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Real Business Cycles and Iran-Korea Trade Relations: A Spectral Analysis on Gravity Approach*

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One channel of country specific shocks transmission across the world is through trade. That is, a business cycle has an impact on the domestic economy by influencing its exports directly through changes in export demand or indirectly through changes in the terms of trade (Lee *et al*., 2003). Calderón *et al*. (2003) show that countries with higher bilateral trade exhibit higher business cycle synchronization. However, research so far has neglected the question how trade relations are affected after business cycles occurring in a country and its trading partners whether simultaneously or not. This paper examines the hypothesis that business cycles affect Iran-Korea bilateral trade relations covering the period 1992-2011. To this end, the paper has analyzed moving correlations between bilateral trade and business cycles in both countries by using a dynamic method. In addition, it has studied how real business cycles affect co-movements of trade relations in both countries. Accordingly, a spectral analysis has been conducted on a trade gravity regression model in order to explore effects of real business cycles on Iran-Korea bilateral trade within different frequencies. The results obtained empirically have confirmed the hypothesis in which synchronization of business cycles has affected significantly bilateral trade between both partners during the period under consideration.

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1. INTRODUCTION

Real Business cycle shows the trend of national production fluctuations that play a crucial role in current and future conditions of an economy. Obviously, conducting a study on the effects of the real business cycles would recognize the degree of changes that occurs in employment, investment and trade. Hence, the existence of business cycles is often of interests for economists and other policymakers to learn from what happens to the economy. During a contraction, market functions begin to break down and, much like any piece of machinery, it is often easier to identify exactly how underlying mechanism operate when they are not functioning properly than when they are. As a result, recessions and depressions present learning challenges for economists, offering them the chance to explore opportunities and threats of an economy (Reynisson, 2012).

By identifying the reasons of these cycles, it is possible to avoid their negative effects such as an economic crisis, while we can benefit from their positive effects such as achieving economic growth and optimal allocation of resources. However, there is a gap in the literature in which it is important to understand why fluctuations in macroeconomic variables of a country can lead to changes in macroeconomic variables of its trading partners. For instance, positive output shock in a country might increase its demand for foreign goods. The impact of this shock on the cycle of the country's trading partners should depend on the depth of the trade and even financial links with each of the partners. Then trade is a channel for transmitting shocks to other trading partners.

Additionally, trade and more generally economic integration among countries have resulted in deeper synchronization of business cycles between individual countries, since economic links serve as a channel for transmission of shocks between countries (see Akin and Kose, 2008; He *et al*., 2007; Kose *et al*., 2008). For instance countries with higher bilateral trade imply higher business cycle synchronization, while countries with more asymmetric structures of production display a smaller business cycle correlation. The impact of trade intensity on cycle correlation is smaller the greater the production structure asymmetries between the countries (Calderón *et al*., 2003).

The motivation of this paper is to analyze the Iran and Korea trade relations spectrally and to find out a new channel of fluctuation transmission between the two partners. Thus, a hypothesis is tested in which real business cycles both countries' GDPs make low and high frequencies affecting possibly trade flows of both countries. More specifically, the GDPs at low frequency may influence the Iran-Korea bilateral trade flows at low frequency, while the GDPs at high frequency may affect the trade flows at high frequency. The estimation of a trade gravity regression, using panel data of both countries over 1992-2011, can provide empirical results with the hypothesis. Such work is indeed rare to the literature, being focused on the bilateral trade relations.

The remaining of this paper is classified to 5 sections. Section 2 reviews the related literature, and then a model specification is raised in section 3. Section 4 will analyzes the empirical results obtained by the gravity model estimation. Finally, section 5 concludes remarks.

2. THE RELATED LITERATURE

The term business cycle refers to fluctuations in production or overall economic activity over time. Because the business cycle is related to aggregate economic activity, a popular indicator of the business cycle is the real gross domestic product (GDP). Such fluctuations move up or down around a long term growth trend and typically shift over time between periods of economic growth or stagnation (Reynisson, 2012).

