Evolution of Bilateral Capital Flows to Developing Countries at Intensive and Extensive Margins*

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12th April 2016

Abstract

Motivated by the rise in capital flows to low-income countries (LICs), we examine the nature of these flows and the factors affecting foreign investors' decision. Recognizing the presence of fixed investment costs, we analyze capital flows at both intensive and extensive margins. To fix ideas, we set out by constructing a rich model of capital flows that incorporates agents making portfolio investment and consumption decisions along with heterogenous firms deciding on production choices. Subsequently, we seek to map the main predictions of the model to estimating relationships by using a two-tier econometric framework with cross-sectional dependence. Our main finding is that market entry costs are statistically and economically very detrimental to LICs, and that portfolio flows act as a substitute for direct investment in the extensive margin when entry costs are prohibitively high.

Keywords: Bilateral capital flows, foreign direct investment, portfolio flows, low-income countries, extensive and intensive margins, cross-sectional dependence.

JEL Classification: C33, C34, F21, F62, O16.

*We are grateful to two referees and the editor of this journal for their constructive and insightful comments. We thank, without implication, Craig Burnside, Alexis Cerkel Meyer, Era Dabla-Norris, Gian Maria Milesi-Ferretti, Catherine Pattillo, Peter Pedroni, M. Hashem Pesaran, Aurelija Proskute, Laurynas Tribaldovas, and Eric van Wincoop for helpful discussions. The views expressed in this paper are those of the authors and do not necessarily represent those of the IMF, its Executive Board, or its management.

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1 Introduction

Low-income countries (LICs) have until recently typically been characterized by modest access to private external funding sources. Since mid-2000s, however, LICs have relied more on non-official inflows with some increasingly gaining market access. Net capital inflows in LICs, which had remained stable in the first half of 2000's with a median of around 2 percent of GDP, peaked at over 5 percent of GDP prior to the global financial crisis and continued to grow reaching an overall peak in 2013 of over 7 percent of GDP.[1] The post-crisis rise in capital inflows to LICs included both FDI and non-FDI inflows (the latter comprising of portfolio, debt and equity inflows, and other non-official investment, e.g., bank deposits, corporate and bank loans, and trade credit). And for both types of inflows, ratios to GDP in LICs have been quite substantial and larger than in most middle-income countries (henceforth MICs).

Despite capital being a major precursor to economic development and one of the major manifestations of globalization, we do not understand what determines capital flows to LICs.[2] In this paper we consider two main types of private long-term capital movements, namely portfolio[3] (henceforth foreign private investment or FPI) and direct investment (henceforth foreign direct investment or FDI).[4] The major difference between the two types is that a foreign direct investor has, on a lasting basis, management interest in a nonresident enterprise, whilst a foreign portfolio investor seeks an investment that is purely financial in nature.[5] Obvious, yet worth reminding, is that the stage of a country's development, of course, influences the investors' decisions, and this is particularly important to bare in mind as we consider flows to countries in transition with less than perfect markets. To adequately consider these issues requires imposing a disciplining but rich theoretical structure that is matched by good data and frontier empirical methods, paying attention to fixed costs incurred by heterogeneous firms, and generating two-tier portfolio decisions under intensive and extensive margins.

Moreover, the foreign direct investment deserves discussion with respect to real and financial aspects of investment. One way to analyze the FDI is to consider movements of the productive factor (real capital) between countries. The trade theory is then fully compatible: the causes of capital flows include different rewards in different economies due to prices, taxes and tariffs,[6] and other reasons like specialization or factor-intensity reversals. Industry-specific and real economy factors are often considered because usually big corporations with a high product differentiation engage in FDI (see Helpman, Melitz, and Yeaple (2004) for a formalization of heterogeneous multinationals engaging in production abroad as opposed to trade). The potential advantages for recipients include the transfer of entrepreneurship and new technology, whereas disadvantages assume outflows of repatriated profits, diminution in sovereignty, and economic policy inefficacies.[7]

Following recent work by Tille and van Wincoop (2010) and Okawa and van Wincoop (2012), we model FDI flows in the unifying framework of a gravity model, making use of bilateral (rather than aggregate)

[1] Data on net capital flows is from Araujo, David, van Hombeeck, and Papageorgiou (2015a) and IMF (2015) and exclude other investment flows to the official sector (the general government and monetary authorities), whether or not originating from official or private sources (the underlying data source provides a breakdown by debtor but not by creditor).

[2] See, for example, Lucas (1990), Caselli and Feyrer (2007), Prasad, Rajan, and Subramanian (2007), and Gourinchas and Jeanne (2013).

[3] For example, holdings of government securities and private equities, with the latter significantly more important than the former, preference shares, equities without control over organization, bonds issued by international organizations, etc.

[4] Other types include international loans and commercial credits with a maturity of more than one year.

[5] Portfolio investment is traditionally considered to be a function of differential yields and risk diversification. Usually the set of efficient portfolios is first determined, independently of the stock of wealth, and later the optimum portfolio is determined employing the investor's utility function. In our framework, we will follow this line of reasoning, and will first pin down optimal weights, which will be mapped to residual income, which can be used for portfolio investment.

[6] Stolper-Samuelson theorem can be invoked to determine a relationship between tariffs and factor rewards. As emphasized by Gandolfo (2002), the effects on the host country can be analyzed drawing from the Rybczynski's theorem because it addresses the effects of changes in factor endowment (capital stock).

[7] Examples of a loss of sovereignty include instructions from the parent company, which need to be followed instead of those from local authorities, whereas monetary policy can become ineffective due to the financial resources of the parent company, which might have access to international financial markets.

capital flows data. Our contribution revolves around three parts. First, a single parsimonious framework for both FDI and portfolio types of capital flows, resulting in simple gravity-type relations, is presented. So far papers on FDI mostly failed to account for capital as a productive input, almost always omitting it from the analysis. We can also test relationships between FDI and portfolio flows, something not possible without linking two types of capital movements in one model. Second, our framework enables us to analyze the changing structure of international investment along the intensive and extensive margins. Our simplifying assumption of separability allows telling the supply story for FDI and demand story for portfolio investment, also admits a simple mapping from the theory to empirics.[8] Third, by decomposing the sample into LICs and MICs, we are able to track differences across development stages. We offer new perspectives for direct and portfolio capital flows, and for countries just starting to be actors in capital markets. Our parsimonious econometric framework is extended in a number of directions (e.g., apply copulae to relax distributional assumptions, allow for crisis, introduce size-adjusted regressions, incorporate negative values of flows, among others).

The main results of the paper suggest that market entry costs are statistically and economically very detrimental to LICs. Specifically, it is shown that obstacles to start a business matter for FDI and portfolio flows, yet exclusively for LICs – MICs show no evidence of similar relationship. Rather, an often omitted variable of a price of capital renders significant effects for portfolio investment in MICs, in particular at an extensive margin. In addition, results suggested by the theory and confirmed by empirics indicate that portfolio flows act as a substitute for direct investment in the extensive margin when entry costs are prohibitively high. In particular, extensive margin of FDI favors an environment with high labor productivity, opposite to portfolio flows.

The paper is organized as follows. We overview theoretical and empirical contributions to FDI and portfolio literatures in Section 2. Section 3 depicts a number of recent stylized facts on developing countries, with an emphasis on intensive and extensive margins of capital flows. A theoretical model is laid down in Section 4. We discuss econometric setting in Section 5 and overview baseline results in Section 6. Extensions and robustness checks are undertaken in Section 7. A set of additional checks and extensions are reported in an Online Appendix. Finally, Section 8 concludes and outlines future research directions and policy implications.

2 Brief Literature Review

Though the literature on capital flows is vast, contributions on the links between theory and empirics are quite scarce. We overview the use of gravity framework to model both FDI and portfolio flows. The empirical literature has focused on advanced and developing economies (see Yeyati, Stein, and Daude (2003), among others) but with little, if at all, work trying to distinguish between countries at different stages of development. Though the theory is pointing to capital markets efficiency and integration, also institutional quality to attract investment, we lack knowledge on factors which generate success or failure to be a target economy for international investors. Before dealing with specificities of low- and middle-income countries, we cover main theoretical and empirical determinants to engage in foreign investment as entertained by the current literature, with the special emphasis on gravity-type studies.

2.1 Gravity in Direct Investment Flows

FDI is usually modeled as an investment made by the multinational firms. The gravity-type dependence for the foreign affiliates sales was derived by Kleinert and Toubal (2010). They employ three different

[8] Unlike, for example, Razin and Sadka (2007a,b), which develop a more dynamic approach for FDI by using current value functions for firms to determine, whether an investment is worthwhile to take place. However, that approach results in a reduced form estimation, with less parsimony, weaker links between theory and empirics, and a whole different emphasis (authors mainly rely on OECD countries with the longer time dimension). Our focus on LICs also makes the theoretical and empirical approach different. That is why, the model we use here ignores mergers and acquisitions, which are less important for the developing economies.

models: the emergence of horizontal multinational firms with firm symmetry and heterogeneity, and the emergence of vertical multinational firms using a factor-proportions approach. Kleinert and Toubal (2010) assume that fixed costs increase with distance, thereby leading to a negative relationship between distance and affiliate sales (the standard proximity - concentration model predicts an opposite result). The factor proportions model augments the otherwise standard gravity specification with a relative factor endowment and a joint size of home and host country regressor.

Obstfeld and Rogoff (2000) also argued that transportation costs may be relevant not only for commodity trade, but also for international asset transactions. Mody (2007) collects research on what attracts and what discourages investment in a foreign country. Distances, especially informational and transactional ones, do play a role as does "herding" behavior believed to be rooted in informational advantages of previous investors into the country. Another line of inquiry is concerned with benefits of FDI. It is found that FDI is not integrating the world in the sense that it flows to places where conditions are already propitious. Interestingly, Mody and Murshid (2005) find that developing countries with better policies succeeded more in absorbing foreign inflows by creating an environment conducive for the diffusion of new technologies and ideas intrinsic to foreign capital. Improved policies probably also reduced the risk of holding domestic assets, which in turn, by discouraging capital outflows, would have further enhanced the relationship between capital flows and domestic investment.

Razin and Sadka (2007c) focus on bilateral FDI flows among OECD countries. An important feature of the FDI model (which distinguishes FDI flows from portfolio flows) is fixed setup costs of new investments. This introduces two margins of FDI decisions. There is an intensive margin of determining the magnitude of the flows of FDI, according to standard marginal productivity conditions, and also an extensive margin of determining, whether to make a new investment. The first decision gives rise to a flow equation, whereas the second decision produces a selection-condition equation. Crucially, productivity and taxes may affect these two margins in different, possibly conflicting, ways. Yet, unlike our inquiry, Razin and Sadka (2007c) concentrate on FDI flows only and differ in an econometric treatment as well as the theory.

2.2 Gravity in Portfolio Flows

There have been numerous applications of gravity specification in analyzing capital flows. Yet, theoretical foundations are quite scant. Martin and Rey (2004) derive a gravity equation for financial holdings when countries trade claims on Arrow Debreu securities. Agents are endowed with a freely traded good, which they can choose to consume, invest in fixed-size risky projects or use to buy shares on the stock market. Investing in a specific project is equivalent to buying an Arrow-Debreu asset that pays in only one state of nature. With endogenously incomplete asset markets economic size becomes important to the determination of asset returns, the breadth of financial markets and the degree of risk sharing, and home bias. Coeurdacier and Martin (2009) analyze trade in bonds, equity and banking assets. The financial version of the gravity equation for the holdings of assets includes a size factor (GDP), the number of assets in a source country and its financial sophistication, transaction costs between the two countries, expected returns and the financial price index, which is specific to each country. However, these approaches are limited to cases which satisfy Arrow Debreu conditions: when the asset of a country has a positive payoff, the assets of all other countries have a zero payoff.

To avoid this limitation, Okawa and van Wincoop (2012) have recently contributed to the literature on the financial flows gravity. The foundations of the model lie in a static portfolio choice framework, where investors hold claims on risky assets from a large number of countries. Asset returns are affected both by a country-specific and a global component. Bilateral financial holdings depend on the product of economic size variables (stock market capitalization in the destination country and total investment in stock in the source country) divided by a relative financial friction. The gravity specification for bilateral asset holdings includes the equity supply, equity holdings, world's demand and supply of equity, information frictions, multilateral resistance terms, which measure the average financial frictions for a destination and source country.[9]

2.3 Empirical Approaches

In the emerging literature on the determinants of capital flows, a number of statistically driven approaches have been pursued. Eicher, Helfman, and Lenkoski (2012) employ Bayesian methodology along with the Heckit approach to control for both, model uncertainty and two margins, intensive and extensive, of FDI. Authors employ OECD data for the period 1988-2000 and 46 countries. Despite a different temporal and spatial focus, our results are in line with their findings, which demonstrate that the gravity approach is appropriate and that the selection methodology for the two investment margins is crucial.

Another important paper in the empirical literature on FDI determinants is Blonigen and Piger (2014). Employing Bayesian Model Averaging (BMA), authors find that the gravity approach withstands the scrutiny of variable selection. After controlling for country pair effects, authors find that GDP and skilled-labour variables, also trade agreements, are all favored empirically. An important angle, pioneered by Blonigen and Piger (2014), was to consider three types of FDI – stocks, sales of affiliates, and mergers and acquisitions. Our focus on LICs makes some types less relevant, however, it is reassuring that, broadly interpreted, our theory-implied variables are favored by purely statistical approaches.[10]

3 Recent Facts

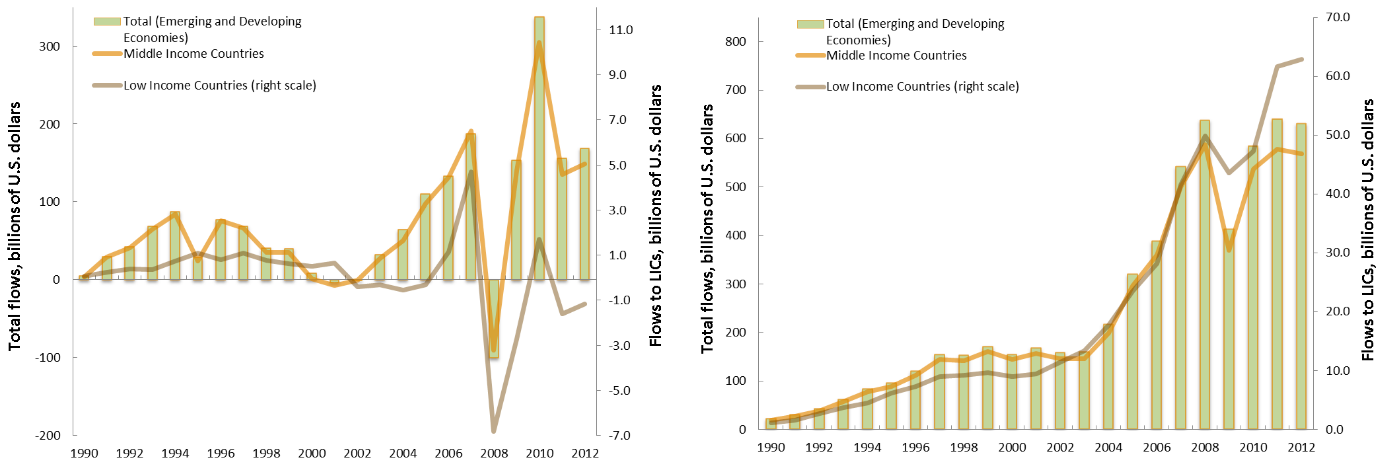
This section briefly overviews some interesting stylized facts on capital flows in developing economies over the last two decades by analyzing aggregate and bilateral flows data. It also reviews some of the factors related to private capital flows commonly discussed in the literature.

3.1 Trends in Developing Countries

Figure 1 describes the evolution of capital flows in low- and middle-income countries. It is clear that the current financial crisis has affected both groups considerably. Interestingly, LICs have started to receive substantial amount of capital only very recently (see the size difference in the right scale). The only period of intensified portfolio investments into LICs are a boom period before and, to some extent, after the financial crisis. Even FDI is a very recent phenomenon with a clear upward trend for LICs for a less than a decade.

[9] As a limitation, Okawa and van Wincoop (2012) demonstrate that gravity cannot be sustained once one allows for a general covariance structure of asset returns, while assuming that factors generating return co-movement cannot be separately hedged, also for taxes on foreign returns, and trade in only risky assets.

