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Foreign direct investment over the international business cycle

Alexander McQuoid, Jacek Rothert, and Katherine Smith

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Alexander McQuoid
U.S. Naval Academy

Jacek Rothert
U.S. Naval Academy
and FAME|GRAPE

Katherine Smith
U.S. Naval Academy

Abstract

Among the G7 economies gross foreign direct investment (FDI) positions are very large, averaging 100% of GDP and dwarfing the absolute values of net FDI positions in most countries. Additionally, inward and outward FDI flows exhibit robust, positive correlation over the business cycle. In the standard international business cycle (IBC) model gross FDI stocks and flows are not well defined, and only net flows matter. We extend the standard model by allowing domestic and foreign ownership of physical capital in the aggregate production function to be imperfect substitutes. We estimate that elasticity of substitution using the co-movement of gross FDI flows, and find it to be less than 2.5 – a value much smaller than the implicitly assumed infinity in the IBC literature. Our results uncover a new source of welfare gains from openness to FDI among otherwise identical, developed economies – a capital diversity channel, akin to product variety in trade models. The channel is quantitatively important – openness to FDI yields steady-state welfare gains equivalent to at least a 4-5% increase in life-time consumption.

Keywords:

FDI, risk-sharing, international financial integration, international business cycles, BKK puzzle, Feldstein-Horioka puzzle

JEL Classification

E, F

Corresponding author

Jacek Rothert, jacek.rothert@gmail.com

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Foundation of Admirers and Mavens of Economics
ull. Mazowiecka 11/14
00-052 Warszaw
Poland

W | grape.org.pl
E | grape@grape.org.pl
TT | GRAPE_ORG
FB | GRAPE.ORG
PH | +48 799 012 202

1 Introduction

Over the last 40 years, *gross* Foreign Direct Investment (FDI) assets and liabilities of the G7 economies have more than quadrupled, exceeding 100% of gross domestic product in 2020. This is roughly twice the ratio of *total* net international investment position to GDP in the United States, Japan, or China (in absolute terms), that spurred a huge literature on global imbalances[1], and is at the heart of many puzzles in international capital flows.[2] Additionally, the gross FDI inflows and outflows, at a country level, are positively correlated over the business cycle. Yet, the vast majority of the international business cycle literature[3] has no prediction about the behavior of gross FDI stocks and flows. In this paper we fill that gap by documenting the magnitude and cyclical behavior of these gross flows and by providing a theoretical model to explain these empirical findings.

First, we document stylized facts on the magnitude and cyclical behavior of gross and net FDI positions among the G7 economies. We find that gross FDI equity positions are very large, dwarfing net FDI positions in most countries, accounting for about 25% of total gross investment positions [4]. Over the last ten years, the ratio of FDI positions relative to GDP has averaged 1.07. Absolute values of net FDI positions are much smaller, not exceeding 20% of GDP in most countries (the average being 17%). Additionally, FDI inflows and outflows are positively correlated over the business cycles, exhibiting a similar behavior as total capital inflows and outflows, previously

[1] Edwards (2005), Obstfeld and Rogoff (2005), Caballero et al. (2008), or Mendoza et al. (2009) are a few examples.

[2] Feldstein and Horioka (1980) document positive co-movement of savings and investment rates, which relies on the limited adjustment of the current account (i.e., net capital outflows) to the domestic investment demand or savings supply shocks. Lucas (1990) shows that, contrary to the predictions of economic theory, capital scarce poor countries are not receiving large enough net inflows from capital abundant rich countries. Gourinchas and Jeanne (2013) show that total net capital inflows lack clear positive correlation with TFP growth . Finally, Rothert (2016) and Rothert and Short (2022) show that the empirical net capital flows are very small, relative to the predictions of the neo-classical growth model.

[3] Backus et al. (1992), Backus et al. (1994), and *numerous* papers that followed.

[4] The remaining 25% and 50% are accounted for by portfolio equity and by debt investment positions, respectively

documented by Broner et al. (2013). On average, the unconditional correlation between inward and outward FDI is 0.470.

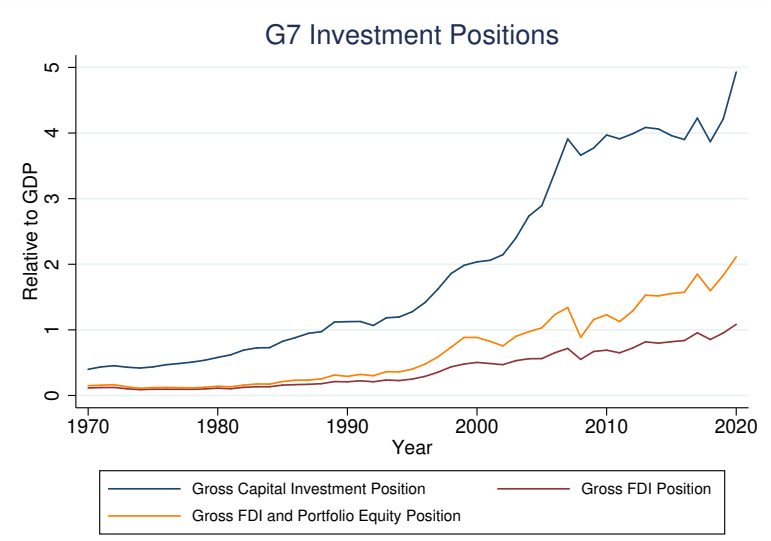


Figure 1: Gross International Investment Position - total, equity, and FDI alone (G7)

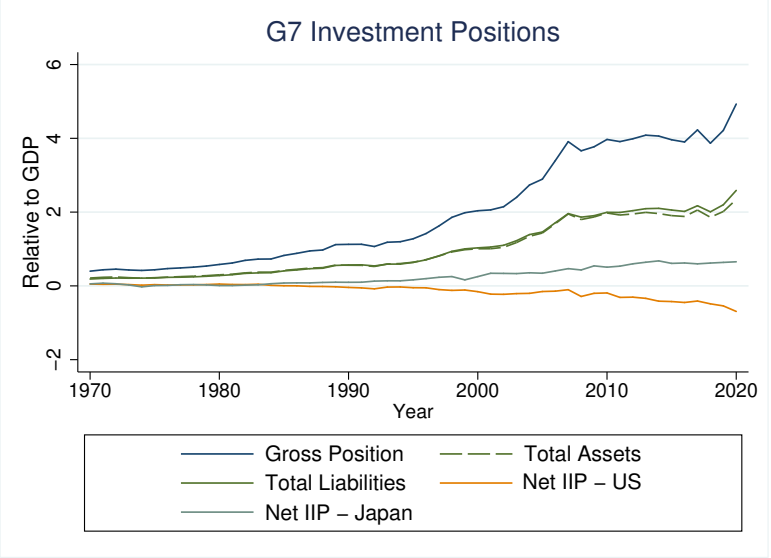


Figure 2: Gross and Net International Investment Position - G7 countries

Second, we extend the classic framework of Backus et al. (1992) (BKK henceforth) to account

for (i) large gross and small net FDI positions, (ii) the large share of FDI flows in total investment expenditures, and (iii) a positive co-movement of FDI inflows and outflows. These stylized facts suggest that, at the aggregate level, the domestic and foreign ownership of physical capital stock are not perfect substitutes. We thus proceed by relaxing the assumption of infinite elasticity of substitution of foreign and domestic capital that is implicit in all BKK-based models. This single modification allows our model to have well defined gross FDI stocks and flows.

