

# Determinants of Financial Market Spillovers: The Role of Portfolio Diversification, Trade, Home Bias, and Concentration



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## Determinants of Financial Market Spillovers: The Role of Portfolio Diversification, Trade, Home Bias, and Concentration

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**IMF Working Paper**

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**Determinants of Financial Market Spillovers: The Role of Portfolio Diversification,  
Trade, Home Bias, and Concentration****Prepared by Yoko Shinagawa<sup>1</sup>**

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**Abstract**

This paper defines financial market spillovers as the comovement between two countries' financial markets and analyzes financial market spillovers over the period 2001-12 through four channels: bilateral portfolio investment, bilateral trade, home bias, and country concentration. The paper finds that, if a country has a large amount of bilateral portfolio exposure in another country, these two countries' comovement of bond yields are large. Also, countries' geographical preferences impact financial spillovers; if a country has a stronger home bias, the country could have less spillovers from foreign financial markets. A policy implication from this result is that, if countries become less home-biased and have a greater amount of portfolio investment assets, they should strengthen prudential regulations to mitigate against rising risks of financial spillovers (or risk greater volatility owing to comovement with foreign markets).

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<b>Contents</b>	<b>Page</b>
I. Introduction .....	<a href="#">4</a>
II. Financial Market Spillovers: What's Involved .....	<a href="#">5</a>
A. Concepts and Definitions of Financial Market Spillovers .....	<a href="#">5</a>
B. Spillover Channels .....	<a href="#">6</a>
III. Data .....	<a href="#">8</a>
IV. Financial Market Spillovers: Stylized Facts and Possible Determinants .....	<a href="#">11</a>
V. Empirical models and results .....	<a href="#">15</a>
A. Model .....	<a href="#">15</a>
B. Empirical Results .....	<a href="#">16</a>
VI. Conclusion and Future Research .....	<a href="#">20</a>
VII. References .....	<a href="#">19</a>
 <b>Figures</b>	
1. Average Bilateral Correlation .....	<a href="#">13</a>
2. Geographical Portfolio in Percent of GDP for Selected Advanced Economies .....	<a href="#">13</a>
3. Geographical Portfolio in Percent of GDP for Selected Emerging Economies.....	<a href="#">14</a>
4. Equity Home Bias for Advanced Economies (average during 2001-2012) .....	<a href="#">14</a>
5. Equity Return Correlation for Advanced Economies (average during 2001-2012) .....	<a href="#">15</a>
 <b>Tables</b>	
1. Summary Statistics .....	<a href="#">11</a>
2. Equity Correlation in 2012 between Advanced Economies .....	<a href="#">12</a>
3. Determinants of Equity Market Spillover .....	<a href="#">17</a>
4. Determinants of Bond Market Spillover .....	<a href="#">18</a>
 <b>Appendix</b>	
1. Summary Statistics .....	<a href="#">11</a>

## I. INTRODUCTION

Since the onset of the 2008 global financial crisis, economic and financial shocks have been greatly transmitted throughout the world. Financial markets are highly interconnected worldwide and, consequently, negative shocks in one country have spilled over into other countries.

Financial market spillovers can be thought of as the correlation between two countries' financial market returns, for example, on equity or debt markets. This paper attempts to assess what determines financial market spillovers.

To address this issue, the paper analyzes possible transmission channels based on: (i) bilateral portfolio investment; (ii) real economic linkages measured by bilateral trade; and (iii) geographical preference of portfolio investment—whether a country geographically diversifies its investment or invests more in domestic markets—captured by a home bias and country concentration index, respectively.

With regard to bilateral portfolio investment, we might expect, *ex ante*, larger spillovers between countries with larger portfolio exposures as a result of financial shocks, and this is what we find in the paper. Other things being equal, data from the Coordinated Portfolio Investment Survey (CPIS) collected by the IMF's Statistics Department shows a positive and significant relationship in financial market returns between countries with extensive financial linkages. CPIS is a global survey of portfolio investment holdings and contains information on bilateral cross-border holdings of equities and debt securities.<sup>2</sup>

Real sector linkages—through bilateral trade—could play a role in spillovers through deepening financial relations between countries. This paper assesses whether real economic linkages through bilateral trade play a role in deepening financial linkages between two countries. In theory, as countries trade more intensely, they become more vulnerable to income shocks that could adversely affect aggregate demand and subsequently, lead to weaker returns on assets in that country. At the same time, financial markets in the other country could also be adversely affected through reduced demand for exports.

With regard to geographical preference of portfolio investment, the paper's results indicate that geographic diversification also matters. Put another way, international portfolio diversification could affect financial spillovers. This transmission channel is assessed through the home bias, defined as the extent to which a country's holdings of own financial assets deviates from the share of an international portfolio; and country concentration, defined as the extent a country's investment portfolio deviates from a “benchmark” international portfolio. Indeed, if a country has a diversified portfolio (*low concentration* country), it should have greater resilience against shocks, because diversifying portfolio assets can help the country reduce the concentration of risks of holding exposure to one

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<sup>2</sup> Foreign direct investment (FDI) can also affect financial market spillover and bilateral FDI information is available from the IMF's Coordinated Direct Investment Survey (CDIS) dataset. However, this paper does not use this dataset because of the limited availability of its time series data (only from 2009) and of possibly less direct impact of FDI on financial markets.

country. Likewise, a country with a stronger home bias would be less affected from financial spillovers because of its lower financial-market exposure to external shocks.

This paper contributes to the literature by finding that: (i) bilateral asset holdings (captured by the CPIS) affect financial spillovers between two countries and (ii) countries' geographical preferences affects financial market spillovers. With respect to the first point, IMF (2014) suggests that financial linkage through bank exposure, foreign direct investment, and portfolio investment can cause financial spillovers.<sup>3</sup> Using stock and flow data, Forbes (2012) empirically investigated financial market spillovers through trade, bank exposure, portfolio investment exposure, and portfolio inflows. This paper features the analyses of how financial market spillovers is explained by the size of bilateral asset holding. With respect to the second point, the contribution of this paper is that it explains bilateral financial spillovers by country-level geographical portfolio preferences. It should be noted that because of the lack of relevant data, country-level geographical preference in connection with financial market spillovers has been less exploited.<sup>4</sup> Sørensen *et al.* (2007) calculated country-level home bias using commercial data distributed by Standard & Poor's and found that home bias is associated with international risk sharing defined by equalization of consumption growth. Sialm *et al.* (2014) focus on hedge funds' home bias and it creates excess comovement and spillovers in financial markets. Using the CPIS, Brushko and Hashimoto (2014) introduced the concept of country-level portfolio concentration from the work on hedge fund's portfolio diversification/concentration done by Kacperczk, Sialim and Zheng (2004).