The idea behind real business cycle (RBC) models is their emphasis on the role of real shocks in driving business fluctuations as first presented by Kydland and Prescott (1982). Other known shocks are monetary, fiscal and oil price shocks but Prescott (1986) argues that technology shocks account for more than half the fluctuations. Prescott (1986) computes total factor productivity (TFP) and treats it as a measure of exogenous technology shocks. But as Hall (1988), Evans (1992) and Hall and McDermott (2007) show TFP, as computed by Prescott (1986), is not a pure exogenous shock, but has some endogenous components (Rebelo, 2005). However, a less concentration was made on business cycles in external economic sector during 80s and 90s.

Kumakura (2006) then examined the empirical relationship between trade and business cycle correlations among thirteen Asia-Pacific countries over period 1984-2003, paying close attention to the structural characteristics of their economies. According to the results, although trade appears to help account for variations in international business cycle co-movements, a more important factor is the extent to which each country specializes in hi-tech industries.

The real business cycle (RBC) theory pioneered by Kydland and Prescott (1982), regards changes of total factor productivity as the primary cause of business cycles. This theory is basically the neoclassical equilibrium theory, and minimizes the role of the government's stabilization policy. The Keynesian theory, in contrast, attributes business cycles to fluctuations of real aggregate demand (De Long and Summers, 1986; Mankiw, 1989; Tobin, 1993).

Additionally, there are several reasons of happening business cycles in countries worldwide to be explored. Iyetomi *et al*. (2011), for instant, investigate causes of business cycles through analyzing Japanese industrial production data. Using the random matrix theory, they show that two largest Eigen-values are significant. Taking advantage of the information revealed by disaggregated data, Iyetomi *et al*., identify the first dominant factor as the aggregate demand, and the second factor as inventory adjustment. They show that in terms of two dominant factors, shipments lead production by four months. Furthermore, out-of-sample test they demonstrate that the RBC model holds up even under the 2008-2009 recession. Because a fall in output during 2008-2009, which decreased exports, there was another justification for identifying the first dominant factor as the aggregate demand. All the findings suggest that the major cause of business cycles is arising from real demand shocks, which can be partly from imports.

Kim and Choi (1997) have sought to present results from a detailed empirical study of contemporary business fluctuations in Korea during 1970-1991. They have followed the methodology of modern business cycle research in conducting a theoretical statistical analysis of the cyclical properties of key aggregate time series. The analysis has shown that many of the cyclical regularities documented for developed countries exist also in Korean business cycles. Those regularities include the relative volatilities of many expenditure components and the co-movement of real and nominal variables with output. A particularly notable one is the counter-cyclicality of prices. Counter-cyclicality of prices signals the importance of supply side shocks in Korean business fluctuations. It has been revealed in the analysis that the fluctuation in the import price of oil may have been the major source of Korean business cycles. The analysis has also revealed that there are some notable idiosyncrasies in Korean business cycles. Net exports are significantly pro-cyclical. There is strong evidence that open economy-related variables are leading the cycle for most of the period under study. Stability analysis showed that usual co-movements didn't hold during 1986-1989 period.

Delavari *et al*. (2011) analyses the underlying causes of Iranian business cycles using structural auto regression (SVAR) in the period between 1965-2009. The findings of this research show that business cycle in Iran is affected by changes in oil revenues. The result verifies that the effect of fiscal policy in generating business cycles is much more than monetary policy and technological shock.

Rana *et al*. (2012) provide relatively a comparative analysis of the relationship between trade intensities and synchronization of business cycles in East Asia and Europe (EU-15). They find that intra-industry trade, rather than inter-industry trade, is the major factor in explaining business cycle co-movements in both regions. They also support the hypothesis that the relationship between trade intensity and output co-movement is stronger in East Asia than in Europe. Frankel and Rose (1998) also find that trade intensity increases cycle correlation among industrial countries.

