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Sovereign Credit Ratings and the Transnationalization of Finance – Evidence from a Gravity Model of Portfolio Investment

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Abstract
It is a matter of debate in how far credit ratings contribute to allocative efficiency or to excessive volatility of asset prices and cross-border capital flows. Yet it is generally taken for granted that ratings play a significant role in the transnationalization of financial relations. This paper tests that hypothesis with data on sovereign credit ratings and foreign portfolio investment. A rating-related gravity model of finance is derived from the choice-theoretical framework of Okawa and van Wincoop (*Gravity in International Finance*, 2012) and estimated in three stages. At the first stage, the authors find that the introduction and evolution of sovereign ratings since the 1970s has affected inward portfolio investment in host countries. At the second stage, they examine to which extent sovereign ratings help to predict the degree of investors' home bias, and whether they can account for the divergent dynamics before and after the global financial crisis. At the third stage, the authors look at the explanatory content of ratings for the determination of the size of bilateral portfolio investment. Evidence for a significant role of sovereign ratings is found at all three stages.

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1 Introduction

Credit rating agencies (CRAs) set standards in transnational finance through their core business of producing and publicizing information about credit risk. The information is signalled through the translation of (more or less) complex assessments into simple grading scales. Since investors rely on asset quality signals that reduce their information costs, ratings help to increase capital mobility across borders. Moreover, the use of ratings is prescribed by state regulations of capital requirements, investment restrictions and risk evaluation in many countries (BIS 2009; IMF 2010). The global rating business is strongly dominated by the 'Big Three' CRAs. Standard & Poor's, Moody's and Fitch are transnational corporations that together account for 95 per cent of the market (White 2010; SEC 2012).

In the context of recent financial crises, the 'Big Three' have been accused of overrating credit derivatives and of acting pro-cyclically through their sovereign ratings (see, e.g. Reinhart 2002; Pagano and Volpin 2009; de Haan and Amtenbrink 2011). In a large body of literature, the focus has been set on the impact of ratings on yields, spreads and other price measures in financial markets that are strongly interconnected across national borders (see, e.g., Cantor and Packer 1996; Jorion and Zhang 2010; Kaminsky and Schmukler 2001; Kiff et al. 2012; Mink and de Haan 2013). Most of these studies have a short-term perspective, confined to particular episodes of boom and bust. It is generally taken for granted that the underlying interconnectedness has been supported by the evolution of the ratings business over recent decades. Yet, this hypothesis has not, to our knowledge, been tested empirically.

The contribution of our paper to the literature is twofold. First, we take a *long-term* perspective on the role of credit ratings in the transnationalization of finance, covering the period from 1976 until 2011 to capture the effects of the introduction and variation of ratings. Setting the focus on the evolution of the *volumes* of cross-border transactions and holdings of securities, we estimate the parameters of a gravity model of finance, in which ratings affect the distance between the home and the host countries. Second, we base our estimations on explicit portfolio-theoretical foundations, extending the gravity model developed by Okawa and van Wincoop (2012) to a framework that allows us to analyse the effects of credit ratings on investors' home bias and other aspects of cross-border investment.

Investors' 'home bias' is considered to be one of the major 'puzzles' in international macroeconomics (Obstfeld and Rogoff 2000). Investors persistently hold a far larger share of domestic assets in their portfolios than what is optimal in terms of the standard international capital asset pricing model (ICAPM). In their survey of the voluminous literature on home bias, Coeurdacier and Rey (2013) argue that *informational asymmetries* provide a particularly relevant explanation for the low degrees of international portfolio diversification observed in most countries. Domestic and foreign investors differ in their information sets on which they form expectations about risks and returns. Such frictions can be used to derive gravity models, in which mass and distance are the determinants of the volumes of trade and the resulting geography of asset holdings. It is with the measures of distance, where credit ratings come into the picture, as they tend to reduce informational asymmetries and trade costs, especially for cross-border flows of capital. In our framework, distance varies with perceptions of risk that are affected by the introduction and variation of credit ratings.

Rather than emphasizing the low levels of portfolio diversification, we set the focus on its increases in recent decades (also indicated by the figures in Coeurdacier and Rey 2013). Estimating a gravity equation derived from the Okawa/van Wincoop (2012) model, we use sovereign debt ratings as a proxy for CRA activities, and foreign portfolio investment (flows and stocks) as a proxy for capital mobility. Sovereign ratings subject the economic policies of a nation to financial risk assessments and serve as benchmarks for ratings of corporate issuers in its realm. They are also part of more general assessments of country risk. Foreign portfolio investment (FPI) comprises domestic residents' transactions and holdings of securities in other countries. This is the range of assets most closely affected by sovereign debt ratings.

Our assessment of the impact of sovereign ratings on portfolio investment follows a three-stage approach. At the first stage, we try to identify the impact of the introduction of sovereign ratings on inward FPI in a set of unilateral data for 119 countries over the period 1976–2011; the data are taken from the *EWN* database of Lane and Milesi-Ferretti (2007), complemented by data from the IMF and the World Bank. We call this first stage *'piloting'*, as we work from the hypothesis that ratings guide foreign funds to countries whose creditworthiness is comparatively difficult to ascertain for foreign investors. While the analysis at the first stage is centred on FPI destinations (host countries), the focus at the second stage is on the origins (home countries). That stage is named '*home bias cutting'*, as we test the hypothesis that sovereign ratings have contributed to a decrease in investors' home bias across a large range of countries. At the third stage, described as '*size-making'*, we bring the home and host country perspectives together by looking at different aspects of ratings as determinants of bilateral investment. For the second and third stage, we use bilateral FPI data for 76 countries over the period 2001–11 from the IMF's *Coordinated Portfolio Investment Survey* (CPIS). It is an open question whether ratings affect the cross-border trade in debt securities, the type of assets to which they are applied, more than the trade in other securities. As the CPIS database allows us to make the distinction, we use data on debt securities as well as total FPI figures (which include equities) in order to assess the scope of ratings.

At the first stage, we present some evidence for the pilot role of credit ratings. We find a strong positive effect of the introduction of sovereign ratings in host countries on foreign portfolio *holdings* after 1976. Additionally, rated countries participate more intensively in the international diversification of portfolio investment. This effect is even stronger for countries with ratings below investment grade. A better rating is associated with larger net *inflows* of foreign capital, which we regard as a long-term quality effect.

