

International Capital Flows, Returns and World Financial Integration

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Abstract

International capital flows have increased dramatically since the 1980s, with much of the increase being due to trade in equity and debt markets. Such developments are often attributed to the increased integration of world financial markets. We present a model that allows us to examine how greater integration in world financial markets affects the behavior of international capital flows and financial returns. Our model predicts that international capital flows are large (in absolute value) and very volatile during the early stages of financial integration when international asset trading is concentrated in bonds. As integration progresses and households gain access to world equity markets, the size and volatility of international bond flows declines. This is the natural outcome of greater risk sharing facilitated by increased integration. This pattern is consistent with declining volatility observed during 1975-2007 period in the G-7 countries. We also find that the equilibrium flows in bonds and stocks predicted by the model are larger than their empirical counterparts, and are largely driven by variations in equity risk premia. The model also predicts that volatility of equity and bond returns declines with integration, again consistent with the data for G-7 economies.

JEL Classification: D52; F36; G11.

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Introduction

International capital flows have increased dramatically since the 1980s. During the 1990s gross capital flows between industrial countries rose by 300 per cent, while trade flows increased by 63 percent and real GDP by a comparatively modest 26 percent. In this paper we document that much of the increase in capital flows is due to trade in equity and debt markets, with the result that the international pattern of asset ownership looks very different today than it did a decade ago. The changes in the holdings of equity and debt have also coincided with significant changes in the volatility of capital flows and asset returns. Namely, in a sample of G-7 countries the volatilities of equity and debt flows have declined during 1975-2007 period. For instance, the volatility of debt inflows and outflows declined by about 30 percent between 1975-1995 and 1996-2007 periods, on average. The volatility of equity outflows has fallen by about 40 percent during the same period. Equity and debt returns have also followed suit. Thus, during the same period, the volatility of equity returns fell by 25 percent, while the volatility of bond returns declined by almost 60 percent.

These developments are often attributed to the increased integration of world financial markets. Easier access to foreign financial markets, so the story goes, has led to the changing pattern of asset ownership as investors have sought to realize the benefits from international diversification. From the theoretical perspective, however, it is not clear how flows and returns should respond to greater integration.

In this paper we present a model that allows us to examine how greater integration in world financial markets affects the behavior of international capital flows and asset returns. Our strategy is to start with a relatively standard international business cycle model, extend it to allow for trade in international bonds and equities, calibrate it to match real business cycle moments in the US, and then use it to address three main questions:

- (i) How is the size and volatility of international capital flows affected by greater financial integration in world debt and equity markets?
- (ii) What factors drive international portfolio flows, and does their influence change with the degree of integration?
- (iii) How does the degree of financial integration affect the behavior of equity and bond prices and returns?

To the best of our knowledge, these questions *jointly* have yet to be addressed in the literature.

The model we present captures the effects of financial integration in the simplest possible way. We consider a symmetric two-country model with production for traded and nontraded goods. Firms in both the traded and nontraded sectors issue equity on domestic stock markets. We examine the impact of financial integration in this world by considering three configurations: Financial Autarky (FA), Partial Integration (PI), and Full Financial Integration (FI). Under FA, households only have access to the domestic stock market and so can only hold their wealth in the form of the equity of domestic firms producing traded and nontraded goods. The equilibrium in this economy serves as a benchmark for gauging the effects of financial integration. Under PI, we open a world bond market. Now households can allocate their wealth between domestic equity and international bonds. This configuration roughly corresponds the state of world financial markets before the mid-1990's where bonds are the main medium for international financial transactions. The third configuration, FI, corresponds to the current state of world financial markets. Under FI, households have

access to international bonds, equity issued by domestic firms, and equity issued by foreign firms producing traded goods.

A particular aspect of our model deserves special note. In all three market configurations we consider, international risk-sharing among households is less than perfect. In other words, we only consider international capital flows in equilibria where markets are incomplete. As we move from the FA to PI and then to FI configurations of the model, the degree of risk-sharing increases, but households never have access to a rich enough array of financial assets to make markets complete. We view this as an important feature of the model. There is ample evidence that incomplete risk-sharing persists even with the high degree of financial integration we see today (see, Backus and Smith (1993), Kollmann (1995) and many others). This observation precludes us from characterizing our FI configuration as an equilibrium with complete markets.

Our analysis is related to three major strands of research. The first strand studies the effects of financial liberalization on capital flows and returns. Examples of theoretical research with this focus include Obstfeld (1994), Bacchetta and van Wincoop (2000), and Martin and Rey (2000), while empirical assessments can be found in Bekaert, Harvey, and Lumsdaine (2002b,a), Henry (2000), Bekaert and Harvey (1995, 2000), Albuquerque, Loayza, and Servén (2005) and many others. Our contribution is primarily to the theoretical branch of this literature and consists of considering a model that allows for a rich menu of risky and riskless assets, including trade in equities. Furthermore, we do so in the environment with incomplete asset markets.

The second strand of research focuses on the joint determination of capital flows and equity returns. Representative papers in this area include Bohn and Tesar (1996), Froot and Teo (2004), Stulz (1999), and Froot, O’Connell, and Seasholes (2001). Hau and Rey (2004, 2006) extend the analysis of the equity return-capital flow interaction to include the real exchange rate. Our focus is on the role of financial integration for this interaction.

Finally, the third strand of the literature studies the macroeconomic implications of financial integration. Baxter and Crucini (1995) and Heathcote and Perri (2002) compare the equilibrium of models with restricted asset trade against an equilibrium with complete markets. The comparative approach adopted by these papers is closest to the methodology we adopt, but our model does not equate financial integration with complete markets. An alternative view of integration is that it reduces the frictions that inhibit asset trade. Examples of this approach include Buch and Pierdzioch (2005), Sutherland (1996), and Senay (1998). In a companion piece, Evans and Hnatkovska (2007), we use the model developed here to study the effects of integration on welfare and the volatility of output and consumption. Our key departure from this literature is the focus on financial variables, such as capital flows and asset returns, and their interaction with the real variables in general equilibrium.

Although the model we develop has a relatively simple structure, several technical problems need to be solved in order to find the equilibrium associated with any of our market configurations. The first of these problems concerns portfolio choice. We interpret increased financial integration as giving households a wider array of assets in which to hold their wealth. How households choose to allocate their wealth among these assets is key to understanding how financial integration affects international capital flows, so there is no way to side-step portfolio allocation decisions. We model the portfolio problem as part of the intertemporal optimization problem of the households allowing for the fact that returns do not follow i.i.d. processes in equilibrium. The second problem relates to the degree of risk sharing. Since markets are incomplete in all the configurations we study, we cannot find the equilibrium allocations by solving an appropriate planning

problem. Instead, the equilibrium allocations must be established by directly checking the market clearing conditions implied by the decisions of households and firms. We use the solution method in Evans and Hnatkovska (2012) to compute equilibrium allocations and prices in this decentralized setting.

Several recent papers have developed and analyzed models with endogenous portfolio choice. The majority of this work (see, for instance, Engel and Matsumoto (2009), Coeurdacier and Gourinchas (2008), Coeurdacier, Kollmann, and Martin (2010), Devereux and Sutherland (2008) and others), focuses on asset positions, while our focus is on capital flows, returns and the role of financial integration. Didier and Lowenkron (2009) analyze capital flows, but in a partial equilibrium setting, where returns are exogenously given. In contrast, ours is a general equilibrium model. Pavlova and Rigobon (2010) work out equilibrium portfolio and capital flows in a general equilibrium setting, but with no production. Furthermore, they do not address the question of how portfolios change with the degree of integration. Tille and van Wincoop (2010) and Devereux and Sutherland (2010) study capital flows in general equilibrium settings with incomplete asset markets, but do not discuss the implications of financial integration for capital flows and asset returns. Furthermore, these papers examine stylized models of endowment economies in which capital flows take the form of equity or bond flows. Our framework allows for both bond and equity flows in a richer modelling environment with production and multiple sectors that is frequently used in the study of international business cycles.

We calibrate the model to match the real business cycle moments in the US and ask whether it can replicate the properties of financial variables and their changes over time. This approach ensures that the financial features we study are consistent with well-established characteristics of real international business cycles. Importantly, we do not embellish the financial side of the model in an attempt to exactly replicate the behavior of capital flows and returns so our findings are clearly linked to the degree of financial integration. (Adding financial frictions to fine tune the model's implications is left for future research.)

A comparison of the equilibria associated with our three market configurations provides us with several striking results:

1. We find that bond and equity flows in the PI and FI financial regimes of the model are larger than in the data, but their volatility is in line with the volatility of bond and equity flows found in the data for G-7 countries.
2. Starting from the PI economy, when households gain access to foreign equity markets (FI economy), we find that the size and volatility of international bond flows declines. While this pattern mimics that found in the data for the G-7 countries, the model underpredicts the size of the decline.
3. Our third main finding concerns the factors driving capital flows. In our model, variations in the equity risk premia account for almost all of the international portfolio flows in bonds and equities. Changes in the risk premia arise endogenously as productivity shocks affect the conditional second moments of returns, with the result that households are continually adjusting their portfolios. Although these portfolio adjustments are small, their implications for international capital flows are large relative to GDP.²

²These results are in line with Tille and van Wincoop (2010) who also emphasize the role of endogenous time-variation in expected returns and risk in determining international portfolio flows.

4. Our model also makes a number of predictions concerning the behavior of asset prices and returns. Not surprisingly, the model fails to reproduce the volatility of returns found in the data. However, it correctly predicts the fall in the volatility of both equity and bond returns following an increase in integration. We also find that global risk factors become more important in the determination of expected returns and show that international equity price differentials can be used as reliable measures of financial integration.

Thus, despite its standard structure (i.e., the absence of financial frictions) and a standard calibration, the model shows success in matching characteristics of capital flows quantitatively, and is able to qualitatively reproduce all empirical facts we set out to understand.

The paper is organized as follows. Section 1 documents how the international ownership of assets and the behavior of capital flows has evolved over the past thirty years. The model is presented in Section 2. In Section 3 we describe the equilibrium and provide an overview of the solution method. Our analysis of capital flows, returns and asset prices in the three market configurations is presented in Section 4. Section 5 concludes.

1 The Globalization of Financial Markets

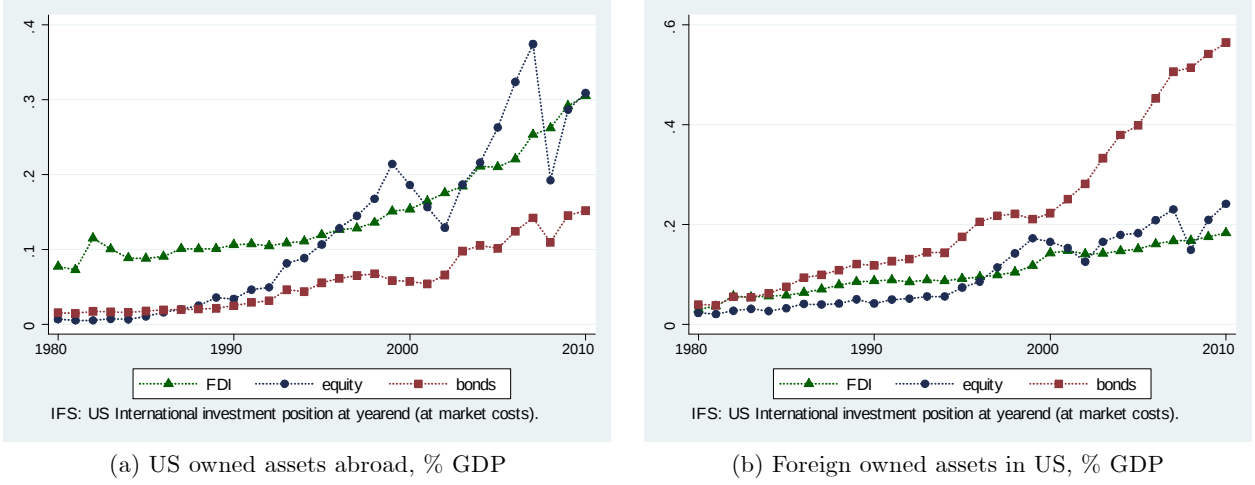
The large increase in international capital flows represents one of the most striking developments in the world economy over the past thirty years. In recent years, the rise in international capital flows has been particularly dramatic. IMF data indicates that gross capital flows between industrialized countries (the sum of absolute value of capital inflows and outflows) expanded 300 percent between 1991 and 2000.³ Much of this increase was attributable to the rise in foreign direct investment and portfolio equity flows, which both rose by roughly 600 percent. By contrast, gross bond flows increased by a comparatively modest 130 percent. The expansion in these flows vastly exceeds the growth in the real economy or the growth in international trade. During 1991-2000 period, real GDP in industrialized countries increased by 26 percent, and international trade rose by 63 percent.⁴ So while the growth in international trade is often cited as indicating greater interdependence between national economies, the growth in international capital flows suggests that the integration of world financial markets has proceeded even more rapidly.

Greater financial integration is manifested in both asset holdings and capital flows. Figure 1 shows how the scale and composition of foreign asset holdings have changed between 1980 and 2010. US ownership of foreign equity, bonds and capital (accumulated FDI) is plotted in Figure 1 (a), while foreign ownership of US corporate bonds, equity, and capital are shown in Figure 1 (b). All the series are shown as a fraction of US GDP. Before the mid-1990s, capital accounted for the majority of foreign assets held by US residents, followed by bonds. US ownership of foreign equity was below 1% of GDP. The size and composition of

³The numbers on capital flows and its components are calculated using Balance of Payments Statistics Yearbooks, IMF. Appendix A.1 provides details on the data used in the paper.

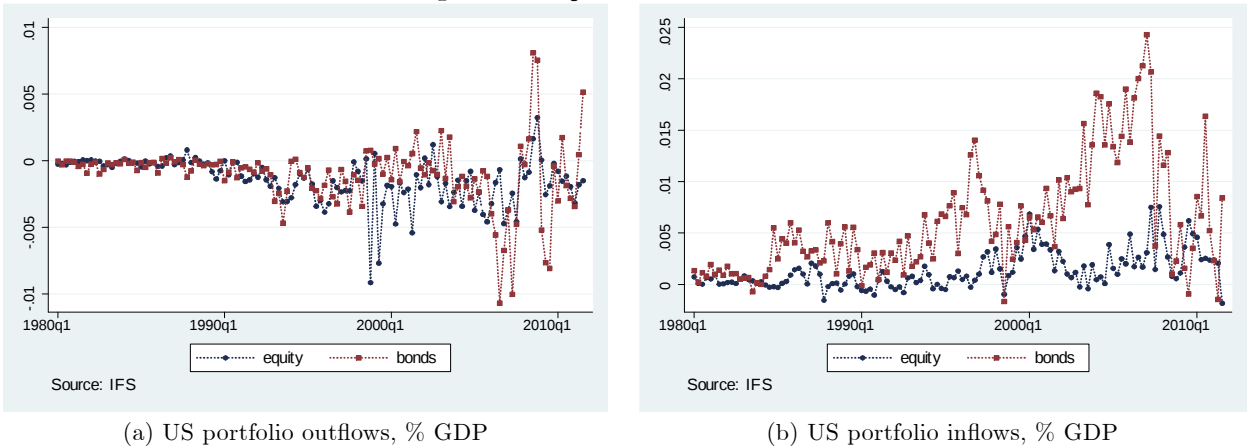
⁴Trade volume is calculated as exports plus imports using International Finance Statistics database, IMF. GDP data comes from World Development Indicators database, World Bank.

Figure 1: US asset and liability positions



these asset holdings began to change in the early 1990s when the fraction of foreign equity surpassed bonds. Thereafter, US ownership of foreign equity increased rapidly peaking at roughly 38 percent of GDP in 2007. US ownership of foreign capital and bonds also increased during this period. In short, foreign equities have become a much more important component of US financial wealth in the last decade or so. Foreign ownership of US assets has also risen significantly. As Figure 1 (b) shows, foreign ownership of corporate bonds, equity and capital have steadily increased as a fraction of US GDP over the past 30 years. By 2010, foreign ownership of debt, equity and capital totalled 99 percent of US GDP.

