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Yamamoto, Shugo

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Shugo Yamamoto

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Banking Network Amplification Effects on Cross-Border Bank Flows*

Shugo Yamamoto†

Faculty of Economics, Yamaguchi University
1677-1 Yoshida, Yamaguchi-shi, Yamaguchi, 7538511, Japan
and
Research Fellow, Graduate School of Economics, Kobe University
2-1, Rokkodai-cho, Nada-ku, Kobe City, Hyogo, 6578501, Japan

Abstract

The global factor often referred to as the volatility index (VIX) is said to be the most important determinant of cross-border bank flows. Contrary to established theory, we investigate the spatial amplification of the network origins of the aggregate fluctuation effect on cross-border bank flows. Results show that first, amplification effects from networks of core–core countries can explain a large share of global shocks, which will replace VIX. Second, because the US is located at the core of the network, the US amplifies shock originating in other countries. Furthermore, monetary policy shocks originating in the US have large amplification effects not only the US itself, but also on the rest of the world. Therefore, domestic shocks apparently propagate throughout the international banking network, affecting other countries, and generating a sizable global factor.

JEL Classification Code: F30, F34
Keywords: Core–periphery, Global factor, Spatial effect, VIX

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† Email: shugo-y@yamaguchi-u.ac.jp

1. Introduction

International capital flows are becoming increasingly globalized. The correlation of financial cycles across countries has increased in recent years. Actually, this correlation is said to be a main cause of the global financial crisis of 2007–08. Therefore, investigating the mechanisms and determinants of international capital flows is important.

Typical research in this area resembles that conducted by Calvo et al. (1996), distinguishing global common factors for capital flows from country-specific factors, and emphasizing the importance of external global common factors in explaining capital flows in emerging countries. Along with this opposing axis, many earlier studies investigated international capital flow mechanisms. For instance, using factor analysis, Fratzscher (2012) extracts global common factors and finds that these factors played an important role in the global financial crisis of 2007–08. Using dynamic factor analysis, Sarno et al. (2015) find that more than 80% of the variation of capital flow results from global common factors. Shirota (2015) reports that the contribution of global common factors increased after the 2000s. However, factor analysis can merely extract common trends. Interpretations of the meanings of those sets of variables have created much controversy. Miranda-Agrippino and Rey (2012) report that the global common factor has high correlation with the volatility index (VIX), which is a proxy for global investor risk sentiment[1]. While particularly addressing VIX, Forbes and Warnock (2012) and Bruno and Shin (2015a) assert that global risk factors played an important role; country-specific characteristics had only a minor role. Evolving from these studies, Bruno and Shin (2015b) and Rey (2015) reveal the positive feedback loops between fall in VIX, rise in credit, capital flows, leverage, and the further fall in VIX.

From these preceding studies, a great deal of emphasis has been assigned to high interpretability of VIX. However, the network origins of aggregate fluctuations are apparently lacking. According to

[1] Using a large cross section of 858 risky asset prices, they find that an important part of the variance of risky returns is explained by a single global common factor.

Acemoglu et al. (2012), in a certain network system, micro-shocks might not remain confined to where they originate. Rather, micro-shocks might propagate throughout an economy, affecting other sectors, and generating a sizable aggregate effect, which is often designated as a cascade effect. After the seminal works of Allen and Gale (2000), Nier et al. (2007), and Haldane and May (2011), numerous theoretical studies have revealed that the structure of financial networks affects their reaction to shocks. A network that is incomplete and asymmetric can amplify the shocks as symbolized by contagion and systemic risk[2]. To this end, von Peter (2007), IMF (2009) and Minoiu and Reyes (2013) analyze a network topological perspective of international financial network. They report that it is asymmetric, with a hierarchical structure. Hoggarth et al. (2010) use input–output analysis to reveal amplification effects of international banking networks. However, this approach can not compare the importance between network amplification effects and VIX.

In this study, through network analysis and by application of a spatial econometrics approach, we explore somewhat further into the identification of a global common factor with consideration of the amplification effect of domestic factors. Then we can integrate the network-related studies with VIX related studies. Spatial econometric approaches present benefits for investigating spatial co-movement among dependent variables and the spillover effects of explanatory variables in one country on the dependent variables of other country[3]. Using this approach, Dell'Erba et al. (2013) and Asgharian et al. (2013) study spatial amplification effects of international financial networks on stock price co-movements. Tonzer (2015) assesses the spatial spillover effects of systemic risk. No report in the relevant literature has described a study investigating the amplification and feedback effect of international financial network on capital flows. This is actually the first point to be discussed. Furthermore, among capital flows of several types, we specifically examine cross-border

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[2] However, if network system is complete and symmetric, it can improve risk-sharing by spreading and decreasing the shock.

[3] The application of spatial econometrics is common in the field of economic geography. See Lesage and Pace (2009) for details. Additionally, this approach is different from a gravity approach, which is used to investigate economic integration by bilateral trade flows based on the economic sizes and distance between two units.

bank flows because the stock of cross-border bank flows accounts for more than 50% of the overall amount of international holdings, according to Lane and Milesi-Ferretti (2008). As referred to a spoke–hub distribution paradigm, economically advanced countries are located in the core and emerging countries are located in the periphery of the network system. Therefore, the mechanisms of cross-border bank flows might differ among core–core and core–periphery networks. This is the second point to be discussed. The results can be summarized as follows. First, in contrast to important earlier studies, spatial effects from networks of core–core countries can explain a large share of global shocks. This explanation is expected to replace VIX. Second, because the US is located at the network core, the US amplifies shocks that originate in other countries. Furthermore, monetary policy shocks originating in the US have strong amplification effects not only within the US, but also throughout the rest of the world. Therefore, domestic shocks might be said to propagate throughout the international banking network, affecting other countries, and producing a sizable global factor.

The remainder of the paper is organized as follows. Section 2 presents a description of the spatial econometric method. Section 3 presents a description of data and descriptive statistics of international banking systems. Section 4 presents a description of empirical results. The final section presents conclusions.

2. Estimation method

The concept of spatial dependence in a regression model is that the values of the dependent variable at a certain location depend on observations at other locations. In general, spatial dependence is present whenever the correlation across location units is non-zero and whenever the pattern of non-zero correlations follows a certain spatial ordering. Two representative models of specifications exist with spatial dependence. One is called the spatial lag model (SLM), which emphasizes the spatial correlation in the dependent variable. The other is called spatial error model (SEM), which emphasizes the spatial correlation in the error term. Although the model specification choice presents an important problem, Lesage and Pace (2009) recommend the use of the more general Spatial Durbin Model (SDM). This model provides a general starting point for the discussion of spatial regression model estimates because this model subsumes SEM and SLM. By following Anselin et al. (2008) and Elhorst (2014), we estimate a panel data version of SDM with slight extension, as described in Eq. (1).

$$Y = \rho(I_T \otimes W)Y + X^D \beta^D + (I_T \otimes W)X^D \theta + X^G \beta^G + D\alpha + \varepsilon \tag{1}$$

Therein, Y is a dependent variable of $NT \times 1$ vector. N denotes the cross-sectional dimension. T stands for the time-series dimension. ρ is a scalar that denotes the spatial autoregressive coefficient, which captures the feedback effect arising from the dependent variable in neighboring locations. W is an $N \times N$ vector of spatial weight with an element w_{ij} of the matrix, which expresses the strength of the interaction between location i (in the row of the matrix) and location j (in the column of the matrix). By convention, because one location can not have an interaction with itself, the diagonal element of W is 0. Also, I_T denotes the identity matrix of $T \times T$ and $\otimes$ denotes the Kronecker product. Therefore the term $\rho(I_T \otimes W)Y$ denotes a spatial lagged dependent variable. D is an $NT \times N$ matrix of location specific dummy and the global constant, and α is the corresponding coefficient vector. ε is an $NT \times 1$ vector of error terms. As described in this paper, we distinguish the explanatory variables as domestic and global variables. A domestic variable is $NT \times K$ matrix of X^D. A global variable is $NT \times L$ matrix of X^G. Their difference is based on whether the variables are common across the locations or not. Because global variables X^G have a feature of global characteristic, they will affect all locations simultaneously without intersection with W.