Third, within our framework, we offer a sharp identification of that elasticity of substitution. The key identifying moment is the business cycle co-movement of *gross* FDI inflows and outflows. We find that in order for the model to replicate the positive correlation of inflows and outflows the elasticity of substitution has to be sufficiently small — we obtain an upper bound of 2.5. We also find that, as that elasticity of substitution approaches infinity (implicit value in the BKK framework and the papers that followed), the co-movement between FDI inflows and outflows approaches negative one, counterfactual to the data.

Our results uncover the existence of a new source of welfare gains from financial integration, which we dub *capital diversity*. Mechanically, the capital diversity channel acts in a manner very similar to the love for variety in trade models. Our estimate of the elasticity of substitution between domestic and foreign ownership of capital stock in the aggregate production function implies that the welfare gains from openness to FDI via the capital diversity channel alone are equivalent to at least a 5% increase in life-time consumption and could be as high as 10-15%, far exceeding the elusive gains reported by Gourinchas and Jeanne (2006), even as we ignore the gains from risk-sharing (Mendoza and Tesar, 1998; van Wincoop, 1999) or from faster convergence of capital stock

to a new steady-state (Dell'Ariccia et al., 1998; Gourinchas and Jeanne, 2006).

The rest of the paper proceeds as follows. Section 2 explains how our work relates to other papers in the field. Section 3 describes stylized facts regarding gross equity positions and flows for the G7. Section 4 provides an explanation of the theoretical model. Section 5 explains our calibration and estimation procedure and our results. Section 6 suggests some of the policy implications from capital diversity and provides concluding comments.

2 Related Literature

Our main contribution is to offer a very simple and tractable method to model gross FDI flows in the international business cycle framework, together with the identification of the key parameter - the elasticity of substitution between domestic and foreign holdings of the country's capital stock in the aggregate production function. The international business cycle literature has always paid careful attention to the international trade in assets, but most of that attention focused on the role of market incompleteness (Baxter and Crucini, 1995; Heathcote and Perri, 2002), the extent of international diversification of passive, short-term portfolio holdings (Baxter and Jermann, 1997; Heathcote and Perri, 2013, 2014), or choices between holdings safe vs. risky assets (Devereux and Sutherland, 2009; Tille and van Wincoop, 2010; Evans and Hnatkovska, 2014; Davis and van Wincoop, 2022). Many papers that looked at the behavior of capital flows focused on net flows (Colacito et al., 2018). Overall, despite numerous papers devoted to the role of international asset trade, the international business cycle literature lacks a simple, empirically identifiable framework that would account for large gross FDI ownerships and have meaningful predictions about the gross

FDI inflows and outflows.[5]

One notable exception in that literature, and the work that is in spirit closest to ours, is the model in Petrosky-Nadeau (2011). In that paper, domestic and foreign firms face frictions in their search for productive opportunities in domestic vs. foreign locations. In a sense, those search frictions can be considered a micro-foundation for the finite elasticity of substitution in the simple, CES specification that we consider. Our main advantage is the analytical simplicity, combined with a clear empirical identification of the key parameter.[6]

Our notion of capital diversity is closely related to studies by McGrattan and Prescott (2009) and by Hoxha et al. (2013). The former study and a number of subsequent papers[7] introduce a concept of intangible, technology capital, which is a non-rival capital good that can be used in multiple locations, generating very large welfare gains from openness to FDI. The latter looks at welfare effects of financial openness in developing countries when capital goods are imperfect substitutes. They find (as do we) that low elasticity of substitution translates into large welfare gains. They consider different values of the elasticity of substitution, based on a number of micro estimates (Goolsbee and Gross, 1997; Goolsbee, 2004; Chun and Mun, 2006). Our main contribution is to estimate the value of that elasticity of substitution at the macroeconomic level.

Historically, the empirical literature on capital flows focused on net flows. The three most famous puzzles in international capital flows (Feldstein-Horioka, Lucas puzzle, and the Allocation

[5] Davis and van Wincoop (2022) recently developed a theory of gross capital flows that would account for a drop in gross capital flows during a global financial crisis. Their focus is on the short-term portfolio allocation of safe and risky assets, rather than on the direct investment flows with an active participation in the production process.

[6] We discuss the possible interpretations of the imperfect elasticity of substitution in Section 4, where we describe our theoretical framework.

[7] See, e.g. McGrattan and Prescott (2009), McGrattan and Prescott (2010a), McGrattan and Prescott (2010b), and McGrattan (2020).

Puzzle) are all about net flows. Capital flows are also at the center of the literature on emerging markets. Again - the main focus is on net flows and stocks. For example, Kaminsky et al. (2005) look at the cyclical behavior of total net flows, while Smith and Valderrama (2009) try to understand the difference between net FDI vs. net debt positions. Only recently have the gross flows begun attracting well deserved attention (Contessi et al., 2013; Li and Rajan, 2015; Avdjiev et al., 2017). The seminal work by Broner et al. (2013) documented a robust, positive correlation between inward and outward *total* capital flows. We extend their work by looking separately at (i) debt flows, (ii) equity portfolio, and (iii) equity FDI flows. We find that the empirical regularities documented for total flows extend to its components, in particular to equity FDI.

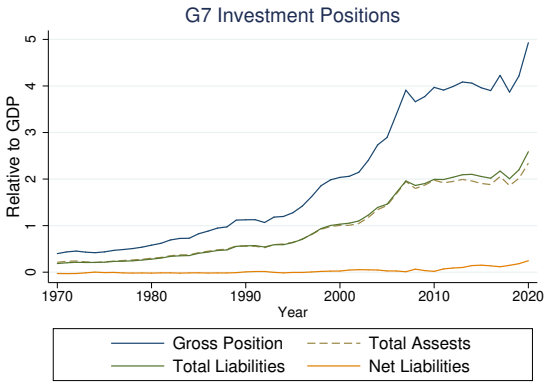
3 Gross Capital Flows over the business cycle: stylized facts

International capital integration has increased dramatically over the last five decades. This is true for both advanced economies (G7) and the rest of the world at large. Looking first at that the external capital structure for the G7, (Figure 3a) shows a dramatic increase over time of gross positions relative to GDP increasing nearly tenfold. Given growth in liabilities and assets has been roughly similar, there was far less change in net capital positions over this time period as seen in (Figure 3a). [8]

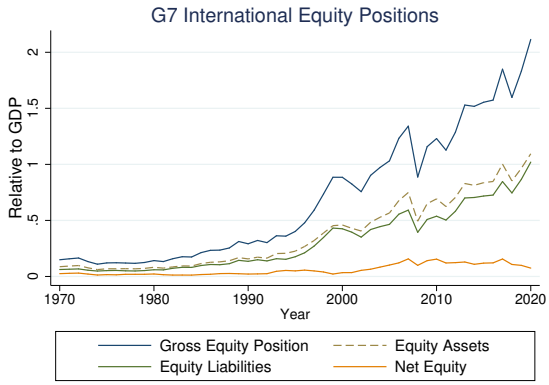
Focusing on gross equity positions, we see in Figure 3b that both assets and liabilities positions have increased tremendously, but as they have grown at similar rates, net investment positions suggest far less international capital integration. Breaking down equity positions into FDI and

[8]Figure 3a also reveals that while there was steady growth in investment positions between 1970 and the mid-2000s, trajectories become more volatile and experienced slower growth for both the G7 and the ROW between 2005 and 2015. However, the last few years has seen a resurgence in growth, with nearly a 25% increase in gross capital positions from 2010 to 2020.