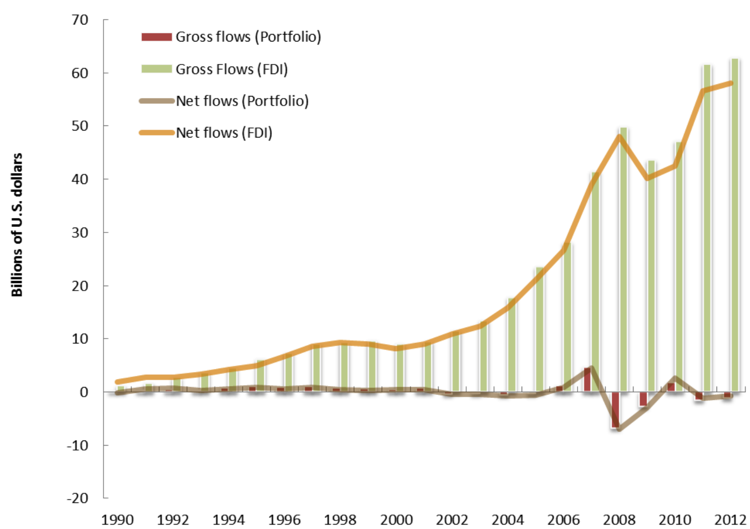
[10] Papers that have a special focus on LICs include Araujo, David, van Hombeeck, and Papageorgiou (2015a), Araujo, David, van Hombeeck, and Papageorgiou (2015b), Asiedu (2002), and Lane (2015), whereas empirically oriented papers with a more general coverage include Alfaro, Kalemli-Ozcan, and Volosovych (2008), Blonigen, Davies, Waddell, and Naughton (2007), Agiomirgianakis, Asteriou, and Papathoma (2003), Baltagi, Egger, and Pfaffermayr (2007), Baltagi, Egger, and Pfaffermayr (2008), Goldstein, Razin, and Tong (2008), Hattari and Rajan (2011), and Stein and Daude (2007), among others.



Note: The left scale measures total flows, the right scale – flows to LICs. Data: IMF, World Economy Outlook

Fig. 1: Portfolio Investment in LICs and MICs (left) and FDI in LICs and MICs (right)

Though FDI is dominant (see Figure 2), portfolio flows, as mentioned, have been taking some acceleration in recent years too. Due to requirements on some financial development, portfolio flows are more important for a few selected economies rather than being as widely spread out as FDI. Moreover, Figure 2 confirms the idea of FDI being relatively stable, most probably because of large fixed costs and, thus, lower liquidity, as compared to the portfolio flows, variation of which, on both positive and negative sides, is substantial.



Data: IMF, World Economy Outlook

Fig. 2: Composition of Capital Flows for LICs

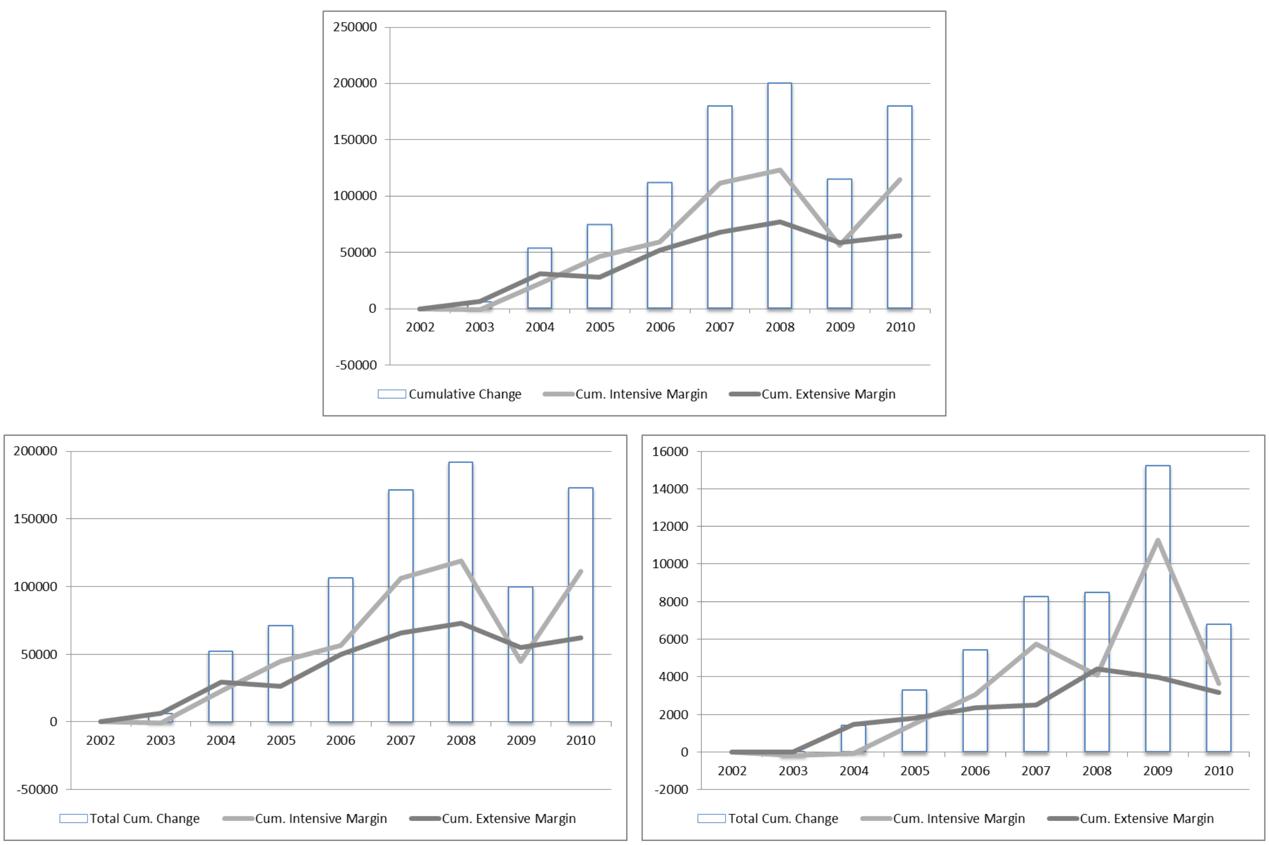
3.2 Intensive and Extensive Margins

To further understand the recent development in capital flows in developing countries, we decompose bilateral flows data on extensive and intensive margins. We draw from Felbermayr and Kohler (2006), which distinguish between changes in the number of active bilateral trade relationships (extensive margin), and the growth of trade volumes in existing relationships (intensive margin). In our context, if attraction in some cases is not strong enough to generate investment at all, then ignoring such cases altogether implies that we systematically overestimate the force of attraction or – equivalently – underestimate the investment-inhibiting force of spatial frictions. Push and pull factors are accounted for by bilateral gravity model with both *intensive* and *extensive* margins. The latter allows modeling newly established links, especially among newly emerged markets.

We use a similar approach for the capital flows analysis. There are a few reasons to concentrate on these two margins rather than the aggregate capital flow. At first, investigation of the extensive margin relates directly to diversification issues and welfare. If flows are based on portfolio diversification, then expansion of world financial movements on the extensive margin seems particularly important from a welfare perspective, since it increases the degree of diversification. Hence, we aim at consistently capturing simultaneous movements on both margins through time.

Moreover, there are many zero capital flows, especially to developing countries. Then, fixed costs generate decisions at the two margins, i.e., the direction and volume. It also helps establishing the path-dependency observed in investors' behavior (see Welch (1992) for the example with the initial public offering shares and references to many other applications). Further, fixed cost allows addressing the emergence of new destinations for investments once the structure of those costs in the country changes relative to the global system.

Our analysis makes it possible to track which factors are responsible for each of the two margins, explore the relative importance of both margins over time, and compare the portfolio and direct investment at each of the margins. A country is said to be financially open if it receives capital from at least one foreign country. Changes on the extensive margin are "weighted" by end-of-period average flow volumes, while changes on the intensive margin are "weighted" by beginning-of-period numbers of links. Our temporal dimension is short, therefore, results are not expected to be significantly affected by time weights (refer to the Online Appendix 10 for details).



Note: The upper graph depicts flows for all countries, the bottom left – MICs, the bottom right – LICs

Fig. 3: Cumulative Difference of Total, Intensive and Extensive Margins of FDI flows from 2002 to 2010

In Figure 3 we plot the changes in capital flows over time period 2003-2010, and their decomposition of the intensive and extensive margins. The graph helps exploring changes in the domination of the respective margins in good times and over economic crisis along the cross-sectional and the time-series dimensions of the data.

The variability of both intensive and extensive margins is substantial for the developing countries. Usually the adjustment takes place at the intensive margin because extensive margin requires reinitiating the link after it has been broken, which may be costly. Indeed, the positive capital flow between two countries arises only if their bilateral asset trade and investment potential exceeds some source-destination economy specific threshold value. Maintaining flow relationships requires certain infrastructure and institutions that facilitate an efficient flow of information and exchange of ideas, in addition to the best-practice banking system. Some relevant institutions are international payment systems, legal agreements, consulates or the activities of the respective chambers of commerce. Regarding portfolio flows, there should be organized equity or debt markets for receiving foreign capital.

Of course, all of these are market entry costs – broadly defined as non-production costs – that have been widely recognized to exist, hinder not only the flow of ideas or trade but also capital (both direct and private) by model of firm dynamics (see e.g., Hopenhayn, 1992, Foster, Haltiwanger, and Syverson, 2008, and Clementi and Palazzo, Forthcoming). In fact, a subset of these models argues that entry costs rise and also change in nature along the development path as different barriers appear with entry to new markets (see e.g., Grossman and Helpman, 1991, Luttmer, 2007, and Acemoglu, Akcigit, Bloom, and Kerr, 2013). On the empirical side, anecdotal evidence of entry costs in LICs and MICs have started to emerge with the pioneering work of Djankov, Porta, de Silanes, and Shleifer (2002), which gave way to the World Bank's Doing Business surveys that offer a glimpse of costs faced by firms including, for example, the number of procedures required to start a firm, and the minimum time for start up. The average costs of entry are found to be high in most developing economies with heavier entry regulations, larger informal economies, and higher corruption.

Firms, funds and other investors will not be able to invest in the absence of services provided by such institutions. Rational governments will invest into these institutions only if the expected benefit from a materializing capital flow potential in present value terms exceeds the investment cost. Therefore, capital inflow will only materialize if its full potential exceeds the threshold level, otherwise bilateral flow will be zero. To track recent changes in the capital network for LICs, refer to the Online Appendix 1, where we visualize and explore how initially a very sparse investment network has been evolving over time.

4 Theory

We now turn attention to modeling capitals flows. Our interest in the topic has been sparked by a steep rise in private capital flows to the emerging and developing countries in the middle of the past decade. Although such flows briefly reversed during the apex of the crisis, very low interest rates in advanced countries and an attenuation of global risk aversion have once again prompted investors to scour the globe in search of attractive investment opportunities. The private flows are increasingly the main source of external financing for many countries in the developing world. Moreover, private flows tend to be more volatile in LICs. There are many factors, which are influential in shaping capital movements. Instead of trying to account for all observable effects, we will instead follow a parsimonious theoretical model with a few important factors. We will try to account for all other factors, left unmodeled, through directional fixed effects, cross-sectional averages, and flexible relationship between intensive and extensive margins. It will turn out that, despite a different economic rationale, the data generating processes for the two types of capital flows are quite similar.

Our theoretical setup incorporates decisions to consume, also portfolio investment, and production choices, including investing abroad. Within the same framework, we introduce the horizontal FDI flows, which require several changes as the driving forces are presumably different compared to portfolio investment.[11] Mainly FDI are flows within multinationals or large companies whose motives can also be described by the gravity equation. For the direct investment, we mainly follow Helpman, Melitz, and Rubinstein (2008) and, instead of trade flows, adapt it to the capital flows.[12] To produce such a framework, we need to consider both, consumption and production sides of the economy (as, for instance, was done in Yotov and Olivero (2012) to model dynamic conditional gravity).

The simplifying assumption will be separability of total expenditure into (portfolio) investment and goods produced by firms located in different markets (FDI), afforded by the functional form choices. This is quite standard practice in the trade literature to arrive at a closed form and tractable expressions. For instance, Anderson and van Wincoop (2003) rely on seperability, whereas Head and Mayer (2015) follow Anderson (2011) and coin it as modularity, which means that output is determined in a different module from the allocation of bilateral flows. Hence, firms will be deciding on FDI, whereas the residual income will be invested to diversify portfolio by the agents. It is a multi-country setting featuring $\mathbb{N}$ countries indexed by $i = 1, \ldots, \mathbb{N}$. Unlike FDI models with labor as the only factor (for example, Anderson and van Wincoop (2003), Helpman, Melitz, and Rubinstein (2008), Bergstrand, Egger, and Larch (2008), among others), we assume two factors of production, labor l and capital k. Country i is endowed with L_i and K_i aggregate units of inelastically supplied labor and capital, respectively. Therefore, companies produce both consumption and investment goods, and can engage in the international activities.

Consider a simple two-period problem of agents in country i to choose aggregate consumption and investment goods (Q_i and I_i, respectively), and the allocation of consumption and investment goods across $\mathbb{N}$ countries (respectively, q_{in} and i_{in} for all n) to maximize the present discounted value (with a discount rate $1/(1+\rho)$) of a lifetime utility (for detailed derivations, see Online Appendix 8):

$$\max U_{it} \equiv \max_{\{Q_{it},\, I_{it},\, i_{it},\, q_{it}\}\geq 0} \left[\sum\nolimits_t \left(\tfrac{1}{1+\rho}\right)^{t-1} \mathbb{E}_1 U\left(Q_{it} + I_{it}\right)\right],$$

subject to

$$P_{it}Q_{it} + P_{it}I_{it} = E_{it},\ t = 1,\, 2,$$

where P_i refers to the aggregate price index for consumption and investment goods in country i, E_{it} is the aggregate expenditure, and $\mathbb{E}_1$ is an expectation operator at time 1. Time is discrete and, in principle, time's upper bound can be infinite, though we limit our analysis to the most trivial dynamics (mainly to reflect a very limited time dimension in the empirical exercise). The residual income will be denoted by $W_{it} \equiv E_{it} - P_{it}I_{it} - P_{it}Q_{it}$ and will be non-zero under imperfect competition only. Further, the consumption and investment goods are aggregated by the CES aggregators, i.e.,

$$Q_{it} = \left(\int_{\omega\in\Omega_i} q_{it}\left(\omega\right)^{\frac{\sigma-1}{\sigma}} d\omega\right)^{\frac{\sigma}{\sigma-1}},\ I_{it} = \left(\int_{\omega\in\Omega_i} i_{it}\left(\omega\right)^{\frac{\sigma-1}{\sigma}} d\omega\right)^{\frac{\sigma}{\sigma-1}},$$

with the same elasticity of substitution (note that $\omega \in \Omega_i$ denotes a brand as a subset of all available varieties in an economy). That is why aggregate prices are identical (see Yotov and Olivero (2012) for a similar approach).

The lifetime utility is maximized subject to the budget constraint, which accounts for spending on both consumption and investment goods across all countries. The production function of the representative firm in country i producing a brand ω is assumed to be,

$$y_{it}\left(\omega\right) = \frac{k_{it}^{\alpha_i}\left(A_{it}l_{it}\right)^{1-\alpha_i}}{\varphi},$$

[11] Though we concentrate on horizontal FDI and multinationals, a theoretic vertical multinationals model due to Helpman (1984) could be also employed. The main prediction is that multinational firms build plants in different countries according to the comparative advantage. We capture the dimension of factor price differences across the countries, but do not model trade patterns, and leave for the future the traditional trade gravity to be complemented with the current approach.

[12] A related piece of work is due to Helpman, Melitz, and Yeaple (2004) which has been a simplified version of firm selection with more symmetry than in Helpman, Melitz, and Rubinstein (2008). Similarly, heterogeneous firm framework has been utilized by Kleinert and Toubal (2010) which derive gravity relationship from the three different models of multinational firms.

where $y_{it}(\omega)$ summarizes output of variety ω, $l_{it}(\omega)$ is labor used in its production, $k_{it}(\omega)$ is capital used in production, $\alpha_i \in (0, 1)$ denotes the factor intensity of production in country i, A_{it} is a country-level labor augmenting technology, and $1/\varphi$ is a firm's idiosyncratic productivity. A firm uses k units of capital and l units of labor in variable production. The ownership structure is such that agents own firms and supply labor and capital for transformation into final goods.