Consequently, global variables are common across the locations. The coefficient of X^G is the $L \times 1$ vector of β^G. However, the domestic variables differ among locations. Furthermore, there are domestic variables of two types. The first is a spillover effect to dependent variables of other locations through W with coefficient θ of vector $K \times 1$. The second is the impact of explanatory variables on the dependent variable of the same location with coefficient β^D of vector $K \times 1$.

The model can be transformed to an estimable reduced form as shown below.

$$Y = \left(I_{NT} - \rho(I_T \otimes W)\right)^{-1}(X^D\beta^D + (I_T \otimes W)X^D\theta + X^G\beta^G + D\alpha + \varepsilon) \quad (2)$$

The existence of the feedback effect produces a simultaneity problem. Consequently, conventional OLS estimates of the model parameters are expected to be inconsistent. Aneslin et al. (2008) and Elhorst (2014) present the maximum likelihood estimation of the SLM and SEM to include fixed effect and random effect. Actually, SDM is an extended version of SLM. Therefore, it can produce an estimate using the same procedure[4].

After estimating the coefficients, we will interpret our results from reference to Lesage and Pace (2009) and to Elhorst (2014). Different from the conventional model, the marginal impacts of explanatory variables are not β^D, θ^D, and β^G because a change in explanatory variable in one location, say location i, affects the dependent variable of that location, which in turn affects the dependent variable in nearby locations, which then feedback to the dependent variable of location i. The coefficients of β^D and β^G, which do not include such a feedback effect, should be interpreted as immediate effects of change in the explanatory variable on the dependent variable of the same location. Similarly, the coefficient of θ should be interpreted as an immediate neighborhood effect of change in the explanatory variables of a certain location to the dependent variable in the other

[4] We use the XSMLE of a command to estimate spatial panel model in Stata. See Belotti et al. (2013) for details.

locations. According to Elhorst (2014), the feedback and amplification effect at given period t can be expressed as Eqs. (3) and (4). This matrix denotes the partial derivatives of y_t with respect to the k-th x_{kt}^D and l-th x_{lt}^G in location 1 up to location N. Eq. (3) is used to derive the domestic variable. It is similar to conventional SDM.

$$\left[\frac{\partial y_t}{\partial x_{1kt}^D} \cdots \frac{\partial y_t}{\partial x_{Nkt}^D}\right] = \begin{bmatrix} \frac{\partial y_{1t}}{\partial x_{1kt}^D} & \cdots & \frac{\partial y_{1t}}{\partial x_{Nkt}^D} \\ \vdots & \ddots & \vdots \\ \frac{\partial y_{Nt}}{\partial x_{1kt}^D} & \cdots & \frac{\partial y_{Nt}}{\partial x_{Nkt}^D} \end{bmatrix} = (I_N - \rho W)^{-1} \begin{bmatrix} \beta_k^D & w_{12}\theta_k & \cdots & w_{1N}\theta_k \\ w_{21}\theta_k & \beta_k^D & \cdots & w_{2N}\theta_k \\ \vdots & \vdots & \ddots & \vdots \\ w_{N1}\theta_k & w_{N2}\theta_k & \cdots & \beta_k^D \end{bmatrix} \quad (3)$$

However, Eq. (4) is for global variables and is similar to SLM.

$$\left[\frac{\partial y_t}{\partial x_{1lt}^G} \cdots \frac{\partial y_t}{\partial x_{Nlt}^G}\right] = \begin{bmatrix} \frac{\partial y_{1t}}{\partial x_{1lt}^G} & \cdots & \frac{\partial y_{1t}}{\partial x_{Nlt}^G} \\ \vdots & \ddots & \vdots \\ \frac{\partial y_{Nt}}{\partial x_{1lt}^G} & \cdots & \frac{\partial y_{Nt}}{\partial x_{Nlt}^G} \end{bmatrix} = (I_N - \rho W)^{-1} \begin{bmatrix} \beta_l^G & 0 & \cdots & 0 \\ 0 & \beta_l^G & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \beta_l^G \end{bmatrix} \quad (4)$$

The equations presented above include the term $(I_N - \rho W)^{-1} = I_N + \rho W + (\rho W)^2 + (\rho W)^3 \ldots$. Therefore it has a feedback and amplification effect. Additionally, it shows that if a particular explanatory variable in a particular location changes, then not only will the dependent variable in that location itself change (direct effect), the dependent variables in other locations will also change (indirect effect). These effects differ for different locations in the sample. Therefore, the representation of these effects is a problem. For example, if we have N cross-section location, then we obtain an $N \times N$ matrix including too many results. To simplify the expression of the estimation results, Lesage and Pace (2009) propose to report two summary measures. The first is a summary measure of the direct effect, defined as the *average direct effect*, which is the average of the diagonal elements of the matrix of Eqs. (3) and (4). The second is a summary measure of indirect effects. It is defined as the *average indirect effect*, which is the average of the row sums of the off-diagonal elements of the matrices of Eqs. (3) and (4).

3. Data and descriptive statistics

3.1 Data description

As described in this paper, we use panel data of 64 countries including economically developed and emerging countries during 2001–2013 on yearly bases. The choice of the countries depends on the data availability. The list of the countries is described in the appendix. The dependent variable is external positions of the reporting country to the rest of the world. It is taken from locational banking statistics of the Bank of International Settlements (BIS)[5]. As described above, we divide explanatory variables into domestic and global variables. The domestic variables are net foreign assets to GDP (NFA/GDP), the real exchange rate against US dollars (REX) and M2 to GDP (M2/GDP). All the data were referred from the World Bank database. We referred to Bruno and Shin (2015a) for the selection of variables[6]. According to their studies, because the debt side of balance sheet is mainly invoiced in US dollars, the appreciation of a certain country's currency against US dollar will strengthen the balance sheet, which will increase cross-border lending. The appreciation is expressed by a decrease of the value. Actually, REX is expected to exert a negative effect on the dependent variables. Next, to increase cross-border lending, funds in hand are needed. Also, NFA/GDP and M2/GDP are expected to have a positive impact on dependent variables. Global variables include VIX and the growth rate of real GDP of economically advanced countries (AD_RGDP). Global variables have the features of being global characteristics. Therefore, they are expected to have an equal influence worldwide and to be common across countries. In fact, VIX, often

[5] We use liabilities to all sectors with all instruments which include debt securities, loans and deposits and other instruments. Notice that, because the format of the original data is external position of the rest of the world to the relevant country, we transformed to inverse direction.

[6] They estimate not lending but borrowing. Therefore, a little difference exists in choice of variables.

referred as the fear index, is a popular measure of the implied volatility of S&P 500 index options. The rise of their value implies an increase of the international risk. It is taken from Global liquidity indicators of BIS. In addition, AD_RGDP is taken from international financial data of the IMF. Finally, except for NFA/GDP and AD_RGDP, all the variables are log-linearized.

3.2 Weight matrix

Weight matrix W determines the structure of dependence among countries. Therefore, the choice of data is crucially important. In the field of financial linkage, the representative data source is BIS and Coordinated Portfolio Investment (CPIS) of IMF. Actually, BIS covers the international banking activity; CPIS covers international portfolio investment. Both series describe bilateral cross-border position toward individual recipient countries. Using these data, numerous attempts have been undertaken to analyze the structure of the international banking network. For instance, to make bilateral financial linkages measures as an explanatory variable, Kalemi-Ozcan et al. (2013) uses BIS data. Ahrend and Goujard (2014) use both BIS and CPIS data. In spatial estimation, Tonzer (2015) uses BIS data; Dell'Erba et al. (2013) and Asgharian et al. (2013) use CPIS data to construct a weight matrix. However, because the country coverage of the BIS data is limited to economically advanced countries, we use CPIS data as the main data source.