The rest of this paper is organized as follows. Section II discusses the notion of financial market spillovers used in the paper, as well as elaborating on the theoretical background on the channels of financial market interconnection/integration. Section III describes the data. Section IV presents the stylized facts on financial spillovers and their determinants. Section V presents the empirical model and its estimation, and the results. Section VI concludes and offers some suggestions for future research.

## II. FINANCIAL MARKET SPILLOVERS: WHAT'S INVOLVED

### A. Concepts and Definitions of Financial Market Spillovers

In a broader sense, spillovers refer to the impact of shocks or policy changes in one country on another because of the large volume of trade or financial linkages.<sup>5</sup> Spillovers can take various forms; for example, shocks in country X can adversely affect country Y's economic growth if these two countries have stronger economic or financial ties. Spillovers can take place in financial markets, observed by financial market indicators' comovement worldwide. This paper focuses on the spillovers in financial markets and its determinants.

In this paper, (bilateral) financial market spillovers are defined as the comovement of equity return or bond yields between two countries. As pointed out in Forbes and Rigobon (2002),

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<sup>3</sup> Empirical work was not provided on this front in IMF (2014).

<sup>4</sup> To conduct such research, comprehensive information on bilateral portfolio holdings is indispensable. However, annual CPIS data has only been released in 2002 with only 29 economies. Over time, the number of CPIS reporters has increased to 78 economies.

<sup>5</sup> IMF (2011) provides a comprehensive discussion on spillovers.

standard correlation coefficients as proxies for spillovers may raise the problem of heteroskedasticity and are potentially biased. Therefore, they propose an “adjusted correlation coefficient”, which accounts for this bias by assuming that only one country causes shocks to be transmitted to the other country and that there are no exogenous global shocks. In this context, this paper calculates the adjusted correlation coefficients as well as standard correlation coefficients.

Regarding the use of stock market returns in the context of financial market spillovers, Forbes (2012) for example, focused on returns in equity markets since: (i) equity returns should incorporate all available information on the expected profitability of companies in a country and capture expected changes in real indicators; (ii) equity returns are available at a high frequency; and (iii) other market measures such as credit default swap and bond spreads are often unavailable for a long time series.

In comparison, Bunda *et al.* (2010) use the correlation of bond returns to assess financial spillovers in emerging markets. They argue that using a simple measure of cross-country correlations together with the commonly used average correlation coefficient can be informative during episodes of heightened market instability.

To examine the determinants of stock market vulnerability defined by local markets’ comovement with the United States (US), Didier *et al.* (2010) analyzed the comovement between monthly stock returns of the US and those of each country in the sample. They argued that each markets’ correlation vis-à-vis the US market is interacted with country-level characteristics that affect comovement such as real and financial linkages between it and each country.

## **B. Spillover Channels**

As noted earlier, we focus in this paper on four possible channels through which financial market spillovers can occur: (i) bilateral portfolio investment, (ii) bilateral trade, (iii) home bias, and (iv) country concentration, and these are elaborated below.

### **Bilateral Portfolio Investment**

Intuitively, if there is a large bilateral linkage in terms of portfolio investment, the correlation of their financial markets would be larger. If a country X has a large amount of its securities owned by residents of country Y, a domestic shock that occurs in country Y could affect country X’s financial market. Kodres and Pritsker (2002) explain financial contagion, for example, through cross-market rebalancing of portfolios using a rational expectations model of financial markets. In their model, investors transmit idiosyncratic shocks to another market by adjusting their portfolios’ exposures. Meanwhile, Forbes (2012) shows that international investment positions and portfolio inflows have increased for advanced economies since the late 1990s, suggesting that this is a factor causing increased contagion over time. Forbes also constructed a model in which market contagion is explained by portfolio investment: both exposures (stocks) and inflows.

In assessing bilateral linkages, the measurement of a portfolio is also an issue to address. In this paper, asset holdings are used to represent bilateral investment. This is in line with Forbes (2012), who argues that the summation of assets and liabilities affects the contagion

of financial markets; likewise IMF (2013) notes that the summation of assets and liabilities affects business cycle comovement. Lane *et al.* (2006) on the other hand, point out that net foreign assets (NFA) can play an important role in determining contagion in the sense that a country with larger NFA can be resilient to global shocks.

### **Bilateral Trade (Merchandise)**

If two countries have greater bilateral trade linkages, the financial linkages between the two are expected to be larger. For example, if country X has a domestic economic shock and aggregate demand declines, the exports of its trade partner, Y, would also shrink, which could result in adverse affects on both countries' financial markets. Also, supply chain implications—represented by the distribution of manufacturing processes over more than one country—might accelerate financial market spillovers. In this case, if country Z and country W are linked through a major supply chain (i.e., country Z has production facilities in country W), a domestic shock in country Z and subsequent decline in production could adversely affect country Z's stock markets. This could cause a decline in imports from W's factories to country Z and at the same time impact country W's stock markets.

### **Home Bias**

French and Poterba (1991) and Coeurdacier and Rey (2011) argue a well-known puzzle in international finance: assuming that there is no friction in international financial markets and that investors are homogenous, the Capital Asset Pricing Model (CAPM) model would predict that an investor's portfolio should be equal to the world market portfolio. In reality, many investors have bias towards their own countries' securities—so-called home bias; this is because financial markets are not frictionless, investors are not homogenous, there are information asymmetries; and there are additional transaction costs for international securities trades. In this context, Faraqee *et al.* (2004) indicate that, based on empirical analysis using the CPIS data, market size, transaction costs, and information asymmetries are major factors behind home bias when applying the CPIS data to a consumption-based asset-pricing model that accommodates transaction costs.

In this context, home bias is often measured as the deviation of an investor's (or a country's) actual holding of securities from the benchmark global portfolio. If a country's portfolio is identical to the global portfolio, its home bias is considered to be equal to zero, while a country has a perfect home bias if it has no foreign asset holdings.

A country's home bias can affect financial market spillovers in two different ways. First, higher home bias can help maintain spillovers or external financial shocks under control, because domestic investors are less subject to fluctuation in returns from foreign financial markets, leading to less financial market spillovers. In contrast, a lesser degree of home bias and the diversification of an international portfolio can provide a country with a hedge against spillovers because such a country would receive higher and stable foreign asset income that could function as buffer. Sørensen *et al.* (2007) and Lewis (1999) argue that home bias can be related to international risk contagion in the sense that less home bias helps a country to be resilient against risks. This is because domestic shocks are partly offset by foreign asset income, and higher home bias can lead to greater contagion from outside of the country.



