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ABSTRACT

Not only are investors biased toward home assets, but when they do invest abroad, they appear to favor countries with returns more correlated with home assets, reducing diversification yet further. This paper argues that understanding this correlation puzzle requires a multi-county theoretical perspective, and we construct an N-country DSGE model that allows for heterogeneous stock return correlations. It shows that bilateral asset holdings depend not only upon the stock return correlation with the destination country, but also on the correlation with all other countries. This effect is analogous to 'multilateral resistance' in the trade literature. An empirical study controlling for this multilateral resistance in correlations overturns the result of preceding literature, finding that higher stock return correlation lowers bilateral equity asset holdings as theory predicts, reducing the losses of home bias.

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1. Introduction

Home bias in equities is a longstanding puzzle in international finance: investors prefer to hold too many domestic assets, given the diversification benefits of foreign assets (French and Poterba 1991, see also Coeurdacier and Rey, 2011). A closely related anomaly is that even if investors invest abroad, evidence has suggested they prefer countries with a high correlation in returns to their home country (Portes and Rey 2005, Aviat and Coeurdacier 2007, Lane and Milesi-Ferretti 2008). Because a high correlation lowers diversification potential, this amplifies the investor losses from home bias. Some researchers have explained this second anomaly in terms of a preference for 'familiarity' when investing abroad (Huberman 2001, Barberis and Thaler, 2004).

This paper studies the second anomaly, the correlation puzzle, and argues that understanding it requires a multi-country perspective both theoretically and empirically. Recently, general equilibrium asset-pricing models have become widespread in international macro-finance research, with the development of higher-order approximation techniques (Devereux and Sutherland 2011; Engel and Matsumoto 2006; Evans and Hnatkovska 2007; and Tille and van Wincoop 2010).[1] However, these models are generally two-country frameworks which permit analysis of the first anomaly of home bias, whether to invest abroad, but do not permit analysis of the second anomaly, where to invest abroad. The very few papers that model more than two countries assume the countries are symmetric and have independent returns (such as Baxter, Jermann and King, 1998, and Okawa and van Wincoop, 2010), so these also cannot study the choice of investors between alternative destination countries without imposing some type of friction.[2] We derive a solution to a general equilibrium model which breaks the independence assumption on capital incomes across countries to allow a non-zero covariance structure of stock returns.[3]

[1] There are more two-country studies to explain international portfolio choice with frictions in international market: Stockman and Dellas (1989), Obstfeld and Rogoff (2000), and Coeurdacier (2009) explain portfolio allocation with trade cost and non-tradable goods. Martin and Rey (2004) and Heathcote and Perri (2004) show portfolio choice by invoking a transaction cost or tax on international financial asset trade.

[2] Okawa and van Wincoop (2010) focus on deriving empirical financial gravity equation from a multi-country model. In their model, they introduce the information cost which has an influence on equity holdings across countries. However, they do not explicitly concern the effect of stock return correlation on equity holdings.

[3] The idea of considering heterogeneous correlations across multiple assets or countries is longstanding in classic finance theory such as the Capital Asset Pricing Model (CAPM). However our model differs in key respects. CAPM presumes that investors take a diversified portfolio, so that it only considers correlations of an asset with the diversified market portfolio. In contrast, our model studies the choice among foreign

The main theoretical implication of the N-country framework is that the optimal share of country *i*'s portfolio in the assets of a foreign country *j* depends not just on the correlation of returns between countries *i* and *j*, but also on the correlation of *i* with all other countries. This has an empirical implication that offers a resolution to the anomaly in the empirical literature. Attempts to estimate the effect of the bilateral correlation on portfolio shares must adequately control for the correlations with all other countries. For instance, suppose the stock return correlation between France and Spain were higher than that between New Zealand and Australia. One might predict less asset diversification between France and Spain than between New Zealand and Australia, because the higher return correlation implies a lower diversification benefit. However, it may be that France has even higher correlations with the other countries surrounding it in Europe that would be an alternative to Spain for diversification, so it might make sense for France to purchase assets in Spain because of the relatively lower correlation compared to the alternatives. Hence, we may find a positive relationship between stock return correlation and bilateral asset holdings when we focus on only the bilateral relationship between country *i* and *j* without controlling for the correlations with other countries

In the international trade literature, a similar N-country effect was discussed by Anderson and van Wincoop (2003, 2004) with respect to the estimation of the determinants of bilateral trade flows. They show that bilateral trade flows are determined not only by bilateral trade costs between two countries but also by average trade barriers with other countries. They refer to the relative cost of trading with other partners as 'multilateral resistance' to trade. Likewise, we follow this logic of 'multilateral resistance' to explain bilateral financial asset holdings in terms of the relative attractiveness of investing in other countries.

We use the theoretical model to suggest an appropriate control for multilateral resistance to include in our empirical specification. This provides a more detailed theoretical foundation for empirical analysis than past empirical work applying gravity equation estimation to this question.[4] In particular, previous research has not considered the effect of

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assets in a context that is consistent with overall home bias in the portfolio, and this produces a different portfolio choice equation below. Another difference is that we take a general equilibrium approach.

[4] See Portes and Rey (2005), Aviat and Coeurdacier (2007), Lane and Milesi-Ferretti (2008), Okawa and van Wincoop (2010), and Coeurdacier and Guibaud (2011)

stock return correlations with outside countries on bilateral financial asset trade.[5] We use a cross-country panel dataset of portfolio equity holdings for 2001-2006.[6] A time-varying output co-movement measure is used as a proxy for stock return correlation based on the empirical evidence that real stock returns are highly correlated with future production growth rates (Fama 1990; Schwert 1990; Choi, Hauser, and, Kopecky 1998). Robustness checks control for endogeneity as well as unobserved determinants of international portfolio holdings.

Our empirical results show that estimates of the effect of stock return correlation on bilateral equity asset holdings are biased unless we consider stock return correlations with multilateral partners in the empirical specification. When controlling for stock return correlations with other countries, a lower bilateral stock return correlation increases bilateral financial investment between countries, as theory would predict.

In Section 2, we introduce the N country portfolio choice model with stock return correlation. Section 3 presents simulations of a 3-country version of the model to illustrate the main theoretical claims and provide intuition. Section 4 derives an empirical specification from the full N-country model. Section 5 presents the empirical results on the international portfolio allocation patterns. Concluding remarks follow in Section 6.

2. Theory: An N country, N+1 asset model

2.1. Set up of the model

The model generally follows the two-country model of Devereux and Sutherland (2011), but expands to an N-country setting, with non-zero covariance structure on capital incomes. Consider a consumer's dynamic optimization problem below.

$$\max E_t \sum_{k=1}^{\infty} \beta^k U_{it} \qquad \text{for } i=1,\ldots,N \tag{1}$$

[5] Coeurdacier and Guibaud (2011), hereafter CG, studies the same puzzle. However, their explanation is based upon the endogeneity of correlations, whereas we emphasize multilateral resistance as an explanation. We also differ in developing a micro-founded model of asset holding in order to inform the empirical specification rather than a mean-variance model. While the instrumental variable approach of CG is very effective in resolving the puzzle in their results, we find that this explanation is sensitive to the specification of the instrument as non-time varying. A conventional specification of the instrument using one-period lags of the correlation does not effectively resolve the puzzle. Further, the instrument used in CG, a non-time varying correlation from a period before the sample, potentially may resolve the puzzle because it indirectly controls for multilateral resistance in a manner similar to country-pair fixed effects.

[6] The Coordinated Portfolio Investment Survey (CPIS), the IMF

$$\text{s.t. } W_{i,t} = \sum_{j=1}^{N} \alpha_{ji,t-1} R_{j,t} + \alpha_{fi} R_{f,t} + Y_{i,t} - C_{i,t} \tag{2}$$

$$\text{where } U_{it} = \frac{C_{i,t+k}^{1-\gamma}}{1-\gamma} \text{ and } W_{i,t} = \sum_{j=1}^{N} \alpha_{ji,t}$$

where $Y_{i,t}$ is the endowment received by country *i*, $W_{i,t}$ is the total net claims of country *i*'s agent on foreign country at the end of period *t* (i.e. net foreign assets of country *i*), $\alpha_{ji,t}$ is the real holdings of country *j*'s assets by country *i*, and $R_{j,t}$ is the gross real returns of country *j*'s assets. We introduce an independent risk-free asset, $R_{f,t}$, as a risk-free bond that is in zero net supply, as this simplifies derivation of an empirical specification later. [7]

Endowments are the sum of two components,

$$Y_{i,t} = Y_{i,t}^{K} + Y_{i,t}^{L} \quad \text{for } i=1,2,3,\ldots,\text{N}. \tag{3}$$

where $Y_{i,t}^{K}$ represents capital income of country *i,* and $Y_{i,t}^{L}$ represents labor income. The endowments are determined by the following simple stochastic processes.

$$\log Y_{i,t}^{K} = \log \overline{Y}_{i,t}^{K} + \varepsilon_{i,t}^{K} \text{ for i=1,2,3,\ldots,N}$$

$$\log Y_{i,t}^{L} = \log \overline{Y}_{i,t}^{L} + \varepsilon_{i,t}^{L} \text{ for i=1,2,3,\ldots,N.}$$

The log of capital incomes of country *i* (*i*=1,2,3,…,N) are assumed to be correlated across countries as follows:

$$\begin{pmatrix} \varepsilon_{1,t}^{K} \\ \vdots \\ \varepsilon_{N,t}^{K} \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ \vdots \\ 0 \end{pmatrix}, \ \Omega \right) \quad where \ \ \Omega = \begin{pmatrix} \sigma_{11} & \cdots & \sigma_{1N} \\ \vdots & \ddots & \vdots \\ \sigma_{1N} & \cdots & \sigma_{NN} \end{pmatrix}.$$

However, the log of labor incomes of country *i* (*i*=1,2,3,…,N) are assumed to be non-tradable and not cross-dependent.

[7] We assume a risk-free bond in the same manner of Okawa and van Wincoop (2010). This assumption can be justified by the existence of nearly risk-free assets such as insured bank deposits or government bonds. Above all, the assumption is useful to derive an empirical specification for equity holdings. Without the risk-free asset as an anchor asset, the optimal equity holdings would depend additively on the expected returns on all equity, thus making it harder to derive a simple form of empirical specification. Note that our real risk-free bond is not related to exchange rate risk. While a bond is used to allow for hedging exchange rate risk in recent studies, Coeurdacier and Gourinchas (2011) argue that equity holdings are not driven by real exchange rate risk, and Engel and Matsumoto (2009) show similar results in a specific model with nominal rigidities.

$$\begin{pmatrix} \varepsilon_{1,t}^{L} \\ \vdots \\ \varepsilon_{N,t}^{L} \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ \vdots \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_L^2 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & \sigma_L^2 \end{pmatrix} \right).$$

There is covariance between the log of capital and labor income of country i such that $Cov(\varepsilon_{i,t}^{L}, \varepsilon_{i,t}^{K}) = \sigma_{LK}^{i}$ (i=1,2,3,…,N).

The assets are assumed to be one-period equity claims on the home and foreign capital incomes following Devereux and Sutherland (2011). The real payoff to a unit of the equity of country i in period t is defined to be $Y_{i,t}^{K}$. The real price of a unit of the equity of country i is denoted as $Z_{i,t-1}^{E}$. Thus, the gross real rate of return on the equity of country i is

$$R_{i,t} = \frac{Y_{i,t}^{K}}{Z_{i,t-1}^{E}} \quad \text{for } i=1,\dots,\text{N}. \tag{4}$$

The price of risk-free bond is denoted as Z_{t-1}^{f}, and the real rate of return on the asset f,

$$R_{f,t} = \frac{1}{Z_{t-1}^{f}} \tag{5}$$

2.2. The asset market equilibrium conditions

We obtain first order conditions with respect to portfolio holdings, $\alpha_{ji,t}$, from the dynamic optimization problem,

$$C_{i,t}^{-\gamma} = \beta \cdot E_t[C_{i,t+1}^{-\gamma} \cdot R_{j,t+1}] \quad \text{for } i, j=1,2,3,..\text{N (N*N FOCs)}. \tag{6}$$

Also we have FOCs for a risk free bond, f,

$$C_{i,t}^{-\gamma} = \beta \cdot E_t[C_{i,t+1}^{-\gamma} \cdot R_{f,t+1}] \quad \text{for } i=1,2,3,..\text{N}. \tag{7}$$

A risk-free bond f is used as a numeraire, so $(R_{N,t} - R_{f,t})$ measures the "excess return" on asset N. At the end of each period, agents select the portfolio of assets to hold into the following period. For instance, at the end of period t, agents in country i select $\alpha_{ji,t}(j \neq i)$ to hold into period $t+1$. Thus, the first order conditions for the choice of $\alpha_{ji,t}(j \neq i)$ can be written as follows below.