Our hypothesis of a decrease in investors' home bias in the presence of ratings finds no support across the complete CPIS sample from 2001 to 2011. However, the global financial crisis, which covers almost a third of that period, appears to have affected the empirical estimation of the theoretical model by its large valuation swings and a high volatility of capital flows. Looking at pre-crisis and crisis sub-samples we find clear evidence for home bias reduction in higher-rated countries before the outbreak of the crisis in 2008, and a quality effect of higher host country ratings on outward FPI of home countries thereafter.

In the estimation of the bilateral gravity model at the stage of 'size-making' we do see a positive relationship between sovereign ratings and FPI across the full sample. For home countries, a better rating translates into a larger bilateral foreign asset share. Coefficients for host countries are equally positive and significant. Despite the volatility in FPI data, sovereign ratings seem to be reliable and stable predictors for portfolio investment across the full set of assets and a large and heterogeneous set of countries. Taking all three stages together, we find strong evidence of a contribution of credit ratings to the transnationalization of finance.

The structure of this paper is as follows. Section 2 highlights the relevant facts of transnational finance and the rating business. Section 3 provides the theoretical underpinnings for our estimations by developing a rating application of gravity analysis with home bias. Section 4 describes the data and equations used for the three stages of estimations. Section 5 presents the results of our study at the stages of *piloting*, *home bias cutting* and *size-making*, respectively. Section 6 reviews estimations with alternative specifications to check the robustness of our results. Section 7 contains our conclusions.

2 Portfolio Investment and Sovereign Credit Ratings

Credit ratings come in two basic varieties. *Issuer ratings* rank sovereign governments, financial institutions, non-financial firms (corporates) and other debt-issuing entities in terms of their relative creditworthiness. *Issue ratings* inform about the default risk of particular issues of bonds and other fixed-income instruments, including "structured finance" (asset backed securities, collateralized debt obligations, etc.). Acting as reputational auxiliaries, or intermediaries between issuers and investors, CRAs can be described as agents of trilateral governance – be it in private ordering or by public regulation (Kruck 2011; Trautwein 2013: 3–7). They transform their risk assessments into scaled rating signals and keep the objects of their ratings under continuous observation.

It is generally held that CRAs "reduce information costs, increase the pool of potential borrowers, and promote liquid markets" plus "influence issuers to take corrective actions" (IMF 2010: 86). They perform thus two types of services traditionally characterized as core functions of the banking business: the screening of investment opportunities and delegated monitoring (Gorton and Winton 2003). In this respect one can speak of an unbundling of bank services. Wherever borrowers substitute marketable debt for bank loans and seek certification from CRAs, the agencies help to replace bank services. Yet, rather than being crowded out, banks themselves make use of credit ratings to expand their business, both in borrowing and lending. On the asset side of their balance sheets they rely on ratings as cost-saving substitutes for in-house risk assessments. On the liabilities side they buy certification services from the CRAs when they issue bonds and other debt instruments.

Moreover, as we argue in the following, sovereign ratings play a significant role in the evolution of cross-border capital flows. The enormous expansion of cross-border flows of capital can be gauged from a first look at GDP and balance-of-payment statistics. Between 1970 and 2011, world GDP increased on average by 7.0% per year (in current USD prices), while world trade (merchandise) grew at an average rate of 8.5%. Still, the volumes of transnational finance grew much faster, with cross-border loans of banks[1] expanding by 1.7 percentage points (p.p.), foreign direct investment (FDI) by 1.9 p.p., and foreign portfolio investment (FPI) by 2.6 p.p. *for each per cent of GDP growth*.

Figure 1 highlights the upward trends of FDI, FPI and cross-border bank lending in absolute and relative terms over all countries. The average growth rate amounts to 12.2% per year for bank lending, 13.1% for FDI net inflows, and 18.5% for portfolio investment net inflows. All types of capital flows are volatile, with strong fluctuations around the peaks in 2000 and 2007. The contractions are explained by the *dot-com* crisis in the first case, and a combination of the great financial crisis with a global surge in non-tariff barriers to trade and capital flows in the second. Since the underlying structures in the financial sector have not changed, it is plausible to assume that the latest contractions are temporary set-backs, not breaks in the trend.[2]

Analysing the co-evolution of cross-border capital flows and credit ratings, we set the focus on FPI flows and stocks. FDI data, too, may contain relevant information about portfolio investment, as issuer ratings are likely to affect acquisitions that amount to more than ten percent of the shares (the dividing line between FPI and FDI), but are not made by control motives. Yet it is hardly possible to extract information about this class of investments from FDI data. With regard to cross-border bank lending, it could be argued that banks take recourse to issuer ratings in their decision-making about direct loans to foreign entities (BIS 2000). However, the available data do not permit to discriminate between such cases and the banks'

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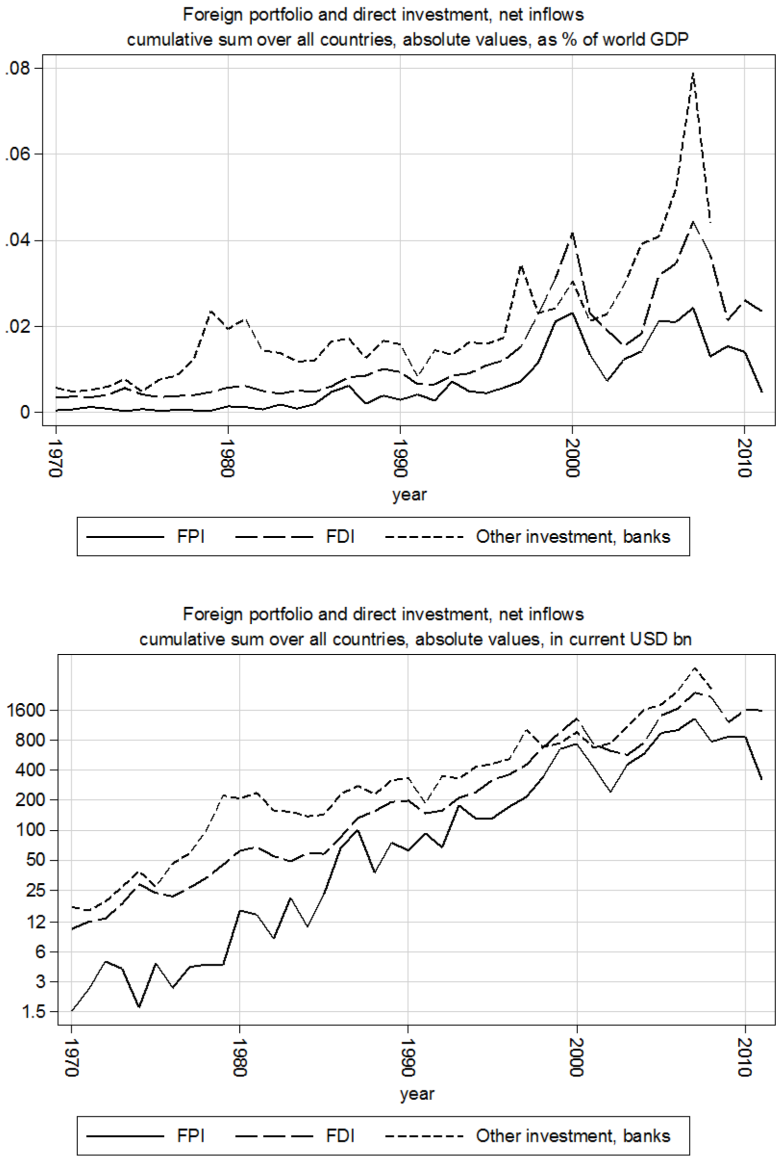
[1] See the BoP item "Other investment, banks" in the IMF *International Financial Statistics* and IMF (2009: 111).