Figure 2: US portfolio investment

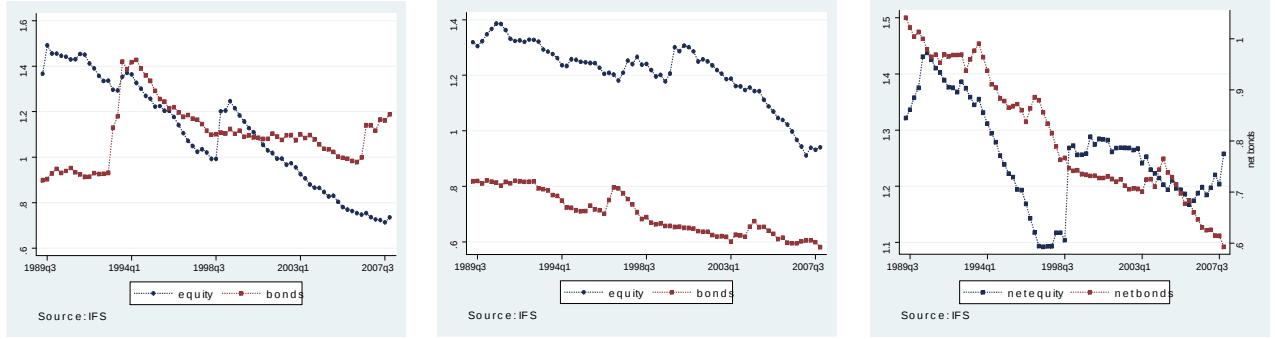


The change in asset ownership has been accompanied by a marked change in international capital flows. Figures 2 (a) and (b) plot the quarterly capital flows associated with transactions in US assets and liabilities as a fraction of GDP. Negative outflows represent US net purchases of foreign assets, while positive inflows

represent foreign net purchases of US assets. Two features of these plots stand out. First, capital flows were a small fraction of GDP before the mid-1980s. On average, annual gross capital flows accounted for only 1 percent of US GDP until the mid 1980s, but by 2007 amounted to more than 11 percent of GDP. Second, the volatility of capital inflows and outflows changed markedly in the 1990s and 2000s. The direction of the change in volatility, however, is somewhat ambiguous since the mean flows and their standard deviation have both increased over time. To account for these joint dynamics we compute a standardized volatility measure where we scale the standard deviation of capital flows by their mean absolute value.⁵ Figure 3 presents this modified coefficient of variation for the US capital flows over a rolling window of 58 quarters.⁶

Interestingly, US flow volatility, as measured by the coefficient of variation, has declined through the 1990s and 2000s for both equity and debt inflows and outflows. We also consider *net* equity and debt flows, obtained as the sum of outflows (-) and inflows (+), and report their coefficient of variation in panel (c) of Figure 3. The volatility of US net flows have also declined during our sample period. This decline in the volatility of capital flows is not limited to the US. Table 1 reports the (modified) coefficient of variation for portfolio flows in G-7 countries for two sub-periods: “low” (or early) integration period (1975:1-1995:4) and “high” (or late) integration period (1996:1-2007:4).

Figure 3: Coefficient of variation for US portfolio investment



(a) US portfolio outflows, % GDP

(b) US portfolio inflows, % GDP

(c) US net portfolio flows, % GDP

These moments mimic our results for the US. Namely, coefficient of variation declines when moving from “low” to “high” integration period for equity, debt and net debt flows in almost all countries in our sample. More precisely, the volatility of equity outflows has declined in all countries, but the U.K.. The average across countries declines as well. The picture is somewhat more mixed for equity inflows, where France, Germany and UK show an increase in volatility over time.⁷ The volatility of debt flows declines over time in all countries except Japan and Canada.⁸ Importantly, the average volatility of debt outflows, inflows and net debt flows across countries declines between “low” and “high” integration periods.

⁵Note that since portfolio outflows and inflows change sign frequently, using mean *absolute* value of these flows is a more meaningful way to measure their size as opposed to a simple average.

⁶We focus on the data between 1975-2007 and exclude the period of 2007-2009 financial crisis.

⁷We find that the increase in volatility in these countries is driven by a short-term rise in the volatility of equity inflows between 1999:1-2000:4 (in both levels and relative to GDP), which coincides with the introduction of the Euro. Thus, it can be driven by a rebalancing of portfolio associated with the introduction of the Euro.

⁸We note that the rise in Canadian inflows coincides with the adoption of NAFTA and conjecture that rising volatility of Japanese debt inflows is related to the importance of Japan as a funding country in the global carry trade.

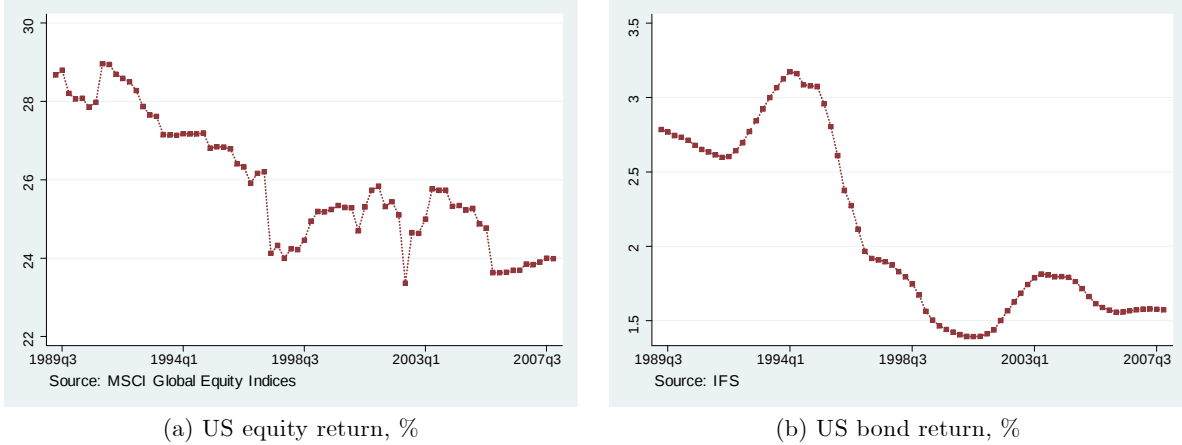
Table 1: Coefficient of variation for capital flows

	equity outflows		equity inflows		debt outflows		debt inflows		net debt flows	
	low	high	low	high	low	high	low	high	low	high
Canada	1.22	0.77	1.44	1.32	1.51	1.10	0.72	1.28	0.74	1.32
France	1.43	0.95	0.83	1.17	1.16	0.56	1.28	0.74	1.49	1.18
Germany	1.76	1.09	1.33	1.71	0.95	0.69	1.44	0.62	1.62	1.22
Italy	2.44	1.21	1.37	1.32	2.30	0.96	1.84	0.93	2.13	1.17
Japan	1.43	0.87	1.49	1.11	0.86	0.83	1.01	1.18	1.22	1.28
UK	1.20	1.26	1.19	2.23	1.26	1.03	1.37	0.88	1.47	1.23
US	1.48	0.77	1.27	0.84	1.16	1.22	0.80	0.54	1.00	0.53
Average	1.56	0.99	1.28	1.38	1.31	0.91	1.21	0.88	1.38	1.13

Note: The table presents modified coefficient of variation obtained as the ratio of standard deviation of the corresponding portfolio flows divided by the mean absolute value of that portfolio flow. Columns labelled “low” refer to low (or early) financial integration period of 1975:1-1995:4; while columns labelled “high” is for high (or late) integration period of 1996:1-2007:4.

Increased financial integration has also coincided with changes in the behavior of equity returns. Figures 4 (a) and (b) depict the volatility of equity and bond returns in the U.S.⁹ Both volatilities are calculated as a standard deviation over the 58 quarters rolling window. As the plots clearly indicate, there has been a general downward trend in the volatility of US equity and bond returns over the past thirty years.

Figure 4: Volatility of returns



These trends in the volatility of asset returns characterize the developments in the international financial markets more generally. Table 2 summarizes equity and bond returns volatilities for G-7 countries by reporting their standard deviations. As before we distinguish low and high integration sub-periods in our analysis. The table shows that the volatility of both equity and bond returns have declined, consistent with our findings for the US.

⁹We measure equity returns using Morgan Stanley MSCI Global Equity Index for the US, and bond return using the 3 month US T-bill rate. Details on data and sources are provided in the Appendix A.1.

Table 2: Std dev of equity and bond returns

	equity returns		bond returns	
	low	high	low	high
Canada	34.38	37.02	3.14	1.07
EuroArea	-	35.30	-	0.90
France	50.45	33.00	2.60	0.83
Germany	43.13	41.37	1.98	0.77
Italy	71.45	36.84	3.09	1.86
Japan	50.35	40.08	1.60	0.20
UK	40.75	25.28	2.90	1.01
US	26.15	25.32	2.87	1.63
Average	45.24	34.13	2.60	1.05

Note: This table presents standard deviation of quarterly equity and bond returns. All returns are annualized. Columns labelled “low” refer to low (or early) financial integration period of 1975:1-1995:4; while columns labelled “high” is for high (or late) integration period of 1996:1-2007:4.

To summarize, we will focus on the three outstanding features of the data in our analysis below: (i) the increase in the size of portfolio flows, (ii) the fall in the volatility of portfolio flows, and (iii) the decline in the volatility of equity and bond returns. In particular, we will investigate whether all three features arise as natural consequences of greater integration in world financial markets.

2 The Model

We consider a world economy consisting of two identical countries, called HOME (H) and FOREIGN (F). Each country is populated by a continuum of identical households who supply their labor inelastically to domestic firms in the traded and nontraded goods sectors. Firms in both sectors are perfectly competitive, and issue equity that is traded on the domestic stock market. Our model is designed to study how the degree of financial integration affects international capital flows and returns. For this purpose, we focus on three equilibria. First we consider the benchmark case of financial autarky (FA). In this environment, households allocate their portfolios between equity in domestic firms producing traded and nontraded goods. Second, we consider a world with partial integration (PI) where households allocate their portfolios between domestic equity and an international bond. Finally, we allow for financial integration of equity markets (FI). Here households can hold shares issued by foreign traded-good firms as well as domestic equities and the international bond. This is not to say that markets are complete. In all three cases {i.e., FA, PI, FI}, the array of assets available to households is insufficient to provide complete risk-sharing.

Below we first describe the production of traded and nontraded goods. Next we present the consumption, saving and portfolio choice problems facing households. Finally, we characterize the market clearing conditions that apply under different degrees of financial market integration.

2.1 Production

The traded goods sector in each country is populated by a continuum of identical firms. Each firm owns its own capital and issues equity on the domestic stock market. Period t production by a representative firm in

the traded goods sector of the H country is

$$Y_t^T = Z_t^T K_t^\theta, \quad (1)$$

with $\theta > 0$, where K_t denotes the stock of physical capital at the start of the period, and Z_t^T is the exogenous state of productivity. The output of traded goods in the F country, $\hat{Y}_t^T$, is given by an identical production function using foreign capital $\hat{K}_t$, and productivity $\hat{Z}_t^T$. Hereafter we use “ $\hat{\cdot}$ ” to denote foreign variables.¹⁰ The traded goods produced by H and F firms are identical and can be costlessly transported between countries. Under these conditions, the law of one price must prevail for traded goods to eliminate arbitrage opportunities.

At the beginning of each period, traded goods firms observe the current state of productivity, and then decide how to allocate output between consumption and investment goods. Output allocated to consumption is supplied competitively to domestic and foreign households and the proceeds are used to finance dividend payments to the owner’s of the firm’s equity. Output allocated to investment adds to the stock of physical capital available for production next period. We assume that firms allocate output to maximize the value of the firm to its shareholders.

Let P_t^T denote the ex-dividend price of a share in the representative H firm producing traded-goods at the start of period t , and let D_t^T be the dividend per share paid at period t . P_t^T and D_t^T are measured in terms of H traded goods. We normalize the number of shares issued by the representative traded-good firm to unity so the value of the firm at the start of period t is $P_t^T + D_t^T$. H firms allocate output to investment, I_t , by solving

$$\max_{I_t} \mathbb{E}_t \sum_{i=0}^{\infty} M_{t+i,t} D_{t+i}^T, \quad (2)$$

subject to

$$\begin{aligned} K_{t+1} &= (1 - \delta)K_t + I_t, \\ D_t^T &= Z_t^T K_t^\theta - I_t, \end{aligned}$$

where $\delta > 0$ is the depreciation rate on physical capital. $M_{t+i,t}$ is the H household’s intertemporal marginal rate of substitution (IMRS) between the consumption of US tradables in period t and $t + i$, with $M_{t,t} = 1$. $\mathbb{E}_t$ denotes expectation conditioned on information at the start of period t . The representative firm in the F traded goods sector chooses investment $\hat{I}_t$ to solve an analogous problem. Notice that firms do not have the option of financing additional investment through the issuance of additional equity or corporate debt. Additional investment can only be undertaken at the expense of current dividends.

The production of nontraded goods does not require any capital.¹¹ The output of nontraded goods by representative firms in countries H and F is given by

$$Y_t^N = \kappa Z_t^N, \quad (3a)$$

$$\hat{Y}_t^N = \kappa \hat{Z}_t^N, \quad (3b)$$

where $\kappa > 0$ is a constant. Z_t^N and $\hat{Z}_t^N$ denote the period t state of nontraded good productivity in countries

¹⁰For notational clarity it proves useful to use a “hat” to denote F country variables rather than log deviations from a steady state (as is often found in the business cycle literature).

¹¹Alternatively, we could assume that production in the N sector used sector-specific capital without affecting our analysis.

H and F respectively. The output of nontraded goods can only be consumed by domestic households. The resulting proceeds are then distributed in the form of dividends to owners of equity. As above, we normalize the number of shares issued by the representative non-traded sector firms to unity, so period t dividends for H firms are $D_t^N = Y_t^N$, and for F firms are $\hat{D}_t^N = \hat{Y}_t^N$. We denote the ex-dividend price of a share in the representative H and F firm, measured in terms of nontraded goods, as P_t^N and $\hat{P}_t^N$ respectively.

Productivity in the traded and nontraded good sectors is governed by an exogenous productivity process. In particular, we assume that the vector $z_t \equiv [\ln Z_t^T, \ln \hat{Z}_t^T, \ln Z_t^N, \ln \hat{Z}_t^N]'$ follows an AR(1) process:

$$z_t = az_{t-1} + e_t, \quad (4)$$

where e_t is a (4×1) vector of i.i.d. normally distributed, mean zero shocks with covariance Ω_e .

2.2 Households

Each country is populated by a continuum of households who have identical preferences over the consumption of traded and nontraded goods. The preferences of a representative household in country H are given by

$$\mathbb{E}_t \sum_{i=0}^{\infty} \beta^i U(C_{t+i}^T, C_{t+i}^N), \quad (5)$$

where $0 < \beta < 1$ is the discount factor, and $U(\cdot)$ is a concave sub-utility function defined over the consumption of traded and nontraded goods, C_t^T and C_t^N :

$$U(C^T, C^N) = \frac{1}{\phi} \ln \left[\lambda_T^{1-\phi} (C^T)^\phi + \lambda_N^{1-\phi} (C^N)^\phi \right],$$

with $\phi < 1$. λ_T and λ_N are the weights the household assigns to tradable and nontradable consumption respectively. The elasticity of substitution between tradable and nontradable consumption is $(1 - \phi)^{-1} > 0$. Preferences for households in country F are similarly defined in terms of foreign consumption of tradables and nontradables, $\hat{C}_t^T$ and $\hat{C}_t^N$.

The array of financial assets available to households differs according to the degree of financial integration. Under financial autarky (FA), households can hold their wealth in the form of equity issued by domestic firms in the traded and nontraded goods sectors. Under partial integration (PI), households can hold internationally traded bonds in addition to their domestic equity holdings. The third case we consider is that of full integration (FI). Here households can hold domestic equity, international bonds and equity issued by firms in the foreign traded-goods sector.