## Country Concentration

Country concentration measures the extent to which a country has geographically concentrated (or diversified) portfolio investment, and can increase or decrease financial market spillovers depending on the way a country diversifies (or less concentrates) its portfolio. A country with higher concentration in its international equity portfolio assets can be vulnerable and have higher risks of financial spillovers because a shock in a portfolio destination can easily transmit to the country's domestic market. However, as long as a country manage risks while concentrating on its portfolio investment to a countries with higher returns, the gain from investment could help it to mitigate spillovers. In this sense, there is a possibility that a country with higher concentration in its international portfolio assets could gain higher return as long as it can mitigate risks, which would enable the country to contain spillovers.<sup>6</sup> On the other hand, lower concentration and greater geographical diversification could enhance resilience from a shock stemming from a destination country. For debt securities, this argument could hold to a lesser degree, given that investors in general invest in bond markets not for returns but for risk avoidance.

Brushko and Hashimoto (2014) calculated a “country concentration index (CCI)” to measure the extent to which the portfolio of a country deviates from a benchmark (or average) portfolio investment, using CPIS data. According to their results, the sensitivity of the international investment position (IIP) to macroeconomic variables depends on the level of CCI, i.e., low-concentration type countries respond strongly to macroeconomic variables.

### III. DATA

This section explains the definition and calculation of each variable.

#### Financial Market Spillovers

To determine financial market spillovers, the paper uses weekly data of equity index and 10-year bond yields from Bloomberg over the period 2001-12. From these data, pair-wise correlations of equity index and bond yields between all possible pairs of the sample countries in a year are calculated.

For the equity index, both the correlation of the bilateral equity index, as well as the correlation of bilateral equity returns were calculated. The equity index source data for each country is listed in Appendix 1. For the 10-year government bond yields, the benchmark 10 year bond yield data available from Bloomberg are used.

The 42 sample countries shown in Appendix 1 are chosen on the basis of availability of the data through the CPIS, IIP, and Bank for International Settlements (BIS) securities statistics.<sup>7</sup>

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<sup>6</sup> Kacperczyk *et. al.*(2004) argue that equity fund managers with higher industry concentration tend to have higher returns in their overall portfolio. While this paper focuses on a country's portfolio patterns and not on private fund managers, their argument could hold for the discussion in this paper.

<sup>7</sup> Two financial center economies are included in the sample, which are Hong Kong and Switzerland. Equation (4) in Section V below was estimated over the full sample countries as well as the sample excluding these

(continued...)

As pointed out in section II, to address the concern over potential bias, this paper calculates adjusted correlation coefficients. The adjusted correlation  $\rho_t$  is calculated as in equation (1).

$$\rho_t = \frac{\rho_t^c}{\sqrt{1 + \delta[1 - (\rho_t^c)^2]}} \quad (1)$$

where,  $\rho_t^c$  is the unadjusted correlation and  $\delta$  is the relative increase in the variance in the country that causes shocks to be transmitted.<sup>8</sup>

### Portfolio Investment

Bilateral portfolio investment data come from the IMF's Coordinated Portfolio Investment Survey (CPIS) database covering 2001-12.<sup>9</sup> CPIS is the collection of comprehensive position data on a bilateral basis of portfolio investment assets, i.e., the amount of a country's resident sector's holding of portfolio investment issued by non-residents. Since 2001, the CPIS has been released annually and the data are broken down into equity and debt securities; with debt securities further broken down into short- and long-term maturities. On the other hand, the CPIS dataset has shortcomings. Its country coverage is not complete with 78 reporting economies as of end-2012. Also, liabilities are reported as "encouraged items" by only some reporting economies and derived liabilities are estimated based on holdings.

### Home Bias

As noted above, home bias is defined as the deviation of a country's holding of own assets from a diversified benchmark international portfolio allocation. Thus, home bias is 0 if the share of country  $j$ 's portfolio investment that is invested domestically equals the share of country  $j$ 's market size (market capitalization) in the total world market size. Home bias is 1 if the country does not hold foreign equity.

For equities, using IIP, CPIS, and the World Bank's World Development Indicators, home bias (HB) is measured in equation (2) following the approach of Sørensen *et al* (2007):

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financial centers. The results with the full sample countries (reported in Tables 4 and 5) were broadly consistent with those without the financial centers.

<sup>8</sup> Following Forbes and Rigobon (2002),  $\delta$  is defined as the relative increase in variance by dividing the sample into two groups within a country  $x$  (the years with high variance  $\sigma_{xx}^h$ , and those with low variance  $\sigma_{xx}^l$ ).

<sup>9</sup> The CPIS data are available from <http://cpis.imf.org/>.

$$\begin{aligned}
 HB_i &= 1 - \frac{\text{share of country } i\text{'s holding of foreign equity security in country } i\text{'s total portfolio investment}}{\text{country } i\text{'s market share of the world}} \\
 &= 1 - \frac{\frac{\text{total foreign equity security held by country } i}{\text{country } i\text{'s total equity portfolio}}}{1 - \frac{\text{equity capitalization of a country } i}{\text{equity capitalization of the world}}}
 \end{aligned}$$

where, country  $i$ 's total equity portfolio

= domestic equity holding in country  $i$  + total equity holding in country  $i$   
 – amount of country  $i$ 's equity held by foreigners

(2)

The term “amount of a country’s equity held by foreigners” is calculated using CPIS, and has some limitations due to the CPIS dataset’s limited country coverage. While this term, in theory, should be the rest of the world’s holding of the equity of country  $i$ , it actually only measures the holding of CPIS reporters.

For debt securities, home bias is measured as in equation (3)

$$\begin{aligned}
 HB_i &= 1 - \frac{\text{share of country } i\text{'s holding of foreign debt security in country } i\text{'s total portfolio investment}}{\text{country } i\text{'s market share of the world}} \\
 &= 1 - \frac{\frac{\text{total foreign debt security held by country } i}{\text{domestic debt security outstanding in country } i + \text{total foreign debt securities in country } i}}{1 - \frac{\text{debt security capitalization of a country } i}{\text{debt market capitalization of the world}}}
 \end{aligned}$$

(3)

The database for IIP can be found at <http://www.imf.org/external/data.htm>

Data for total foreign debt securities held by each country come from the IMF’s IIP database, while data for domestic securities outstanding and total foreign debt securities come from the BIS’ securities statistics. These are the outstanding debt instruments issued by non-residents and residents in a country. Currently the data on amount held by institutional units (agents) are not available; thus, the securities data used only reflect the amounts issued.