To simplify our analysis, we choose iso-elastic utility function, which helps obtaining closed-form solutions for portfolio allocations, also makes consumption and investment decisions independent of each other.[13] Recall that for a constant relative risk aversion utility the investment decision is independent of the consumption decision (Samuelson, 1969 and Merton, 1969). Therefore, agents will be deciding on consumption, whereas heterogeneous firms will be deciding on production and direct investment. Portfolio investment will enter as another module, and will exist due to imperfect competition. Since firms have to overcome fixed costs before entering, we will call that requirement a fund and let households purchase claims over it. Firms' decisions will not be affected by the time dimension – we follow Melitz (2003) type dynamics, where each period is not linked to the previous one by intertemporal adjustments (this assumption is in line with our short dynamic panel but would certainly need a change had we analyzed developed economies under a longer horizon). That is, physical capital is not subject to adjustment costs. Consumption, however, is inherently linked in time, as households' assets purchased initially constitute an endowment in the final period. Admittedly, some assumptions are quite stark and is the price paid to arrive at tractable predictions. However, the very inclusion of spatial averages in our preferred empirical model relaxes some of the theoretical assumptions, and accommodates correlation among decision makers across different economies. We now turn to firm choices, and, for convenience, omit time subscript when it is not essential.

4.1 Firms Decisions

A firm with productivity φ from country i incurs costs

$$C_{in,t}(q) = v_{it}\left(q\tau_{in}\varphi + f_{in,t}\right)$$

to supply $q > 0$ units of goods to country n, where τ_{in} is 'iceberg' type variable trade costs and $f_{in,t}$ stands for fixed costs to enter n's market. We refer to v_{it} as the cost of the composite input bundle in a country i,

$$v_{it}(\omega) = \frac{r_{it}^{\alpha_i}\tilde{w}_{it}^{1-\alpha_i}}{\alpha_i^{\alpha_i}(1-\alpha_i)^{1-\alpha_i}},$$

where $\tilde{w}_{it} \equiv w_{it}/A_{it}$ and r_i are country i's (stationary) payments for labor and capital, respectively.[14] The marginal costs are $c_{in,t}(\varphi) \equiv dC_{in,t}(q)/dq = v_{it}\tau_{in}\varphi$. Profit maximization implies that a firm charges a constant markup over its marginal cost, $p_{in,t}(\varphi) = (\sigma/(\sigma-1))\, c_{in,t}(\varphi)$. In this case, a firm's market-specific revenue is proportional to its marginal cost,

$$R_{in,t}(\varphi) = \frac{(Q_{nt}+I_{nt})\,P_{nt}}{P_{nt}{}^{1-\sigma}}\left(\frac{\sigma}{\sigma-1}c_{in,t}(\varphi)\right)^{1-\sigma} = R_{nt}\left(\frac{p_{in,t}(\varphi)}{P_{nt}}\right)^{1-\sigma}, \tag{1}$$

[13] Isoelastic functions exhibit constant elasticities. A class of such functions is known as monomials, loosely understood as polynomials with only one term. The functional form is not that operational for FDI but is crucial for demand driven portfolio flows, as covered in the Online Appendix 8. Separability assumption is in line with the constant elasticity in a demand function, also closed-form solutions enable deriving a testable empirical model.

[14] We abstract from modeling exchange rate dynamics both theoretically and empirically, mainly because of the data for our targeted, developing, countries. It should be said, however, that Gourinchas and Rey (2007) emphasize that global imbalances and external imbalances (NXA) adjusted via the trade and the valuation channels. Hence, NXA is a linear combination of exports/imports and net foreign asset position. Corte, Sarno, and Sestieri (2012) find a strong predictive power for US dollar rates as well as other numeraire currencies for NXA on a bilateral basis across four major countries.

and its market-specific variable profit is proportional to its revenue. With Cobb-Douglas production functions, payments to labor and capital can be expressed as functions of revenue, i.e.,

$$\begin{aligned} w_{it} l_{in,t}(\varphi) &= (1-\alpha_i) R_{in,t}(\varphi), \\ r_{it} k_{in,t}(\varphi) &= \alpha_i R_{in,t}(\varphi). \end{aligned} \tag{2}$$

Firms engage in monopolistic competition. Because of Dixit-Stiglitz preferences, monopolists produce a constant output in equilibrium. It is a stylized fact that only a part of firms actually engage in activities abroad, see Bernard, Redding, and Schott (2007). In our setup, product and firm partitioning is fully determined by the productivity space since productivities map one-to-one to varieties. Therefore, we consider a measure of firms in country i, which invest into market n. This happens if the variable profit a firm earns there covers its fixed market access costs. Denote by $\varphi_{in,t}^{FDI}$ the productivity allowing to invest in country n

$$\left(\varphi_{in,t}^{FDI}\right)^{1-\sigma} \frac{R_{nt}}{\sigma^{\sigma}(\sigma-1)^{1-\sigma} P_{nt}^{1-\sigma}} = v_{nt}^{\sigma} f_{in,t}^{FDI}, \tag{3}$$

noting that no iceberg cost is paid when a firm chooses FDI over export, and production costs are priced in a destination country.[15] Hence, no trade costs will be featured in the equilibrium conditions. To enter, a firm incurs a fixed entry cost of $f^e > 0$ (assumed to be time invariant) units of the composite input bundle v_{nt}, making startup costs in country n to be equal to $f^e v_{nt}$. A modeling innovation is to treat these costs as a required fund (rather than as a disappearing black-box), which can be used by households to smooth their consumption. Upon entry, firms draw their productivity φ from the same distribution $G(\varphi)$, assumed to be truncated Pareto.[16] It is defined as $G(\varphi) = \frac{\varphi^k - \varphi_L^k}{\varphi_H^k - \varphi_L^k}$, $k > \sigma - 1$, where k is the shape parameter, and φ_H^k, φ_L^k denote the highest and the lowest value φ can assume. This framework allows for asymmetric capital flows, $M_{in,t} \neq M_{in,t}$, which may also be unidirectional, with $M_{in,t} > 0$ and $M_{in,t} = 0$, or $M_{in,t} = 0$ and $M_{in,t} > 0$.

To deal with the extensive margin, we introduce a latent variable, $Z_{in,t}^{FDI} \equiv \left(\varphi_{in,t}^{FDI}/\varphi_L\right)^{\sigma-1}$, which is the ratio of variable profits of the most productive firm to the fixed costs to invest from i to n (recall that the most productive firm is described by a productivity $1/\varphi_L$). Positive multinational sales are observed if and only if $Z_{in,t}^{FDI} > 1$.[17] Plugging in (3) and log-linearizing, yield (log values are denoted in a lower case, e.g., $\ln Z_{in,t}^{FDI} \equiv \mathsf{z}_{in,t}$):[18]

$$\begin{aligned} \mathsf{z}_{in,t} &= \gamma_0 - \phi_i - \phi_n - \gamma \ln \text{startup}_{in,t} - \sigma \ln v_{nt} + X_{nt} + \eta_{in,t} \\ &= \gamma_0 - \phi_i - \phi_n + \gamma \ln \text{startup}_{in,t} - \sigma \alpha_n \ln r_{nt} - \sigma (1-\alpha_n) \ln \tilde{w}_{nt} + X_{nt} + \eta_{in,t}, \end{aligned} \tag{4}$$

where we assumed an unobservable entry cost to be defined as $f_{in,t}^{FDI} = \exp\left(\gamma \ln \text{startup}_{in,t} + \phi_i + \phi_n - v_{in,t}\right)$, also $\eta_{in,t} \equiv u_{in,t} + v_{in,t} \sim N\left(0, \sigma_u^2 + \sigma_v^2\right)$ is an i.i.d. error where $u_{in,t}$ is a shock in the intensive margin, ϕ_i, ϕ_n are directional fixed effects (investor and destination), $\text{startup}_{in,t}$ refers to startup costs of establishing a company in a targeted economy, and X_{nt} captures the multilateral resistance term that is

[15] See Online Appendix 8.3 for the possibility to model trade flows; however, this aspect is not empirically addressed and is, thus, left for future research.

[16] As evidenced by Aoyama, Fujiwara, and Ikeda (2010), a number of phenomena obey the power-law distribution, such as income and net profit, capital and sales and the number of employees. Axtell (2001) also finds that Pareto reasonably approximates the observed distribution of firm sizes in the USA. As a caveat, however, we note that power laws are less successful in dealing with the smaller establishments, also with predicting a number of links for the most central firms in the network and firms with low in-degrees, refer to Atalay, Hortacsu, Roberts, and Syverson (2011).

[17] Refer to Helpman, Melitz, and Rubinstein (2008), which pioneered the use of the extensive margin in the empirical international trade.

[18] Note that the separation of input cost does not work in our model, as opposed to Behar and Nelson (2009), because FDI relies on destination country's labor hiring and capital rental rates. Econometrically, the extensive margin in our setting should be driven by destination variables only, i.e., destination multilateral resistance term, destination income, destination cost of labor and capital, and the fixed costs of direct investment. The source economy's effect is introduced by defining f_{in}^{FDI}, which is otherwise a hardly observable variable.

left unaccounted for by the fixed effects.[19] This means that identification comes from a pair-specific and time variation.[20] The latter, however, despite being short, is controlled by the cross-sectional averages. Another factor v_{nt} refers to payments to productive factors, which will be captured by labor productivity and capital cost.[21] Note that the fixed effects are crucial in the capital flows theory because they allow controlling for the state of domestic financial markets as well as other country-specific and time-invariant (or very slowly changing) effects.[22]

In this setup, the total direct investment from country i to country n is

$$\begin{aligned} M_{in,t}^{FDI} &= \left(\frac{\sigma-1}{\sigma}\right) \int_{\varphi_L}^{\varphi_{in,t}^{FDI}} p_{in,t}^{FDI}(\omega)^{1-\sigma} E_{nt} {P_{nt}}^{\sigma-1} N_{it} dG(\varphi) \\ &= E_{nt} P_{nt}^{\sigma-1} N_{it} \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} v_{nt}^{1-\sigma} V_{in,t}^{FDI}, \end{aligned} \tag{5}$$

where the selection is subsumed within a variable

$$V_{in,t}^{FDI} = \frac{k(\varphi_L)^{k-\sigma+1}}{(\varphi_H^k - \varphi_L^k)(k-\sigma+1)} \left[\left(\varphi_{in,t}^{FDI}/\varphi_L\right)^{k-\sigma+1} - 1\right], \tag{6}$$

and N_{it} is the mass of entering firms, which is an endogenous object. Note that the aggregation works for all companies at least as productive as the FDI investor with a productivity $\varphi_{in,t}^{FDI}$. The multilateral resistance index with firms investing abroad is defined as

$$\begin{aligned} P_{it}^{1-\sigma} &= \sum_{n=0}^{\mathbb{N}} N_{nt} \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1} v_{nt}^{1-\sigma} \int_{\varphi_L}^{\varphi_{in,t}} \varphi^{1-\sigma} dG(\varphi) \\ &= \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1} \sum_{n=0}^{\mathbb{N}} v_{nt}^{1-\sigma} N_{nt} V_{in,t}^{FDI}. \end{aligned} \tag{7}$$

In the endogenous entry case, the free entry condition implies that total profits are equal to zero, which leads to $((\sigma-1)/\sigma) E_{it} = ((\sigma-1)/\sigma) P_{it}(Q_{it} + I_{it})$ and $(1/\sigma) E_{it}$ goes to cover the required fund to start production (factors are paid their marginal products under constant returns to scale technology).[23] Using the result on the number of entering firms and the gravity equation

$$\sum_{n=1}^{\mathbb{N}} M_{in,t}^{FDI} = \frac{\sigma-1}{\sigma} E_{it} = N_{it} \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} \sum_{n=1}^{\mathbb{N}} E_{nt} P_{nt}^{\sigma-1} v_{nt}^{1-\sigma} V_{in,t}^{FDI},$$

and, getting rid of an endogenous N_{it}, we obtain

$$\begin{aligned} M_{in,t}^{FDI} &= \frac{\left(\frac{\sigma-1}{\sigma} E_{it}\right)\left(\frac{\sigma-1}{\sigma} E_{nt}\right) P_{nt}^{\sigma-1} v_{nt}^{1-\sigma} V_{in,t}^{FDI}}{\sum_{n=1}^{\mathbb{N}} E_{nt} P_{nt}^{\sigma-1} v_{nt}^{1-\sigma} V_{in,t}^{FDI}} \\ &= v_{nt}^{1-\sigma} V_{in,t}^{FDI} \frac{\left(\frac{\sigma-1}{\sigma} E_{it}\right)\left(\frac{\sigma-1}{\sigma} E_{nt}\right)}{\left[P_{nt}\Pi_{it}\right]^{1-\sigma}}. \end{aligned} \tag{8}$$

[19] Note that the price index and general revenues are the functions of variables that the destination economy has economic activities with (subsumed within X_{nt}; we ignore parameters on X_{nt} as they are nuisance for our purposes). We use cross-sectionally averaged variables in the Mundlak Chamberlain specifications to capture these effects, often ignored in the literature (also refer to the Online Appendix 9). There are few ways of dealing with $P_n \Pi_i$, the (directional) fixed effects being the most common approach, see Feenstra (2004). Other methods include approximation around a symmetric center in which all countries trade (see Behar and Nelson, 2009, Baier and Bergstrand, 2009), Bayesian approach (Koch and LeSage, 2009) and nonlinear estimation, as in Anderson and van Wincoop (2003).

[20] Note that an inclusion of pair-specific fixed effects would have left almost no variation for identification due to a short time dimension.

[21] Normality of errors can be relaxed by using a copula approach (see robustness checks in the Online Appendix 2). Further, note that a new destination fixed effect ϕ_n shall include factor intensities $\sigma \ln \alpha_n^{\alpha_n} (1-\alpha_n)^{1-\alpha_n}$, but we do not change notation as the model with a new fixed effect is observationally equivalent to the one reported in the equation (4).

[22] Failure to control for time invariant factors would have necessitated grouping countries by observable differences in the financial sophistication. Arguably, economies with a developed financial market are very different from the ones, where the required facilities to receive foreign capital are absent. In our case, all the time-invariant specificities are controlled for by fixed effects in both, source and destination economies.

[23] Endogenous entry, coupled with linear homogeneity, yields a full employment of productive inputs, $((\sigma-1)/\sigma) E_{it} = w_{it} L_{it} + r_{it} K_{it}$.

Note there is another multilateral resistance term (adjusted for the extensive margin V_{in}^{FDI}), included in the gravity-type relationship,

$$\Pi_{it}^{1-\sigma} = \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma-1} \sum_{n=1}^{\mathbb{N}} E_{nt} V_{in,t}^{FDI} \left(v_{nt}/P_{nt}\right)^{1-\sigma}, \tag{9}$$

which leads to an expression similar to that in Anderson and van Wincoop (2003). However, there are important differences. First, the destination cost term v_n is an aggregator of the labour costs and capital rental rate (a standard theory by and large fails to account for capital costs). Moreover, there are no trade costs, therefore, a standard distance variable is not featured (however, one can interpret that we proxy for an institutional distance in case of FDI flows and informational distance in the portfolio flows). Finally, there is also another term V_{in}^{FDI}, which captures the probability of entering into n's economy and the extensive margin of capital network (there is no partitioning in Anderson and van Wincoop, 2003). It is then clear that the flow of capital decreases, *ceteris paribus*, in destination's wages and cost of capital (recall that $\sigma > 1$), increases in own and destination expenditures, and increases in the multilateral resistance terms, which capture all the weighted costs to invest in all other economies.

Knowing the production behavior of firms, we have to account for their decisions with regards to a required fund. Engaging in asset trade (portfolio flows) provides a way to smooth agents' consumption.

4.2 Portfolio Decisions

We mainly build on Okawa and van Wincoop (2012) and demonstrate how the FDI model can be extended to portfolio flows in a global economy with $\mathbb{N}$ countries. Following the latter contribution, we define $\mathbb{N}+2$ assets, where the first $\mathbb{N}$ assets are country-specific risky assets, also a risk-free bond and an asset, return of which is perfectly correlated with the global shock. Both assets are in zero net supply.