The household budget constraint associated with each of these different financial structures can be written in a simple common form. In the case of the representative H household, we write

$$W_{t+1} = R_{t+1}^W (W_t - C_t^T - Q_t^N C_t^N), \quad (6)$$

where Q_t^N is the relative price of H nontradables in terms of tradables. R_{t+1}^W is the (gross) return on wealth between period t and $t + 1$, where wealth, W_t , is measured in terms of tradables. The return on wealth depends on how the household allocates wealth across the available array of financial assets, and on the

realized return on those assets. In the FI case, the return on wealth is given by

$$R_{t+1}^W = R_t + \alpha_t^T(R_{t+1}^T - R_t) + \alpha_t^{\hat{T}}(R_{t+1}^{\hat{T}} - R_t) + \alpha_t^N(R_{t+1}^N - R_t), \quad (7)$$

where R_t is the return on bonds, R_{t+1}^T and $R_{t+1}^{\hat{T}}$ are the returns on H and F tradable equity, and R_{t+1}^N is the return on H nontradable equity. The fraction of wealth held in H and F tradable equity and H nontradable equity by H households are $\alpha_t^T, \alpha_t^{\hat{T}}$ and α_t^N respectively. In the PI case, H households cannot hold F tradable equity, so $\alpha_t^{\hat{T}} = 0$. Under FA, households can only hold domestic equity, so $\alpha_t^{\hat{T}} = 0$ and $\alpha_t^T + \alpha_t^N = 1$.

The budget constraint for F households is similarly represented by

$$\hat{W}_{t+1} = \hat{R}_{t+1}^W(\hat{W}_t - \hat{C}_t^T - \hat{Q}_t^N \hat{C}_t^N), \quad (8)$$

with
$$\hat{R}_{t+1}^W = R_t + \hat{\alpha}_t^T(\hat{R}_{t+1}^T - R_t) + \hat{\alpha}_t^{\hat{T}}(\hat{R}_{t+1}^{\hat{T}} - R_t) + \hat{\alpha}_t^{\hat{N}}(\hat{R}_{t+1}^{\hat{N}} - R_t), \quad (9)$$

where $\hat{R}_{t+1}^T$, and $\hat{R}_{t+1}^{\hat{T}}$ denote the return on H and F tradable equity, and $\hat{R}_{t+1}^{\hat{N}}$ is the return on F nontradable equity faced by F households. Although these returns are also measured in terms of tradables, they can differ from the returns available to H households. In particular, the returns on nontradable equity received by F households, $\hat{R}_{t+1}^{\hat{N}}$, will in general differ from the returns received by H households because the assets are not internationally traded. Arbitrage will equalize returns in other cases. In particular, if bonds are traded, the interest received by H and F households must be the same as (7) and (9) show. Similarly, arbitrage will equalize the returns on tradable equity in the case of PI and FI so that $R_{t+1}^T = \hat{R}_{t+1}^T$ and $R_{t+1}^{\hat{T}} = \hat{R}_{t+1}^{\hat{T}}$.

2.3 Market Clearing

The market clearing requirements of the model are most easily stated if we normalize the national populations to unity, as well as the population of firms in the tradable and nontradable sectors. Output and consumption of traded and nontraded goods can now be represented by the output and consumption of representative households and firms. In particular, the market clearing conditions in the nontradable sector of each country are given by

$$C_t^N = Y_t^N, \quad \text{and} \quad \hat{C}_t^N = \hat{Y}_t^N. \quad (10)$$

Recall that firms in the nontraded sector pay dividends to their shareholders with the proceeds from the sale of nontradables to households. Thus, market clearing in the nontraded sector also implies that

$$D_t^N = Y_t^N, \quad \text{and} \quad \hat{D}_t^N = \hat{Y}_t^N. \quad (11)$$

The market clearing conditions in the tradable goods market are equally straightforward. Recall that the traded goods produced by H and F firms are identical and can be costlessly transported between countries. Market clearing therefore requires that the world demand for tradables equals world output less the amount allocated to investment:

$$C_t^T + \hat{C}_t^T = Y_t^T + \hat{Y}_t^T - I_t - \hat{I}_t. \quad (12)$$

Next, we turn to market clearing in financial markets. Let $A_t^T, A_t^{\hat{T}}$ and A_t^N denote the number of shares of H tradable, F tradable and H nontradable firms held by H households between the end of periods t and $t+1$.

F household share holdings in H tradable, F tradable and F nontradable firms are represented by $\hat{A}_t^T$, $\hat{A}_t^{\hat{T}}$ and $\hat{A}_t^{\hat{N}}$. H and F household holdings of bonds between the end of periods t and $t + 1$ are denoted by B_t and $\hat{B}_t$. Household demand for equity and bonds are determined by their optimal choice of portfolio shares (i.e., α_t^T , $\alpha_t^{\hat{T}}$ and $\alpha_t^{\hat{N}}$ for H households, and $\hat{\alpha}_t^T$, $\hat{\alpha}_t^{\hat{T}}$ and $\hat{\alpha}_t^{\hat{N}}$ for F households) described below. We assume that bonds are in zero net supply. We also normalized the number of outstanding shares issued by firms in each sector to unity.

The market clearing conditions in financial markets vary according to the degree of financial integration. Under FA, households can only hold the equity issued by domestically located firms, so the equity market clearing conditions are

$$\text{HOME:} \quad 1 = A_t^T, \quad 0 = A_t^{\hat{T}}, \quad \text{and} \quad 1 = A_t^{\hat{N}}, \quad (13a)$$

$$\text{FOREIGN:} \quad 0 = \hat{A}_t^T, \quad 1 = \hat{A}_t^{\hat{T}}, \quad \text{and} \quad 1 = \hat{A}_t^{\hat{N}}, \quad (13b)$$

while bond market clearing requires that

$$0 = B_t, \quad \text{and} \quad 0 = \hat{B}_t. \quad (14)$$

Notice that FA rules out the possibility of international borrowing or lending, so neither country can run at positive or negative trade balance. Domestic consumption of tradables must therefore equal the fraction of tradable output not allocated to investment. Hence, market clearing under FA also implies that

$$D_t^T = C_t^T, \quad \text{and} \quad \hat{D}_t^T = \hat{C}_t^T. \quad (15)$$

Under PI, households can hold bonds in addition to domestic equity holdings. In this case, equity market clearing requires the conditions in (13), but the bond market clearing condition becomes

$$0 = B_t + \hat{B}_t. \quad (16)$$

The bond market can now act as the medium for international borrowing and lending, so there is no longer a balanced trade requirement restricting dividends. Instead, the goods market clearing condition in (12) implies that

$$D_t^T + \hat{D}_t^T = C_t^T + \hat{C}_t^T. \quad (17)$$

Under FI, households have access to domestic equity, international bonds and equity issued by firms in the foreign tradable sector. In this case market clearing in equity markets requires that

$$\text{TRADABLE :} \quad 1 = A_t^T + \hat{A}_t^T, \quad \text{and} \quad 1 = A_t^{\hat{T}} + \hat{A}_t^{\hat{T}}, \quad (18a)$$

$$\text{NONTRADABLE :} \quad 1 = A_t^{\hat{N}}, \quad \text{and} \quad 1 = \hat{A}_t^{\hat{N}}. \quad (18b)$$

Market clearing in the bond market continues to require condition (16) so tradable dividends satisfy (17). In this case international borrowing and lending takes place via trade in international bonds and the equity of H and F firms producing tradable goods.

3 Equilibrium

An equilibrium in our world comprises a set of asset prices and relative goods prices that clear markets given the state of productivity, the optimal investment decisions of firms producing tradable goods, and the optimal consumption, savings and portfolios decisions of households. Since markets are incomplete under all three levels of financial integration we consider, an equilibrium can only be found by solving the firm and households' problems for a conjectured set of equilibrium price processes, and then checking that resulting decisions are indeed consistent with market clearing. In this section, we first characterize the solutions to the optimization problems facing households and firms. We then describe a procedure for finding the equilibrium price processes.

3.1 Consumption, Portfolio and Dividend Choices

Consider the problem facing a H household under FI. In this case the H household chooses consumption of tradable and nontradable goods, C_t^T and C_t^N , and portfolio shares for equity in H and F firms producing tradables and H firms producing nontradables, α_t^T , $\alpha_t^{\hat{T}}$ and α_t^N , to maximize expected utility (5) subject to (6) and (7) given current equity prices, $\{P_t^T, P_t^{\hat{T}}, P_t^N\}$, the interest rate on bonds, R_t , and the relative price of nontradables Q_t^N . The first order conditions for this problem are

$$Q_t^N = \frac{\partial U / \partial C_t^N}{\partial U / \partial C_t^T}, \quad (19a)$$

$$1 = \mathbb{E}_t [M_{t+1} R_{t+1}^T], \quad (19b)$$

$$1 = \mathbb{E}_t [M_{t+1} R_{t+1}^N], \quad (19c)$$

$$1 = \mathbb{E}_t [M_{t+1} R_t], \quad (19d)$$

$$1 = \mathbb{E}_t [M_{t+1} R_{t+1}^{\hat{T}}], \quad (19e)$$

where $M_{t+1} \equiv M_{t+1,t} = \beta (\partial U / \partial C_{t+1}^T) / (\partial U / \partial C_t^T)$ is the discounted intertemporal marginal rate of substitution (IMRS) between the consumption of tradables in period t and period $t + 1$. Condition (19a) equates the relative price of nontradables to the marginal rate of substitution between the consumption of tradables and nontradables. Under FA, consumption and portfolio decisions are completely characterized by (19a) - (19c). When households are given access to international bonds under PI, there is an extra dimension to the portfolio choice problem facing households so (19d) is added to the set of first order conditions. Under FI, all the conditions in (19) are needed to characterize optimal H household behavior. An analogous set of conditions characterize the behavior of F households.

It is important to note that all the returns in (19) are measured in terms of tradables. In particular, the return on the equity of firms producing tradable goods in the H and F counties held by H investors are

$$R_{t+1}^T = (P_{t+1}^T + D_{t+1}^T) / P_t^T, \quad \text{and} \quad R_{t+1}^{\hat{T}} = (\hat{P}_{t+1}^T + \hat{D}_{t+1}^T) / \hat{P}_t^T. \quad (20)$$

Because the law of one price applies to tradable goods, these equations also define the return F households receive on their equity holdings in H and F firms producing tradable goods. In other words, $\hat{R}_{t+1}^T = R_{t+1}^T$ and $\hat{R}_{t+1}^{\hat{T}} = R_{t+1}^{\hat{T}}$. The law of one price similarly implies that the return on bonds R_t is the same for all

households.

The returns on equity producing nontradable goods differ across countries. In particular, the return on equity for H households is

$$R_{t+1}^N = \{ (P_{t+1}^N + D_{t+1}^N) / P_t^N \} \{ Q_{t+1}^N / Q_t^N \}, \quad (21)$$

while for F households the return is

$$\hat{R}_{t+1}^N = \left\{ \left(\hat{P}_{t+1}^N + \hat{D}_{t+1}^N \right) / \hat{P}_t^N \right\} \left\{ \hat{Q}_{t+1}^N / \hat{Q}_t^N \right\}, \quad (22)$$

where $\hat{Q}_t^N$ is the relative price of nontradables in country F.

The returns R_{t+1}^N and $\hat{R}_{t+1}^N$ differ from each other for two reasons: First, international productivity differentials in the nontradable sectors will create differences in returns measured in terms of nontradables. These differences will affect returns via the first term on the right hand side of (21) and (22). Second, international differences in the dynamics of relative prices Q_t^N and $\hat{Q}_t^N$ will affect returns via the second term in each equation. These differences arise quite naturally in equilibrium as the result of productivity shocks in either the tradable or nontradable sectors.

Variations in the relative prices of nontraded goods also drive the real exchange rate, which is defined as the ratio of price indices in the two countries:

$$Q_t = \left\{ \frac{\lambda_T + \lambda_N (Q_t^N)^{\frac{\phi}{\phi-1}}}{\hat{\lambda}_T + \hat{\lambda}_N (\hat{Q}_t^N)^{\frac{\phi}{\phi-1}}} \right\}^{\frac{\phi-1}{\phi}}. \quad (23)$$

The returns on equity shown in (20) - (22) are functions of equity prices, the relative price of nontradables, and the dividends paid by firms. The requirements of market clearing and our specification for the production of nontraded goods implies that dividends D_{t+1}^N and $\hat{D}_{t+1}^N$ are exogenous. By contrast, the dividends paid by firms producing tradable goods are determined optimally. Recall that H firms choose real investment I_t in period t to maximize the value of the firm. Combining (19b) with the definition of returns R_{t+1}^T in (20) implies that $P_t^T = \mathbb{E}_t [M_{t+1} (P_{t+1}^T + D_{t+1}^T)]$. This equation identifies the price a H household would pay for equity in the firm (after period t dividends have been paid). Using this expression to substitute for P_t^T in the H firm's investment problem (2) gives the following first order condition:

$$1 = \mathbb{E}_t \left[M_{t+1} \left(\theta Z_{t+1}^T (K_{t+1})^{\theta-1} + (1-\delta) \right) \right]. \quad (24)$$

This condition implicitly identifies the optimal level of dividends in period t because next period's capital depends on current capital, productivity and dividend payments: $K_{t+1} = (1-\delta)K_t + Z_t^T K_t^\theta - D_t^T$. Dividends on the equity of F firms producing tradable goods are similarly determined by

$$1 = \mathbb{E}_t \left[\hat{M}_{t+1} \left(\theta \hat{Z}_{t+1}^T (\hat{K}_{t+1})^{\theta-1} + (1-\delta) \right) \right], \quad (25)$$

where $\hat{M}_{t+1}$ is the IMRS for tradable goods in country F, and $\hat{K}_{t+1} = (1-\delta)\hat{K}_t + \hat{Z}_t^T \hat{K}_t^\theta - \hat{D}_t^T$.

The dividend policies implied by (24) and (25) maximize the value of each firm from the perspective of domestic shareholders. For example, the stream of dividends implied by (24) maximizes the value of H firms

producing traded goods for households in country H because the firm uses M_{t+1} to value future dividends. This is an innocuous assumption under financial autarky and partial integration because domestic households must hold all the firm's equity. Under full integration, however, foreign households have the opportunity to hold the H firm's equity so the firm's dividend policy need not maximize the value of equity to all shareholders. In particular, since markets are incomplete even under full integration, the IMRS for H and F households will differ, so F households holding domestic equity will generally prefer a different dividend stream from the one implied by (24). In short, the dividend streams implied by (24) and (25) incorporate a form of home bias because they focus exclusively on the interests of domestic shareholders.