[2] The figures relate to *net* inflows of capital, netting the credit and debit entries for the same assets (IMF 2009: 134). The strong contraction after 2007 reflects a global slump in the issuance of securities rather than a reversal of the trend of transnationalization.

Figure 1: Cross-border Bank Lending, FDI and FPI (1970–2011)



Note: "Other investment, banks" only until 2008 (IMF, IFS).
Source: Own computation, World Bank Financial Indicators, IMF International Financial Statistics (IFS), Lane and Milesi-Ferretti (2007).

use of internal risk assessment and other modes of evaluation.[3]

The scope of our analysis is thus confined to *portfolio investment*, i.e. to cross-border transactions and positions that involve debt and equity securities. Given the millions of ratings for issuers and issues of bonds and other debt instruments (long-term and short-term), it appears safe to assume that there is a close correspondence between the debt instruments rated and those recorded in the FPI statistics. Ratings of the underlying debt securities affect, moreover, the shares of fixed-income funds, which in the FPI statistics range under "equities".

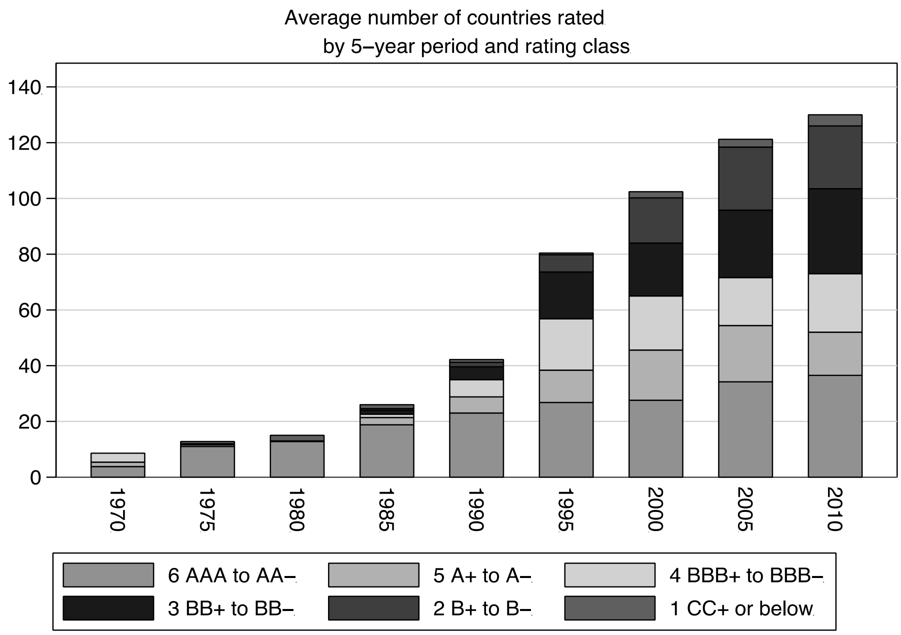
On the side of the ratings, we set the focus on *sovereign ratings.* These are essentially ratings of the ability and willingness of national governments to repay their debt. In spite of an overhaul in the early 2000s, sovereign foreign currency ratings continue to set the maximum value for most of the ratings assigned to private sector and sub-national government entities (Gaillard 2012: 24–25). There is ample evidence that they are a main determinant of sovereign bond spreads in global capital markets and thereby of the borrowing cost in different economies (Kiff et al. 2012). The underlying reason for this influence is the pilot role that sovereign ratings play for investors in assessing the country risk component in cross-border engagements. On the issuers' side, sovereign ratings "are a stimulus for enhancing the capability of countries' governments and private sectors to access global capital markets, attract foreign direct investment, encourage domestic financial sector development, and support governments' efforts on financial and economic improvements and transparency, especially in emerging markets" (Al-sakka and ap Gwilym 2010: 2615).

Figure 2 shows (in combination with Figure 1) that the sovereign ratings business has developed largely in line with FPI flows. The (average) number of countries covered by sovereign ratings rose from a mere 15 in the mid-1980s to over 130 in 2011.[4] The figure illustrates also a change in the distribution of rating grades. Before the 1990s, when only few countries were rated, nearly all of them

[3] Derivatives, too, are beyond the scope of this paper. While their growth rates are spectacular, their time series are rather short, scant and not sufficiently compatible with the data we use in our longer-term perspective.

[4] The averages in Figure 2 relate to the sovereign ratings of Moody's and Standard & Poor's. Fitch did not resume rating sovereigns until 1994 and rated fewer countries in the first years; see Gaillard (2012: Ch.2).

Figure 2: Average Number of Rated Sovereign Issuers by Five-Year Period (1970–2011)



Note: Five-year period starting in 2010 covers years 2010/11 only.
Source: Own computation, Moody's, Standard & Poor's.

had investment grade ratings (AAA to BBB- in Standard & Poor's scale). Since then, the share of countries with sovereign ratings in the category of speculative grade (BB and below) has risen to nearly 50% in 2010/11. This tendency may to some extent reflect the increase in the frequency and intensity of financial crises since the early 1990s, but first and foremost it indicates an increased market access of issuers from low and middle-income countries.