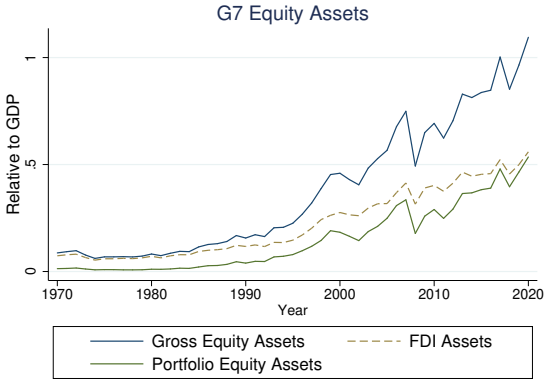
(a) G7 External Capital Relative to GDP



(b) G7 Equity Position Relative to GDP



(c) G7 Equity Assets Relative to GDP



(d) G7 Equity Liabilities Relative to GDP

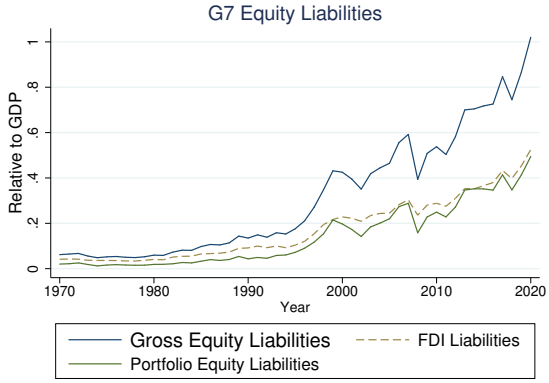


Figure 3

Note:Data is drawn from External Wealth of Nations Database (Lane and Milesi-Ferretti (2018)). In our analysis, we focus primarily on the G7 advanced economics – U.S., Germany, France, Great Britain, Italy, Canada, and Japan. We use this data to focus on the stock of international capital. External financial assets (liabilities) are claims by domestic residents (nonresidents) on nonresidents (residents).

portfolio equity (PE) investment specifically, similar patterns emerge. Figure 3c shows the evolution of FDI and PE assets collectively, for the G7. Gross equity positions have steadily increased, growing from 0.2 in 1980 to 3.2 in 2020, nearly a 16-fold increase. Equity assets are roughly the size of GDP. Likewise as evident in Figure 3d, both PE and FDI have risen dramatically. Together they are roughly the size of GDP for the G7.

With an eye towards understanding the importance of the *capital diversity channel*, we center our attention on changes in the gross equity positions and gross equity flows at the business cycle frequency. While the upward trend in financial integration is clear, there are cyclical movements observable as well. Using data from the IMF's Balance of Payments database for the G7 advanced economies, we calculate the inward and outward FDI and PE flows, broad measures of international capital movements. Results are reported in Table 1.

Table 1 provides summary statistics overall and for each decade. Each variable is measured relative to trend GDP. Gross FDI, PE, and gross FDI plus PE follow similar patterns over time. Gross FDI has a median value of 2.7% of trend GDP over the whole sample, which ranges from a low of 0.9% in the 1970s to 4.7% in the 2000s. Gross FDI flows relative to trend GDP increased by a factor of 4 compared to the 1970s. Gross PE flows averaged 3.6% over the whole sample, and grew by a factor of 10 between the 1970s and the 2020s. The combination of gross FDI and PE flows made up nearly 10% of trend GDP from 2010-2020.

Table 1 provides a similar breakdown of volatility for each type of capital flow. Gross PE flows are more volatile than gross FDI flows, and they are positively correlated, resulting in a larger standard deviation for the aggregate measure of FDI plus PE. When broken out by decades, gross

Table 1: FDI and Portfolio flows relative to GDP

1970-2020		Median	Mean	Std Dev	
Gross FDI		0.027	0.036	0.038	
Gross PE		0.036	0.050	0.054	
Gross FDI+PE		0.067	0.085	0.079	
Medians	1970s	1980s	1990s	2000s	2010s
Gross FDI	0.009	0.011	0.027	0.047	0.040
Gross PE	0.005	0.019	0.047	0.078	0.052
Gross FDI+PE	0.016	0.031	0.081	0.131	0.087
Standard Deviations	1970s	1980s	1990s	2000s	2010s
Gross FDI	0.012	0.016	0.039	0.055	0.027
Gross PE	0.009	0.023	0.045	0.072	0.042
Gross FDI+PE	0.016	0.036	0.068	0.104	0.048

Note: FDI and PE Flows are measured relative to trend GDP. Source: IMF's Balance of Payments database.

FDI flows were most volatile in the 2000s, and while volatility declined in the 2010s, gross FDI volatility has more than doubled over the last five decades. Similar patterns emerge for both gross portfolio flows as well as the combination of gross FDI and PE flows.

Table 2 looks at gross FDI flows relative to domestic investment. For all G7 countries across all years, the median value of gross FDI flows to domestic investment is 0.122, with a standard deviation of 0.194. When dis-aggregated across decades, we see a rising influence of gross FDI relative to domestic investment from the 1970s to the 2000s, increasing roughly 7-fold between the 1970s and 2000s. If we look at averages instead of medians, we see a 5-fold increase over this time period. The standard deviation goes from 0.048 in the 1970s to 0.287 in the 2000s.

The following decade shows a break in this upward trend, although the median is still about 50% higher in the 2010s when compared to the 1990s. Taken over the entire sweep of the sample, it

Table 2: FDI flows relative to Domestic Investment

		All Years	1970s	1980s	1990s	2000s	2010s
Gross FDI Flows	Median	0.122	0.034	0.047	0.123	0.216	0.192
	Mean	0.168	0.062	0.076	0.181	0.298	0.190
	Std Dev	0.194	0.048	0.065	0.202	0.287	0.134
Net FDI Flows	Median	-0.019	0.000	-0.009	-0.023	-0.042	-0.034
	Mean	-0.024	0.002	-0.014	-0.037	-0.040	-0.021
	Std Dev	0.081	0.028	0.026	0.064	0.114	0.107
FDI Inflows	Median	0.052	0.018	0.022	0.055	0.095	0.078
	Mean	0.072	0.032	0.031	0.072	0.129	0.084
	Std Dev	0.092	0.030	0.030	0.079	0.137	0.088
FDI Outflows	Median	0.063	0.021	0.032	0.065	0.134	0.115
	Mean	0.096	0.030	0.045	0.109	0.169	0.106
	Std Dev	0.117	0.025	0.040	0.127	0.170	0.083

Note: FDI flows are measured relative to gross capital formation, drawn from the World Development Indicators. Net FDI inflows are measured as inflows minus outflows. Gross FDI is measured as inflows plus outflows.

is clear that gross FDI is playing an increasingly important role as a share of domestic investment. Such dynamics are not captured when net FDI flows are used in the place of gross FDI flows (see Table 2). All told, over the five decades under consideration, gross foreign direct investment flows as a percent of domestic investment have tripled in magnitude, while the standard deviation has more than doubled.

Further, FDI outflows, FDI inflows, and gross FDI flows are all strongly pro-cyclical, while net flows have no clear trend over the business cycle. Table 3 reports correlations between ln (real GDP) and four measures of FDI flows (all as a percent of GDP). For all variables, we have taken the cyclical component after using an HP filter. We find that the average correlation for gross FDI flows and real GDP is 0.4 in our sample, with a median of 0.32. The highest correlation comes from Canada (0.66), while Germany has the lowest at 0.15. For net FDI flows, 5 of our 7 countries have negative correlations, with an average correlation of -0.06. Thus, while net FDI flows show no distinct patterns over the business cycle, gross FDI flows are strongly pro-cyclical.