Because we use cross-border bank flows as a dependent variable, the use of data related to capital flow as a weight matrix might entail some risk of impairing the exogeneity of the estimated model. To avoid this problem, traditional studies use geographic distances as the weight matrix[7]. Other studies, for example, one by Amaral et al. (2014), use trade linkages as a weight matrix to study the spillover of banking crises. However, although the geographic distance and trade linkage, which

[7] Two justifications for the use of geographic distances are the following. First, a country's economic linkage is strong for nearby countries because of the business cycle synchronization by export and import. Second, it provides a clear identification because geographic distances are strictly exogenous.

represent the real side of the economy, might explain some share of real business synchronization, they might not explain financial linkages because financial transactions need not transport physical objects. They merely transmit electronic signals through the international settlement system. Financial networks have nothing to do with geographic distances. Furthermore, according to Schiavo et al. (2010), the respective structures of international trade and financial networks differ[8]. Although the use of geographic distances is expected to improve the exogeneity problem, it will impair the quality of the proxy of financial networks. Therefore, the weight matrix constructed by CPIS data presents a contradictory tradeoff between exogeneity problems and goodness of proxy of international banking network. The point here is to use the CPIS data as a proxy of the level of interaction in the banking network. However, it is noteworthy that the use of CPIS data rather than BIS data as a weight matrix can be expected to correct the exogeneity problem to some degree. Because according to Broner et al. (2013) and Contessi et al. (2013), portfolio investment has different properties from those of cross-border bank flows.

The weight matrix construction is the following. We use two measures of the weight matrix from CPIS data[9]. One is calculated from the total of debt securities. The other is calculated from equity and investment fund shares. Furthermore, we defined the former matrix as DEBT_WEIGHT and the latter as EQUITY_WEIGHT. The (i,j) element of the matrix W is denoted by w_{ij} and is calculated using the following equation.

$$w_{ij} = \left| \frac{outward_{ij} + outward_{ji}}{\sum_{k=1}^{k=N} outward_{ik} + \sum_{k=1}^{k=N} outward_{ki}} \right| \tag{5}$$

[8] This paper exploits complex network analysis to compare international trade and financial networks. According to the study, hierarchical structure is more pronounced in financial networks, which implies that most financial transactions occur through a handful of countries acting as hubs.

[9] Notice that some blank and confidential values exist in CPIS data. We remedy this problem using the following procedure. First, we assume blank as non-existence of a transaction and assign it zero. Second, we construct a periodic average of weight matrix without a confidence value. In constructing a sub-period weight matrix, there are several elements of matrix which consist only of confidence values. In this case, we assigned zero.

Actually, $outward_{ij}$ is the periodic average of portfolio investment from country i to country j during 2001–2013. Additionally, we conduct row normalization: each row of W will sum to 1 [10].

3.3 International banking network

Because the international banking network is comparable to a spoke–hub distribution paradigm, the spatial amplification effect might be different between core and periphery countries. To confirm this point, we divide all 64 sample countries to two sub-groups: 22 OECD countries that indicate the core and 42 Non-OECD countries that indicate the periphery. The classification is based on the following two points. The first is whether the country is an OECD country or not. The second is that, to check the validity of the weight matrix based on CPIS data, we must conduct a comparison with BIS consolidated data. Therefore, countries in both groups must coincide[11]. Although the coverage of the countries is limited, because BIS data capture international banking activity, a weight matrix based on BIS data is more accurate than one based on CPIS data. From Figure 1, which describes the top 25 network interconnectedness of OECD countries, we compare the weight matrix constructed using consolidated banking statistics of BIS, Total debt securities, and Equity and investment fund shares[12]. The figure below portrays a similar asymmetric core–periphery structure. The bulk of financial transactions occur through the US, UK, Germany, and France which act as hubs, which implies the validity of using CPIS data as a proxy of the international banking network, which is represented by BIS data.

<<Insert Figure 1 here>>

[10] This is done for computational simplicity and to clarify the interpretation of the estimate results. See Anselin et al. (2008) for details.

[11] Because of a lack of data in consolidated banking statistics of BIS, we did not include Luxembourg in the group of OECD.

[12] This figure is calculated from the numerator part of Eq. (5) of the previous subsection.

<<Insert Figure 2 here>>

Next, we compare the individual characteristics of OECD and Non-OECD countries. Figure 2 shows the international lending and borrowing of Belgium and Brazil, which are respectively typical OECD and Non-OECD countries. It is apparent that the lending and borrowing of Belgium has similar trend behavior. In contrast to this, the lending and borrowing of Brazil has a different trend behavior, from which we can confirm the divergence of the two lines. This fact implies that borrowing will induce lending in OECD countries. This observation is not confined to the cases of these two countries. We can make a generalization of this phenomenon. Figure 3 presents a scatter plot of international lending and borrowing of all 64 countries including OECD and Non-OECD countries[13]. According to this figure, the regression estimate of the coefficient of straight line of OECD countries is 1.107; R-squared is 0.923. In contrast to this, the estimated coefficient in Non-OECD is 0.739; R-squared is 0.621. Therefore, we can say that the relation between lending and borrowing in OECD countries is higher than that in Non-OECD countries. From this evidence, we can infer that country A's lending to B will spark a chain reaction to B's lending to C, and so on, in OECD countries. This inference is in line with results of a study by Broner et al. (2013), which suggest that the correlation of capital flow among economically advanced countries is higher than that among emerging countries. Therefore, the mechanisms of cross border bank flows might differ between OECD and Non-OECD countries. This point demands further discussion.

<<Insert Figure 3 here>>

4. Empirical Results

[13] Data are taken from locational banking statistics of the BIS. The scatter plot shows the periodic average of lending and borrowing from 2001 to 2013 with a logarithmic scale.

4.1 Main results of all 64 countries

In this subsection, we examine the empirical results obtained for all 64 countries including OECD and Non-OECD countries from Tables 1 and 2. In the table, PERIOD OF WEIGHT: 2001-13 stand for periodic average of weight matrix during 2001–2013. FIXED and RANDOM respectively denote fixed and random effect models. ρ is a spatial coefficient. β is the coefficient of explanatory variables including coefficients of both β^D and β^G. It is referred to as an immediate effect. θ stands for the immediate neighbor effect. A-Dir and A-InD respectively stand for the average direct and indirect effects. Here, because we are analyzing the component of global common factor, we specifically examine the results of ρ and VIX. Additionally, we specifically examine direct and indirect effects of M2/GDP, representing a spillover of monetary policy.

<<Insert Table 1 here>>

According to Table 1, the coefficient of ρ is 0.369–0.421 at the model using DEBT_WEIGHT. It is 0.265–0.290 at the model using EQUITY_WEIGHT. All the estimation results were significant at the 1% level, which indicates that the dependent variable of a certain country has a spatial effect on the dependent variables of the other countries. Next, except for AD_RGDP, all the coefficients of β from models (1)–(8) in Table 1 are significant at the 1% level. Furthermore, both NFA/GDP and M2/GDP have a positive impact, although both REX and VIX have a negative impact on international lending[14]. Consequently, it is consistent with theoretical hypothesis. For comparison, we check the empirical result of non-spatial case from model (9) and (10), labeled as NO_WEIGHT in Table 1. From the table, one can confirm that the coefficient of all five variables is significant at the 1% level. Similarly, NFA/GDP and M2/GDP have a positive impact, whereas REX and VIX have a negative

[14] The decrease of REX reflects appreciation of real exchange rate and increase of VIX indicates reflects increased uncertainty in international financial markets.

impact on international lending. Consequently, except for AD_RGDP, the result of β without spatial term is consistent with the results of the inclusion of spatial term[15]. Next, the estimation results of the coefficient θ, which represent an immediate neighborhood effect are as follows. Actually, M2/GDP is significant at the 1% level. It has a positive sign from models (1)–(8). However, NFA/GDP is significant only for the model using DEBT_WEIGHT. REX is not significant at all, which indicates that M2/GDP. In other words monetary policy has a strong spillover effect on other countries.