In our perspective of transnationalization, three points are particularly noteworthy about sovereign ratings. The first point is their *normative power*. The three big CRAs prefer to declare their judgments about the creditworthiness of national governments to be "opinions" only. Yet, it is evident that their sovereign ratings carry a high signal value for investors, affecting the borrowing cost of the entire economies in the respective nations (Kiff et al. 2012). It is also evident, from their own publications as well as from empirical research, that the CRAs base their sovereign ratings on similar criteria (Gaillard 2012: Ch.6). This consensus forces governments to take the CRAs' rating criteria into account in their economic policies. Sovereign ratings are thus an instrument of transnational governance, by which private corporations standardize the evaluation of the macroeconomic performance of states.

The second point is the *growing resilience of transnational corporations.* The CRAs' allowance for discrepancies between country ceilings and sovereign ratings reflects an increasing independence of financial institutions and industrial firms from local conditions of finance. Local subsidiaries of TNCs can "outrate" their sovereigns, insofar as they have better access to global finance through their networks. Far from reducing the signal value of sovereign ratings, the resilience of TNCs increases the normative power of those ratings. With the assessment of gaps between country ceilings and sovereign ratings, national governments may find themselves under pressure towards more investor-friendly policies.

The third point is the *congruence* of the chosen variables. Nearly all measurements of cross-border flows and holdings of financial assets are based on national statistics, in the balances of payments as well as in other sets of financial indicators. Sovereign ratings represent the credit risk assessments for the corresponding entities. This makes them the most appropriate variable for proxying the influence of credit ratings on the transnationalization of finance.

3 Home Bias and Gravity

3.1 Three Hypotheses on Distance and Risk Perceptions

Credit ratings serve to assist investors in their choice of financial assets under the aspects of risk and return. The benchmark model for determining investors' portfolio selection in the global economy is ICAPM, the international capital asset-pricing model (Solnik 1974). For a world with fully integrated markets, in which information and transaction costs are zero and no other frictions occur, ICAPM "predicts" that investors minimize risk in relation to return, if they diversify their portfolio so as to hold assets of different countries in proportion to the respective countries' share in the world market portfolio. In other words, the share of foreign assets in a country's portfolio holdings should equal the share of foreign assets in the world market portfolio.

Empirical evidence contradicts this prediction spectacularly. There is a strong home bias of investors in almost all countries. The standard definition of home bias *(HB_j)* of investors from country *j* is an index of the following kind:

$$HB_j = 1 - \frac{share\ of\ foreign\ assets\ in\ the\ domestic\ portfolio}{share\ of\ all\ foreign\ assets\ in\ the\ world\ market\ portfolio} \quad (1)$$

A value of $HB_j = 1$ is associated with full home bias while $HB_j = 0$ is the theoretically ideal case of full diversification. In the latter case, domestic asset holdings are exactly equal to the world market portfolio share of the respective country. As noted before, Coeurdacier and Rey (2013) consider informational asymmetries as frictions that explain the low degree of international portfolio diversification.

Credit ratings should help to reduce such frictions, since the combined sets of solicited ratings, for which the "issuer pays", and unsolicited ratings make private and local information about credit risk available worldwide at no cost for the investor (for the ratings *per se),* or at a relatively low cost (for further information). Accordingly, we would expect ratings to contribute to a decline in home bias, a tendency that is indeed observable. Despite its persistence, home bias shows a falling trend in most economies since the early 1990s and concurrent with the sharp increase in the number of sovereign ratings displayed in Figure 2.[5]

We adopt a three-stage identification process to proxy the transnationalization of finance by the increasing use of credit ratings since the 1970s. We label the first stage "*piloting*", emphasizing the function of ratings to attract foreign investment into a country.

5 While there seem to be no data for developments before 1993, Sørensen et al. (2007: Tables 2 and 3) show that the equity home bias in OECD countries shrank by 16 percentage points between 1993 and 2003, and the bond home bias by 11 p.p. For the period 2001-08, Coeurdacier and Rey (2013: Figs. 1–3) report falling trends of home bias in equity and bonds at the global level and for most of the world regions (with the exceptions of Central and Eastern Europe and South Africa); they also show a falling trend for banking assets in OECD countries, 1995–2007 (Fig. 4).

Hypothesis 1, "Piloting": *The stocks and flows of inward portfolio investment increase after a country is being rated and/or upgraded by at least one of the big CRAs.*

At the second stage, we take a look at investors' use of ratings. Investors from countries, in which ratings are well established as a means of credit risk analysis, are themselves more likely to invest in other rated countries, because the ratings make risks more comparable.[6] Home bias in portfolio investment holdings is therefore expected to be lower with increases in the general availability of ratings and in the quality of ratings in the home countries. This leads to:

Hypothesis 2, "Home bias cutting": *Portfolio investment home bias is lower for countries with better credit ratings.*

We label the third stage the "*size-making*" phase. Sovereign ratings serve as a qualitative guide for foreign investors since the majority of countries have been rated since the late 1990s or the early 2000s. We look at different categories of rating quality as a set of factors explaining the direction and size of foreign portfolio investment:

Hypothesis 3, "Size-making": *Rating quality serves as a determinant of the size of bilateral portfolio holdings.*

An appropriate approach to test these hypotheses is to estimate a gravity equation, a framework widely used in the International Trade literature. In gravity equations trade is positively related to the size of the involved economies and negatively related to the distance (trade barriers) between them. In the case of cross-border portfolio investment it can be argued that distance corresponds to informational asymmetry in the perception of credit risk. Reflecting country credit risk, sovereign ratings provide a proxy for distance that allows for more sophisticated analysis than simple measures of physical distance, general communication (common language, phone call figures etc.) or the like. Distance, or rather: the negative relationship with cross-border trade in financial assets, should vary with the availability of the information and with its content. The introduction of sovereign ratings for a country, as well as track records of continuous ratings, can thus be expected to shrink the distance between FPI destinations and source countries. The same

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[6] In addition, regulations may require investors to seek overseas investments with ratings in order to qualify for risk-weighted asset assessment (BIS 2009; Partnoy 2009; Reisen 2010; Kruck 2011).

should apply to shifts from speculative grade to investment grade and to rating upgrades in general, whereas distance would grow and FPI decrease with changes in the other direction.

Studying home bias and related issues of portfolio investment through gravity models has become fairly standard in recent years, starting with the seminal paper of Portes and Rey (2005, in circulation since 1999).[7] As in the trade literature, the finance literature has been quite successful in producing robust findings of correlations of FDI and FPI with size (positive) and distance (negative), while work at the theoretical underpinnings has been lagging behind. Okawa and van Wincoop (2012: 207–210) develop a theoretical gravity equation from a simple static framework of portfolio choice, and they discuss the general limitations to the use of gravity models in finance. Even considering those limitations, we find their analytical framework to be less restrictive than other approaches and more useful as a theoretical base for our empirical analysis of the role of ratings. Therefore we outline its relevant characteristics here (with slightly modified notation), adapt it for our purposes in Sections 3.3 and 4.2, and present the results in Section 5.

