate the effect of national currency devaluation (increase in the exchange rate) on Iran's non-oil trade balance or the exchange rate pass through on non-oil trade balance and find the presence or absence of the J and S curves in the economy based on. The exchange rate behavior on non-oil trade balance during the 1981-2004 in, Iran in order to achieve this aim time series data and SVAR structural vector auto-regression test have been used. First, the stationary of the variables was tested using the augmented Dickey-Fuller test and Phillips- Perron test and it was found out that all of the variables in the model were stationary with a single differentiation, i.e., all the variables in model I (1).

The results indicated that an increase in the real effective exchange rate worsens the non-oil trade balance in the short term. Based on the results of short-term relationships, the global GDP is directly related to the non-oil trade balance. In addition, the global currency in circulation is directly related to non-oil trade balance. Furthermore, interest rates on deposits and GDP have a direct relationship with non-oil trade balance. The volume of currency in circulation in Iran has a negative relationship with the non-oil trade balance of Iran.

Regarding the long-term results, the global GDP is inversely related to non-oil trade balance and global currency in circulation in the long term, while domestic deposit interest rate in Iran is directly and positively related to non-oil trade balance. Finally, GDP and currency in circulation are inversely related to non-oil trade balance in the long term.

The increase in the real effective exchange rate has two price effects and a quantity effect on non-oil trade balance. On the one hand, with the national currency devaluation or an increase in the real effective exchange rate, exported goods become cheaper in terms of foreign currency and imported goods become more expensive in terms of domestic currency. As a result, the price effect overcomes the quantity effect and worsens the non-oil trade balance in the short term. However, the quantity effect overrides the price effect. In fact, the quantity of exports increases when domestic goods become cheaper from the foreigners' point of view, and the volume of imports

[DOI: 10.52547/jme.17.1.89]

decreases when imported goods become more expensive in terms of national currency. The long-term effect is related to a slight improvement in non-oil trade balance, confirming the claim of Krugman and Obstfeld. The changes of the real effective exchange rate over time on non-oil trade balance are shown in Figure J, which is related to the stickiness on imports and exports values in the short term, indicating that the Marshall-Lerner condition is not fixed on the negative branch of the J-curve in the short term. In other words, the total exports and imports elasticities relative to the exchange rate is less than one, while the Marshall-Lerner condition is established on the positive branch of the J-curve, in a way that the total exports and imports are higher than one in exchange rates.

The S-curve phenomenon was found due to the cross-correlation between real effective exchange rate and non-oil trade balance, indicating that the increase in non-oil trade balance in the future is the result of the national currency devaluation at the present time. Thus, a today's decrease in the national currency can be related to an increase in non-oil trade balance in the past.

References

Agenor, P.R. (1991), Output, Devalution and Real Exchange Rate in Developing Countries, Weltwirtchaftliches Archive, Band 127.

Arize, A. (1995). The effect of Exchange Rate Volatility on US Export: An Empirical Investigation. *Journal of Southern Economic, 62, 34-43.*

Backus D.K., Kehoe P.J., & Kydland, F. E. (1994). Dynamics of the Trade Balance and the Terms of Trade: the J -Curve? *American Economic Review, Vol. 84, No.1, 84-103.*

Bahmani-Oskooee, M. (1985). Devaluation and the J-Curve: Some Evidence from LDCs, *The Review of Economics and Statistics*, vol. 67, issue 3, 500-504.

Balassa B. (1990). Incentive Policies and Export Performance in Sub-Saharan Africa. *World Development, Vol.18, pp. 91-383.*

Blanchard, O. and Quah, D. (1989), The Dynamic Effects of Aggregate Demand and Supply Disturbances, *The American Economic Review*, Vol.79, No.4, pp. 655-673.

Byrne, Joseph P., Chavali, A. & Kontonikas, A. (2010). Exchange Rate Pass-Through to Import Prices: Panel Evidence from Emerging Market Economies. *Department of Economics, University of Glasgow, Glasgow, UK.*

Bahmani-Oskooee, M & Artarana, R (2011). S-curve Dynamics of Trade between Sweden and her Trading Partners, Economic Systems Volume 35, Issue 3, Pages 355-362.