From these results, we can calculate direct and indirect effects by applying the estimated coefficients to Eqs. (3) and (4) of section 2. Except for AD_RGDP, it is apparent that all average direct effects are significant at the 1% level and that the sign is consistent with the result of β. Different from the immediate effect of β, direct effects have an amplification effect. For example, the estimation of β and the average direct effect of M2/GDP from model (1) are, respectively, 0.485 and 0.508. The difference between two values represents feedback and the amplification effect through weight matrix. The average direct effect in the table is a summary measure. The element of matrix W varies across countries. The direct effect also varies across countries. Unfortunately, because the sample countries are 64, it cannot be shown here because of a lack of space. Therefore, we will specifically examine the direct effect of the 5 highest and lowest countries against M2/GDP as an example. In Figure 4, the bar graph shows a direct effect of each country. The cross line represents average direct effect. Both are based on model (1). According to the figure, the highest countries are US, Germany, UK, France, and Japan. The lowest are Ukraine, Pakistan, Vanuatu, Bolivia, and Mongolia. In more detail, direct effects of US and Mongolia are, respectively 0.627 and 0.485, which indicates that US has a large amplification effect but Mongolia has no amplification effect.

<<Insert Figure 4 here>>

[15] The negative coefficient of AD_RGDP in NO_WEIGHT implies that the stagnation of economy will induce monetary expansion policy, which will increase international lending.

Next, the average indirect effect of M2/GDP and VIX are significant at the 1% level from models (1)–(8). However, NFA/GDP was found to be significant from models (1)–(6). REX is only significant for models (7) and (8). Actually, AD_RGDP is not significant at all. Furthermore, different from the direct effect, the indirect effect has an amplification effect on other countries. For example, the estimation of average direct effect and average indirect effect of M2/GDP from model (1) are, respectively, 0.508 and 1.813. Therefore, the average indirect effect is three times greater, which indicates a strong spillover effect of monetary policy of certain country to the rest of the world. As is the case with direct effects, we will specifically examine the indirect effect of 5 highest and lowest countries against M2/GDP as an example. In Figure 5, the bar graph shows indirect effects of each country. The cross line presents the average indirect effect. Both are based on model (1). According to the figure, the countries with the most indirect effects are the US, the UK, Germany, France, Luxembourg. The lowest are Costa Rica, Pakistan, Vanuatu, Bolivia, and Mongolia. The order of the highest and lowest countries is similar to that shown in Figure 4. In more detail, indirect effects of the US and Mongolia are, respectively 21.700 and 0.001, which indicates that the indirect effect of the US is more than 10 times larger than the summary indicator. Consequently, the shock originated in the US has strong spillover effects on the rest of the world.

<<Insert Figure 5 here>>

Finally in this subsection, we check the weight matrix robustness. The international banking system structure presents the possibility of structural change over time. Therefore, the weight matrix of W might not be stable throughout the sample period. To check this point, we divide the sample period of weight matrix to 2 sub-periods. The results are presented in Table 2. On the left side of the table, PERIOD OF WEIGHT: 2001-05 stand for periodic average of weight matrix during 2001–2005. On the right side of the table, PERIOD OF WEIGHT: 2009-13 stand for periodic average of weight matrix from 2009–2013. Other notations show similar results to those of Table 1. According to Table 2, the value of coefficient ρ is 0.267–0.497. Although the range of the value is wide, we can say approximately that the coefficient is stable throughout the entire sample period. Furthermore, not only the other estimated coefficients, but also the significance level and sign are similar. Therefore, it can be said that the weight matrices of both DEBT_WEIGHT and EQUITY_WEIGHT are stable through all sample periods.[16]

<<Insert Table 2 here>>

4.2 Importance of the US

The results of the previous subsection showed that the US is located at the core of the international banking system. Therefore, the US can be expected to play an important role in the spillover and amplification effects. In this subsection, by particularly addressing indirect effect of the impact of M2/GDP as an example, we conduct a simple simulation to analyze the importance of the US in the international banking network. The starting point of the simulation is to assume that the bilateral lending and borrowing of a certain country with the US suddenly vanishes to zero, which indicates that we set up the row and column of the US in weight matrix W to zero. Then we can calculate the indirect effect of each country similarly, but without the US (WITHOUT US). The results are shown in Figure 6. For comparison, the result of Figure 5, which is labeled as WITH US, is also shown in Figure 6. The order of the countries is based on Figure 5. We delete the US as the figure shows. Therefore, the number of the countries is four. According to the figure, the indirect

[16] Because we make row normalization and because each row of W will sum to 1, the relative position of the country is important. This result demonstrates that the relative structure of international banking network is stable during our sample period.

effect of each country decreased drastically by eliminating the row and column of the US element to zero. For example, the indirect effect of UK decreased from 13.421 to 3.705. Furthermore, the indirect effect of Germany decreased from 11.064 to 2.526. Therefore, it can be said that the US plays an important role in the spillover and amplification of shocks that originate in other countries.

<<Insert Figure 6 here>>

4.3. Comparison between OECD and Non-OECD

Comparing the international banking system to a spoke–hub distribution paradigm illustrates that the spatial amplification effect might be different between core and periphery countries. To confirm this point, using the definition presented in section 3.3, we divide all 64 sample countries to two sub-groups: 22 OECD countries that denote the core and 42 Non-OECD countries that denote the periphery.

The results of OECD and Non-OECD countries are presented respectively in Tables 3 and 4. According to Table 3, the coefficient of ρ is 0.521–0.630 in OECD countries. However, according to Table 4, the coefficient of ρ of Non-OECD countries is 0.239–0.334. Therefore, we can infer that the spatial coefficient of OECD countries is about two times higher than Non-OECD countries. However, the interpretability of the coefficient of β and θ decreased drastically in OECD countries. It is noteworthy that global explanatory variables of VIX and AD_RGDP have almost no interpretability in OECD countries. In comparison, the respective interpretabilities of VIX and the other coefficients in Non-OECD countries are strongly significant and similar with the results obtained for all 64 countries of Table 1.

<<Insert Table 3 here>>

<<Insert Table 4 here>>

Next, the interpretability of both average direct and indirect effects of OECD countries also decreased. In stark contrast to this, in Non-OECD countries, average direct effects of NFA/GDP, REX, M2/GDP, VIX are significant at the 1% level from models (29)–(36) of Table 4. Furthermore, the average indirect effects of REX, M2/GDP, VIX are almost significant at the 1% level from models (29)–(36). Results from average indirect effects imply that OECD countries can be described as a large closed economy model that is unaffected by the explanatory variables of other countries. Similarly, because Non-OECD countries are affected by explanatory variables of other countries, they can be described as small open economies.

Some points of empirical results of this subsection must be mentioned briefly here. First, in OECD countries, the coefficient of ρ is higher than it is in Non-OECD countries. Second, in OECD countries, VIX has almost no interpretability. Furthermore, according to section 3.3, one is reminded that the correlation of lending and borrowing of OECD countries is higher than that of Non-OECD countries. Therefore, these three important pieces of evidence indicate that not a global common factor represented by VIX but a high spatial coefficient of ρ is the major factor of high correlation of international lending in OECD countries[17]. This point stands in stark contrast with important earlier studies that explained global common factor by VIX.

Finally, to clarify the identity of VIX in OECD countries, we conduct an additional empirical test. In the last parts of Tables 3 and 4, which show models (27), (28), (37), (38), and NO_WEIGHT respectively describe non-spatial estimation of OECD and Non-OECD countries. According to this non-spatial estimation, the coefficient of VIX is significant at the 1% level in both OECD and

[17] As a robustness check, although a risk of impairing the exogeneity of the estimated model exists, we additionally estimate the same model using the weight matrix constructed from BIS consolidated data of 22 OECD countries. According to the results, ρ is 0.532–0.558. Neither VIX nor AD_RGDP is significant.

Non-OECD countries. However, as described previously, inclusion of the spatial term will drastically decrease the interpretability of VIX in OECD countries, which implies omitted variable biases in non-spatial estimation. Therefore, we can infer that, in OECD countries, the identity of global common shock is explained by the high spatial coefficient of ρ. However, in Non-OECD countries, the coefficient of ρ is low. Moreover, VIX still has strong interpretability. Consequently, the mechanisms of international lending in core and periphery countries differ.