We combine FOCs on N assets for country i, and write them in terms of the excess return of country j's asset, $(R_{j,t} - R_{f,t})$,

$$E[C_{i,t+1}^{-\gamma}\cdot(R_{j,t+1}-R_{f,t+1})]=0 \quad \text{for } j=1,2,3,..\text{N}. \tag{6'}$$

Assets are assumed to be in zero net supply, so market clearing in the asset market implies

$$\alpha_{j1,t}+\alpha_{j2,t}+\cdots+\alpha_{jN,t}=0 \quad \text{for } j=1,\ldots,\text{N} \tag{8}$$

For the risk-free bond, *f*,

$$\alpha_{f,t}=0. \tag{8'}$$

We also have equilibrium consumption plans that satisfy the resource constraint,

$$C_{1,t}+C_{2,t}+\cdots+C_{N,t}=Y_{1,t}+Y_{2,t}+\cdots+Y_{N,t} \tag{9}$$

2.3. Solution of the model

2.3.1 First- and second- order approximation

Denote with (^) the log deviations of the variables from the steady state equilibrium: $\hat{x}=\log\left(\frac{x}{\overline{x}}\right)$ where $\overline{x}$ is the value at the equilibrium. To solve for portfolio holdings, we follow the approach of Devereux and Sutherland (2011) and Tille and van Wincoop (2009). A first-order approximation of the non-portfolio equations (equations (2) for each N country) and a second-order approximation of the Euler equations are needed to express the zero-order component ($\overline{x}$) of equilibrium portfolios. For simplicity, we assume that N countries' non-stochastic steady state of wealth is equal to zero ($\overline{W}=0$).

$$\overline{\alpha}_{1,i}+\overline{\alpha}_{2,i}+\cdots+\overline{\alpha}_{N,i}=0 \quad \text{for } i=1,\ldots,\text{N} \quad \text{and} \quad \overline{\alpha}_f=0 \tag{10}$$

A first-order approximation of a country *i*'s budget constraint, equation (2), implies

$$\hat{W}_{i,t+1}=\sum_{j=1}^{N}\tilde{\alpha}_{ji}(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})+\hat{Y}_{i,t+1}-\hat{C}_{i,t+1} \tag{2'}$$

where $\hat{W}_{i,t}=(W_{i,t}-\overline{W})/\overline{C}$ and $\tilde{\alpha}_{ji}=\overline{\alpha}_{ji}/(\overline{Y})$.[8]

Take a second-order approximation of the country *i*'s portfolio condition, (6'), to yield

$$E_t[\hat{R}_{j,t+1}-\hat{R}_{f,t+1}+\frac{1}{2}\hat{R}_{j,t+1}^2-\frac{1}{2}\hat{R}_{f,t+1}^2]=\gamma\cdot E_t[\hat{C}_{i,t+1}(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})] \quad \text{for } j=1,\ldots,\text{N}. \tag{11}$$

[8] Because $\overline{\alpha}_f=0$ and $\sum_{j=1}^{N}\tilde{\alpha}_{ji}\hat{R}_{f,t+1}=\hat{R}_{f,t+1}\sum_{j=1}^{N}\tilde{\alpha}_{ji}=0$

From N equations of (11) for country i, we make pairs between country i and k, and derive $N(N-1)$ equations like below

$$E_t[(\hat{C}_{i,t+1}-\hat{C}_{k,t+1})(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]=0 \quad \text{for } j=1,\ldots,\text{N, and } i,\ k=1,\ldots\text{N, } k\neq i \tag{12}$$

The first order accurate solution for $(\hat{C}_{i,t+1}-\hat{C}_{k,t+1})$ is also straightforward to derive from (2'). Substitute it into (11), and the first-order accurate behavior of $\hat{R}_{j,t+1}-\hat{R}_{f,t+1}$ is particularly simple in this model. First-order approximations of (4) and (5) imply

$$\hat{R}_{j,t+1}-\hat{R}_{f,t+1}=\hat{Y}^K_{j,t+1}-\hat{Z}^E_{j,t}-\hat{Z}^B_{j,t}+O(\varepsilon^2)$$

where $O(\varepsilon^2)$ is a residual which contains all terms of order higher than one, so

$$E_t(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})=E_t(\hat{Y}^K_{j,t+1})-\hat{Z}^E_{j,t}-\hat{Z}^B_{j,t}+O(\varepsilon^2).$$

The return on equities must equal to each other, up to a first-order approximation. Moreover, first components of the equity return and bond return are assumed to be equal,

$$E_t(\hat{R}_{i,t+1}-\hat{R}_{f,t+1})=0 \text{ , so}$$

$$\hat{Z}^E_{j,t}-\hat{Z}^B_{j,t}=E_t(\hat{Y}^K_{j,t+1})+O(\varepsilon^2) \quad \text{where } E_t(\hat{Y}^K_{j,t+1})=0$$

Therefore, $$\hat{R}_{j,t+1}-\hat{R}_{f,t+1}=\hat{Y}^K_{j,t+1}+O(\varepsilon^2)$$

Hence, the distribution of first order components of excess equity returns follows that of first order components of capital incomes like below

$$\begin{pmatrix} \hat{R}_{1,t+1}-\hat{R}_{f,t+1} \\ \hat{R}_{2,t+1}-\hat{R}_{f,t+1} \\ \vdots \\ \hat{R}_{N,t+1}-\hat{R}_{f,t+1} \end{pmatrix} \sim N \begin{pmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{pmatrix} \begin{pmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1N} \\ \sigma_{21} & & & \sigma_{2N} \\ \vdots & & \ddots & \vdots \\ \sigma_{N1} & \sigma_{N2} & \cdots & \sigma_{NN} \end{pmatrix}$$

2.3.2. Solution method

Based on equation (12), we make a matrix system to solve the equity holdings (See Appendix A)

$$\Pi A = B$$

$$A=\Pi^{-1}B \tag{13}$$

where $\boldsymbol{A}'=\left(\tilde{\alpha}_{11} \quad \tilde{\alpha}_{21} \quad \ldots \quad \tilde{\alpha}_{N1} \quad \tilde{\alpha}_{12} \quad \ldots \quad \tilde{\alpha}_{N2} \quad \tilde{\alpha}_{13} \quad \ldots \quad \tilde{\alpha}_{N3} \quad \ldots \quad \tilde{\alpha}_{1N} \quad \ldots \quad \tilde{\alpha}_{NN}\right).$

A' is a solution for equity holdings, and is an $(N \times N) \times 1$ matrix. B is an $N(N-1) \times 1$ matrix which consists of the variance and covariance of the excess stock returns and the covariance between capital and labor incomes of each country pair. Π is $N(N-1) \times (N \times N)$ matrix. Variance and covariance of the excess stock returns are identified by a box, otherwise zero (see Appendix B). With asset market clearing conditions (8) and (8'), and steady state equilibrium conditions (10), we derive the solution of portfolio holding matrix, A, which is a function of the variance and covariance of the excess returns and the covariance between domestic labor and capital income. We present the example of 3×3 model to provide intuition of the model in the next section.

3. Simulation results with 3×3 portfolio allocation model

3.1. Simulation results

To develop intuition, we simulate numerical experiments in a three country version of the model (N=3).[9] We demonstrate three points. First, the model is capable of generating equity home bias as an equilibrium portfolio, so as to be a relevant starting point for analysis. Second, even under home bias, the model confirms intuition that investors have an incentive to choose foreign assets with a lower returns correlation with home returns, and thereby maximize the insurance benefit of the foreign assets they do hold. Third, when the model considers heterogeneous correlations across countries, bilateral asset shares can appear to violate this principle, with higher correlations sometimes associated with higher rather than lower asset holdings. But these cases reflect third country effects, and they are still consistent with a portfolio that maximizes hedging benefits.

The input to the simulation consists of a 3×3 covariance matrix among capital returns across countries, Ω defined above, as well as the 3×1 correlation between capital and labor income within each country, $\Lambda = \begin{pmatrix}\sigma_{LK}^1 & \sigma_{LK}^2 & \sigma_{LK}^3\end{pmatrix}'$. The output consists of the 3×3 transformed equity holding matrix, A. We add 1 (capital endowment itself) to the domestic equity holdings (α_{ii}), thus, the sum of equity holdings of each country is equal to 1.

[9] See the derivation of the 3x3 model in Appendix C.

Case 1.Portfolio choice: Depending on the domestic labor and capital income correlation

Capital-Labor income correlation	International return correlations	Equity holdings
i) $\sigma^i_{LK} = 0$		
$\Lambda = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$	$\Omega = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$	$A=$ 0.3333 0.3333 0.3333 0.3333 0.3333 0.3333 0.3333 0.3333 0.3333
ii) $\sigma^i_{LK} < 0$ and close to zero (Bottazzi et al. 1996),		
$\Lambda = \begin{pmatrix} -0.1 \\ -0.1 \\ -0.1 \end{pmatrix}$	$\Omega = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$	$A=$ 0.4000 0.3000 0.3000 0.3000 0.4000 0.3000 0.3000 0.3000 0.4000
iii) $\sigma^i_{LK} > 0$ and close to one (Baxter and Jermann 1997)		
$\Lambda = \begin{pmatrix} 0.9 \\ 0.9 \\ 0.9 \end{pmatrix}$	$\Omega = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$	$A=$ -0.2667 0.6333 0.6333 0.6333 -0.2667 0.6333 0.6333 0.6333 -0.2667

As seen in the experiments of Case 1, if there is no domestic labor and capital income correlation, Λ=(0;0;0)', countries always have 'balanced portfolio holdings'(1/3,1/3,1/3), which is similar to the finding of Devereux and Sutherland (2011). Experiments confirm this result is not affected by the correlation structure (Ω).

Our model follows a strand of the literature that has attempted to explain home bias on financial assets as a hedge against non-tradable labor income (or human capital return) risk (Baxter and Jermann, 1997). Given large exposure to domestic labor income risk, investors should favor either domestic or foreign assets that are a better hedge against their domestic labor income risk. If labor income is negatively correlated with the returns to domestic assets, then labor income risk is hedged by investing in domestic assets, thus leading to a long position in home equity portfolios (Bottazzi, Pesenti, and van Wincoop, 1996, Heathcote and Perri 2009 and Coeurdacier, Kollmann and Martin 2010). In the sub-case ii), we calibrate the labor correlation based on the estimates of Bottazzi et al (1996) to a value less than but close to zero, $\Lambda = (-0.1,-0.1,-0.1)'$. Our model can replicate equity home bias under the assumption of a negative correlation between domestic labor and capital income. We use this as the benchmark calibration of capital and labor income for the remainder of the simulation analysis. When we assume a positive labor and capital correlation in the sub-case iii), there is foreign equity bias that is opposite to the observation in data.

Case 2.Non-zero capital (stock) return correlation (and $\Lambda = (-0.1, -0.1, -0.1)'$ for all)

International return correlations	Equity holdings
i) $\Omega = \begin{pmatrix} 1 & 0.1 & 0.1 \\ 0.1 & 1 & 0.1 \\ 0.1 & 0.1 & 1 \end{pmatrix}$	*A*= 0.4074 0.2963 0.2963 0.2963 0.4074 0.2963 0.2963 0.2963 0.4074
ii) $\Omega = \begin{pmatrix} 1 & 0.5 & 0.5 \\ 0.5 & 1 & 0.5 \\ 0.5 & 0.5 & 1 \end{pmatrix}$	*A* = 0.4667 0.2667 0.2667 0.2667 0.4667 0.2667 0.2667 0.2667 0.4667
iii) $\Omega = \begin{pmatrix} 1 & 0.9 & 0.9 \\ 0.9 & 1 & 0.9 \\ 0.9 & 0.9 & 1 \end{pmatrix}$	*A* = 1.0000 0.0000 0.0000 0.0000 1.0000 0.0000 0.0000 0.0000 1.0000

The experiments of Case 2 explore alternative degrees of international correlation of stock returns, but maintain the assumption that these correlations are identical for all country pairs. We find that a lower stock return correlation causes higher bilateral equity holdings between countries. In sub-case i) and ii), when the stock return correlation between country 1 and 2 increases from 0.1 to 0.5, equity holdings between country 1 and 2 decrease from 0.2963 to 0.2667. This confirms the intuition that even under home bias, investors should find low correlations more attractive than high correlations.

Furthermore, stock return correlation affects the overall degree of equity home bias. In sub-case ii) and iii), equity home bias becomes bigger, a country's domestic equity holdings increase from 0.4 to 0.4667, and from 0.4667 to 1 respectively. The equity home bias becomes more severe because a home country has less incentive to invest foreign assets which are highly correlated with domestic assets.

Case 3. Asymmetric stock return correlation (and $\Lambda = (-0.1, -0.1, -0.1)'$ for all)

International return correlations	Equity holdings
i) $\Omega = \begin{pmatrix} 1 & \underline{\boldsymbol{-0.5}} & 0 \\ -0.5 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$	*A* = 0.4000 **<u>0.3333</u>** 0.2667 0.3333 0.4000 0.2667 0.2667 0.2667 0.3667

$\text{ii})\,\Omega = \begin{pmatrix} 1 & \boldsymbol{-0.3} & 0 \\ -0.3 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$	$A = \begin{matrix} 0.3956 & \mathbf{0.3187} & 0.2857 \\ 0.3187 & 0.3956 & 0.2857 \\ 0.2857 & 0.2857 & 0.3857 \end{matrix}$
$\text{iii})\,\Omega = \begin{pmatrix} 1 & \underline{\boldsymbol{-0.3}} & 0.6 \\ -0.3 & 1 & 0 \\ 0.6 & 0 & 1 \end{pmatrix}$	$A = \begin{matrix} 0.4727 & \underline{\mathbf{0.3455}} & 0.1818 \\ 0.3455 & 0.4073 & 0.2582 \\ 0.1818 & 0.2582 & 0.4564 \end{matrix}$

The experiments of Case 3 study the effects of heterogeneity among international correlations. On one hand, we find that some bilateral shares support the finding above, that higher stock correlation causes lower equity holdings between countries. In sub-case i) and ii), equity holdings between country 1 and 2 decrease from 0.3333 to 0.3187, when the stock return correlation between country 1 and 2 increases from -0.5 to -0.3.

