# Business cycle synchronization and its determinants in OECD countries: The panel data evidence


## Abstract

This study follows Imbs (2004) and Hsu *et al.* (2011) to examine the possible interactions of the trade, industrial dissimilarity, FDI and monetary policy with the business cycle co-movements of 30 OECD countries using a panel data set covering the period 1990 through 2009. The analysis is carried out using both the single-equation and the simultaneous equations model estimation techniques. The error component three-stage least squares (EC3SLS) estimates from simultaneous equations model with panel data appear to be superior to the estimates obtained from single equation models with panel data or simultaneous equations models with cross sectional data, simply because EC3SLS can control the problem of endogeneity. The results reveal that bilateral trade intensity, industrial dissimilarity (i. e., specialization-in-production), FDI, and monetary policy closeness play a very strong role in the business cycle synchronization of sample economies. The estimated results of EC3SLS suggest that both trade and industrial dissimilarity have direct as well as indirect impact on the business cycle synchronization of OECD countries. On the contrary, FDI exhibits only an indirect impact on output correlation of sample countries via trade and similarity in industrial structure. The findings also indicate that trade and FDI complement each other. Furthermore, the results reveal that monetary policy serves as an important and independent source of shock transmission across these OECD countries.



**Keywords:** Business cycle movements; bilateral trade; industrial dissimilarity; FDI; monetary policy closeness; OECD countries

**JEL Classifications:** E32; F02; F10; C23; C33


## 1. Introduction

Empirical macro-economists have always been curious to understand the various channels through which international business cycle co-movements are propagated and transmitted across the national borders. In the current times, such an analysis becomes all the more important because of two main reasons: (1) over the last few decades, the phenomenon of globalization and market economy has increased the economic integration among countries and the world economy; (2) the contagion nature revealed by the 2008 financial slowdown in the United States and the more recent Eurozone sovereign debt crisis have revived the long-lasting interest among researchers to understand the mechanism of international propagation of business cycles from one country to another. Existing literature suggests that trade serves as an important channel of business cycle co-movement. Yet, international trade is not the only source of shock transmission across national boundaries. In fact, there are many channels which might influence business cycle synchronisation. Besides intense bilateral trade, the other possible channels of business cycle synchronisation are: similarity in industrial structure, similarity of fiscal policies, foreign direct investment (FDI), currency union, monetary and financial integration, exchange rate volatility, common monetary policies, and economic integration, etc. The theoretical interactions among these determinants of international business cycle synchronisation are very complex. It is these interactions that I explore in this study. More specifically, this paper analyses the impact of trade, FDI, industrial dissimilarity, and monetary policy closeness on the business cycle synchronisation of 30 countries belonging to the region of Organization of Economic Co-operation and Development (OECD), using a panel dataset spanning from 1990 to 2009. No doubt, both theoretically and practically, disentangling the relative contributions of major macro-variables (trade, FDI, industrial dissimilarity, similar monetary policy, etc.) is crucial simply from the point of view of business cycles research. Besides, it is also a relevant policy question, in the sense that international correlation of business cycles is an important metric used to measure the desirability and feasibility of a potential entrant to join a currency union. More generally, the channels this study proposes to determine are aptly relevant to policymakers asking if, and why, they should be concerned with foreign developments affecting domestic fluctuations.

From a theoretical perspective, the relation between trade integration and business cycle synchronization is not clear-cut. On the one hand, greater trade integration will carry demand shocks occurring in one country to another country, thereby increasing their synchronization. On the other hand, trade integration may lead to specialisation in production (Dornbusch, Fisher and Samuelson 1977). Specialisation, in turn, will lead to differences in the exposure to industry-specific shocks in different countries. Eventually, this may lead to more idiosyncratic business cycles (Krugman 1993, Kose and Yi 2002). It should be noted that specialisation argument is particularly relevant in the case of inter-industry trade, and not in the case of intra-industry trade, as specialisation in the latter case occurs within the same industry.[1]

Also, in the current wave of globalisation, FDI in technology diffusion and financial investment has become an important channel for the international transmission of shocks. FDI is a category of cross-border investment that reflects the objective of establishing a lasting interest by a resident enterprise in one economy (direct investor) in an enterprise that is resident in an economy other than that of the direct investor.[2] Such investment arises because of the incentives offered by the national, regional and local governments in the form of financial benefits, fiscal benefits and regulatory benefits.[3] Existing literature suggests various possible channels through which bilateral FDI contributes to the business cycle synchronisation. These are: (1) introduction of new processes by foreign firms into the domestic market may result in accelerated diffusion of new technology and technological know-how in to the domestic market; (2) flow of inward FDI in a host country might reduce in size and magnitude because of a deterioration in the economic conditions in the foreign investor's home country as it may weaken the financial health of the parent companies. Eventually, this may reduce the size of investment and finally resulting in manifold increase

[1] Specialisation is likely to influence the synchronization of business cycles across economies. This will naturally occur in the presence of sector-specific shocks, because two countries which produce same type of goods will be subjected to similar stochastic developments. But it may also occur in the absence of any sector-specific shock. For instance, if sectors differ in their response to monetary shocks, because of different market structures or different labour market institutions, countries with different production patterns will be synchronized even though shocks are purely aggregate (Kraay and Ventura 2002).

[2] See 4th Edition of the OECD Benchmark Definition of Foreign Direct Investment (2008). http://www.oecd.org/daf/inv/investmentstatisticsandanalysis/40193734.pdf

[3] See UNCTAD's World Investment Report (2014). http://unctad.org/en/PublicationsLibrary/wir2014_en.pdf

in the level of unemployment in the host country via the working of investment multiplier, thereby causing the spread of local macroeconomic shocks from one country to another; (3) under the condition of capital mobility, a change in the saving-investment decision in one country is likely to affect the price and availability of financial assets in other countries, thereby leading towards more closely synchronized business cycles; (4) regarding outward FDI position, unfavourable disturbances in the host foreign countries may reduce the net worth of the domestic investing firms, which may further hurt domestic investment via (i) the balance sheet channel, (ii) the stock market channel, (iii) the wealth effect through an adverse impact on domestic consumption. These outlined channels of business cycle transmission through FDI are related to the notions of technology spill-over, activities of multinational firms and financial integration in a more general sense (Otto et al. 2001, Jansen and Stockman 2004, Hsu *et al.* 2011).

Given the ambiguity of economic theory in this line of research, few empirical literatures emerged to study the different channels through which shock transmission across economies takes place. For instance, Frankel and Rose (1998) and Clark and van Wincoop (2001) find that countries with closer trade links tend to have more tightly correlated business cycles. Baxter and Kouparitsas (2005), while investigating the empirical relationship between trade links and business cycles, found that higher bilateral trade between two countries is robustly correlated with a higher business cycle correlation between them. Similar conclusion is drawn by Artis and Okubo (2011). In contrast to this, Gruben *et al.* (2002) and Inklaar *et al.* (2008) find smaller impact of trade integration than previously reported. Inklaar *et al.* (2005) find support for the role of bilateral trade intensity; although the authors stress that other factors such as policy coordination, financial integration and specialization are equally important. Likewise, Otto *et al.* (2001) confirm an important role for trade, a less robust performance by finance indicator, but insignificant role of policy coordination and specialization. Fidrmuc (2004) stresses that it is intra-industry trade which leads to synchronization; while Crosby (2003) suggests that intensity of trade do not explain the correlation at all. Midelfart *et al.* (2003) find: (i) monetary unification increases specialization; (ii) the size and relevance of industry-specific shocks is very small and does not raise the cost of monetary policy. Doyle and Faust (2005) show that despite the large increase in economic integration experienced by G7 countries, there does not exist any evidence of a significant shift in correlations; while Camacho *et al.* (2006) conclude that international economies have become less synchronized over the last 15 years. Moreover, Kalemli-Ozcan *et al.* (2001, 2003) provide empirical support for the hypothesis that financial integration, by promoting specialization, is conducive to less synchronized cycles. Using a simultaneous equation framework that accounts for the interactions between trade, finance, industrial specialization and output co-movements, Imbs (2004) concludes that financially integrated economies are more synchronized despite the fact that they are also more specialized. Hsu *et al.* (2011) employ a panel dataset of 77 developed country pairs and conclude that— (i) trade, FDI and monetary policy serve as important channels of international business cycle transmission; (ii) industrial dissimilarity has only an indirect impact on the business cycle correlation through trade and FDI. Finally, Dées and Zorell (2012) do not find any direct relationship between bilateral financial linkages and business cycle synchronization for the OECD economies. This clearly shows that the various proposed channels of shock transmission have been evaluated with mixed results.

Against this background, this study sets to examine the business cycle synchronisation using a 20 year panel data of 30 OECD countries. The study follows Imbs (2004) and Hsu *et al.* (2011) to empirically investigate the interactions between trade, specialisation patterns, monetary policy and FDI and their linkages with cyclical co-movements of sample economies. In the beginning, both the single equation and simultaneous equations estimations are applied on a 3-equation model using the panel data of 405 country-pairs.[4] Next, FDI is included as the other source of shock transmission, thereby making the model a 4-equation model. Same procedure, as that used in the 3-equation model, is followed to estimate the 4-equation model. However, because of the unavailability of bilateral FDI data for some countries, the number of country-pairs reduces to 105 in this case.[5] The main focus is to investigate the impact of bilateral trade, FDI, industrial dissimilarity and monetary policy on the business cycle correlation of sample economies. Bilateral trade is included as it is considered an important source of shock transmission across economies. Figure 1 and Figure 2 show, respectively, the exports and imports of goods and services as a share of GDP among the OECD countries including the world at different points of time.[6] For the world, the exports, as percentage of GDP, have increased from 19.20% (1990) to 25.78% (2009). Imports, as a share of GDP, have also increased by almost same percentage. So far as individual economies is concerned, Australia, Austria, Czech Republic, Denmark, Germany, Hungary, Iceland, Japan, Korea, Luxembourg, Mexico, Poland, Slovakia, Slovenia, Sweden, Switzerland, the UK, and the US show an increase in exports as a share of GDP; while Belgium, Canada, Estonia, Finland, France, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, and Spain show an increase in exports (as % of GDP) in the initial years but a decrease in the latter years. Imports also show almost the same trend with the exception of Austria, Finland, and the US. While Finland shows an increase in its imports as a share of GDP from 1990 through 2009, Austria and the US show a decrease in imports in year 2009

[4] Data on 30 OECD countries is used in the 3-equation model estimation. These are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, the UK, and the US. The remaining 4 OECD countries i.e., Turkey, New Zealand, Israel and Chile are left out because of unavailability of data on some variables.

[5] The sample countries used in the 4-equation model are: Austria, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, the UK, and the US.

[6] Data are obtained from the World Bank (2014) World Development Indicators. http://data.worldbank.org/indicator/NE.EXP.GNFS.ZS http://data.worldbank.org/indicator/NE.IMP.GNFS.ZS

compared to 2000. The interesting case is that of Luxembourg which shows both imports and exports are more than its GDP. This is the same

**[Figure 1 about here]**

**[Figure 2 about here]**

**[Figure 3 about here]**

**[Figure 4 about here]**

story as that of Singapore (not reported in this study). This may be because of the reason that imports are re-exported and exports are re-imported in the global value chain (GVC) and production networks. As far FDI flows are concerned, all the sample economies –except Switzerland- show an increase in FDI net inflows as a share of GDP in year 2000 compared to 1990 and a decrease in net FDI inflows (as % of GDP) in 2009 compared to 2000.[7] This is shown in Figure 3. The world net FDI inflows as share of GDP are 0.91% in 1990, 4.0% in 2000 and 2.13% in 2009, respectively. Figure 4 shows the net FDI outflows as a percentage of GDP compared for the years 2005, 2007 and 2009. This time period is chosen because of the data being available from 2005 onwards only. This is the period of global financial crisis. The economic recession arising from the global financial crisis is completely reflected in the decreasing trend of net FDI outflows across these economies over this period. In the case of the UK economy, the FDI net outflows even turn up negative in 2009. The fluctuating behaviour of both trade (exports and imports) and (inward and outward) FDI flows shows the important role that they could play in the cross-border business cycle co-movements and hence the incorporation of these variables in our model is justified. The notion of introducing capital flows is akin to the financial integration variable first considered in Imbs (2004) and

[7] Data on both FDI Net Inflows and FDI Net Outflows are obtained from the World Bank (2014) World Development Indicators. http://data.worldbank.org/indicator/BX.KLT.DINV.WD.GD.ZS http://data.worldbank.org/indicator/BM.KLT.DINV.GD.ZS

also in Inklaar *et al.* (2008). This article chooses to focus on the channel through FDI rather than through financial integration. The main objective is to estimate the total impact (both direct as well as indirect effect) of trade intensity, FDI, monetary policy and industrial dissimilarity on business cycle correlations of sample economies. And to carry out such an analysis, the study adopts simultaneous equations estimation panel data technique of error component three-stage least squares (EC3SLS) proposed by Baltagi (1981).

