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The Effect of Real Exchange Rate Variability on Industrial Output: Empirical Evidence from OIC

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Abstract

The exchange rate plays an essential role for firms which export goods and import raw materials. In this paper, the effects of real specific exchange rate fluctuations in imports, exports and aggregate trade on industry sector, chemical and transportation industries outputs in 49 OIC countries were investigated by using a panel data model over 1990-2014. Particularly, this paper presents evidence on the impact of industry specific real exchange rate indices, using the method developed by Goldberg (2004) on production in each of the specific OIC industries. The results show that the effects of specific real exchange rate and aggregate exchange rate are different. In fact, there is a significant and positive relationship between specific real exchange rate and industrial production in Islamic countries, but this relationship is negative for aggregate index.

Keywords: *Industry Specific Real Exchange Rate Index, Bilateral Real Exchange Rate, OIC.*

JEL Classification: *C23, E02, N10.*

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1. Introduction

Exchange rate fluctuations have important implications for producers, workers, and the overall economic activity. Depreciation of a local currency may benefit local firms that export to a foreign market as local products become more affordable to foreign firms and consumers. However, if local firms depend on imported intermediate inputs, currency depreciation may reduce profits due to increased production costs (Al-Shammari, 2007).

Many studies have been carried out to measure the exchange rate fluctuation and its impact on economic activities in the industrial sectors. In general, changes in exchange rates are very important for the profitability of industrial firms. Also, by increasing the insecurity and decreasing the production and profit for exporting and importing enterprises, the risk of exchange rate volatility can be considered as a trade barrier. Thus, firms consider the risk of exchange rate changes as a vital and important aspect of financial decision-making process. The importance of trading partners as trading competitors in an industry may vary with trade across the country. The industry specific real exchange rate indices might fail to change in various economic conditions. In general, the industry specific real exchange rate indices consider changes in competitive conditions of industry by using exchange rate changes bilaterally. In fact, exchange rate fluctuations significantly affect industries' profitability and their entry into global markets. Moreover, if manufacturing enterprises use foreign intermediate inputs, the devaluation may reduce industries' profitability due to the rise of costs. That is to say, the importance of trading partners in trading competition within an industry may be quite different from its importance in the overall level and inside the country (Goldberg, 2004).

Real exchange rate index may not reflect changes in economic conditions at the industry level, but industry specific exchange rate reflects changes in competitive conditions of industry much better through considering bilateral exchange rate fluctuations. Indeed, choosing trading partners to determine the exchange rate parameters is very important for examining the reaction of firms in each country. In fact, exchange rate fluctuations play a crucial role in the profitability of the industries importing goods and intermediate inputs and enterprises exporting the products. Exchange rate fluctuations can lead to increased uncertainty as a barrier to trade. As a result, firms consider exchange rate fluctuations as an important factor in decision-making. This paper extends

previous studies by considering the impact of specific exchange rate movements on industry output in OIC countries.

2. Literature Review

Recent significant declines in the trade-weighted U.S. dollar again raise questions about what exchange rate fluctuations mean for producers and more broadly for economic activities. When the exchange rate depreciates, the prices of goods imported into the host country typically rise. All else equal, such exchange-rate-induced import price increases generally improve the competitiveness of host producers in manufacturing and non-manufacturing industries relative to that of foreign competitors. Although some industries are made worse off by real exchange rate depreciation, perhaps due to their net reliance on imported productive inputs, on average the profits of host producers' rise. At the national level, discussions of exchange rate movements often rely on aggregate trade-weighted exchange rates, such as the carefully constructed measures computed by the Board of Governors of the Federal Reserve System for the aggregate economy.