However, a change in stock return correlation between country 1 and 3 affects bilateral equity holdings between country 1 and 2. Less opportunity of international risk-hedging in country 3 lets country 1 divert the original investment to country 3 into country 2. Thus, when we compare sub-case i) and iii), if we observe only the bilateral relationship between county 1 and 2, even though the stock return correlation between country 1 and 2 increases from -0.5 to -0.3, bilateral equity holdings increase from 0.33 to 0.3455. This seems to be puzzling. However, when we consider the role of a third country in a multi-country framework, the positive relationship between stock return correlation and bilateral equity asset holdings can be justified by rational risk diversification behavior. This is one simple example of the principle of third country effects.

4. Empirical Specification

4.1. Empirical Equation

The N country model above is used to help construct the empirical equation for estimation. As a benchmark, we derive equity holdings between source country 1 and N destination countries. As shown in Appendix D, combine equation (11), the second order approximation to country 1's portfolio equation with equation (2), the log linearization of the budget constraint evaluated for a country *i*=1, along with market clearing condition for the risk free asset (8') and zero net supply in the equilibrium.

This implies a system of equations with N unknown variables, which can be expressed,

$$\Omega \cdot A_{(i=1)} = H\,. \tag{14}$$

Thus $$A_{(i=1)} = \Omega^{-1} H \quad \text{where } \Omega^{-1} = \frac{1}{\det(\Omega)} adj(\Omega)$$

(14')

where

$$A = \begin{pmatrix} \tilde{\tilde{\alpha}}_{11} \\ \tilde{\alpha}_{21} \\ \vdots \\ \tilde{\alpha}_{N1} \end{pmatrix}, H = \begin{pmatrix} \frac{1}{\gamma} E_t[\hat{R}_{1t+1} - \hat{R}_{ft+1} + \frac{1}{2}(\hat{R}^2_{1t+1} - \hat{R}^2_{ft+1})] \\ \frac{1}{\gamma} E_t[\hat{R}_{2t+1} - \hat{R}_{ft+1} + \frac{1}{2}(\hat{R}^2_{2t+1} - \hat{R}^2_{ft+1})] \\ \vdots \\ \frac{1}{\gamma} E_t[\hat{R}_{Nt+1} - \hat{R}_{ft+1} + \frac{1}{2}(\hat{R}^2_{Nt+1} - \hat{R}^2_{ft+1})] \end{pmatrix}, \Omega = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1N} \\ \sigma_{12} & \sigma_{22} & \cdots & \sigma_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{1N} & \sigma_{2N} & \cdots & \sigma_{NN} \end{pmatrix}.$$

To facilitate an analytical expression for portfolio holdings, we assume a particular covariance structure.[10] As we wish to focus on the relationship between country 1 (source) and the other destination countries, we assume zero covariances among the other countries.

$$\Omega_1 = \begin{pmatrix} 1 & \sigma_{12} & \ldots & \sigma_{1N} \\ \sigma_{12} & 1 & 0 & 0 \\ \vdots & 0 & \ddots & 0 \\ \sigma_{1N} & 0 & 0 & 1 \end{pmatrix}$$

We derive portfolio holdings between country 1 and country *j*,

$$\tilde{\alpha}_{j1} = \frac{1}{\det(\Omega_1)} \left[\left(EX_{jt} \cdot \{ (\sum_{k=2,k\neq j}^{N} \sigma_{1k} - 1)\sigma_{1j} + 1 - \sum_{k=2,k\neq j}^{N} \sigma^2_{1k} \} \right) + \sigma^1_{LK} \sigma_{1j} \right] \quad \text{for } j=1,\ldots,\text{N}. \tag{15}$$

where $$\det(\Omega_1) = 1 - \sum_{k=2}^{N} \sigma^2_{1k} \text{ and, } EX_{jt} = \frac{1}{\gamma} \cdot E_t(\hat{R}_{jt+1} - \hat{R}_{ft+1} + \frac{1}{2}(\hat{R}^2_{jt+1} - \hat{R}^2_{ft+1}))$$

We rearrange the equation (15) to obtain

[10] Without this special covariance structure, it's hard to derive a simple empirical equation for portfolio holdings. However, we did not assume any restrictions on the covariance of the capital returns in our general equilibrium theory.

$$\tilde{\alpha}_{j1} = \underbrace{\underbrace{\frac{1}{\det(\Omega_1)}}_{\substack{\textit{Source country}\\ \textit{specific factor}}} \cdot \underbrace{EX_{j,t}}_{\substack{\textit{Destination country}\\ \textit{specific factor}\\ (\textit{with Expected Return}\\ \textit{of coutnry } j)}}}_{\phi_{1j}} \cdot \underbrace{\left[\left((\sum_{k\neq j}^{N}\sigma_{1k} - 1) + \frac{\sigma_{LK}^{1}}{EX_{j,t}}\right)\sigma_{1j} + 1 - \sum_{k\neq j}^{N}\sigma_{1k}^{2}\right]}_{f(\sigma_{1j},\ \sum_{k\neq j}^{N}\sigma_{1k})} \qquad (16)$$

Note several things about this equation. First, the portfolio shares of the country *j* asset respond positively to higher excess returns in country *j*, $EX_{j,t}$, as one should expect. Second, they also depend on the correlation of stock returns between the source and destination countries, σ_{1j}. The sign of this effect depends upon other terms such as the correlation of capital and labor income in the source country 1, σ_{LK}^{1}, which may carry a negative sign as in the cases shown in our previous section. But note, thirdly, that the portfolio share of the source country 1 with destination country *j* also depends upon the sum of the correlation between country 1 returns and all countries other than *j*, $\sum_{k\neq j}^{N}\sigma_{1k}$. This term represents the effects of "multilateral resistance": even if the correlation with country *j* is unattractively high, if the correlations with countries other than *j* are even higher, country 1 may have a high share of country *j* asset.

The empirical specification is informed by the log of the portfolio solution above, and takes the form:

$$(\log)\textit{Financial asset holdings}_{ijt}$$

$$= \phi_0 + \underbrace{\phi_i + \phi_j}_{or\ \phi_{ij}} + \beta_1 SYNC_{ijt}(\sigma_{ijt}) + \beta_2 \ln Y_{jt} + \beta_3 MT_{ijt}(\sum_{k\neq j}^{N}\sigma_{ik,t}) + \beta_4 X_{ijt} + \varepsilon_{ijt} \qquad (17)$$

A full nonlinear estimation of equation (16) would be prohibitively complicated.[11] The terms in solution (16) that are specific to the destination country, such as, $EX_{j,t}$ will be represented in our empirical specification with destination country effects, ϕ_j and $\ln Y_{jt}$ which is a log real

[11] Due to the incidental parameters problem, it's hard to implement non-linear least squares in panel data analysis. While estimating within estimates of linear equation, we can easily purge the fixed effects from the regression and obtain consistent estimates. However, if the fixed effects are included in the non-linear equation, it is not easy to separate and purge fixed effects during the estimation process. Thus, the estimates can be biased.

GDP per capita of a destination country *j*. Source fixed effects, will absorb terms in (16) specific to country *i*, such as $\det(\Omega_i)$. The combination of these may also be replaced by country-pair fixed effects, ϕ_{ij}.[12] $SYNC_{ijt}$ is a monotone measure for stock return correlation between country *i* and *j,* the higher value of measure is, the more symmetric stock return correlations are. The maximum value of $SYNC_{ijt}$ is 0, that means stock returns are perfectly symmetric between two countries. We will introduce how to construct this measurement in the next section.

Given the nonlinear nature of equation (16) it is not obvious how most effectively to capture the effect of multilateral resistance. We construct a measure MT_{ijt} to capture stock return correlations with other countries, referring to it as the multilateral resistance term of stock return correlation. If a country has a better chance of risk hedging with other countries, then the country redirects its original financial asset investment to a bilateral partner into the other countries and even reduces bilateral financial asset holdings. The multi-lateral resistance measure of source country *i* is constructed as $-\ln\left(\sum_{k=1,k\neq j}^{N} Y_{kt} \times (-SYNC_{ikt})\right)$. We also multiply each stock return correlation measure between country *i* and *k (k≠j)* by the country *k*'s income per capita before we sum all the correlations. Through this measure, we can consider market return weighted stock return correlations with the other countries (rest of the world). Thus, MT_{ijt} is bigger when not only destination countries (*k*) are less profitable and developed, but also when stock return correlation between country *i* and *k* is more symmetric. It is expected that the multilateral resistance is positively associated with bilateral financial asset holdings.

In the recent trade literature such as Anderson and van Wincoop (2003, 2004), when researchers investigate bilateral trade flow between countries, they introduce a multilateral resistance term which represents average trade costs of source and destination countries with all other partners. Due to iceberg trade cost assumption, source and destination country's price indices imply this multilateral resistance term in the bilateral trade equation. However, many researchers point out that constructing a multilateral resistance term with data is computationally cumbersome, so they instead use country fixed effects to minimize measurement errors on the multilateral resistance term.

[12] Country fixed effects and country pair fixed effects are widely used by international trade research. (i.e. country fixed effects: Anderson and van Wincoop 2003, 2004, and country-pair fixed effects: Glick and Rose 2002 and many others)

Our multilateral resistance measure (MT_{ijt}) in terms of stock return correlation differs from the multilateral resistance to trade, although the two concepts have similar intuition. First, our multilateral resistance term concerns average stock return correlation. So, we finally investigate how the relative bilateral stock return correlation to average stock return correlation affects bilateral asset holdings. Moreover, we obtain MT_{ijt} from the theory and can construct it using data without a computational problem.[13] We also use country or country pair fixed effect with MT_{ijt} not only to control a country's specific factors in the theory but also to minimize measurement error on the MT_{ijt} term as the international trade literature did. Our MT_{ijt} is time-varying, thus country or country pair fixed effects cannot replace it. A way to control time-varying multilateral resistance in trade is to use country time-varying fixed effects (Baldwin and Taglioni 2006). We also try to introduce country time-varying fixed effects in our regression.[14] However, this method includes too many dummy variables, which soak up too much of the time series variation to get statistically significant results.

The vector X_{ijt} comprises the other determinants of equity holdings standard in gravity equations, such as distance, border, common language, etc.

4.2. Data and Measurement

4.2.1. Financial Asset holding Measure (Measure for Financial Integration)

We use bilateral portfolio equity holdings as a dependent variable. The equity holdings data are from the Coordinated Portfolio Investment Survey (CPIS) published by the International Monetary Fund (IMF). The IMF has conducted the Coordinated Portfolio Investment Survey (CPIS) annually since 2001 (and for the first time in 1997). The first CPIS involved 29 source economies, while the CPIS has expanded participation up to 67 source economies in 2006, including several offshore and financial centers. In each case, the bilateral positions of the source countries in 218 destination countries/territories are reported.

The CPIS provides a breakdown of a country's stock of portfolio investment assets by country of residence of issuer. Lee (2008) and Lane and Milesi-Ferretti (2008) point out the problems of survey methods and under-reporting of assets by participating countries, which are shortcomings of the CPIS data (See the details in Lane and Milesi-Ferretti 2008). Nevertheless, the survey presents a unique opportunity to examine foreign equity and debt

[13] Baier and Bergstrand (2009) successfully compute the multilateral resistance term to trade with linear approximation in bilateral trade flow equation.
[14] The results of country time-varying fixed effects are available from the authors upon request.

holdings of many participating countries. We choose bilateral equity holdings for the period 2001 to 2006 and take logs. [15]

4.2.2. Measure for stock return correlation: Output Growth Co-movement

We use output co-movement as a proxy for stock return correlation. In the finance literature, many studies have examined the relationship between stock return and real economic activity (output). For instance, the model of simple discounted cash flow valuation states that stock prices reflect investors' expectations about the future real economic variables such as corporate earnings, or its aggregate proxy, industrial production. If these expectations are correct on average, lagged stock returns should be correlated with the contemporaneous growth rate of industrial production.

Fama (1990) and Schwert (1990) show that real stock returns are highly correlated with future production growth rates in the U.S. stock market. Choi, Hauser, and, Kopecky (1999) confirm Fama-Schwert's findings that the stock returns are prescient for the real sector of the economies in not only the U.S. but also G-7 countries. Also, empirical research such as Davis, Nalewaik, and Willen (2001) and Lane and Milesi-Ferretti (2008) use the output growth rate correlation between countries as a proxy for the gains from bilateral risk diversification. Moreover, the stock return data are limited and available only for financially developed countries. Financial assets are so various that it is hard to determine which asset should be used as a representative asset. Therefore, output growth co-movement can be a good proxy for stock return correlation. The advantages of using output growth co-movement is that we can have more available data and avoid a simultaneity problem between stock return correlation and bilateral stock holdings because output co-movement is highly correlated with lagged stock return correlation.

There are various ways to measure output growth co-movement. Previous studies use the 5-year correlation of the cyclical component of output, as measured with the Baxter and King (1999) Band-Pass filter or pure output growth correlation itself during the period (Lane and Milesi-Ferretti 2008). However, these measures are not available year by year and limited to fully account for time-variant information of output co-movement. We introduce a year by year output co-movement proxy to effectively use all the information of the dataset.