We can now summarize the equilibrium actions of firms and households. At the beginning of period t , firms in the traded-goods sector observe the new level of productivity and decide on the amount of real investment to undertake. This decision determines dividend payments D_t^T and $\hat{D}_t^T$ as a function of existing productivity, physical capital, expectations regarding future productivity and the IMRS of domestic shareholders. Firms in the nontradable sectors have no real investment decision to make so in equilibrium D_t^N and $\hat{D}_t^N$ depend only on current productivity. At the same time, households begin period t with a portfolio of financial assets. Under FA the menu of assets is restricted to domestic equities, under PI households may hold domestic equities and bonds, and under FI the menu may contain domestic equity, foreign equity and bonds. Households receive dividend payments from firms according to the composition of their portfolios. They then make consumption and new portfolio decisions based on the market clearing relative price for nontradables, and the market-clearing prices for equity. The first-order conditions in (19) implicitly identify the decisions made by H households. The decisions made by F households are characterized by an analogous set of equations. The portfolio shares determined in this manner will depend on household expectations concerning future returns and the IMRS. As equations (20) - (22) show, equity returns are a function of current equity prices and future dividends and prices, so expectations regarding the latter will be important for determining how households choose portfolios in period t . Current and future consumption decisions also affect period t portfolio shares through the IMRS. Households' demand for financial assets in period t follows from decisions on consumption and the portfolio shares in a straightforward manner. In the case of FI, the demand for each asset from H and F households is

	H households	F households	
H TRADABLE EQUITY:	$A_t^T = \alpha_t^T W_t^C / P_t^T,$	$\hat{A}_t^T = \hat{\alpha}_t^T \hat{W}_t^C / P_t^T,$	(26)
F TRADABLE EQUITY:	$A_t^{\hat{T}} = \alpha_t^{\hat{T}} W_t^C / \hat{P}_t^T,$	$\hat{A}_t^{\hat{T}} = \hat{\alpha}_t^{\hat{T}} \hat{W}_t^C / \hat{P}_t^T,$	
NONTRADABLE EQUITY:	$A_t^N = \alpha_t^N W_t^C / Q_t^N P_t^N,$	$\hat{A}_t^N = \hat{\alpha}_t^N \hat{W}_t^C / \hat{Q}_t^N \hat{P}_t^N,$	
BONDS	$B_t = \alpha_t^B W_t^C R_t,$	$\hat{B}_t = \hat{\alpha}_t^B \hat{W}_t^C R_t,$	

where $W_t^C \equiv W_t - C_t^T - Q_t^N C_t^N$ and $\hat{W}_t^C \equiv \hat{W}_t - \hat{C}_t^T - \hat{Q}_t^N \hat{C}_t^N$ denote period t wealth net of consumption expenditure with $\alpha_t^B \equiv 1 - \alpha_t^T - \alpha_t^{\hat{T}} - \alpha_t^N$ and $\hat{\alpha}_t^B \equiv 1 - \hat{\alpha}_t^T - \hat{\alpha}_t^{\hat{T}} - \hat{\alpha}_t^N$. Equation (26) shows that asset demands depend on expected future returns and risk via optimally chosen portfolio shares, α_t , accumulated net wealth W_t^C and $\hat{W}_t^C$, and current asset prices (i.e., P_t^T , $\hat{P}_t^T$, P_t^N and $\hat{P}_t^N$ for equity, and $1/R_t$ for bonds).

3.2 Solving and Calibrating the Model

We solve the model using the method developed in Evans and Hnatkovska (2012). The equilibrium of the model is characterized by the set of nonlinear equations that describe the households’ and firms’ first-order conditions, their budget constraints, the market clearing conditions, and the productivity process. The solution method uses first-order log-linear approximations to the equilibrium conditions concerning real variables, and second-order log-linear approximations to those concerning financial variables. The real-side approximations are quite standard, and use the steady state values of real variables as the approximation point. On the financial side we approximate the log return on wealth with the expression developed by Campbell, Chan, and Viceira (2003). This second-order approximation holds exactly in the continuous-time limit and does not require knowledge of the steady-state portfolio shares. These shares are found as part of the solution to the set of approximations that characterize the model’s equilibrium. Appendix A.2 summarizes the approximations used to solve the model. We discuss the accuracy of the solution method and robustness in Appendix A.3.

Our solutions to the model use the parameter values summarized in Table 3. For the purpose of calibration we identify the world economy as consisting of two symmetric countries, matching the properties of US economy in quarterly data. We assume that household preferences and firm technologies are symmetric across the two countries. The value for ϕ is chosen to set the intratemporal elasticity of substitution between tradables and nontradables at 0.74, consistent with the value in Corsetti, Dedola, and Leduc (2008). The share parameters for traded and nontraded goods, λ_T and λ_N , are both set to 0.5, and the discount factor β equals 0.99. On the production side, we set the capital share in tradable production θ to 0.36, and the depreciation rate δ to 0.02. These values are consistent with the estimates in Backus, Kehoe, and Kydland (1995). The only other parameters in the model govern the productivity process. We assume that each of the four productivity processes (i.e. $\ln Z_t^T, \ln \hat{Z}_t^T, \ln Z_t^N$, and $\ln \hat{Z}_t^N$) follow AR(1) processes with independent shocks. The AR(1) coefficients in the processes for tradable-goods productivity, $\ln Z_t^T$ and $\ln \hat{Z}_t^T$, are 0.78, while the coefficients for nontradable productivity, $\ln Z_t^N$, and $\ln \hat{Z}_t^N$, are 0.99. These values are comparable to those used by Corsetti, Dedola, and Leduc (2008). We also follow the literature in assuming that N shocks are more persistent than T shocks (see, e.g., Stockman and Tesar (1995) and Corsetti, Dedola, and Leduc (2008)). Shocks to all four productivity processes have a variance of 0.0001. This number is very close to the one used by Backus, Kehoe, and Kydland (1992) in their study of international business cycles between the U.S. and an aggregate of major European countries (Austria, Finland, Germany, Italy, Switzerland, and the United Kingdom). This specification implies that all shocks have persistent but temporary effects on productivity. Any permanent effects they have on other variables must arise endogenously from the structure of the model.

With this parsimonious calibration the model provides a reasonable match to the real business cycle moments in the US data. This is not surprising given that we used “off the shelf” configuration of parameter values used extensively in the international business cycles literature. At the same time, it is far less well documented how such models and calibrations fair in replicating the moments of financial variables such as international capital flows and returns. To provide such an analysis, we choose not to target any moments of the financial variables in our calibration. Instead, we are interested in showing how close can a standard model with a standard calibration come to replicating the characteristics of such variables.

Table 3: Model parameters

Preferences	β 0.99	λ_T 0.5	λ_N 0.5	$1/(1-\phi)$ 0.74
Production	θ 0.36	δ 0.02		
Productivity	a_{ii}^T 0.78	a_{ii}^N 0.99	Ω_e 0.0001	

4 Results

We analyze the equilibrium properties of our model in three steps. First, we examine how the economy responds to productivity shocks. Next, we study the behavior of international capital flows. Finally, we examine the implications of differing degrees of integration for the behavior of asset prices and returns.

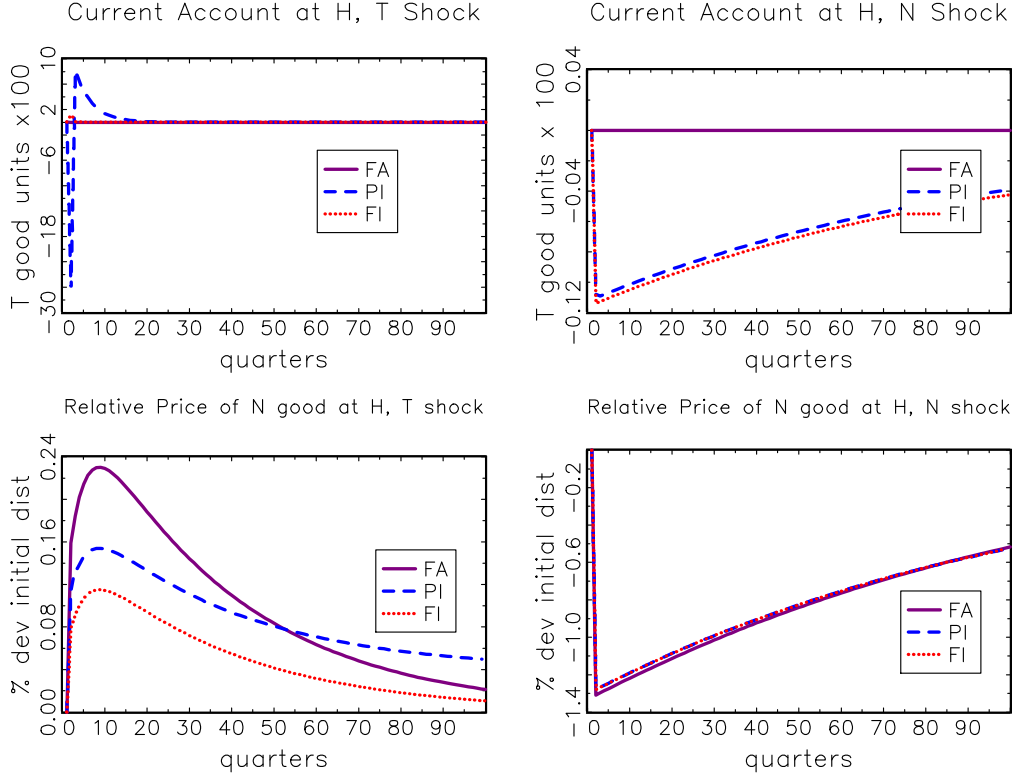
4.1 Risk-Sharing and Financial Integration

The consequences of greater financial integration are most easily understood by considering how the economy responds to productivity shocks. With this in mind, consider how a positive productivity shock to domestic firms producing traded goods affects real output and consumption in both countries under our three market configurations. The effects on the current account and the relative price of tradables are shown in the left hand panels of Figure 5, while the effects on bond and equity positions in domestic tradable sector firms are presented in the left hand panels of Figure 6.¹²

Recall that productivity shocks only have temporary affects on the marginal product of capital. Thus, a positive productivity shock in the domestic traded-goods sector will induce an immediate one-period rise in real investment as firms in that sector take advantage of the temporarily high marginal product of capital. In short, there is an investment boom in the domestic tradable goods sector. Because the equity issued by these firms represents a claim on the future dividend stream sustained by the firm's capital stock, one effect of the investment boom is to increase the equilibrium price of tradable equity P_t^T . Under FA, this capital gain raises the wealth of H households so the domestic demand for both tradable and nontradable goods increases. While increased domestic output can accommodate the rise in demand for tradables, there is no change in the output of nontradables, so the relative price of nontradables, Q_t^N , must rise to clear domestic goods markets.

¹²The current account in country H is calculated from the individual's budget constraint as the sum of net exports and net foreign income: $CA_t = D_t^T - C_t^T + (\hat{D}_t^T A_{t-1}^T - D_{t-1}^T \hat{A}_{t-1}^T) + B_{t-1}(R_t - 1)/R_t$. The current account is also identically equal to the change in net foreign asset position: $CA_t = \hat{P}_t^T \Delta A_t^T - P_t^T \Delta \hat{A}_t^T + (1/R_t) \Delta B_t$. Here Δ denotes the first-difference in a variable between periods t and $t - 1$. Under PI, the current account is equal to the trade balance plus net income from bond holdings, which in turn equals the change in bond holdings valued at current bond price: $CA_t = D_t^T - C_t^T + B_{t-1}(R_t - 1)/R_t = (1/R_t) \Delta B_t$.

Figure 5: Real effects of productivity shocks



A similar adjustment pattern occurs under PI. The capital gain enjoyed by H households again translates into increased demand for tradables and nontradables, but now the demand for tradables can be accommodated by both H and F firms producing tradables. As a result, the productivity shock is accompanied by a trade deficit in the H country and a smaller rise in Q_t^N than under FA. Once the investment boom is over, the domestic supply of tradables available for consumption rises sharply above domestic consumption. From this point on, the H country runs a trade surplus. Initially, this surplus is used to pay off the foreign debt incurred during the investment boom. Once this is done, H households start lending to F households by buying bonds. This allows H households to smooth the consumption gains from the productive shock far beyond the point where its direct effects on domestic output disappear. As a consequence, the temporary shock to productivity has permanent effects on the international distribution of wealth.

In the case of FI, the increase in P_t^T represents a capital gain to both H and F households because everyone diversifies their international equity holdings (i.e., all households hold equity issued by H and F firms producing tradable goods). As a result, the demand for tradables and nontradables rise in both countries. At the same time, by taking a fully diversified positions in T equities, households in both countries can finance higher tradable consumption without borrowing from abroad. As the trade deficit is exactly offset by the positive net foreign income, the current account remains in balance.¹³ Market clearing in the nontradable

¹³The size of the trade deficit is approximately the same under PI and FI. However, under FI the current account also includes net foreign dividend income. For the H country, net foreign dividend income under FI is $\hat{D}_t^T A_{t-1}^T - D_t^T \hat{A}_{t-1}^T$.

markets raises relative prices (i.e. Q_t^N and $\hat{Q}_t^N$), but less than under PI.

The right hand panels of Figure 5 and 6 show the effects of positive productivity shock in the H nontradable sector. Once again, the shock produces a trade and current account deficits under PI, but it is much smaller and persists for longer than the deficit associated with productivity shocks in the tradable sector.¹⁴ A positive productivity shock in H nontradables increases the supply of nontradable output available for domestic consumption. This has two equilibrium effects. First, it lowers the relative price of nontradables, Q_t^N , so that the H market for nontradables clears. This is clearly seen in the lower right hand panel of Figure 5. Second, it raises the H demand for tradables because tradables and nontradables are complementary. The result is a persistent trade and current account deficit, financed by borrowing from abroad. Under FI, a productivity increase in the N sector leads to a similar adjustment in the current account. The size of the deficit is comparable with that under PI, and likewise is financed by borrowing from abroad. However, the amount of such borrowing under FI is much larger as it is used to finance both consumption demand and purchases of a diversified portfolio of T equity shares.

To summarize, the current account dynamics displayed in Figure 5 are readily understood in terms of intertemporal consumption smoothing once we recognize that shocks to tradable productivity induce domestic investment booms. In addition, these dynamics differ under the PI and FI configurations. When given a choice between international bonds and equity, households choose to take fully diversified positions in stocks allowing them to share country specific risks internationally. Then, depending on the productivity shock, bonds are either used to finance the purchases of equity, or become redundant. When equity is not available, bonds must be used to smooth consumption.

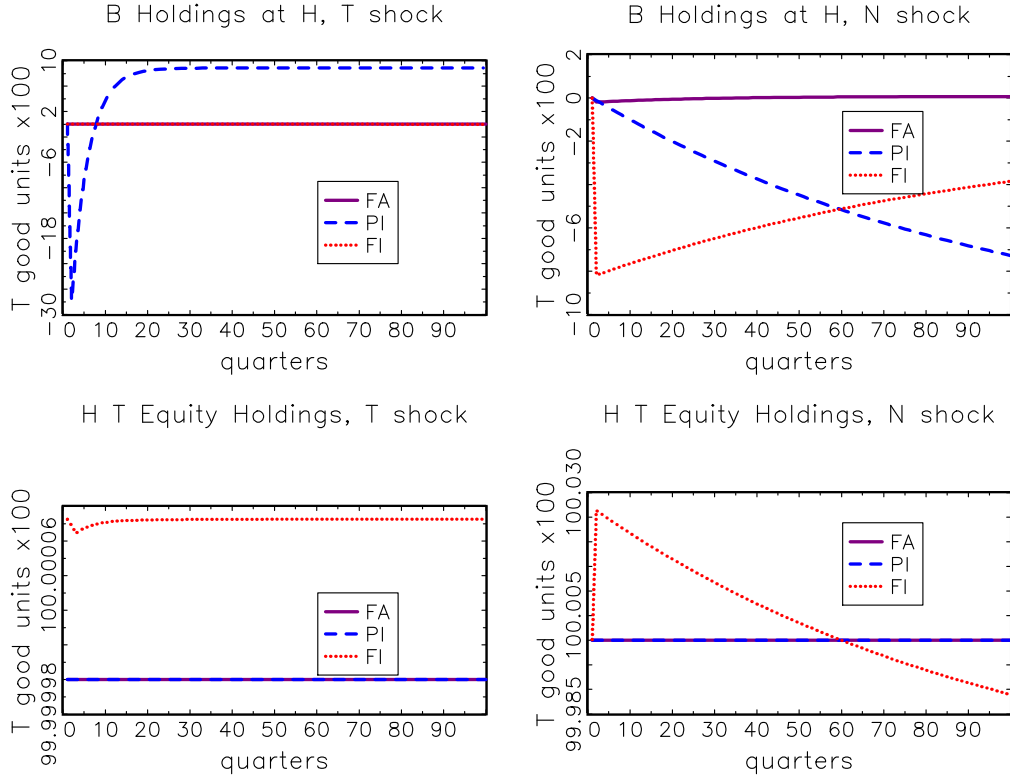
We are now ready to think about capital flows. Capital flows can be easily inferred from Figure 6 as changes in the holdings of the corresponding assets. More precisely, in what follows we define bond flows as $\frac{1}{R_t}(B_t - B_{t-1}) \left[= -\frac{1}{R_t}(\hat{B}_t - \hat{B}_{t-1}) \right]$, net domestic purchases of foreign assets (or domestic equity outflow) as $\hat{P}_t^T(\hat{A}_t^T - \hat{A}_{t-1}^T)$, and net foreign purchases of domestic assets (or domestic equity inflow) as $P_t^T(\hat{A}_t^T - \hat{A}_{t-1}^T)$ from the equilibrium portfolio shares and wealth as shown in (26).