Tables 4 provides additional empirical evidence about the relationship between FDI inflows and outflows for our panel of G7 countries. Country by country for both FDI inflows and outflows, we de-mean and standardize each series. We then estimate the impact of FDI outflows on inflows (and separately inflows on outflows), including country-specific time trends as well as year dummies. We consider 1970-2010 and 1970-2020 to evaluate whether the decade following the global financial crisis altered the relationship between inflows and outflows (having seen already that magnitudes of flows declined during this period).

Table 4 show inflows and outflows of FDI are highly positively correlated, and these estimated

Table 3: Correlations between measures of FDI and Real GDP

	ρ (Gross FDI, y)	ρ (FDI In, y)	ρ (FDI Out, y)	ρ (Net FDI, y)
Canada	0.663	0.663	0.437	0.454
Germany	0.153	0.093	0.209	-0.018
France	0.538	0.581	0.432	-0.228
United Kingdom	0.289	0.139	0.350	-0.300
Italy	0.513	0.440	0.489	-0.093
Japan	0.320	-0.187	0.458	-0.528
United States	0.244	0.409	0.041	0.317
Average	0.389	0.305	0.345	-0.057
Median	0.320	0.409	0.432	-0.093
Std Dev	0.184	0.302	0.164	0.345

Note: y is measured as the cyclical component using an HP filter on the natural log of real GDP. FDI measures are the cyclical component using an HP filer on each FDI series as a percent of GDP.

relationships are robust to sample selection and additional controls. Table 5 reports the correlations between FDI inflows and FDI outflows for each country separately. A clear pattern emerges that FDI inflows and outflows are highly positively correlated, with a high of 0.64 (Italy) to a low of 0.165 (Japan). On average, the correlation of FDI inflows and FDI outflows is 0.467.

4 Model

To understand the cyclical patterns in FDI evident in the data, we study the behavior of FDI over the business cycle using a classic international business cycle framework of Backus et al. (1992). There two countries: Home (A) and Foreign (B). The GDP in each country is produced using capital and labor, and is then used for either consumption or investment purposes. The consumption and investment goods in both countries are perfect substitutes.

Table 4: Correlations between FDI Inflows and FDI Outflows

	(1) FDI In	(2) FDI Out	(3) FDI In	(4) FDI Out	(5) FDI In	(6) FDI Out	(7) FDI In	(8) FDI Out
FDI Outflows	0.761****		0.317***		0.707****		0.455****	
	(0.0724)		(0.106)		(0.0525)		(0.0702)	
FDI Inflows		0.733****		0.288**		0.705****		0.470****
		(0.0835)		(0.118)		(0.0698)		(0.0874)
Standard Errors	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust
Country-Specific Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	No	No	Yes	Yes	No	No	Yes	Yes
Time Period	1970-2010	1970-2010	1970-2010	1970-2010	1970-2020	1970-2020	1970-2020	1970-2020
Observations	248	248	248	248	332	332	332	332

Note: FDI inflows and outflows are recorded as positive values.

Table 5: Correlations between FDI Inflows and Outflows for each G7 country

	ρ (FDI in, FDI out)
Canada	0.508
Germany	0.439
France	0.449
United Kingdom	0.599
Italy	0.643
Japan	0.165
United States	0.467
Average	0.467
Median	0.467
Std Dev	0.154

Note: based on residuals from an HP filter.

Technology and resource constraints In order to study gross FDI flows in that model, we need a notion of capital ownership, so that it makes a difference whether capital located physically in country A is owned by residents of the Home or the Foreign. We do so by defining a concept of effective capital stock, $\tilde{K}$, as follows:

$$\tilde{K} = \left[\omega {k_A}^{\frac{\theta-1}{\theta}} + (1-\omega){k_A^*}^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}, \tag{4.1}$$

where k_A is owned by residents of the Home country, k_A^* is owned by residents of the Foreign country, ω is the home bias, and θ is the elasticity of substitution between domestic and foreign ownership. Similar specification for $\tilde{K}^*$ reads: $\tilde{K}^* = \left[\omega {k_B^*}^{\frac{\theta-1}{\theta}} + (1-\omega){k_B}^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}$. This is our key innovation, and the key difference between the classic BKK framework and ours. In the standard BKK framework it does not matter who owns capital stock, which corresponds to $\theta = \infty$. In that framework gross FDI flows are not well defined, and only net flows matter.

The notion of effective capital stock in (4.1) hints at additional sources of welfare gains from financial integration. In the standard BKK framework, the only source of those gains is insurance against country-specific shocks, i.e. risk-sharing. When the elasticity of substitution between domestic and foreign capital is finite, the increase in the effective capital stock that follows financial integration will be larger than the increase in the sum of its components. Hence, financial integration has a potential for increasing steady-state levels output and consumption.

There are at least two ways in which the concept of effective capital stock can be interpreted. One is similar to the idea of intangible capital in McGrattan and Prescott (2009). Another interpretation is countries benefiting from having comparative advantage in different sectors, resulting from accumulated know-how - the Swiss may own part of German watch-making sector, while Germans

may own part of the Swiss automobile industry.

The effective capital stock, along with labor, is used to produce a final consumption and investment good, using a Cobb-Douglas production function:

$$Y\left(s^t\right) = e^{z\left(s^t\right)} \cdot \tilde{K}\left(s^{t-1}\right)^{\alpha} L\left(s^t\right)^{1-\alpha}$$

where s^t is the exogenous state of the world encompassing the history of all past shocks, $s^t = (s_1, s_2, ..., s_t)$, z is the logarithm of total factor productivity, and L is labor input. We consider inelastic labor supply and set $L = 1$. The specification for the production of the final output in the Foreign country is similar.

The capital stocks located in country A and owned by either Home or Foreign residents evolve over time as follows:

$$k_A\left(s^t\right) = (1-\delta)k_A\left(s^{t-1}\right) + x_A\left(s^t\right) - \phi_D\left(k_A\left(s^t\right), k_A\left(s^{t-1}\right)\right)$$

$$k_A^*\left(s^t\right) = (1-\delta)k_A^*\left(s^{t-1}\right) + x_A^*\left(s^t\right) - \phi_F\left(k_A^*\left(s^t\right), k_A^*\left(s^{t-1}\right)\right)$$

where x_A and x_A^* are purchases of country A capital goods made by domestic and foreign residents, respectively. It's important to notice that nothing restricts either x_A or x_A^* from being negative. Similar relationships hold for k_B and k_B^*. The functions $\phi_D(\cdot)$ and $\phi_F(\cdot)$ capture the capital adjustment costs, potentially differing for capital located domestically or in a foreign country.

The global resource constraint is given by:

$$C\left(s^t\right) + C^*\left(s^t\right) + x_A\left(s^t\right) + x_A^*\left(s^t\right) + x_B\left(s^t\right) + x_B^*\left(s^t\right) = Y\left(s^t\right) + Y^*\left(s^t\right)$$

Preferences The expected life-time utility of a stand-in household in each country is given by:

$$E_0 \left\{ \sum_{t=1}^{\infty} \beta^t \psi_t U\left(c_t, \ell_t\right) \right\},$$

with a similar specification in country B, where ψ_t represents the inter-temporal preference shock, introduced to ensure the model captures the relative volatility as well as the cross-country correlation of consumption expenditures.