[15] Equity holdings are reported in terms of millions of U.S. dollars. A unit is converted from millions to thousands. All values are real: we convert nominal value into real term using US GDP deflator (2005=100)

In addition, financial investment could be sensitive to current or future expected risk factors. Thus, it is important that stock return correlation measure should be designed to reflect time-varying risk components, being measured year by year. Cerqueira and Martins (2009) show that capturing time variability of business cycle co-movement is worthwhile to verify the accurate effect of other determinants on business cycle synchronization.[16] We construct three different time-varying stock return correlation measures following the previous studies (Alesina, Barro and Tenreyo 2002; Kalemli-Ozcan et al. 2009) to support the robustness of our results.

We use the measurement of output co-movement proposed by Alesina, Barro and Tenreyo (2002) as our base-indicator of stock return correlation.[17] It is assumed that the relative log GDP difference between countries follows an auto-regressive order 2 processes. With the error term, we measure the co-movement between countries.

$$\ln\left(\frac{Y_t^i}{Y_t^j}\right) = a_0 + a_1 \cdot \ln\left(\frac{Y_{t-1}^i}{Y_{t-1}^j}\right) + a_2 \cdot \ln\left(\frac{Y_{t-2}^i}{Y_{t-2}^j}\right) + u_{ijt}^Y \tag{18}$$

Thus, stock return correlation measurement is defined as

$$SYNC1_{ijt} = -\left| u_{ijt}^Y \right| .$$

The maximum value of *SYNC1* is 0, which means that output growth or return is perfectly synchronized between countries. The lower value of *SYNC1* means that return movement is more asymmetric between countries, and the bigger value means returns are more synchronized with each other.

We further use another stock return correlation measurement for gauging the risk-hedging effect on financial asset holdings. We measure stock return correlation with the negative of divergence, defined as the absolute value of real GDP growth differences between country *i* and *j* in year *t*.

$$SYNC2_{ijt} = -\left|(\ln Y_t^i - \ln Y_{t-1}^i) - (\ln Y_t^j - \ln Y_{t-1}^j)\right|$$

This simple index is derived following Giannone, Lenza, and Reichlin (2009) and Kalemli-Ozcan et al.(2009). This index does not reflect the volatility of output growth of each country in a pair but only captures the co-variation of output growth.

[16] When they use time-varying business cycle as a dependent variable, they find the negative effects of financial openness on business cycle synchronization, which differs from the previous findings.

[17] They use this measurement to analyze the benefit and cost of the optimal currency area in terms of business cycle which affects the cost of losing independent monetary policy.

The third measurement is from Morgan, Rime, and Strahan (2004). We construct this as follows. First, we regress GDP growth on a country fixed effect and time (year) fixed effect.

$$\ln\left(\frac{Y_t^i}{Y_{t-1}^i}\right) = \alpha_i + \alpha_t + v_t^i \qquad \text{for all } i \tag{19}$$

The residuals (v_t^i and v_t^j) represent how much output growth (of country i and j) deviates from average growth over the estimation. We then construct the proxy of stock return correlation as the negative absolute value of difference of residuals:

$$SYNC3_{ijt} = -\left|v_t^i - v_t^j\right|.$$

This index measures how similarly output growth moves between two countries in any given year. All measures are constructed with real GDP data from Penn World Table 6.3.
Table 1 show that there are high correlations among three measures.

4.2.3. Other Controls

We control other important determinants (X_{ijt}) of bilateral financial asset holdings that are identified by previous literature. These control variables include specific geographical proximity and political and cultural factors. Financial markets are expected to be integrated more between neighboring countries because of less transaction and transportation costs. To measure geographical proximity, we use two variables—(i) the log of bilateral distance between countries and (ii) a binary variable whether they share a border or not. These variables are from Rose and Spiegel (2004).

Cultural and historical factors can affect financial asset holdings between countries. We add a binary variable for common language, for country pairs with a history of colonization and for common colonizer to control cultural and/or historical characteristics that affect financial asset holdings between countries. Common language is closely related with cultural proximity, and furthermore, it lowers information costs between countries, so investors can more easily access each other's financial market. The same colonial experience may affect overall financial institutions in a country. The past colonial relationship or having a common colonizer could increase financial investment in each other.

We include currency union dummies. It is expected that currency union increases financial asset holdings between countries because currency union not only decreases transaction costs but also removes risk from exchange rate volatility (Alesina et al. 2002, and

Coeurdacier and Martin, 2009). Previous studies introduce a time difference dummy as a determinant of portfolio equity investment between countries in order to proxy for communication difficulties when the overlap between office hours is limited (Portes and Rey, 2005 and Lane and Milesi-Ferretti 2008). We include the difference in longitude between countries to measure time difference. The data is from the CIA World Fact book.

Recent research by Lane and Milesi-Ferretti (2008) investigates the pattern of financial asset holdings dividing into two groups—OECD countries and emerging market countries. They show that different factors in each group play an important role in determining the pattern of equity investments. We add an OECD dummy variable coded as 1 if two countries in a pair are both OECD members. This variable also can control for income level and development of financial institution of a country pair.

Political relationship might affect economic activity across countries. Recent research about war and trade has found that political tensions between countries hinder bilateral or multilateral economic performance such as trade between countries (Lee and Pyun, 2011). We include the number of years of military inter-state conflicts from 1980 to 2001. This variable of political tensions represents how often countries are involved in military conflicts and fail to reach a settlement. Moreover, we control very recent political conflicts between countries. The variable is binary coded as 1 if military conflicts are ongoing for the 2000-2001 period.[18]

We include the log of real bilateral trade[19] (sum of imports and exports between countries and deflated with the U.S. GDP deflator, 2005=100) in line with Aviat and Coeurdacier (2007), and Lane and Milesi-Ferretti (2008).

We also introduce stock market capitalization of a host country in the specification. The capitalization of the stock exchange is an important indicator in the stock market.[20] This measure can reflect the size of stock market, as well as how much domestic stock markets are developed. We take a logarithm of domestic stock market capitalization after adding 1. Domestic stock market capitalization is available for 90 countries from the Global Financial Database.

[18] Military inter-state conflicts dataset is available up to 2001. The data source is from COW project. (http://www.correlatesofwar.org/)
[19] Direction of Trade (DOT) in the IMF.
[20] There is a caveat. Although most stock market indices are capitalization-based today, the indices do not capture the growth in the value of the companies listed on stock exchanges. As more companies are listed on stock exchanges, capitalization increases, even if the price of the average stock remains the same.

Lastly, legal origin is controlled in the specification. In the finance literature, not only the development of financial market, but also the protection of investors /shareholders varies according to legal origin (La porta et al. 1998). Common legal origin is likely to lead to similar institutions, regulation and custom for financial transaction between countries. The variable is coded as 1 if both a source and a host country have a legal system from the same origin; English(Common), French, German or Scandinavian law. We use the Rose and Spiegel dataset that provides the information on legal origins for 107 countries.

5. Empirical Results

5.1. Main results

Tables 2 and 3 present the estimation results of the effect of stock return correlation on bilateral equity asset holdings. We implement two types of fixed effect approaches: country fixed effects for source and host country and country-pair fixed effects.

Table 2 shows the result of the determinants of cross-border equity holdings with source and host country fixed effects. The model fits the data well, explaining a substantial part of the variation in financial asset holdings. We introduce as a proxy for stock return correlation the *SYNC1* measure to check the effect of stock return correlation on bilateral equity holdings. In columns (1), (2) and (3), we use a dependent variable *ln(equity holdings)*. Column (1) reports OLS regression results without country fixed effects. The estimated coefficient on stock return correlation (*SYNC1*) is significantly positive at the 1% critical level, which is puzzling as previous studies have found (Portes and Rey 2005, Aviat and Coeurdacier 2007, Lane and Milesi-Ferretti 2008, Coeurdacier and Guibaud 2011). However, when we include source and host country fixed effects in the regression, column (2) shows that the estimated coefficient of *SYNC1* becomes negative but statistically insignificant. In column (3), moreover, as we include the multilateral resistance term of stock return correlations which captures stock return correlations with the multilateral partners, the estimated coefficient of *SYNC1* turns out to be significantly negative at the 10% critical level. Thus, we confirm that a higher return correlation lowers bilateral equity asset holdings once we take into consideration correlations with third countries. Furthermore, the estimated coefficient of the multilateral resistance term is significantly positive at the 1% critical level, as our theory would predict.

Columns (4)-(6) show the results are the same if we define the dependent variable as *ln(equity+1),* to prevent observations from dropping when taking a log of zeros. Again the coefficient on the measure of stock return correlation initially has the wrong sign, but this is corrected once we control for multilateral resistance in column (7).

Throughout columns (1)-(6) in Table 2 other standard gravity-equation explanatory variables have the expected signs. Higher asset holdings are associated with higher GDP per capita in a host country, as are common language, colonial relationship, and currency union. Distance has a negative effect.

Column (7) includes additional explanatory variables explored in recent research. Bilateral asset holdings is found to be positively influence by bilateral trade in goods and services, as found in Aviat and Coeurdacier (2007), Lane and Milesi-Ferretti (2008) and Lee (2008). Stock market capitalization and common legal origin data are not available for all sample countries, so the number of observation shrinks from 25550 to 14854. The substantial reduction in sample size reduces the significance of our coefficient of *SYNC1* in this regression. But these additional controls do uncover a significantly negative sign for longitude difference, which measures differences in time zone that prevent investors from responding quickly to fluctuations in the financial market.

Column (8) implements tobit estimation with host and source country fixed effects to consider lots of left censored observations. Most of the estimated coefficients remain as the same as those of column (6), in particular, the estimated coefficient of *SYNC1* is significantly negative at the 5% critical level. Hence, it is confirmed that a stock return correlation is negatively associated with financial asset holdings.

Including country-pair fixed effects is another regression specification which matches the theoretical foundation that we proposed in the previous section. These are able to capture any time-invariant correlation (within a pair) between a dependent variable and error term, so they help address problems of engodeneity and omitted variables. This specification has also been used by the trade literature to help deal with multilateral resistance, though it does not fully obviate the need for our multilateral resistance term, *MT*, as this captures multilateral resistance that is time varying whereas country pair fixed effects cannot. Table 3 reports results, where most inherent dyadic characteristics are soaked up by the country-pair fixed effects, and so time-invariant country pair characteristics dropped out.

In column (1), the estimated coefficient of *SYNC1* is already negative and significant at 5% critical level, however the addition of our multilateral resistance control (*MT*) in column (2) makes the estimated coefficient become statistically more significant at 1% critical level as well as larger in magnitude. Country-pair fixed effects seem to contribute to controlling multilateral resistance of stock return correlations. But our additional time-varying multilateral resistance control (*MT*) continues to play a role in correcting the response to bilateral correlation, and its coefficient remains significantly positive at the 1% critical level. This conclusion is supported under the expanded sample in columns (6)-(7), where our *MT* control is required to achieve the significantly negative coefficient on returns correlation (*SYNC*).

In columns (4) and (5), we introduce different stock return correlation measurements for robustness check. We report the estimated coefficients for the second correlation measurement (*SYNC2*) proposed by Giannone et al. (2009) and the third correlation measurement (*SYNC3*) by Morgan et al. (2004) respectively. The estimates of *SYNC2* and *SYNC3* are significantly negative and confirm that a lower stock return correlation between countries stimulates to increasing bilateral equity asset holdings when we control multilateral resistance of stock return correlations. The results of other controls are qualitatively and quantitatively similar with those in column (2).

It is common in the empirical literature to consider year fixed effects to control for common trends or common shocks at a given year. Unlike country fixed effects, which were included in our benchmark empirical estimation, our theoretically derived empirical specification does not call for year fixed effects. Nonetheless, Table 4 reports results with year fixed effects included. Estimates in columns (1) and (2) are very similar to the corresponding results in columns (1) and (2) of table 2, suggesting year fixed effects do not much affect the puzzle of asset holdings associated with high correlations. Column (3) differs somewhat from the corresponding column (3) of table 2, in that the multilateral resistance term (*MT*) is not positive, and the coefficient on *SYNC* is not statistically significant. So the year fixed effects do seem to overlap with the control we use for multilateral resistance. Substantial collinearity between *MT* term and year fixed effects is not surprising, as *MT* term takes an average across essentially all countries which reduces cross-sectional variation.

5.2. An Instrumental Variable Approach

The empirical investigation of the effects of stock return correlation on financial asset holdings may encounter an endogeneity problem, as discussed in Coeurdacier and Guibaud (2011). The causality can run in the opposite direction: financial asset holdings between countries (financial integration) may have either a negative effect (Kalemli-Ozcan et al. 2009) or a positive effect (Imbs 2006) on the stock return correlation and output growth co-movement.[21] Hence, the former estimates of stock return correlation on bilateral asset holdings might be biased, although the fixed effects that we used partially relieve endogeneity and omitted variable problems by controlling unobserved components which are related to error terms. As a robustness check, this section implements an instrument variable (IV) approach. We use as an instrument the lagged stock return correlation, as suggested by Lane and Milesi-Ferretti (2008) and Coeurdacier and Guibaud (2011).

Panel B of Table 5 presents the first stage regression of IV with country-pair fixed effect estimation. We instrument *SYNC1* on its lag. The estimated coefficient of lagged *SYNC1* on current stock return correlation (*SYNC1)* is significantly negative. The existing econometric literature defines weak instruments based on the strength of the first-stage equation (Staiger and Stock, 1997; Stock and M. Yogo, 2003). F-test statistics on the first stage regression all exceed 10, the threshold number recommended by Staiger and Stock (1997). Thus, we can reject the null hypothesis that the IV equation is weakly identified and confirm that the instruments are theoretically and statistically powerful.