Under PI, capital flows only take place through the bond market and can be easily inferred from the dynamics of the trade balance. In particular, the sharp reversal in the trade balance immediately following a shock to productivity in the tradable sector will be matched by a sharp outflow and then inflow of bonds into the H country. In contrast, productivity shocks in the nontradables sector induce a much smaller initial outflow that persists until the trade balance eventually reverts back to zero. In sum, our model generates high volatility in capital flows under PI because shocks to tradable productivity create short-lived investment booms that necessitate large changes in international bond holdings if households are to intertemporally smooth consumption.

Under FI the story is quite different. The left panel of Figure 6 tells us that the traded productivity shocks do not induce any borrowing or lending as households are able to share the country specific risks using equity markets. In effect, households choose to follow a buy-and-hold strategy for their diversified

¹⁴Higher persistence of endogenous variables after N shocks in the model is due to higher persistence of N productivity in our calibration.

Figure 6: Portfolio effects of productivity shocks



T equity portfolio and to passively consume T dividends every period. Such behavior is characteristic of an equilibrium with complete markets. By contrast, immediately following a nontraded productivity shock households borrow enough to finance increased demand for T consumption and T equities. As the effect of the shock dies out, agents start selling off some of their equity holdings. These proceeds and dividend receipts are used to finance still higher T consumption and to pay back their debt with interest. The equity holdings are run down until the current account balance is restored.

4.2 International Capital Flows

Figures 5 and 6 show us how the response of the economy to productivity shocks differs with the degree of financial integration. We now examine how these differing responses show up in the dynamics of international capital flows and returns. For this purpose, we simulate the model over 400 quarters for each financial configuration {i.e., FA, PI, FI}. The innovations to equilibrium wealth are small enough to keep H and F wealth close to its initial levels over this span so our solution of the model remains accurate. The statistics we report below are derived from 100 simulations for each financial configuration and so are based on 10,000 years of simulated quarterly data in the neighborhood of the initial wealth distribution.¹⁵

¹⁵The results reported here are based on an initial equal distribution of wealth between H and F households. We have also examined solutions with uneven initial distributions. As Appendix A.3 explains, the implications of these solutions for the capital flow dynamics are very similar to those presented here.

Table 4 compares the behavior of the bond and equity flows between countries in the PI and FI configurations. We study their behavior measured relative to GDP, defined as $Y_t = Y_t^T + Q_t^N Y_t^N$. Panel I of Table 4 reports various moments of bond and equity flows in the model. We report three moments that capture volatility of portfolio flows: (i) modified coefficient of variation (denoted by “c.v.”), obtained as standard deviation of flow normalized by the mean absolute flow; (ii) minimum and maximum flow (denoted respectively by “min” and “max”) also normalized by the mean absolute flow. Panel II of Table 4 reports the same moments computed as averages across the G-7 data.

To compare the model’s implications with the data we map portfolio flows and integration regimes as follows. First, since bonds in the model are in zero net supply, we use *net* debt flows, obtained as a sum of debt outflows (-) and debt inflows (+), as their empirical counterpart. For equity we use equity outflows and equity inflows from the data. Second, we compare the PI and FI integration regimes in the model with periods of “low” and “high” integration, spanning 1975:1-1995:4 and 1996:1-2007:4, respectively. The literature generally agrees that the 1990s were associated with a period of rapid international financial integration, so we use the middle of the 1990s as a break point in the data. Finally, since international equity trade only occurs in the FI regime, we compare equity flows from the FI equilibrium of the model with flows in the G-7 between 1975:1 and 2007:4.¹⁶

Table 4: International Portfolio Flows (quarterly, percent of GDP)

I: Model				II: Data		
net bond flow	PI	FI	FI-PI	low	high	high-low
c.v.	1.26	1.25	-0.80%	1.38	1.13	-18.00%
min	-6.10	-5.77	-5.42%	-3.53	-2.16	-38.72%
max	6.53	5.72	-12.42%	5.04	3.27	-35.06%
equity flow	outflow	inflow		outflow	inflow	
c.v.	1.27	1.27		1.28	1.33	
min	-9.07	-8.38		-5.26	-2.78	
max	8.16	9.68		2.87	4.94	

Notes: The top panel reports statistics for net bond flows, while the bottom panel is for equity flows. Statistics reported in panel I are based on 100 simulations of quarterly series, each 400 periods long. Statistics in panel II are reported for two sub-periods for net bond flows: low integration period of 1975:1-1995:4; and high integrational period of 1996:1-2007:4. For equity flows data statistics are obtained over the entire sample period of 1974:1-2007:4. Rows labelled “c.v.” refer to a modified coefficient of variation obtained as the ratio of standard deviation to mean absolute flow. “min” refers to minimum flow scaled by mean absolute flow, while “max” refers to maximum flow divided by mean absolute flow.

Panel I of Table 4 shows that bond flows are quite volatile under partial financial integration (PI). While the coefficient of variation is very close to that in the data, the min and max flows in the model are well above their data counterparts. In this configuration, bonds serve two purposes. First, they allow households to share risks. Second, they provide the only medium through which international borrowing and lending takes place. Under FA, the cross-country correlation in marginal utility is zero because the productivity shocks hitting each sector are independent. Under PI, the correlation rises to 0.52, so the creation of an international bond market facilitates a good deal of international risk-sharing.

¹⁶When we use equity flow data from 1996:1-2007:4 we obtain somewhat larger moments that are closer to the moments implied by the FI equilibrium of the model.

When foreign equity markets open up (i.e., in the FI regime), the volatility of both bond and equity flows changes. Two features stand out: First, bond flows are less volatile than they were under PI, consistent with the data. The predicted decline, however, is smaller than what we observed in the second half of our data sample.¹⁷ It is important to remember, however, that these flows are computed from the equilibrium in which FI is established and do not include any of the adjustment flows that would accompany the opening of foreign equity markets. Second, bond and equity flows display similar degrees of volatility, with equity flows being slightly more volatile, as measured by min and max statistics. Importantly, the volatilities are comparable to their counterparts computed in the G-7 data. The coefficient of variation for equity outflows and inflows in the model of 1.27 is very similar to the values of 1.28 for outflows and 1.33 for inflows in the data, while range for equity and net flows, as measured by the min and max statistics, are somewhat larger. As one would expect, the degree of risk-sharing in the FI configuration is higher than in the PI case - the cross-country correlation in marginal utility is 0.67. Access to foreign equity allows households to share more risk, but markets are still incomplete.

Overall, the statistics in Table 4 reveal a distinct relation between the degree of financial integration and the volatility of international capital flows. During the early stages of integration, characterized here by the PI equilibrium, the volatility of international capital flows is high. However, as integration proceeds further, volatility declines.

We can gain further insight into the origins of the international equity and bond flows by decomposing each flow into two components. For this purpose, we use (26) to re-write the flow of equity in traded-good firms as:

$$\begin{aligned} P_t^T \Delta A_t^T &= \alpha_t^T W_t^C - \alpha_{t-1}^T W_{t-1}^C \frac{P_t^T}{P_{t-1}^T}, \\ &= \Delta \alpha_t^T W_t^C + \left[\alpha_{t-1}^T \Delta W_t^C - \left(\frac{P_t^T}{P_{t-1}^T} - 1 \right) W_{t-1}^C \alpha_{t-1}^T \right]. \end{aligned} \quad (27)$$

The first term in the second line captures portfolio flows resulting from each household's desire to alter portfolio shares due to changes in expected returns and risk. Bohn and Tesar (1996) name this term the "return chasing" component. The second term reflects each household's intention to acquire or sell off some of the asset when wealth changes or when there are some capital gains or losses on the existing portfolio. They call this term the "portfolio rebalancing" component. Bond flows can be decomposed in a similar manner:

$$\frac{1}{R_t} \Delta B_t = \Delta \alpha_t^B W_t^C + \left[\alpha_{t-1}^B \Delta W_t^C - \left(\frac{R_{t-1}}{R_t} - 1 \right) W_{t-1}^C \alpha_{t-1}^B \right]. \quad (28)$$

Again, the first term on the right identifies the "return chasing" component, and the second the "portfolio rebalancing" component.

¹⁷We should note that the statistics and their changes over regimes are computed from 40,000 simulated observations and therefore are highly statistically significant.

Alternatively, we can decompose the equity and bond flows as

$$P_t^T \Delta A_t^T = \alpha_t^T \Delta W_t^C + \left[\Delta \alpha_t^T - \left(\frac{P_t^T}{P_{t-1}^T} - 1 \right) \alpha_{t-1}^T \right] W_{t-1}^C \quad \text{and} \quad (29)$$

$$\frac{1}{R_t} \Delta B_t = \alpha_t^B \Delta W_t^C + \left[\Delta \alpha_t^B - \left(\frac{R_{t-1}}{R_t} - 1 \right) \alpha_{t-1}^B \right] W_{t-1}^C. \quad (30)$$

Here the first term on the right-hand-side identifies how changes in household wealth contribute to the flows, while the second identifies the effects of changing portfolio shares and asset-price variations. Kraay and Ventura (2003) and Tille and van Wincoop (2010) refer to these terms as the portfolio growth and portfolio reallocations components, respectively.¹⁸

Table 5 shows how the different components contribute to the volatility of bond and equity flows in the PI and FI regimes. Column (i) reports the standard deviation of the flows in each regimes. The statistics in columns (ii) and (iii) report the variance contributions of the return chasing and portfolio rebalancing components identified in (27) and (28), while those in columns (iv) and (v) report the contributions of the portfolio growth and portfolio allocation components identified in (29) and (30). As the table shows, the contributions of the return chasing and portfolio reallocation components in columns (ii) and (v), and the portfolio rebalancing and portfolio growth components in columns (iii) and (iv) are very similar across the equity and bond flows in both regimes. This is not entirely surprising. In the case of the bond flows, the portfolio reallocation component will be well-approximated by $\Delta \alpha_t^B W_{t-1}^C$ when interest rates are stable, which closely tracks the return chasing component, $\Delta \alpha_t^B W_t^C$. Similar reasoning applies to the components of the equity flows when the quarterly capital gains on equity are small.

Table 5: Variance Decomposition of International Portfolio Flows

	std(flow)	Return Chasing	Portfolio Rebalancing	Portfolio Growth	Portfolio Reallocation
	(i)	(ii)	(iii)	(iv)	(v)
Partial Integration					
Equity	-	-	-	-	-
Bonds	42.84%	1.0004	-0.0004	-0.0004	1.0004
Full Integration					
Equity	6.43%	2.2878	-1.2876	-1.2990	2.2992
Bonds	11.56%	1.0000	-0.000	-0.0003	0.9998

Notes: Let $F_t = F_t^I + F_t^{II}$ denote the decomposition of the flows in equations (27)-(30). We compute the variance decomposition from the fact that $Var(F_t) = Cov(F_t^I, F_t) + Cov(F_t^{II}, F_t)$. Columns (ii) and (iii) report the values of $Cov(F_t^I, F_t)/Var(F_t)$ and $Cov(F_t^{II}, F_t)/Var(F_t)$ based on the decompositions in (27) and (28), while columns (iv) and (v) report the values $Cov(F_t^I, F_t)/Var(F_t)$ and $Cov(F_t^{II}, F_t)/Var(F_t)$ based on the decompositions in (29) and (30). Note that these calculations use the levels of flows rather than flows measured relative to GDP.

¹⁸Strictly speaking, the decompositions in (29) and (30) differs from the one found in Kraay and Ventura (2003) because their model only identifies the change in net foreign assets rather than bond and equity capital flows. Also, Tille and van Wincoop (2010) identify the components in a first-order approximation to equity flows, rather than in a decomposition of the exact flow as in (30).

The statistics in Table 5 clearly show how the level of financial integration affects the volatility and composition of capital flows. From column (i) we see that the standard deviation of bond flows falls substantially as integration increases. In the PI regime, the return chasing (portfolio reallocation) component is the dominant source of volatility in bond flows - portfolio rebalancing (growth) plays an insignificant role. This is not a surprising result. In the PI equilibrium, the bond positions of households vary but on average are quite small. Under these circumstances, the second term in (28) and the first term in (30) make negligible contributions to bond flows.

The lower panel of Table 5 presents the decompositions under FI. Here we see that portfolio rebalancing (growth) continues to play an insignificant role as a driver of bond flows. In the case of equities, both components play a role. Households increase the share of tradable equity in their portfolios in response to shocks that increase the price of tradable equity so the variations in the two components are negatively correlated. The figures of 2.29 and -1.29 mean that a unit of positive equity flow results from an increase of 2.29 units in the return chasing (portfolio reallocation) component and a 1.29 fall in the portfolio rebalancing (growth) component. Rebalancing plays a more important role in equity flows because households begin each period with *approximately* 50 percent of their wealth in tradable equity, which is evenly split between stocks issued by domestic and foreign firms. These results are broadly consistent with the findings in Tille and van Wincoop (2010). In their model the transmission of shocks to equity flows occurs more through portfolio reallocation than through portfolio growth, and the components are negatively correlated.

4.3 Returns

We now examine how greater financial integration affects the behavior of asset returns. This analysis naturally complements the study of capital flows. Panel I of Table 6 reports the standard deviations of realized returns computed from our model simulations. Column (i) reports volatility under FA. Here we see that the model produces far less volatility in bond and equity returns than we observe in the data. This is not surprising given our very standard specification for productivity, production and preferences. We do note, however, that the relative volatility of returns is roughly in accordance with reality: equities are much more volatile than the risk free rate, and foreign exchange returns, $\Delta q_t \equiv \ln Q_t - \ln Q_{t-1}$, are an order of magnitude more volatile than equity. Note also that the volatility of the return on equity in firms producing nontradable goods is almost twice that of the return on firms producing tradables.

Columns (ii) - (v) of Table 6 show how the volatility of returns change as the degree of financial integration increases. Columns (ii) and (iii) report the standard deviation of returns in the PI and FI regimes, while columns (iv) and (v) show how the standard deviations change as the level of integrating rises. From column (iv) we see that opening trade in international bonds reduces the volatility of equity returns and the risk-free rate by approximately one third, while the volatility of foreign exchange returns falls by roughly 5%. The volatility of returns changes further when households are given access to foreign T equity. As column (v) shows, the largest changes occur in the volatility of portfolio returns (i.e., the return on wealth), which falls by 5%. Volatility of the N equity return decreases by roughly 3%. These findings are consistent with the empirical trends in the returns volatility we reported earlier. Panel II reports the average standard deviations across the G-7 for the risk free rate and equity returns during the “low” and “high” integration periods.

Table 6: Return Volatility, (annual, percent std. dev.)

	I: Model				
	differences (per cent)				
	FA (i)	PI (ii)	FI (iii)	PI-FA (iv)	FI-PI (v)
Risk free rate r_t	0.15	0.11	0.11	-33.94	0.00
Tradable equity r_t^T	0.57	0.44	0.44	-27.17	-0.01
Nontradable equity r_t^N	1.09	0.94	0.92	-14.65	-2.77
Portfolio returns r_t^W	0.80	0.64	0.61	-21.29	-4.63
Foreign exchange Δq_t	3.75	3.56	3.55	-5.15	-0.17
Depository receipt $\tilde{r}_t^T$	0.44	0.44	0.44	-1.92	-0.04
	II: Data				
	low	high		high-low	
Risk free rate	2.60	1.05		-59.45%	
Equity	45.24	34.13		-24.55%	
Notes: Statistics reported in panel I are based on 100 simulations of quarterly series, each 400 periods long. Statistics in panel II are reported for two sub-periods: low integration period of 1975:1-1995:4; and high integrational period of 1996:1-2007:4.					