Inklaar *et al*. (2005) re-examine the relationship between trade intensity and business cycle synchronization for 21 OECD countries during 1970-2003. They estimate a multivariate model including variables capturing specialization, financial integration, and similarity of economic policies. They confirm that trade intensity affects business cycle synchronization, but the effect is smaller than previously reported.

Tayebi and Zamani (2013) evaluate a possible synchronized relationship between recent financial crisis and international business cycles in the selected Asian countries. By using annual data of GDP growth rates during 1980-2010, they test a relationship between recent financial crisis, arising originally from the US, and international business cycles. They thus analyzes moving correlations between financial crisis and business cycles in Asia, using dynamic econometric methods. In addition, they have studied how the financial crisis has influenced co-movements of output in Asian economies for different frequencies in the framework of the spectral analysis. Overall, analyzing spectrally the determinants of the selected Asian economies' *GDPs* (such as Korea, Japan, China, etc.) has indicated a significant synchronized effect of the business cycles and the recent global crisis on such economies.

Chiquiar and Ramos-Francia (2005) provide evidence that production-side links between Mexico and the U.S. manufacturing sectors became stronger after NAFTA was enacted and, as a consequence, business cycles in these countries became more synchronized. This suggests that the positive effect of bilateral trade on business cycle synchronization found in previous studies for the case of industrial countries may also hold for industrial and less developed country pairs. The recent entry of other unskilled labor-abundant countries into global trade, however, seems to be affecting Mexico's competitiveness in some industries and causing Mexico to be losing market share in the U.S. import market. As a consequence, this event could lead to a permanent negative shift in Mexico's manufacturing output levels, relative to the U.S., and could possibly weaken the degree of business cycle synchronization between these countries. A related effect is shown to be that, in some industries where strong Mexico-U.S. production-sharing links persist, overall North American output is apparently being affected by the global movement of these activities towards the Asian block.

Kapounek and Poměnkova (2012) define rules for decision of existence spurious synchronization of countries within the currency area. They devote this new methodological approach from an empirical research based on the variability of a dynamic correlation (correlation in frequency domain). They show a dynamic correlation in full range and in the business cycle frequencies as well. Calderón *et al*. (2003) study whether trade intensity increases cycle correlation among developing countries. They gathered annual information for 147 countries for 1960-1999 and found countries with higher bilateral trade exhibit higher business cycle synchronization. They also found that the impact of trade integration on business cycles is higher for industrial countries than both developing and industrial-developing country pairs.

To the case of Japan, Artis and Toshihiro (2010) apply the Hodrick-Prescott filter to identify cycles in Japan annual data from 1955 to 1995 and calculate bilateral cross-correlations of prefectural GDPs for all pairs of prefectures. The results show fairly high cross-correlations. Then they used gravity model framework and found that two prefectures with similar GDPs and a shorter distance between them led to business cycle synchronization whilst those with larger regional gaps in factor endowment (capital, labor and human capital) resulted in more idiosyncratic business cycle.

A number of debates indeed have taken place around the existence of a common cycle, trade intensities and synchronization of business cycles and many researches use gravity approach for studying the effect of GDPs and other factors on bilateral trade. But there is a gap in the literature that there is no study using gravity model and determinant factors of bilateral trade in low and high frequencies. Therefore, in this study we analyze spectrally the effect of business cycle on bilateral trade in low and high frequencies in the framework of a specified gravity model, in which such analysis is an innovation to relationship between trade and real business cycles.

3. THE MODEL

Traditional business cycle analysis recognizes two types of cycles. There is a classical cycle, which can be recognized from the fact that it involves an absolute decline in economic activity from peak and absolute rise in activity from the trough. The second type of the cycle is a deviation or growth (occasionally growth rate) cycle where the business cycle is relative to trend. It is the concept of the deviation cycle that it needs to use a filter to measure the trend so that the cycle measured as deviations from the trend, can be identified (Artis and Toshihiro, 2010). On this basis it is used a Hodrick-Prescott (HP) filter. Then the standard deviation of the cyclical component of the time series is measured as business cycle and another way to calculate it is using the band-pass filter that it decomposes time series into trend, cycle, and irregular components that correspond to the low frequencies, the business cycle, and the high frequencies of the spectrum (Stock and Watson, 2002).