Panel A of Table 5 reports estimates from the second stage instrumental variable regressions, beginning with a specification drawn from column (7) of table 2 with source and host country fixed effects. Results confirm the conclusions from previous tables. Comparing columns (1) and (2) shows that once again including our control for multilateral resistance (MT) confers statistical significance (at the 10% level) to the negative relationship between equity holdings and returns correlations (*SYNC*1). And once again the coefficient on MT is significantly positive. These results are echoed in the other columns of Table 5 for alternative measures of output correlation, and for the larger sample that includes zeros by

[21] In fact, the causal effect of financial market integration on output comovement has been a popular topic in the preceding literature, in contrast with the scarcity of work studying our question of the causal effect running the other way. Some theoretical research discusses the implication of limited international financial asset trade (incomplete financial market) on international real business cycles (See Baxter and Crucini 1995; Heathcote and Perri 2002). Moreover, empirical studies inspect the effect of financial asset integration on real economic linkage. The results are mixed and reach no consensus on the effect of financial integration on output co-movement. Kose et al.(2003) finds negligible effects of financial integration on consumption and output correlation in the 1990's. Kalemli-Ozcan, Sorenson and Yosha (2003) and Kalemli-Ozcan, Papaioannou and Peydró (2009) emphasize that financial integration between countries causes capital reallocation between them. This may promote industrial specialization of each country cause output co-movement to be less synchronized. However, Imbs (2004, 2006) find that an increase in financial integration generates correlated capital flows, which raises business cycle synchronization.

adding 1 to the dependent variable before taking logs. We conclude that IV estimation reinforces the robustness of our estimation results.

5.3. The patterns of financial asset holdings: OECD versus Non-OECD

This section considers sub-sample regressions of OECD and Non-OECD groups of countries in order to examine any specific patterns of financial asset holdings according to the different level of income and financial development. We categorize source and host countries into either OECD or Non-OECD, and make 4 country pair sub-samples: i) OECD (source) to OECD (destination), ii) OECD to Non-OECD, iii) Non-OECD to OECD, and iv) Non-OECD to Non-OECD.

As reported in Table 6, the estimates on stock return correlation are significantly negative for all those cases where the destination country is OECD (odd numbered columns), but statistical significance fails for cases where non-OECD countries are the destination. In the former group, the degree of statistical significance tends to be stronger than in any of our previous tables. It is also interesting that the identity of the source country does not seem to play as important a role as does the destination.

6. Concluding remarks

This paper studies how asset diversification between a pair of countries is affected by correlations with third countries, in a manner that resembles the multilateral resistance to trade in the recent trade literature. Our N-country theoretical framework offers an explanation for why recent empirical work has found that higher return correlations are sometimes associated with higher portfolio holdings, which is contrary to the pursuit of risk hedging. The model suggests a means for controlling for third-country effects, and empirical specifications implementing these controls reverse the finding of preceding literature.

Hence, we show that a multi-county perspective is required to understand this possible positive relationship between stock return correlation and bilateral asset holdings. We also find that heterogeneous stock return correlations among countries contribute to explaining the degree of equity home bias. When stock returns among countries are highly associated, equity home bias becomes more severe because a home country has less international risk diversification incentives to invest in foreign assets which are highly correlated with home assets.

Our empirical results have implications for the benefits of international financial market integration. The recent global financial crisis caused a spillover of negative shocks between closely integrated countries. Due to this negative effect of economic integration, some doubt arises whether the consequence of economic integration is a net positive. However, this paper shows that if one controls for multilateral resistance arising from third-country effects, then holding equities in a foreign country is associated with lower rather than higher output correlations. This highlights the benefit of international financial integration to facilitate risk sharing and raise economic welfare.

References

[1] Anderson, J. and E. van Wincoop. 2003. Gravity with Gravitas: A Solution to the Border Puzzle. *American Economic Review*. 93. 170-192.

[2] Anderson, J. and E. van Wincoop. 2004. Trade Costs, *Journal of Economic Literature*, 42, 691-751

[3] Alesina, Alberto, Robert J. Barro, and Silvana Tenreyo, 2002, "Optimal Currency Unions", *NBER Macroeconomics Annual*, Mark Gertler and Kenneth Rogoff, eds. Cambridge, MA: MIT Press

[4] Aviat, A., and N. Coeurdacier, 2007, The geography of trade in goods and asset holdings, *Journal of International Economics* 71, 22-51.

[5] Baldwin, Richard and D. Taglioni. 2006. Gravity for Dummies and Dummies for Gravity Equations, NBER Working paper 12516.

[6] Baier, S. and J. Bergstrand. 2009. Bonus vetus OLS: A simple method for approximating international trade-cost effects using gravity equation. *Journal of International Economics*. 77. 77– 85.

[7] Barberis, N., and R. Thaler, 2004. A Survey of Behavioral Finance, in G. Constantinides, M. Harris, and R.M. Stulz, eds.: *Handbook of the Economics of Finance* (Elsevier North-Holland).

[8] Baxter, M., U. Jermann, and R. King, 1998, Nontraded goods, Nontraded factors, and international non-diversification, *Journal of International Economics* 44, 211-229.

[9] Baxter, M. and U.J. Jermann, 1997, The International Diversification Puzzle is Worse than You Think, *American Economic Review* 87:1, 170-191

[10] Bottazzi, Laura, Paolo Pesenti, and Eric van Wincoop. 1996. Wages, Profits, and the International Portfolio Puzzle. *European Economic Review* 40, 219-54.

[11] Cerqueira, P. and R. Martins, 2009. Measuring the determinants of business cycle synchronization using a panel approach, *Economics Letters*, vol. 102(2), 106-108.

[12] Chan, K., V.M. Covrig, and L.K. Ng, 2005, What determines the domestic and foreign bias? Evidence from mutual fund equity allocations worldwide, *Journal of Finance* 60, 1495-1534.

[13] Choi, J.-J., Hauser, S., Kopecky, K.J., 1999. Does the stock market predict real activity? Time series evidence from the G-7 countries. *Journal of Banking and Finance* 23 (12), 1771–1792.

[14] Coeurdacier, Nicolas 2009, Do Trade costs in Goods Markets Lead to Home Bias in Equities, *Journal of International Economics* 77, 86-100.

[15] Coeurdacier, N. and Martin, Philippe, 2009. The Geography of Asset Trade and the Euro: Insiders and Outsiders, *Journal of the Japanese and International Economies*, vol. 23(2), 90-113

[16] Coeurdacier, N., R. Kollmann and P. Martin, 2010, International Portfolios, Capital Accumulation and Foreign Assets Dynamics, *Journal of International Economics*, Volume 80, Issue 1, 100-112

[17] Coeurdacier, N. and Helene Rey. 2010 Home bias in Open Economy Financial Macroeconomics", working papers, Sciences Po

[18] Coeurdacier, N. and with Stéphane Guibaud 2011, International Portfolio Diversification Is Better Than You Think, *Journal of International Money and Finance*, vol. 30 (2), 289-308.

[19] Davis, Steven, Jeremy Nalewaik, and Paul Willen, 2001, On the Gains to International Trade in Risky Financial Assets, Chicago Graduate School of Business mimeograph

[20] Devereux, M. B., and A. Sutherland. 2010. Country Portfolios in Open Economy Macro Models*, Journal of the European Economic Association*, forthcoming.

[21] Engel, C. and Akito Matsumoto, 2009, The International Diversification Puzzle When Prices are Sticky: It's Really about Exchange-Rate Hedging not Equity Portfolios, *American Economic Journal: Macroeconomics* 1, July 2009, 155-188.

[22] Evans, M., and V. Hnatkovska. 2007. Solving General Equilibrium Models with Incomplete Markets and Many Financial Assets, working paper, Georgetown University.

[23] Fama, E.F., 1990. Stock returns, expected returns, and real activity. *Journal of Finance,* 45, 1089-1108.

[24] Feenstra, Robert C., 2004. *Advanced International Trade*. Princeton press

[25] French, Kenneth R., and James M. Poterba. 1991. Investor Diversification and International Equity Markets. *American Economic Review* 81, 222-26.

[26] Giannone, D., Lenza M. and Reichlin, L. 2009, Did the Euro Imply More Correlation of Cycles?, in Alesina, A. and Giavazzi, F. (eds.) Europe and the Euro, NBER Volume, University of Chicago Press, forthcoming.

[27] Glick, R., Rose, A.K., 2002. Does a currency union affect trade? The time-series evidence*. European Economic Review* 46 (6), 1125–1151.

[28] Heathcote, J. and F. Perri, 2002, Financial autarky and international business cycles, *Journal of Monetary Economics*, 49, pp. 601–627

[29] Heathcote, J. and F. Perri, 2004, Financial globalization and real regionalization, *Journal of Economic Theory*, 119, pp.207–243

[30] Heathcote, J. and F. Perri, 2009, The International Diversification Puzzle is Not as Bad as You Think, unpublished manuscript

[31] Imbs, Jeans, 2004, Trade, Finance, Specialization and Synchronization?, *The Review of Economics and Statistics*, 86(3),723-34

[32] Imbs, Jeans, 2006. The Real Effects of Financial Integration, *Journal of International Economics*, 68, 296-324.

[33] Kalemli-Ozcan, Sebnem, Bent Sorensen, and Oved Yosha, 2003, Risk Sharing and Industrial Specialization: Regional and International Evidence, *American Economic Review* 93:1.

[34] Kalemli-Ozcan, S., E. Papaioannou and J. L. Peydró, 2009. Financial Integration and Business Cycle Synchronization, NBER working paper, No. 14887.

[35] Kose, Eswar S. Prasad, Marco E. Terrones, 2003, How Does Globalization Affect the Synchronization of Business Cycles?, *American Economic Review*, Vol. 93, No. 2.

[36] La Porta, Rafael, Florencio Lopez-de-Silanes, Andrei Shleifer, and Robert Vishny, 1998, Law and finance, *Journal of Political Economy* 106, 1113-1155.

[37] Lane, P. and G.M. Milesi-Ferretti, 2003. International Financial Integration, *IMF Staff Papers* 50, 82-113.

[38] Lane, P. and G.M. Milesi-Ferretti, 2008, International Investment Patterns*, Review of Economics and Statistics*, vol. 90(3), pages 538-549

[39] Lee, J.-W., 2008, Patterns and Determinants of Cross-border Financial Asset Holdings in East Asia, Asian Development working paper.

[40] Lee, J.-W. and J.H. Pyun, 2011, Does Trade Integration contributes to peace?, UC Davis working paper.

[41] Lucas, Robert Jr., 1982. Interest rates and currency prices in a two-country world, *Journal of Monetary Economics*, vol. 10(3), 335-359.

[42] Martin, P. and H. Rey, 2004, "Financial Super-Markets: Size Matters for Asset Trade", *Journal of International Economics*, 64, 335-361.

[43] Morgan, D. P., Rime, B. and Strahan, P. E. 2004. Bank Integration and State Business Cycles, *Quarterly Journal of Economics*, 119(3): 1555-85.

[44] Obstfeld, M., and K. Rogoff, 2000. The six major puzzles in international macroeconomics: Is there a common cause?, NBER Macroeconomics Annual, 339-390.

[45] Okawa, Y. and E. van Wincoop, 2009. Gravity in International Finance, mimeo

[46] Portes, R. and H, Rey, 2005, The Determinants of Cross-border Equity Flows, *Journal of International Economics*, 65,pp. 269–296

[47] Rose, A.K. and M. Spiegel, 2004, A Gravity Model of Sovereign Lending: Trade, Default and Credit, *IMF Staff Papers*, 51:S, 64-74

[48] Schwert, G.W., 1990. Stock returns and real economic activity: A century of evidence. *Journal of Finance* 45, 1237-1257.

[49] Staiger, D. and J. Stock. 1997. Instrumental Variables Regression with Weak Instruments. *Econometrica.* 65(3). 557-586.

[50] Stock, J. H. and M. Yogo, 2002. Testing for Weak Instruments in Linear IV Regressions. NBER Technical Working Paper 284.

[51] Stockman, A. and H. Dellas, 1989, International portfolio non diversification and exchange rate variability, *Journal of International Economics* 26, 271-90.

[52] Tille, C., and E. van Wincoop. 2010. International Capital Flows, *Journal of International Economics*, 80, 157–175.

[53] Wooldridge, J.M. (2002), *Econometric Analysis of Cross Section and Panel Data*, Cambridge, MA, MIT Press.