Stochastic shocks There are two stochastic shocks in each country - a shock to the total factor productivity, z, and the inter-temporal preference shock, ψ. We assume the following stochastic process for the two shocks in each country $i = A, B$:

$$z_{i,t} = \rho_z z_{i,t-1} + \epsilon^z_{i,t} \tag{4.2}$$

$$\ln \psi_{i,t} = \rho_\psi \ln \psi_{i,t-1} + \epsilon^\psi_{i,t} \tag{4.3}$$

The four shocks have a joint normal distribution, and are potentially correlated between countries:

$$\begin{pmatrix} \epsilon^z_{A,t} \\ \epsilon^z_{B,t} \\ \epsilon^\psi_{A,t} \\ \epsilon^\psi_{B,t} \end{pmatrix} \sim N\left(0, \Sigma\right), \qquad \Sigma = \begin{bmatrix} \sigma_z^2 & \sigma_z^2 \cdot \rho_{z,z^*} & 0 & 0 \\ \sigma_z^2 \cdot \rho_{z,z^*} & \sigma_z^2 & 0 & 0 \\ 0 & 0 & \sigma_\psi^2 & \sigma_\psi^2 \cdot \rho_{\psi,\psi^*} \\ 0 & 0 & \sigma_\psi^2 \cdot \rho_{\psi,\psi^*} & \sigma_\psi^2 \end{bmatrix}$$

where Σ is the variance-covariance matrix.

4.1 Planner's problem

The planner's problem (assuming equal welfare weights across countries) can be set up by treating k_A and k_A^* (as well as k_B and k_B^*) as distinct capital goods. The planner solves the following

problem:

$$\max \sum_{i\in\{A,B\}} \sum_{t=1}^{\infty} \beta^t \left[\sum_{s^t} \pi\left(s^t\right) \psi_i\left(s^t\right) \cdot U\left(C_i\left(s^t\right)\right) \right]$$

subject to:

$$\begin{aligned}
Y_A\left(s^t\right) + Y_B\left(s^t\right) &= C_A\left(s^t\right) + C_B\left(s^t\right) + X_A\left(s^t\right) + X_B\left(s^t\right) \\
Y_i\left(s^t\right) &= e^{z_i\left(s^t\right)} \cdot \tilde{K}_i\left(s^{t-1}\right)^{\alpha} L_i\left(s^t\right)^{1-\alpha}, \qquad i = A, B \\
\tilde{K}_i\left(s^t\right) &= \left[\omega k_i^i\left(s^t\right)^{\frac{\theta-1}{\theta}} + (1-\omega) k_i^{-i}\left(s^t\right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \qquad i = A, B \\
k_i\left(s^t\right) + k_i^{-i}\left(s^t\right) &= (1-\delta)\left[k_i\left(s^{t-1}\right) + k_i^{-i}\left(s^{t-1}\right)\right] + X_i\left(s^t\right) \\
&\quad - \phi_D\left(k_i(s^t), k_i(s^{t-1})\right) - \phi_F\left(k_i^{-i}(s^t), k_i^{-i}(s^{t-1})\right), \qquad i = A, B
\end{aligned}$$

4.2 Competitive Equilibrium

In the decentralized economy, we consider two types of assets that can be traded internationally. First are physical capital stocks located in a different country. Second are claims to future consumption, i.e. a non-contingent, international bond (debt). We add capital controls to both types of assets (separate for each) so that we can consider different types and degrees of financial integration.

Utility maximization A stand-in household in country A is endowed with a unit of labor and solves:

$$\max \sum_{t=1}^{\infty} \beta^t \left[\sum_{s^t} \pi\left(s^t\right) \psi\left(s^t\right) U\left(c(s^t), \ell\left(s^t\right)\right) \right]$$

subject to:

$$c(s^t) + x_A\left(s^t\right) + x_B\left(s^t\right) + d\left(s^{t-1}\right) \leq w(s^t)\ell\left(s^t\right) + r_A\left(s^t\right)k_A\left(s^{t-1}\right) + \left(1-\kappa^F\right)r_B\left(s^t\right)k_B\left(s^{t-1}\right) + q\left(s^t\right)d\left(s^t\right) + T\left(s^t\right) - \frac{\kappa^D}{2\cdot\left(1-\kappa^D\right)}d\left(s^t\right)^2 \tag{4.4}$$

$$k_A\left(s^t\right) \leq (1-\delta)k_A\left(s^{t-1}\right) + x_A\left(s^t\right) \tag{4.5}$$

$$k_B\left(s^t\right) \leq (1-\delta)k_B\left(s^{t-1}\right) + x_B\left(s^t\right) \tag{4.6}$$

where w is the wage income (inelastic labor supply is set to one), $d(s^t)$ is the debt issued in state s^t, q is the price of newly issued debt, and T are lump-sum transfers, taken as given by the household, and given by:

$$T\left(s^t\right) = \kappa^F \cdot r_A^* k_A^*\left(s^t\right) + \frac{\kappa^D}{2\cdot\left(1-\kappa^D\right)}d\left(s^t\right)^2$$

We rebate the portfolio adjustment cost back to the household so that any increase in κ^D only captures the distortionary effect of incomplete markets. The household takes as given all prices as well as the aggregate allocations. The problem for the household in country B is similar.

Profit maximization In country A, a representative firm maximizes profits by solving:

$$\max_{\tilde{K},L,k_A,k_A^*} e^z \cdot \tilde{K}^\alpha L^{1-\alpha} - wL - r_A k_A - r_A^* k_A^* \qquad \text{subject to (4.1)}$$

The profit maximization problem in country B is similar. We dropped the notation that makes it explicit that allocations and prices are functions of the aggregate state s^t, because the problem is static.

Capital controls and financial integration The two parameters, κ^F and κ^D capture various degrees of financial integration. The first one, κ^F, is a tax imposed on return to capital earned by foreign owners, that is then lump-sum rebated to domestic residents. Specifically, if the rental rate on foreign owned capital in country A is r_A^*, the foreign owner receives a payment of $\left(1-\kappa^F\right) r_A^* k_A^*$ and the amount $\kappa r_A^* k_A^*$ is rebated to the stand-in household in country A (similar tax and transfer is taking place in country B). The second one, κ^D is the cost associated with ending a period with a non-zero amount of foreign debt.

The two parameters are restricted to be between 0 (financial integration) and 1 (autarky). When $\kappa^F = \kappa^D = 0$, international financial markets are complete, and the competitive equilibrium allocations are the same as the solution to the planner's problem (see Theorem 4.2 in the next section). When $\kappa^F = 0$ but $\kappa^D = 1$, there is freedom to buy, own, and sell physical capital stock located in a different country, but the cost of issuing any amount of non-contingent debt is prohibitively high. The markets are incomplete, but there is still international trade in assets in the form of FDI and, in general, $NX \neq 0$.[9] When $\kappa^F = 1$ but $\kappa^D = 0$, any return from foreign-owned capital is confiscated and only non-contingent debt can be issued. Finally, when $\kappa^F = \kappa^D = 1$, we have a financial autarky.

Definition 4.1 (Competitive Equilibrium)**.** A competitive equilibrium consists of price and allocation functions: $\left[C_i(s^t), \tilde{K}_i(s^t), k_i^j(s^t), Y_i(s^t), r_i^j(s^t), w_i(s^t), x_i^j(s^t), q(s^t), T_i(s^t)\right]_{i,j=A,B}$, such that, given prices, allocations solve the utility and maximization problems, and all markets clear.

[9] This intermediate (between autarky and complete markets) level of financial integration is different from the one typically considered in the international business cycle literature (Heathcote and Perri, 2002; Corsetti et al., 2008; Rothert, 2020). In those papers, the intermediate level of integration relies on consumption smoothing via the international bond. The case of $\kappa^F = 0$ and $\kappa^D = 1$ shuts down the risk-sharing via the non-contingent bond, while still allowing for international holdings of foreign assets.

4.3 Characterization

We provide partial characterization of the model to facilitate the explanation of our main results later on. We start with the relationship between the allocations that solve the planner's problem and the allocations in the competitive equilibrium, summarized in Theorem 4.2.