Changes in different frequencies imply changes in components of the GDP in each country, enabling us to raise possible synchronization between RBC and different frequencies of trade in our sampling countries, that is, Iran and Korea. The implication is that trade relations among these countries has resulted in deeper synchronization of business cycles between individual countries, since economic links serve as a channel for transmission of shocks between countries. These facts are referred to as decoupling of business cycles in the recent literature (See Akin and Kose, 2008; He *et al*., 2007; Kose *et al*., 2008). In their seminal paper, Frankel and Rose (1998) argue that countries with more intense trade ties have more similar business cycles. Fidrmuc and Korhonen (2010) find a significant link between trade ties and dynamic correlations of GDP growth rates in emerging Asian and OECD

Table 1 Empirical Results on the Relationship between Output Co-movements and Iran-Korea Bilateral Trade Relations (1992-2011)

Variable	Coefficient	Z	$P > \|Z\|$
Cons	0.043	0.16	0.875
Trade	0.013	2.87	0.004

Wald chi2(1) = 8.26*
Prob.> chi2 = 0.0041
LR chi2(1) = 600.34**
Prob.> chi2 = 0.0000

Note: * and ** stand for Wald and LR tests, which refer to test for the explanatory regression power and heteroskedasticity, respectively.
Source: Authors.

countries. Accordingly, an interesting objective here is to predict, through an empirical model, the probability that Iran and Korea may have a significantly synchronized business cycle based on the volume of their trade flows. The model can be defined as fallows and shows such idea:

$$\mathrm{Ln}\left(\frac{1+p_{ij}}{1-p_{ij}}\right)=\beta_0+\beta_1 Trade_{ij}+\varepsilon_{ij}, \tag{1}$$

where p_{ij}[1)] is the moving correlation coefficient of output in the selected countries i and j, while $Trade_{ij}$ denotes trade flows between both countries. Fidrmuc and Korhonen (2010) note that the correlation coefficient is bounded between –1 and 1 and use the Fisher transformation to transpose its values to an unbounded variable. Table 1 shows that trade flows between Iran and Korea have a positive and significant effect on co-movements of their outputs during 1992-2011. The result implies that trade plays a core

1) $\rho_{ij}=\mathrm{cov}(GDP_i,\ GDP_j)/\sqrt{\mathrm{var}(GDP_i)\mathrm{var}(GDP_j)}$ where ρ_{ij} is the moving average of 5 years correlation between the Iran and Korea' GDP. $\mathrm{Cov}(GDP_i,\ GDP_j)$, $V(GDP_i)$ and $V(GDP_j)$ denote the moving average of covariance between the Iran's *GDP*, Korea's GDP, Variance of Iran's *GDP and* Korea's GDP.

role in co-movements of GDPs of both countries, so that a higher rate of trade relation can lead to deeper synchronization in GDPs of both countries.

As already indicated empirically, real business cycle plays a crucial role in an economy, transmitting particularly various shocks in low and high frequencies to its economic indicators. One channel of country specific shocks transmission across the world is thus made through exports. That is, the foreign business cycle has an impact on the domestic economy by influencing its exports, directly through changes in export demand, or indirectly through changes in the terms of trade (Lee *et al*., 2003).

Theoretically, trade intensity has an ambiguous effect on the co-movement of output. If business cycles are dominated by industry-specific shocks, trade-induced specialization leads to decreasing business cycle correlations. However, if trade is dominated by intra-industry trade industry-specific shocks may lead to more symmetric business cycles. Furthermore, in case of intensive trade relations economy-wide shocks in one country will generally have an effect on demand for goods from the other country (Inklaar, 2005). Hence, it is assumed that any shock arising from real business cycles in two the trading partner countries should affect their trade relations.