Existence of the global asset, which allows hedging against the global risk factor, simplifies analysis considerably since the only risk that matters for portfolio allocation across the $\mathbb{N}$ equity is the country-specific risk. In other words, agents are given a chance to smooth their consumption by optimizing the weights over each country's firm funds. Let the amount to be invested be denoted by W_{it}, total income by E_{it}, consumption and investment goods by Q_{it} and I_{it}, and the price of an asset P_{it}. A simple accounting relation is described by

$$W_{i1} = E_{i1} - P_{i1}\left(Q_{i1} + I_{i1}\right) = \frac{1}{\sigma} E_{i1}.$$

Notice that the share of expenditure E_{it}, devoted for portfolio investment, is fixed by the elasticity of substitution, under the assumption of capital and labor being owned by agents (refer the equation (2)). In other words, we abstract from potential endogeneity of the very fraction of total output to be spent on portfolio investment but concentrate on how that fraction is allocated among many economies. Expenditure is also considered as given – households treat it as an exogenous variable, similarly to firm's decisions over FDI. That is, next period's level of expenditure is a function of investment opportunities globally but, despite a specific value realization, separability (modularity) makes sure that the same proportion is devoted to the fund. We interpret the appearance of firm market power as the need to have a fund, equal to $v_{it} f^e$, before starting to operate in the market. The accounting equation tells that the wealth is formed from unconsumed income – provided all expenditure was spent on consumption and investment goods in the initial period, there would be no need for portfolio investment. However, the latter can be used for consumption in the second period, and the agents need to take that aspect into account. Facing a short time dimension, we assume that assets and FDI are in net zero supply globally (recall that truncated Pareto admits asymmetry in bilateral FDI flows but requires global balancedness to close the model).

The agents' decision space includes consumption in both periods and allocation of claims across $\mathbb{N}+2$ assets in period 1. The budget constraint over the portfolio fund in period two is

$$W_{i1} R_{i2}^{p} = \frac{1}{\sigma} E_{i1} R_{i2}^{p},$$

where R_{i2}^{p} is the mean return of all country i's portfolio-type assets in period 2. That is, a value of the fund is equal to the share of expenditure that has been devoted to it, adjusted for by the average return. More precisely, the portfolio return is a weighted average,

$$R_i^p = \sum_{n=1}^{\mathbb{N}} w_{in} R_n + w_{ig} R_g + w_{if} R_f,$$

where w_{in} describes country i's fraction invested in country n, yielding return R_n, w_{ig} is the fraction invested in the global asset (with return R_g), and w_{if} is the share invested in the risk-free asset, return of which is R_f. It is assumed that due to differences in language and regulatory systems, and easier access to local information, domestic agents are more informed than foreigners about the idiosyncratic payoff components on domestic equity claims. In other words, suppose that country i return includes a stochastic payoff innovation ϵ_i, and, from the perspective of agents in country i, ϵ_n has a mean of 0 and variance $\tau_{in}\sigma_n^2$, where information asymmetry is captured by $\tau_{in} > \tau_{nn}$, when $n \neq i$. Hence, there is more uncertainty about foreign payoffs if an investor is from a home economy. Iceberg costs are split at the country pair level but are otherwise assumed to be identical.

4.2.1 Portfolio Flows Gravity

Denote by w_{ii} the share invested in the domestic economy, and let w_{in} be the shares invested in n from i.[24] Then the fraction employed in the riskless activity, w_{if}, is:

$$w_{if} = 1 - w_{ii} - w_{ig} - \sum_{n \neq i}^{\mathbb{N}} w_{in}.$$

We then have to define the household's budget constraint, also the objective function and impose regularity conditions to obtain the solutions. To concentrate on empirics, we simplify by choosing a special case of iso-elastic utility function, $\lim_{\eta \to 1} \frac{Q^{1-\eta}-1}{1-\eta} = \ln(Q)$. With the logarithmic utility, we obtain that consumption is proportional to portfolio investment (and the latter proportional to wealth, which is a function of expenditure, as described above). A reader is referred to the Online Appendix 8 for a more detailed derivation. Given the CES demand structure, the optimal choice of an agent boils down to solving

$$\begin{gathered}
\max_{\left\{Q_{i1}, Q_{i2}, \{w_{in}\}_{n=1}^{\mathbb{N}}\right\} \geq 0} \left[\ln(Q_{i1} + I_{i1}) + \tfrac{1}{1+\rho}\mathbb{E}_1 \ln(Q_{i2} + I_{i2})\right], \\
\text{s.t. } P_{i1}(Q_{i1} + I_{i1}) + \tfrac{1}{\sigma} E_{i1} = E_{i1}, \\
P_{i2}(Q_{i2} + I_{i2}) = \tfrac{1}{\sigma}\left(\textstyle\sum_{n=1}^{\mathbb{N}} w_{in} R_n + w_{ig} R_g + w_{if} R_f\right) E_{i1}, \\
\textstyle\sum_{n=1}^{\mathbb{N}} w_{in} + w_{if} + w_{ig} = 1.
\end{gathered}$$

Investment and consumption shares are pinned down by the elasticity of substitution in the first period. Further, note that the value of a fund in the second period is fully used for consumption and investment goods, as there is no future and no market entry. Hence, households can buy a claim of firm funds all over the world, and that affects their consumption. We can use the first period's constraint in the expression for the second period, and compute the consumption Euler equation (as we have no money in the model economy, we use $P_{i2} = 1$ as a numeraire):

$$\frac{1}{1+\rho}\mathbb{E}_1 \frac{1}{Q_{i2} + I_{i2}} = \frac{1}{P_{i1}(Q_{i1} + I_{i1})} \frac{1}{R_i^p}$$

which, upon substitution into the budget constraint, yields

$$\frac{\sigma - 1}{1 + \rho} = 1.$$

[24] See Tille and van Wincoop (2010), which focus on the new approximation and solution method to compute optimal shares in the DSGE framework. A closely related but independent paper that uses effectively the same solution strategy is Devereux and Sutherland (2011).

This is an important implication of the model: for the fund to be consistent with agents' investment decisions, elasticity of substitution shall be larger than 2, and be equal to $\sigma = \rho + 2$, where ρ measures agents' impatience (infinite impatience would have implied that all the income is consumed in the first period, with no investment, consistent with the infinite substitutability, which leads to zero value fund). Since the foregone utility in period 1 is the same for agents in economy i, and the risk-free asset is an existing alternative, the other two components in R_i^p must comply to the following Euler equations:

$$\tfrac{1}{1+\rho}\mathbb{E}_1 \tfrac{1}{Q_{i2}+I_{i2}} R_i = \tfrac{1}{1+\rho}\mathbb{E}_1 \tfrac{1}{Q_{i2}+I_{i2}} R_f \text{ for all } i = 1, \ldots, \mathbb{N},$$
$$\tfrac{1}{1+\rho}\mathbb{E}_1 \tfrac{1}{Q_{i2}+I_{i2}} R_g = \tfrac{1}{1+\rho}\mathbb{E}_1 \tfrac{1}{Q_{i2}+I_{i2}} R_f.$$

These conditions embody tradeoffs between investment in the equity claim of country n and either the risk-free or global assets. We employ local approximation solution method to derive the optimal shares to be invested in each economy. Since returns are stochastic, we need to capture higher than zero order (deterministic) terms, as allocation cannot be a deterministic state. Our solution entails terms up to the second order.[25]

The optimal investment shares are given by

$$w_{in} = \gamma_{in}(\tau_{in})\,\widetilde{R}_n,$$

where $\widetilde{R}_n \equiv \mathbb{E}_1 (\ln R_n(2) - \ln R_f(2)) - \frac{\theta_n}{\theta_g}\mathbb{E}_1 (\ln R_{g2}(2) - \ln R_{f2}(2))$, $1/\gamma_{in}(\tau_{in}) = \ln R(0)^2 \tau_{in}\sigma_n^2$, weights θ_n/θ_g determine the strength of a transmitter of global payoff innovation (where θ_g is a weighted average of θ_n, such that all $\theta_n = 1$ imply $\theta_g = 1$). The returns term $\widetilde{R}_n$ refers to the second-order components, implying that we have considered the effect of variances, covariances, and squares of return innovations. Using the weights yields the steady state total fund claims by agents from country i as

$$\sum_{n=1}^{\mathbb{N}} w_{in} W_i = \sum_{n=1}^{\mathbb{N}} \gamma_{in}(\tau_{in})\,\widetilde{R}_n W_i,$$

where the price index $\mathcal{P}_i \equiv \sum_{n=1}^{\mathbb{N}} \gamma_{in}(\tau_{in})\,\widetilde{R}_n = \sum_{i=1}^{\mathbb{N}} w_{in}$ is such that the value of a fund is $\mathcal{P}_i W_i$. This produces the total equity claim by country i on country n as

$$w_{in} W_i = \gamma_{in}(\tau_{in})\,\widetilde{R}_n W_i. \tag{10}$$

Bilateral asset demand depends on the price (risk-return ratio) of country i equity relative to an overall price index. To close the model, we impose a standard set of market clearing equations, $\sum_{i=1}^{\mathbb{N}} w_{in} W_i = \frac{1}{\sigma} E_n = W_n \mathcal{P}_n$. This yields

$$\sum_{i=1}^{\mathbb{N}} \gamma_{in}(\tau_{in})\,\widetilde{R}_n W_i = W_n \mathcal{P}_n = \frac{1}{\sigma} E_n,$$

Therefore, the returns are described by

$$\widetilde{R}_n = W_n \mathcal{P}_n \frac{1}{\sum_{i=1}^{\mathbb{N}} \gamma_{in}(\tau_{in})\, W_i} = \frac{W_n \mathcal{P}_n}{\mathit{\Pi}_n},$$

where $\mathit{\Pi}_n \equiv \sum_{i=1}^{\mathbb{N}} \gamma_{in}(\tau_{in})\, W_i$ is the so-called portfolio multilateral resistance variable that measures the average financial frictions for country n as a destination country. Substituting this solution back into (10), we get the following specification for bilateral asset holdings (an intensive margin):

$$w_{in} W_i = \gamma_{in}(\tau_{in}) \frac{W_n \mathcal{P}_n}{\mathit{\Pi}_n} \frac{W_i \mathcal{P}_i}{\mathcal{P}_i} = \gamma_{in}(\tau_{in}) \frac{\left(\frac{1}{\sigma} E_n\right)\left(\frac{1}{\sigma} E_i\right)}{\mathit{\Pi}_n \mathcal{P}_i},$$

where optimal weights are the n's share in the total equity weighted by the relative financial friction $\gamma_{in}(\tau_{in})/\mathit{\Pi}_n$.

[25] The meaning is simple: stochastic return can be decomposed into its components of different orders, $R_i = R_i(0) + R_i(1) + R_i(2) + \ldots$. The first order accounts for a standard deviation, the second order includes variance, covariance, square of error or a product of two errors, and so on.

4.2.2 Extensive Margin

Similarly to foreign direct investment, a regularity of home bias requires an introduction of the fixed costs of holding foreign assets. This partitions investors into two groups: investors with access to international financial markets (all equity) and investors with no such access (only domestic equity). Both groups can still invest in the risk-free and global assets. This changes the optimal shares for domestic investors, namely, $w_{ii}^{D} = \gamma_{ii}(\tau_{ii})\widetilde{R}_i$, and investors with the access to international finance, $w_{in}^{A} = \gamma_{in}(\tau_{in})\widetilde{R}_n$.

The market equilibrium yields

$$\frac{1}{\sigma}E_n = \sum_{i\neq n}^{\mathbb{N}} w_{in}^{A}W_i^{A} + w_{ii}^{D}W_i^{D} = \sum_{i\neq n}^{\mathbb{N}} \gamma_{in}(\tau_{in})\widetilde{R}_n W_i^{A} + \gamma_{ii}(\tau_{ii})\widetilde{R}_i W_i^{D}, \tag{11}$$

where $W_i = W_i^{A} + W_i^{D}$, $\mathcal{P}_i \equiv \sum_{n=1}^{\mathbb{N}} \gamma_{in}(\tau_{in})\widetilde{R}_n\delta_{in}$, and

$$\delta_{in} = \begin{cases} 1, & i \neq n, \\ W_i/W_i^{A}, & i = n. \end{cases} \tag{12}$$

Using the aggregate demand for equity in country i in (11) yields $\frac{1}{\sigma}E_i/\mathcal{P}_i = W_i^{A}$, and, applying the same logics as before, $\widetilde{R}_n = \frac{1}{\sigma}E_n/\left(\sum_{i=1}^{\mathbb{N}} \gamma_{in}(\tau_{in})W_i^{A}\delta_{in}\right)$, hence, $\mathit{\Pi}_n = \sum_{i=1}^{\mathbb{N}} \gamma_{in}(\tau_{in})W_i^{A}\delta_{in}$. Plugging this result into the new flows equation, we obtain

$$\begin{aligned} M_{in}^{I} &= \gamma_{in}(\tau_{in})\widetilde{R}_n\delta_{in}\left(\tfrac{1}{\sigma}E_i\right)/\mathcal{P}_i \\ &= \gamma_{in}(\tau_{in})\frac{\left(\frac{1}{\sigma}E_n\right)\left(\frac{1}{\sigma}E_i\right)}{\mathcal{P}_i\mathit{\Pi}_n}\delta_{in} \end{aligned} \tag{13}$$

because $\delta_{in} = 1$ when $i \neq n$ and $W_i^{A} = \delta_{ii}W_i$ otherwise. This is the equation we will use for estimation purposes. Recall that δ_{in} embodies a fixed cost friction that partitions investors into two classes: domestic and internationally diversified ones. Effectively, this is like Z_{in} variable in the FDI case. Notice that there is no distance effect but there are informational frictions, which make investors from abroad worse-off. In other words, there is an embedded regularity of a home bias.

In short, under given functional form restrictions for utility and production function, the two decisions are *conditionally* independent. To see this, notice that, had we conditioned on expenditure levels, we could have predicted portfolio flows and FDI separately, as they are potentially driven by different set of variables. However, if we fail to condition on bilateral expenditure levels (E_i and E_n), then FDI and portfolio are endogenously interlinked, and their separate treatment may lead to biased results (we can, therefore, indirectly test if separability is a viable assumption). Statistically, both FDI and FPI can be modeled separately, according to the theory, if one includes incomes of both economies. We will explore a few theoretical implications after reporting major empirical results. However, before turning the empirical model, we first describe the employed variables.

4.3 Data and Variables

In our estimation, we combine a number of datasets, covering 135 destination economies (71 LICs and 64 MICs) and 25 OECD economies, which are investors (refer to the Appendix A for the country identities). The time frame is 2002 to 2010, thus forming a short unbalanced panel. Capital flows data come from IMF (Coordinated Portfolio Investment Survey, CPIS), which measures the global stock and geographical distribution of portfolio investment holdings, as reported by creditor countries. Therefore, data refer to the asset side, and account for equity and investment fund shares, and debt instruments. The total portfolio assets are expressed in USD dollars (end of period) and linked by the holder and issuer. The FDI flows are accounted for by the OECD (Globalization statistics). They are measured as outward flows for a particular year, measured in USD dollars, as investment by the source economy into a host economy with the lasting interest in an enterprise with at least 10% of the voting power in a company. Advanced economies should be more reliable sources to account for capital flows, so we use outward rather than inward flows.

Other variables are summarized in the 1, together with the sources of data and brief descriptions. Conversion of theoretical model into an estimable model is not straightforward, and we relied on a few proxies due to limited data for developing countries. We exploit the cost side, which has been emphasized in a number of studies. Recall that prices, and thus capital flows in a gravity form, are functions of v_n, the cost of the composite input bundle. For instance, we use wages statistics from International Labor Organization to proxy for labor productivity – the two agree in perfect labor markets, otherwise, there is some disconnect. Wages are purported to be economically relevant in Egger and Radulescu (2011) too:[26] a firm cares about employer-borne taxes of high skilled workers, who are elemental to the firm set-up, because higher wage costs lead to higher costs of production. Authors employ the average wage in the manufacturing sector; unfortunately, this measure is unavailable for many developing countries in our sample. Therefore, we will use a more aggregate measure. Razin, Sadka, and Tong (2008) emphasize the role of labor productivity rather than costs in the host country to increase the volume of the FDI flows through the standard marginal profitability effect.[27] Productivity is also proxied by fitting a regression on capital over labor ratio and years of schooling. Though theoretically acknowledged, startup costs are not included in their estimating equations. Seeking a more structural approach and already having accounted for the effects of GDP in our estimating equations, we measure labor productivity by using wage data. However, we experiment with the value added at factor cost in the robustness checks.

Similarly, we use lending rate to proxy for capital productivity as well as theoretically derived rates from Lowe, Papageorgiou, and Perez-Sebastian (2012), used as a robustness check due to their limitation in country coverage. For more details refer to the Appendix A.