3.2 A Gravity Theory for Financial Assets

The Okawa/van Wincoop gravity theory of bilateral portfolio holdings is based on a one-good, two-period, $N+2$ assets, N country framework. The gravity equation that they derive applies to the first N assets (equity, bonds or loans), which carry risks that are country-specific. The $N+1^{st}$ asset is a risk-free bond that is in zero net supply, as in standard portfolio choice theory. The $N+2^{nd}$ asset (also in zero net supply) is an asset that allows investors to hedge the global market risk separately, as its return is perfectly correlated with global shocks. This reduces the portfolio selection problem to the choice among the domestic and foreign N assets with country-specific risks. Okawa and van Wincoop point out that the possibility to hedge the global risk factor with the global asset is a critical assumption. If it is not fulfilled, it is not possible (at least not in their framework) “to express bilateral asset holdings as a gravity form in a general setup” (2012: 211). Yet they also

[7] Okawa and van Wincoop (2012: 205 n. 1) provide a long, though incomplete list of references to papers that have estimated gravity equations for equity, bond and banking assets. Further references follow in this paper.

indicate that the assumption of such a global asset is not as outlandish as it may seem at first sight. It could be interpreted as a global futures contract, or as a futures contract on a set of multinational firms. “For such firms country-specific shocks naturally play less of a role as a result of their global operations” (2012: 207).

In period 1, agents in country j start with a *total wealth portfolio* W_j that includes a claim on all risky assets of country j, denoted as Q_jK_j , with Q denoting the asset price and K the capital stock. They maximize intertemporal utility by deciding about consumption in period 1 and allocation of the remainder of W_j across the $N+2$ financial assets, expected to yield the *portfolio return* R_j^p:

$$R_j^p = \sum_{i=1}^{N} \alpha_{ij} R_i + \alpha_{gj} R_g + \alpha_{fj} R_f \tag{2}$$

summing up to 1, the portfolio shares are α_{ij} for investments in country i assets (foreign portfolio investment if $j \neq i$), α_{gj} for the global asset, and α_{fj} for the risk-free asset. The Euler equations yield the standard first-order conditions for consumption and portfolio choice, representing the trade-offs between consumption in periods 1 and 2, and between the investments in the different assets. The relevant market clearing condition for country *i asset supply* S_i is:

$$\sum_{j=1}^{N} \alpha_{ij} W_j = Q_i K_i = S_i \tag{3}$$

Okawa and van Wincoop (2012: 208) assume that domestic agents are better informed than foreigners about the returns on domestic assets. From the perspective of agents in country j, the return on country i assets has a mean of zero and a variance of $\sigma_i^2\, \tau_{ij}$. “Information asymmetry is therefore captured by $\tau_{ij} > \tau_{ii}$ when $j \neq i$ ” *(ibidem)*. By solving the model they obtain the following expression for the *risky asset portfolio shares* α_{ij}:

$$\alpha_{ij} = \frac{1}{\gamma R \sigma_i^2\, \tau_{ij}} \left[E\left(R_i - R_f\right) - \frac{E(R_g - R_f)}{\sum_{i=1}^{N} (K_i/K)} \right] \tag{4}$$

where γ captures risk aversion. The next step is to define the RHS of Equation (4) *without* the informational friction component τ_{ij} as $1/p_i$, with p_i representing a risk-return ratio, the country-specific risk of asset i being divided by the expected excess return. The risk-return ratio for agents from country j investing in country i can accordingly be written as $\alpha_{ij} = 1/\tau_{ij}\, p_i$. The total foreign asset holdings by agents from country j are $A_j = \sum_{i=1}^{N} \alpha_{ij} W_j$. Substitution for α_{ij} yields $W_j = A_j P_j$ where $1/P_j = \sum_{i=1}^{N} 1/\tau_{ij} p_i$. This leads to the definition of *foreign portfolio investment holdings* X_{ij} of country j in country i as:

$$X_{ij} = \frac{P_j}{\tau_{ij} p_i} \tag{5}$$

It is important to note that it follows from Equation (5) that bilateral asset demand depends on "a relative price": the price of country i assets in terms of their risk-return ratio relative to the overall price index P_j . Combining the demand Equation (5) with the market clearing conditions for the asset market of country i, $\sum_{j=1}^{N} X_{ij} = Q_i K_i = S_i$, and relating it to the world demand and supply of risky assets, $A = S$, the country-specific market clearing condition gives the following solution for the *relative price of i's assets* p_i:

$$p_i = \frac{S}{S_i \Pi_i} \tag{6}$$

where Π_i indicates average multilateral frictions of investing in country i. Substituting this into the FPI definition of Equation (5) finally yields the gravity equation for *bilateral asset holdings* of country j in country i:

$$X_{ij} = \frac{S_i A_j}{A} \frac{\Pi_i P_j}{\tau_{ij}} \tag{7}$$

On the one hand, bilateral FPI is thus driven by a size factor: the product of total asset holdings of country j and the asset supply of country i, divided by global demand (equal to supply in general equilibrium). Bilateral FPI is, on the other hand, determined by a distance factor in terms of the "relative financial friction". This relates the *country-pair-specific information asymmetry* (and other specific frictions), denoted by τ_{ij} , to the so-called "*multilateral resistance variables*" Π_i and P_j which "measure the average financial frictions for respectively country i as a destination country and country j as a source country" (Okawa and van Wincoop

2012: 209).[8] If the specific friction τ_{ij} is lower than the average friction with regard to all destinations, agents from country *j* will invest relatively more in country *i*. If, on the other hand, the average friction is high for country *i*, it will have to offer a low risk-return ratio through a high expected return. In this way, general equilibrium effects of changes in barriers to cross-border flows of capital can be taken into account.