### Country Concentration Index

Kacperczk *et al.* (2004) introduced the concept of industry concentration index to quantify the extent of a fund’s portfolio concentration in a set of ten industries. In line with Brushko and Hashimoto (2014), this paper extends the notion of the CCI by calculating an index that tracks how a country’s portfolio investment deviates from the benchmark portfolio as shown in equation (4) below.

$$CCI_{i,t} = \sum_{j=1, j \neq i}^N (\omega_{i,j,t} - \bar{\omega}_{j,t})^2 \quad (4)$$

where

$\omega_{i,j,t}$  is the share of total assets of country  $i$  invested into country  $j$  in year  $t$   
 $\bar{\omega}_{j,t}$  is the world average share of total assets invested in country  $j$  in year  $t$

The CPIS and IIP data are used to calculate this index, for both debt and equity securities.

Summary statistics for the variables are shown in Table 1.

**Table 1. Summary Statistics**

Variable	Obs	Mean	Std. Dev.	Min	Max
Equity market bilateral correlation	11306	0.185	0.283	-1.000	1.000
Bond market bilateral correlation	11308	0.305	0.364	-0.901	0.998
Bilateral equity portfolio investment as of GDP	8887	0.008	0.029	-0.001	0.723
Bilateral debt portfolio investment as of GDP	8651	0.010	0.030	0.000	0.392
Bilateral trade as of GDP	11177	0.021	0.066	0.000	1.816
Home bias for equity	10864	0.623	0.364	-0.950	1.000
Country Concentration for equity	7072	0.132	0.161	0.009	0.888
Country Concentration for debt securities	7322	0.493	4.054	0.006	0.530

#### IV. FINANCIAL MARKET SPILLOVERS: STYLIZED FACTS AND POSSIBLE DETERMINANTS

The degree of financial market interconnectedness and potential spillovers may differ by country and depend on the degree of financial development and depth; thus, advanced countries tend to show greater financial interconnectedness compared with emerging countries. This is particularly the case for equity markets, which are typically deeper and more developed in advanced countries reflecting more sophisticated and transparent legal and governance structures and greater supply of products, which attract a larger share of inflows. Figure 1 shows the average weekly bilateral correlations in equity returns and bond yields for non-euro advanced economies, euro area countries, and emerging economies. The figure indicates that bilateral correlations in equity markets tend to be higher for euro and lower for emerging economies, and the same generally holds for bond markets with some observed anomaly since 2008, probably because of market participants' sensitivity to the onset of the global financial crisis. The higher financial market correlation for euro area countries partly reflects higher comovement between pairs of euro area countries, as shown in Table 1 for equity-return correlations between advanced economies, including those from the euro area in 2012.

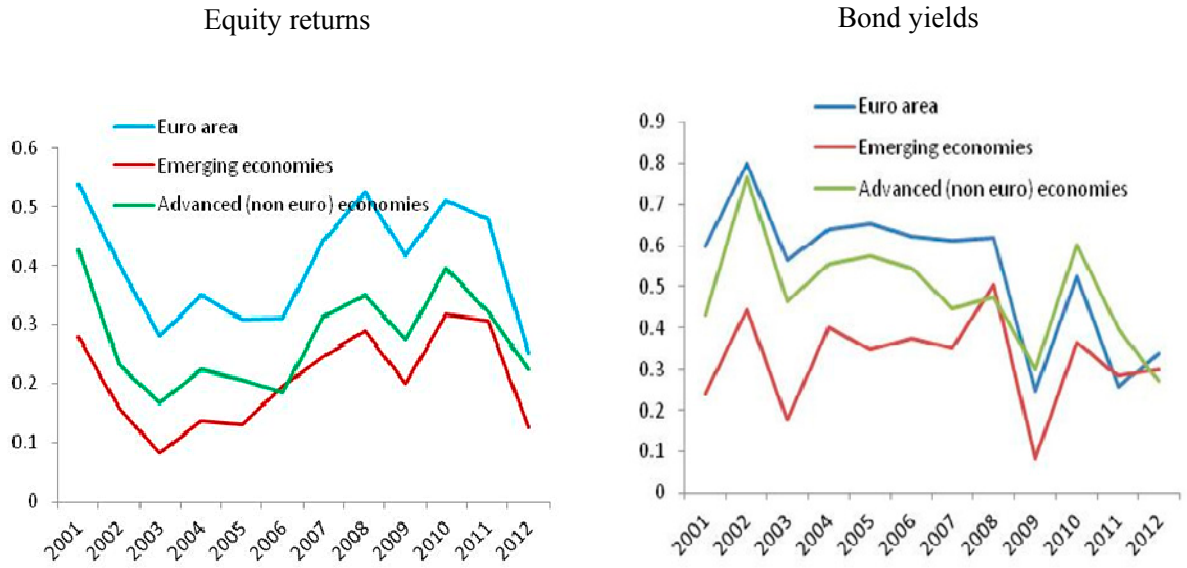
**Table 2. Equity Correlation in 2012 between Advanced Economies**

	USA	UK	Belgium	Denmark	France	Germany	Italy	Netherlands	Norway	Sweden	Switzerland	Canada	Japan	Iceland	Spain	Australia	NZ
<b>USA</b>	1.00																
<b>UK</b>	0.83	1.00															
<b>Belgium</b>	0.73	0.85	1.00														
<b>Denmark</b>	0.24	0.24	0.21	1.00													
<b>France</b>	0.82	0.92	0.87	0.23	1.00												
<b>Germany</b>	0.82	0.88	0.82	0.22	0.92	1.00											
<b>Italy</b>	0.77	0.85	0.84	0.24	0.91	0.86	1.00										
<b>Netherlands</b>	0.77	0.89	0.88	0.22	0.93	0.89	0.86	1.00									
<b>Norway</b>	0.16	0.18	0.17	0.75	0.17	0.16	0.17	0.17	1.00								
<b>Sweden</b>	0.14	0.16	0.11	0.74	0.16	0.15	0.17	0.14	0.73	1.00							
<b>Switzerland</b>	0.77	0.85	0.79	0.28	0.85	0.82	0.80	0.83	0.23	0.17	1.00						
<b>Canada</b>	0.74	0.79	0.69	0.22	0.77	0.73	0.72	0.74	0.16	0.13	0.68	1.00					
<b>Japan</b>	0.58	0.62	0.54	0.16	0.63	0.62	0.60	0.59	0.07	0.08	0.56	0.61	1.00				
<b>Iceland</b>	0.09	0.01	0.07	0.13	0.03	0.05	0.06	0.06	0.16	0.10	0.01	0.07	0.08	1.00			
<b>Spain</b>	0.74	0.80	0.79	0.21	0.87	0.82	0.88	0.80	0.17	0.15	0.76	0.66	0.54	-0.01	1.00		
<b>Australia</b>	0.64	0.72	0.66	0.16	0.70	0.64	0.68	0.68	0.11	0.09	0.65	0.72	0.66	0.03	0.62	1.00	
<b>NZ</b>	0.13	0.14	0.14	0.49	0.12	0.11	0.10	0.13	0.48	0.41	0.15	0.11	0.08	0.17	0.10	0.07	1.00

Advanced economies have larger and more geographically diversified portfolio investment assets. Figures 2 and 3 show selected advanced and emerging countries' equity and bond portfolio asset holdings by destination. Advanced economies generally have higher exposure as a share of GDP than emerging economies. In particular, the US and UK have relatively higher holdings of emerging economies' equity and debt portfolio, which could imply that they are subject to higher risks of valuation changes in emerging economy securities. Emerging economies have lesser amounts of portfolio investment assets.