The contribution that this paper makes to the literature is manifold. First, it uses EC3SLS approach which can tackle the problem of endogeneity[8] and the indirect effects of each variable, thereby making it superior over other econometric techniques including the single equation estimation techniques of fixed effects (FE) and random effects (RE) model. However, for comparison purpose, in addition to 3SLS cross-sectional estimates, single equation estimates of FE and RE models are also reported in this study. Second, this paper is based on a rich data set, which makes it feasible to compare the extent of co-movement in economic activity within the OECD region. Besides, the use of panel data set helps to exploit more information and allows a better identification of the business cycles. Third, since there is no consensus on the important determinants of business-cycle co-movement (de Haan *et al.* 2008), probably because of the reason that there are many potential candidate explanations (Baxter and Kouparitsas 2005), this paper makes use of multiple macroeconomic variables to characterize business cycles. Such an approach can be traced back to the classical contribution of Burns and Mitchell (1946) and Zarnowitz (1992). Fourth, nowadays, in this new global framework, FDI might be one of the important sources of shock transmission across national borders as it may better explain the interdependencies, co-movements and exceptional behaviours among the national economies. Earlier studies have generally taken

[8] The study uses Durbin-Wu-Hausman test to check for endogeneity. In this study, 8 cases are checked for endogeneity: 4 are with time effects and 4 without time effects. Overall 5 out of 8 cases reject the null hypothesis of no endogeneity against the alternative hypothesis of the presence of endogeneity in the sample data set.

other proxies of financial integration and FDI has been largely ignored. This study explores the role that FDI might play in the cycle synchronization of sample economies. Last, Canova (1998) makes aware of the fact that applying different filters to output may 'extract different types of information', this study uses three different measures of output to construct the business cycle correlation variable. The use of these various measures of output will help to figure out whether results are sensitive to a particular type of output measure (Canova and Dellas 1993).

The paper is structured as follows. Section 2 discusses the econometric model, the formulation of variables along with their sources of data, and the empirical strategy used in the study. Section 3 analyses the estimated results derived from the 3-equation model and the 4-equation model. Finally, Section 4 offers some concluding remarks.

## 2. The econometric model

### *2.1. Model specification and data*

In order to investigate the relationship that exists among trade intensity (T), industrial dissimilarity (ID) and business cycle correlation ( $\rho$ ), the study estimates the following 3-equation model as given below:

$$\rho_{i,j,t} = \alpha_0 + \alpha_1 T_{i,j,t} + \alpha_2 ID_{i,j,t} + \alpha_3 I_{1,i,j,t} + \mu_{1,i,j} + \varepsilon_{1,i,j,t} \quad (1)$$

$$T_{i,j,t} = \beta_0 + \beta_1 ID_{i,j,t} + \beta_2 I_{2,\mathrm{i,j,t}} + \mu_{2,i,j} + \varepsilon_{2,i,j,t} \quad (2)$$

$$ID_{i,j,t} = \gamma_0 + \gamma_1 T_{i,j,t} + \gamma_2 I_{3,i,j,t} + \mu_{3,i,j} + \varepsilon_{3,i,j,t} \quad (3)$$

The inclusion of FDI variable develops the above system of equations into a 4-equation model as given below:

$$\rho_{i,j,t} = \alpha_0 + \alpha_1 T_{i,j,t} + \alpha_2 ID_{i,j,t} + \alpha_3 FDI_{i,j,t} + \alpha_4 I_{1,i,j,t} + \mu_{1,i,j} + \varepsilon_{1,i,j,t} \quad (4)$$

$$T_{i,j,t} = \beta_0 + \beta_1 ID_{i,j,t} + \beta_2 FDI_{i,j,t} + \beta_3 I_{2,\mathrm{i,j,t}} + \mu_{2,i,j} + \varepsilon_{2,i,j,t} \quad (5)$$

$$ID_{i,j,t} = \gamma_0 + \gamma_1 T_{i,j,t} + \gamma_2 FDI_{i,j,t} + \gamma_3 I_{3,i,j,t} + \mu_{3,i,j} + \varepsilon_{3,i,j,t} \quad (6)$$

$$FDI_{i,j,t} = \lambda_0 + \lambda_1 T_{i,j,t} + \lambda_2 ID_{i,j,t} + \lambda_3 I_{4,i,j,t} + \mu_{4,i,j} + \varepsilon_{4,i,j,t} \quad (7)$$

Where, *i, j, t* are the values of index country pairs (*i, j*) in year *t*. $\mu$ is the time-invariant country-pair specific term used to control for individual heterogeneity [9] and $\varepsilon$ is an idiosyncratic random error. Vectors $I_1$, $I_2$, $I_3$, and $I_4$ contain exogenous variables that are employed in the system in order to achieve identification.[10] While the exogenous variable set $I_1$ includes a measure of the similarity of the monetary policies between the two countries, the exogenous variable set $I_2$ comprises a set of 'gravity' variables. These gravity variables include: dummy for a common official language which equals 1 when both the countries share a common language and 0 otherwise; the geographic distance between the two countries' capitals measured using *Great Circle* formula; a dummy for land adjacency which has a value of 1 when two countries share common border and 0 otherwise; and, the log of the ratio of GDPs of the two countries (GDP_gap variable). Monetary policy closeness between a country-pair is measured as the correlation of short-term interest rates between these two countries.[11] Data on the gravity variables is collected from *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII) database. $I_3$ contains the GDP_gap

[9] For these pair-specific terms, Hausman specification test is used to detect whether the differences across the units are constant (fixed effects model) or whether the terms are randomly drawn from a large population (random effects model).

[10] For identification of the model, I check the following two conditions. (1) *Order Condition*: Every equation should satisfy the condition of $K - M \geq G - 1$, where $K$ is the total number of variables (both exogenous and endogenous) in the model, $M$ is the total number of variables in one particular equation, and $G$ is the total number of equations in the model. (2) *Rank Condition*: Every equation should satisfy the condition that the rank of the matrix of parameter coefficients left after deleting the row of the endogenous variable and the columns of all the variables existing in that particular equation should be greater than or equal to $G - 1$.

[11] Data on the short-term interest rates is collected from International Financial Statistics (IFS) CD_ROM of the IMF using money market rates. Wherever money market rate data is not available the gap is filled using call money rate data or discount rate (end of period). In the case of the US, federal funds rate is used to achieve correlation of short-term interest rates in place of money market rate. All kinds of data come from IFS CD_ROM.

variable and the log of the product of GDPs (GDP_product) of the two countries. Last, the exogenous variable set $I_4$ consists of a dummy for common legal origin in the two countries and a monetary policy closeness variable. The dummy variable of legal origin equals unity when both the countries share same legal origins and the data for this variable is available on La Porta *et al.* (1998). The complete system of 3-equation model and 4-equation model can then be represented by equations (8) and (9), respectively, as

$$\begin{bmatrix} \rho \\ T \\ ID \end{bmatrix} = \begin{bmatrix} \alpha_0 & \alpha_1 & \alpha_2 & \alpha_3 & 0 & 0 & 0 & 0 & 0 \\ \beta_0 & 0 & \beta_1 & 0 & \beta_2 & \beta_3 & \beta_4 & \beta_5 & 0 \\ \gamma_0 & \gamma_1 & 0 & 0 & 0 & 0 & 0 & \gamma_2 & \gamma_3 \end{bmatrix} \begin{bmatrix} 1 \\ T \\ ID \\ MP \\ Language \\ Distance \\ Adjacency \\ GDP\ gap \\ GDP\ product \end{bmatrix} + \begin{bmatrix} \mu_{1,i,j} \\ \mu_{2,i,j} \\ \mu_{3,i,j} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,i,j,t} \\ \varepsilon_{2,i,j,t} \\ \varepsilon_{3,i,j,t} \end{bmatrix} \qquad (8)$$

$$\begin{bmatrix} \rho \\ T \\ ID \\ FDI \end{bmatrix} = \begin{bmatrix} \alpha_0 & \alpha_1 & \alpha_2 & \alpha_3 & \alpha_4 & 0 & 0 & 0 & 0 & 0 & 0 \\ \beta_0 & 0 & \beta_1 & \beta_2 & 0 & \beta_3 & \beta_4 & \beta_5 & \beta_6 & 0 & 0 \\ \gamma_0 & \gamma_1 & 0 & \gamma_2 & 0 & 0 & 0 & 0 & \gamma_3 & \gamma_4 & 0 \\ \lambda_0 & \lambda_1 & \lambda_2 & 0 & \lambda_3 & 0 & 0 & 0 & 0 & 0 & \lambda_4 \end{bmatrix} \begin{bmatrix} 1 \\ T \\ ID \\ FDI \\ MP \\ Language \\ Distance \\ Adjacency \\ GDP\ gap \\ GDP\ product \\ LO \end{bmatrix} + \begin{bmatrix} \mu_{1,i,j} \\ \mu_{2,i,j} \\ \mu_{3,i,j} \\ \mu_{4,i,j} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,i,j,t} \\ \varepsilon_{2,i,j,t} \\ \varepsilon_{3,i,j,t} \\ \varepsilon_{4,i,j,t} \end{bmatrix} \qquad (9)$$

Coming to the measures of key variables used in the system of equations, let us first explain the business cycle correlation variable. In this analysis, three different measures of output are used to construct the business cycle correlation variable. These measures are as follows. First is the ‘HP-filtered output’ which is measured as the natural logarithm of real GDP, detrended with a Hodrick and Prescott (1997) filter, and is denoted as $\rho_{HP}$. Second is the 'CF-filtered output,' measured in the same way as that of HP-filtered output. However, in this measure of output, the natural logarithm of real GDP is detrended using the Christiano and Fitzgerald (2003) band-pass filter. It is denoted as $\rho_{CF}$. The third measure of output is the annual growth rate of real GDP, referred as 'First-differenced output,' and is denoted as $\rho_{FD}$. $\rho_{HP}$ and $\rho_{FD}$ are included as they have become the standard ones and have also been used by earlier important studies including Hsu *et al.* (2011). $\rho_{CF}$ is included because of being more efficient in extracting the undesired periods in the time series. Besides, it is considered more close to an ideal filter among the class of band-pass filters (Grochová and Rozmahel 2015). The various measures of output will serve as to check whether results are sensitive to a particular type of output measure (Canova and Dellas 1993). The annual data for real GDP covering the period 1990 to 2009 is taken from the World Bank's World Development Indicators and is measured in 2005 constant US dollars.