3.3 A Rating Application of Gravity Theory with Home Bias

Our contribution is to transform the general gravity Equation (7) into a home bias expression. Remember that $W_j = A_j P_j$; hence, W_j / A_j can be substituted for P_j to cancel out A_j which yields:

$$\frac{X_{ij}}{W_j} = \frac{S_i}{A}\frac{\Pi_i}{\tau_{ij}} \tag{8}$$

Given that $\Pi_i = \left(\sum_{j=1}^{N} P_j/\tau_{ij}\, A_j/A\right)^{-1}$, substituting for P_j generates the foreign assets counterpart of the home bias Equation (1). Summing over all investing countries *j* in the numerator "explains" to what extent host country *i* receives FPI, given financial frictions and information asymmetries between the countries. These average frictions of all investor countries k with $j \in k$ are related to the bilateral friction on investment holdings X_{ij} between the country *j* and country *i*:

$$\frac{X_{ij}}{W_j} = \frac{S_i}{A}\frac{\sum_{k=1}^{N}\frac{W_k}{\tau_{ik}A}}{\tau_{ij}} \tag{9}$$

Equation (9) is another way to describe relative financial frictions defined in Equation (5). Foreign asset holdings of source country *j* in destination *i* equal the product of the share of country *i* assets in the world portfolio[9] and the bilateral friction in relation to the average financial friction that investor country *j* faces relative to

[8] For given values of bilateral frictions (τ_{ij}), asset supplies (S_i), and wealth in the source countries (W_j), the model can be solved for A_j , P_j and Π_i ; see Okawa and van Wincoop (2012: 209).

[9] Remember from Section 3.2 that globally $S=A$.

all destinations. Bilateral frictions can be calculated as follows in Equation (10) and used as inputs in Equation (9) with τ_{ii} set to 1.[10]

$$\frac{\tau_{ij}}{\tau_{ij}} = \left(\frac{X_{ij}/W_j}{X_{ii}/W_i}\right)^{-1} \tag{10}$$

Since overall domestic wealth $W_j = X_{jj} + \sum_{i \neq j}^{N} X_{ij}$ is either held domestically or abroad, the home bias of investors from country j can be written, in line with Equation (1), as the complement of the share of foreign assets in the domestic portfolio over the share of all foreign assets in the world market portfolio:

$$HB_j = 1 - \left(\frac{\sum_{i \neq j}^{N} X_{ij}}{W_j}\right) \Big/ \left(1 - \frac{A_j}{\mathrm{A}}\right) \tag{11}$$

substituting (9) into (11), gravity Equation (7) is transformed into a measure of home bias from the perspective of the investing country j relative to all investment destinations:

$$HB_j = 1 - \left(\frac{\sum_{i \neq j}^{N} S_i}{A} \frac{\sum_{k=1}^{N} \frac{W_k}{\tau_{ik} A}}{\sum_{i \neq j}^{N} \tau_{ij}}\right) \Big/ \left(1 - \frac{A_j}{\mathrm{A}}\right) \tag{12}$$

The values obtained for τ_{ij} can be plugged into Equation (12). Based on the Okawa/van Wincoop model of portfolio choice (described in Section 3.2), and fully compatible with the standard definition of home bias in Equation (1), we derive thus an expression for the selection of domestic and foreign asset holdings, in which the home bias increases whenever relative frictions from investing country j become stronger compared with average frictions of all other investing countries. Conversely, if frictions are reduced, the home bias becomes smaller.

In each of these specifications, the gravity model defines cross-border asset holdings as a function of the home and host country frictions. These are associated with the variable τ_{ij} in the set of variables measuring information asymmetries. Sovereign ratings are among the variables thought of affecting financial market

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[10] In the trade literature τ_{ii} is estimated in more sophisticated specifications (Behrens et al. 2012: 782). But in the case of asset trade, costs of physical transport that matter for internal goods trade may be neglected.

frictions and particularly information frictions. They condense information and reduce the informational friction for foreigners who rely on them more than domestic investors.

We therefore choose to include sovereign ratings in all three stages of the analysis. This is an innovation, both in terms of an application of the Okawa/van Wincoop model and an inclusion of credit ratings in gravity models. To our knowledge, the only other paper in which ratings are used for the analysis of bilateral asset holdings and home bias is Vanpée and De Moor (2012). Their approach differs, however, from ours in terms of methodology and data. They do not take into account the relativity of bilateral frictions and investments inherent in a global setting of portfolio choice theory, and they take recourse only to levels of Standard & Poor's sovereign ratings. As we explain in the next section, we make broader and more intensive use of rating data. We put particular emphasis on the unilateral stage of *piloting,* despite the loss of information compared to the bilateral analyses of *home bias cutting* and *size-making*: Since for most countries sovereign ratings were introduced in the 1980s and 1990s, we can compare the developments of portfolio investment in rated and non-rated countries exclusively at this early stage, for which we do not have bilateral data. Yet, as we will show, even our unilateral analysis at the *piloting* stage remains well-connected to the estimation procedure derived from the theoretical model in this section.

4 Data and Estimation

The framework by Okawa and van Wincoop (2012) requires precise data on cross-border asset holdings. However, the empirical application of the estimation models defined in Equations (9) and (11) is severely restricted by the availability of quality data, a notorious problem in the measurement of capital mobility (Obstfeld and Taylor 2004: Ch. 2). The most comprehensive dataset, the IMF's *Coordinated Portfolio Investment Survey* (CPIS) was started only in 1997, with annual surveys running since 2001. The data from this survey is strongly affected by the global financial crisis and exchange rate gyrations. With 78 reporting countries the 2012 CPIS covers only a fraction of world portfolio holdings. Even though this fraction comprises over a third of all countries in the world, it leaves out many financial centers and offshore hubs. Given the heterogeneity and the limited availability of FPI data, we find it appropriate to take the three-stage approach outlined above.

4.1 Data

In the 1970s and 1980s the number of countries rated by one or more of the then two global CRAs that provided sovereign ratings was rather small (Fitch re-introduced them only in 1994). It grew strongly in the 1990s and arrived at 138 by 2011. We approach the relation between the transnationalization of finance and sovereign credit ratings in a three-stage process as described in Section 3.1. At the "piloting" stage we work with unilateral data, at the "home bias cutting" stage we create average data from bilateral holdings, and at the "size making" stage we use a large dataset of bilateral investment data. The data sources are listed in Appendix A.1 and further described below.

First, at the piloting stage, we try to identify the impact of the introduction of credit ratings on inward portfolio investment. This approach adopts a host country perspective in the sense of looking at the influence of credit ratings on a country's attractiveness for international investors. Attempting to identify long-term changes and the role of CRAs therein, we look at both stock and flow measures. The advantage of flows is that we can readily assess whether changes in the rating environment a country is operating in have a direct and immediate effect. We expect rating changes to induce a surge in PFI inflows—in particular for new ratings and in cases of upgrades from non-investment to investment grade status.