Those aggregate indices use weighting schemes applied to trade-partner exchange rates; the weights are based on all imports and exports of the entire economy. Such indices are extremely useful at a macroeconomic level—for example, in discussions of the relationships between exchange rates and the aggregate trade balance. Yet this focus on national aggregates necessarily omits industry-specific distinctions concerning trade partners and competition. The importance of particular countries as competitors within an industry can differ substantially from their importance in the aggregated trade of the United States. As a consequence, aggregate trade-weighted indices may be less effective than industry-specific real exchange rate indices in capturing changes in industry competitive conditions induced by movements in specific bilateral exchange rates. Goldberg (2004) makes a noteworthy attempt to construct indices for industry specific real exchange rates. She estimates the impact of these indices on producer profits of specific U.S. industries. However, Goldberg shows how different the impact on U.S. producer profits would be using these industry specific real exchange rate indices as opposed to aggregate exchange rate. The industry specific real exchange rates index consist of three indices by industry: 1) Based on export partner weights, 2) Based on import partner weights, and 3) Based on the average of export and import partner weights (Al-Shammari 2007).

With the devaluation of the national currency, the price of foreign goods increases more than the domestic goods and the international competitiveness improves. The end result can improve economic activity. In other words, due to home currency devaluations, spending on foreign goods changes direction to domestic goods. Of course, the success of currency devaluation in stimulating foreign trade balance to a considerable extent depends on the shift in demand towards the right direction as well as the economic capacity to meet additional demands through greater supply of goods (Dornbusch, 1988). According to traditional economists, the impact of the value of money on economy is tensional while the new structural economists emphasize the contractile effect of the devaluation on economy. In this regard, the economies can be referred to in which Marshal-Lerner Conditions are violated and devaluation leads to reduced production (Gylfason and Radetzki, 1991). The price of exporting goods decreases and the price of importing goods increases due to devaluation. While the foreign business is in balance and in unchanged trade relationship, price changes neutralize each other. As a result, imports increase more than exports and the real income of countries will decrease (Tavakoli and Sayah 2010).

The effect of devaluation on economic performance is complex in relation to goods supply. In semi-industrial economies, like most of the Middle Eastern and Islamic countries where production entities are extremely dependent on importing inputs and the inputs are not easily accessible in the country, the cost of firms increases due to devaluation and the price of domestic commercial goods increases sharply (Bruno, 1987).

Gylfason and Schmid (1983) believe that the ultimate effect depends on the changes of supply and demand curves which will occur as a result of currency devaluation. Due to the increase of exchange rate, the net exports will improve, but production costs will increase too. Similarly, as the value of domestic currency increases (devaluation), the net exports and production costs will decrease. The effects of exchange rate fluctuations on economy can be specified by taking supply and demand into account (Tavakoli and Sayah, 2010).

In petroleum and raw material exporting countries where the aggregate demand's reaction to currency devaluation is weak and exports are priced by dollar (Qandil and Mirzaei, 2008), devaluation creates windfall profits in international trades. In such economies, if the nominal wages increase with delay in comparison to the rise of prices, and the marginal propensity for

savings from profits is more than the marginal propensity for savings from wages, the national savings will increase and will be associated with the reduction of actual production (Barbone and Rivera, 1987). Moreover, the expected devaluation which causes the domestic and foreign investors to lose their trust can lead to a decrease in production (Tavakoli and Sayah, 2010).

Woo (1984) investigated the effects of industry specified exchange rate indices on energy and non-food materials in the United States and Japan during 1960-1980. The results indicate the further effect of exchange rate index on import and export rather than the aggregate index.

Ohno (1989) examined the effects of exchange rates on manufacturing industry in the United States and Japan using the indices of 16 foreign currencies for exports and imports. The results indicated significant effect of industry specified exchange rate indices on the production of 19 industries.

Feinberg (1991) studied the effect of exchange rate indices of 101 currencies on the production of 81 industries in the United States. The results indicate the significant and positive effect of the exchange rate indices specified for export and import on industrial production.

Choi and Prasad (1995) reviewed the effect of real and nominal exchange rate of 409 international firms in U.S.A. The results indicated the significant effect of real and nominal exchange rate on output value. However, the results of the research offer limited support on their effects on 20 major industries.