Since the main idea of this study is to recognize the effective process of synchronized business cycles in Iran and Korea, we explore the effects of such movements on the Iran and Korea bilateral trade. It is quite important to investigate the co-movements of GDP changes in both countries which is possibly influence their external sectors. The hypothesis is that low and high frequencies in each trading partner arising from GDP fluctuations can affect particularly Iran and Korea trade flows. To this end, we specify an augmented trade gravity model for Iran and Korea bilateral trade flows. Then, we estimate the model by using cross data of both countries' exports. By following Frankel and Rose (1998) and most subsequent studies we employ gravity models for studying business cycle synchronization.

If a country and its trading partners face economic shocks, its trade flows are affected simultaneously by internal and external shocks since it causes disorganization in their business affairs. Therefore, we follow Anderson

(1979) and Deardorff (1998) who extracted trade gravity model initially from the Newton approach, in order to estimate international trade flows, while data are under effects of business cycles in the main economic indicators. The simplest case when there is no obstacle and no reward, bilateral trade flows can be considered as a direct function of the economic size of the two countries. In the framework of the gravity approach, bilateral trade can be a function of both countries' GDPs, and population POP_{Irn} and POP_{Kor}, respectively.

Additionally, it is assumed that fluctuations in trade relations between two countries is affected by trade imbalance to each partner which is even more pronounced when both partners' economies are in different stages of real business cycles. An index for trade imbalance variable of country *i* (Iran and Korea) is defined as follows:

$$Imb_i = \frac{|X_i - M_i|}{|X_i + M_i|}, \tag{2}$$

where X_i and M_i show exports and imports of country *i*. In addition, it is assumed that an episode, like East Asia financial crisis in 1997-1998, generates possibly a structural break in the process of synchronized business cycles of both countries. Accordingly, a dummy variable is used to indicate the effect of the crisis on the Iran-Korea trade relations at the different levels of frequencies. Based on the theoretical literature of international trade (Deardorff, 1998), income convergence/divergence may affect directly/ indirectly the countries' trade flows, even co-movements of business cycles dominants changes of the economic variables in both countries. Therefore, an augmented trade gravity model in logarithmic form is defined, while a Linder variable is applied to explain the role of income convergence/divergence in their trade relations during the periods of business cycles. Overall, the variables of bilateral trade (exports flows of both countries) and GDPs are considered spectrally both in low and high frequencies. An augmented gravity model is now defined as follows:

$$SEX_{kijt} = \alpha_0 + \alpha_1 SGDP_{it} + \alpha_2 SGDP_{jt} + \beta_1 POP_{it} + \beta_2 POP_{jt} \\ + \gamma_1 imb_{it} + \gamma_2 LIND_{ijt} + \gamma_3 Dum_{97} + \varepsilon_{ijt}. \tag{3}$$

SEX_{kijt} is spectral exports of sector k (k=agriculture, industry) from country i (Iran/Korea) to country j (Korea/Iran) at time t. $SGDP_{it}$ and $SGDP_{jt}$ denote spectrally GDP of exporter country i (Iran/Korea) and importer country j (Korea/Iran) at time t, respectively. POP_{it} and POP_{jt} show populations of country i and j country at time t. imb_{it} is trade imbalance to each partner at time t. $LIND_{ijt}$ explains the role of income convergence/divergence in their trade relations. Dum_{97} shows 1997-1998 Asia financial crisis. ε_{ijt} is an error term which is distributed identically and independently.

While analysis in time dimension is a standard tool of business cycle analysis, the application of spectral analysis may introduce new and more robust insights. Statistical filters, especially the Hodrick-Prescott filter, may generate artificial cycles (Harvey and Jaeger, 1993). Moreover, the Hodrick-Prescott filter suffers from an end-point bias. The band-pass filter, which is recommended in the more recent literature, results in a loss of observation at the beginning and ending of the time series.