Consistent with our model, the volatility of returns falls with greater integration, but the level of volatility in the data is far higher than in any of the equilibria we study.¹⁹

Next, we turn to issue of how financial integration affects the relation between returns. There is a large empirical literature that is concerned with using asset prices and returns to measure the degree of financial integration. This is especially relevant for policy-makers in environments with de-facto restrictions on capital mobility. Our model allows us to provide a theory-based perspective on these questions.

We begin by assessing the role of global factors in determining returns under different degrees of financial integration. For this purpose, we first derive a log version of the CAPM implied by our model. Under our log specification for household utility, the IMRS for each household is proportional to the reciprocal of the (gross) return of optimally invested wealth, R_{t+1}^W . Using this fact, we can rewrite the log linearized version of the H household's first order conditions in (19b) - (19e) as

$$\mathbb{E}_t r_{t+1}^\chi - r_t + \frac{1}{2} \mathbb{V}_t(r_{t+1}^\chi) = \mathbb{C}\mathbb{V}_t(r_{t+1}^W, r_{t+1}^\chi) = \mathcal{B}_t^\chi \mathbb{V}_t(r_{t+1}^W) \quad (31)$$

where r_{t+1}^χ is the log return on equity $\chi = \{T, \hat{T}, N\}$ and $r_{t+1}^W \equiv \ln R_{t+1}^W$. $\mathcal{B}_t^\chi$ is the beta for asset χ , defined as the ratio of conditional covariance between asset χ and return on domestic wealth, and the conditional variance of the market portfolio: $\mathcal{B}_t^\chi = \mathbb{C}\mathbb{V}_t(r_{t+1}^W, r_{t+1}^\chi) / \mathbb{V}_t(r_{t+1}^W)$, where $\mathbb{V}_t(\cdot)$ and $\mathbb{C}\mathbb{V}_t(\cdot, \cdot)$ denote the variance and covariance conditioned on period t information. As in the standard CAPM, $\mathbb{V}_t(r_{t+1}^W)$ is the same for all assets χ , while the $\mathcal{B}_t^\chi$ varies from asset to asset. Following the finance literature, we interpret

¹⁹Insufficient volatility in asset prices is a common feature of general equilibrium models such as our with a standard specification for households' preferences. One way to address this would be to amend household's preferences with habits, as in Campbell and Cochrane (1999), but this would considerably complicate our analysis, and so is left for future work.

$\mathbb{V}_t(r_{t+1}^w)$ as the price of risk and $\mathcal{B}_t^\chi$ as the quantity of risk in asset χ . Of course, unlike the standard CAPM, both the price and quantity of risk in this formulation depend on the moments of log rather than gross returns.

The household first order conditions in (19b) - (19e) imply that $1 = \mathbb{E}_t[M_{t+1}R_{t+1}^w]$, so the approximate relation in (31) also applies to the log return on wealth. In this case $\mathcal{B}_t^w = 1$, so the approximation simplifies to

$$\mathbb{E}_t r_{t+1}^w - r_t = \frac{1}{2} \mathbb{V}_t(r_{t+1}^w). \quad (32)$$

Our log version of the CAPM is obtained by combining (31) and (32):

$$\mathbb{E}_t r_{t+1}^\chi - r_t + \frac{1}{2} \mathbb{V}_t(r_{t+1}^\chi) = \mathcal{B}_t^\chi (\mathbb{E}_t r_{t+1}^w - r_t + \frac{1}{2} \mathbb{V}_t(r_{t+1}^w)). \quad (33)$$

This equation says that the expected log excess return on equity is proportional to the log excess return on optimally invested wealth. Importantly, this relation is based on the optimality of households' portfolio choice and holds true in the equilibria we compute for the FA, PI and FI regimes. It therefore provides a natural framework for examining how increased financial integration affects the relationship between equilibrium returns.

We examine the effects of integration with the regression

$$\mathbb{E}_t r_{t+1}^\chi - r_t + \frac{1}{2} \mathbb{V}_t(r_{t+1}^\chi) = \alpha_0 + \alpha_1 \mathbb{E}_t er_{t+1}^w + \alpha_2 \mathbb{E}_t er_{t+1}^{\hat{w}} + \alpha_3 \mathbb{E}_t er_{t+1}^{\text{FX}} + \eta_t, \quad (34)$$

for $\chi = \{\text{T}, \text{N}\}$, where $\mathbb{E}_t er_{t+1}^i \equiv \mathbb{E}_t r_{t+1}^i - r_t + \frac{1}{2} \mathbb{V}_t(r_{t+1}^i)$ for $i = \{\text{W}, \hat{\text{W}}, \text{FX}\}$. Here we consider the regression of the expected log excess equity return on the expected log excess return on domestic wealth, $\mathbb{E}_t er_{t+1}^w$, foreign wealth, $\mathbb{E}_t er_{t+1}^{\hat{w}}$, and the expected excess return on foreign exchange, $\mathbb{E}_t er_{t+1}^{\text{FX}}$ (where $r_{t+1}^{\text{FX}} \equiv q_{t+1} - q_t + \hat{r}_t$). Our CAPM equation in (33) implies that if the price of risk for equity is constant, the coefficients α_0 , α_2 and α_3 should equal zero, and the R^2 of the regression should be very close to unity. Alternatively, if the price of risk varies, and the variations are unrelated to returns on foreign wealth or foreign exchange, the R^2 of the regression will be lower but α_0 , α_2 and α_3 should still equal zero. Only when the variations in the price of risk are correlated with the return on foreign wealth and/or foreign exchange, will α_2 and/or α_3 differ from zero.

Table 7 presents the results from estimating (34) with simulated data on expected log excess returns from our model.²⁰ Three results stand out. First, excess equity returns are unrelated to the foreign exchange returns across all degrees of financial integration; the estimates of α_3 are zero in all cases. Second, as integration increases, the time-varying price of risk (betas) play a larger role in the determination of T equity returns and a smaller role in the determination of returns on N equity. The R^2 statistics for T equity fall from 0.82 to 0.66 as we move from the FA to FI equilibria, while the statistics for N equity rise from 0.27 to 0.99. Since returns satisfy the CAPM equation (33), a small R^2 signals the presence of a time-varying price of risk that is largely uncorrelated with the expected excess returns on wealth and foreign exchange. Third, the expected return on domestic (foreign) wealth has less (more) of an influence on T equity returns

²⁰We can compute log excess returns directly from the model, so the regression can be estimated without the need to instrument for the expected returns on the right hand side. Since our simulations span 10,000 years of quarterly data (i.e., 100 simulations of quarterly series, each 400 periods long), all the regression coefficients are estimated with great precision. We therefore omit standard errors from the table for the sake of clarity.

as integration rises. This result accords with the idea that foreign risk factors play an increasing important role in the determination of equilibrium expected returns as integration rises. In the last row of the table we report estimates of α_1 from (34) with the restriction $\alpha_1 = 1 - \alpha_2$. These estimates show that the relative influence of domestic risk on traded equity falls from unity to approximately 0.5 as we move from the FA to FI equilibrium.

Table 7: Excess Return Regression Results

	Autarky		Partial Integration		Full Integration	
	T equity (i)	N equity (ii)	T equity (iii)	N equity (iv)	T equity (v)	N equity (vi)
$\mathbb{E}_t er_{t+1}^W: \alpha_1$	2.675	-0.341	0.257	0.767	0.067	0.934
$\mathbb{E}_t er_{t+1}^{\tilde{W}}: \alpha_2$	0.000	0.000	-0.149	0.120	0.068	-0.069
$\mathbb{E}_t er_{t+1}^{FX}: \alpha_3$	0.000	0.000	0.000	0.000	0.000	0.000
R^2	0.818	0.273	0.420	0.823	0.657	0.987
$\alpha_1 = 1 - \alpha_2$	1.000	1.000	2.390	0.865	0.496	1.079

Overall, the results in Table 7 confirm the idea that global risks have a larger impact on the behavior of excess returns on assets that are more widely traded as financial integration increases.²¹ In our model, $\mathbb{E}_t er_{t+1}^{\tilde{W}}$ represents the effects of global risk from the perspective of domestic T equity. Once all households are free to trade this equity, global risk accounts for approximately 50% of the variation in excess returns. By contrast, excess returns on N equity remain largely unaffected by global risk even under FI because these equity are only held domestically.²² Our results also show the pure foreign exchange risk, as represented by $\mathbb{E}_t er_{t+1}^{FX}$, exerts no independent influence on expected excess equity returns in any equilibrium (all the estimates of α_3 are zero). Currency risk only affects equity returns via its impact on the domestic and foreign risk factors, $\mathbb{E}_t er_{t+1}^W$ and $\mathbb{E}_t er_{t+1}^{\tilde{W}}$.

The results in Tables 6 and 7 reflect the important role time-varying conditional second moments play in the equilibria we study. Equation (31) shows that all the variations in the equilibrium expected log excess returns on asset χ we compute reflect changes $\mathbb{C}\mathbb{V}_t(r_{t+1}^W, r_{t+1}^\chi)$, or equivalently changes in $-\mathbb{C}\mathbb{V}_t(m_{t+1}, r_{t+1}^\chi)$. Thus, the level of financial integration affects the behavior of expected excess returns in our model because it affects how conditional second moments *change* in response to productivity shocks. These changes also affect capital flows because they alter households' portfolio choices. Substituting for the log return on wealth on the right-hand-side of (31) for $\chi = \{T, \tilde{T}, N, FX\}$ and re-arranging the resulting equations produces

$$\alpha_t = -\mathbb{V}_t(\mathbf{r}_{t+1})^{-1} \mathbb{C}\mathbb{V}_t(m_{t+1}, \mathbf{r}_{t+1}), \quad (35)$$

²¹The large empirical literature relating returns to local and global risk factors includes Korajczyk and Viallet (1989), Chan, Karolyi, and Stulz (1992), Errunza, Losq, and Padmanabhan (1992), Dumas and Solnik (1995), Heston, Rouwenhorst, and Wessels (1995), Bekaert and Harvey (1995, 1997), Hardouvelis, Malliaropoulos, and Priestley (2006) and Fratzscher (2002).

²²These results provide theoretical perspective on the literature examining the relative importance of country and industry factors in explaining equity return dynamics. See, for example, Heston and Rouwenhorst (1994), Griffin and Karolyi (1998), Rouwenhorst (1999) and Adjaoute and Danthine (2003).

where $\alpha_t = [\alpha_t^T, \alpha_t^{\hat{T}}, \alpha_t^N, \alpha_t^B]'$ is the vector of portfolio shares and $\mathbf{r}_{t+1} = [r_{t+1}^T, r_{t+1}^{\hat{T}}, r_{t+1}^N, r_{t+1}^{FX}]'$ is a vector of risky returns. This equation shows that changes in the conditional variance of returns and their conditional covariance with the log IMRS induced by productivity shocks alter the optimal composition of H households' portfolios. This is why the "return chasing" (or portfolio reallocation) component is such an important component of equity flows under FI.

We should also emphasize that all the variations in conditional second moments arise endogenously in our model from the propagation of productive shocks; they do not reflect variations in the volatility of exogenous shocks hitting the economy. We can identify one import link between the productivity shocks and the second moments by examining the components in $\mathbb{C}\mathbb{V}_t(m_{t+1}, r_{t+1}^X)$. Substituting for m_{t+1} we find that

$$\mathbb{C}\mathbb{V}_t(m_{t+1}, r_{t+1}^X) = \gamma_t \mathbb{C}\mathbb{V}_t(c_{t+1}^T, r_{t+1}^X) + (1 - \gamma_t) \mathbb{C}\mathbb{V}_t(q_{t+1}^N + c_{t+1}^N, r_{t+1}^X), \quad (36)$$

where

$$\gamma_t \equiv \mathbb{E}_t \left[\left\{ 1 + \frac{\lambda_N}{\lambda_T} (Q_{t+1}^N)^{\frac{\phi}{\phi-1}} \right\}^{-1} \right].$$

Thus, $\mathbb{C}\mathbb{V}_t(m_{t+1}, r_{t+1}^X)$ is a weighed average of two covariances: the covariance between the log equity return and the log tradable consumption c_{t+1}^T , and covariance between the log equity return and log nontradable consumption measured in terms of tradables, $q_{t+1}^N + c_{t+1}^N$. In principle, both covariances can change as productivity shocks hit the economy, but in practice most of the variation in $\mathbb{C}\mathbb{V}_t(m_{t+1}, r_{t+1}^X)$ come through changes in γ_t . Recall from Figure 5 that productivity shocks have an immediate and long-lasting effects on the relative price of nontraded goods, Q_t^N . Furthermore, we saw that productive shocks in the traded sector induce different responses in Q_t^N in the FA, PI and FI regimes. These responses account for most of the differences in the dynamics of conditional second moments across different levels financial integration, which are ultimately reflected in the behavior of expected excess returns, portfolio allocations, and capital flows.

4.4 Asset Price Differentials

We can also use our model to study how integration affects the behavior of equity price differentials. This analysis provides a theoretical perspective on the large empirical literature that uses the behavior of asset prices as a metric for measuring the degree of financial integration between countries (see, e.g., Karolyi (2002), Hunter (2005), and Levy Yeyati, Schmukler, and Van Horen (2006)).

Recall that in equilibrium the price of equity for H and F firms producing traded goods, P_t^T and $\hat{P}_t^T$ satisfy

$$P_t^T = \mathbb{E}_t [M_{t+1}(P_{t+1}^T + D_{t+1}^T)] \text{ and } \hat{P}_t^T = \mathbb{E}_t [\hat{M}_{t+1}(\hat{P}_{t+1}^T + \hat{D}_{t+1}^T)]. \quad (37)$$

Notice that these expressions are based on households' first order conditions and hold true in the FA, PI and FI equilibria we study. They imply that cross-country differences in the price of T equity can arise from either differences in the dividends paid out by H and F firms, D_t^T and $\hat{D}_t^T$, and/or differences in the IMRS of H and F households. To differentiate between these sources, it is useful to consider the price of a claim to the stream of dividends paid by F firms, $\hat{D}_t^T$, valued with the H IMRS, M_{t+1} . This security has the features

of an American Depositary Receipt (ADR). In equilibrium, the price of this claim must satisfy

$$\tilde{P}_t^T = \mathbb{E}_t \left[M_{t+1} (\tilde{P}_{t+1}^T + \hat{D}_{t+1}^T) \right]. \quad (38)$$

The price differential between P_t^T and $\tilde{P}_t^T$ reflect differences in how H households value the dividend streams of H and F firms. Similarly, cross-country differences in the IMRS will be reflected in the price differential between $\hat{P}_t^T$ and $\tilde{P}_t^T$.

Table 8 reports statistics on the price differential between $\hat{P}_t^T$ and $\tilde{P}_t^T$ across the FA, PI and FI equilibria. As the economy moves from FA to PI both the average price differential and its volatility decline dramatically. Recall that T equity is only held domestically in the PI equilibrium, so all the change in the price differential reflects the effects of greater international risk-sharing on M_{t+1} and $\hat{M}_{t+1}$ facilitated via trade in international bonds. Under FI, all households can hold T equity issued by both H and F firms. Under these circumstances, optimal portfolio choice by H households requires that $\hat{P}_t^T = \mathbb{E}_t[M_{t+1}(\hat{P}_{t+1}^T + \hat{D}_{t+1}^T)]$, so $\hat{P}_t^T$ must equal $\tilde{P}_t^T$ and the price differential disappears. This is clearly reflected by the statistics in the right hand column of the table.