Theorem 4.2. *Let $\hat{Z}$ be the allocation that solves the Social Planner's problem and let $\tilde{Z}$ be the allocation in the Competitive Equilibrium. Then $\hat{Z} = \tilde{Z}$ if and only if $\kappa^F = \kappa^D = 0$.*

Proof. The proof is standard and relies on the comparison of the first order conditions and resource constraints. It is available upon request. □

4.3.1 MRS vs. BKK

It should come as no surprise that our model approaches the BKK model as $\theta \to \infty$. Specifically, if an endogenous variable X is well defined in the BKK framework, we have:

$$\lim_{\theta \to \infty} X^{MRS(\theta)}\left(s^t\right) = X^{BKK}\left(s^t\right), \qquad \forall s^t.$$

4.3.2 FDI vs. domestic investment

The inter-temporal Euler conditions for domestically and foreign-located capital in the competitive equilibrium for household $i = A, B$ are as follows:

$$U'\left(C_i\left(s^t\right)\right) = \beta \sum_{s^{t+1}} \pi\left(s^{t+1}|s^t\right) \frac{\psi_i(s^{t+1})}{\psi_i(s^t)} U'\left(C_i\left(s^{t+1}\right)\right)\left[1 - \delta + MPK_i(s^{t+1}) \cdot \tilde{K}_{i,i}(s^t)\right]$$

$$U'\left(C_i\left(s^t\right)\right) = \beta \sum_{s^{t+1}} \pi\left(s^{t+1}|s^t\right) \frac{\psi_i(s^{t+1})}{\psi_i(s^t)} U'\left(C_i\left(s^{t+1}\right)\right)\left[1 - \delta + MPK_j(s^{t+1}) \cdot \tilde{K}_{j,i}(s^t)(1 - \kappa^F)\right]$$

where $MPK \equiv \alpha e^z \tilde{K}^{\alpha-1}$ is the marginal product of the effective capital stock, and $\tilde{K}_{i,j} \equiv \frac{\partial \tilde{K}_i}{\partial k_i^j}$ is the partial derivative of the effective capital stock $\tilde{K}_i$ w.r.t. to the capital owned by household j.

The most important price in our model is the return to capital. In country A, the rental rates

on k_A and k_A^* are given by:

$$r_A = \alpha \exp(z) \tilde{K}^{\frac{1}{\theta}+\alpha-1} \cdot \omega_K \cdot {k_A}^{-\frac{1}{\theta}} \tag{4.7}$$

$$r_A^* = \alpha \exp(z^*) \tilde{K^*}^{\frac{1}{\theta}+\alpha-1} \cdot (1-\omega_K) \cdot {k_A^*}^{-\frac{1}{\theta}} \tag{4.8}$$

The equations above illustrate the important role that the elasticity of substitution plays in the decision to sell part of capital stock located in one country and purchase it in another country. The key is the impact of the changes in current level of effective capital stock, $\tilde{K}$, on the return to either k_A or k_A^*. When $\frac{1}{\theta} > 1-\alpha$, i.e. when the elasticity of substitution between domestic and foreign ownership is sufficiently small, a fall in $\tilde{K}$ reduces the rental rate. An outflow of foreign-owned capital, k_A^*, which reduces $\tilde{K}$ would then reduce r_A. This makes domestic residents reduce their holdings of domestic capital and, instead, purchase capital stock located in country B, generating a positive correlation between FDI inflows and outflows at a country level, and a positive co-movement of bilateral FDI flows.

4.3.3 Imperfect risk-sharing

A corollary to Theorem 4.2 is that perfect (up to preference shocks) risk-sharing, i.e. $\psi_A\left(s^t\right) U'\left(C_A\left(s^t\right)\right) = \psi_B\left(s^t\right) U'\left(C_B\left(s^t\right)\right), \forall s^t$, in the competitive equilibrium happens only if $\kappa^D = 0$. This follows from the direct comparison of the risk-sharing condition in the planner's problem and the inter-temporal

Euler conditions for debt in the competitive equilibrium below:

$$\begin{aligned}
\text{(Planner)} \qquad & \psi_A(s^t)U'(C_A(s^t)) = \psi_B(s^t)U'(C_B(s^t)) \\
\text{(Eq'm, country A)} \qquad & \psi_A(s^t)U'(C_A(s^t)) = \frac{1}{q(s^t)}\beta E\psi_A(s^{t+1})U'(C_A(s^{t+1}))\cdot\frac{1}{1-\frac{\kappa^D}{1-\kappa^D}d(s^t)} \\
\text{(Eq'm, country B)} \qquad & \psi_B(s^t)U'(C_B(s^t)) = \frac{1}{q(s^t)}\beta E\psi_B(s^{t+1})U'(C_B(s^{t+1}))\cdot\frac{1}{1+\frac{\kappa^D}{1-\kappa^D}d(s^t)}
\end{aligned}$$

5 Quantitative Analysis

We now use our framework to re-evaluate the welfare effects of international financial integration. The key step in this process is the estimation of the elasticity of substitution between domestic and foreign ownership, θ. We estimate this parameter (together with other model parameters) using the simulated method of moments. The key moment that helps us estimate the value of θ in our model is the business cycle co-movement of gross FDI flows.

5.1 Parameter values and functional forms

We impose values of a few parameters that are well established in the literature. The period in our model is one year, so we set the discount factor to $\beta = 0.96$; the depreciation rate of capital stock is set to $\delta = 0.05$; the capital share of national income is set to $\alpha = 0.33$. We consider two model specifications with Cobb-Douglas, separable or GHH preferences:

$$U(c,\ell) = \frac{\left[c^{1-\eta}\cdot(1-\ell)^{\eta}\right]^{1-\sigma}}{1-\sigma} \quad \text{or} \quad U(c,\ell) = \frac{c^{1-\sigma}}{1-\sigma} - \eta\cdot\frac{\ell^{1+\gamma}}{1+\gamma} \quad \text{or} \quad U(c,\ell) = \frac{\left[c-\eta\cdot\frac{\ell^{1+\gamma}}{1+\gamma}\right]^{1-\sigma}}{1-\sigma}$$

In both cases we set the inter-temporal elasticity of substitution is set to $\frac{1}{\sigma} = \frac{1}{2}$, we calibrate η so that in steady-state $\ell = 0.33$. In the specification with separable we set $\gamma = 2$ (Heathcote et al., 2008), and with GHH preferences we set $\gamma = 0.6$ (Neumeyer and Perri, 2005).

Table 6: Imposed, fixed parameters

Parameter description	**Value**	**Sources**
Discount factor	$\beta = 0.96$	GJ, RS
Inter-temporal elasticity of substitution	$1/\sigma = 0.5$	HSV
Frisch elasticity of labor supply	$1/\gamma = 0.5$	HSV
Capital depreciation	$\delta = 0.06$	GJ, RS
Capital share	$\alpha = 0.3$	GJ, R

GJ: Gourinchas and Jeanne (2013) RS: Rothert and Short (2022) R: Rothert (2020) HSV: Heathcote et al. (2008)

5.1.1 Method of moments estimation

We compute the decision rules using first-order approximation around the non-stochastic steady-state. We then use Simulated Method of Moments (SMM) to estimate the model, using the empirical moments for the United States as targets.

Parameters There are eight parameters that we estimate: standard deviation and cross-country correlation of TFP shocks — σ_z and σ_{z,z^*}; standard deviation and cross-country correlation of preference shocks — σ_ψ and σ_{ψ,ψ^*}; persistence of the TFP and preference shocks — ρ_z and ρ_ψ; and the elasticity of substitution between the domestic and foreign ownership of capital stock in the aggregate production function — θ. During the estimation of θ, the home bias parameter ω is re-calibrated so that the model in the steady-state matches the ratio of gross FDI inflows and outflows to aggregate investment expenditures.