Bilateral trade intensity ($T_{i,j,t}$) used in this analysis is defined as

$$T_{i,j,t} = \frac{x_{i,j,t} + m_{i,j,t} + x_{j,i,t} + m_{j,i,t}}{X_{i,t} + M_{i,t} + X_{j,t} + M_{j,t}} \tag{10}$$

Where, $x_{i,j,t}$ ($x_{j,i,t}$) is the value of exports from country *i* (country *j*) to country *j* (country *i*) in year *t*; $m_{i,j,t}$ ($m_{j,i,t}$) is the value of the imports of country *i* (country *j*) from country *j* (country *i*) in year *t*; $X_{i,t}$ and $X_{j,t}$ are the values of country *i*'s exports and country *j*'s exports to all countries in year *t*, respectively. Similarly, $M_{i,t}$ and $M_{j,t}$ are the values of country *i*'s imports and country *j*'s imports, respectively, from the whole world in year *t*. In this measure of trade intensity index, both $x_{i,j,t}$ and $m_{j,i,t}$ are retained because $x_{i,j,t} \neq m_{j,i,t}$.[12] It has also become the standard trade intensity index in the recent years as it saves from understating actual trade flows, a concern acknowledged by Frankel and Rose (1998). A higher value of $T_{i,j,t}$ indicates a greater trade intensity between countries *i* and *j*. The annual export and import data is extracted from Direction of Trade Statistics (DOTS) CD_ROM of International Monetary Fund and is measured in current US dollars.

Industrial dissimilarity measure is created in the same way as that built by Hsu et al. (2011) and is given below.

$$ID_{i,j,t} = \sum_{k}^{K} \left| S_{k,i,t} - S_{k,j,t} \right| \qquad (11)$$

Where, $S_{k,i,t}$ is the GDP share of industry *k* in country *i* in year *t*; and $S_{k,j,t}$ is the GDP share of industry *k* in country *j* in year *t*.[13] A larger value of $ID_{i,j,t}$ indicates a greater degree of industrial dissimilarity in industrial structure. This indicator uses manufacturing sector value-added shares relative to total economy taken from the OECD (2012) STAN Indicators Rev. 4 Database.

Next, given the fact that there is no standard measure of bilateral FDI intensity, this (bilateral FDI intensity) index is measured on the same lines as that of bilateral trade intensity index and is shown below.

$$FDI_{i,j,t} = \frac{\text{Inward } fdi_{i,j,t} + \text{ Outward } fdi_{i,j,t} + \text{Inward } fdi_{j,i,t} + \text{Outward } fdi_{j,i,t}}{\text{Inward } FDI_{i,t} + \text{Outward } FDI_{i,t} + \text{Inward } FDI_{j,t} + \text{Outward } FDI_{j,t}} \qquad (12)$$

[12] One reason that $x_{i,j,t} \neq m_{j,i,t}$ may be that IMF Direction of Trade Statistics reports exporting country data 'free-on-board' (fob) with the corresponding import data reported by the importer inclusive of the 'costs of insurance and freight' (cif).

[13] This measure was first suggested by Krugman (1991).

The data on bilateral inward and outward FDI flows is collected from the OECD (2014) International Direct Investment Statistics.

Equation (1) illustrates the major determinants of output synchronization. As mentioned in the introduction, the sample dataset consists of highly developed countries and in order to be consistent with our intuition, it needs to be the case of positive relationship between trade intensity and business cycle co-movements. Therefore, the value of $\alpha_1$ should be greater than zero, which is confirmed in most of the estimated results. Positive sign of $\alpha_1$ means that closer trade ties among these OECD countries result in more synchronized business cycle co-movements because common disturbances are more prevalent and intra-industry trade dominates. As far the sign of $\alpha_2$ is concerned, we expect a negative relationship between industrial dissimilarity and output correlation if business cycles are driven by industry-specific shocks. Therefore, it should be the case of $\alpha_2 < 0$. In other words, countries with greater similarities in their industrial structure tend to move together. Equations (2) and (3) are for bilateral trade and industrial dissimilarity, respectively. Classical Ricardian theory predicts a positive linkage between trade and specialisation, which means that industrial dissimilarities generate more trade (Dornbusch *et al.* 1977, Balassa 1986). This implies $\beta_1$ and/or $\gamma_1$ need to be greater than zero. This happens when trade leads to industry fragmentation. However, if trade leads to industry concentration, then $\gamma_1$ is expected to be less than zero.

Equations (4) – (7) are an extension of the above 3-equation model. Here, bilateral FDI —in addition to output correlation, industrial dissimilarity, and trade intensity— is also included as a possible channel of shock transmission. As emphasized in the Introduction, FDI can transmit shocks across economies through various channels such as technology, or its connection with international financial markets through the process of reallocation of capital. This study includes bilateral FDI flows as a proxy for financial integration. So far as 4-equation model is concerned, we believe that in the current times of economic globalisation, FDI is an important carrier of disturbances across national boundaries. Hence, it is a case of $\alpha_3 > 0$. That is, FDI and output co-movements are expected to have a positive relationship. Regarding the sign of $\beta_2$, we expect it to be positive because bilateral trade and FDI flows are likely to be governed by common characteristics that are specific to the country-pair. Such a relationship is also supported by the EC3SLS estimates. Since the relationship between bilateral trade and FDI intensity is very complex, it needs more description. It depends on the nature of FDI flows. In their study, Hsu *et al.* (2011) distinguish between two kinds of FDI —horizontal FDI and vertical FDI. Horizontal FDI flows occur among the countries when multiple-plant firms undertake the same production activities in multiple countries, while vertical FDI takes place when firms locate different stages of production in different countries (Markusen and Maskus 2001). Under horizontal FDI, host firms indulge in producing homogeneous goods with the sole purpose to capture overseas market and avoid high transportation costs; vertical FDI is directed by relative factor prices which could boost trade. Hence, a negative sign of $\beta_2$ is expected if horizontal FDI prevails, while in the latter case, $\beta_2$ should be positive. The sign of $\lambda_2$ is governed by the same principle as that of $\gamma_1$. If FDI leads to industry fragmentation, we get $\lambda_2 > 0$; if it leads to industry concentration, we observe $\lambda_2 < 0$. This makes, in general, the sign of $\lambda_2$ ambiguous. The ambiguity is also supported by the absence of any rigorous theory dealing with the relationship between FDI and specialisation.

As far exogenous variables are concerned, we expect the coefficient of monetary policy variable, i.e., $\alpha_3$ of 3-equation model or $\alpha_4$ of 4-equation model to be greater than zero. This is because of the fact that similar economic structures and the underlying disturbances may give rise to similar monetary policy behaviour (Otto *et al.* 2001). Even Frankel and Rose (1998) emphasize the role of similar monetary policies in explaining the high output correlation among European economies. Thus, $I_1$ controls for the possibility of a common shock to both economies from an external source (Hsu *et al.* 2011). Also, two countries which are highly integrated through FDI and which share similar monetary policy objectives might transmit the idiosyncratic shock occurring in one country to the other country's real activities via FDI channel, thereby giving $\lambda_3 > 0$. The gravity variables are included as they play an important role in explaining the trade flows between the two countries. The huge literature available on the 'gravity model of international trade' governs us about the signs of these variables. Therefore, we expect $\beta_3 > 0$, $\beta_4 < 0$, and $\beta_5 > 0$. La Porta *et al.* (2008) emphasize the important role of 'legal origin' in forming government infrastructure and financial development because countries with similar legal systems may have more integrated financial markets and corporate regulations. This might 'contagion' the financial shocks between countries. We have $\lambda_4 > 0$. Following Imbs (2004), two exogenous determinants of specialisation —the log of the ratio of two countries GDPs and the log of the product of two countries GDPs— are used in equation (3) in order to achieve identification. These two variables are expected to affect the patterns of specialisation. According to Imbs and Wacziarg (2003), there exist a non-monotonic relationship between per capita income and the stages of specialization. As income per capita grows, economies initially diversify by spreading their economic activities more equally across sectors, but start specializing at higher levels of development or income per capita. Since our sample data comprises highly developed OECD economies, therefore we expect a positive relationship between specialisation and the measures of income per capita. In other words, pairs of countries at different stages of development, as measured by the gap between their GDPs, tend to display different economic structures. It sums up to saying that a negative relationship should exist between industrial dissimilarity and GDP_gap, GDP_product in our case.

### *2.2. Econometric methodology*

This study uses both the single equation and simultaneous equations estimation methods. At the first stage of analysis, single equation techniques of fixed effects and random effects are applied for pair-specific effects. A Hausman specification test is used to check the appropriateness of RE null hypothesis against the FE alternative hypothesis. The main focus of this study is the estimation of simultaneous equations model using error component three-stage least square (EC3SLS) estimation method proposed by Baltagi (1981). The use of this procedure allows efficient estimation in models with panel data. More details about these panel data econometric techniques can be found in Baltagi (2008).

Both the single equation and simultaneous equations EC3SLS estimation methods adopt the panel data approach, which incorporates the cross-sectional and the time-series information as well. Such an advantage of panel data is even reflected in the estimated results of panel data being superior over cross-sectional 3SLS regression estimates.

In the beginning, bilateral correlations of business cycles are computed on the basis of the cyclical component of annual real GDP data, isolated using the Hodrick-Prescott (1997) filter and Band-Pass filter introduced by Christiano and Fitzgerald (2003). Time series are filtered to remove unwanted characteristics such as trends and seasonal components. This will help to estimate components driven by stochastic cycles from a specified range of periods. The main purpose is to estimate the business cycle component of the macroeconomic variable of real GDP.

## 3. Empirical results

Since we have bilateral FDI data available only for 15 countries, we examine results separately under 3-equation model and 4-equation model.[14] Due to data availability, we collect annual observations over the period 1990–2009.[15] And to construct our panel dataset, we group the data into four time periods: 1990–1994, 1995–1999, 2000–2004, and 2005-2009. We take average of each data group resulting in four observations for each country-pair.[16] Table 1 reports the unconditional correlations and summary statistics for all the variables (both exogenous and endogenous) in the system. We find that both trade and FDI are positively correlated with two measures of cycle synchronization i.e., CF-filtered output and First-differenced output, but negatively correlated with HP-filtered measure of output. Also, in contrast to Hsu *et al.* (2011), the correlation of cycle synchronization with trade is larger than that with FDI. This might imply that the cross-border shock transmission mechanism from trade is more influential than that from the channel of FDI over the sample period 1990–2009. It is noted that industrial dissimilarity is negatively correlated with all the correlation measures of output, and positively correlated with bilateral trade and FDI. Also monetary policy has positive correlation with all the variables, except FDI, distance and GDP_product; while Distance shows negative correlation with all the variables, except GDP_product. The pair-wise correlation coefficients of other variables, viz., adjacency, legal origin, common language, GDP_gap and GDP_product are also reported.

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[14] The 30 OECD countries used in our sample dataset of 3-equation model produce $N \times (N-1)/2 = 435$ country-pairs. The limitation of unavailability of bilateral FDI data for Australia, Belgium, Canada, Czech Republic, Estonia, Finland, Greece, Hungary, Iceland, Ireland, Korea, Luxembourg, Mexico, Slovakia, and Slovenia reduces the number of country-pairs in the 4-equation model to $N \times (N-1)/2 = 105$. While the number of sample observation in the former case is 1740, the number reduces to 420 in the 4-equation model.

[15] The data on manufacturing sector value-added shares relative to total economy taken from the OECD (2012) STAN Indicators Rev. 4 Database is not available after 2009. Hence we are prevented from expanding our sample to include data for more recent years.

[16] One advantage of averaged data groups is that it reduces the chances of the presence of autocorrelation in the data series.