Prasad and Rajan (1995) investigated the effects of specified exchange rate on stock returns in the United States. In this study, unilateral and multilateral exchange rates and linear approach were used. The results indicated the effectiveness of the specified exchange rate on stock returns.

Williamson (2001) examined the effect of within-industry competition on automotive industry in U.S.A using industry specified exchange rate index. The results indicated the significant effect of industry specified exchange rate on the products of automotive industry and within-industry competition.

Goldberg (2004) studied the effect of industry specified exchange rate indices on profits of manufacturing industries of U.S.A. The results indicate that the effect of industry specified real exchange rate indices is contrary to the effect of aggregate exchange rate indices. Industry specified exchange rate indices include the weighted average of import partners, the weighted average of export partners, and the weighted average of export and import partners. In this study, panel regressions were applied seasonally by using the data of 14

industries during 1970-2003. The results indicate that the effect of changes in the U.S. dollar on profit is significant and negative just for the industry specified exchange rate index.

Domínguez and Tesar (2006) examined the effect of exchange rate on firms' profit for 8 OECD and developing countries during 1980-1999. According to the results, the use of import and export indices is not much different from the use of exchange rate of U.S.A. Moreover, the exchange rate has a significant and positive impact on the profitability of the firms.

Al-Shamari (2007) investigated the effect of industry specified exchange rates on profitability of industries in the Middle Eastern countries during 1990-2004 using panel data approach. The results indicate the significant and positive effect of industry specific exchange rate and the significant effect of the aggregated exchange rate on the profitability of industries in the Middle Eastern countries.

Alexandre, Bação, Cerejeira, Portela (2009) examined the effect of partial and general specified exchange rate index on industrial products in the economy of Portugal during 1988-2006. The results indicate the similar effect of both indices on the industrial products of the country. Of course, the effect of partial specified exchange rate index was more than that of the overall specified exchange rate index. Moreover, there was a high correlation between the two indices.

Lu and Pan (2012) studied the effect of industry specific exchange rate on 20 industries of the United States using the panel data approach for 1974-2006. The results indicated the significant and negative effect of industry specified exchange rate on profitability of 10 industries and the significant and positive effect of industry specified exchange rate on profitability of the other 10 industries in the United States.

3. Measuring Industry Specified Exchange Rate

Maskus (1989), Martson (1990), Knentter (1994) and Haskel, Pereira and Slaughter (2002) have examined exchange rate behavior and its effects on firms' products and industries. Goldberg (2004) designed industry specified exchange rate indices based on trade weight for each trade partner i.e. exports real exchange rate index, imports real exchange rate index and average real exchange rate index. These indices reflect the weight of trading partners in

industry and the relative value of their currencies. The industry specific real exchange rate indices are examined by three components including the weight of exporting trade partner, the weight of importing trade partner, and the average weight of exporting and importing trade partners. Suppose i represents industry and trade partner for each industry is shown by j. Also, BREX is bilateral real exchange rate among the trading partners for Islamic countries. Bilateral real exchange rate is as nominal bilateral exchange rate divided by the consumer price index for the country and its trading partners. Export and import are shown by X and M. Then, industry specific real exchange rate indices are based on the weight of business partners. Export real exchange rate is defined as follows:

$$XBREX_t^i = \sum_j x_t^{ij} BREX_t^j \text{ , Where } \qquad x_t^{ij} = \frac{X_t^{ij}}{\sum_j X_t^{ij}} \tag{1}$$

where export real exchange rate index for each country is the bilateral real exchange rate for each trading partner country multiplied by the weighted exports of the countries. Similarly, import real exchange rate is calculated as follows:

$$MBREX_t^i = \sum_j m_t^{ij} BREX_t^j \text{ , Where } \qquad m_t^{ij} = \frac{M_t^{ij}}{\sum_j M_t^{ij}} \tag{2}$$

where import real exchange rate index for each country is as the bilateral real exchange rate for each trading partner country multiplied by the weighted imports of the countries. The average trade real exchange rate index is as follows:

$$TBREX_t^j = \sum_j \langle \left(0.5x_t^{ij} + 0.5m_t^{ij}\right) BREX_t^j \rangle \tag{3}$$

According to the trade-weighted index, a decrease in the value of any of these industry specific real exchange rate indices represents a real depreciation of the country's currency in the OIC countries. Any real appreciation of the country's currency is represented by an increase in the value of any of these industry specific real exchange rate indices.