Moments We target eleven moments in the estimation: standard deviation and persistence of real GDP; standard deviation (relative to that of GDP) and persistence of real consumption and investment expenditures; cross-country correlations of GDP, consumption, and investment expenditures;

standard deviation (relative to that of GDP) of total gross FDI flows over GDP; and correlation of gross FDI inflows with gross FDI outflows. All moments are computed using residuals from the quadratic trend.

5.2 Results

Before discussing the results of our estimation, we want to explain how the co-movement of gross FDI flows helps us identify the key parameter in our model - the elasticity of substitution between domestic and foreign ownership θ.

5.2.1 Capital diversity and FDI co-movement - identification of θ

Figure 4 illustrates how the capital diversity, inversely related to the elasticity of substitution between domestic and foreign ownership θ, impacts the co-movement of gross FDI flows in the model — as θ gets smaller, the gross FDI inflows and outflows become more correlated. The intuition behind that relationship varies slightly depending on the source of exogenous shock, which we will now discuss.

Preference shocks Consider a one-time positive shock to the discount factor in country A. The shock has no direct impact on the return to capital, because it does not affect the marginal product of $\tilde{K}$. Since the households in country A are more patient, they want to save more, which means buying more capital stock. But the inter-temporal Euler equations imply that the country A households will be buying more of both domestic and foreign located capital. This means, we will see an increase in gross FDI outflows — $FDI_{A\to B}$ is rising. What about $FDI_{B\to A}$, i.e. gross FDI inflows?

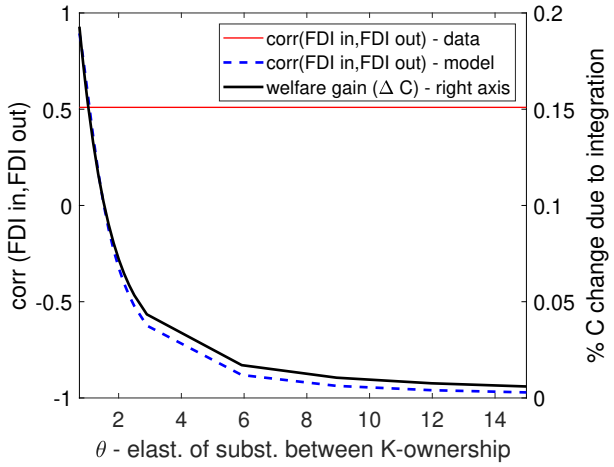


Figure 4: Capital diversity and FDI-comovement

The answer depends on the impact on r_A^* - the return to capital located in country A and owned by residents in country B. Since k_A is rising, $\tilde{K}_A$ is rising, and therefore $MPK \equiv \partial Y_A/\partial \tilde{K}_A$ is falling. However, $r_A^* = MPK \cdot \partial \tilde{K}_A/\partial k_A^*$. While an increase in k_A is lowering MPK, it will increase $\partial \tilde{K}_A/\partial k_A^*$, because k_A and k_A^* are not perfect substitutes. The greater the complementarity between k_A and k_A^*, the bigger will be positive impact of a rise in k_A on $\partial \tilde{K}_A/\partial k_A^*$. For low enough values of θ, the increase in $\partial \tilde{K}_A/\partial k_A^*$ will outweigh the decline in MPK, leading to an increase in r_A^*, which will then lead to an increase in k_A^*, i.e. an increase in $FDI_{B\to A}$ — gross FDI inflows into country A.

Productivity shocks Next, consider a positive productivity shock in country A. First, suppose that shock is transitory ($\rho_z = 0$). This means there is no impact on future productivity and the only impact is via an increase in today's income. Since K_A is held by households from both countries, we will see an increase in income in both countries. However, because of labor income, and because of

home bias in $\tilde{K}$, the incomes of households in country A will increase more. households in country A want to save more. They start buying capital located in both countries, and we see an increase in gross FDI outflows — $FDI_{A\to B}$ is rising.

When the productivity shock is persistent — $\rho_z > 0$ — there is an additional effect: the future marginal product of the effective capital stock $\tilde{K}_A$ is rising. This has a direct effect on future returns to domestic and foreign ownership of local capital stock — it raises both $r_{A,t+1}$ and $r^*_{A,t+1}$. The increase in $r^*_{A,t+1}$ gives additional incentives to households in country B to buy capital located in country A, raising $FDI_{B\to A}$ (relative to the case of $\rho_z = 0$). This means that, for the same level of θ, we would expect a higher correlation between FDI inflows and outflows.

5.2.2 Parameter values and model fit

Our results are summarized in Tables 7 and 8. The two tables present our estimated parameter values and model fit, respectively. We provide results from three different specifications of the model (with Cobb-Douglas preferences, separable preferences, and GHH preferences), each estimated using a restricted set of FDI-related moments as well as richer set (see Table 8). In each case the model fits the data quite well. Across all specifications, we obtain an estimate for our key parameter θ that is far below infinity, in the range between 1 and 2.5.

5.2.3 Welfare gains from financial integration

The bottom two lines in Table 7 report the percentage drop in the steady-state level of consumption resulting from an increase in κ^F that would lead to either a 50% or 90% drop in the steady-state FDI/GDP ratio ("% ΔC low" and "% ΔC high", respectively). Naturally, the importance of capital diversity in the aggregate production function (inversely related to the elasticity of substitution θ),

Table 7: Parameter Estimates

	Restricted Set			Full Set		
Parameter	CD	SEP	GHH	CD	SEP	GHH
κ^D	0.044	0.017	0.027	0.466	0.358	0.370
ϕ_D	0.314	0.316	0.417	5.365	5.124	3.313
ϕ_F	19.951	13.759	11.089	21.257	21.469	15.857
ρ_ψ	0.536	0.420	0.444	0.211	0.246	0.189
ρ_{ψ,ψ^*}	-0.263	-0.021	-0.072	0.269	0.383	0.034
ρ_z	0.976	0.982	0.919	0.979	0.987	0.937
ρ_{z,z^*}	0.483	0.458	0.493	0.246	0.257	0.214
σ_ψ	2.223	1.567	6.523	4.070	3.698	9.373
σ_z	0.662	0.925	0.500	0.716	1.002	0.500
θ	1.081	1.644	2.103	2.158	2.460	2.296
% ΔC - low	5.899	4.535	6.066	4.225	3.555	5.694
% ΔC - high	18.869	9.844	10.066	6.861	5.208	8.695

NOTES: Method of moments estimation based on residuals from quadratic trend; See Table 8 for Restricted Set vs. Full Set of moments.

has an impact on the implied welfare loss from policies that reduce FDI flows. Our estimates for θ range between one and two, implying that the long-run welfare loss from a 50% reduction in FDI is at least 3.6% of steady-state consumption (and as high as 6%, in the case of GHH preferences). An almost complete elimination of FDI can result in very large welfare losses in the long-run - potentially equivalent to almost 9-10% of consumption. [10]

6 Conclusions

In this paper we showed that the welfare gains from international financial integration can be many orders of magnitude larger than the typical gains from risk-sharing and consumption smoothing. We allowed for the possibility that domestic and foreign ownership of capital stock were not perfect

[10] We want to point out that we abstract from additional sources of gains such as technological spillovers. Those may be less important for G7 economies that are on a similar level of technological development, but could be substantial for developing countries.