In the beginning, for comparison purpose, we consider the cross-sectional regression estimates for the time-averaged data over the period 1990–2009. The estimated results are reported in Table 2. First column of Table 2 shows the results of the ordinary

**[Table 1 about here]**

**[Table 2 about here]**

least squares (OLS) estimation on a larger dataset of 435 country-pairs when the FDI variable is not included, while the third column of Table 2 shows the OLS regression results when FDI is also included in the model. That is, the results of column 3 correspond to the 4-equation model OLS results. Column 1 of Table 2 suggests that a higher bilateral trade between two countries is associated with more correlated business cycles only in the case of HP-filtered output and First-differenced output; while column 3 of Table 2 shows that industrial similarity can enhance business cycle co-movement only in these two measures of output. Also, monetary policy closeness is significant only in the regression excluding FDI. These OLS estimates need to be explored more as most of the results (the relationship between trade and industrial dissimilarity or the impact of FDI on output co-movements in the regression including FDI, etc.) in columns 1 and 3 of Table 2 are insignificant. Such results are hard to reconcile with trade theories and the main findings documented in many earlier studies. The possible reason may be that OLS method ignores the endogeneity problem and thereby leads to estimation bias and inconsistency.

### *3.1. 3-Equation Model estimates*

This section uses Model (8) to investigate the relationship between trade, industrial dissimilarity and business cycle co-movements. The model is estimated with the single equation approach (results reported in Table 4) and the simultaneous equations approach (results reported in Table 5). The purpose of presenting the single equation estimates of fixed effects and random effects model is to compare them with those from models free of endogeneity bias. A Hausman test is used to choose the appropriate model between the FE and RE specifications. A statistically significant test statistic indicates that the RE specification is rejected against the FE alternative. Besides, 3SLS simultaneous equation estimates of cross-sectional regressions are also reported in Table 3 in order to compare panel data estimates with cross-section estimates. In Table 3, we find that bilateral trade and monetary policy have a positive and significant relationship with all the measures of output synchronisation, while industrial dissimilarity has a negative and significant relationship with all the measures of output correlation. This provides the evidence that: (1) closer bilateral trade relationship would contribute to business cycle synchronisation in a very strong way; (2) homogeneity in industrial structure is associated with highly-correlated business cycles between pairs of countries; and (3) monetary policy closeness help explain business cycle correlation. On the other hand, the relatively small coefficient of industrial dissimilarity in the trade equation weakly challenges the well perceived idea that industrial differences between two countries generate more trade between them (Balassa 1986). The empirical performance of so-named gravity variables in accounting for trade flows is in line with the gravity literature as these (gravity) variables show a high predictive power on trade flows. More specifically, the coefficients of distance and adjacency in Table 3 suggest that bilateral distance between two countries reduces the flow of trade between them, while two countries which share borders with each other will trade more. However, common language does not provide any significant impact on bilateral trade flows. The results also support the Classical Ricardian theory that there is a positive linkage between trade and specialisation. This is shown by the positive and significant coefficient of trade in Panel C of Table 3. However, contrary to our expectation, the two proxy variables– GDP_gap and GDP_product–

determining the development stages of industrial specialisation are significantly positive, thereby suggesting that these highly developed economies have diversified even at higher levels of income.

**[Table 3 about here]**

Coming to panel data, the results in Table 4 are for single equations that consider fixed effects or random effects, and with or without time effects. Panels A1, A2 and A3 are results for the single equation of output correlation, using either HP-filtered or CF-filtered or first-differenced output measures. In Panels A1, A2, and A3, the Hausman test rejects the null hypothesis of random effects in all the 6 cases at 1% significance level. However, to our surprise, trade has significant effect on output correlation in only 1 out of these 6 cases at 5% significance level, and that too the impact is now reversed (Panel B fixed effect model estimates with time effects). Industrial dissimilarity has negative impact on output co-movements when only time effects are not taken into consideration. Also, now monetary policy closeness help explain business cycle correlation in only 3 out of 6 cases at 5% significance. Panel B is the trade equation. In this equation, the Hausman test favours random effects specification in both the cases. However, the results suggest that homogeneity in industrial structure promote trade only when time effects are considered in the model. Except adjacency, the gravity variables now show a very low predictive power on trade flows. In panel C of Table 4 we find that the fixed effect estimates favoured by Hausman test support a positive association between trade and specialisation. Also, in contrast to the cross-sectional estimates, the two exogenous variables GDP_gap and GDP_product have a negative and significant impact on industrial dissimilarity in 3 out of 4 cases. In sum, most of the results of single equation estimation do not confirm with the existing literature, the possible reason may be the presence of endogeneity bias in these single equation estimates. This demands simultaneous equations estimation of the equations (1) – (3).

Table 5 displays the error component three-stage least squares (EC3SLS) estimates of the 3-equation model. The total number of model specifications related to output correlation is six (three without time effects and the other three specifications with time effects). The advantage of using this procedure of simultaneous equation approach is that the estimates are consistent even when the dependent variables are endogenous. The main results reported in Table 5 can be summarized as follows. First, the impact of trade intensity on the business cycle synchronization of sample countries is positive, significant, and of substantial magnitude. Intuitively, this empirical evidence of closer trade links associated with tightly correlated business cycles suggests that international trade patterns and international business cycle correlations are endogenous. That is, a country is more likely to satisfy the criteria for entry into a currency union *ex-post* than *ex-ante*. Second, the industrial dissimilarity is better able to explain the business cycles synchronization in five out of six cases. The negatively significant industrial dissimilarity coefficients are compatible with the perception that business cycle disturbances are mainly industry-specific. Third, in

**[Table 4 about here]**

**[Table 5 about here]**

contrast to Hsu *et al.* (2011), monetary policy has a direct and positive impact on the business cycle synchronization. Fourth, in Panel B, trade and industrial dissimilarity are not statistically related to each other in many model specifications. Basically, this finding is inconsistent with the prediction of economic theories. However, in Panel C, trade has a positive and significant impact on industrial dissimilarity. Fifth, all the gravity variables have the expected sign. Last, the two proxy variables determining the development stages of industrial specialization become statistically insignificant now. This is in sharp contrast to the significant findings in the single equation fixed effect estimates, as reported in Panel C of Table (4).

### *3.2. 4-Equation Model estimates*

Given the above evidence that trade is positively linked with business cycle correlation, the other question raised in this paper is to check whether FDI provides another crucial channel on transmitting shocks between countries. FDI is included in the model as it is expected to be an important source of shock transmission across borders in the current period of globalisation. Besides, FDI capital flows serve a better proxy of financial integration. In Tables (6) and (7), we report the 3SLS cross-sectional estimates and single equation panel data estimates when FDI is also included in the model. Table (8) reports the EC3SLS estimates of the 4-equation model with panel data. A birds-eye inspection of the estimation results reveals that these estimates now become sensitive to the type of output measure used in estimating the model (Canova and Dellas 1993). Table (6) produces results which are hard to reconcile with the existing empirical literature. In most of the specifications the variables are insignificant. Even the variables which are significant have changed their sign. For instance, industrial dissimilarity is the only significant variable (but with a positive sign) in all the specifications of Panel A; trade is significant only in first-differenced output measure —but with a negative sign; in Panel B, distance does not influence trade; in Panel C, trade does not lead to specialization; however, FDI and trade show a positive relationship in Panel D.

**[Table 6 about here]**

In Table (7), the Hausman test in Panels A1, A2, and A3 favours fixed effects specification at 5% level of significance when time effects are ignored, but in the presence of time effects the fixed effects specification is rejected in favour of random effects specification. In the FE specification, trade has a significant but negative impact at 5% significance in Panels A1 and A2, industrial dissimilarity has a significantly negative impact on output

**[Table 7 about here]**

**[Table 8 about here]**

correlation in Panels A1 and A3, monetary policy variable has a positive and significant impact in Panels A1 and A3; while in the RE specification, the only significant variable is monetary policy. Panels B and C of Table (7) are the trade equation and specialisation-in-production equation, respectively. In these Panels the null hypothesis of random effects is rejected. From the results of FE specification of Panel B, it is clear that FDI and industrial dissimilarity are positively linked with trade. In Panel C, trade is positively linked with specialization in the absence of time effects. Panel D is the bilateral FDI flows equation which suggests that bilateral trade has a positive, significant and sizeable impact on FDI capital flows. In short, Table (6) and Table (7) produce very weird results in most of the cases. This might be because of the presence of endogeneity bias in the single equation estimates and less efficient 3SLS method which fails to use the dynamic information embedded in the panel data.

With the EC3SLS estimates of Table (8), we find that the channels of trade, FDI, production specialization and monetary policy closeness are more or less equally important in explaining the business cycle correlation. This is more discernible in the case of CF-filtered output correlation, with trade intensity and monetary policy closeness showing a positive relation, while FDI flows and industrial dissimilarity report a negative relation. Although $\alpha_1$ and $\alpha_2$ of Model (9) corresponding to the coefficients of trade intensity and industrial dissimilarity have expected signs, the sign of $\alpha_3$ corresponding to FDI flows is in contrast to our intuition that intensive FDI activities could contribute to output co-movements similar to the way in which trade activities would. Also, unlike the 3SLS cross-sectional estimates which suggest that monetary policy plays only a trivial role in determining output correlation, the EC3SLS estimates show that monetary policy closeness contributes to output co-movements as a separate channel of shock transmission.

Panels B and C of Table (8) are for the trade equation and production specialization. In Panel B, the coefficient of industrial dissimilarity is positive and significant at 1% level. This is consistent with the argument that countries with different industrial structures will enjoy an abundance of inter-industry trade (Ricardian-type trade). But in contrast to the finding of Hsu et al. (2011), the coefficient of FDI (i.e., $\beta_2$) is positive and highly significant in all the 6 specifications. This means more FDI encourages more trade and is therefore of the vertical type. That is, trade and FDI complement each other. Such a finding contrasts the views of Markusen and Maskus (2001). The 'gravity variables' which supply the DNA of 'geography of trade' have the expected signs. For example, more geographic distance between two countries reduces their bilateral trade because the transportation cost is high. For the same reason, adjacency boosts trade. Coming to Panel C of Table (8), as far signs of $\gamma_1$ and $\gamma_2$ are concerned, the Classical Ricardian theory expects $\gamma_1 > 0$ which is what has been obtained in the estimated results, i.e., trade and specialization are positively linked to each other. However, there is no rigorous theory which talks about the relationship between FDI and specialization. In our case, it is negative and significant at conventional levels. Among the two proxy variables determining the development stages of industrial specialization, GDP_gap shows a negative and significant relationship with industrial dissimilarity at conventional levels. This finding is in harmony to our expectation that these highly developed countries have specialized (in production) as these economies have already reached the higher stages of economic development.

Panel D of Table (8) displays the results for the FDI equation. In this equation, the coefficient of trade, $\lambda_1$, is expected to be positive if bilateral trade is able to promote FDI between two countries. This proposition is supported by the significantly positive coefficients of trade across all the specifications in Panel D of Table (8), which also confirms the intuition that closer trade ties could bring in more FDI when these two activities are likely to be affected by common institutional factors or infrastructure attributes given a country-pair. Even the same results regarding the impact of trade on FDI flows are obtained in Table (6) and Table (7) of this study. Furthermore, specialisation in production (industrial dissimilarity) has a negative and significant impact on FDI variable. Although this finding is same as that obtained by Hsu *et al.* (2011), there is no theoretical guidance on the relationship between production specialisation and FDI flows. On the other hand, as mentioned above, industrial dissimilarity is positively and significantly related to trade at 1% level across all the 6 specifications in Panel B of Table (8). One way to interpret such a result is that countries with similar industrial structures would trade less and engage in more FDI. In other words, trade occurs more intensively between countries that concentrate on different industries, while FDI develops more heavily for countries that share similar sectoral structures. Yet, the relationship is not so strong because of the small and negligible coefficients of $\beta_1$ and $\lambda_2$ of Model (9).[17] However, in contrast to Hsu *et al.* (2011), monetary policy closeness does not have any effect on FDI. Hence, monetary policy does not show any indirect impact on output correlation of the sample economies during the sample period. Also, legal origins do not have any significant impact on FDI flows. This result is in line with the finding of Hsu *et al.* (2011).

[17] With an objective to review the impact of monetary union on the spatial structure of economic activity in the European Union (EU), Midelfart *et al.* (2003) find the size of industry-specific shocks to be very small and argue that EMU is likely to promote a slight increase in specialization amongst the EU. However, such a small magnitude of industry-specific shocks is not going to pose any difficulty for macroeconomic management.