Does a country's asset holding pattern such as home bias have any implications for financial market spillovers? Figure 4 depicts equity market home bias and bilateral correlations for equity returns (average during 2001-12) among selected advanced economies. Figure 5 shows bilateral correlations of equity returns (average during 2001-12). The relationship between home bias and bilateral correlation is not evident from these figures but appears to be inversely related. Indeed, for some countries, higher home bias could be associated with a lower degree of market spillovers, indicating the possibility that greater degree of home bias can contain financial spillovers. For example, countries with higher home bias, such as Japan and Iceland, observe lower correlations. On the other hand, UK, Germany, and Switzerland have lower home bias and a greater degree of equity market correlation.

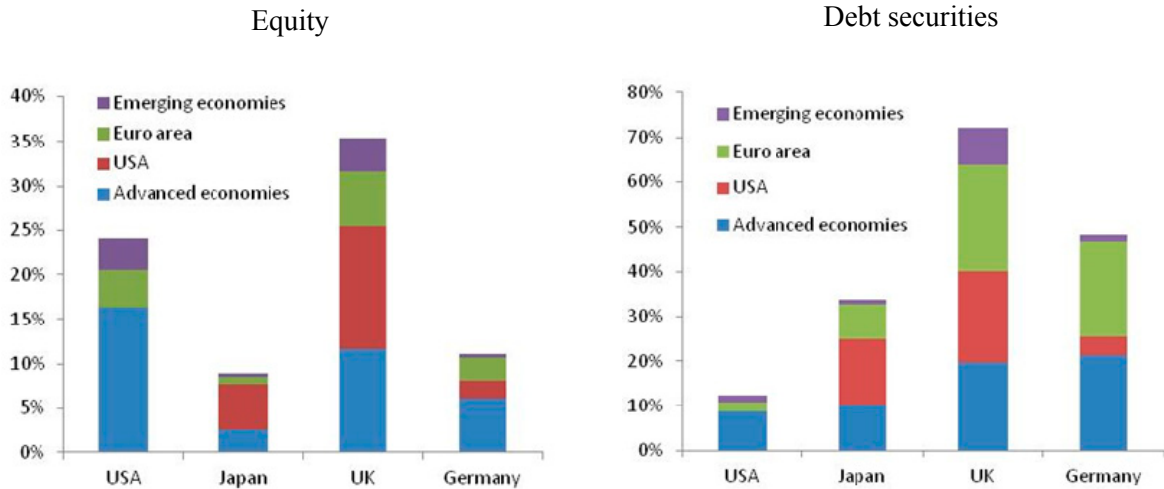
**Figure 1. Average Bilateral Correlation**



Source: Bloomberg

Note: The classification of emerging and advanced economies follows that of WEO.

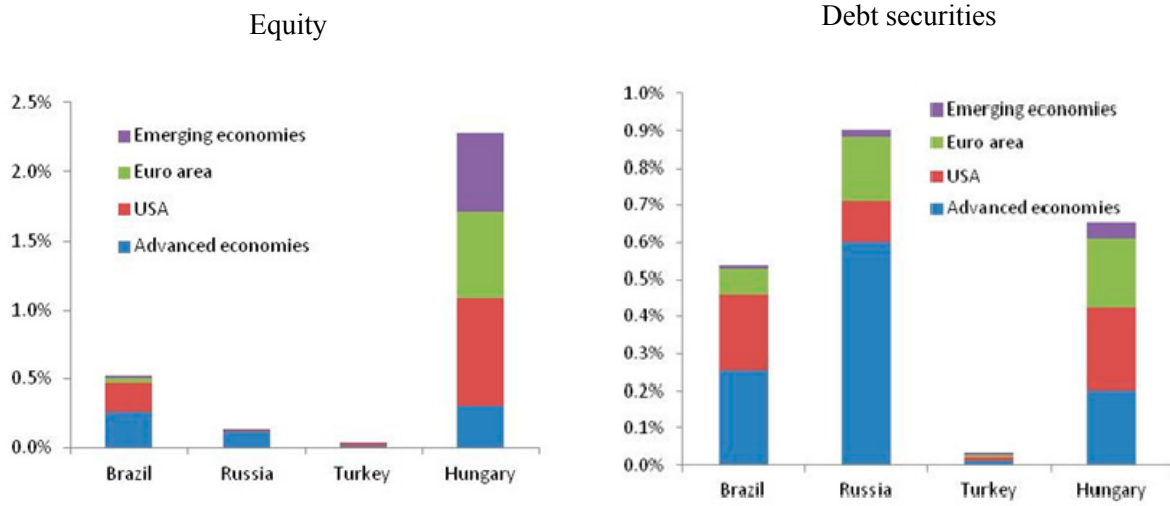
**Figure 2. Geographical Portfolio in Percent of GDP for Selected Advanced Economies**