[26] Egger and Radulescu (2011) concentrate on the effective labor tax rates and bilateral outward FDI stocks among 52 countries in 2002 and document that the employee-borne part of labor taxes determines bilateral FDI significantly different from zero. Moreover, personal income tax rates turn out somewhat less important than profit tax rates. Taxes affect FDI in more complicated ways, as emphasized by Razin, Rubinstein, and Sadka (2005), which argue that international tax differentials act on the direction and magnitude of FDI flows in a different way: the source country tax rate works primarily on the selection process, whereas the host-country tax rate affect mainly the magnitude of the FDI, once they occur. In a similar spirit of our analysis, Razin and Sadka (2007c) analyze FDI flows along two margins, intensive and extensive. Their question is the effect of corporate tax rate on FDI flows for 18 OECD economies in a period of 1987-2003. Authors also analyze the role of labor productivity on the flows (the productivity is measured as output per worker in PPP value). Their prediction of a positive effect on the intensive margin with an ambiguous effect on the extensive margin finds some empirical support.

[27] However, such a shock may lower the likelihood of making any new FDI flows by the source country through a total profitability effect due to an increase in domestic input prices. A sample of 62 OECD and non-OECD countries over the period 1987-2000 was analyzed by Razin, Sadka, and Tong (2008) using the Heckman procedure with two margins: one decides how much to invest abroad, while ignoring the fixed setup cost; then, a decision is made whether to invest at all, taking into account this cost. The key explanatory variable, productivity is the output per worker as measured by PPP-adjusted real GDP per worker.

Tab. 1: Sources of non-investment variables

Variable	Description	Data Source
Contract risk*	The risk of contract modification or cancellation and, at worst, expropriation of foreign owned assets	ICRG, The PRS Group, Inc.
Startup costs	Cost to register a business, normalized by gross national income per capita	World Bank's Starting Business Database
The marginal productivity of capital (MPK)	Private MPK uncovered from the sectoral share of investment using IMF (WEO)	Lowe, Papageorgiou, and Perez-Sebastian (2012)
Gross domestic product	GDP based on PPP valuation (international dollars)	IMF (WEO)
Wages	GDP per person engaged at constant prices and PPP	ILO (KLIM), sourced from many databases (GDP and employment)
Lending rate	Lending interest rate (%)	World Bank/IMF (WEO)
Bilateral investment treaty (BIT)	A dummy for having signed a bilateral investment treaty at a given year or earlier	International Investment Agreements Navigator, UNCTAD; author's coding
Proxy for labour productivity (cost/GDP)	Value added at factor cost (constant 2000 US dollars)	World Bank

* A higher value reflects lower risk.

5 Empirical Analysis

In a system with many zero capital flows, care must be taken to model zero observations and their relationship with the volumes of capital flows. Note that a higher number of investors implies higher asset trade volumes. However, this extensive margin is negatively correlated with the financial, institutional and informational frictions, and omitting a control for it would lead to overestimation of these barriers on capital flows. Another source of bias is the selection when country pairs with zero capital flows are excluded. It induces a positive correlation between the unobserved disturbance terms and various flow frictions (see Online Appendix 9 for an extensive treatment of econometric methodology, including probit, pseudo-Poisson maximum likelihood, correlated tobit and panel extensions tailored specifically for our theoretical framework).

Thus, extensive margin requires to account for the decision to invest in a location out of many existing possibilities.[28] Henceforth, we will concentrate on two most popular methodologies – probit and tobit modeling. We will emphasize both statistical aspects as well as differences in economic treatment of capital flows of value zero. Our statistical novelties include treatment of absence of capital flows as a deliberate decision, in accord with the theory,[29] rather than as purely missing observations, also the explicit

[28] There are several alternatives to model this decision making. To account for both margins, trade literature has used probit (Helpman, Melitz, and Rubinstein, 2008), logit (Crozet and Koenig, 2010), tobit (Felbermayr and Kohler, 2006) and Poisson (Santos-Silva and Tenreyro, 2007, Silva and Tenreyro, 2009) specifications. Though all these models are similar in many ways, they possess some differences. Poisson specification is best suited for modeling data with heteroskedastic disturbances. Probit works best when a large number of dependent variable assumes the value of zero. Probit and tobit differ, however, in how the unobserved flow is translated into the observed one. In the tobit model, we know the value of latent flow $M^{\star}_{in}$ when $M^{\star}_{in} > 0$, while in the probit model we only know if $M^{\star}_{in} > 0$, so the former should be more efficient. From a technical point of view, the tobit loglikelihood function is really a probit model combined with a truncated regression model, with the coefficient vectors in the two models restricted to be proportional to each other. This restriction can be tested by means of an LR test.

[29] The extensive margin is particularly acute for the developing countries as demonstrated in the Section 3 on empirical facts.

treatment of cross-sectional dependence and arbitrary dependence between two, intensive and extensive, margins. Moreover, the incidental parameter problem is attenuated by using a tobit specification – this aspect, despite fixed effects being particularly important in the gravity literature, has been largely ignored despite a frequent use of nonlinear specifications.[30] Moreover, compared to the literature, we also allow for a richer structure to capture the unobserved multilateral resistance terms. A number of important robustness checks are also pursued, some of which not entertained in the empirical capital flows studies (copulae methods or iteratively differenced multiple fixed effects).

5.1 Estimating Equilibrium Relations

We seek to map our parsimonious theoretical account of the main forces of capital flows into estimating relations. Ignoring any constant terms (elasticities of substitution, which will be captured by time invariant effects), our main equations of interest are as follows (the first one refers to the equation (8) whereas the second is (13)):

$$M_{in,t}^{FDI} = v_{nt}^{1-\sigma} V_{in,t}^{FDI} \frac{\left(\frac{\sigma-1}{\sigma} E_{it}\right)\left(\frac{\sigma-1}{\sigma} E_{nt}\right)}{\left(P_{nt}\Pi_{it}\right)^{1-\sigma}}, \tag{14}$$

and the portfolio investment as

$$M_{in,t}^{I} = \gamma_{in,t}\left(\tau_{in,t}\right) \frac{\left(\frac{1}{\sigma} E_{nt}\right)\left(\frac{1}{\sigma} E_{it}\right)}{\mathcal{P}_{it} \mathit{\Pi}_{nt}} \delta_{in,t} \tag{15}$$

In other words, the entire expenditure is composed of FDI and portfolio capital.[31] Notice that the relative size of portfolio to FDI flows is being pinned down by the three intuitive terms, i.e.,

$$\frac{M_{in,t}^{I}}{M_{in,t}^{FDI}} \propto \frac{\gamma_{in,t}\left(\tau_{in,t}\right)}{v_{nt}^{1-\sigma}} \frac{\left(P_{nt}\Pi_{it}\right)^{1-\sigma}}{\mathcal{P}_{it}\mathit{\Pi}_{nt}} \frac{\delta_{in,t}}{V_{in,t}^{FDI}}, \tag{16}$$

where $\gamma_{in,t}\left(\tau_{in,t}\right)/v_{nt}^{1-\sigma}$ refers to relative (bilateral) variable costs, associated with investment, $\left(P_{nt}\Pi_{it}\right)^{1-\sigma} / \left(\mathcal{P}_{it}\mathit{\Pi}_{nt}\right)$ stands for the relative multilateral resistance terms, and $\delta_{in,t}/V_{in,t}^{FDI}$ denotes a ratio of extensive margin terms (factors, affecting the very probability to invest). Taking logs in (14)-(16) and introducing stochastic shocks,[32] lead to

$$\ln M_{in,t}^{FDI} = \beta_{in}^{FDI} + (1-\sigma)\left[\alpha_n \ln r_{nt} + (1-\alpha_n)\ln w_{nt} - \ln P_{nt} - \ln \Pi_{it}\right] + \ln E_{it} + \ln E_{nt} + \ln V_{in,t}^{FDI} + \varepsilon_{in,t}^{FDI}, \tag{17a}$$

$$\ln M_{in,t}^{I} = \beta_{in}^{I} + \left[\ln \gamma_{in,t}\left(\tau_{in,t}\right) - \ln \mathcal{P}_{it} - \ln \mathit{\Pi}_{nt}\right] + \ln E_{it} + \ln E_{nt} + \ln \delta_{in,t} + \varepsilon_{in,t}^{I}, \tag{17b}$$

$$\begin{aligned} \ln\left(M_{in,t}^{I}/M_{in,t}^{FDI}\right) = {} & \beta_{in}^{I/FDI} + (1-\sigma)\left(\ln P_{nt} + \ln \Pi_{it}\right) - \left(\ln \mathcal{P}_{it} + \ln \mathit{\Pi}_{nt}\right) + \ln \gamma_{in,t}\left(\tau_{in,t}\right) \\ & - (1-\sigma)\left[\alpha_n \ln r_{nt} + (1-\alpha_n)\ln w_{nt}\right] + \left[\ln \delta_{in,t} - \ln V_{in,t}^{FDI}\right], \end{aligned} \tag{17c}$$

[30] Refer to Greene (2004) for the Monte Carlo simulations, which demonstrate that slope parameters in the tobit specifications are robust to incidental parameter problem. However, efficiency is affected. Therefore, we conduct an iterative demeaning procedure, along the lines of Guimarães and Portugal (2010), and demonstrate that linear probability models with demeaned two-way fixed effects would have yielded largely the same results. Not only their slopes are not affected by the incidental parameter problem but deviations from Gaussianity are also way less consequential. Therefore, very similar results are reassuring. Note that Poisson model, put forward by Santos-Silva and Tenreyro (2007), does not suffer from the incidental parameters problem with two fixed effects, as demonstrated by Fernandez-Val and Weidner (2016). We will contrast results with the Poisson pseudo-maximum likelihood approach in the robustness section.

[31] Constant elasticity of substitution yields fixed proportionality and makes consumption and trade separable.

[32] We could have added shocks in labor and technology, as is standard in empirical macroeconomics literature, instead of this more ad hoc approach, but that would not have changed our estimation. The introduction of shocks more structurally is important when one wants to explore, say, demand and supply effects. This is not feasible having very short panel as is ours.

such that the extensive margins are given in the equations (4) and the definition of δ_{in} in (13) for FDI and portfolio flows, respectively. The intensive margins for both FDI and portfolio flows in (17a) and (17b) justify using the same expenditure (GDP) aggregate variables. Using fixed effects is crucial – the arbitrary correlation must be allowed for controlling different development stages of financial markets, in particular, for the set of LICs, also general equilibrium effects. We will use startup costs to model the decision to invest (FDI) and contract enforcement for FPI. Both capture institutional differences, whereas the second one has aspects of informational distance, too.[33] Note that we include directional, source and destination, fixed effects but not pair fixed effects. Controlling for all time-invariant factors at a pair level would have made estimation even less structural and barely feasible with a short time series, which is still pertinent to LICs. However, our preferred Mundlak-Chamberlain approach enables controlling for unobserved factors, therefore, there is a degree of correlation between decisions to invest that is allowed for in the econometric setting. Cross-sectional averages also capture spatial correlations and common dynamic effects, such as financial development or technology. Coupled with fixed directional effects, we have a rich correlation structure that is accounted for in the error term.

We first proceed under the assumption $\varepsilon_{in,t}^{FDI} \perp \varepsilon_{in,t}^{I}$ (after conditioning on covariates), which can be relaxed estimating both flows simultaneously with unspecified covariance structure. The two equations are functions of income at investor and the destination economy, global effects are captured by the multilateral resistance terms (we will control for the cross-sectional dependence too), and selection effects are taken care by V_{in}^{FDI} (empirically taken care by z_{in}) and δ_{in}. The difference lies in capital and labor prices featuring in FDI flow but not in the portfolio flow. The extensive margins are modeled as functions of fixed effects and startup costs, with factor payments for FDI extensive margin and contract risk for the portfolio extensive margin.

To appreciate the econometric issues involved, we start with the standard approach, when extensive margin is totally ignored. We then proceed to more flexible ways of modeling two margins. To be more precise, our first choice is coined as Lognormal Hurdle. We effectively treat intensive and extensive margins as being independent, conditional on explanatory variables. Economically, we treat absence of financial flows as a conscious decision, rather than a missing observation as in Heckman approach, applied by, for instance, Razin, Rubinstein, and Sadka (2005); Razin and Sadka (2007c); Razin, Sadka, and Tong (2008) for FDI flows or Helpman, Melitz, and Rubinstein (2008) for trade flows. Not only theory hints that partitioning into investor and non-investors arises as an optimal equilibrium result, Heckman approach also requires exclusion restriction, which is not necessarily needed for two-part models for corners at zero.[34] What is more, idiosyncratic shocks for the two margins are likely to be correlated, thus causing efficiency issues. This leads to our second approach, coined as Exponential Type II Tobit (ET2T), where we allow for common unobserved factors. Let financial flow be $M_{in}^{\star} = \exp(\boldsymbol{X}_{in}\beta + u)$ and the extensive margin be $\{\Pr(M_{in} > 0 \mid \boldsymbol{X}_{in})\} = 1(\boldsymbol{X}_{in}\boldsymbol{\gamma} + v > 0)$, then we allow u and v to be correlated.[35] Yet, we still think that the multilateral resistance terms have not been fully captured by directional (source-destination) fixed effects, hence, we also cover Mundlak Chamberlain panel. This aspect has not been fully entertained in the literature. That is, we believe that the dynamic nature of the global effects, as captured by the multilateral resistance terms, cannot be fully accounted for by time-invariant fixed effects.

Mundlak Chamberlain panel allows us relaxing the crucial random effects assumption of indepen-

[33] Notice that contract enforcement will be used to proxy for both, $\gamma_{in}(\tau_{in})$ and δ_{in}. As stated, will use startup costs to proxy for the institutional setting, also for the purposes to see whether portfolio flow can be treated as the substitute when costs establishing a long-run business relationship are too high.

[34] It is well known that Heckman approach works with an exclusion restriction as otherwise the correlation coefficient between two margins is poorly identified, also leading to identification issues for other parameters of the model.

[35] Cragg's original specification was relaxed by Jones (1992) to allow for correlated errors. In such a case, both parts of the (normal) likelihood function must be maximized simultaneously as there is no two-step procedure to split the likelihood. Literature has emphasized that if the assumption of homoskedastic, normally-distributed, errors is violated, then ML estimates are inconsistent. See Robinson (1982) which demonstrates that ML estimation of latent dummy variable models yields inconsistent estimates if the assumption of normality does not hold. We run a few robustness checks on heteroskedasticity, including Poisson regressions and size-adjusted capital flows.

dence of individual effects and independent variables, and enables analysis when error terms in decision and volume equations are correlated. To achieve this in the panel probit model, we follow Papke and Wooldridge (2008) in that the unobserved effects are proxied by the observables which are time averages of the independent variables $\boldsymbol{X}_{it}$, and this helps dealing with more general unobserved heterogeneity.[36] We report results of this procedure under the heading "Mundlak Chamberlain Panel".[37] This approach also helps to parametrize multilateral resistance terms and allows them vary in a very parsimonious way. We also worry about parametric assumptions, stability, heteroskedasticity, negative flow values, and the measurement of variables – all of these issues are addressed in the robustness checks.

6 Baseline Results

Let us start with the baseline regressions for FDI, reported in Table 2, where two margins are modeled separately. Results do not account for changes in capital network evolution, effectively treating the variable z_{in} as irrelevant. The measures of fit refer to within (R-squared from the mean-deviated regression), between (the squared correlation between predicted values using FE and the within-individual means of the original dependent variable) and overall (the squared correlation between predicted values using FE and the untransformed dependent variable). In our model larger destination income should act as an attractor and incentivize the investment. Opposite to the gravity predictions, results seem to support neoclassical theory for MICs and overall sample (the elasticity of destination income is negative), with no significant effects for LICs. However, this result echoes findings in Baltagi, Egger, and Pfaffermayr (2008), where FDI increases in the difference of home-to-host GDPs (thus, for a given level of home economy, FDI increases in a lower host's GDP). Investment increases in source income and destination labor productivity (wages) but decreases in capital rental rate (lending rate). Note that a failure to include directional fixed effects would have made positive correlation for both incomes (refer to the Online Appendix 1, where depicted unconditional correlations are clearly positive). It seems that allowing for general equilibrium effects, subsumed within the fixed effects, make the net effect of destination income negative. Importantly, one can inadvertently conclude that all the variables are robust and important drivers of capital flows.

Similarly, Table 3 reports results of the intensive margin only for portfolio flows (see estimating equations reported in (17a) and (17b), which underlie the following results). GDPs of both host and home economies act as attractors, in line with empirical findings in, for instance, Portes and Rey (2005). Recall that a higher value of a contract risk index is associated with a lower risk. The prediction does not contradict common sense and links a larger volume of portfolio investment when the risk is lower.