## 4. Conclusions

The main aim of this paper was to investigate the relationship between business cycle co-movement and a host of macroeconomic variables using a panel dataset on 30 OECD countries covering the period 1990 to 2009. The major findings are:

(i) Bilateral trade between two countries is positively and significantly correlated with business-cycle correlation between them. Since our sample data contains Euro-area countries also, therefore one implication of this finding is that if currency unions create trade, and trade increases cycle correlation, then perhaps countries should not be so concerned with ex-ante lack of business cycle correlation when deciding whether to enter into a currency union or not (Frankel and Rose 1998). An entry into a currency union may result in more highly correlated business cycles. This is a direct application of the celebrated Lucas Critique. Besides this conventionally-known trade channel, specialization-in-production (industrial dissimilarity), FDI, and monetary policy closeness serve other important channels for transmitting shocks from one country to another.

(ii) While industrial dissimilarity, like that of trade, has both direct and indirect impact on output correlation of OECD countries, FDI exhibits only an indirect impact on the business cycle synchronization of sample economies via trade and similarity in industrial structure. In Panel A of Table (8), FDI has a significant impact on output correlation only in the case of CF-filtered output, but no impact in the case of HP-filtered output and First-differenced output. Even in this case of CF-filtered output the impact is negative which suggests that FDI is a source of instability. This result is contrary to our expectation that FDI could help in the integration of economies. Such a finding becomes interesting in the sense of FDI being utilised in the right sense or not. Nonetheless, this requires further exploration and may provide a possible direction for future research.

(iii) The positive relationship between trade and industrial dissimilarity is consistent with the argument that countries with different industrial structures will enjoy an abundance of inter-industry trade. However, the small magnitude of industrial dissimilarity coefficient in the trade equation suggests that trade-induced specialization has but a weak effect on cycles synchronization. Also, trade intensity and FDI flows are positively and significantly related to each other. This means more FDI encourages more trade and *vice-versa*. That is, trade and FDI complement each other.

(iv) Monetary policy serves an important and independent source of shock transmission across the entire set of OECD countries. Such a conclusion is drawn from the positive and significant impact of monetary policy closeness variable on output correlation of OECD economies.

(v) Gravity variables suggest that 'bilateral distance' between a pair of countries reduces trade between them as it raises their transportation costs; 'adjacency' boosts trade; while 'common language' produces mixed results. Also, the two proxy variables for stages of economic development suggest that these industrial economies have specialized in production. Last, 'common legal origins' do not play any significant role in the business cycle synchronization of these OECD countries.

In short, the aim in writing this paper was to find out the major determinants of business cycle synchronization on a sample of highly developed OECD countries. In doing so, I hope that this study will provide a guidance for future empirical as well as theoretical investigations into the sources and propagation mechanisms of international business cycles.

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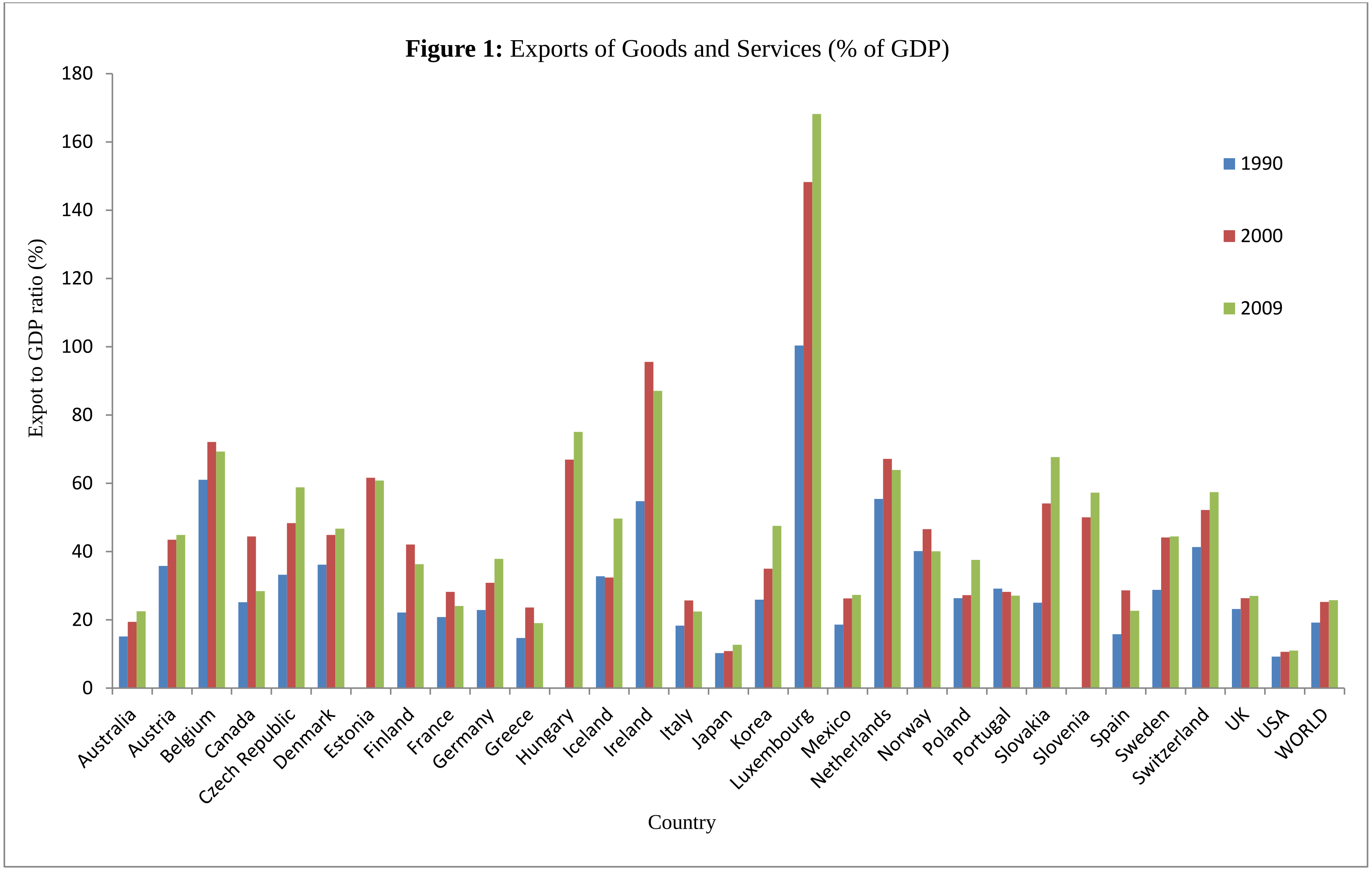
Figure 1: Exports of Goods and Services (% of GDP)
Expot to GDP ratio (%)
0
20
40
60
80
100
120
140
160
180
1990
2000
2009
Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Japan
Korea
Luxembourg
Mexico
Netherlands
Norway
Poland
Portugal
Slovakia
Slovenia
Spain
Sweden
Switzerland
UK
USA
WORLD
Country

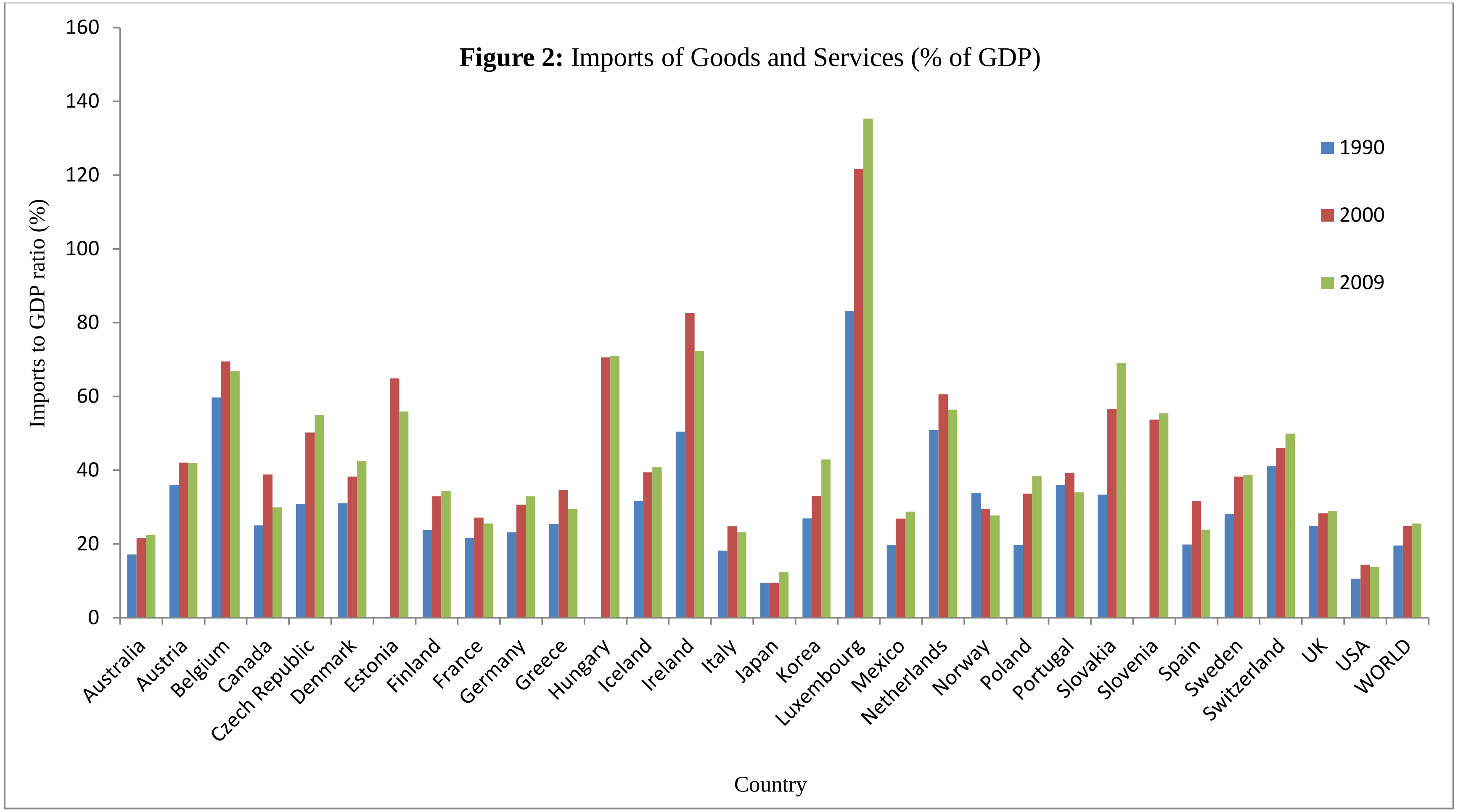

Figure 2: Imports of Goods and Services (% of GDP)
Imports to GDP ratio (%)
160
140
120
100
80
60
40
20
0
1990
2000
2009
Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Japan
Korea
Luxembourg
Mexico
Netherlands
Norway
Poland
Portugal
Slovakia
Slovenia
Spain
Sweden
Switzerland
UK
USA
WORLD
Country