4. Methodology and Experimental Model

In this study, Goldberg (2004) approach is used to estimate the effect of industry specified real exchange rate indices on industrial output in Islamic countries. Due to lack of statistical data in the study, the real output variability is used instead of the real profit. Typically, there is a positive relationship between the real product and the real profit. Therefore, the results can be compared with the results of Goldberg. Also, in this study, the special real exchange rate index is used. This variable shows the effect of industry specified exchange rate index for Islamic Countries over time as a result of changes on the composition of trading partners (the weight of industry and the relative value of their currencies). Besides, it includes a specific real exchange rate index variable. This variable captures the effect of the OIC industry specific exchange rate index on outputs over time as a result of changing composition in the trading partners' weights for the industry and their currencies' relative values. By interacting the variable of the industry specific exchange rate index with the trade variable (which consists of the sum of export and import over production of a specific industry), this may help in capturing the industry exchange rate variable interacted with the exposure level to international trade. Including the interacted variable allows the impact of industry exchange rate on outputs to grow as the trade share grows over time (Goldberg, 2004)

First-order differential model is as follows:

$$\Delta Y_t^{ij} = \alpha_1^i + \beta_0 \Delta GDP_t^j + \beta_1 \Delta I_t^j + \beta_2 \Delta ISER_t^{ij} + \beta_3 \Delta ISER_t^{ij} * Trade_t^{ij} + \epsilon i_t \qquad (4)$$

where *Y* represents the dependent variable and the profit of each industry. In this case the real output of industry is used as a proxy which is adjusted by CPI of each country to be converted into real value. In general, there is a positive relationship between actual production and profitability. Symbol *i* represents the industry, *j* represents the countries, α and β are parameters, and Δ represents the change in the logarithm of all variables except the interest rate. GDP has entered the model in real values. *I* is the interest rate, ISER is the industry specified exchange rate including three indices (XREX, MREX, TREX) and *Trade* is the share of each industry in trade (equal to the export and import of *i* country in comparison to aggregate output of that industry at time *t*). The non-interacted industry specific real exchange rates term ($\beta_2 \Delta ISER_t^{ij}$) represents the effect of currency fluctuations on industry

specified real exchange rate indices in the Islamic countries, and the interacted exchange rate ($\beta_3 \Delta ISER_t^{ij}$) represents the aggregate effects of an industry exposed to international trade in the Islamic countries. Therefore, β_2 represents the effect of industry specified real exchange rate index on industrial output in the Islamic countries and β_3 represents the effect of industry specified real exchange rate index exposed to the international trade in the Islamic countries. ε_{it} is the variable that indicates the error estimation of panel data which involves all the conditions related to the error term under the assumptions of Gauas-Markov.

In this study like Al Shamarri (2007), we use all available trading partners for each OIC country unlike Goldberg (2004) who uses only the main U.S. trading partners. Data availability usually limits the ability to have the same trading partner over time for a particular OIC country. This prevents using Goldberg's approach to control for trade weight endogeneity through lagging the trade weighted share for each U.S. trading partner. As a result, we used the one-year lag for the trade variable ($Trade_{t-1}^{ij}$), which is interacted with the industry specific exchange rate index in the regression. The key point is that using the interaction term in the model without lagging the trade variable may introduce an undesirable simultaneity relationship between the dependent variable and the interaction term. However, in order to solve this simultaneity problem we used one year lag for the trade variable ($Trade_{t-1}^{ij}$) . In the empirical section, I show that lagging the trade variable does not make any significant changes in the results.