Table 1. Correlations of Measures for Stock Return Correlation

	SYNC1	*SYNC2*	*SYNC3*
SYNC1	1		
SYNC2	0.840	1	
SYNC3	0.830	0.911	1

Table 2. The Determinants of Bilateral Equity Holdings: Country fixed effects

Method	Panel FE OLS							Tobit
Dependent variables	*ln(equity)*			*ln(equity+1)*			*ln(eq)*	*ln(eq+1)*
Country Fixed Effects	No	Yes	Yes	No	Yes	Yes	Yes	Yes
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SYNC1(Measure for	6.341***	-0.569	-1.279*	8.232***	-0.277	-0.967*	-1.308	-4.504**
stock return correlation)	[1.081]	[0.743]	[0.753]	[0.875]	[0.540]	[0.540]	[0.871]	[1.785]
(log)Destination GDP	0.409***	5.190***	4.512***	1.351***	4.366***	3.765***	2.828***	9.111***
per capita ($\ln Y_{jt}$)	[0.053]	[0.271]	[0.309]	[0.051]	[0.280]	[0.291]	[0.414]	[0.787]
Multilateral Resistance	--	--	0.213***	--	--	0.350***	0.118***	0.466***
(MT_{ijt})			[0.041]			[0.057]	[0.043]	[0.113]
Border	0.877***	0.623***	0.623***	0.935**	0.495***	0.492***	0.545***	0.195
	[0.263]	[0.082]	[0.082]	[0.406]	[0.157]	[0.157]	[0.082]	[0.284]
(log) Distance	-0.029	-0.821***	-0.820***	-0.335**	-1.166***	-1.168***	-0.354***	-2.357***
	[0.100]	[0.041]	[0.040]	[0.133]	[0.056]	[0.056]	[0.046]	[0.115]
Common language	1.034***	0.390***	0.392***	1.651***	0.383***	0.383***	0.437***	1.158***
	[0.145]	[0.059]	[0.059]	[0.188]	[0.077]	[0.077]	[0.062]	[0.162]
Colony dummy	0.678**	0.655***	0.653***	0.907*	0.969***	0.969***	0.238**	2.272***
	[0.313]	[0.106]	[0.105]	[0.488]	[0.170]	[0.170]	[0.100]	[0.293]
Common colonizers	-0.413	0.683***	0.694***	0.048	0.300*	0.304*	0.581***	2.912***
	[0.279]	[0.165]	[0.165]	[0.319]	[0.162]	[0.163]	[0.132]	[0.390]
Currency Union	1.655***	0.108	0.111*	2.015***	0.309***	0.307***	0.214***	-1.017***
	[0.214]	[0.067]	[0.067]	[0.343]	[0.115]	[0.115]	[0.074]	[0.176]
Longitude difference	0.007***	0.001	0.001	0.003	0.002**	0.002**	-0.001**	-0.001
	[0.002]	[0.001]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]
Both OECD countries	2.435***	1.764***	1.764***	5.880***	4.256***	4.253***	1.618***	1.097***
	[0.139]	[0.110]	[0.109]	[0.221]	[0.112]	[0.112]	[0.090]	[0.245]
# of years of military	0.091	-0.002	-0.002	0.211*	0.008	0.008	-0.023	0.028
conflicts, 1980-2001	[0.117]	[0.020]	[0.020]	[0.126]	[0.035]	[0.035]	[0.021]	[0.063]
Military conflict	0.362	-0.131	-0.136	0.298	-0.756**	-0.763**	0.075	-0.684
dummy, 2000-2001	[0.779]	[0.219]	[0.219]	[1.357]	[0.381]	[0.380]	[0.236]	[0.706]
(log) Bilateral trade							0.322***	
							[0.020]	
Stock Market Capitalization,							0.452***	
Host country (*j*)							[0.071]	
Common legal origin							0.052	
							[0.041]	
Observations	10384	10384	10384	25550	25550	25550	14854	25550
Adj-R^2 (Pseudo-R^2)	0.304	0.758	0.7586	0.388	0.7171	0.7175	0.723	(0.289)

Note: Robust standard errors are reported in brackets. *,**,and *** are respectively significance level at 10%, 5% and 1%.

Table 3. The Determinants of Bilateral Equity Holdings: Country-pair fixed effects

Method	Panel FE: Country-pair fixed effect							
Dependant variables	*ln(equity holdings)*					*ln(equity holdings+1)*		
Measure for stock return correlation	***SYNC1***			***SYNC2***	***SYNC3***	***SYNC1***		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$SYNC_{ijt}$	-1.495**	-2.338***	-2.267***	-1.112**	-0.958*	-0.348	-1.230***	-1.247***
	[0.657]	[0.623]	[0.609]	[0.501]	[0.581]	[0.383]	[0.369]	[0.365]
log Destination GDP per capita($\ln Y_{jt}$)	6.272***	5.506***	5.160***	5.507***	5.383***	4.859***	4.144***	3.934***
	[0.251]	[0.264]	[0.285]	[0.251]	[0.266]	[0.264]	[0.260]	[0.263]
Multilateral Resistance (MT_{ijt})		0.230***	0.228***	0.239***	0.213***		0.391***	0.389***
		[0.027]	[0.027]	[0.026]	[0.025]		[0.038]	[0.038]
(log) Bilateral Trade			0.136***					0.098***
			[0.039]					[0.022]
Observations	10384	10384	10384	10384	10384	25550	25550	25550
Country pairs	2631	2631	2631	2631	2631	7139	7139	7139
Adjusted R-squared	0.922	0.9231	0.9234	0.921	0.920	0.895	0.896	0.897

Note: Clustered robust standard errors are reported in brackets. *,**,and *** are respectively significance level at 10%, 5% and 1%.

Table 4. Including Year Fixed Effects

Dependent Variable		*ln(equity)*	
Country Fixed Effects	No	Yes	Yes
	(1)	(2)	(3)
SYNC1(Measure for stock return correlation)	6.175***	-0.711	-0.248
	[1.099]	[0.920]	[1.076]
(log)Destination GDP per capita	0.277***	0.930*	0.918*
	[0.052]	[0.507]	[0.508]
Multilateral Resistance (MT_{ijt})			-0.079
			[0.085]
Border	0.265**	0.547***	0.547***
	[0.118]	[0.079]	[0.079]
(log) Distance	0.052	-0.370***	-0.370***
	[0.048]	[0.048]	[0.048]
Common language	1.213***	0.445***	0.444***
	[0.076]	[0.061]	[0.061]
Colony dummy	0.642***	0.249**	0.249**
	[0.151]	[0.111]	[0.111]
Common colonizers	0.463**	0.591***	0.587***
	[0.188]	[0.204]	[0.205]
Currency Union	1.569***	0.214***	0.213***
	[0.091]	[0.065]	[0.065]
Longitude difference	0.004***	-0.001**	-0.001**
	[0.001]	[0.001]	[0.001]
Both OECD countries	1.705***	1.617***	1.617***
	[0.067]	[0.123]	[0.123]
# of years of military conflicts, 1980-2001	-0.028	-0.024	-0.024
	[0.033]	[0.019]	[0.019]
Military conflict dummy, 2000-2001	0.367	0.072	0.072
	[0.338]	[0.203]	[0.204]
(log) Bilateral trade	0.379***	0.309***	0.309***
	[0.015]	[0.024]	[0.024]
Stock Market Capitalization, Host country (*j*)	0.109***	0.194**	0.196**
	[0.013]	[0.091]	[0.091]
Common legal origin	-0.458***	0.05	0.05
	[0.059]	[0.039]	[0.039]
Observations	8921	8921	8921
Adjusted R-squared	0.399	0.795	0.795

Note: Clustered robust standard errors are reported in brackets. *,**,and *** are respectively significance level at 10%, 5% and 1%.

Table 5. Instrument variable estimation[a]

Dependent variables	*ln(equity)*					*ln(equity holdings+1)*		
Stock return correlation Measures	***SYNC1***	***SYNC1***	***SYNC1***	***SYNC2***	***SYNC3***	***SYNC1***	***SYNC2***	***SYNC3***
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Second stage IV estimates: Dependent variable is Financial asset holdings								
$SYNC_{ijt}$	-28.306	-35.982*	-3.571***	-4.651***	-7.263***	-4.858***	-9.333***	-11.023***
	[17.513]	[21.863]	[1.238]	[1.368]	[1.385]	[1.766]	[2.649]	[2.442]
(log) Host GDP per capita($\ln Y_{jt}$)	4.377***	3.357***	5.211***	5.123***	4.981***	3.923***	3.673***	3.517***
	[0.940]	[0.556]	[0.286]	[0.278]	[0.308]	[0.266]	[0.295]	[0.299]
Multilateral Resistance (MT_{ijt})	--	0.645*	0.236***	0.294***	0.314***	0.439***	0.627***	0.615***
		[0.336]	[0.031]	[0.035]	[0.035]	[0.047]	[0.073]	[0.063]
(log) Bilateral trade	0.314***	0.314***	0.135***	0.141***	0.134***	0.100***	0.104***	0.106***
	[0.021]	[0.022]	[0.039]	[0.039]	[0.039]	[0.022]	[0.023]	[0.023]
Border	0.587***	0.593***						
	[0.092]	[0.095]						
(log) Distance	-0.368***	-0.369***						
	[0.050]	[0.051]						
Common language	0.482***	0.501***						
	[0.070]	[0.076]						
Colony dummy	0.223**	0.212**						
	[0.105]	[0.108]						
Common colonizers	0.837***	0.890***						
	[0.216]	[0.243]						
Currency Union	0.269***	0.290***						
	[0.085]	[0.092]						
Longitude difference	-0.001*	-0.001*						
	[0.001]	[0.001]						
Both OECD dummy	1.699***	1.726***						
	[0.107]	[0.117]						
Stock Market Capitalization(*j*)	0.473***	0.249*						
	[0.074]	[0.149]						
Common legal origin	0.017	0.006						
	[0.049]	[0.052]						
Panel B: 1st stage IV estimates & Diagnostics: Dependent variable is *SYNC*								
$SYNC_{ij(t-1)}$[b]	-0.048***	-0.039***	-0.269***	-0.226***	-0.212***	-0.222***	-0.121**	-0.138***
(a year lagged *SYNC*)	[0.01]	[0.009]	[0.023]	[0.022]	[0.015]	[0.013]	[0.017]	[0.014]
F- test on IV	21.8	16.21	139.14	100.81	189.69	280.68	50.02	92.22
Country Two-way FE	Yes	Yes	--	--	--	--	--	--
Country pair FE	--	--	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8921	8921	9915	9915	9915	24214	24214	24214
Country pairs			2162	2162	2162	5803	5803	5803

Note: a. Clustered robust standard errors are reported in brackets. *,**,and *** are respectively significance level at 10%, 5% and 1%. b. We report only the estimation results of $SYNC_{ij(t-1)}$ and omit those of other variables of the first stage regression in Panel B. The full estimation results of the first stage regression are available from the authors upon request.

Table 6. The Patterns of Bilateral Equity Holdings: OECD vs Non-OECD countries.

Methods	Panel FE: Country-pair fixed effects							
Dependant variables	*ln(equity holdings)*				*ln(equity holdings+1)*			
Source countries Host countries	OECD OECD	OECD Non-OECD	Non-OECD OECD	Non-OECD Non-OECD	OECD OECD	OECD Non-OECD	Non-OECD OECD	Non-OECD Non-OECD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$SYNC1_{ijt}$	-3.242***	-1.106	-4.385***	-0.64	-4.116*	-0.593	-4.691**	-0.231
	[1.201]	[0.679]	[1.441]	[1.518]	[2.466]	[0.464]	[2.097]	[0.506]
(log) Host GDP per capita($\ln Y_{jt}$)	7.472***	3.720***	7.039***	3.678***	9.694***	2.885***	13.532***	2.044***
	[0.471]	[0.302]	[0.845]	[0.663]	[0.983]	[0.297]	[1.163]	[0.378]
Multilateral Resistance (MT_{ijt})	0.087***	0.173***	0.235***	0.027	0.038	0.488***	0.256**	0.007
	[0.029]	[0.054]	[0.068]	[0.092]	[0.068]	[0.070]	[0.113]	[0.061]
(log) Bilateral trade	0.615***	0.170***	0.052	-0.238***	0.727***	0.124***	-0.055	0.018
	[0.085]	[0.046]	[0.070]	[0.083]	[0.169]	[0.046]	[0.088]	[0.024]
Observations	3859	3381	2054	1090	4412	11577	3538	6023
Adjusted R-squared	0.964	0.911	0.884	0.881	0.924	0.898	0.859	0.857

Note: Clustered robust standard errors are reported in brackets. *,**,and *** are respectively significance level at 10%, 5% and 1%.