An alternative to the described simplistic modeling strategy has been put forward by Santos-Silva and Tenreyro (2007). The proposed Pseudo Poisson Maximum Likelihood estimator (PPML) helps to account for heteroskedasticity, which undermines the use of log-linearization by making conditional expectation dependent on the regressors and zero capital inflow values.[38]

[36] Moreover, this approach is somewhat similar to the recent contribution by Pesaran (2006) where cross sectional averages are used to mimic common factors, similarly to a global approach in Dees, Mauro, Pesaran, and Smith (2007), where global unobserved factor can be approximated by observable cross sectional averages.

[37] An alternative to this approach is that of Kyriazidou (1997). The method relies on differencing out the selection and unobservable individual effects. The proposed estimator is of nonparametric nature and requires kernel weights. The choice of kernel density function and a sequence of bandwidths is not trivial. Moreover, the window widths crucially affect the variance of the limiting distribution of the estimator and sensitivity is an issue for smaller samples. Therefore, we resort to a parametric approach which allows for sufficiently general unobserved heterogeneity.

[38] Among desirable properties of PPML are consistency even if the data does not follow a Poisson distribution. What is more, given there is no information on the pattern of heteroskedasticity, PPML seems natural in that it weighs all the observations equally, since the expected value is assumed to be proportional to the variance, $\mathbb{E}\left(M_{in}\right) \propto Var\left(M_{in}\right)$. Since this assumption is unlikely to hold in practice, a failure to fully account for the heteroskedasticity should be corrected for by an Eicker-White (Eicker, 1963; White, 1980) robust covariance matrix estimator. Arvis and Shepherd (2011) demonstrated that Poisson QML estimator is the only in the class of (quasi-) ML estimators to preserve total flows between the actual and estimated bilateral trade matrices. Coined as the "adding up" problem, it is an important issue as in our application FDI flow equation is linear in a constant term with an elasticity of 1, $\varepsilon_{\hat{M}_{int},\text{const}} \equiv \partial \ln \hat{M}_{int} / \partial \ln \text{const} = 1$ or $\partial \hat{M}_{int} / \partial \text{const} = (1/\text{const})\, \hat{M}_{int}$.

Tab. 2: Pooled and Panel Results of Bilateral FDI Ignoring the Extensive Margin

	LIC			MIC			Overall Sample		
Variables	Pooled OLS	FE	RE (GLS)	Pooled OLS	FE	RE (GLS)	Pooled OLS	FE	RE (GLS)
Log Destination	-1.08	-0.80**	-1.07	-1.28**	-1.28***	-1.28**	-1.18**	-1.14***	-1.18***
GDP	(0.852)	(0.344)	(0.880)	(0.564)	(0.570)	(0.482)	(0.477)	(0.418)	(0.483)
Log Source	3.66***	4.14***	3.68***	5.26***	5.32***	5.26***	4.99***	5.080***	5.00***
GDP	(1.153)	(0.958)	(1.191)	(0.744)	(0.744)	(0.752)	(0.634)	(0.638)	(0.642)
Log Lending	-1.11***	-1.03***	-1.10***	-0.23**	-0.27***	-0.24**	-0.30***	-0.32***	-0.30***
Rate	(0.365)	(0.157)	(0.377)	(0.110)	(0.090)	(0.111)	(0.106)	(0.071)	(0.108)
Log Labor	3.36***	2.38***	3.32**	2.51***	2.56***	2.51***	2.51***	2.48***	2.51***
Productivity	(1.288)	(1.005)	(1.330)	(0.640)	(0.508)	(0.647)	(0.574)	(0.416)	(0.581)
Observations	736	736	736	3209	3209	3209	3945	3945	3945
Within R^2		0.15	0.15		0.20	0.20		0.19	0.19
Between R^2			0.56			0.64			0.64
Overall R^2			0.47			0.56			0.57

Note: time coverage is 2002-2010. Pooled OLS refer to pooled least squares where any time-specific effects are assumed to be fixed and the individual affects are centered around a common intercept; cluster robust standard errors are reported, also directional fixed effects (source and destination countries) are included. FE stands for fixed effects with the reported Driscoll-Kraay standard errors which help controlling for spatial (cross-sectional) dependence. RE (GLS) for random effects generalized least squares estimator (effectively a weighted average of within and between estimators which are not reported separately), also directional fixed effects (source and destination countries) are included. Robust Hausman test has been conducted which works under clustered standard errors therefore not making a claim of RE being efficient (see Wooldridge (2010) for the procedure). Fixed effects are preferred. Standard errors in parentheses; *, **, *** denote significance at 10%, 5% and 1% respectively. All specifications include a constant term.

Tables 4 and 5 report the estimates of Poisson regression whose specification is $\mathbb{E}\left(M_{in} \mid \boldsymbol{X}_{in},\, M_{in} > 0\right) = \exp\left(\boldsymbol{X}_{in}\beta\right)$ with conditional expectation of error being zero. That is, capital inflows, instead of taking logarithms, are modeled in levels (therefore, zeroes are not lost in the *intensive* margin). The cost of that comes by implicitly assuming the same process for positive and zero flows. As results indicate, destination GDP is not a robust predictor. Source GDP, though, is a strong and positive covariate for MICs. Labor productivity matters for the least developed economies. Startup costs affect negatively LICs but, as we use the same variable for positive flows, it is imprecisely estimated. When it comes to portfolio investment, LICs are barely explained by the included variables, mainly because there are still very few data points for them. It is worth to draw attention that startup costs may attract portfolio flows for LICs, thus suggesting about potential substitutability with FDI. Moving to the middle income and overall country groups, source and destination income, as well as startup costs and contract risk all play an important role. Notice that the startup costs and risk variable enter negatively; hence, the latter result is counter-intuitive. This could be that our baseline model still misses important aspects that we consider in more complete specifications. Also, though the PPML approach has many advantages to control for heteroskedasticity and zero values of capital flows, it, nevertheless, lacks mechanisms that give rise to zeroes, also does not model cross-sectional dependencies or unobserved factors. Nor do we learn the mechanisms behind an extensive margin.[39]

Regarding results, they are qualitatively similar to the baseline ones that we are about to present: destination GDP enters negatively (though insignificantly), source income exerts positive sign as does labor productivity, and lending rate is of a negative sign. Regression on a full sample exerts most significant

Maximizing the Poisson QML on the constant scale equalizes the total values of foreign investment. However, its unintended consequence is a perfect fit between the fixed effects and the multilateral resistance terms (see Head and Mayer (2015) and references therein).

[39] Though not crucial, capital data is not distributed as a Poisson random variable (it is not a count variable), which makes mapping from the theory to empirics not particularly obvious. However, PPML, due to desirable statistical properties, acts as an excellent robustness check for more theory-driven approaches.

Tab. 3: Panel Results of Bilateral Portfolio Ignoring the Extensive Margin

	Overall Sample		
Variables	Pooled OLS	FE	RE (GLS)
Log Destination	0.0729**	0.0866***	0.0837***
GDP	(0.0325)	(0.0159)	(0.0322)
Log Source	0.9831***	1.083***	1.032***
GDP	(0.0836)	(0.0572)	(0.0828)
Log Contract	0.4795*	0.4252	0.4762*
	(0.2722)	(0.3421)	(0.2575)
Observations	2,738	2,738	2,738
Within R^2		0.1898	0.1897
Between R^2			0.7773
Overall R^2	0.6687		0.6659

Note: time coverage is 2002-2010. Pooled OLS refer to pooled least squares where any time-specific effects are assumed to be fixed and the individual affects are centered around a common intercept; robust standard errors are reported, also directional fixed effects (source and destination countries) are included. FE stands for fixed effects; we report Driscoll-Kraay standard errors which help control for spatial (cross-sectional) dependence. RE (GLS) - random effects generalized least squares estimator (effectively a weighted average of within and between estimators which are not reported separately), also directional fixed effects are included. Standard errors in parentheses; *, **, *** denote significance at 10%, 5% and 1% respectively. All specifications include a constant term.

results. Portfolio regressions are in line with our main results too, except for the contract risk. The latter enters negatively, whereas both destination and source income are positive when significant. To learn a broader picture about the level of development and two margins of investment, we now turn to exploring the results of statistical models, which allow for a two-tier structure, embedded in the theory.

6.1 Two-Tier Model

Having considered the two margins separately, we map the theory to data by introducing the mechanism that governs not only the choice of capital intensity but also the likelihood of an investment. The use of two-part (hurdle) model seems natural as it is mainly driven by economic arguments: the decision to start investing in an economy and the volume of investment are governed by non-identical mechanisms as portrayed in the theory. The first part of the model estimates the odds of observing a positive capital inflow (participation equation), while the second one estimates the volume of capital, conditional on observing positive flows. Therefore, such statistical specifications as standard tobit are too restrictive as they assume a single mechanism for both intensive and extensive margins. However, an extended tobit is a useful tool: it does not suffer from the limitations of lognormal hurdle (e.g., incidental parameters), and allows for correlation between the two, intensive and extensive, margins.

Indeed, the two-part models, which assume conditional independence of deciding on investing and the amount, also raise a question of reliability. Note that the first part of the model estimates the probability of observing a positive capital flow, while the second one estimates the volume of capital, conditional on observing positive inflows.[40] Table 6 collects results from different methods, which account for the two decisions. Lognormal hurdle refers to the model, where the variable can be decomposed into a product of an indicator function and lognormally distributed capital flow, provided it is positive.

The panel data two-part models comply well to the traditional pooling estimation absent unobserved

[40] Since two models are non-nested, the use of Vuong test is appropriate – it strongly rejects the lognormal in favor of the truncated model in terms of fit with p value of 0.000.

Tab. 4: Poisson Regressions for FDI

	LIC	MIC	Overall Sample
	Poisson PML	Poisson PML	Poisson PML
Log Destination GDP	-0.798	0.352	0.277
	(1.967)	(0.964)	(0.915)
Log Source GDP	0.913	2.231**	2.314**
	(2.115)	(0.970)	(0.918)
Log Lending Rate	-1.102***	-0.398**	-0.410**
	(0.426)	(0.190)	(0.186)
Log Labor Productivity	6.116**	1.263	1.340
	(2.501)	(1.185)	(1.147)
Log Startup Costs	-0.201	0.154	0.143
	(0.355)	(0.138)	(0.131)

Note: time coverage is 2002-2010. Solved using Quasi ML Fisher scoring.
Include DFEs, i.e., directional (source and destination countries) fixed effects and a constant term.
Standard errors are bootstrapped (400 replications), reported in parentheses.
*, **, *** denote significance at 10%, 5% and 1% respectively.

Tab. 5: Poisson Regressions for Portfolio Investment

	LIC	MIC	Overall Sample
	Poisson PML	Poisson PML	Poisson PML
Log Destination GDP	2.614	0.690**	0.721**
	(1.946)	(0.321)	(0.318)
Log Source GDP	1.067	2.540***	2.541***
	(2.735)	(0.552)	(0.544)
Log Startup Costs	0.359*	-0.168*	-0.152*
	(0.216)	(0.087)	(0.083)
Log Contract Risk	0.703	-0.591**	-0.581**
	(0.638)	(0.262)	(0.259)

Note: time coverage is 2002-2010. Solved using Quasi ML Fisher scoring.
Include DFEs, i.e., directional (source and destination countries) fixed effects and a constant term.
Standard errors are bootstrapped (400 replications), reported in parentheses.
*, **, *** denote significance at 10%, 5% and 1% respectively.

Tab. 6: Panel Bilateral FDI at Extensive and Intensive Margins

	LIC			MIC			Overall Sample		
Variables	Lognormal Hurdle	Exponential Type II Tobit	Mundlak Chamberlain Panel	Lognormal Hurdle	Exponential Type II Tobit	Mundlak Chamberlain Panel	Lognormal Hurdle	Exponential Type II Tobit	Mundlak Chamberlain Panel
Intensive Margin of Log FDI									
Log Destination GDP	-1.41	-1.872	-1.153	-1.54**	-1.143*	-1.284***	-1.53***	-1.230**	-1.182***
	(1.266)	(1.262)	(-0.962)	(0.648)	(0.65)	(0.481)	(0.576)	(0.583)	(0.428)
Log Source GDP	2.37	1.965	3.608***	5.30***	4.673***	5.259***	5.00***	4.373***	4.989***
	(1.468)	(1.484)	(1.104)	(0.883)	(0.885)	(0.577)	(0.766)	(0.776)	(0.511)
Log Lending Rate	-1.07**	-0.992*	-1.122***	-0.07	-0.17	-0.230**	-0.156	-0.243	-0.297***
	(0.445)	(0.542)	(0.342)	(0.156)	(0.187)	(0.0993)	(0.150)	(0.181)	(0.0954)
Log Labor productivity	5.03***	6.582***	3.519***	2.44***	2.047**	2.504***	2.650***	2.522***	2.509***
	(1.772)	(2.038)	(1.341)	(0.770)	(0.805)	(0.548)	(0.727)	(0.773)	(0.503)
Extensive Margin of FDI									
Log Startup Costs	-0.189**	-0.185**	-0.188**	0.0614	0.0586	0.0613	-0.0287	-0.0305	-0.0281
	(0.0854)	(0.0886)	(0.0854)	(0.0658)	(0.0657)	(0.0659)	(0.0493)	(0.0493)	(0.0493)
Log Lending Rate	0.153	0.154	0.1506	-0.0726	-0.0722	-0.0611	-0.0596	-0.0574	-0.0465
	(0.22)	(0.22)	(0.2205)	(0.101)	(0.101)	(0.101)	(0.0932)	(0.0931)	(0.093)
Log Labor productivity	0.894	0.92	0.893	1.036***	1.041***	1.040***	0.882***	0.891***	0.888***
	(0.551)	(0.566)	(0.55)	(0.272)	(0.273)	(0.273)	(0.238)	(0.238)	(0.238)
Observations			687/2375			2962/5170			3649/7800
Log likelihood		-4748.95	-4650.88		-22304.34	-21720.51		-27168.72	-26459.18

Note: time coverage is 2002-2010 The difference in observations in ET2T arises because all negative flows are excluded whereas in other estimations they are truncated as zeroes, potentially carrying information on the existence of a link but absence of a positive capital flow. Mundlak Chamberlain method includes time averages of relevant explanatory variable. Time averages of startup costs and labor productivity are omitted in the first stage due to collinearity. Clustered standard errors in parentheses. *, **, *** denote significance at 10%, 5% and 1% respectively. All specifications include a constant term and directional fixed effects (source and destination countries).

Tab. 7: Panel Bilateral Portfolio Investment at Extensive and Intensive Margins

	LIC	MIC	Overall Sample	
Variables	Lognormal Hurdle	Lognormal Hurdle	Lognormal Hurdle	Mundlak Chamberlain Panel
Intensive Margin of Log Portfolio				
Log Destination GDP	0.290	0.059*	0.073**	0.0825***
	(0.235)	(0.032)	(0.032)	(0.026)
Log Source GDP	0.127	1.034***	0.983***	1.024***
	(0.338)	(0.085)	(0.082)	(0.063)
Log Contract Risk	0.425	0.469**	0.480*	0.481**
	(1.410)	(0.275)	(0.269)	(0.232)
Extensive Margin of Portfolio				
Log Startup Costs	-0.117*	0.329***	0.208***	0.208***
	(0.070)	(0.048)	(0.0417)	(0.0417)
Log Contract Risk	-0.176	0.105	0.0807	0.0807
	(0.257)	(0.106)	(0.0987)	(0.0987)
Observations	147	2591	2738	4932

Note: time coverage is 2002-2010. Clustered standard errors in parentheses. *, **, *** denote significance at 10%, 5% and 1% respectively. All specifications include a constant term and directional fixed effects (source and destination countries). ET2T extensive margin is the same as that of Normal hurdle due to collinearity of time averages of startup costs and contract risk.

effects (see Wooldridge, 2010). The needed adaptation is the robust variance matrix estimator to account for the serial correlation in the score across time dimension.[41] As stated before, the existence of unobserved effects creates an incidental parameters problem for "small" T panels, when we want to estimate these effects together with the other model's parameters and error variances.[42] One solution is to assume independence of the unobserved effects and covariates along with several other assumptions. This would yield a random effects tobit model. However, we are interested in the "dual" nature of capital flows, and proceed to a two-step estimation procedure to unravel two margins. As before, a full sample probit estimation is followed by a selection equation carried out on the positive-flows subsample. The model assumes that different sets of variables could be used in the two-step estimations. Crucially, the second method, Exponential Type II Tobit, allows for a conditional correlation between selection and positive inflow equations, even after controlling for observable covariates.