Table 8: Data vs. Model Moments

		Restricted Set			Full Set		
Moment	Data	CD	SEP	GHH	CD	SEP	GHH
(*) $\rho(c_t, c_{t-1})$	0.87	0.89	0.93	0.82	0.84	0.89	0.69
(*) $\rho(c, c^*)$	0.34	0.42	0.47	0.32	0.27	0.31	0.17
$\rho(fdi_t, fdi_{t-1})$	0.15	0.95	0.95	0.94	0.65	0.66	0.72
(*) $\rho(fdi, fdi^*)$	0.59	0.52	0.52	0.58	0.45	0.44	0.50
$\rho(fdi_t^*, fdi_{t-1}^*)$	0.58	0.96	0.95	0.95	0.65	0.64	0.72
$\rho(inv, fdi)$	0.13	0.32	0.27	0.32	0.72	0.71	0.67
$\rho(inv_t, fdi_{t-1})$	0.30	0.25	0.22	0.27	0.27	0.27	0.28
$\rho(inv, fdi^*)$	0.61	0.55	0.60	0.64	0.66	0.68	0.70
$\rho(inv_t, fdi_{t-1}^*)$	0.51	0.42	0.45	0.45	0.32	0.33	0.34
(*) $\rho(inv_t, inv_{t-1})$	0.70	0.62	0.59	0.65	0.43	0.44	0.46
(*) $\rho(inv, inv^*)$	0.40	0.38	0.38	0.34	0.57	0.61	0.61
$\rho(y, fdi)$	0.26	0.49	0.49	0.51	0.42	0.44	0.37
$\rho(y_t, fdi_{t-1})$	0.42	0.45	0.42	0.48	0.29	0.26	0.39
$\rho(y, fdi^*)$	0.69	0.91	0.88	0.87	0.70	0.69	0.68
$\rho(y_t, fdi_{t-1}^*)$	0.70	0.87	0.84	0.84	0.68	0.66	0.67
$\rho(y, fdi + fdi^*)$	0.57	0.80	0.78	0.77	0.66	0.66	0.61
(*) $\rho(y_t, y_{t-1})$	0.79	0.92	0.90	0.95	0.90	0.86	0.95
(*) $\rho(y, y^*)$	0.46	0.40	0.36	0.43	0.31	0.28	0.30
(*) $sd(nx)/sd(y)$	1.06	1.08	1.05	1.05	1.01	0.99	0.94
(*) $sd(c)/sd(y)$	1.13	0.93	0.85	1.05	0.98	0.91	1.13
(*) $sd(fdi)/sd(y)$	0.85	0.82	0.81	0.82	0.85	0.84	0.88
(*) $sd(inv)/sd(y)$	2.82	2.81	2.80	2.83	2.75	2.74	2.75
(*) $sd(y)$	3.12	3.11	3.12	3.13	3.13	3.14	3.18

NOTES: All moments computed on residuals from the quadtratic trend. (*) are included in the Restricted Set. fdi^* denote FDI inflows (foreign investment purchases made by foreign residents) and fdi denote FDI outflows. When time subscripts are dropped, correlations are contemporaneous.

substitutes. This small deviation from the standard international business cycle model allowed us to model gross FDI flows within the classic BKK framework. We showed that the standard BKK model (a limiting case of our economy) delivers a strong counter-factual prediction of a perfectly negative correlation of FDI inflows and outflows, that is reversed when the elasticity of substitution between domestic and foreign ownership of capital is sufficiently low.

Our model offers a new channel of such openness that we dubbed a "capital diversity" channel. We estimated the model to match the business cycle co-movement of gross FDI flows in the United States and found that the welfare gains from openness to FDI can be substantial and equivalent to as high as a 7% increase in lifetime consumption. Given the size of the U.S. economy, and the fact that the share of foreign-owned capital in the U.S. is smaller than in other developed economies, we expect those gains to be even larger for smaller countries.

We offer a very flexible framework to study gross FDI flows over the international business cycle, opening doors for a research agenda focusing on that important aspect of open economy macroeconomics.

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7 Appendix

Table 9: Business Cycle Statistics

	G7	USA	Germany	France	Japan	Canada	Italy	GB
sdev (Y)	2.826	3.117	2.429	2.334	3.579	1.942	2.451	3.932
sdev(C) / sdev (Y)	1.181	1.128	1.122	1.044	0.661	1.901	1.034	1.378
sdev (I) / sdev (Y)	3.457	2.815	3.442	3.080	2.892	5.146	4.050	2.776
sdev (NX) / sdev (Y)	0.523	0.341	0.554	0.495	0.308	0.931	0.677	0.358
sdev (Gross FDI) / sdev (Y)	0.838	0.343	1.064	1.086	0.157	1.245	0.567	1.400
sdev (Net FDI) / sdev (Y)	0.450	0.213	0.600	0.652	0.144	0.631	0.264	0.645
sdev (Gross Portfolio) / sdev (Y)	1.453	0.680	1.604	2.469	0.587	1.135	2.009	1.688
sdev (Net Portfolio) / sdev (Y)	1.032	0.454	0.988	1.384	0.717	1.263	0.940	1.478
sdev (Gross FDI and Portfolio) / sdev (Y)	1.839	0.849	2.296	3.168	0.600	1.471	2.104	2.383
sdev (Net FDI and Portfolio) / sdev (Y)	1.002	0.449	0.986	1.472	0.732	1.084	0.903	1.386
ρ (C, Y)	0.824	0.957	0.854	0.844	0.880	0.410	0.853	0.967
ρ (I, Y)	0.801	0.855	0.847	0.825	0.928	0.414	0.852	0.883
ρ (NX, Y)	-0.231	-0.603	-0.068	-0.105	0.144	0.091	-0.442	-0.636
ρ (FDI In, FDI Out)	0.547	0.453	0.595	0.670	0.124	0.648	0.658	0.684
ρ (Portfolio In, Portfolio Out)	0.272	0.450	0.463	0.528	-0.196	-0.119	0.641	0.137
ρ (FDI and Portfolio In, FDI and Portfolio Out)	0.466	0.595	0.696	0.686	-0.198	0.297	0.692	0.497
ρ (Gross FDI, Y)	0.460	0.477	0.230	0.588	0.286	0.501	0.576	0.560
ρr (Net FDI, Y)	0.066	-0.016	-0.060	0.351	0.326	-0.398	0.100	0.158
ρ (FDI Out, Y)	0.401	0.364	0.240	0.523	0.331	0.333	0.512	0.502
ρ (FDI In, Y)	0.405	0.460	0.188	0.603	-0.016	0.525	0.541	0.534
ρ (Gross Portfolio, Y)	0.155	0.467	0.064	0.382	0.196	-0.451	0.073	0.351
ρ (Net Portfolio, Y)	-0.074	-0.602	-0.153	0.102	-0.055	0.523	-0.113	-0.219
ρ (Portfolio Out, Y)	0.104	0.078	-0.030	0.356	0.081	0.117	0.019	0.106
ρ (Portfolio In, Y)	0.169	0.586	0.121	0.309	0.170	-0.596	0.113	0.481
ρ (Gross FDI and Portfolio, Y)	0.337	0.567	0.151	0.499	0.267	0.069	0.225	0.578
ρ (Net FDI and Portfolio, Y)	-0.060	-0.616	-0.190	0.251	0.010	0.370	-0.088	-0.160
ρ (FDI and Portfolio Out, Y)	0.259	0.259	0.069	0.483	0.165	0.252	0.182	0.400
ρ (FDI and Portfolio In, Y)	0.310	0.686	0.200	0.427	0.175	-0.161	0.230	0.610

Note: All statistics calculated after taking a quadratic filter of each series. For alternative filtering processes, see data appendix.