Appendix

A. Solving for the portfolio holdings, equation (12)

(12) $E_t[(\hat{C}_{i,t+1}-\hat{C}_{k,t+1})(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]=0$ for i,j=1,…N, and k=2,…,N, k≠i

$$= E_t[\{\tilde{\alpha}_{1i}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})+\cdots+\tilde{\alpha}_{Ni}(\hat{R}_{N,t+1}-\hat{R}_{f,t+1})-\tilde{\alpha}_{1k}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})-\cdots-\tilde{\alpha}_{Nk}(\hat{R}_{N,t+1}-\hat{R}_{f,t+1})$$
$$+(\hat{Y}_{i,t+1}-\hat{Y}_{k,t+1})-(\hat{W}_{i,t+1}-\hat{W}_{k,t+1})\}\times(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]=0$$
$$= E_t[\{\tilde{\alpha}_{1i}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})+\cdots+\tilde{\alpha}_{Ni}(\hat{R}_{N,t+1}-\hat{R}_{f,t+1})-\tilde{\alpha}_{1k}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})-\cdots-\tilde{\alpha}_{Nk}(\hat{R}_{N,t+1}-\hat{R}_{f,t+1})$$
$$+(\hat{Y}^K_{i,t+1}-\hat{Y}^K_{j,t+1})+(\hat{Y}^L_{i,t+1}-\hat{Y}^L_{j,t+1})\}\times(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]$$

where $E_t[\{(\hat{W}_{i,t+1}-\hat{W}_{k,t+1})\times(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]=0$

$$=(\tilde{\alpha}_{1i}-\tilde{\alpha}_{1k})\operatorname{cov}(XR_{1t+1},XR_{jt+1})+(\tilde{\alpha}_{2i}-\tilde{\alpha}_{2k})\operatorname{cov}(XR_{2t+1},XR_{jt+1})+\cdots+(\tilde{\alpha}_{Ni}-\tilde{\alpha}_{Nk})\operatorname{cov}(XR_{Nt+1,},XR_{jt+1})$$
$$+\operatorname{cov}(XR_{it+1},XR_{jt+1})-\operatorname{cov}(XR_{kt+1,},XR_{jt+1})+(\sigma_{LK}^{i(if\ i=j)}-\sigma_{LK}^{k(if\ k=j)})=0$$

where $XR_{i,t+1}=\hat{R}_{i,t+1}-\hat{R}_{f,t+1}$

For instance, country 1 and country 2 have,

(12)’ $E_t[(\hat{C}_{1,t+1}-\hat{C}_{2,t+1})(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]=0$ for j=1,…,N

$$= E_t[\{\tilde{\alpha}_{11}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})+\cdots+\tilde{\alpha}_{N1}(\hat{R}_{N,t+1}-\hat{R}_{f,t+1})-\tilde{\alpha}_{12}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})-\cdots-\tilde{\alpha}_{N2}(\hat{R}_{N,t+1}-\hat{R}_{f,t+1})$$
$$+(\hat{Y}_{1,t+1}-\hat{Y}_{2,t+1})-(\hat{W}_{1,t+1}-\hat{W}_{2,t+1})\}\times(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]=0$$
$$= E_t[\{\tilde{\alpha}_{11}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})+\cdots+\tilde{\alpha}_{N1}(\hat{R}_{N,t+1}-\hat{R}_{f,t+1})-\tilde{\alpha}_{12}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})-\cdots-\tilde{\alpha}_{N2}(\hat{R}_{N,t+1}-\hat{R}_{f,t+1})$$
$$+(\hat{Y}^K_{1,t+1}-\hat{Y}^K_{2,t+1})+(\hat{Y}^L_{1,t+1}-\hat{Y}^L_{2,t+1})\}\times(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]$$

where $E_t[\{(\hat{W}_{1,t+1}-\hat{W}_{2,t+1})\times(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]=0$

$$=\tilde{\alpha}_{11}\operatorname{cov}(XR_{1t+1},XR_{jt+1})+\cdots+\tilde{\alpha}_{N1}\operatorname{cov}(XR_{Nt+1},XR_{jt+1})-\tilde{\alpha}_{12}\operatorname{cov}(XR_{1t+1},XR_{jt+1})-\cdots-\tilde{\alpha}_{N2}\operatorname{cov}(XR_{Nt+1,}XR_{jt+1})$$
$$+\operatorname{cov}(XR_{1t+1},XR_{jt+1})-\operatorname{cov}(XR_{2t+1,}XR_{jt+1})+(\sigma_{LK}^{1(if\ j=1)}-\sigma_{LK}^{2(if\ j=2)})=0$$

where $XR_{i,t+1}=\hat{R}_{i,t+1}-\hat{R}_{f,t+1}$

Thus, based on the above, $N(N-1)$ equations of country *i* and *k*,

B. Matrix Algebra

(12) $A = \Pi^{-1}B$

where $\boldsymbol{A}' = \left(\tilde{\alpha}_{11} \quad \tilde{\alpha}_{21} \quad \ldots \quad \tilde{\alpha}_{N1} \quad \tilde{\alpha}_{12} \quad \ldots \quad \tilde{\alpha}_{N2} \quad \tilde{\alpha}_{13} \quad \ldots \quad \tilde{\alpha}_{N3} \quad \ldots \quad \tilde{\alpha}_{1N} \quad \ldots \quad \tilde{\alpha}_{NN}\right)$

$\boldsymbol{A}'$ is a solution for equity holdings and it is $(N \times N) \times 1$.

$$B = \begin{bmatrix} -\mathrm{cov}(XR_{1t+1}, XR_{1t+1}) + \mathrm{cov}(XR_{2t+1,} XR_{1t+1}) - (\sigma_{LK}^{1}) \\ -\mathrm{cov}(XR_{1t+1}, XR_{2t+1}) + \mathrm{cov}(XR_{2t+1,} XR_{2t+1}) + (\sigma_{LK}^{2}) \\ \vdots \\ -\mathrm{cov}(XR_{1t+1}, XR_{Nt+1}) + \mathrm{cov}(XR_{2t+1,} XR_{Nt+1}) \\ -\mathrm{cov}(XR_{1t+1}, XR_{1t+1}) + \mathrm{cov}(XR_{3t+1,} XR_{1t+1}) - (\sigma_{LK}^{1}) \\ -\mathrm{cov}(XR_{1t+1}, XR_{2t+1}) + \mathrm{cov}(XR_{3t+1,} XR_{2t+1}) \\ -\mathrm{cov}(XR_{1t+1}, XR_{1t+1}) + \mathrm{cov}(XR_{3t+1,} XR_{1t+1}) + (\sigma_{LK}^{3}) \\ \vdots \\ -\mathrm{cov}(XR_{1t+1}, XR_{1t+1}) + \mathrm{cov}(XR_{Nt+1,} XR_{1t+1}) - (\sigma_{LK}^{1}) \\ \vdots \\ -\mathrm{cov}(XR_{1t+1}, XR_{Nt+1}) + \mathrm{cov}(XR_{Nt+1,} XR_{Nt+1}) + (\sigma_{LK}^{N}) \end{bmatrix}$$

B is an $(N-1)N \times 1$ matrix which consists of 1) variance of excess stock returns (or covariance of stock returns between two countries) and 2) covariance between capital and labor income of country. We generate special variance- covariance matrix of excess stock return between countries, Π, like below

$\Pi =$

$$
\left(\begin{array}{ccccc|ccccc|ccccc|ccccc|cc|ccccc}
\sigma_{11} & \sigma_{12} & \sigma_{13} & \ldots & \sigma_{1N} & -\sigma_{11} & -\sigma_{12} & -\sigma_{13} & \ldots & -\sigma_{1N} & 0 & 0 & 0 & \ldots & 0 & 0 & \ldots & 0 & \ldots & 0 & 0 & & 0 & 0 & \ldots & 0 & 0 \\
\sigma_{21} & \sigma_{22} & \sigma_{23} & \ldots & \sigma_{2N} & 0 & 0 & 0 & \ldots & 0 & -\sigma_{21} & -\sigma_{22} & -\sigma_{23} & \ldots & -\sigma_{2N} & 0 & \ldots & 0 & & 0 & 0 & & 0 & 0 & \ldots & 0 & 0 \\
\sigma_{31} & \sigma_{32} & \sigma_{33} & \ldots & \sigma_{3N} & 0 & 0 & 0 & \ldots & 0 & 0 & 0 & 0 & \ldots & 0 & -\sigma_{31} & -\sigma_{32} & -\sigma_{33} & \ldots & -\sigma_{3N} & 0 & \ldots & 0 & 0 & \ldots & 0 & 0 \\
\vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & & \vdots & \vdots & \ldots & \ldots & & \vdots & \ldots & \ldots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\sigma_{N1} & \sigma_{N2} & \sigma_{N3} & \ldots & \sigma_{NN} & 0 & 0 & 0 & \ldots & 0 & 0 & 0 & & 0 & 0 & 0 & \ldots & \ldots & \ldots & 0 & 0 & 0 & -\sigma_{N1} & -\sigma_{N2} & -\sigma_{N3} & \ldots & -\sigma_{NN} \\
\hline
\sigma_{11} & \sigma_{12} & \sigma_{13} & \ldots & \sigma_{1N} & 0 & 0 & 0 & \ldots & 0 & -\sigma_{11} & -\sigma_{12} & -\sigma_{13} & \ldots & -\sigma_{1N} & 0 & \ldots & \ldots & \ldots & 0 & 0 & 0 & 0 & 0 & \ldots & 0 & 0 \\
\sigma_{21} & \sigma_{22} & \sigma_{23} & \ldots & \sigma_{2N} & 0 & 0 & 0 & \ldots & 0 & 0 & 0 & 0 & \ldots & 0 & -\sigma_{21} & -\sigma_{22} & -\sigma_{23} & \ldots & -\sigma_{2N} & 0 & \ldots & 0 & 0 & \ldots & 0 & 0 \\
\vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & & \vdots & \ldots & \ldots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\sigma_{N1} & \sigma_{N2} & \sigma_{N3} & \ldots & \sigma_{NN} & 0 & 0 & 0 & \ldots & 0 & 0 & 0 & 0 & \ldots & 0 & 0 & \ldots & \ldots & \ldots & 0 & 0 & 0 & -\sigma_{N1} & -\sigma_{N2} & -\sigma_{N3} & \ldots & -\sigma_{NN} \\
\hline
\sigma_{11} & \sigma_{12} & \sigma_{13} & \ldots & \sigma_{1N} & 0 & 0 & 0 & \ldots & 0 & 0 & 0 & 0 & \ldots & 0 & -\sigma_{11} & -\sigma_{12} & -\sigma_{13} & \ldots & -\sigma_{1N} & 0 & 0 & 0 & 0 & \ldots & 0 & 0 \\
\vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & & \vdots & 0 & 0 & \ldots & \ldots & 0 & \ldots & \ldots & \vdots & \vdots & \ldots & \vdots & 0 \\
\sigma_{N1} & \sigma_{N2} & \sigma_{N3} & \ldots & \sigma_{NN} & 0 & 0 & 0 & \ldots & 0 & 0 & 0 & 0 & \ldots & 0 & 0 & 0 & \ldots & \ldots & 0 & 0 & 0 & -\sigma_{N1} & -\sigma_{N2} & -\sigma_{N3} & \ldots & -\sigma_{NN} \\
\hline
\sigma_{11} & \sigma_{12} & \sigma_{13} & \ldots & \sigma_{1N} & 0 & 0 & 0 & \ldots & 0 & 0 & 0 & \ldots & \ldots & 0 & 0 & \ldots & \ldots & 0 & 0 & \ldots & \ldots & 0 & 0 & \ldots & 0 & 0 \\
\vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & \ldots & \vdots & \vdots & \vdots & \ldots & \ldots & \vdots & \vdots & \ldots & \ldots & \vdots & \vdots & 0 & \ldots & \vdots & \vdots & \vdots & \vdots & \vdots \\
\sigma_{N1} & \sigma_{N2} & \sigma_{N3} & \ldots & \sigma_{NN} & 0 & \ldots & 0 & \ldots & 0 & 0 & 0 & \ldots & \ldots & 0 & 0 & \ldots & \ldots & 0 & 0 & 0 & \ldots & -\sigma_{N1} & -\sigma_{N2} & -\sigma_{N3} & \ldots & -\sigma_{NN} \\
\hline
\vdots & \vdots & \vdots & & \vdots & \vdots & \vdots & \vdots & \ldots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & 0 & 0 & 0 & 0 & 0 & \ldots & \ldots & 0 & 0 & \vdots & 0 & 0 \\
\sigma_{N1} & \sigma_{N2} & \sigma_{N3} & \ldots & \sigma_{NN} & 0 & \ldots & 0 & \ldots & 0 & 0 & 0 & \ldots & \ldots & 0 & 0 & 0 & 0 & 0 & 0 & \ldots & \ldots & -\sigma_{N1} & -\sigma_{N2} & -\sigma_{N3} & \ldots & -\sigma_{NN}
\end{array}\right)
$$

where Π is an $N(N-1)\times(N\times N)$ matrix. Variance and covariance of excess stock returns are inside the red-line box, otherwise zero.

C. 3×3 model on portfolio allocation

$$U_{i,t} = E_t \sum_{k=1}^{\infty} \beta^k \frac{C_{i,t+k}^{1-\gamma}}{1-\gamma} \qquad \text{For } i\text{=1,2,3}$$

s.t. $W_{i,t} = \sum_{j=1}^{3} \alpha_{ji,t-1} R_{j,t} + \alpha_{f,i} R_{f,t} + Y_{i,t} - C_{i,t}$ where $W_{i,t} = \sum_{j=1}^{3} \alpha_{ji,t}$

$Y_{i,t}$ is the endowment received by country i, $W_{i,t}$ is the total net claims of country *i*'s agents on foreign assets at the end of period t (i.e. net foreign assets of country *i*), $\alpha_{ji,t}$ is the real holdings of country *j*'s assets by country *i*, and $R_{j,t}$ is the gross real returns of country *j*'s assets. Because of capital income correlation across countries, the vector of assets is correlated each other. $R_{f,t}$ is an independent risk free bond that is in zero net supply.