Our preferred model, coined as Mundlak Chamberlain Panel, also allows for global (multilateral) effects. These are captured by the cross-sectional averages of regressors, thus helping to account for spatial correlations.[43] As is clear from the Table 6, the extensive margin (or the decision to invest) is affected by the startup costs (entry barriers) only for the LICs, consistently among estimation methods. Indeed, market entry barriers are consistent with many zeroes and absence of investment links. Further, labor productivity is a strong and consistent determinant of the decision to invest only for MICs and overall sample. Lending rate, though always negative, never affects investment decision (establishing a link) significantly. This can reflect the fact that financial markets are underdeveloped in low- and middle-income countries, therefore, making investors rely on access to financial markets elsewhere.

We further find that the source income is a strong predictor of the volume of capital. Finally, labor productivity matters for the intensity, consistently across estimations. This finding is supportive of supply side arguments – productivity at destination market, conditional on other factors, affects the intensity of direct investment. Note that a failure to account for cross-sectional averages as is done in the literature would have led to a conclusion that lending rate is not a significant deterrent to FDI flows. Therefore, a theoretical inclusion of capital input seems to be supported by our preferred econometric model.

Regarding portfolio flows, once both margins are considered, the effect of contract variable vanishes in the extensive margin but remains an important driver of a volume of investment (Table 7); this emphasizes a need to account for a two-tier structure in a flexible statistical model. Note that, unlike FDI flows, destination income acts as an attractor. Moreover, it seems that portfolio flows act as substitutes for the FDI, since startup costs positively correlate with the probability to engage in FPI (except for LICs, where entry costs are arguably prohibitively high), after conditioning on other included variables. In line with the theory, higher source incomes allow for larger share of today's consumption to be allocated for tomorrow by engaging in foreign portfolio investment.

To have more confidence in the results, we extend the previous results along two directions. First, we introduce the bilateral investment treaty variable, found robust in the variable selection studies. Second, we consider all the variables for both FDI and portfolio equations. This helps to track main mechanisms both for the two margins and across development stages. Table 8 reports findings: source GDP and labor productivity stand out as very robust capital attractors at an intensive margin. There is some evidence on LICs receiving larger volumes if there was an investment treaty signed (though there is no predictive power for the investment link). Startup costs still act as an important deterrant for both FDI

[41] For the dynamically complete panel data model (i.e., $D\left(M_{it} \mid \boldsymbol{X}_{it}, M_{it-1}, \boldsymbol{X}_{it-1}, \ldots\right) = D\left(M_{it} \mid \boldsymbol{X}_{it}\right)$ where $D\left(\cdot\right)$ denotes conditional distribution of M_{it}), inference is the same as would be for the independent cross sections.

[42] We also run a linear probability model to infer the magnitude of the bias as the slope parameters of interest in a linear model do not suffer from the incidental parameters problem (variance can be affected though). Our results, in terms of a sign and significance, remain largely unaffected. Moreover, Mill's ratios are computed for each cross-section separately rather than for a panel. We have also experimented with panel versions and the result has not substantially differed (indeed, as Heckman demonstrates, the bias tends to be small for $T = 8$, similar to our timespan of 9 years).

[43] As previously noted, this approach is similar to Pesaran (2006) but applied to a nonlinear environment. Moreover, we can interpret the use of cross-sectional averages as trying to mimic an unobserved dynamic factor, thus allowing for flexible time trends.

Tab. 8: Panel Bilateral FDI and Portfolio Investment at Extensive and Intensive Margins

	LIC		MIC		Overall Sample	
Variables	FDI	Portfolio	FDI	Portfolio	FDI	Portfolio
Intensive Margin of Log Portfolio						
Log Destination GDP	-1.456	0.274	-1.058**	-0.041	-1.004**	-0.033
	(0.989)	(0.249)	(0.499)	(0.032)	(0.444)	(0.032)
Log Source GDP	3.868***	0.382	4.946***	1.051***	4.739***	1.014***
	(1.122)	(0.364)	(0.587)	(0.080)	(0.520)	(0.078)
Log Contract Risk	-1.385***	2.268	0.242	0.457*	0.065	0.490*
	(0.487)	(2.032)	(0.167)	(0.258)	(0.158)	(0.256)
Log Lending Rate	-0.970***	-1.277	-0.226**	0.037	-0.286***	0.016
	(0.344)	(2.155)	(0.099)	(0.146)	(0.095)	(0.146)
Log Labor productivity	3.578**	2.020	2.356***	2.014***	2.344***	2.050***
	(1.385)	(2.796)	(0.562)	(0.493)	(0.515)	(0.485)
Bilateral Investment Treaty	0.448*	0.112	0.050	0.132	0.059	0.111
	(0.260)	(0.627)	(0.135)	(0.123)	(0.119)	(0.121)
Extensive Margin of Portfolio						
Log Startup Costs	-0.158*	-0.530***	0.059	0.170**	-0.022	0.054
	(0.089)	(0.163)	(0.071)	(0.070)	(0.052)	(0.059)
Log Contract Risk	-0.231	0.548	0.068	-0.133	-0.007	-0.101
	(0.383)	(0.445)	(0.133)	(0.154)	(0.126)	(0.148)
Log Lending Rate	0.02	0.776**	-0.061	-0.629***	-0.045	-0.531***
	(0.226)	(0.376)	(0.103)	(0.110)	(0.095)	(0.104)
Log Labor productivity	0.695	-2.183**	1.020***	-1.481***	0.838***	-1.649
	(0.598)	(0.977)	(0.287)	(0.348)	(0.247)	(0.313)
Bilateral Investment Treaty	0.112	-0.041	0.163*	-0.055	0.120	-0.049
	(0.160)	(0.149)	(0.084)	(0.058)	(0.074)	(0.053)
Observations	673/2055	115/572	3140/4937	1978/3807	3813/7211	2093/4380

Note: time coverage is 2002-2010. Clustered (robust) standard errors in parentheses. *, **, *** denote significance at 10%, 5% and 1% respectively. All specifications include a constant term and directional fixed effects (source and destination countries).

Tab. 9: Correlated Mundlak Chamberlain for FDI and Portfolio Investment

	LIC	MIC	Overall Sample	
Variables	FDI	FDI	FDI	Portfolio
Intensive Margin of Log Portfolio				
Log Destination GDP	-2.743	-0.507	-1.244	0.114
	(2.454)	(0.988)	(1.015)	(0.219)
Log Source GDP	2.786	3.931***	4.157***	0.882***
	(2.842)	(1.057)	(1.071)	(0.262)
Log Contract Risk	-1.623*	0.572*	0.110	-1.387
	(0.870)	(0.328)	(0.311)	(1.034)
Log Lending Rate	-2.877	-0.066	-0.162	0.461
	(5.205)	(0.616)	(0.568)	(1.933)
Log Labor productivity	5.256*	2.299*	3.145***	-5.205*
	(2.752)	(1.241)	(1.108)	(2.881)
Bilateral Investment Treaty	0.738**	-0.036	0.064	-0.813
	(0.306)	(0.255)	(0.213)	(0.670)
Observations	364	1648	2012	166

Note: time coverage is 2002-2010. Due to the inverse Mills ratios, all standard errors are bootstrapped and reported in parentheses. *, **, *** denote significance at 10%, 5% and 1% respectively. All specifications include a constant term and directional fixed effects (source and destination countries).

and portfolio flows in case of LICs. A possible interpretation of the differential results on the extensive margin of FDI obtained between LICs and MICs is that, while for LICs it is more likely that foreign firms are creating new operations otherwise known as "greenfield" FDI, for MICs a large share of FDI could take the form of mergers and acquisitions of existing local companies. This could explain the contrasted impact of the startup cost for the economies at different stages of development. What is more, the idea of substitutability between two types of capital is further strengthened: extensive margin of FDI favors an environment with high labor productivity, opposite to portfolio flows. Also, lending rate, instead of deterring investment as it does for FDI, has a positive effect for the existence of a portfolio link. This is in line with the notion of capital being used in production in case of foreign investment and return on capital in case of portfolio investment. Low- and middle-income countries differ substantially in case of a contract risk at an intensive margin: a risky environment correlates with the volume of FDI only for LICs, changing the direction for MICs. It is likely that, even after conditioning on all covariates, directional fixed effects, and cross-sectional averages, some LICs yield exceedingly high returns.

Finally, to be sure that our results do not rest on conditional independence between two margins, we allow for arbitrary correlation between them and selectivity by introducing inverse Mills ratios. The price for the latter is a substantially reduced number of observations (that is why, we report only aggregate sample for portfolio equation). Loss of information leads to inevitable inefficiency, as is clear from Table 9. However, source country GDP, labor productivity and bilateral treaty for LICs remain important predictors of investment volumes (extensive margin remains intact, thus implying that startup costs deter investment at an extensive margin for a LIC group).

In summary, zeroes of investment flows require both theoretical and empirical treatment. We observe that ignoring extensive margin affects estimates and their statistical significance. Moreover, failure to account for a global factor, proxied by cross-sectional averages, may lead to omission of relevant regressors and, therefore, biased results. Importantly, modeling two margins reveals differences among developing countries. This is critical for both, understanding the current developments and drawing policy implications, in particular across development stages.[44] The same framework, which addresses FDI and portfolio flows, is also useful to infer substitutability effects, and different effects of the same variables.

7 Robustness

Next, we deviate from the baseline model, and consider a number of robustness checks. One could argue that a zero threshold to split investment flows may not be optimal. We thus analyze how stable results are to changes in the investment threshold. We also consider quantiles of parameters, rather than simple means, thus avoid making parametric assumptions about the error term. Last, theory-driven modeling allows us testing whether the two mechanisms for FDI and portfolio inflows, stemming from the theory, find any empirical support. Other checks, including more flexible dependence structures using copulae, negative values of capital inflows, and effects of crisis period are reported in the Online Appendix.[45]

7.1 Stability and Endogenous Investment Threshold

One of the main problems regarding statistical treatment of FDI lies in its very definition that requires an equity stake of 10% or more for an investment to be classified as FDI. In general, FDI itself has three components: equity capital, intra-firm loans, and reinvestment of retained earnings. Because of this definition, it is not clear if all zeroes are indeed unique – there might be "marginal" investments, which are not reported. Moreover, there might be measurement errors that produce this result instead of being a deliberate choice of investors, which would then be at odds with our theoretical motivation.

We start by considering how parameters behave once we model different quantiles of capital flows, rather than its conditional mean. This helps to avoid parametric assumptions about the error term. We plot in Figures 4 and 5 the bootstrapped parameters and their confidence intervals from both FDI and portfolio quantile (median) regressions (without and with directional fixed effects to otherwise baseline specifications). For FDI flows, the effects exerted by source are always positive, mainly positive for labor productivity (in particular for LICs),[46] and varies for lending rate depending on the quantile (tends to be negative for LICs). Destination income has mainly negative effect only if directional fixed effects are accounted for (thus capital intensity increases with lower development, but only conditional on fixed effects, which mimic multilateral resistance terms). Intuition is mainly confirmed – the investor should be more developed to engage in FDI, whereas more opportunities are found at destinations, which have a conditionally higher labor productivity and conditionally lower income. Portfolio flows are positively related to source income but very weakly related to destination income and lower contract risk, both effects being largely dependent on the quantile. Again, failure to account for the directional fixed effects would have led to erroneous conclusions of source income exerting no (or slightly negative) effects on portfolio flows.

Another problem related to the parameter stability concerns the nature of zero flows. Eaton and Tamura (1994) developed an early solution to incorporate zeros that can be thought of as a model of $\ln(M_{in} + a)$, where instead of arbitrarily setting a, it is instead treated as a parameter to be estimated.

[44] Note that we do not claim that LICs results can be thought of as representing an average world's economy, so sample selection is not an issue. Quite the opposite, we report pooled results to demonstrate what results would have been drawn if we followed the literature and did not differentiate between country development stages.

[45] In addition to these checks, we consider an additional rich set of robustness checks. We demonstrate in the Online Appendix that our interpretations are largely unaffected. A number of other checks are also pursued: a persistence in extensive margin is explored in Section 3; a different variable for measuring lending rate, marginal product of capital, is used in Section 4; finally, we also use size adjusted capital flows to explore if our results are consistent with the theory and robust to expenditure generated heteroskedasticity, see Section 5. The latter exercise complements our experiments with pseudo Poisson maximum likelihood as proposed by Santos-Silva and Tenreyro (2007) since a log linear model can suffer from a bias (a result of Jensen's inequality).

[46] We also graph parameters for LIC and MIC countries separately, however, report results for a full sample. Other graphs are available from authors.

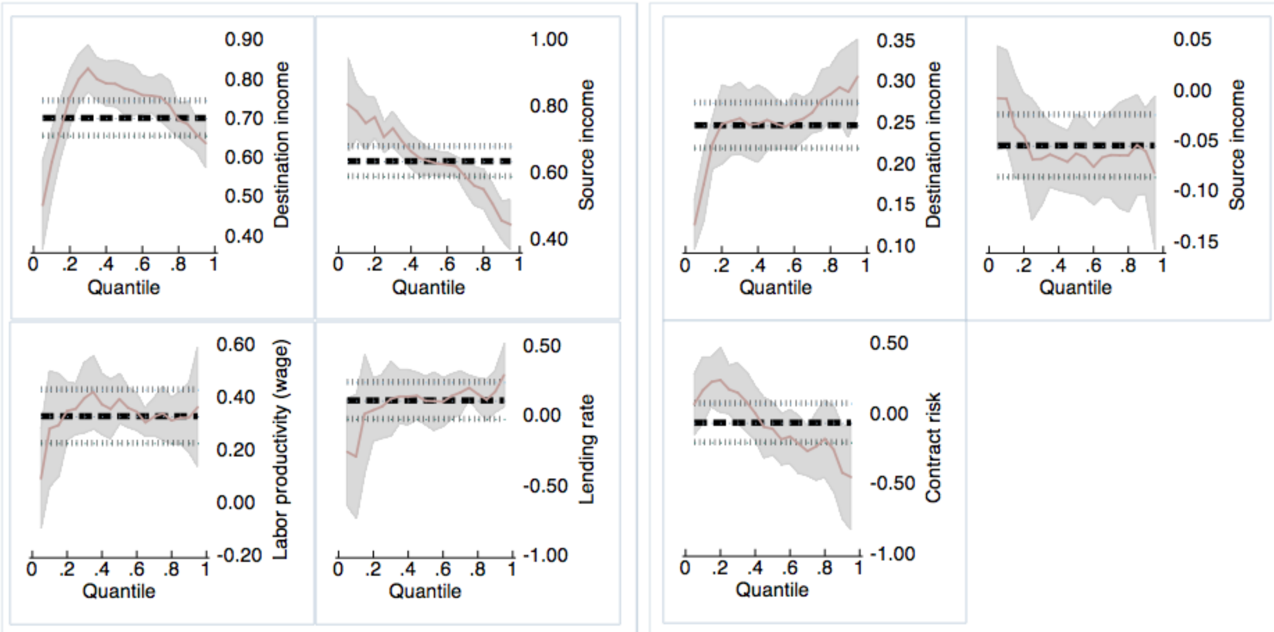


Fig. 4: Simple OLS (horizontal lines) and quantile coefficients and their confidence intervals for FDI (left panel) and portfolio (right panel) flows without directional fixed effects, full sample

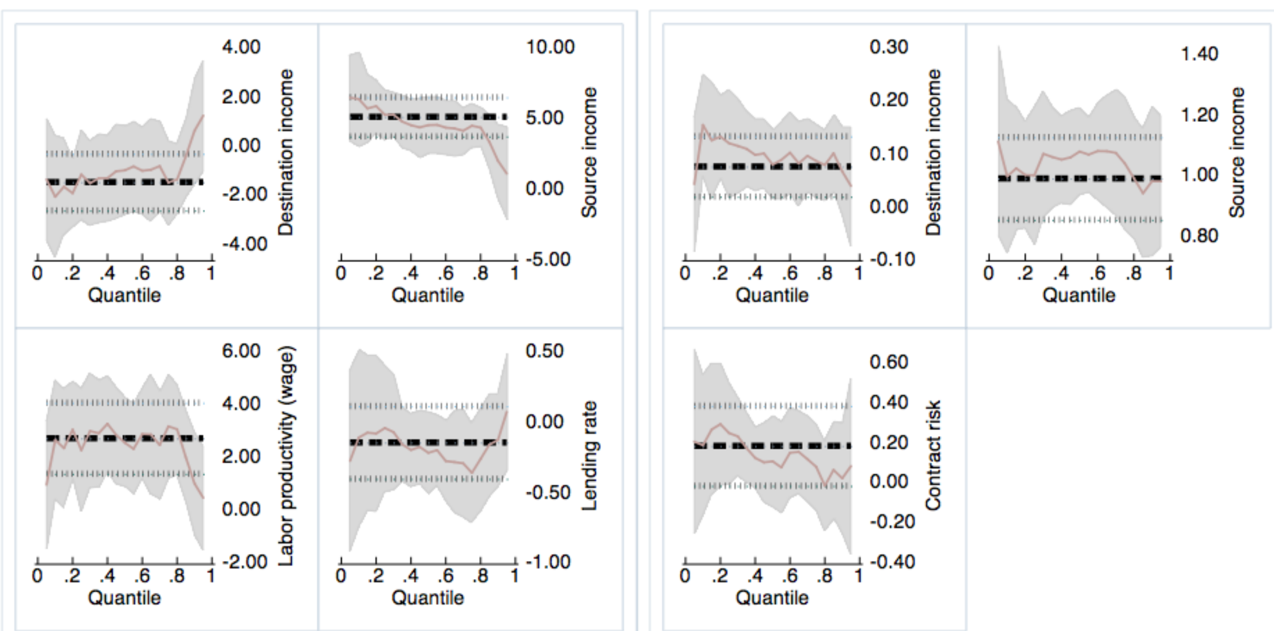


Fig. 5: Simple OLS (horizontal lines) and quantile coefficients and their confidence intervals for FDI (left panel) and portfolio (right panel) flows with directional fixed effects, full sample

In our context, one could think of a as a minimum investment level that is needed to be incurred before the flow is accounted for. Effectively, this is an extended tobit which defines a strictly positive latent variable $M^{\star}_{in}$ and a threshold $\hat{a}$ which, unfortunately, lacks a compelling structural interpretation. We, however, report a set of results with the level a that produces both FDI and FPI non-negative (Online Appendix 3). All results are at large in line with our reported findings. The only noticeable difference concerns portfolio flows: it seems that for this model, startup costs deter both, FDI and FPI. Hence, a policy implication, regarding fixed entry costs, are very clear for an economy that aspires to be financially more open and better integrated into the world markets. All other variables preserve signs and significance as before.