5. Conclusion

The correlation of cross-border bank flows across countries has increased remarkably since the mid-1990s. Over the past few years, a considerable number of studies have emphasized analyses of global common factors. Miranda-Agrippino and Rey (2012) report high correlation between the global common factor and VIX, which is a proxy for the risk sentiment of global investors. Bruno and Shin (2015b) and Rey (2015) propose a structural interpretation of the factor and explain the amplification effect of VIX in cross-border banking flows. They are positive feedback loops between the fall in VIX, rise in credit, capital flows, and leverage, and further declines in VIX.

However, because international banking networks are strongly interconnected and because its density is high and complex, the possibility exists that local micro-shocks will amplify and become global common shocks. In this study, by applying a spatial econometrics approach, we investigate the spatial amplification effects of international banking networks on cross-border bank flows. The conclusions are summarized as follows. First, in a core–core relation that includes only OECD countries, spatial amplification effects from international banking networks can explain much of the global common factor. This amplification is expected to replace VIX in terms of analytical importance. This result stands in stark contrast to those of major preceding studies as described above. Second, in a core–periphery relation that includes both OECD and Non-OECD countries, both spatial effects and VIX explain the global common factor. Therefore, the possibility exists that interaction between VIX and spatial feedback effects will further strengthen the global common factor and boost cross-border bank flows. Furthermore, our study integrates network-related studies with VIX related studies. Third, monetary policy shocks originating in the US have a large amplification effect not only in one's own country, but also throughout the rest of the world. Therefore, to stabilize the international financial system, the FRB must consider the rest of the world. Fourth, because the US is located at the center of the core of the international banking network, the US can amplify shocks originating in other countries. Therefore, not only the monetary policy of core country, but also the mere existence of core country is playing an important role in the amplification of cross-border bank flows, which underscores the importance of financial regulation, especially for core countries. Furthermore, to expand the discussion of post-crisis banking regulation, we must apply implications from the theory of financial networks such as those proposed by Nier et al. (2007) and Haldane and May (2011).

As a final remark, because global common factors are a complex of diverse shocks, the effects and their analyses are extremely complicated. We investigate this topic from a network perspective. Furthermore, it is apparent that domestic shocks can propagate throughout the international banking network, affecting other countries, and constituting a sizable global factor.

Appendix: List of countries

64 countries are listed below. OECD countries defined in section 3.3 are underlined.

Argentina, <u>Australia</u>, <u>Austria</u>, Bahamas, Bahrain, <u>Belgium</u>, Bolivia, Brazil, Bulgaria, <u>Chile</u>, Hong Kong, Macao, Colombia, Costa Rica, Cyprus, Czech Republic, <u>Denmark</u>, Egypt, Estonia, <u>Finland</u>, <u>France</u>, <u>Germany</u>, <u>Greece</u>, Hungary, Iceland, India, Indonesia, <u>Ireland</u>, <u>Italy</u>, <u>Japan</u>, Kazakhstan, <u>Korea</u>, Kuwait, Latvia, Lebanon, Lithuania, Luxembourg, Malaysia, Malta, Mauritius, <u>Mexico</u>, Mongolia, Netherlands, Pakistan, Panama, Philippines, Poland, Portugal, Romania, Russian, Singapore, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, Ukraine, United Kingdom, United States, Uruguay, Vanuatu, Venezuela

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BIS Total debt securities Equity and investment fund

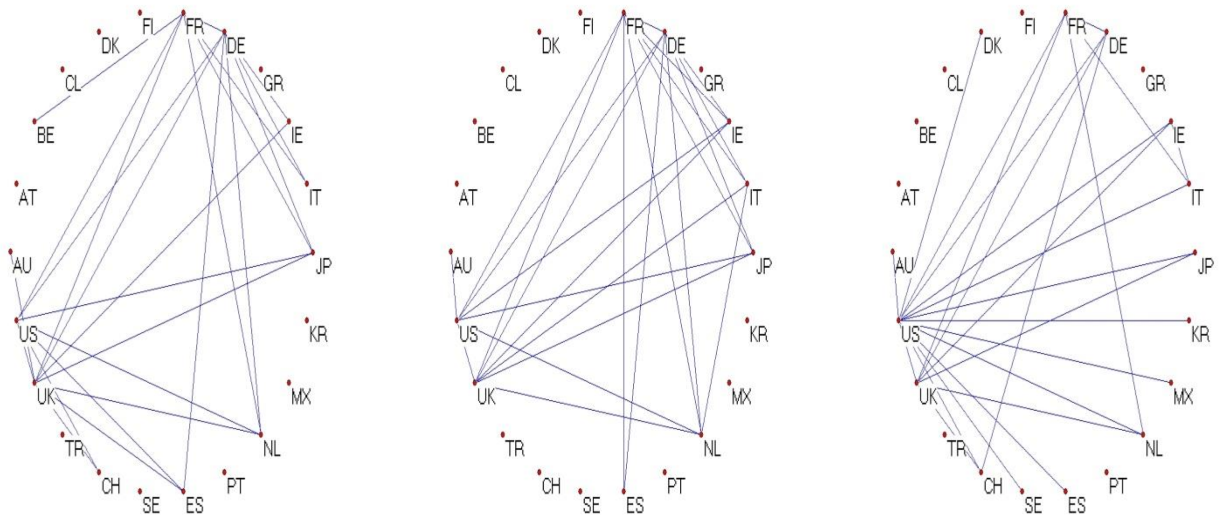

Figure 1. Top 25 network interconnectedness of the OECD countries.
Note: Data were obtained from consolidated banking statistics of BIS, Total debt securities and equity and investment fund shares. We use the numerator part of Eq. (5) for calculations. Abbreviations are the following: AU, Australia; AT, Austria; BE, Belgium; CL, Chile; DK, Denmark; FI, Finland; FR, France; DE, Germany; GR, Greece; IE, Ireland; IT, Italy; JP, Japan; KR, Korea; MX, Mexico; NL, Netherland; PT, Portugal; ES, Spain; SE, Sweden; CH, Switzerland; TR, Turkey; UK, United Kingdom; US, United States

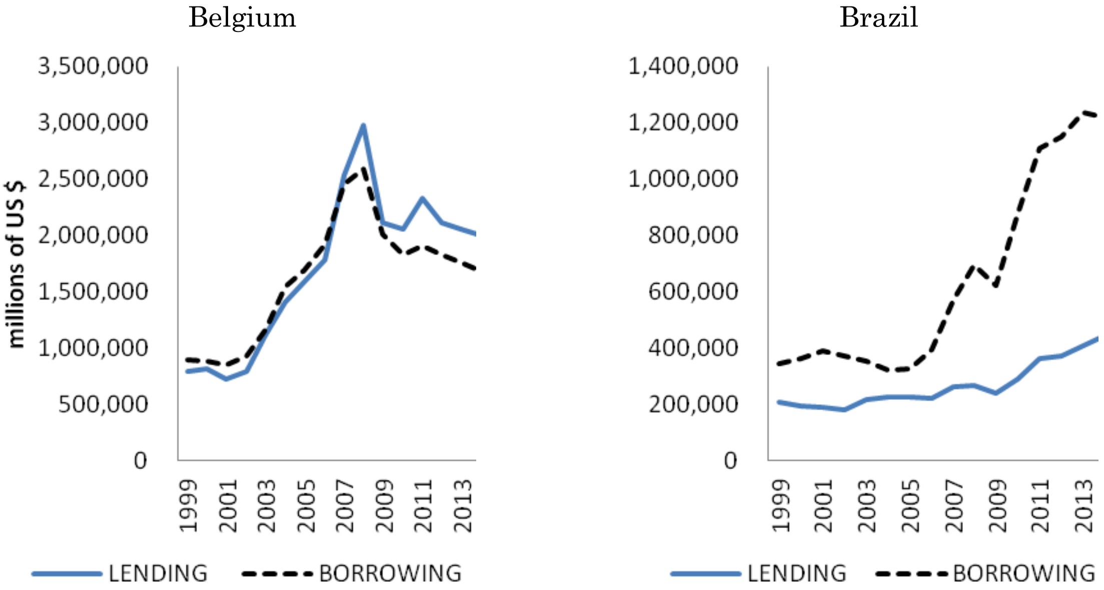

Figure 2. Lending and borrowing of Belgium and Brazil to the rest of the world.
Note: Data were obtained from BIS locational banking statistics.