5. Results

In this study, the data related to 49 Muslim countries were used during 1990-2014. The number of countries was selected based on the availability of data. The data of real exchange rate have been extracted from the Economic Research Service International Macroeconomics Database with the year of 2000 as the base year. GDP, interest rate, and CPI were extracted from the database of the World Bank and IFS. GDP and CPI are based on the base prices of 2000. Export and import data were extracted from the United Nations database and the COMTRADE database. The number of countries in different industries varies based on the data availability. Moreover, the trade value based on CPI and 2000 as the base year have been normalized.

Table 1. F Test Results for All Models

F Test	F-statistic	*Probe*
Total Industries	20.31	0.000
Chemical Industry (import)	4.26	0.02
Chemical Industry (export)	5.30	0.01
Chemical Industry (trade)	4.24	0.02
Transport Industry (import)	11.12	0.000
Transport Industry (export)	26.41	0.000
Transport Industry (trade)	22.77	0.000

Source: Research results.

According to the F-test, models must be estimated by panel data. The Hausman test can be used to differentiate between fixed effects model and random effects model in panel data. In this case, Random Effects (RE) is preferred under the null hypothesis due to higher efficiency; while under the alternative, Fixed Effects (FE) is at least consistent and thus preferred. Tables 1 and 2 display F and Hausman tests.

Table 2. Hausman Test Results

Hausman test	Chi-Sq. Statistic	*Probe*
Total Industries	38.51	0.000
Chemical Industry (import)	17.05	0.000
Chemical Industry (export)	21.21	0.000
Chemical Industry (trade)	4.24	0.000
Transport Industry (import)	6.50	0.16
Transport Industry (export)	4.71	0.31
Transport Industry (trade)	6.03	0.19

*Source: R*esearch results.

In this study, we investigated the impact of exchange rate movements on outputs of specific industries for OIC countries using industry specific real exchange rate indices. We used data from 49 countries in the OIC during 1990 - 2014. Particularly, we present evidence on the impact of industry

specific real exchange rate indices, using the method developed by Goldberg (2004), on production in each of the specific OIC industries.

Table 3. Regression of Total Industries

Dependent Variable *Δ* output	**Total industries**
C	-18.69 (-1.44)
BREX*Trade Δ	3.22 (10.02)
BREX Δ	-2.50 (-4.81)
Real GDP Δ	1.44 (25.55)
Real Interest Rate Δ	-18.69 (-1.43)
Adjusted R^2	0.98

Source: Research results.

Table 4. Regression of Petrochemical Products

Dependent Variable *Δ* output	***Regression***		
	Import	**Export**	**Total Trade**
C	11.79 (5.45)	14.26 (5.60)	12.55 (5.73)
BREX*Trade Δ	1.72 (10.27)	2.73 8.25	2.06 (10.00)
BREX Δ	-0.19 (-10.31)	-0.38 (-8.27)	-0.12 (-10.02)
Real GDP Δ	-1.90 (-1.90)	7.17 (0.25)	-1.12 (0.46)
Real Interest Rate Δ	-0.86 (2.37)	-0/4 (0.97)	-0.72 1.98
Adjusted R^2	0/91	0/86	0/91

Source: Research results.

Table 5: Regression of Transport Industry

Dependent Variable Δ **output**	***Regression***		
	Import	**Export**	**Total trade**
C	40/90 (16.86)	40.91 (15.81)	38.94 (15.88)
*BREX*Trade* Δ	1.11 (4.91)	9.99 (2.77)	1.09 (3.85)
BREX Δ	-0.04 (-5.71)	-0.02 (-2.54)	-0.02 (-4.38)
Real GDP Δ	-2.96 (-0.6)	-2.81 (-0.23)	-1.56 -0.05
Real Interest Rate Δ	-0.27 (-2.08)	-0.30 (-2.63)	-0.29 (-2.29)
Adjusted R^2	0.21	0.13	0.15

*Source: R*esearch results.