Finally, we are concerned about our parameter stability and corner at zero. Kourtellos, Stengos, and Tan (2009) propose estimating a threshold parameter based on a concentrated least squares method that involves an inverse Mills ratio bias correction term in each regime. The method is coined as Structural Threshold Regression and is composed of two regressions for two regimes. We allow for relationship between the variables of interest in each of the two regimes and use different threshold variables. To operationalize this approach, we implement successive Chow tests for endogenous thresholds to detect when significant relationship starts appearing. Our results indicate that the behavior of the main equations remain stable across different levels of capital flows and development stages of receiving economies. In other words, there is no detectable structural break. Therefore, our results should not suffer from the misspecification of investment threshold in two-tier (intensive and extensive) estimations. Lastly, we re-estimate all the specifications using a dummy variable for 2008 crisis showing that there is no noticeable effect of crisis (Online Appendix 4).

7.2 Theory Implied Relationship Between FDI and FPI

Finally, after considering how robust our results are, we also check other theory implied results for both FDI and portfolio flows, which at least partly confirm the validity of theoretical specification. Recall the sum and the ratio of the two types of investment, as reported in equations (14)-(15) and (16). The sum implies that the main driving forces are source and destination income, with all other variables entering as one nonlinear term, whereas the ratio makes sure that the effects of income are eliminated.

To have a glimpse about this prediction, we construct a new variable which is a ratio of bilateral capital flows (portfolio to FDI). We take logs of the sum and the ratio, and consider random and fixed effects regressions for both specifications. Using robust (applicable with cluster-robust standard errors) Hausman test, as outlined in Wooldridge (2010), we conclude that random effects cannot be employed.[47] We, therefore, use multiple fixed effects and, for comparison, our preferred Mundlak Chamberlain Panel. In addition, we also implement the Poisson model, used in the empirical trade literature.

Our fixed effects estimator is the one that filters out the directional fixed effects, and, therefore, does not suffer from the incidental parameters problem (refer to Guimarães and Portugal, 2010). Table 10 describes results for the ratio and the sum of capital flows. The income effects disappear in the ratio and prevails in the sum, as predicted by the theory.[48] Labor productivity dictates the capital flow – it increases the sum of two types of investment. It seems this is a robust prediction across a range of models and bears important policy implications. Notably, data confirm that modeling two types of investment requires to condition on aggregate income to avoid biasedness; however, dealing with relative capital flows, the inclusion of incomes is not instrumental. This was embedded in the theory – the two types of investment are driven by GDPs which are consequences of profitable investments abroad (FDI), and the intertemporal fund diversification worldwide. Since FDI data are more abundant, the results are affected more by the direct than by portfolio investment. There is substantial noise in the ratio; the sum, reflecting

[47] The null of no systematic differences is rejected in both cases. In ratio case, $F(4, 475) = 7.00$ whereas in the sum case $F(6, 581) = 41.48$. The associated p values are zero.

[48] Refer to Araujo, Lastauskas, and Papageorgiou (2015) for the more detailed results from the Correlated Mundlak Chamberlain Panel.

Tab. 10: Theory Implied Relationships: Ratio and Sum of Capital Flows

	Log Ratio $\left(\frac{M^{I}_{in,t}}{M^{FDI}_{in,t}}\right)$			Log Sum $(M^{FDI}_{in,t} + M^{I}_{in,t})$*		
Variables	Two-way FE	MC	PPML	Two-way FE	MC	PPML
Log Destination	0.526	0.414	-0.603	-0.995	-0.876*	-0.054
GDP	(1.011)	(0.971)	(0.473)	(0.621)	(0.496)	(0.124)
Log Source	0.123	0.308	0.185	4.053***	4.215***	0.650***
GDP	(1.244)	(1.150)	(0.513)	(0.782)	(0.606)	(0.161)
Log Labor	-0.544	-0.570	0.966	2.808***	2.741***	0.340**
Productivity	(1.311)	(1.174)	(0.733)	(0.736)	(0.609)	(0.148)
Log Lending	0.391	0.357	0.053	-0.169	-0.123	-0.048*
Rate	(0.309)	(0.236)	(0.138)	(0.148)	(0.128)	(0.029)
Log Startup	0.158	0.175	0.038	0.053	0.061	0.016
Costs	(0.167)	(0.147)	(0.087)	(0.096)	(0.081)	(0.020)
Contract	-0.120	0.003	-0.016	0.344*	0.239	0.097**
Risk	(0.402)	(0.363)	(0.175)	(0.203)	(0.181)	(0.039)
Bilateral Investment	-0.148	-0.078	0.042	0.245*	0.212*	0.058***
Treaty	(0.190)	(0.182)	(0.074)	(0.146)	(0.127)	(0.017)
Observations	1637		999	2413		2374
F, χ^2 test (incomes irrelevant)	$F(2,78) = 0.35$	$\chi^2(2) = 1.03$	$\chi^2(2) = 2.21$	$F(2,86) = 22.36$	$\chi^2(2) = 75.86$	$\chi^2(2) = 44.45$
	$p = 0.70$	$p = 0.60$	$p = 0.33$	$p = 0.00$	$p = 0.00$	$p = 0.00$

Note: time coverage is 2002-2010. Two-way FE stand for high-dimensional fixed effects being filtered out as in Guimarães and Portugal (2010). MC (Mundlak Chamberlain) entails time averages of all regressors to control for a global factor (multilateral resistance terms). PPML (Pseudo Poisson Maximum Likelihood) includes directional fixed effects. Standard errors are clustered at the pair level or bootstrapped (for PPML, 400 replications) and reported in parentheses; *, **, *** denote significance at 10%, 5% and 1% respectively. All specifications include a constant term.

* Using expressions from the main text, it follows that $\ln\left(M^{FDI}_{in,t} + M^{I}_{in,t}\right) = \ln\left(\left[\frac{v_{nt}^{1-\sigma} V^{FDI}_{in,t}}{\{P_{nt}\Pi_{it}\}^{1-\sigma}} + \frac{\gamma_{in,t}\left(\tau_{in,t}\right)^{\delta_{in,t}}}{\Pi_{nt}\mathcal{P}_{it}}\right] E_{it}E_{nt}\right)$.

an intensive margin, is not affected by the arguments, which are put forward to justify the existence of an extensive margin (startup costs or contract risk), however, it can be predicted by a source GDP and labor productivity. Lower contract risk and bilateral investment treaties also help predicting the total volume; their signs, as encountered in the Mundlak Chamberlain panel for both types of capital, confirm that FDI drives the results. Last, a battery of unreported tests indicated that the use of cross-sectional averages has been statistically motivated. Therefore, a failure to account for both directional fixed effects and cross-sectional averages, a current practice in the literature, tends to mis-specify capital equations.

8 Conclusions

Today's economic landscape is quickly changing and calls for an enquiry into global adjustments and capital flows, in particular with regard to low-income countries (LICs). To address recent intensification of capital flows to LICs, we analyze intensive and extensive margins of capital flows (the size of a flow versus a number of investors and receiving countries). Our motivation involved many zeroes in capital flows, in particular in early 2000s. The network structure has considerably changed along both dimensions. We set a simple theory for both FDI and portfolio flows, which yields a parsimonious semi-structural statistical model. The investment decision involves a share of costs, which is fixed in nature, thereby generating a two-stage decision setup. FDI is portrayed as a supply whilst portfolio as a demand stories. Ignoring extensive margin affects estimates and their statistical significance. In addition, a failure to account for cross-sectional dependence can also result in poor policy recommendations. The latter aspect is also important as a control for multilateral terms with a short time dimension. Results indicate that market entry costs do statistically affect decision to invest only for the LICs, consistently among estimation methods. Generally, market entry barriers are consistent with many zeroes and absence of links, and most probably reflect institutional environment, as emphasized by Alfaro, Kalemli-Ozcan, and Volosovych (2008).

Our econometric framework has enabled us to model intensive and extensive margins, driven by different mechanisms, in a flexible and parsimonious way. Our methodology, consistent with zero capital flows, does not require exclusion restriction, accounts for time-varying global factors, and allows for correlation between two margins. We are also more concerned with controlling for the multilateral resistance terms in the investment panel than the literature has been so far. Following our approach, it is clear that capital costs affect intensity – a variable, which has been by and large omitted in the recent models. Further, results indicate that labor productivity is a strong and consistent determinant of the decision to invest to developing countries. It matters for both, intensive and extensive margins. This is an important message to the policy makers: it seems that richer advanced economies tend to diversify more, just as predicted by the theory.

Startup costs refer to another potential targeted area in LICs – excessively high level of entry costs can deter the very decision to choose an economy for investment. Theoretical account helps to hypothesize about the driving forces of FDI and portfolio flows. We find some evidence of portfolio investment, when market entry costs are prohibitively high, acting as a substitute for direct investment (FDI) in the extensive margin. Lastly, gravity-type forces, linking FDI and portfolio flows, are also supported by data on bilateral capital flows (this finding is in line with the variable selection literature). Thus, it seems that theoretical model may be capturing important features of investment decision making – it does also carry statistical implications, enabling to deal with the two forms of investment separately, provided one conditions on aggregate incomes.

These results, demonstrating differences at two investment margins for different country groups, call for more research along the proposed lines. We foresee an extension with an explicit role for bilateral trade to be particularly promising.[49] This should be relatively easy as trade flows can be modeled using the same gravity framework (despite details of microfoundations, under mild qualifications, trade yields gravity relationship, see Head and Mayer, 2015).[50] Of course, seeking a parsimonious approach, we have abstracted from a number of important issues. One relates to the risks of volatility and its effect on growth prospects (see Broner, Didier, Erce, and Schmukler (2013) on capital flows volatility over a business cycle and a contribution by Aghion and Banerjee (2005), whose framework might be useful to introduce capital flows), another one to global imbalances and growth (refer to Alfaro, Kalemli-Ozcan, and Volosovych (2014)).[51] Also, abundance of natural resources constitutes an important source of attractiveness to invest and need a more complex modeling environment where, as in traditional Hecksher-Ohlin economy, endowment plays a role in determining a capital flow's direction and intensity.[52] These are important extensions, which would help to evaluate the effects of capital flows to more fragile LICs.

[49] One advantage from macroeconomic perspective is the analysis of Balance of payments, BoP. We have analyzed capital account but still lack account and interaction of another, current account. Recall that BoP = Current Account + Capital Account + Error Term (balancing item).

[50] At the modeling front, a more general specification that extends and encompasses gravity, along the lines of Okawa and van Wincoop (2012), would also be desirable to learn relative costs and gains from deviating from some gravity-generating theoretical assumptions.

[51] Statistically, we are still constrained in time dimension and foresee many more explorations with explicit role for dynamics, especially from the network's perspective, once more and better quality data become available. In such a case, we would be able to track transmission of shocks and spatio-temporal evolution of capital movements. For medium sized time series, one promising route is to draw from the current contribution due to Rebucci, Cesa-Bianchi, Pesaran, and Xu (2012), which analyze how changes in trade linkages between China, Latin America, and the rest of the world have altered the transmission mechanism of international business cycles to Latin America. Our framework could be used to infer the role of capital flows in synchronicity (or lack of it thereof) of business cycles among low- and high-income economies.

[52] Esfahani, Mohaddes, and Pesaran (2012, 2014) draw long run implications of a resource discovery, unlike the standard literature on the "Dutch disease" and the "resource curse". Real output in the long run is shaped by oil exports through their impact on capital accumulation, and the foreign output as the main channel of technological transfer.

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Appendix

A Data Issues

A.1 Country Coverage

Developing Countries are selected by PRGT-Eligibility. The list of countries included in the analysis is produced in the table below (71 LICs):

Afghanistan	Armenia	Bangladesh	Benin
Bhutan	Bolivia	Burkina Faso	Burundi
Cambodia	Cameroon	Cape Verde	Central African Rep.
Chad	Comoros	Congo, Dem. Rep. of	Congo, Republic of
Cote d'Ivoire	Djibouti	Dominica	Eritrea
Ethiopia	Gambia, The	Georgia	Ghana
Grenada	Guinea	Guinea-Bissau	Guyana
Haiti	Honduras	Kenya	Kiribati
Kyrgyz Republic	Lao People's Dem.Rep	Lesotho	Liberia
Madagascar	Malawi	Maldives	Mali
Mauritania	Moldova	Mongolia	Mozambique
Myanmar	Nepal	Nicaragua	Niger
Nigeria	Papua New Guinea	Rwanda	Samoa
Sao Tome and Principe	Senegal	Sierra Leone	Solomon Islands
St. Lucia	St. Vincent & Grens.	Sudan	Tajikistan
Tanzania	Timor-Leste	Togo	Tonga
Uganda	Uzbekistan	Vanuatu	Vietnam
Yemen, Rep.	Zambia	Zimbabwe	

and 63 MICs:

Albania	Algeria	Angola	Antigua and Barbuda
Argentina	Azerbaijan	Belarus	Belize
Bosnia & Herzegovina	Botswana	Brazil	Bulgaria
Chile	China	Colombia	Costa Rica
Dominican Republic	Ecuador	Egypt	El Salvador
Equatorial Guinea	Fiji	Gabon	Guatemala
India	Indonesia	Iran	Iraq
Jamaica	Jordan	Kazakhstan	Lebanon
Libya	Lithuania	Macedonia, FYR	Malaysia
Mauritius	Mexico	Montenegro	Morocco
Namibia	Pakistan	Panama	Paraguay
Peru	Philippines	Romania	Russian Federation

Seychelles	Serbia	Syrian Arab Republic	South Africa
Sri Lanka	St. Kitts and Nevis	Suriname	Swaziland
Thailand	Tunisia	Turkey	Turkmenistan
Ukraine	Uruguay	Venezuela, Rep. Bol.	

A.2 OECD Data

FDI Outflows are expressed in US dollars. The country coverage of reporting economies are (25 countries in total):

Australia	Austria	Belgium	Canada
Denmark	Finland	France	Germany
Greece	Iceland	Ireland	Israel
Italy	Japan	Korea	Luxembourg
Netherlands	New Zealand	Norway	Portugal
Spain	Sweden	Switzerland	United Kingdom
United States of America			

A.3 CPIS Data

The CPIS measures the global stock and geographical distribution of portfolio investment holdings, as reported by creditor countries. The survey may have gaps in coverage owing to nonparticipation of some important investing countries and international financial centers, as well as difficulties faced by many participating countries in capturing cross-border portfolio investment by households (and in some cases, enterprises) that do not use the services of resident custodians. The stocks are measured at market value; thus, annual changes reflect valuation effects and flows.

B Online Appendix

All the remaining materials are collected in the Online Appendix. It includes robustness checks, data facts, economic and econometric methodology, and other relevant but less central results.