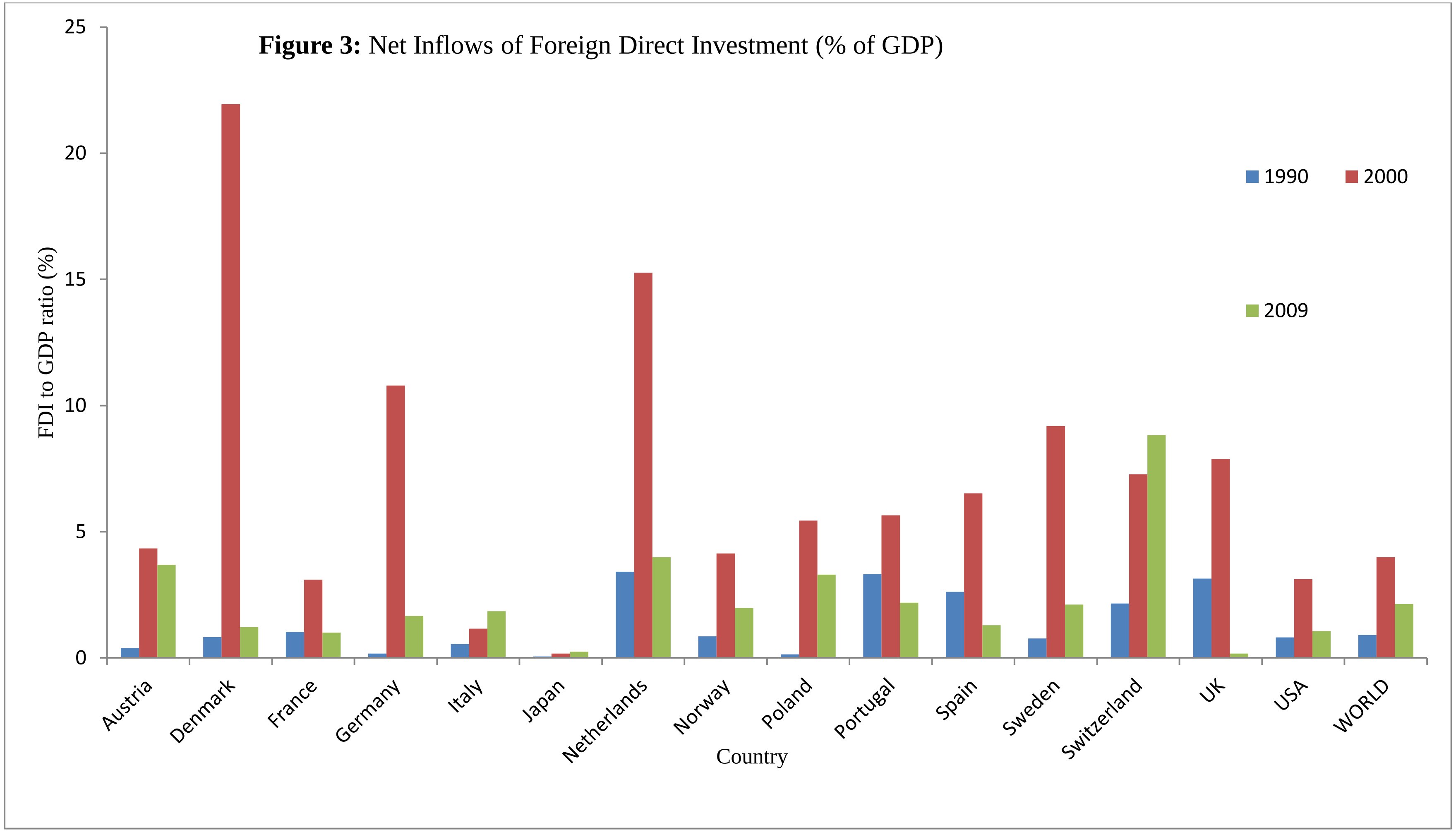
Figure 3: Net Inflows of Foreign Direct Investment (% of GDP)
FDI to GDP ratio (%)
25
20
15
10
5
0
1990
2000
2009
Austria
Denmark
France
Germany
Italy
Japan
Netherlands
Norway
Poland
Portugal
Spain
Sweden
Switzerland
UK
USA
WORLD
Country

**Figure 4:** Net Outflows of Foreign Direct Investment (% of GDP)

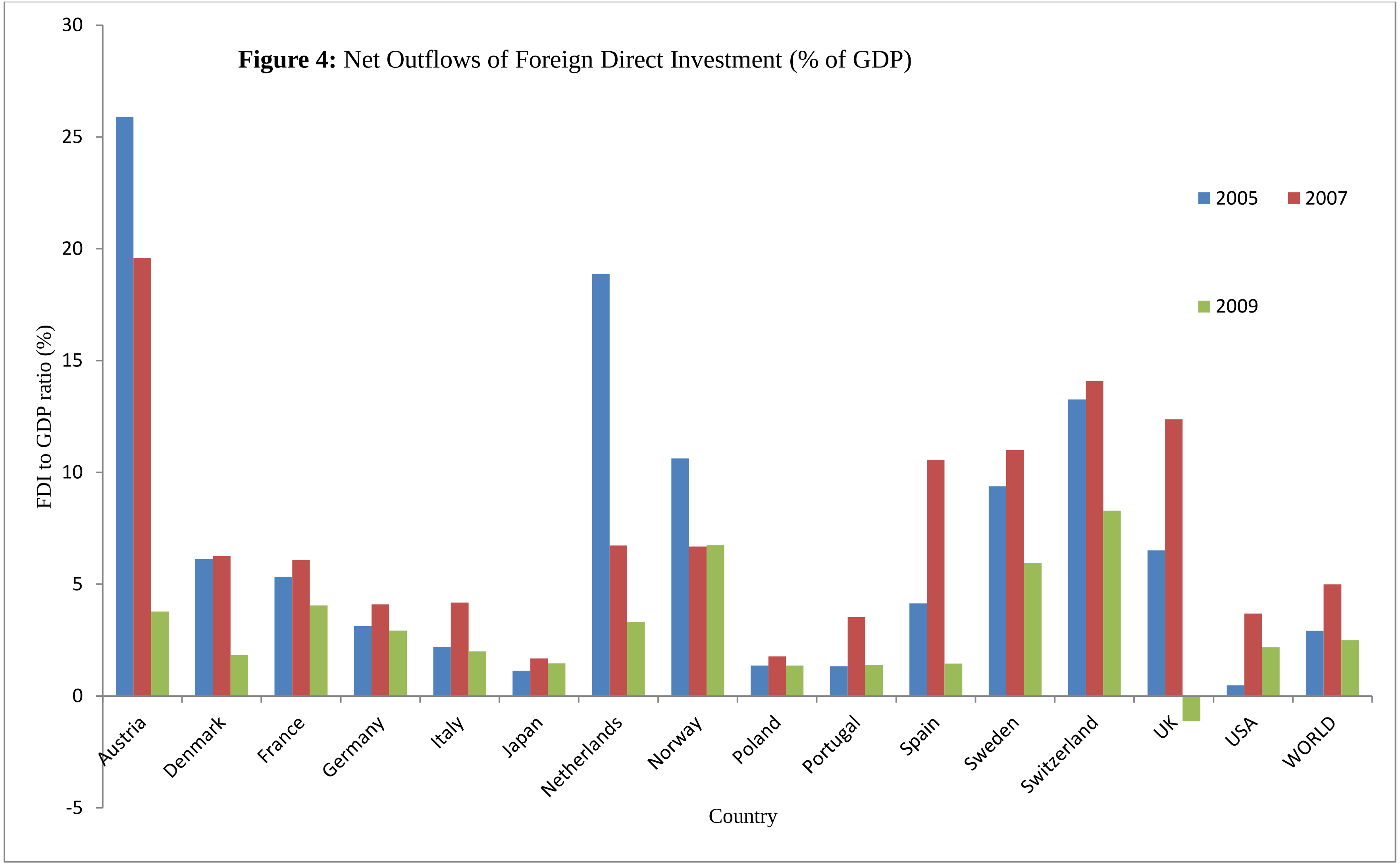

**Table 1: Summary statistics**

| | $\rho_{HP}$ | $\rho_{CF}$ | $\rho_{FD}$ | Trade | ID | FDI | MP | LO | Adjacency | Language | Distance | GDP_gap | GDP_product |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sample correlation between variables* | | | | | | | | | | | | | |
| $\rho_{HP}$ | 1.000 | | | | | | | | | | | | |
| $\rho_{CF}$ | 0.559* | 1.000 | | | | | | | | | | | |
| $\rho_{FD}$ | 0.692* | 0.487* | 1.000 | | | | | | | | | | |
| Trade | -0.031 | 0.035 | 0.069 | 1.000 | | | | | | | | | |
| ID | -0.065 | -0.035 | -0.126* | 0.101* | 1.000 | | | | | | | | |
| FDI | -0.015 | 0.004 | 0.014 | 0.642* | 0.014 | 1.000 | | | | | | | |
| MP | 0.207* | 0.097* | 0.277* | 0.089 | 0.082 | -0.033 | 1.000 | | | | | | |
| LO | 0.077 | 0.082 | 0.141* | 0.358* | 0.169* | 0.260* | 0.181* | 1.000 | | | | | |
| Adjacency | 0.083 | 0.110* | 0.097* | 0.543* | 0.155* | 0.177* | 0.108* | 0.309* | 1.000 | | | | |
| Language | 0.071 | 0.089 | 0.078 | 0.226* | 0.158* | 0.215* | 0.009 | 0.299* | 0.507* | 1.000 | | | |
| Distance | -0.283* | -0.216* | -0.163* | -0.235* | -0.048 | -0.022 | -0.133* | -0.089 | -0.296* | -0.112* | 1.000 | | |
| GDP_gap | -0.081 | -0.005 | 0.016 | 0.063 | -0.077 | -0.057 | 0.214* | 0.118* | 0.068 | 0.056 | -0.179* | 1.000 | |
| GDP_product | -0.222* | -0.086 | -0.017 | 0.348* | -0.033 | 0.396* | -0.031 | -0.003 | 0.01 | 0.056 | 0.606* | -0.196* | 1.000 |
| *Summary statistics* | | | | | | | | | | | | | |
| Mean | 0.566 | 0.446 | 0.477 | 0.031 | 13.137 | 0.03 | 0.574 | 0.19 | 0.133 | 0.057 | 3103.732 | -0.247 | 54.846 |
| Std. dev. | 0.504 | 0.597 | 0.522 | 0.032 | 5.126 | 0.042 | 0.346 | 0.393 | 0.34 | 0.232 | 3273.271 | 1.775 | 1.690 |
| Max. | 0.999 | 0.999 | 0.998 | 0.193 | 23.229 | 0.301 | 0.999 | 1 | 1 | 1 | 11034.52 | 3.298 | 59.389 |
| Min. | -0.962 | -0.977 | -0.982 | 0.001 | 0.577 | -0.072 | -0.521 | 0 | 0 | 0 | 379.175 | -4.198 | 51.621 |

Notes: * shows significance at 0.05

**Table 2: Single equation estimation with cross-sectional data**

| | excluding FDI | | including FDI | |
|---|---|---|---|---|
| *Panel A1: HP-filtered Correlation* | | | | |
| Trade | 1.091** | (0.468) | 0.574 | (0.951) |
| Industrial Dissimilarity | 0.001 | (0.003) | 0.015*** | (0.006) |
| FDI | | | 0.435 | (0.790) |
| Monetary Policy | 0.280*** | (0.058) | 0.114 | (0.104) |
| *Panel A2: CF-filtered Correlation* | | | | |
| Trade | 0.329 | (0.444) | -0.992 | (1.124) |
| Industrial Dissimilarity | -0.004 | (0.003) | 0.009 | (0.007) |
| FDI | | | 0.673 | (0.933) |
| Monetary Policy | 0.156*** | (0.055) | 0.002 | (0.123) |
| *Panel A3: First-differenced Correlation* | | | | |
| Trade | 1.197*** | (0.397) | 0.601 | (0.909) |
| Industrial Dissimilarity | 0.003 | (0.002) | 0.013** | (0.005) |
| FDI | | | 0.524 | (0.755) |
| Monetary Policy | 0.205*** | (0.049) | 0.236** | (0.100) |
| *Panel B: Trade* | | | | |
| Industrial Dissimilarity | 0.001 | (0.001) | 0.001 | (0.001) |
| FDI | | | 0.572*** | (0.046) |
| Language | 0.008 | (0.005) | -0.027*** | (0.008) |
| Distance | -5.02e-07* | (2.59E-07) | -8.32E-07 | (5.29E-07) |
| Adjacency | 0.050*** | (0.005) | 0.044*** | (0.006) |
| GDP gap | -0.001* | (0.001) | 0.001 | (0.001) |
| *Panel C: Industrial Dissimilarity* | | | | |
| Trade | 13.455 | (8.308) | 28.171 | (17.191) |
| FDI | | | -16.696 | (15.038) |
| GDP gap | -0.022 | (0.100) | -0.298 | (0.214) |
| GDP product | 0.017 | (0.042) | -0.048 | (0.252) |
| *Panel D: FDI* | | | | |
| Trade | | | 0.852*** | (0.086) |
| Industrial Dissimilarity | | | -0.001 | (0.001) |
| Monetary Policy | | | -0.027** | (0.013) |
| Legal Origin | | | 0.008 | (0.007) |

*Notes:* ***, **, and * report 1%, 5%, and 10% significance. Standard errors are in parenthesis. Constant estimates are not reported.