Source: CPIS

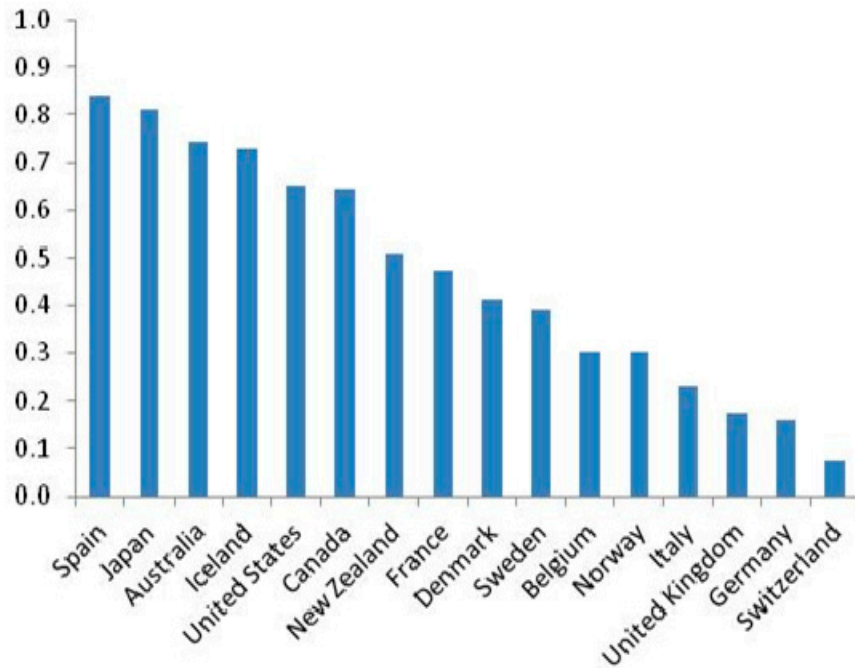
Note: The data are 2012

**Figure 3. Geographical Portfolio in Percent of GDP for Selected Emerging Economies**

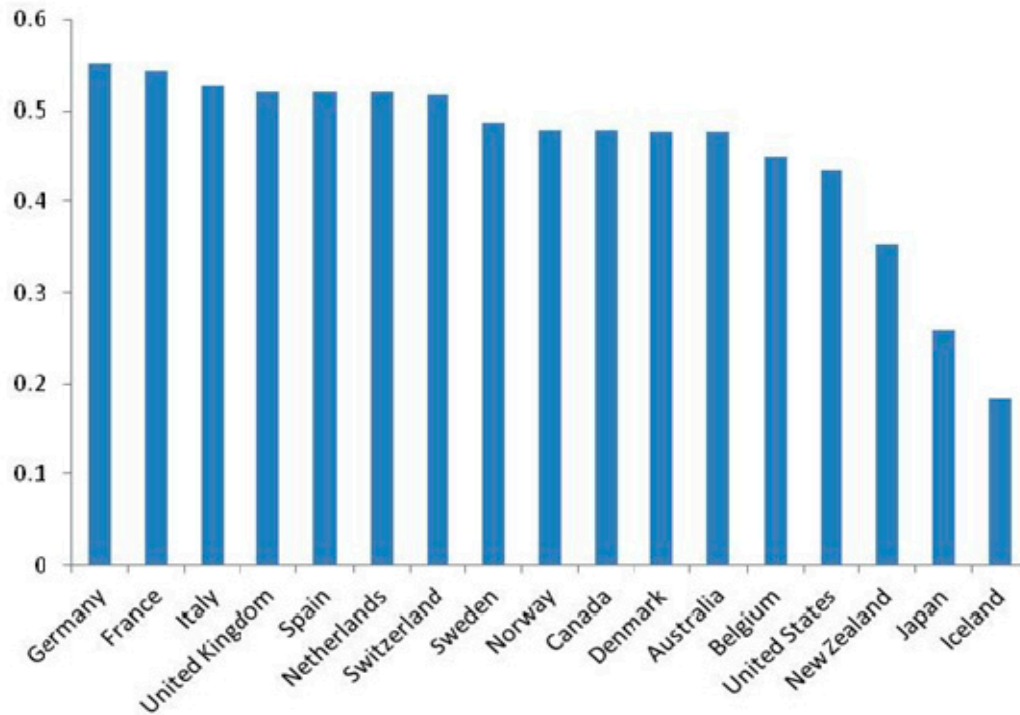


Source: CPIS  
 Note: The data are 2012

**Figure 4. Equity Home Bias for Advanced Economies (average during 2001-2012)**



Sources: IMF, World Bank  
 Note: Definition of Home Bias is given in Section III of this paper

**Figure 5. Equity Return Correlation for Advanced Economies (average during 2001-2012)**

Source: Bloomberg

## V. EMPIRICAL MODELS AND RESULTS

### A. Model

To empirically assess the four channels of financial market spillovers discussed above, the paper proposes a model which features the spillover for equity or bond markets as a function of these channels. The Arellano–Bond (1991) Generalized Method of Moments (GMM) estimation is used to estimate the model since some serial correlation was detected in the data. The estimation is applied to dynamic panel data with the lagged dependent variables as an instrument variable as in the following regression (equation 4), which is run over all sample countries (advanced economies (non-euro), euro zone countries, and emerging economies). To examine whether these spillover channels become more or less substantial during the 2008-2010 crisis, a separate model (equation 5) was estimated which include interaction terms of crisis dummies and spillover channels.



$$\text{Corr}(R_{i,\tau,t}, R_{j,\tau,t}) = \beta_0 + \beta_1 \text{Corr}(R_{i,\tau,t-1}, R_{j,\tau,t-1}) + \beta_2 Y_{i,j,t-1} + \beta_3 \text{Trade}_{i,j,t} + \beta_4 \text{HB}_{i,t-1} + \beta_5 \text{CCI}_{i,t-1} + \beta_6 \text{Dummy}_t \times Y_{i,j,t-1} + \beta_7 \text{Dummy}_t \times \text{Trade}_{i,j,t} + \beta_8 \text{Dummy}_t \times \text{HB}_{i,t-1} + \beta_9 \text{Dummy}_t \times \text{CCI}_{i,t-1} + u_{i,j,t} \quad (5)$$

where

$\text{Corr}(R_{i\tau\tau}, R_{j\tau\tau})$  is the correlation of the equity returns (or bond yields) in the week  $\tau$ , between country  $i$ 's equity (or bond) securities and country  $j$ 's equity (or bond) securities in year  $t$ ;

$Y_{i,j,t}$  is portfolio investment of country  $i$  into  $j$  (equity or debt securities) as a share of GDP;

$\text{Trade}_{i,j,t}$  is bilateral trade between  $i$  and  $j$  as a share of GDP;

$\text{HB}_{i,t}$  is the home bias index for country  $i$  in the year  $t$ ;

$\text{CCI}_{i,t}$  is country concentration index for country  $i$  in the year  $t$ ; and

$\text{Dummy}_t$  is a dummy variable for the 2008 financial crisis (1 for 2008, 2009, and 2010).

A large bilateral linkage through portfolio investment asset holding at the beginning of year  $t$ , i.e., larger  $Y_{i,j,t-1}$  could cause greater financial spillovers captured by  $\text{Corr}(R_{i,\tau,t}, R_{j,\tau,t})$ .<sup>10</sup> Real economic linkages from bilateral trade can also enhance financial spillovers. Higher home bias at the beginning of year  $t$  can decrease financial spillovers with domestic investors less affected by foreign markets; however, it could keep a country from gaining higher investment returns and therefore from building buffer against shocks.  $\text{CCI}_{i,t}$  at the beginning of year  $t$  could work in two ways: (i) concentrating on countries with greater returns could provide higher portfolio investment gain as long as risks are well managed, leading to more resilience and less spillovers; and (ii) lower concentration (and greater diversification) can provide more resilience from a shock, leading to lesser financial spillovers.