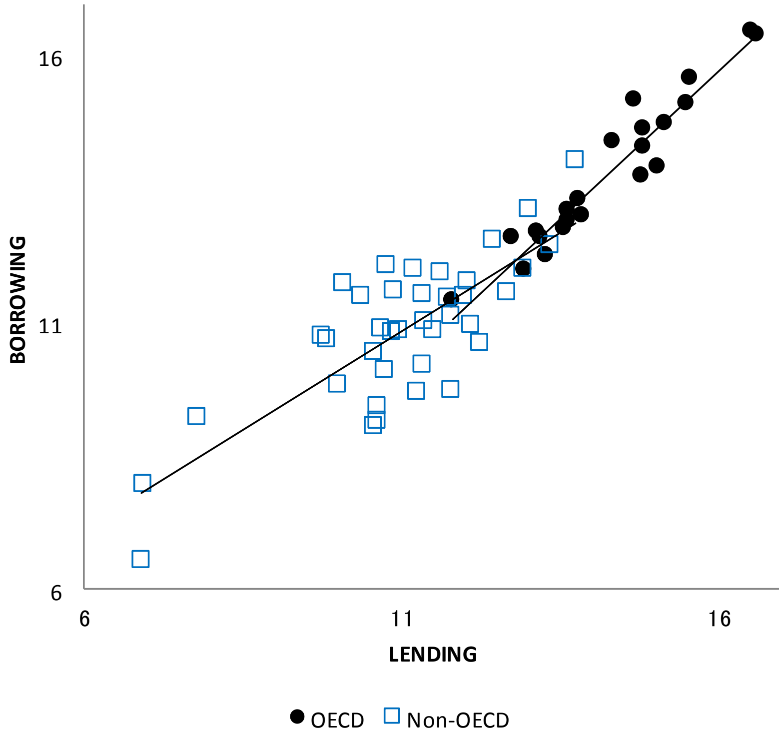

Figure 3. Scatterplots of lending and borrowing of OECD and Non-OECD countries to the rest of the world

Note: Scatter plot shows the periodic average of lending and borrowing during 2001–2013 with a logarithmic scale. Data are from BIS locational banking statistics.

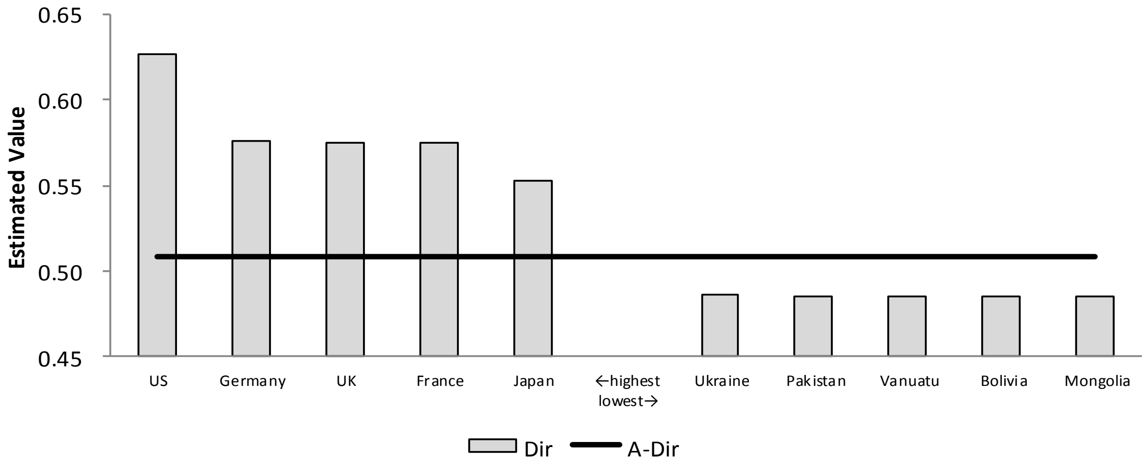

Figure 4. Direct effects of five highest and lowest countries against M2/GDP.
Note: Dir denotes direct effect of five highest and lowest countries. A-Dir denotes the average direct effect. Eq. (3) of section 2. The results from model (1) in Table 1 are used for calculations.

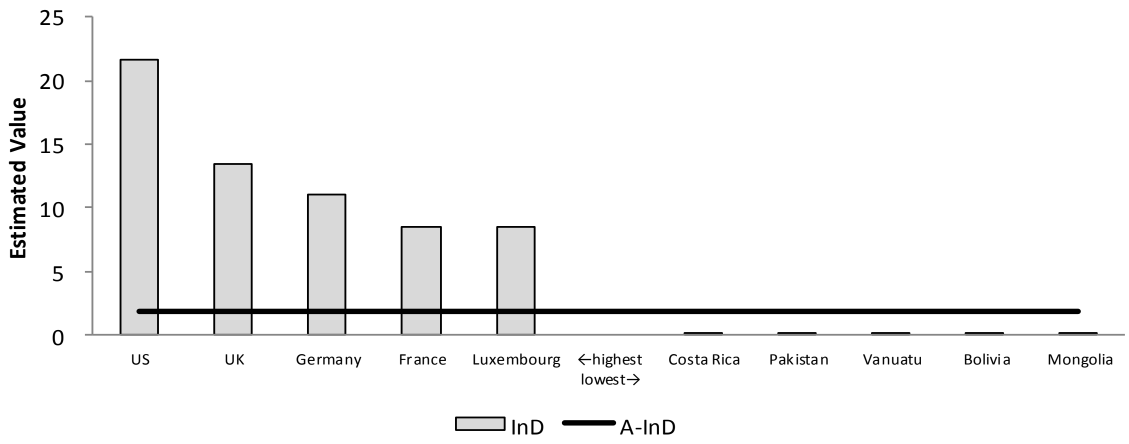

Figure 5. Indirect effects of the five highest and lowest countries against M2/GDP.
Note: InD denotes indirect effects of the five highest and lowest countries and A-InD denotes average indirect direct effect. Eq. (3) of section 2 and the results from model (1) in Table 1 are used for calculations.

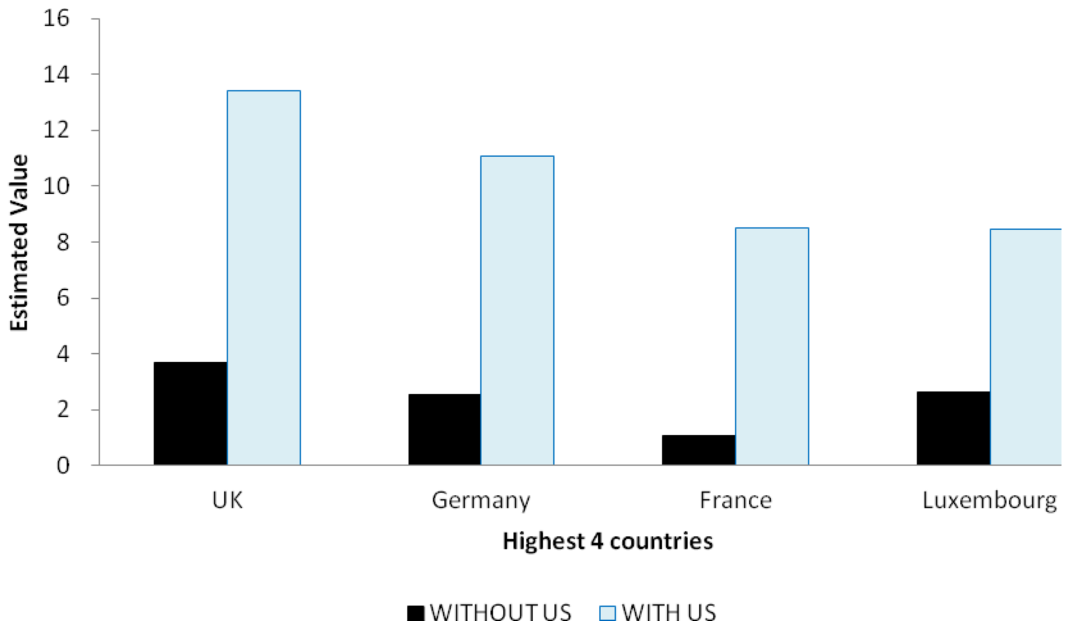

Figure 6. Indirect effects of WITH US and WITHOUT US of the four highest countries against M2/GDP.