**Table 3: Simultaneous equation estimation with cross-sectional data: 3-Equation Model estimates**

| Output measure | HP-filtered | CF-filtered | First-differenced |
|---|---|---|---|
| *Panel A: Correlation* | | | |
| Trade | 18.126 (2.148)*** | 14.737 (1.717)*** | 13.660 (1.839)*** |
| Industrial Dissimilarity | -0.456 (0.0373)*** | -0.349 (0.034)*** | -0.381 (0.032)*** |
| Monetary Policy | 0.792 (0.101)*** | 0.533 (0.094)*** | 0.667 (0.087)*** |
| *Panel B: Trade* | | | |
| Industrial Dissimilarity | 0.011 (0.002)*** | 0.011 (0.002)*** | 0.011 (0.002)*** |
| Language | 0.005 (0.004) | 0.005 (0.004) | 0.005 (0.004) |
| Distance | -4.96e-07 (2.17e-07)** | -3.71e-07 (2.19e-07)* | -5.91e-07 (2.19e-07)*** |
| Adjacency | 0.023 (0.006)*** | 0.018 (0.006)*** | 0.027 (0.006)*** |
| GDP gap | -0.001 (0.001)*** | -0.002 (0.001)*** | -0.001 (0.000)** |
| *Panel C: Industrial Dissimilarity* | | | |
| Trade | 49.946 (10.322)*** | 63.056 (10.716)*** | 40.489 (10.494)*** |
| GDP gap | 0.111 (0.030)*** | 0.155 (0.036)*** | 0.097 (0.031)*** |
| GDP product | 0.052 (0.013)*** | 0.017 (0.015) | 0.076 (0.013)*** |

*Notes:* ***, **, and * report 1%, 5%, and 10% significance. Standard errors are in parenthesis. Constant estimates are not reported.

**Table 4: Single equation estimation with panel data excluding FDI**

| Time effects | No | | Yes | |
|---|---|---|---|---|
| | FE | RE | FE | RE |
| *Panel A1: HP-filtered Correlation* | | | | |
| Trade | -0.870 (2.195) | 0.622 (0.501) | -3.375 (2.081) | 0.661 (0.496) |
| ID | -0.032 (0.004)*** | -0.013 (0.002)*** | 0.003 (0.005) | -0.003 (0.003) |
| Monetary Policy | 0.259 (0.043)*** | 0.320 (0.036)*** | 0.124 (0.042)*** | 0.210 (0.036)*** |
| Hausman Test [prob > $\chi^2$ ] | $\chi^2$ (3) = 33.220 [0.000] | | $\chi^2$ (6) = 47.270 [0.000] | |
| *Panel A2: CF-filtered Correlation* | | | | |
| Trade | -2.130 (2.629) | 1.144 (0.552)** | -5.539 (2.356)** | 1.201 (0.503)** |
| ID | -0.023 (0.005)*** | -0.009 (0.003)*** | -0.001 (0.005) | -0.004 (0.003) |
| Monetary Policy | 0.101 (0.052)* | 0.145 (0.041)*** | 0.035 (0.048) | 0.096 (0.039)** |
| Hausman Test | $\chi^2$ (3) = 13.480 [0.004] | | $\chi^2$ (6) = 22.410 [0.001] | |
| *Panel A3: First-differenced Correlation* | | | | |
| Trade | -0.032 (1.976) | 1.012 (0.425)** | -3.196 (1.750)* | 1.103 (0.369)*** |
| ID | 0.046 (0.004)*** | -0.011 (0.002)*** | -0.001 (0.004) | 0.003 (0.002) |
| Monetary Policy | 0.221 (0.039)*** | 0.308 (0.033)*** | 0.054 (0.036) | 0.152 (0.029)*** |
| Hausman Test | $\chi^2$ (3) = 127.400 [0.000] | | $\chi^2$ (6) = 38.700 [0.000] | |
| *Panel B: Trade* | | | | |
| ID | -0.001 (0.000) | -6.30e-06 (0.001) | 0.001 (0.000)** | 0.001 (0.000)** |
| Language | | 0.005 (0.005) | | 0.006 (0.004) |
| Distance | 0.001 (0.000) | -4.58e-07 (2.54e-07)* | 0.000 (0.000) | -4.48e-07 (2.49e-07)* |
| Adjacency | | 0.052 (0.004)*** | | 0.052 (0.004)*** |
| GDP gap | -0.002 (0.002) | -0.001 (0.000)* | -0.001 (0.002) | -0.001 (0.001)* |
| Hausman Test | $\chi^2$ (3) = 1.400 [0.705] | | $\chi^2$ (6) = 2.840 [0.828] | |
| *Panel C: Industrial Dissimilarity* | | | | |
| Trade | 36.501 (13.473)*** | 30.699 (8.394)*** | 27.369 (12.271)** | 18.364 (7.391)** |
| GDP gap | -2.718 (0.851)*** | -0.028 (0.110) | -3.078 (0.775)*** | 0.057 (0.098) |
| GDP product | -4.915 (0.245)*** | -0.895 (0.113)*** | 3.772 (0.804)*** | -0.079 (0.108) |
| Hausman Test | $\chi^2$ (3) = 351.500 [0.000] | | $\chi^2$ (6) = 33.270 [0.000] | |

*Notes:* ID is the Industrial Dissimilarity.
Standard errors are in parenthesis.
Probability values in [ ].
Constant estimates are not reported.
*** 1% significance
** 5% significance
* 10% significance.

**Table 5: Simultaneous equation estimation with panel data: 3-Equation Model estimates**

| Output measure | HP-filtered | | CF-filtered | | First-differenced | |
|---|---|---|---|---|---|---|
| Time effects | No | Yes | No | Yes | No | Yes |
| *Panel A: Correlation* | | | | | | |
| Trade | 1.470 (0.498)*** | 1.492 (0.498)*** | 2.365 (0.563)*** | 2.320 (0.563)*** | 1.870 (0.434)*** | 1.927 (0.434)*** |
| Industrial Dissimilarity | -0.013 (0.003)*** | -0.022 (0.003)*** | -0.013 (0.003)*** | -0.015 (0.003)*** | -0.002 (0.002) | -0.016 (0.002)*** |
| Monetary Policy | 0.334 (0.037)*** | 0.335 (0.037)*** | 0.142 (0.042)*** | 0.142 (0.042)*** | 0.302 (0.033)*** | 0.304 (0.033)*** |
| *Panel B: Trade* | | | | | | |
| Industrial Dissimilarity | 0.001 (0.000) | 0.001 (0.000)* | 0.001 (0.000) | 0.001 (0.001)* | 0.001 (0.000) | 0.001 (0.000)* |
| Language | 0.005 (0.002)* | 0.005 (0.002)* | 0.005 (0.002)* | 0.005 (0.002)* | 0.005 (0.002)* | 0.005 (0.002)* |
| Distance | -5.22e-07 (1.37e-07)*** | -5.21e-07 (1.37e-07)*** | -5.28e-07 (1.37e-07)*** | -5.26e-07 (1.37e-07)*** | -5.35e-07 (1.37e-07)*** | -5.33e-07 (1.37e-07)*** |
| Adjacency | 0.054 (0.002)*** | 0.054 (0.002)*** | 0.054 (0.002)*** | 0.054 (0.002)*** | 0.054 (0.002)*** | 0.054 (0.002)*** |
| GDP gap | -0.001 (0.001)*** | -0.001 (0.000)*** | -0.001 (0.000)*** | -0.001 (0.001)*** | -0.001 (0.000)*** | 0.001 (0.000)*** |
| *Panel C: Industrial Dissimilarity* | | | | | | |
| Trade | 17.399 (5.670)*** | 18.362 (5.668)*** | 17.328 (5.670)*** | 18.356 (5.669)*** | 17.489 (5.669)*** | 18.384 (5.669)*** |
| GDP gap | 0.011 (0.064) | 0.009 (0.064) | 0.011 (0.064) | 0.012 (0.064) | 0.015 (0.064) | 0.009 (0.064) |
| GDP product | -0.068 (0.072) | -0.067 (0.072) | -0.066 (0.072) | -0.067 (0.072) | -0.071 (0.072) | -0.068 (0.072) |

*Notes:* ***, **, and * report 1%, 5%, and 10% significance. Standard errors are in parenthesis. Constant estimates are not reported.

**Table 6: Simultaneous equation estimation with cross-sectional data: 4-Equation Model estimates**

| Output measure | HP-filtered | CF-filtered | First-differenced |
|---|---|---|---|
| *Panel A: Correlation* | | | |
| Trade | -1.433 (1.946) | -1.934 (2.140) | -4.451 (1.679)*** |
| Industrial Dissimilarity | 0.084 (0.019)*** | 0.071 (0.021)*** | 0.050 (0.017)*** |
| FDI | 1.715 (2.021) | 0.897 (2.217) | 6.296 (1.724)*** |
| Monetary Policy | 0.066 (0.155) | -0.028 (0.176) | 0.322 (0.145)** |
| *Panel B: Trade* | | | |
| Industrial Dissimilarity | 0.003 (0.001)** | 0.003 (0.001)** | 0.003 (0.001)** |
| FDI | 0.977 (0.071)*** | 0.980 (0.071)*** | 0.973 (0.071)*** |
| Language | -0.026 (0.007)*** | -0.026 (0.007)*** | -0.024 (0.007)*** |
| Distance | -9.02e-08 (3.71e-07) | -9.58e-08 (3.80e-07) | -2.18e-07 (3.70e-07) |
| Adjacency | 0.020 (0.005)*** | 0.019 (0.005)*** | 0.019 (0.005)*** |
| GDP gap | 0.003 (0.001)*** | 0.003 (0.001)*** | 0.003 (0.001)*** |
| *Panel C: Industrial Dissimilarity* | | | |
| Trade | 10.330 (27.182) | 10.946 (27.339) | 17.728 (27.576) |
| FDI | 39.678 (31.573) | 43.850 (32.165) | 20.755 (33.026) |
| GDP gap | -0.405 (0.188)** | -0.509 (0.195)*** | -0.402 (0.201)** |
| GDP product | -0.547 (0.241)** | -0.664 (0.255)*** | -0.277 (0.273) |
| *Panel D: FDI* | | | |
| Trade | 0.817 (0.108)*** | 0.820 (0.108)*** | 0.811 (0.108)*** |
| Industrial Dissimilarity | .003 (0.002) | 0.003 (0.002) | 0.003 (0.002) |
| Monetary Policy | -0.024 (0.016) | -0.023 (0.016) | -0.024 (0.016) |
| Legal Origin | -0.003 (0.005) | -0.004 (0.005) | -0.002 (0.005) |

*Notes:* ***, **, and * report 1%, 5%, and 10% significance. Standard errors are in parenthesis. Constant estimates are not reported.