Bahmani-Oskooee., M. & Hegerty, S.W. (2010). The J- and S-Curves: a Survey of the Recent Literature. *Journal of Economic Studies, 37(6), 580-596.*

Bahmani−Oskooee, M. (2011). S-Curve Dynamics of Trade between Sweden and her Trading Partners. *Economic System, Vol. 35.*

Bahmani-Oskooee., M. & Ratha, A. (2007). The S-curve Dynamics of US Bilateral Trade. *Review of International Economics, 15(2), 430–439.*

Bickerdike, C. F. (1920) The Instability of Foreign Exchanges. *The Economic Journal*, v. 30, n. 117, p. 118-122.

Cologni, A., & M. Manera (2008). Oil Prices, Inflation and Interest Rates in a Structural Cointegrated VAR Model for the G-7 Countries. *Energy Economics, 30(3), 856-888.*

Jian, Lu. (2007). Empirical Study on the Influence on the RMB Exchange Rate Misalignment on China's Export – based on the Perspective of Dualistic Structure. *Frontiers of economics in china, 2(2), 224-236.*

Harberger, A. C. (1950). Currency Depreciation, Income and the Balance of Trade. *Journal of Political Economy, Vol. 58.*

Hacker, S., & Kim, H. (2010). How Does a Depreciation in the Exchange Rate Affect Trade over Time. *Jankoping International Business School, No. 2.*

Krugman, P., & Obstfeld, M. (2001). International Economics: Theory and Policy. 5th Ed.Boston: Addison-Wesley Longman Incorporated.

Lopes, A.F., & Sequeira, T.N. (2014). The Dynamics of the Trade Balance and the Terms of Trade in Central and Eastern European Countries, Economics Research Center, Lisbon University Institute. *Working paper 03-10.*

McCarthy, J. (2006). Pass through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies. *Eastern Economic Journal, 33(4), 511-537.*

Magee, S. (1973). Currency Contracts, Pass-Through and Devaluation. *Brooking Paper on Economic Activity, Vol. 4, No. 1, PP. 303–323.*

Madura, J. (2000). International Financial Management. *6th Edition, South-Western College Publishing*.

Metzler, L. (1948). A Survey of Contemporary Economics. Homewood: Richard Irwin. v. 1.

Miller, R.L. and Benjamin, D.K. (2005), the Economics of Macro Issues (2^{nd} Ed), Boston, MA, Pearson-Addison Wesly.

Misztal, P. (2010). “Harbeger–Larsen–Metzler (HLM) Effect: Theory and Practice in Poland”, The Romanian Economics Journal, 38, 12- 146.

Mosconi, R. and Giannini, C. (1992). Non-causality in Cointegrated Systems: Representation Estimation and Testing Oxford Bulletin of Economics and Statistics, vol. 54, issue 3, 399-417.

Ono, M., & Baack, S. (2014). Revisiting the J-Curve for Japan. *Modern Economy, 5, 32-47.*

Pilbeam, K. (2006). International Finance. Palgrave Macmillan, London.

Robinson, J. (1947) Essays in the Theory of Employment. London: Basil Blackwell.

Samanta S K. (2006). Exchange rate Uncertainty & foreign Trade for a Developing Country: an Empirical Analysis. The *Indian Economic Journal, 51-65.*

[DOI: 10.52547/jme.17.1.89]

Sims, A. (1986), Are Forecasting Model Usable for Policy Analysis, Federal Reserve Bank of Minnepolis, Quarterly Review,Vol 10, No. 1, winter, pp.2-16.

Soleimani, A., & Chua, S.Y. (2013). S-Curve at the Industry Level: Evidence from Malaysia's Bilateral Trade with its Major Trading Partners in East Asia. *Asia-Pacific Journal of Accounting & Economics, forthcoming.*

Vigfussan R. G., Sheets N., and Gagnon J. (2007). Exchange Rate Pass-Through to Export Prices: Assessing Some Cross-Country Evidence, Board of Governors of the Federal Reserve System. *International Finance Discussion Papers*, *Number 902*.

[DOI: 10.52547/jme.17.1.89]