The application of proper spectral method can enhance the comprehension of the structure and cyclical behavior of the series in different time scale without the end-point bias or loss of observations therefore the issue of analyzing the business cycle is the most frequent object of spectral tools. The spectral analysis may provide a solution to several of caveats of standard business cycle analysis (Bátorová, 2012).

As previously explained, the main idea of this study is to examine the effect of real business cycle on Iran-Korea bilateral trade across different frequencies, the issue is a lack in the literature. Such effect can be studied by a gravity framework in which we need to consider low and high frequencies of the countries' GDPs and trade flows through spectral analysis and frequency data.

Spectral analysis is concerned with exploration of cyclical patterns of data and its main purpose is to decompose the original series into an infinite sum of periodic functions, each having a different frequency ω ranging between 0 and π. Such basis of the spectral analysis is captured in spectral representation theorem which states that any covariance-stationarity process $\{Y_t\}_{t=-\infty}^{\infty}$ can be expressed as:

$$Y_t = \mu + \int_0^{\pi} \alpha(\omega).\cos(\omega t)d\omega + \int_0^{\pi} \beta(\omega).\sin(\omega t)d\omega, \tag{4}$$

where each frequency ω is related to a unique time horizon *T*, such $T = 2\pi / \omega$ and weights $\alpha(\omega)$ and $\beta(\omega)$ are random variables with zero mean. It means that the process Y_t is periodic function with frequency ω or with period *T* (Bátorová, 2012).

Applying spectral analysis, one may estimate a regression model by using time series of variables which are filtered by the Fourier approach. In this condition variables are measured in low and high frequencies depending on the nature of the relevant data. According to Assenmacher and Gerlach (2005), we consider a high frequency band with less than 2 and a low frequency band with greater than 2 for the annual data of the selected countries' *GDPs*, having duration between 2 and 8 years. By such transforming, we can study the effect of business cycle in different (low and high) levels of frequency on bilateral trade, and develop gravity model by applying frequency data of Iran and Korea. In case, bilateral trade flows between two partners are classified in two groups: agricultural and industrial exports, for the period 1992-2011, including 80 observations totally.

4. EMPIRICAL RESULTS

The trade gravity model specified in equation (3) explains changes in Iran-Korea bilateral trade through specific changes in the countries' GDPs during the conducted business cycles, implying a spectral analysis of the variables used. To carry out the spectral analysis on empirical results, we use converted data based on the spectral domains in both low and high frequencies where the original time series data (1992-2011) are obtained from the World Development Indicators (WDI) database of the World Bank[2] and Iran Customhouse.[3]

Data on the bilateral trade include bilateral export values of industrial and agricultural products based on the *ISIC* codes. Such data, which are measured and filtered by the WinRATS (7.1), are used to estimate a re-specified trade gravity model shown in equation (5) by the panel data approach.

In the model, spectral GDPs have been replaced by their spectral GDPs per capita, to fit data more consistently, while population variables have been dropped. Equation (5) is thus defines as follows:

$$\begin{aligned} SEX_{kijt} &= \alpha_0 + \alpha_1 SGDPPC_{it} + \alpha_2 SGDPPC_{jt} \\ &\quad + \gamma_1 imb_{it} + \gamma_2 LIND_{ijt} + \gamma_3 Dum_{97} + \varepsilon_{ijt}, \end{aligned} \tag{5}$$

where $SGDPPC_{it}$ and $SGDPPC_{jt}$ are GDP per capita for countries *i* and *j* (Iran/Korea).

Before estimating the model, we should check the stationary data of variables through a panel unit root test. To do so, we use Levin-Lin-Chu (LLC) test, in which the null hypothesis stands for the non-stationary variables. Table 2 summarizes the LLC statistics for all the variables, which are significantly stationary at the level. This confirms our model estimation is not suffering from the spurious regression problem.