The results of the research are shown in Tables 1 to 5, using first-order differential technique. According to the results, the real GDP at different modes of estimation is positive and significant. In fact, as the GDP increases, the real profit in industries increases, too. In relation to the weak significance of GDP or its insignificance, it can be said that since industry does not include a considerable share of the economy in Islamic Countries, changes in GDP do not actually result from changes in industry but they originate from other factors such as oil revenues, growth of other sectors, and so on. Therefore, the relationship between GDP and industrial production is not very significant in some cases. The effect of real exchange rate on transportation industry, petrochemical industry, and the whole industries is statistically significant but negative. With regard to the rate of interest, its increase leads to the decline of investment and profit. The coefficient of non-interacted industry specific real exchange rate is statistically significant and if the currencies of the Islamic countries change in comparison to their trading partners, the production of their industries will decline.

In the chemical industry, 10 percent increase in the value of the Islamic Countries' currencies in comparison to their trading partners will be associated with 1.9%, 3.8%, and 1.2% reduction in their chemical industry production.

In transportation industry, 10% increase in the value of the Islamic countries' currencies in comparison to their trading partners will be associated with 0.4%, and 0.2% reduction in the production of this industry.

Interacted exchange rate results from changes in industry specified exchange rate ($\Delta ISER$) and the interactive effect of trade. The results shown in Tables (1 to 5) indicate that the effect of changes in the exchange rate of the Islamic countries on production is positive and significant. In fact, an increase in the currency value in Islamic countries (with the weight of international trade) leads to the increase of industrial production. The general interpretation of this positive sign is that the firms in the Islamic countries are mainly dependent on the intermediate products imported. Therefore, with the increase of the currency value of the Islamic countries in industries dependent on international trade, the imported intermediate inputs and the imported capital inputs become cheaper. As a result, the production of such industries will increase due to the reduction of production costs.

The results of the research show that there is a positive and significant relationship between the products of Islamic countries' industries and industry specified real exchange rate indices while Goldberg found the opposite results. It can be said that intermediate inputs and capital inputs in U.S.A are produced inside the country while in the Islamic countries they are produced outside the country. In the United States the negative effect of the exchange rate increase on the profits results from the lower demand for final products. Thus, the effect of demand exists in the Goldberg's findings, but this effect does not exist in the Islamic countries and the reduction of the costs of intermediate inputs leads to the increase of production and consequently, the increase of the real exchange rate.

However, at the microeconomic level the real exchange rate index masks industry specific differences in trading partners and market competitions. In this case, using industry real exchange rate indices may provide some useful guidance to policymakers. Industry specific real exchange rate indices capture changes in industry competitive conditions brought about by bilateral exchange rate movements. Therefore, if policymakers need to understand fluctuations in industry outputs, the industry exchange rate indices will help provide useful guidance regarding exchange rate movements. Hence, our results provide evidence for analyzing changes in economic activity resulting from movements in exchange rates, for OIC countries at the industry level.

6. Conclusion

In this study, the impact of exchange rate movements on outputs of specific industries for OIC has been investigated using industry specific real exchange rate. The results of the research indicate that there is a positive and significant relationship between the products of the Islamic countries' industries and industry specified real exchange rate indices. The results are contrary to the findings of Goldberg. This can be explained that intermediate inputs and capital inputs in U.S.A are produced inside the country while in the Islamic countries they are produced outside the country. In the United States the negative effect of the exchange rate increase on the profits results from the lower demand for final products. Thus, the effect of demand exists in the Goldberg's findings, but this effect does not exist in the Islamic countries and the reduction of the costs of intermediate inputs leads to the increase of production and consequently the increase of the real exchange rate. Furthermore, the results of the effect of industry specified real exchange rate indices, on the contrary to the exchange rate indices, are general. The real GDP at different modes of estimation is positive in case of being significant. In fact, as GDP increases, the real profit of industries will increase, too. The effect of real exchange rate is statistically negative and significant.

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