	Table 8: T Equity Price Differentials (quarterly, percent)		
	Autarky	Partial Integration	Full Integration
	(i)	(ii)	(iii)
mean	0.06	0.00	0.00
std.	1.25	0.12	0.00
min	-4.87	-0.67	0.00
max	4.72	1.96	0.00
mean abs	0.99	0.05	0.00

We can also use the price of ADRs to study the components of realized return differentials. By definition the return differential on the T equity issued by H and F firms can be written as

$$r_t^T - \hat{r}_t^T = (r_t^T - \tilde{r}_t^T) + (\tilde{r}_t^T - \hat{r}_t^T), \quad (39)$$

where $\hat{r}_t^T$ is the log return on an ADR defined as $\ln(\tilde{P}_t^T + \hat{D}_t^T) - \ln \tilde{P}_{t-1}^T$. The first term on the right identifies the effects of cross-country differences in the dividends D_t^T and $\hat{D}_t^T$. Realized equity returns in our model are predominantly driven by unexpected changes in equity prices (rather than changes in the risk free rate or risk premia). This means that $r_t^T - \tilde{r}_t^T$ will reflect news concerning differences in the future path of T dividends across countries. Similarly, news concerning cross-country differences in the future IMRS will be reflected in $\tilde{r}_t^T - \hat{r}_t^T$. To measure these contributions, we multiply both sides of (39) by $r_t^T - \hat{r}_t^T$ and take expectations to give

$$\mathbb{V}(r_{t+1}^T - \hat{r}_{t+1}^T) = \mathbb{C}\mathbb{V}(r_{t+1}^T - \tilde{r}_{t+1}^T, r_{t+1}^T - \hat{r}_{t+1}^T) + \mathbb{C}\mathbb{V}(\tilde{r}_{t+1}^T - \hat{r}_{t+1}^T, r_{t+1}^T - \hat{r}_{t+1}^T). \quad (40)$$

Table 9 presents components of the decomposition in (40) computed as fractions of $\mathbb{V}(r_{t+1}^T - \hat{r}_{t+1}^T)$ from simulations of the FA, PI and FI equilibria. The first row of the table shows that the volatility of the

return differential declines as soon as there is any financial integration. Notice, also, that the volatility does not disappear entirely under FI. This reflects the fact that the equity issued by H and F firms producing traded goods represent claims to different streams of dividends. The bottom two rows of the table show how cross-country differences in dividends and the IMRS contribute to the volatility of the return differential. Approximately 2/3 of the volatility is attributable to differences in the IMRS and 1/3 to differences in dividends under FA. By contrast, under both PI and FI, the volatility of the return differential is almost completely attributable to differences in the dividend process.

Table 9: Volatility Decomposition of Return Differentials			
	Autarky (i)	Partial Integration (ii)	Full Integration (iii)
$\text{Std}(r_{t+1}^T - \hat{r}_{t+1}^T)$ (annual %)	81.06	32.64	32.64
Volatility Shares			
Dividends	0.357	0.997	0.998
IMRS	0.643	0.003	0.002

Table 9 shows that the behavior of the return differentials is almost identical in the PI and FI equilibria. This result may seem surprising at first sight because the equilibria are not equivalent in terms of risk sharing. Nevertheless, the intuition for the result is straightforward: unexpected changes in equity prices account for almost all the variation in realized returns. This means that news concerning the future path of dividends and/or expected future returns account for most of the variation in the return differentials. In the PI and FI equilibria, news about future dividends dominates news concerning future expected returns. And, since the dividend policies followed by T firms are largely the same in the PI and FI equilibria, the behavior of the return differentials remains largely unchanged as we move from PI to FI.

5 Conclusion

The goal of this paper is to study how international financial integration affects the behavior of international capital flows and asset prices. We examine the effects of greater financial integration through the lens of an international business cycles model with traded and non-traded sectors. We extend the model to allow for trade in international bonds and equities and consider three financial configurations: FA, PI and FI. While such models have been used extensively in the study of international business cycles, their fit for financial variables, such as capital flows and asset returns is far less understood. We provide such an evaluation. Our findings suggest that at the early stages of financial integration international capital flows are large (in absolute value) and volatile. When households gain access to foreign equity markets, the size and volatility of international bond flows falls, although the model underpredicts the size of the decline relative to the data. While the integration of world equity markets facilitates greater risk-sharing in our model, it leaves markets incomplete with the result that productivity shocks induce significant international capital flows.

Our model also predicts that volatility of bond and equity returns should decline with integration, in line with the data for the G-7 countries. However, the model has hard time reproducing the high volatility of asset returns in the data. The model also provides theoretical guidance on the appropriate way to measure the degree of financial integration. In particular, we find that as integration rises global risk factors become

more important in determining excess equity returns. We also find the equity price differentials using ADRs can be used as reliable measures of financial integration. This finding is consistent with the intuition behind the recent empirical literature examining international financial integration.

Overall, we interpret these results as encouraging to the use of international business cycle models in the study of international capital flows and asset returns. Such models show some quantitative success (in matching characteristics of capital flows), and are qualitatively consistent with stylized facts on asset returns and effects of integration on capital flows and returns. Improving the quantitative fit to the latter would constitute an interesting research agenda for the future work.

References

- ADJAOUTE, K., AND J.-P. DANTHINE (2003): “European Financial Integration and Equity Returns: A Theory-Based Assessment,” FAME Research Paper Series rp84, International Center for Financial Asset Management and Engineering.
- ALBUQUERQUE, R., N. LOAYZA, AND L. SERVEN (2005): “World market integration through the lens of foreign direct investors,” *Journal of International Economics*, 66(2), 267–295.
- BACCHETTA, P., AND E. VAN WINCOOP (2000): “Trade in Nominal Assets and Net International Capital Flows,” *Journal of International Money and Finance*, 19(1), 55–72.
- BACKUS, D., P. J. KEHOE, AND F. E. KYDLAND (1995): “International Business Cycles: Theory and Evidence,” in *Frontiers of Business Cycle Research*, ed. by T. F. Cooley, pp. 331–356. Princeton University Press, Princeton.
- BACKUS, D. K., P. J. KEHOE, AND F. E. KYDLAND (1992): “International Real Business Cycles,” *Journal of Political Economy*, 100(4), 745–75.
- BACKUS, D. K., AND G. W. SMITH (1993): “Consumption and Real Exchange Rates in Dynamic Economies with Non-traded Goods,” *Journal of International Economics*, 35(3-4), 297–316.
- BAXTER, M., AND M. J. CRUCINI (1995): “Business Cycles and the Asset Structure of Foreign Trade,” *International Economic Review*, 36(4), 821–854.
- BEKAERT, G., AND C. R. HARVEY (1995): “Time-Varying World Market Integration,” *Journal of Finance*, 50(2), 403–44.
- BEKAERT, G., AND C. R. HARVEY (1997): “Emerging equity market volatility,” *Journal of Financial Economics*, 43(1), 29–77.
- (2000): “Foreign Speculators and Emerging Equity Markets,” *Journal of Finance*, 55(2), 565–613.
- BEKAERT, G., C. R. HARVEY, AND R. L. LUMSDAINE (2002a): “Dating the integration of world equity markets,” *Journal of Financial Economics*, 65(2), 203–247.
- BEKAERT, G., C. R. HARVEY, AND R. L. LUMSDAINE (2002b): “The dynamics of emerging market equity flows,” *Journal of International Money and Finance*, 21(3), 295–350.

- BOHN, H., AND L. L. TESAR (1996): “U.S. Investment in Foreign Markets: Portfolio Rebalancing or Return Chasing?,” *American Economic Review, Papers and Proceedings*, 86(2), 77–81.
- BUCH, C. M., AND C. PIERDZIOCH (2005): “The integration of imperfect financial markets: Implications for business cycle volatility,” *Journal of Policy Modeling*, 27(7), 789–804.
- CAMPBELL, J., AND J. COCHRANE (1999): “By force of habit: A consumption-based explanation of aggregate stock market behavior,” *Journal of political Economy*, 107(2), 205–251.
- CAMPBELL, J. Y., Y. L. CHAN, AND L. M. VICEIRA (2003): “A Multivariate Model of Strategic Asset Allocation,” *Journal of Financial Economics*, 67(1), 41–80.
- CHAN, K. C., G. A. KAROLYI, AND R. STULZ (1992): “Global financial markets and the risk premium on U.S. equity,” *Journal of Financial Economics*, 32(2), 137–167.
- COEURDACIER, N., AND P.-O. GOURINCHAS (2008): “When Bonds Matter: Home Bias in Goods and Assets,” Working Paper Series 2008-25, Federal Reserve Bank of San Francisco.
- COEURDACIER, N., R. KOLLMANN, AND P. MARTIN (2010): “International portfolios, capital accumulation and foreign assets dynamics,” *Journal of International Economics*, 80(1), 100–112.
- CORSETTI, G., L. DEDOLA, AND S. LEDUC (2008): “International Risk Sharing and the Transmission of Productivity Shocks,” *Review of Economic Studies*, 75(2), 443–473.
- DEVEREUX, M. B., AND A. SUTHERLAND (2008): “Country Portfolios in Open Economy Macro Models,” NBER Working Paper 14372, National Bureau of Economic Research, Inc.
- (2010): “Country portfolio dynamics,” *Journal of Economic Dynamics and Control*, 34(7), 1325 – 1342.
- DIDIER, T., AND A. LOWENKRON (2009): “The current account as a dynamic portfolio choice problem,” Policy Research Working Paper Series 4861, The World Bank.
- DUMAS, B., AND B. SOLNIK (1995): “The World Price of Foreign Exchange Risk,” *Journal of Finance*, 50(2), 445–79.
- ENGEL, C., AND A. MATSUMOTO (2009): “The International Diversification Puzzle When Goods Prices Are Sticky: It’s Really about Exchange-Rate Hedging, Not Equity Portfolios,” *American Economic Journal: Macroeconomics*, 1(2), 155–88.
- ERRUNZA, V., E. LOSQ, AND P. PADMANABHAN (1992): “Tests of integration, mild segmentation and segmentation hypotheses,” *Journal of Banking & Finance*, 16(5), 949–972.
- EVANS, M. D., AND V. V. HNATKOVSKA (2007): “Financial Integration, Macroeconomic Volatility, and Welfare,” *Journal of the European Economic Association*, 5(2-3), 500–508.
- EVANS, M. D. D., AND V. V. HNATKOVSKA (2012): “A Method for Solving General Equilibrium Models with Incomplete Markets and Many Financial Assets,” *Journal of Economic Dynamics and Control*, forthcoming.

- FRATZSCHER, M. (2002): “Financial Market Integration in Europe: On the Effects of EMU on Stock Markets,” *International Journal of Finance & Economics*, 7(3), 165–93.
- FROOT, K. A., P. G. J. O’CONNELL, AND M. S. SEASHOLES (2001): “The portfolio flows of international investors,” *Journal of Financial Economics*, 59(2), 151–193.
- FROOT, K. A., AND M. TEO (2004): “Equity Style Returns and Institutional Investor Flows,” NBER Working Papers 10355, National Bureau of Economic Research, Inc.
- GRIFFIN, J. M., AND A. G. KAROLYI (1998): “Another look at the role of the industrial structure of markets for international diversification strategies¹,” *Journal of Financial Economics*, 50(3), 351–373.
- HARDOUVELIS, G. A., D. MALLIAROPULOS, AND R. PRIESTLEY (2006): “EMU and European Stock Market Integration,” *Journal of Business*, 79(1), 365–392.
- HAU, H., AND H. REY (2004): “Can Portfolio Rebalancing Explain the Dynamics of Equity Returns, Equity Flows, and Exchange Rates?,” *American Economic Review*, 94(2), 126–133.
- HAU, H., AND H. REY (2006): “Exchange Rates, Equity Prices, and Capital Flows,” *Review of Financial Studies*, 19(1), 273–317.
- HEATHCOTE, J., AND F. PERRI (2002): “Financial autarky and international business cycles,” *Journal of Monetary Economics*, 49(3), 601–627.
- HENRY, P. B. (2000): “Stock Market Liberalization, Economic Reform, and Emerging Market Equity Prices,” *Journal of Finance*, 55(2), 529–564.
- HESTON, S. L., AND K. G. ROUWENHORST (1994): “Does industrial structure explain the benefits of international diversification?,” *Journal of Financial Economics*, 36(1), 3–27.
- HESTON, S. L., K. G. ROUWENHORST, AND R. E. WESSELS (1995): “The structure of international stock returns and the integration of capital markets,” *Journal of Empirical Finance*, 2(3), 173–197.
- HUNTER, D. M. (2005): “What Drives Time Variation In Emerging Market Segmentation?,” *Journal of Financial Research*, 28(2), 261–280.
- JUDD, K. L. (1992): “Projection Methods for Solving Aggregate Growth Models,” *Journal of Economic Theory*, 58(2), 410–452.
- KAROLYI, A. G. (2002): “The Role of ADRs in the Development and Integration of Emerging Equity Markets,” Working papers, Ohio State University.
- KAZIMOV, K. (2010): “Comparing Methods for Solving GE Models with Portfolio Choice,” manuscript, Georgetown University.
- KOLLMANN, R. (1995): “Consumption, Real Exchange Rates and the Structure of International Asset Markets,” *Journal of International Money and Finance*, 14(2), 191–211.

- (1996): “Incomplete Asset Markets and the Cross-Country Consumption Correlation Puzzle,” *Journal of Economic Dynamics and Control*, 20(5), 945–961.
- KORAJCZYK, R., AND C. VIALLET (1989): “An Empirical Investigation of International Asset Pricing,” *Review of Financial Studies*, 2(4), 553–585.
- KRAAY, A., AND J. VENTURA (2003): “Current Accounts in the Long and Short Run,” *NBER Macro Annual*.
- LEVY YEYATI, E., S. L. SCHMUKLER, AND N. VAN HOREN (2006): “International financial integration through the law of one price,” Policy Research Working Paper Series 3897, The World Bank.
- MARTIN, P., AND H. REY (2000): “Financial integration and asset returns,” *European Economic Review*, 44(7), 1327–1350.
- OBSTFELD, M. (1994): “Risk-Taking, Global Diversification, and Growth,” *American Economic Review*, 84(5), 1310–29.
- PAVLOVA, A., AND R. RIGOBON (2010): “Equilibrium Portfolios and External Adjustment under Incomplete Markets,” Working paper series, London Business School.
- ROUWENHORST, K. (1999): “European equity markets and the EMU,” *Financial Analysts Journal*, pp. 57–64.
- SENAY, O. (1998): “The Effects of Goods and Financial Market Integration on Macroeconomic Volatility,” *The Manchester School of Economic & Social Studies*, 66(0), 39–61.
- STOCKMAN, A. C., AND L. L. TESAR (1995): “Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements,” *American Economic Review*, 85(1), 168–185.
- STULZ, R. M. (1999): “International Portfolio Flows and Security Markets,” Discussion paper.
- SUTHERLAND, A. (1996): “Financial Market Integration and Macroeconomic Volatility,” *Scandinavian Journal of Economics*, 98(4), 521–39.
- TILLE, C., AND E. VAN WINCOOP (2010): “International Capital Flows,” *Journal of International Economics*, 80(2), 157–175.

A Appendix

A.1 Data sources for G-7 countries

Our data for portfolio flows consists of both equity and debt outflows (net purchases of foreign assets by a given domestic economy) and inflows (net purchases of domestic assets by foreigners). The data on portfolio flows comes from the International Financial Statistics (IFS) database compiled by the IMF. All flows are measured in US dollars and are scaled by the GDP of their respective economies.

We compute equity returns using quarterly Morgan Stanley MSCI Global Equity Indices.²³ Bond returns are measured by the interest rate on 3-month T-bills obtained from the IFS database. All returns are annualized.