Note. WITHOUT US is calculated as setting up the row and column of US in weight matrix W to zero. WITH US is taken from Figure 5. The order of the countries is based on Figure 5 and we delete US as the figure shows. Therefore, four countries are shown.

Table 1. Main results of all 64 countries

Interval:		PERIOD OF WEIGHT: 2001-13									
Weight:		DEBT_WEIGHT				EQUITY_WEIGHT				NO_WEIGHT	
Type:		FIXED		RANDOM		FIXED		RANDOM		FIXED	RANDOM
Model:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ρ		0.395 ***	0.369 ***	0.421 ***	0.401 ***	0.269 ***	0.265 ***	0.290 ***	0.286 ***		
β	NFA/GDP	0.170 ***	0.175 ***	0.166 ***	0.171 ***	0.173 ***	0.179 ***	0.168 ***	0.172 ***	0.253 ***	0.212 ***
	REX	−0.357 ***	−0.355 ***	−0.318 ***	−0.318 ***	−0.332 ***	−0.324 ***	−0.282 ***	−0.279 ***	−1.095 ***	−0.654 ***
	M2/GDP	0.485 ***	0.489 ***	0.544 ***	0.546 ***	0.472 ***	0.479 ***	0.519 ***	0.523 ***	0.875 ***	1.114 ***
	VIX	−0.292 ***	−0.257 ***	−0.290 ***	−0.257 ***	−0.327 ***	−0.277 ***	−0.311 ***	−0.268 ***	−0.421 ***	−0.439 ***
	AD_RGDP		0.013		0.011		0.015		0.012	−0.029 ***	−0.033 ***
θ	NFA/GDP	0.231 **	0.286 ***	0.175	0.216 **	0.052	0.077	0.029	0.046		
	REX	0.038	0.086	0.100	0.123	−0.094	−0.051	−0.255	−0.242		
	M2/GDP	0.891 ***	1.033 ***	0.888 ***	0.987 ***	1.467 ***	1.565 ***	1.315 ***	1.382 ***		
A-Dir	NFA/GDP	0.174 ***	0.180 ***	0.170 ***	0.174 ***	0.174 ***	0.180 ***	0.168 ***	0.173 ***		
	REX	−0.351 ***	−0.348 ***	−0.314 ***	−0.314 ***	−0.327 ***	−0.318 ***	−0.283 ***	−0.280 ***		
	M2/GDP	0.508 ***	0.511 ***	0.568 ***	0.571 ***	0.500 ***	0.508 ***	0.546 ***	0.551 ***		
	VIX	−0.294 ***	−0.257 ***	−0.292 ***	−0.258 ***	−0.328 ***	−0.278 ***	−0.312 ***	−0.269 ***		
	AD_RGDP		0.015		0.013		0.016 **		0.014		
A-InD	NFA/GDP	0.530 ***	0.587 ***	0.449 ***	0.478 ***	0.150 **	0.185 **	0.122	0.136		
	REX	−0.079	−0.023	−0.090	−0.049	−0.181	−0.153	−0.496 **	−0.479 **		
	M2/GDP	1.813 ***	1.920 ***	1.843 ***	1.967 ***	2.195 ***	2.290 ***	1.991 ***	2.097 ***		
	VIX	−0.198 ***	−0.145 ***	−0.205 ***	−0.165 ***	−0.124 ***	−0.098 ***	−0.124 ***	−0.103 ***		
	AD_RGDP		0.009		0.008		0.006		0.005		
R-sq	within	0.613	0.618	0.613	0.617	0.620	0.623	0.620	0.623	0.509	0.491
	between	0.206	0.201	0.238	0.232	0.226	0.212	0.267	0.259	0.181	0.249
	overall	0.224	0.219	0.254	0.249	0.243	0.230	0.282	0.275	0.185	0.254

Note: PERIOD OF WEIGHT: 2001-13 stand for periodic average of weight matrix during 2001–2013. DEBT_WEIGHT and EQUITY_WEIGHT denote weight matrices. NO_WEIGHT denotes non-spatial panel estimation. FIXED and RANDOM respectively denote fixed and random effect models. *** and ** respectively denote significance of 1% and 5% levels.

Table 2. Robustness of the weight matrix

Interval:		PERIOD OF WEIGHT:2001-05				PERIOD OF WEIGHT:2009-13			
Weight:		DEBT_WEIGHT		EQUITY_WEIGHT		DEBT_WEIGHT		EQUITY_WEIGHT	
Type:		FIXED	RANDOM	FIXED	RANDOM	FIXED	RANDOM	FIXED	RANDOM
Model:		(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
ρ		0.453 ***	0.497 ***	0.267 ***	0.295 ***	0.378 ***	0.343 ***	0.327 ***	0.294 ***
β	NFA/GDP	0.160 ***	0.160 ***	0.179 ***	0.169 ***	0.142 ***	0.148 ***	0.150 ***	0.160 ***
	REX	-0.301 ***	-0.292 ***	-0.286 ***	-0.232 ***	-0.309 ***	-0.297 ***	-0.252 ***	-0.264 ***
	M2/GDP	0.528 ***	0.587 ***	0.502 ***	0.546 ***	0.401 ***	0.503 ***	0.383 ***	0.478 ***
	VIX	-0.229 ***	-0.235 ***	-0.273 ***	-0.263 ***	-0.256 ***	-0.258 ***	-0.250 ***	-0.258 ***
	AD_RGDP	0.001	0.000	0.012	0.010	0.013	0.008	0.011	0.007
θ	NFA/GDP	0.061	0.018	0.089	0.048	0.168 **	0.109	-0.002	-0.001
	REX	-0.516 **	-0.305	-0.297	-0.446 ***	-0.075	-0.361 **	-0.456 **	-0.626 ***
	M2/GDP	0.439 **	0.426 **	1.338 ***	1.203 ***	1.244 ***	0.968 ***	1.436 ***	1.181 ***
A-Dir	NFA/GDP	0.162 ***	0.162 ***	0.180 ***	0.170 ***	0.146 ***	0.149 ***	0.151 ***	0.160 ***
	REX	-0.306 ***	-0.298 ***	-0.283 ***	-0.234 ***	-0.304 ***	-0.299 ***	-0.255 ***	-0.271 ***
	M2/GDP	0.546 ***	0.608 ***	0.525 ***	0.569 ***	0.429 ***	0.524 ***	0.417 ***	0.504 ***
	VIX	-0.231 ***	-0.237 ***	-0.273 ***	-0.264 ***	-0.257 ***	-0.258 ***	-0.252 ***	-0.259 ***
	AD_RGDP	0.003	0.001	0.014	0.012	0.015	0.009	0.013	0.009
A-InD	NFA/GDP	0.272 **	0.197	0.202 ***	0.141	0.377 ***	0.243	0.085	0.067
	REX	-1.136 ***	-0.928 ***	-0.473	-0.748 ***	-0.258	-0.723 ***	-0.746 ***	-1.002 ***
	M2/GDP	1.244 ***	1.385 ***	2.004 ***	1.895 ***	2.203 ***	1.668 ***	2.267 ***	1.799 ***
	VIX	-0.187 ***	-0.224 ***	-0.097 ***	-0.106 ***	-0.148 ***	-0.127 ***	-0.118 ***	-0.102 ***
	AD_RGDP	0.002	0.001	0.005	0.005	0.009	0.004	0.006	0.003
R-sq	within	0.608	0.608	0.625	0.624	0.635	0.633	0.633	0.631
	between	0.112	0.166	0.340	0.388	0.187	0.224	0.203	0.239
	overall	0.141	0.185	0.352	0.398	0.202	0.240	0.218	0.254

Note: On the left side of the table, PERIOD OF WEIGHT: 2001-05 stands for periodic average value of the weight matrix during 2001–2005. On the right side of the table, PERIOD OF WEIGHT: 2009-13 stands for the average value of weight matrix during 2009–2013. DEBT_WEIGHT and EQUITY_WEIGHT respectively denote the weight matrices. NO_WEIGHT denotes non-spatial panel estimation. FIXED and RANDOM respectively denote fixed and random effect models. *** and ** respectively denote significance of 1% and 5% levels.