## B. Empirical Results

Tables 3 and 4 report the estimates of equation (4) for all sample and sub-sample countries and the significance of the various channels of financial market spillovers.

<sup>10</sup> CPIS and IIP data refer to the values at the end of the period. Thus, three of the independent variables in equation (4) are lagged ones.

**Table 3. Determinants of Equity Market Spillover**

This is the estimation results for equation (4) for equity market spillovers. The dependent variable is the correlation in weekly returns of equity between each pair of 42 sample countries over the period from 2001 to 2012. Lagged dependent variable is the value for the dependent variable in the previous period. Bilateral Portfolio Investment is equity portfolio investment of country  $i$  into  $j$  as a share of GDP. Trade is bilateral trade between country  $i$  and  $j$  as a share of GDP. Dummy is the 2008-2010 crisis dummy. Country Concentration is the concentration index for country  $i$  in the year  $t$ . Home Bias is the home bias index for country  $i$  in each year. Year dummies are included but not reported. T-statistics based on The Arellano–Bond (1991) GMM estimation are reported: \* denotes significance at 10%; \*\* at 5%; and \*\*\* at 1%.

	all sample		advanced		euro area		emerging	
Lagged dependent variable	0.6705	***	0.6772	***	0.7702	***	0.5084	***
	(0.0201)		(0.0224)		(0.0208)		(0.0340)	
Bilateral Portfolio Investment	0.5377	***	0.6246	***	0.6188	*	0.9243	***
	(0.1583)		(0.2114)		(0.3295)		(0.3108)	
Trade	-0.0111		-0.1241	***	0.4891	***	0.2705	**
	(0.0897)		(0.0456)		(0.1128)		(0.1167)	
Home Bias	-0.0387	***	-0.0504	**	-0.0120		-0.1196	***
	(0.0095)		(0.0208)		(0.0113)		(0.0319)	
Country Concentration	-0.0453	*	0.0640		-0.1225		-0.0552	
	(0.0277)		(0.0484)		(0.1018)		(0.0345)	
Dummy *Bilateral Portfolio Investment	0.2736		0.2684		-0.5386		1.2505	
	(0.2796)		(0.2025)		(0.3933)		(1.0783)	
Dummy *Trade	-0.0495		-0.0957	*	0.0879		0.2614	*
	(0.0395)		(0.0536)		(0.0883)		(0.1410)	
Dummy *Home Bias	-0.0012		0.0646	***	0.0638	**	-0.0335	**
	(0.0086)		(0.0165)		(0.0260)		(0.0114)	
Dummy *Country Concentration	0.0847	***	-0.0629		0.1893	**	0.0812	**
	(0.0332)		(0.0613)		(0.0810)		(0.0355)	
Constant	0.0955	***	0.0897	***	0.0505	***	0.1928	***
	(0.0085)		(0.0131)		(0.0097)		(0.0319)	
Number of observations	4380		1877		1280		1190	

**Table 4. Determinants of Bond Market Spillover**

This is the estimation results for equation (4) for bond market spillovers. The dependent variable is the correlation in weekly bond yields between each pair of 42 sample countries over the period from 2001 to 2012. Lagged dependent variable is the value for the dependent variable in the previous period. Bilateral Portfolio Investment is debt securities portfolio investment of country  $i$  into  $j$  as a share of GDP. Trade is bilateral trade between country  $i$  and  $j$  as a share of GDP. Country Concentration is the concentration index for country  $i$  in the year  $t$ . Home Bias is the home bias index for country  $i$  in each year. Dummy is the 2008-2010 crisis dummy. Year dummies are included but not reported. T-statistics based on The Arellano–Bond (1991) GMM estimation are reported: \* denotes significance at 10%; \*\* at 5%; and \*\*\* at 1%.

	all sample		advanced		euro area		emerging	
Lagged dependent variable	0.2646	***	0.2464	***	0.2929	***	0.1663	***
	(0.0276)		(0.0353)		(0.0480)		(0.0369)	
Bilateral Portfolio Investment	0.9902	***	0.8411	***	0.3444		-3.4647	***
	(0.2482)		(0.3201)		(0.3290)		(0.7544)	
Trade	0.1429	***	0.0368		1.0352	***	0.5809	
	(0.0504)		(0.0729)		(0.3077)		(0.1981)	
Home Bias	-0.0812	**	-0.8561	*	0.0639	**	-0.4656	***
	(0.0235)		(0.1043)		(0.0317)		(0.0584)	
Country Concentration	-0.0064	***	-0.8561	***	1.3104	***	-0.0040	***
	(0.0030)		(0.1043)		(0.2505)		(0.0014)	
Dummy *Bilateral Portfolio Investment	-1.0464		-0.1541		-0.5733		1.4372	
	(0.6619)		(0.6446)		(0.8545)		(0.9294)	
Dummy *Trade	0.1426		0.1236		-0.3196		0.6614	***
	(0.0975)		(0.1004)		(0.3276)		(0.2542)	
Dummy *Home Bias	-0.1245	***	-0.0937	***	-0.3099	***	-0.1566	***
	(0.0221)		(0.0322)		(0.0626)		(0.0230)	
Dummy *Country Concentration	0.0124	*	0.4481	***	1.0515		0.1481	**
	(0.0671)		(0.1306)		(0.7736)		(0.0684)	
Constant	0.2960	***	0.2737	***	0.1772	***	0.6432	***
	(0.0204)		(0.0280)		(0.0350)		(0.0597)	
Number of observations	4231		1806		1277		1115	

## Bilateral Portfolio Investment

As shown in Tables 3 and 4, when estimated over the whole sample the positive and significant coefficient on  $Y_{i,j,t}$  for both equity and debt securities indicates that countries with extensive bilateral portfolio are likely to have larger spillovers in financial markets.

When the equation is separately estimated for non-euro advanced economies, euro area countries, and emerging economies, the results for the equity market spillovers were consistent with those for the whole sample countries, while the results for bond market were mixed. For equity spillovers, the estimators were positive and significant for non-euro advanced economies, euro area and emerging economies, implying that larger bilateral portfolio asset holding results in greater degree of equity market spillovers for any country categories. For bond market spillovers, the estimators were positive and significant for non-euro advanced economies, not significant for euro area countries, and negative and significant for emerging economies. A factor behind the result for the emerging economies could be their smaller amount of bond portfolio asset holdings (relative to GDP), which could possibly prevent bilateral asset holdings from affecting bond market spillovers.