Since there is a lack of bilateral portfolio investment data for the period prior to 2001, when the pace of integrating further countries into the sovereign rating systems was strongest, we have to make do with unilateral data. We use Lane and Milesi-Ferretti's (2007) *External Wealth of Nations* (EWN) database, and updates thereof, for portfolio debt and equity holdings, and datasets from the World Bank on net inflows of portfolio investment. The World Bank data come from the 'featured indicators' in the Financial Sector database. Sources are the IMF's *Balance* *of Payments* database and World Bank *International Debt Statistics*. We use data for 119 countries from 1976 to 2011 (the current limit of the EWN database).[11]

Second, at the stage of home bias cutting, we aim to identify the influence of ratings on foreign portfolio holdings. In this step, we use CPIS data for 2001 to 2011 to calculate the home bias measure for each of the 76 reporting countries.[12] A panel dataset is created for all available countries from CPIS Table 1, named "*Reported Portfolio Investment Assets by Economy of Nonresident Issuer: Total Portfolio Investment*". It contains data on bilateral portfolio investment holdings in 76 reporting countries ('to' or *i*), with disaggregation of the holdings figures for 214 investing countries ('from' or *j*). The data comprise holdings of equity, short-term and long-term debt securities, and an overall measure.

Third, at the size-making stage, we examine to which extent ratings act as a guide for bilateral portfolio investment flows, using again the CPIS dataset of 76 countries for their reports of investment inflows from up to 200 countries from 2001 to 2011. We look at different measures of ratings to identify their possible size effects on bilateral FPI relations.

The portfolio investment dataset is enriched with data from the OECD, the World Bank and the IMF's *International Financial Statistics* as well as the EWN database (Lane and Milesi-Ferretti 2007) on debt statistics, bond issuance, balance of payments and national accounts data. For bilateral data, we rely on the dataset compiled by Rose (2004) as well as further control variables used in the empirical trade and portfolio investment literatures (see, e.g., Daude and Fratzscher 2008, Hattari and Rajan 2011); see also Appendices A.1 and A.2 below.

All independent variables apart from dummy variables are transformed into logarithms, where feasible. Negative values are possible for portfolio flows and some measure of country portfolios W_j in cases in which inward foreign investment exceeds domestic investment. In these instances we use level data for the variables, which can be straightforwardly interpreted in the multiplicative Poisson

[11] *Portfolio equity, net inflows* are non-FDI equity securities inflows "including shares, stocks, deposit receipt and direct purchases of shares in local stock markets by foreign investors in current U.S. dollars". For detailed descriptions of the data sources and their use see Appendices A.1 and A.2.

[12] Given that more recent CPIS data are available, it would have been desirable to extend the estimations at stages 2 and 3 to an end point beyond 2011. However, the World Bank's GFD data required to calculate the total portfolio values (domestic and foreign) were at the time of writing available only until 2011.

framework. All money-related data is converted to 2005 US dollars to keep them comparable with US dollar portfolio investment flows and holdings from CPIS and EWN. Ratings are converted into a numerical 20-step scale with 21 as the top rating (AAA for S&P, Aaa for Moody's) and 1 for default (D). Investment grade status is attributed to ratings above 12 (BBB- or Baa3, respectively), while lower values indicate non-investment grade. The bilateral country panel is balanced; it comprises annual observations from 2001 to 2011, yet the panel is not fully balanced since several countries joined only after the annual surveys started in 2001. See Appendices B.1–B.3 for summary statistics.

4.2 Estimation

The gravity model is often estimated in a log-linearized regression equation. Santos Silva and Tenreyro (2006) show this procedure to be associated with inefficient and inconsistent estimators in the presence of heteroskedasticity, when the variance of the error term is not proportional to its conditional mean, a perennial feature of trade and portfolio investment data. We follow them, and a recent trade-related application by Nitsch and Wolf (2013), in estimating the gravity model in a multiplicative framework using a Pseudo Poisson Maximum Likelihood estimator (PPML). For PPML estimators, the interpretation of coefficients differs from standard regression models (Santos Silva and Tenreyro 2006: 643): An economic relation between a dependent variable y_i and a set of explanatory variables x_i in a constant-elasticity model is denoted by $y_i = \exp(x_i\beta)$. The interpretation of the function $\exp(x_i\beta)$ is of it being the conditional expectation of y_i, $E[y_i|x]$, which holds on average but not for each *i*. While the dependent variable is usually a "count" variable in Poisson applications, the derived estimator is consistent even for continuous variables which are not Poisson-distributed, thus labelled pseudo-Poisson (Santos Silva and Tenreyro: 645). In our estimations, independent variables enter in logs, when continuous, to permit interpretation as elasticities, otherwise in levels, as in the case of ratings, or dummy and index variables. In these specifications (or for small changes in *x*), the coefficient can be approximated as a percentage change in the observed count variable.

Our three-stage estimation approach to rating effects on foreign portfolio investment is presented in the following.[13] All estimation equations are based on the same adjusted Okawa/van Wincoop (2012) financial gravity model. Piloting adopts a unilateral version; home bias cutting uses normalized bilateral holdings with a single value by country and point of time, while size-making is the truly bilateral version of the gravity model of finance.

4.2.1 Piloting

The first stage estimation is a simplified unilateral version of the gravity model. At this stage, we relate the share of the sum of foreign investment from all countries in host country i, X_i, in the investor countries' portfolio, W_k, only to asset supply and average frictions, Π_i for investment in this country.[14] The country k subscript is employed as a catch-all term for the rest of the world in this specification. The results from the following estimation equation (omitting time subscripts) are presented in Section 5.1:

$$\frac{X_{ik}}{W_k} = \alpha_0 S_i^{\alpha_1} A^{\alpha_2} {\Pi_i}^{\alpha_3} e^{\theta_i d_i} \tag{13}$$

4.2.2 Home Bias Cutting

Estimating the home bias equation in line with the theoretical model by Okawa and van Wincoop (2012: 212) requires shifting the gravity focus onto the share of domestically held assets, X_{jj} in the home country of foreign portfolio investors. We therefore rearrange the theoretical derivation for foreign portfolio holdings by Okawa and van Wincoop (as presented in Section 3.3) to create a home bias meas-

13 Technically, we carry out our estimations in STATA 12.1 using the *xtpoisson* command for panel poisson ML estimations with the option *fe* for fixed effects and *robust* standard errors from the package *xtpqml*.