Tables 3, 4, and 5 report the empirical results for three cases: an ordinary panel estimation without considering frequency in data on GDPs per capita and bilateral exports (Case 1), panel estimation considering low frequency in data on GDP per capita and bilateral exports (Case 2) and panel estimation with high frequency in GDP per capita and bilateral exports (Case 3), respectively.

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[2] http://data.worldbank.org/data-catalog/world-development-indicators.

[3] www.irica.gov.ir. The website provide data on bilateral exports on agricultural and industrial products.

Table 2 Unit Root Test of the Model Variables by the LLC Method

	LLC Statistic	*P*-value
Case 1*		
EX_{kijt}	–12.6536	0.0000
$GDPPC_i$	–95.4233	0.0000
$GDPPC_j$	–72.0190	0.0000
Case 2**		
SEX_{kijt}	–28.968	0.0000
$SGDPPC_i$	–7.0702	0.0000
$SGDPPC_j$	–4.6059	0.0000
Case 3***		
SEX_{kijt}	–4.2659	0.0000
$SGDPPC_i$	–4.6019	0.0000
$SGDPPC_j$	–3.3663	0.0000
imb_i	–4.1993	0.0000
$LIND_{ij}$	–2.9423	0.0000

Note: *, ** and ***: See table 3, table 4, and table 5.
Source: Authors.

Table 3 reports the estimation results for Case 1 which has been obtained by the FGLS method, to remove the heteroskedastic problem (see results of the LR test). Iterated GLS with autocorrelation does not produce the maximum likelihood estimates, so we cannot use the likelihood-ratio test procedure, as with heteroskedasticity. However, Wooldridge (2002) derives a simple test for autocorrelation in panel-data models. Drukker (2003) provides simulation results showing that the test has good size and power properties in reasonably sized samples. The result for the test has been reported in the table (and also tables 4 and 5), indicating no autocorrelation of residuals.

The empirical results which are reported in the table are namely consistent

Table 3 Panel Estimation Results for Iran and Korea Bilateral Exports Based on Cross-sectional Time-series FGLS Regression: Case 1

Variable	Coefficient	Z	$P > \|Z\|$
Constant	–35.49	–1.75	0.081
$SGDPPC_i$	3.30	2.79	0.005
$SGDPPC_j$	2.24	1.84	0.065
imb_i	5.71	3.40	0.001
$LIND_{ij}$	0.06	0.13	0.831
Dum_{97}	–4.91	–2.62	0.009
Diagnostic Tests	Wald chi2 (5) = 22.78, Prob. > chi2 = 0.0004 LR chi2 (3) = 20.78, Prob. > chi2 = 0.0001 $F_{\text{Autocorrelation}}$ (1, 1) = 6.396, Prob. > F = 0.2397*		

Note: * Wooldridge test for autocorrelation in panel data, in which the null hypothesis stands for no autocorrelation.
Source: Authors.

Table 4 Panel Estimation Results for Iran and Korea Exports Based on Cross-sectional Time-series FGLS Regression, Using GDPs in High Frequency: Case 2

Variable	Coefficient	Z	$P > \|Z\|$
Constant	–13.22	–3.53	0.000
$SGDPPC_i$	0.75	7.36	0.000
$SGDPPC_j$	0.858	11.09	0.000
imb_i	–0.12	–1.08	0.278
$LIND_{ij}$	–0.042	–1.23	0.219
Diagnostic Tests	Wald chi2 (4) = 226.98, Prob. > chi2 = 0.0000 LR chi2 (3) = 297.33, Prob. > chi2 = 0.0000 $F_{\text{Autocorrolation}}$ (1, 3) = 2.732, Prob. > F = 0.1969		

Source: Authors.