**Table 7: Single equation estimation with panel data including FDI**

| Time effects | No | | Yes | |
|---|---|---|---|---|
| | FE | RE | FE | RE |
| *Panel A1: HP-filtered Correlation* | | | | |
| Trade | -10.052 (4.051)** | -1.207 (1.121) | -10.635 (3.824)*** | -1.106 (1.101) |
| ID | -0.015 (0.007)** | -0.010 (0.005)** | 0.017 (0.008)** | 0.008 (0.006) |
| FDI | 0.419 (1.159) | 0.446 (0.805) | -0.111 (1.095) | 0.226 (0.780) |
| Monetary Policy | 0.338 (0.081)*** | 0.336 (0.070)*** | 0.211 (0.079)*** | 0.217 (0.069)*** |
| Hausman Test | $\chi^2$ (4) = 11.420 [0.022] | | $\chi^2$ (7) = 8.120 [0.322] | |
| *Panel A2: CF-filtered Correlation* | | | | |
| Trade | -15.019 (5.339)*** | 0.835 (1.210) | -12.736 (4.683)*** | 0.742 (1.118) |
| ID | -0.002 (0.009) | -0.006 (0.006) | 0.011 (0.010) | -0.001 (0.006) |
| FDI | 0.592 (1.528) | -0.300 (0.913) | 0.727 (1.341) | -0.183 (0.837) |
| Monetary Policy | 0.086 (0.107) | 0.165 (0.085)* | 0.104 (0.097) | 0.166 (0.080)** |
| Hausman Test | $\chi^2$ (4) = 9.960 [0.041] | | $\chi^2$ (7) = 10.230 [0.175] | |
| *Panel A3: First-differenced Correlation* | | | | |
| Trade | -4.259 (4.285) | 1.202 (1.009) | -4.626 (3.866) | 1.433 (0.923) |
| ID | -0.043 (0.007)*** | -0.016 (0.005)*** | 0.000 (0.008) | 0.006 (0.005) |
| FDI | -0.741 (1.226) | -0.267 (0.761) | -1.386 (1.107) | -0.533 (0.691) |
| Monetary Policy | 0.310 (0.086)*** | 0.427 (0.071)*** | 0.152 (0.080)* | 0.259 (0.066)*** |
| Hausman Test | $\chi^2$ (4) = 38.090 [0.000] | | $\chi^2$ (7) = 9.940 [0.192] | |
| *Panel B: Trade* | | | | |
| ID | 0.001 (0.000)*** | 0.001 (0.000)*** | 0.001 (0.000)*** | 0.001 (0.000)** |
| FDI | 0.051 (0.016)*** | 0.107 (0.017)*** | 0.051 (0.016)*** | 0.108 (0.017)*** |
| Language | | 0.013 (0.009) | | -0.013 (0.009) |
| Distance | | -7.64e-07 (5.97e-07) | | -7.72e-07 (5.98e-07) |
| Adjacency | | 0.050 (0.007)*** | | 0.050 (0.007)*** |
| GDP gap | -0.002 (0.005) | 0.001 (0.001) | -0.004 (0.005) | 0.001 (0.001) |
| Hausman Test | $\chi^2$ (3) = 93.510 [0.000] | | $\chi^2$ (6) = 93.860 [0.000] | |
| *Panel C: Industrial Dissimilarity* | | | | |
| Trade | 125.704 (31.099)*** | 46.405 (13.897)*** | 34.856 (28.045) | 28.313 (12.893)** |
| FDI | 0.871 (9.169) | -3.392 (8.346) | 6.017 (7.614) | -1.132 (6.987) |
| GDP gap | 0.234 (2.752) | -0.404 (0.227)* | -2.557 (2.292) | -0.306 (0.219) |
| GDP product | -4.993 (0.688)*** | -0.830 (0.243)*** | 11.587 (2.475)*** | -0.098 (0.249) |
| Hausman Test | $\chi^2$ (4) = 65.980 [0.000] | | $\chi^2$ (7) = 32.030 [0.000] | |
| *Panel D: FDI* | | | | |
| Trade | 0.589 (0.195)*** | 0.801 (0.078)*** | 0.583 (0.196)*** | 0.801 (0.079)*** |
| ID | -0.000 (0.001) | -0.001 (0.000) | 0.000 (0.000) | -0.000 (0.001) |
| Monetary Policy | -0.004 (0.004) | -0.006 (0.004) | -0.006 (0.004) | -0.007 (0.004)* |
| Legal Origin | | 0.006 (0.007) | | 0.006 (0.007) |
| Hausman Test | $\chi^2$ (3) = 4.870 [0.182] | | $\chi^2$ (6) = 5.360 [0.498] | |

*Notes:* ***, **, and * report 1%, 5%, and 10% significance.
ID is the Industrial Dissimilarity.
Standard errors are in parenthesis.
Probability values in [ ].
Constant estimates are not reported.

**Table 8: Simultaneous equation estimation with panel data: 4-Equation Model estimates**

| Output measure | HP-filtered | | CF-filtered | | First-differenced | |
|---|---|---|---|---|---|---|
| Time effects | No | Yes | No | Yes | No | Yes |
| *Panel A: Correlation* | | | | | | |
| Trade | 0.371 (1.125) | 0.560 (1.130) | 4.350 (1.362)*** | 4.255 (1.358)*** | 0.575 (1.141) | 1.132 (1.134) |
| Industrial Dissimilarity | 0.002 (0.006) | -0.028 (0.006)*** | -0.026 (0.007)*** | -0.021 (0.007)*** | 0.006 (0.006) | -0.025 (0.006)*** |
| FDI | -0.333 (0.944) | -0.439 (0.950) | -2.652 (1.144)** | -2.837 (1.142)** | 0.555 (0.956) | 0.229 (0.952) |
| Monetary Policy | 0.317 (0.070)*** | 0.335 (0.071)*** | 0.162 (0.085)* | 0.159 (0.085)* | 0.423 (0.071)*** | 0.439 (0.071)*** |
| *Panel B: Trade* | | | | | | |
| Industrial Dissimilarity | 0.001 (0.000)*** | 0.001 (0.000)*** | 0.001 (0.000)*** | 0.001 (0.000)*** | 0.001 (0.000)*** | 0.001 (0.000)*** |
| FDI | 0.715 (0.023)*** | 0.716 (0.023)*** | 0.715 (0.023)*** | 0.716 (0.023)*** | 0.716 (0.023)*** | 0.716 (0.023)*** |
| Language | -0.013 (0.004)*** | -0.013 (0.004)*** | -0.013 (0.004)*** | -0.013 (0.004)*** | -0.013 (0.004)*** | -0.013 (0.004)*** |
| Distance | -5.82e-07 (2.27e-07)*** | -5.61e-07 (2.27e-07)** | -5.20e-07 (2.28e-07)** | -4.96e-07 (2.27e-07)** | -4.57e-07 (2.29e-07)** | -4.40e-07 (2.28e-07)** |
| Adjacency | 0.022 (0.003)*** | 0.022 (0.003)*** | 0.022 (0.003)*** | 0.021 (0.003)*** | 0.022 (0.003)*** | 0.022 (0.003)*** |
| GDP gap | 0.001 (0.001) | 0.001 (0.001) | 0.001 (0.001) | 0.001 (0.000)* | 0.001 (0.000)* | 0.001 (0.000)* |
| *Panel C: Industrial Dissimilarity* | | | | | | |
| Trade | 58.016 (11.456)*** | 71.871 (11.354)*** | 57.005 (11.456)*** | 72.733 (11.355)*** | 57.651 (11.455)*** | 72.779 (11.355)*** |
| FDI | -37.370 (9.985)*** | -50.459 (9.921)*** | -38.396 (9.986)*** | -49.826 (9.923)*** | -38.018 (9.981)*** | -49.674 (9.923)*** |
| GDP gap | -0.352 (0.142)** | -0.274 (0.141)* | -0.297 (0.142)** | -0.318 (0.142)** | -0.333 (0.142)** | -0.316 (0.142)** |
| GDP product | -0.264 (0.165) | -0.104 (0.164) | -0.175 (0.165) | -0.166 (0.164) | -0.217 (0.164) | -0.174 (0.164) |
| *Panel D: FDI* | | | | | | |
| Trade | 1.152 (0.046)*** | 1.155 (0.046)*** | 1.154 (0.046)*** | 1.158 (0.046)*** | 1.154 (0.046)*** | 1.158 (0.046)*** |
| Industrial Dissimilarity | -0.002 (0.000)*** | 0.002 (0.001)*** | -0.002 (0.000)*** | -0.002 (0.001)*** | -0.002 (0.001)*** | -0.002 (0.000)*** |
| Monetary Policy | -0.005 (0.003) | -0.005 (0.003) | -0.005 (0.003) | -0.005 (0.003) | -0.005 (0.003) | -0.005 (0.003) |
| Legal Origin | 0.001 (0.003) | 0.001 (0.003) | 0.001 (0.003) | 0.001 (0.003) | 0.001 (0.003) | 0.001 (0.003) |

*Notes:* ***, **, and * report 1%, 5%, and 10% significance. Standard errors are in parenthesis. Constant estimates are not reported.

**Appendix: Simultaneous equation estimation with panel data: 3-Equation Model estimates (Based on the dataset excluding 2007-09 Global Financial Crisis Period**

| Output measure | HP-filtered | | CF-filtered | | First-differenced | |
|---|---|---|---|---|---|---|
| Time effects | No | Yes | No | Yes | No | Yes |
| *Panel A: Correlation* | | | | | | |
| Trade | 1.422 (0.619)** | 1.454 (0.619)** | 2.400 (0.692)*** | 2.291 (0.691)*** | 2.055 (0.498)*** | 2.152 (0.497)*** |
| Industrial Dissimilarity | -0.008 (0.004)** | -0.009 (0.004)*** | -0.011 (0.004)*** | -0.001 (0.004) | -0.007 (0.003)** | -0.002 (0.003) |
| Monetary Policy | 0.292 (0.049)*** | 0.292 (0.056)*** | 0.055 (0.054) | 0.054 (0.055) | 0.216 (0.039)*** | 0.217 (0.039)*** |
| *Panel B: Trade* | | | | | | |
| Industrial Dissimilarity | 0.001 (0.000)*** | 0.001 (0.000)*** | 0.001 (0.000)*** | 0.001 (0.001)*** | 0.001 (0.000)*** | 0.001 (0.000)*** |
| Language | 0.004 (0.003)* | 0.004 (0.003)* | 0.004 (0.003)* | 0.004 (0.003)* | 0.004 (0.001)* | 0.004 (0.003)* |
| Distance | -4.84e-07 (1.67e-07)*** | -4.84e-07 (1.67e-07)*** | -4.90e-07 (1.67e-07)*** | -4.91e-07 (1.67e-07)*** | -5.02e-07 (1.67e-07)*** | -5.02e-07 (1.67e-07)*** |
| Adjacency | 0.053 (0.003)*** | 0.053 (0.003)*** | 0.053 (0.003)*** | 0.053 (0.003)*** | 0.053 (0.003)*** | 0.053 (0.003)*** |
| GDP gap | -0.001 (0.001)** | -0.001 (0.000)** | -0.001 (0.000)** | -0.001 (0.001)** | -0.001 (0.000)*** | -0.001 (0.000)** |
| *Panel C: Industrial Dissimilarity* | | | | | | |
| Trade | 16.177 (6.206)*** | 15.942 (6.206)*** | 15.970 (6.204)*** | 15.991 (6.205)*** | 16.374 (6.205)*** | 15.998 (6.206)*** |
| GDP gap | 0.008 (0.071) | 0.008 (0.071) | 0.010 (0.071) | 0.008 (0.071) | 0.011 (0.071) | 0.009 (0.071) |
| GDP product | 0.127 (0.081) | 0.127 (0.081) | 0.133 (0.080) | 0.126 (0.081) | -0.121 (0.081) | -0.125 (0.081) |

*Notes:* ***, **, and * report 1%, 5%, and 10% significance. Standard errors are in parenthesis. Constant estimates are not reported.