We obtain FOCs and combine them, we attain below 6 equations with second-order approximation,

(i) $E_t[(\hat{C}_{1,t+1} - \hat{C}_{2,t+1})(\hat{R}_{i,t+1} - \hat{R}_{f,t+1})] = 0$ for i=1,2,3

$$= E_t[\{\tilde{\alpha}_{11}(\hat{R}_{1,t+1} - \hat{R}_{f,t+1}) + \tilde{\alpha}_{21}(\hat{R}_{2,t+1} - \hat{R}_{f,t+1}) + \tilde{\alpha}_{31}(\hat{R}_{3,t+1} - \hat{R}_{f,t+1}) - \tilde{\alpha}_{12}(\hat{R}_{1,t+1} - \hat{R}_{f,t+1})$$

$$- \tilde{\alpha}_{22}(\hat{R}_{2,t+1} - \hat{R}_{f,t+1}) - \tilde{\alpha}_{32}(\hat{R}_{3,t+1} - \hat{R}_{f,t+1}) + (\hat{Y}_{1,t+1} - \hat{Y}_{2,t+1}) - (\hat{W}_{1,t+1} - \hat{W}_{2,t+1})\} \times (\hat{R}_{i,t+1} - \hat{R}_{f,t+1})]$$

$$= E_t[\{\tilde{\alpha}_{11}(\hat{R}_{1,t+1} - \hat{R}_{f,t+1}) + \tilde{\alpha}_{21}(\hat{R}_{2,t+1} - \hat{R}_{f,t+1}) + \tilde{\alpha}_{31}(\hat{R}_{3,t+1} - \hat{R}_{f,t+1}) - \tilde{\alpha}_{12}(\hat{R}_{1,t+1} - \hat{R}_{f,t+1})$$

$$- \tilde{\alpha}_{22}(\hat{R}_{2,t+1} - \hat{R}_{f,t+1}) - \tilde{\alpha}_{32}(\hat{R}_{3,t+1} - \hat{R}_{f,t+1}) + (\hat{Y}^K_{1,t+1} - \hat{Y}^K_{2,t+1}) + (\hat{Y}^L_{1,t+1} - \hat{Y}^L_{2,t+1})\} \times (\hat{R}_{i,t+1} - \hat{R}_{f,t+1})]$$

where $E_t[\{(\hat{W}_{1,t+1} - \hat{W}_{2,t+1})\} \times (\hat{R}_{1,t+1} - \hat{R}_{f,t+1})] = 0$

for i=1, $= \tilde{\alpha}_{11}\sigma_{11} + \tilde{\alpha}_{21}\sigma_{12} + \tilde{\alpha}_{31}\sigma_{13} - \tilde{\alpha}_{12}\sigma_{11} - \tilde{\alpha}_{22}\sigma_{12} - \tilde{\alpha}_{32}\sigma_{13} + (\sigma_{11} - \sigma_{12}) + \sigma^1_{LK} = 0$

for i=2, $= \tilde{\alpha}_{11}\sigma_{12} + \tilde{\alpha}_{21}\sigma_{22} + \tilde{\alpha}_{31}\sigma_{23} - \tilde{\alpha}_{12}\sigma_{12} - \tilde{\alpha}_{22}\sigma_{22} - \tilde{\alpha}_{32}\sigma_{23} + (\sigma_{12} - \sigma_{22}) - \sigma^2_{LK} = 0$

for i=3, $= \tilde{\alpha}_{11}\sigma_{13} + \tilde{\alpha}_{21}\sigma_{23} + \tilde{\alpha}_{31}\sigma_{33} - \tilde{\alpha}_{12}\sigma_{13} - \tilde{\alpha}_{22}\sigma_{23} - \tilde{\alpha}_{32}\sigma_{33} + (\sigma_{13} - \sigma_{23}) = 0$

(ii) $E_t[(\hat{C}_{1,t+1}-\hat{C}_{3,t+1})(\hat{R}_{i,t+1}-\hat{R}_{f,t+1})]=0$ for i=1,2,3

$$=E_t[\{\tilde{\alpha}_{11}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})+\tilde{\alpha}_{21}(\hat{R}_{2,t+1}-\hat{R}_{f,t+1})+\tilde{\alpha}_{31}(\hat{R}_{3,t+1}-\hat{R}_{f,t+1})-\tilde{\alpha}_{13}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})$$

$$-\tilde{\alpha}_{23}(\hat{R}_{2,t+1}-\hat{R}_{f,t+1})-\tilde{\alpha}_{33}(\hat{R}_{3,t+1}-\hat{R}_{f,t+1})+(\hat{Y}_{1,t+1}-\hat{Y}_{3,t+1})-(\hat{W}_{1,t+1}-\hat{W}_{3,t+1})\}\times(\hat{R}_{i,t+1}-\hat{R}_{f,t+1})]$$

$$=E_t[\{\tilde{\alpha}_{11}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})+\tilde{\alpha}_{21}(\hat{R}_{2,t+1}-\hat{R}_{f,t+1})+\tilde{\alpha}_{31}(\hat{R}_{3,t+1}-\hat{R}_{f,t+1})-\tilde{\alpha}_{13}(\hat{R}_{1,t+1}-\hat{R}_{f,t+1})$$

$$-\tilde{\alpha}_{23}(\hat{R}_{2,t+1}-\hat{R}_{f,t+1})-\tilde{\alpha}_{33}(\hat{R}_{3,t+1}-\hat{R}_{f,t+1})+(\hat{Y}^K_{1,t+1}-\hat{Y}^K_{3,t+1})+(\hat{Y}^L_{1,t+1}-\hat{Y}^L_{3,t+1})\}\times(\hat{R}_{i,t+1}-\hat{R}_{f,t+1})]$$

where $E_t[\{(\hat{W}_{1,t+1}-\hat{W}_{3,t+1})\}\times(\hat{R}_{i,t+1}-\hat{R}_{f,t+1})]=0$

for i=1, $=\tilde{\alpha}_{11}\sigma_{11}+\tilde{\alpha}_{21}\sigma_{12}+\tilde{\alpha}_{31}\sigma_{13}-\tilde{\alpha}_{13}\sigma_{11}-\tilde{\alpha}_{23}\sigma_{12}-\tilde{\alpha}_{33}\sigma_{13}+(\sigma_{11}-\sigma_{13})+\sigma^1_{LK}=0$

for i=2, $=\tilde{\alpha}_{11}\sigma_{12}+\tilde{\alpha}_{21}\sigma_{22}+\tilde{\alpha}_{31}\sigma_{23}-\tilde{\alpha}_{13}\sigma_{12}-\tilde{\alpha}_{23}\sigma_{22}-\tilde{\alpha}_{33}\sigma_{23}+(\sigma_{12}-\sigma_{23})=0$

for i=3, $=\tilde{\alpha}_{11}\sigma_{13}+\tilde{\alpha}_{21}\sigma_{23}+\tilde{\alpha}_{31}\sigma_{33}-\tilde{\alpha}_{13}\sigma_{13}-\tilde{\alpha}_{23}\sigma_{23}-\tilde{\alpha}_{33}\sigma_{33}+(\sigma_{13}-\sigma_{33})-\sigma^3_{LK}=0$

We solve the system of equations (i),(ii) (6 equations) with asset market clearing conditions and the steady state assumption of wealth($\overline{W}=0$)(3 equations).

$\tilde{\alpha}_{11}+\tilde{\alpha}_{21}+\tilde{\alpha}_{31}=0$

$\tilde{\alpha}_{21}+\tilde{\alpha}_{31}-\tilde{\alpha}_{12}-\tilde{\alpha}_{13}=0$

$\tilde{\alpha}_{13}+\tilde{\alpha}_{23}-\tilde{\alpha}_{31}-\tilde{\alpha}_{32}=0$

which are derived from $\tilde{\alpha}_{1i}+\tilde{\alpha}_{2i}+\tilde{\alpha}_{3i}=0$ & $\tilde{\alpha}_{i1}+\tilde{\alpha}_{i2}+\tilde{\alpha}_{i3}=0$

D. Empirical derivation

To solve for the holdings by country 1 of country *j* assets, combine the below equation

(11') $E_t[\hat{R}_{j,t+1}-\hat{R}_{f,t+1}+\frac{1}{2}\hat{R}^2_{j,t+1}-\frac{1}{2}\hat{R}^2_{f,t+1}]=\gamma\cdot E_t[\hat{C}_{1,t+1}(\hat{R}_{j,t+1}-\hat{R}_{f,t+1})]$ for *j*=1,2,…,N

with equation (2''), the log linearization of the budget constraint evaluated for country *i*=1,

(2'') $\hat{W}_{1,t+1}=\sum_{k=1}^{N}\tilde{\alpha}_{k1}(\hat{R}_{k,t+1}-\hat{R}_{f,t+1})+\hat{Y}_{1,t+1}-\hat{C}_{1,t+1}$

where $\hat{W}_{1,t}=(W_{1,t+1}-\overline{W})/\overline{C}$ and $\tilde{\alpha}_{k1}=\overline{\alpha}_{k1}/(\overline{Y})$, along with market clearing condition for the risk free asset (8') and zero net supply in the equilibrium. Substitute (2'') into (11') and examine the conditions in terms of country specific assets (*j*=1,2,…,N), then we obtain equations (11'') like below

$$E_t[\hat{R}_{j,t+1} - \hat{R}_{f,t+1} + \frac{1}{2}\hat{R}^2_{j,t+1} - \frac{1}{2}\hat{R}^2_{f,t+1}] = \gamma \cdot E_t[(\sum_{k=1}^{N}\tilde{\alpha}_{k1}(\hat{R}_{k,t+1} - \hat{R}_{f,t+1}) + \hat{Y}_{1,t+1} - \hat{W}_{1,t+1})(\hat{R}_{j,t+1} - \hat{R}_{f,t+1})]$$

for j=1,…,N

Therefore,

$$E_t[\hat{R}_{j,t+1} - \hat{R}_{f,t+1} + \frac{1}{2}\hat{R}^2_{j,t+1} - \frac{1}{2}\hat{R}^2_{f,t+1}] = \gamma \cdot E_t[\sum_{k=1}^{N}\tilde{\alpha}_{k1}(\hat{R}_{k,t+1} - \hat{R}_{f,t+1})(\hat{R}_{j,t+1} - \hat{R}_{f,t+1}) + \hat{Y}_{1,t+1}(\hat{R}_{j,t+1} - \hat{R}_{f,t+1})]$$

for j=1,…,N

where, $E_t[\hat{W}_{1,t+1}(\hat{R}_{j,t+1} - \hat{R}_{f,t+1})] = 0$

Hence, we have N equations like below

for j=1, $E_t[\hat{R}_{1t+1} - \hat{R}_{ft+1} + \frac{1}{2}(\hat{R}^2_{1t+1} - \hat{R}^2_{ft+1})]$

$$= \gamma \cdot E_t[(\tilde{\alpha}_{11}(\hat{R}_{1t+1} - \hat{R}_{ft+1})^2 + \tilde{\alpha}_{21}(\hat{R}_{2t+1} - \hat{R}_{ft+1})(\hat{R}_{1t+1} - \hat{R}_{ft+1}) + \ldots$$

$$+ \tilde{\alpha}_{N1}(\hat{R}_{Nt+1} - \hat{R}_{ft+1})(\hat{R}_{1t+1} - \hat{R}_{ft+1}) + (\hat{Y}^K_{1t+1} + \hat{Y}^L_{1t+1})(\hat{R}_{1t+1} - \hat{R}_{ft+1})]$$

$$\vdots$$

for j=N, $E_t[\hat{R}_{Nt+1} - \hat{R}_{ft+1} + \frac{1}{2}(\hat{R}^2_{Nt+1} - \hat{R}^2_{ft+1})]$

$$= \gamma \cdot E_t[(\tilde{\alpha}_{11}(\hat{R}_{1t+1} - \hat{R}_{ft+1})(\hat{R}_{Nt+1} - \hat{R}_{ft+1}) + \tilde{\alpha}_{21}(\hat{R}_{2t+1} - \hat{R}_{ft+1})(\hat{R}_{Nt+1} - \hat{R}_{ft+1}) + \ldots$$

$$+ \tilde{\alpha}_{N1}(\hat{R}_{Nt+1} - \hat{R}_{ft+1})^2 + (\hat{Y}^K_{1t+1} + \hat{Y}^L_{1t+1})(\hat{R}_{Nt+1} - \hat{R}_{ft+1})]$$

Solve the expectation terms of right hand side of the above N equations,

for j=1, $\frac{1}{\gamma}E_t[\hat{R}_{1t+1} - \hat{R}_{ft+1} + \frac{1}{2}(\hat{R}^2_{1t+1} - \hat{R}^2_{ft+1})] = \tilde{\alpha}_{11}\sigma_{11} + \tilde{\alpha}_{21}\sigma_{12} + \ldots + \tilde{\alpha}_{N1}\sigma_{1N} + \sigma_{11} + \sigma^1_{LK}$

$$\vdots$$

for j=N, $\frac{1}{\gamma}E_t[\hat{R}_{Nt+1} - \hat{R}_{ft+1} + \frac{1}{2}(\hat{R}^2_{Nt+1} - \hat{R}^2_{ft+1})] = \tilde{\alpha}_{11}\sigma_{1N} + \tilde{\alpha}_{21}\sigma_{2N} + \ldots + \tilde{\alpha}_{N1}\sigma_{NN} + \sigma_{1N}$

We rearrange these equations,

$$\underbrace{(1+\tilde{\alpha}_{11})}_{\tilde{\tilde{\alpha}}_{11}}\sigma_{11}+\tilde{\alpha}_{21}\sigma_{12}+\ldots+\tilde{\alpha}_{N1}\sigma_{1N}=\frac{1}{\gamma}E_t[\hat{R}_{1t+1}-\hat{R}_{ft+1}+\frac{1}{2}(\hat{R}^2_{1t+1}-\hat{R}^2_{ft+1})]-\sigma^1_{LK}$$

$$\vdots$$

$$\underbrace{(1+\tilde{\alpha}_{11})}_{\tilde{\tilde{\alpha}}_{11}}\sigma_{1N}+\tilde{\alpha}_{21}\sigma_{2N}+\ldots+\tilde{\alpha}_{N1}\sigma_{NN}=\frac{1}{\gamma}E_t[\hat{R}_{1t+1}-\hat{R}_{ft+1}+\frac{1}{2}(\hat{R}^2_{1t+1}-\hat{R}^2_{ft+1})]$$