## Trade

The results for trade are less consistent, implying that the trade channel can only indirectly affect financial market spillovers at best and that a greater bilateral linkage through trade does not necessarily lead to comovements in financial markets.<sup>11</sup> The results were significant and positive in bond markets and were not significant for equity markets when the equation was estimated for the full sample of countries. The results were uneven when it was estimated for each country group. The estimated coefficients were positive and significant for the euro area in both equity and bond markets and for emerging economies in equity markets, indicating that the linkage through real economy can impact financial market spillovers in the euro area and emerging economies. Regarding the results for non-euro advanced economies, the estimated coefficient was negative and significant in equity markets, and was insignificant in bond markets.

## Home Bias

The results for  $HB_{i,t}$  are overall significant and negative, indicating that higher home bias helps countries keep spillovers from external financial shocks under control because of less financial interaction with foreign markets, leading to less financial market spillovers. A policy implication from this result is that, as countries become less home-biased, they should strengthen prudential regulations to mitigate against risks of financial spillovers. The estimation result was not positive when the equation was estimated over euro area countries' equity markets and was significantly positive with a very small coefficient,

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<sup>11</sup> The scope of financial markets in this paper is limited to equity and bond markets. If the definition of financial markets is expanded to foreign exchange markets, trade should matter more because of higher demand for foreign exchange transactions for the purpose of trade settlements.

possibly because euro area countries generally already have lower home bias and its impact was marginalized.

### **Concentration**

The results for  $CCI_{i,t}$  are significant and negative when the equation was estimated for the full sample countries, and mixed for each country group. For equity markets, the results were insignificant when the equation was estimated over non-euro advanced economies and euro area countries, and significantly negative over emerging economies. For bond markets, the result was significantly negative over non-euro advanced economies and emerging economies, and significantly positive over euro area countries. Thus, non-euro advanced economies and emerging economies could possibly mitigate financial spillovers by increasing their portfolio concentration by gaining higher returns, while the opposite outcome can be observed for euro area countries. These mixed results could be owing to the fact that concentration index only impacts financial market spillovers indirectly through countries' preparedness of shocks that are transmitted. It is possible that countries can build resilience against shocks contagious to their financial markets in different ways—such as having more mature and deeper domestic financial markets.

### **Interaction Terms with the Crisis Dummy Variables**

The results for the interaction terms with the 2008-2010 crisis variables vary across variable; these were significant for home bias (in bond markets) and country concentration (in both equity and bond markets). The coefficient estimates for  $Dummy_t \times Y_{t-1}$  are not significant for both equity and bond markets, indicating that the impact of bilateral portfolio investment on spillovers did not get greater or less during the crisis. The results for  $Dummy_t \times Trade_t$  are not significant for both markets when the model was estimated for the full sample. The results for  $Dummy_t \times HB_{t-1}$  are not significant for equity markets over whole samples, while positive and significant for bond markets. Together with the results for Home Bias term discussed above, greater home bias helps a country to keep external shocks under control, while during the crisis this function of home bias was working to a lesser extent in bond markets. The results for  $Dummy_t \times CCI_{t-1}$  are significant and positive, indicating that the impact of country concentration on spillovers were greater during the crisis.

## **VI. CONCLUSION AND FUTURE RESEARCH**

In conclusion, bilateral portfolio asset holdings, as well as a country's geographical preferences, affect financial market spillovers. If a country has a large amount of bilateral equity or debt securities exposure in another country, these two countries' financial market comovement is larger because domestic shocks of the investment partner countries affect the originating country's financial market. If a country has a stronger home bias, the country could have less spillovers from abroad in its financial markets. A policy implication from this result is that, as countries become less home-biased and have greater amount of portfolio investment assets, they should strengthen prudential regulations to mitigate against rising risks of financial spillovers. On the other hand, the role of trade and country concentration was not confirmed by the empirical results of the paper.

While this paper mainly focuses on portfolio diversification as the determinant of financial market spillovers, there could be other factors that affect financial spillovers, such as

financial channels through bilateral bank lending and bilateral foreign direct investment.<sup>12</sup> For example, if country X has a large bank lending exposure to country Y, domestic shocks in country X could impact country Y's financial markets. Parent banks of country X would have an incentive to decrease the supply of credit in country Y in order to restore capital adequacy or to meet other regulatory requirements, which causes squeezing of credits in country Y and adversely impact country Y's stock markets.

Data shortcomings could have hampered the analysis in this paper. For example, insufficient country coverage affected the calculation of the variable for home bias. Home bias should reflect the deviation of a country's holding of its own assets from international portfolio allocation which is the country's market share in the world. However, the CPIS dataset covers only 78 economies, limiting the scope of the "world" as used in this paper.

For future research, the measurement of spillovers can be further exploited. Forbes and Rigobon (2002) discuss the approaches to test if financial market contagion exists, based on a model in which shocks are transmitted by a crisis country during a turmoil period. While this paper used the adjusted correlation coefficients in line with Forbes and Rigobon (2002) which are adjusted for heteroskedasticity, they argued that the incidence of contagion based on the adjusted correlation coefficients were empirically challenged. Furthermore, because the spillovers in this paper are captured by correlations, causation is not necessarily implied. In this sense, future research could focus on more precise spillover mechanisms through the spillover channels that this paper has discussed.

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<sup>12</sup> While bilateral bank exposure data are available from BIS consolidated bank statistics, its country coverage is not broad enough for the analysis in this paper. Although bilateral foreign direct investment data are available from the CDIS, this dataset was not used because CPIS is only available from 2009 with limited country coverage.

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## Appendix 1. Sample Countries' Stock Markets

Argentina	MERVAL Index
Australia	AS51 Index
Belgium	BEL20 Index
Brazil	IBOV Index
Canada	SPTSX
Chile	IPSA Index
China	SHCOMP Index
Colombia	COLCAP Index
Croatia	CRO Index
Czech Republic	PX Index
Denmark	KFX Index
France	CAC Index
Germany	DAX Index
Hong Kong	HSI Index
Hungary	BUX Index
Iceland	ICEXI Index
India	SENSEX Index
Indonesia	JCI Index
Israel	TA-25 Index
Italy	FTSEMIB Index
Japan	NKY Index
Korea	KRX100 Index
Malaysia	FBMKLCI Index
Mexico	MEXBOL Index
Netherlands	AEX Index
Norway	OSEBX Index
New Zealand (NZ)	NZSE50FG Index
Pakistan	KSE100 Index
Peru	IGBVL Index
Philippines	PCOMP Index
Poland	WIG Index
Russia	INDEXCF Index
Saudi Arabia	SASEIDX Index
Singapore	FSSTI Index
South Africa	TOP40 Index
Spain	IBEX Index
Sweden	OMX Index
Switzerland	SMI Index
Thailand	SET Index
Turkey	XU100 Index
United Kingdom	UKX Index
United States of America (USA)	INDU