A.2 Approximations

The equilibrium conditions include equations (6), (7) and (19a)-(19e) characterizing household's behavior, equation (24) describing firm's problem at H country, a symmetric system of conditions for the F country, a set of market clearing conditions in equations (10)-(12) and (16)-(18b), plus return definitions in (20)-(22). The system is summarized below.

$$\begin{aligned}
R_{t+1}^W &= R_t + \alpha_t^T (R_{t+1}^T - R_t) + \alpha_t^{\hat{T}} (R_{t+1}^{\hat{T}} - R_t) + \alpha_t^N (R_{t+1}^N - R_t), \\
W_{t+1} &= R_{t+1}^W (W_t - C_t^T - Q_t^N C_t^N), \\
Q_t^N &= \left(\frac{\lambda_N}{\lambda_T} \right)^{1-\phi} \left(\frac{C_t^N}{C_t^T} \right)^{\phi-1}, \\
1 &= \mathbb{E}_t [M_{t+1} R_t], \\
1 &= \mathbb{E}_t [M_{t+1} R_{t+1}^T], \\
1 &= \mathbb{E}_t [M_{t+1} R_{t+1}^{\hat{T}}], \\
1 &= \mathbb{E}_t [M_{t+1} R_{t+1}^N],
\end{aligned} \tag{A1}$$

²³This data is available from <http://www.msci.com/products/indices/>

$$\begin{aligned}
M_{t+1} &= \beta \left(\frac{C_t^T + Q_t^N C_t^N}{C_{t+1}^T + Q_{t+1}^N C_{t+1}^N} \right), \\
K_{t+1}^T &= (1 - \delta) K_t^T + e^{z_t^T} K_t^{T\theta} - D_t^T, \\
1 &= \mathbb{E}_t \left[M_{t+1} \left(\theta Z_{t+1}^T (K_{t+1})^{\theta-1} + (1 - \delta) \right) \right], \\
C_t^N &= Y_t^N = D_t^N, \\
C_t^T + \hat{C}_t^T &= Y_t^T + \hat{Y}_t^T - I_t - \hat{I}_t, \\
1 &= A_t^T + \hat{A}_t^T, \\
1 &= A_t^N, \\
B_t + \hat{B}_t &= 0,
\end{aligned} \tag{A2}$$

An analogous set of conditions applies for the foreign country.

To solve the model, we first find its non-stochastic steady state. The system of equilibrium equations is then log-linearized as follows. The equations pertinent to the real side of the model are log-linearized up to the first order, while those related to the financial side are log-linearized up to the second order. Real variables, such as capital, dividends, etc. are stationary around their steady state. Individual's financial wealth is linearized around its initial distribution (see below). Consumption and portfolio shares are pinned down endogenously by the model.

Let all small letters denote log transformation of the corresponding variable, measured as deviation from the steady state or its initial level. The log return on H wealth is approximated as

$$r_{t+1}^w = r_t + \alpha_t' \epsilon_{t+1} + \frac{1}{2} \alpha_t' (\sigma_t^2 - \Sigma_t \alpha_t). \tag{A3}$$

Campbell, Chan, and Viceira (2003) show that this approximation holds exactly in continuous time and remains a good approximation in discrete formulation with short time intervals.

The budget constraint of the H household in (6) can be simplified when preferences are logarithmic. In particular, the optimal consumption-wealth ratio under log-utility preferences is constant and is equal to $(1 - \beta)$ so $C_t^T + Q_t^N C_t^N = (1 - \beta) W_t$. The simplified budget constraint then becomes

$$W_{t+1} = R_{t+1}^w (W_t - C_t^T - Q_t^N C_t^N) = \beta R_{t+1}^w W_t,$$

whose log-linearized form is

$$\Delta w_{t+1} = r_{t+1}^w + \ln \beta. \tag{A4}$$

Next, we turn to the IMRS. By definition,

$$M_{t+1} = \frac{\beta (\partial U / \partial C_{t+1}^T)}{(\partial U / \partial C_t^T)} = \beta \left(\frac{C_t^T + Q_t^N C_t^N}{C_{t+1}^T + Q_{t+1}^N C_{t+1}^N} \right),$$

which can be simplified further with log preferences to

$$M_{t+1} = \beta \frac{W_t}{W_{t+1}},$$

or in logs

$$m_{t+1} = -\Delta w_{t+1} + \ln \beta.$$

The Euler equations are linearized using standard log-normal (second-order) approximations. We start with the consumption Euler equation in (19a):

$$1 = \mathbb{E}_t [\exp(m_{t+1} + r_t)] \simeq \exp \left[\mathbb{E}_t (m_{t+1} + r_t) + \frac{1}{2} \mathbb{V}_t (m_{t+1}) \right].$$

Taking logs on both side yields a log-linearized Euler equation for the international bond:

$$0 = r_t + \mathbb{E}_t m_{t+1} + \frac{1}{2} \mathbb{V}_t (m_{t+1}). \quad (\text{A5})$$

The equity Euler equations are log-linearized analogously:

$$1 = \mathbb{E}_t [M_{t+1} R_{t+1}^X] \simeq \exp \left[\mathbb{E}_t (m_{t+1} + r_{t+1}^X) + \frac{1}{2} \mathbb{V}_t (m_{t+1} + r_{t+1}^X) \right].$$

Again, taking logs and substituting in the bond Euler equation gives:

$$\mathbb{E}_t r_{t+1}^X - r_t + \frac{1}{2} \mathbb{V}_t (r_{t+1}^X) = -\mathbb{C} \mathbb{V}_t (m_{t+1}, r_{t+1}^X). \quad (\text{A6})$$

The system (19b)-(19e) can be summarized in terms of portfolio shares α_t and first and second moments of asset returns as

$$\mathbb{E}_t e r_{t+1} = \Sigma_t \alpha_t - \frac{1}{2} \text{diag}(\Sigma_t). \quad (\text{A7})$$

Using this equation, the budget constraint in (A4) can be rewritten as:

$$\Delta w_{t+1} = r_t + \frac{1}{2} \alpha_t' \Sigma_t \alpha_t + \alpha_t' (e r_{t+1} - \mathbb{E}_t e r_{t+1}). \quad (\text{A8})$$

The optimal dividend policy of domestic firm implies

$$1 = \mathbb{E}_t \left[M_{t+1} \left(\theta Z_{t+1}^\top (K_{t+1})^{\theta-1} + (1 - \delta) \right) \right].$$

Again, we apply the log-normal approximation to get

$$\mathbb{E}_t r_{t+1}^k - r_t + \frac{1}{2} \mathbb{V}_t (r_{t+1}^k) = -\mathbb{C} \mathbb{V}_t (m_{t+1}, r_{t+1}^k), \quad (\text{A9})$$

where $r_{t+1}^k = \psi z_{t+1}^\top - (1 - \theta) \psi k_{t+1}$ and $\psi = 1 - \beta(1 - \delta)$.

Next, we turn to the market clearing conditions. Bond market clearing from (16) requires $B_t + \hat{B}_t = 0$. Substituting for bonds from (26) into this condition gives

$$\beta (W_t + \hat{W}_t) = (P_t^\top + \hat{P}_t^\top) + (Q_t^N P_t^N + \hat{Q}_t^N \hat{P}_t^N).$$

In addition, since each aggregate consumption is a constant fraction of wealth, the same relation holds at the global level

$$(1 - \beta) (W_t + \hat{W}_t) = (C_t^\top + \hat{C}_t^\top) + (Q_t^N C_t^N + \hat{Q}_t^N \hat{C}_t^N).$$

Combining the last two equations gives

$$(1 - \beta) \left[\left(P_t^T + \hat{P}_t^T \right) + \left(Q_t^N P_t^N + \hat{Q}_t^N \hat{P}_t^N \right) \right] = \beta \left[\left(C_t^T + \hat{C}_t^T \right) + \left(Q_t^N C_t^N + \hat{Q}_t^N \hat{C}_t^N \right) \right].$$

The linearized version of this expression is

$$\begin{aligned} & \frac{\left\{ P^T p_t^T + \hat{P}^T \hat{p}_t^T + Q^N P^N (q_t^N + p_t^N) + \hat{Q}^N \hat{P}^N (\hat{q}_t^N + \hat{p}_t^N) \right\}}{\left(P^T + \hat{P}^T \right) + \left(Q^N P^N + \hat{Q}^N \hat{P}^N \right)} \\ &= \frac{\left\{ D^T d_t^T + \hat{D}^T \hat{d}_t^T + Q^N D^N (q_t^N + d_t^N) + \hat{Q}^N \hat{D}^N (\hat{q}_t^N + \hat{d}_t^N) \right\}}{\left(D^T + \hat{D}^T \right) + \left(Q^N D^N + \hat{Q}^N \hat{D}^N \right)}, \end{aligned} \quad (\text{A10})$$

where we have also applied the T and N goods market clearing conditions. Here capital letters with no time subscripts denote non-stochastic steady state values of the corresponding variables. We adopt the same notation below.

Market clearing in the T equity market requires $1 = A_t^T + \hat{A}_t^T$. Substituting for A_t^T and $\hat{A}_t^T$ in terms of portfolio shares α_t from (26) we obtain

$$\exp(p_t^T - w_t - \ln \beta) = \alpha_t^T + \hat{\alpha}_t^T \cdot \exp(\hat{w}_t - w_t).$$

Approximation of the exponential terms on both sides is done around the aggregate steady state share of T equity issued in H country, $\bar{\alpha}^T = \alpha^T + \hat{\alpha}^T$. In a symmetric parametrization this share is equal to half of H country wealth. The other half is allocated into N equity. This split is determined by the preference parameters on T and N consumption and the assumption of an equal initial distribution of wealth across countries. Notice that this approximation point does not require knowledge of the individual portfolio shares in H and F wealth allocated into T equity issued by H country. Rather, we only need to know the aggregate share of such equity held by H and F households jointly. This simplification arises naturally in the model with equal initial wealth distribution. In the robustness section below, when we consider unequal initial wealth distribution as an approximation point, we must adjust the approximation point in the equation above for the relative initial wealth in the two countries.

The approximate version of equation above is:

$$\frac{P^T}{\beta W} + \frac{P^T}{\beta W} (p_t^T - w_t) + \frac{1}{2} \frac{P^T}{\beta W} (p_t^T - w_t)^2 = \alpha_t^T + \hat{\alpha}_t^T \left(\frac{\hat{W}}{W} + \frac{\hat{W}}{W} (\hat{w}_t - w_t) + \frac{1}{2} \frac{\hat{W}}{W} (\hat{w}_t - w_t)^2 \right),$$

which, under the assumption of equal initial wealth distribution (i.e. $\frac{\hat{W}}{W} = 1$), becomes

$$\bar{\alpha}^T \left(1 + (p_t^T - w_t) + \frac{1}{2} (p_t^T - w_t)^2 \right) = \alpha_t^T + \hat{\alpha}_t^T \left(1 + (\hat{w}_t - w_t) + \frac{1}{2} (\hat{w}_t - w_t)^2 \right). \quad (\text{A11})$$

The approximation for the F country T equity market clearing is symmetric and is approximated around the

aggregate steady state share of T equity issued by the foreign country, $\bar{\alpha}^{\hat{T}} = \alpha^{\hat{T}} + \hat{\alpha}^{\hat{T}}$:

$$\bar{\alpha}^{\hat{T}} \left(1 + (\hat{p}_t^T - \hat{w}_t) + \frac{1}{2} (\hat{p}_t^T - \hat{w}_t)^2 \right) = \alpha_t^{\hat{T}} + \hat{\alpha}_t^{\hat{T}} \left(1 + (w_t - \hat{w}_t) + \frac{1}{2} (w_t - \hat{w}_t)^2 \right). \quad (\text{A12})$$

Again, note that this approximation utilizes the assumption of equal initial wealth distribution in the two countries.

In summary, the system of linearized equations used to characterize the equilibrium in full integration model consists of:

- the productivity process in (4);
- the three Euler equations for equity as given by equation (A6) for $\chi = \{T, \hat{T}, N\}$ in each country;
- the Euler equation for capital, given in (A9) for each country;
- the budget constraint in each country as given in equation (A8);
- T goods market clearing

$$c_t^T + \hat{c}_t^T = d_t^T + \hat{d}_t^T;$$

- bond market clearing reformulated in terms of dividends and prices in (A10);
- T equity market clearing as derived in (A11)-(A12);
- N equity definition from equation (26)

$$\begin{aligned} \alpha_t^N &= \bar{\alpha}^N \left(1 + (q_t^N + p_t^N - w_t) + \frac{1}{2} (q_t^N + p_t^N - w_t)^2 \right) \\ \hat{\alpha}_t^N &= \hat{\alpha}^N \left(1 + (\hat{q}_t^N + \hat{p}_t^N - \hat{w}_t) + \frac{1}{2} (\hat{q}_t^N + \hat{p}_t^N - \hat{w}_t)^2 \right). \end{aligned} \quad (\text{A13})$$

A.3 Solution Method and Robustness

A complete and detailed presentation of the solution method can be found in Evans and Hnatkovska (2012). The FI equilibrium of our model is one of the many models used in that paper to illustrate the solution method and assess its accuracy. We therefore refer to that analysis in our discussion below.

A.3.1 Accuracy

We examine the accuracy of the solution method by computing the Euler equation errors households and firms make in the approximate equilibrium of the model. Following Judd (1992), we compute these errors as a fraction of aggregate consumption so their size has an economic interpretation. These errors are very small in our solution for the FI equilibrium. On average they are about a tenth of 1 percent of consumption. This is the same level of accuracy achieved by standard solution methods in models without portfolio choice. In Evans and Hnatkovska (2012) we also compute the Euler equation errors from applying the third-order solution method proposed by Tille and van Wincoop (2010) and Devereux and Sutherland (2010) to the FI equilibrium. We find that the Euler equation errors from the equations governing portfolio choice are

considerably larger than those computed from our method, accounting for up to 1 percent of consumption. Kazimov (2010) confirms these findings in a more extensive comparison of the solution methods.

A.3.2 The Wealth Distribution

In our model, and many others with incomplete markets, real shocks have permanent effects on the wealth of individual households, so there is no well-defined long-run distribution of wealth across countries that can be used as an approximation point when computing a solution to the model. Our solution method uses an equal initial wealth distribution as the approximation point. When the model is parameterized to two symmetric economies, this implies that the approximation is performed around a symmetric non-stochastic steady state point for wealth. Our approximation, therefore, describes the equilibrium behavior of the economy in a neighborhood of that initial wealth distribution. This means that our characterization of the model's equilibrium dynamics will only remain accurate while wealth remains in the neighborhood of the initial distribution. Evans and Hnatkovska (2012) shows that this is not a concern for the FI equilibrium of our model over the simulation spans we consider. Specifically, we show that there is no economically significant change in the distribution of the Euler equation errors as the span of the simulations increases from 50 to 500 quarters. We also show that these distributions are somewhat *smaller* than those obtained from an amended version of the model with an endogenous discount factor (as in Kollmann (1996)). Since there is a well-defined long-run wealth distribution in the amended model (equal to the initial distribution in the original model), our solution method appears to work well over the simulation span of 400 quarters we use to derive our results in the text.

A.3.3 Robustness

In the text we report results based on the assumption that the initial wealth distribution is equal across countries. To check the robustness of our results, we considered an alternative solution to the model based on the relative wealth of country F to H equal to 1.00218. This wealth distribution implies an initial current account deficit for country H equal to 4% of GDP. Re-solving the model with this initial wealth distribution (and the other model parameters unchanged) does not materially affect the model solution. In particular, the dynamics of international capital flows and returns are similar to those we report in the text.

Our model parametrization assumes that the two countries are perfectly symmetric in terms of preferences, production and shocks. As a result, the model predicts that investors take fully diversified positions in T equity shares. This prediction is, however, at odds with the persistent equity home bias observed in the actual portfolio holdings of most developed countries. In our next robustness check we study the effects of integration on capital flow dynamics in the presence of home bias in equity portfolios.

For this purpose we assume that the share parameters λ_N and $\hat{\lambda}_N$ in the utility function increase to 0.75. When households put more weight on N consumption in their utility function, they also increase the share of their wealth allocated into equity providing claims to N consumption, thus leading to the home bias in aggregate domestic portfolios. In particular, the average N equity share in both H and F countries is equal to 81.53% under the new parametrization. The remaining wealth is allocated into T equity, which, under FI is equally split between H and F issued claims. As a result, even though the model generates home bias through an increase in the share of N equity, the T equity holdings remain fully diversified. We find that the

degree of risk sharing under FI is smaller in this version of the model: the cross-country correlation in log IMRS is now 0.562 rather than 0.669. The size and volatility of both bond and equity flows are higher than in our benchmark case, under FI. By contrast, the size and volatility of bond flows under PI remain much the same.