Table 3. Results of OECD countries

Interval:		PERIOD OF WEIGHT: 2001-13									
Weight:		DEBT_WEIGHT				EQUITY_WEIGHT				NO_WEIGHT	
Type:		FIXED		RANDOM		FIXED		RANDOM		FIXED	RANDOM
Model:		(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
ρ		0.636 ***	0.630 ***	0.625 ***	0.617 ***	0.548 ***	0.533 ***	0.538 ***	0.521 ***		
β	NFA/GDP	0.264 **	0.269 **	0.229	0.235	0.300 **	0.312 **	0.259	0.273 **	0.396 **	0.304
	REX	−0.607 ***	−0.603 ***	−0.436 ***	−0.432 ***	−0.635 ***	−0.627 ***	−0.425 ***	−0.418 ***	−1.372 ***	−0.683 ***
	M2/GDP	0.136	0.134	0.184	0.182	0.146	0.144	0.209	0.206	0.692 ***	1.086 ***
	VIX	−0.094	−0.076	−0.110 **	−0.086	−0.072	−0.048	−0.104	−0.074	−0.155 **	−0.243 ***
	AD_RGDP		0.005		0.007		0.010		0.012	−0.008	−0.014
θ	NFA/GDP	−0.654	−0.640	−0.516	−0.501	0.386	0.288	0.314	0.194		
	REX	0.311	0.307	0.284	0.281	0.316	0.324	0.279	0.290		
	M2/GDP	0.582 **	0.614 **	0.651 **	0.691 **	0.275	0.397	0.453	0.600		
A−Dir	NFA/GDP	0.217	0.226	0.204	0.203	0.343 ***	0.342 ***	0.297 **	0.294 **		
	REX	−0.599 ***	−0.597 ***	−0.426 ***	−0.426 ***	−0.622 ***	−0.615 ***	−0.415 ***	−0.408 ***		
	M2/GDP	0.205	0.204	0.254 **	0.257 **	0.173	0.178	0.247 **	0.253 **		
	VIX	−0.101	−0.081	−0.116 **	−0.091	−0.075	−0.049	−0.108	−0.077		
	AD_RGDP		0.007		0.009		0.012		0.014		
A−InD	NFA/GDP	−1.200	−1.142	−0.636	−0.860	1.446	1.068	1.278	0.728		
	REX	−0.053	−0.124	0.074	−0.003	0.095	0.052	0.121	0.104		
	M2/GDP	1.795 **	1.827 **	1.845 **	1.996 ***	0.710	0.976	1.065	1.406 **		
	VIX	−0.169	−0.123	−0.173 **	−0.132	−0.084	−0.046	−0.111	−0.071		
	AD_RGDP		0.011		0.013		0.013		0.014		
R−sq	within	0.744	0.747	0.739	0.743	0.746	0.748	0.739	0.742	0.661	0.617
	between	0.280	0.281	0.317	0.319	0.294	0.298	0.340	0.346	0.306	0.393
	overall	0.295	0.295	0.338	0.340	0.305	0.310	0.359	0.366	0.304	0.395

Note: PERIOD OF WEIGHT: 2001-13 stand for periodic average of weight matrices during 2001–2013. DEBT_WEIGHT and EQUITY_WEIGHT denote weight matrices. NO_WEIGHT denotes non-spatial panel estimation. FIXED and RANDOM respectively denote fixed and random effect models. *** and ** respectively denote significance of 1% and 5% levels.

Table 4. Results of Non-OECD countries

Interval:		PERIOD OF WEIGHT: 2001-13									
Weight:		DEBT_WEIGHT				EQUITY_WEIGHT				NO_WEIGHT	
Type:		FIXED		RANDOM		FIXED		RANDOM		FIXED	RANDOM
Model:		(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)
ρ		0.334 ***	0.331 ***	0.319 ***	0.316 ***	0.293 ***	0.289 ***	0.241 ***	0.239 ***		
β	NFA/GDP	0.228 ***	0.225 ***	0.243 ***	0.239 ***	0.194 ***	0.190 ***	0.216 ***	0.212 ***	0.243 ***	0.215 ***
	REX	−0.551 ***	−0.549 ***	−0.343 ***	−0.340 ***	−0.335 ***	−0.334 ***	−0.281 ***	−0.281 ***	−1.056 ***	−0.542 ***
	M2/GDP	0.683 ***	0.678 ***	0.710 ***	0.703 ***	0.582 ***	0.576 ***	0.678 ***	0.670 ***	0.883 ***	1.103 ***
	VIX	−0.290 ***	−0.314 ***	−0.282 ***	−0.320 ***	−0.260 ***	−0.298 ***	−0.277 ***	−0.323 ***	−0.54 ***	−0.539 ***
	AD_RGDP	0.000 ***	−0.006	4.337 ***	−0.010	0.000 ***	−0.010	3.059 ***	−0.012	−0.039 ***	−0.046 ***
θ	NFA/GDP	0.049 **	0.045	0.031	0.026	−0.030	−0.035	−0.014	−0.020		
	REX	−0.249	−0.254	−0.527 ***	−0.524 ***	−0.767 ***	−0.769 ***	−0.804 ***	−0.794 ***		
	M2/GDP	0.594 ***	0.582 ***	0.444 **	0.434 **	1.288 ***	1.278 ***	1.057 ***	1.051 ***		
A-Dir	NFA/GDP	0.232 ***	0.229 ***	0.245 ***	0.241 ***	0.194 ***	0.190 ***	0.217 ***	0.212 ***		
	REX	−0.555 ***	−0.553 ***	−0.357 ***	−0.355 ***	−0.359 ***	−0.357 ***	−0.301 ***	−0.302 ***		
	M2/GDP	0.720 ***	0.712 ***	0.737 ***	0.730 ***	0.648 ***	0.637 ***	0.721 ***	0.713 ***		
	VIX	−0.293 ***	−0.317 ***	−0.284 ***	−0.323 ***	−0.263 ***	−0.301 ***	−0.279 ***	−0.324 ***		
	AD_RGDP		−0.004	0.000 ***	−0.008	0.000 ***	−0.008	0.000 ***	−0.010		
A-InD	NFA/GDP	0.199 ***	0.185 ***	0.163 ***	0.147 **	0.045	0.033	0.054	0.041		
	REX	−0.584 **	−0.624 ***	−0.923 ***	−0.934 ***	−1.125 ***	−1.146 ***	−1.093 ***	−1.097 ***		
	M2/GDP	1.262 ***	1.169 ***	0.895 ***	0.887 ***	1.997 ***	1.913 ***	1.480 ***	1.481 ***		
	VIX	−0.149 ***	−0.150 ***	−0.125 ***	−0.140 ***	−0.107 ***	−0.113 ***	−0.082 ***	−0.094 ***		
	AD_RGDP		−0.002		−0.003		−0.003		−0.003		
R-sq	within	0.534	0.534	0.537	0.536	0.589	0.589	0.585	0.585	0.474	0.451
	between	0.214	0.217	0.294	0.303	0.225	0.224	0.249	0.248	0.207	0.279
	overall	0.230	0.233	0.314	0.319	0.240	0.239	0.264	0.264	0.208	0.281

Note: PERIOD OF WEIGHT: 2001-13 stand for periodic average of weight matrices during 2001–2013. DEBT_WEIGHT and EQUITY_WEIGHT denote weight matrices. NO_WEIGHT denotes non-spatial panel estimation. FIXED and RANDOM respectively denote fixed and random effect models. *** and ** respectively denote significance of 1% and 5% levels.