Table 5 Panel Estimation Results for Iran and Korea Exports Based on Cross-sectional Time-series FGLS Regression, Using GDPs in Low Frequency: Case 3

Variable	Coefficient	Z	$P > \|Z\|$
Constant	25.85	2.69	0.007
$SGDPPC_i$	0.17	0.42	0.67
$SGDPPC_j$	–0.44	–1.35	0.178
imb_i	1.40	2.66	0.008
$LIND_{ij}$	–0.073	–0.77	0.443
Diagnostic Tests	Wald chi2 (4) = 10.69, Prob. > chi2 = 0.0303 LR chi2 (3) = 9.91, Prob. > chi2 = 0.0194 $F_{\text{Autorrolation}}$ (1, 3) = 3.743, Prob. > F = 0.1485		

Source: Authors.

with theoretical expectations as the signs of variable coefficients seem to be true expectedly. The coefficient of the *GDP* per capita for both partners *i* and *j* (Iran and Korea) are significantly positive, implying higher growth rates of their *GDPs* per capita raise their trade relations. On the contrary, *LIND* variable does not have a significant effect on export flows of the partners. It reveals indeed a current difference between incomes of both countries so that the more income divergence, the more trade between Iran and Korea. The coefficient of dummy variable is negative and shows that 1997-1998 Asia financial crisis has affected negatively export flows of various products in both countries. The empirical results indicate a significant and positive coefficient of the trade imbalance in the estimated model while the interpretation of the result seems ambiguous.

The results related to Case 2 and Case 3 have been reported in table 4 and table 5, respectively. These results cover our research objective in which business cycles appear in GDP per capita for two trading partners (Iran and Korea) may affect their spectral bilateral trade flows during recent two decades (1992-2011). Due to the results obtained for diagnostic tests including LR and Wald statistics, the estimation results have been found by the FGLS method, to eliminate the heteroskedastic problem (see results of the LR test in table 4 and table 5). A Wald test shows the model estimation, which is in goodness of fit. The result of the Wooldridge test also accounts for no autocorrelation in both cases (tables 4 and 5).

Table 3 summarizes the panel estimation results for Iran and Korea Exports based on cross-sectional time-series FGLS regression, in which high frequency data for *GDPs* per capita of both countries have used in the estimation process. Indeed, such data indicates synchronized real business cycles in a high frequency band with less than 2 for the annual data of the selected countries' *GDPs* per capita (Assenmacher and Gerlach, 2005). As shown in the table, the coefficients of GDPs per capita in high frequency for both countries as exporters and/or importers explain significantly and directly short-run changes in their bilateral exports of agricultural and industrial products over the period 1992-2011. The implication is that industry shocks dominate economic fluctuations in the short run, and then we would expect the effects of business cycles to be positive on the Iran-Korea bilateral trade flows.

Table 4, however, reports no significant effect of *GDPs* per capita in low frequency (a frequency band with greater than 2 for the annual data of the GDPs per capita) since their estimated coefficient have not been statistically significant. The results indicate no long-run shocks arising from synchronized business cycles affect the bilateral trade relations. It implies that there is no sign of vertical specialization between two countries towards more intra-industry trade.

5. CONCLUSION

Empirical results were obtained by estimating a trade gravity model in several cases due to exploring the effective factors of Iran-Korea bilateral exports in different frequencies. In Case 1, we estimated the model in general using ordinary data through a panel regression model, while in Cases 2 and 3 we estimated the model considering high and low frequencies of bilateral exports and GDPs per capita, as proxies for synchronized real business cycles in both countries during 1992-2011. The objective of this paper was thus to examine whether business cycles have effect on Iran and Korea bilateral trade in different frequencies. Accordingly, we used panel data of both economies during the period by computing moving correlation coefficients and using dynamic econometric methods, particularly by focusing on the spectral regression analysis and gravity approach. Our findings concluded that trade had positive and statistically significant effect on the GDP co-movements of both countries. In addition, the empirical results arising from the spectral method showed a significant short-run effect of the business cycles on Iran and Korea bilateral trade.

The core results obtained refer to the effects of business cycles to be positive on the Iran-Korea bilateral trade flows since industry shocks dominate economic fluctuations in both countries. Our findings thus imply that expansion of trade relations between two countries should lead to synchronization of business cycles in the long-run.

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