14 Due to a lack of bilateral data, we cannot estimate τ_{ij} directly; we use average financial frictions contained in Π_i instead.

ure congruent with the standard definition. Home bias Equation (12) can be estimated for all bilateral holdings as:

$$HB_j = \alpha_0 (S_i/A)^{\alpha_1} (W_k/\tau_{ik}A)^{\alpha_2} \left(1 - A_j/A\right)^{\alpha_3} {\tau_{ij}}^{\alpha_4} e^{\theta_i d_i + \theta_j d_j} \tag{14}$$

where S_i/A measures the global market share of the host country, $W_k/\tau_{ik}A$ relates the home country's domestic and foreign assets to average bilateral frictions, τ_{ij} is the relative friction between and host and home countries i and j, and $1 - A_j/A$ is the "rest of the world" market share, as seen from the home country. Multilateral financial frictions are included in the measure of τ_{ij} with credit ratings and other measures of information asymmetries. Results of the estimation are presented in Section 5.2.

4.2.3 Size-making

The third stage is the estimation of the standard gravity model measuring the share of a country's portfolio investment, X_{ij}, in its overall portfolio, W_j. The ratio is regressed on the country's available domestic assets, a destination country dummy and measures of informational frictions. The latter are expressed in terms of the multilateral financial frictions of the host country, $\Pi_i = \sum_{k=1}^{N} (W_k/\tau_{ik}A)$. Estimation results are presented in Section 5.3.

$$\frac{X_{ij}}{W_j} = \alpha_0 (S_i/A)^{\alpha_1} (W_k/\tau_{ik}A)^{\alpha_2} {\tau_{ij}}^{\alpha_3} e^{\theta_i d_i + \theta_j d_j + \theta_k d_{ij}} \tag{15}$$

5 Results

Results from the empirical assessment of the theoretical gravity model derived in Section 3.3 are presented in the three-stage order described above. In the gravity model of finance, we proxy "financial distance" by various indicators derived from sovereign credit ratings, which are described in the results section. These indicators are based on Hypotheses 1–3 in line with the qualitative assessment of the transnationalization of finance in the preceding sections. Variables are described in Appendix A.2 and summary statistics are presented in Appendices B.1–B.3.

5.1 First Stage: Piloting

For the first stage analysis, we use the PFI data for 119 countries for the period 1976–2011 from the EWN and World Bank databases, as described in Section 4.1. Out of this sample, 68 countries had a sovereign rating by 1976 or received their first rating thereafter. This subset is heterogeneous, comprising high-income countries with well-developed financial markets, but also developing countries in Latin America, Africa and Asia.

5.1.1 Portfolio Investment Holdings

The baseline estimation is carried out in accordance with the estimation model presented in Section 4.2. The dependent variable is incoming portfolio investment holdings, X_i, reported in the EWN database as a country's FPI liabilities, which are divided by all potentially available foreign capital, W_k. This share is regressed on the variables from the gravity model of Okawa and van Wincoop (2012) and several rating variables. The details and data sources of the variables used at the three different stages are described in Appendix A.1–A.2. The model is estimated in its multiplicative form, using pseudo Poisson maximum likelihood panel fixed effects estimations with heteroskedasticity-robust standard errors (Cameron and Trivedi 2010) and time fixed effects (not reported).

Results are presented in Table 1.[15] The variable rating stage (rtg_stage) in Model (2) is an indicator variable of the rating stage of the host country. It has a value of 0 if the host country does not have a sovereign credit rating, 1 for having a rating below investment grade level (lower than BBB-) and 2 for having an investment grade rating. The coefficient is negative and not significant. The result may be driven by the fact that, while countries with large market volumes and high sovereign ratings (e.g. Germany, Italy, Spain, the Netherlands and Belgium) were rated only from the mid-1980s onwards; in conjunction with the mostly later dates of first ratings for smaller and portfolio holdings may be lower on average for

15 Robustness checks using ordinary panel fixed effects and clustered OLS estimations for all three estimation stages are available in the data repository at http://dx.doi.org/10.7910/DVN/26723; see also Section 6 below.

Table 1: Piloting: PPML Panel Estimation of Host Country Investment Holdings (1976–2011)

Dependent Variable: **Host country FPI holdings / available foreign capital**	**(1)**	**(2)**	**(3)**	**(4)**	**X_i_W_j**
Host country market size	0.7385***	0.7597***	0.8135***	0.7890***	log(S_i)
Rest-of-the-World market size	–0.8032***	–0.8077***	–0.8426***	–0.8169***	log(A)
Rating stage		–0.0767			rtg_stage
Initial host rating			0.2910***		rtg_1st_i
Initial rating x investment grade			–0.2526**		invXrtg_1st_i
Host rating				0.0333	rating_i
Host rating x investment grade				–0.0074	invXrtg_i
N	4282	4282	1652	1652	
ll	–80.2461	–80.2307	–64.5743	–64.5706	
aic	232.492	234.461	205.148	205.141	
bic	461.530	469.861	410.718	410.711	
Fixed effects	Yes	Yes	Yes	Yes	

Pseudo Poisson Maximum Likelihood estimation using heteroskedasticity-robust standard errors, time fixed effects not reported, more detailed variable descriptions can be found in Appendix A.2.

*** $p< 0.01$, ** $p< 0.05$, * $p< 0.1$.

Note: Lane & Milesi-Ferretti (2007), S&P, Moody's, insufficient values for 2011 dropped. N Smaller number of observations in Models (3) to (6) due to inclusion of restricted variables (i.e. only rated countries). ll is the maximum of the log-likelihood estimation for the respective model;. aic and bic pertain to the Akaike and Schwartz-Bayesian information criterion respectively. Significance p is denoted at 10%, 5% and 1% levels.

unrated countries, several weaker candidates this may render the resulting coefficient negative and insignificant.[16]

In Model (3) we dissect the influence of an initial rating in line with Hypothesis 1 for investment grade (IG) and non-investment grade (non-IG) countries. Here, the effect of a newly introduced credit rating (*rtg_1st_i*), is strongly positive and significant at the 1% level. However, this main effect is only valid for non-IG countries since the interaction effect with the investment grade (*invgrade is* 1 for

[16] The same is true in isolation (not reported) for an indicator variable of being rated, which is 1 in the first year of being rated by Standard & Poor's or Moody's.

investment grade-rated countries) indicator is negative and significant (*invXrtg_1st* captures the additional effect for *invgrade=1*). Foreign investment in newly rated countries increases, but only if they are initially rated below investment grade. 34 countries in our sample fall into this category, while 17 newly rated countries directly received an investment grade rating after 1976 and 11 had already been rated at investment grade level right from the start of the sample period in 1976. For the 28 investment grade countries, the positive introduction effect is almost exactly offset (.29–.25). Investment increases on average by 4 p.p. after correcting foreign investment in non-investment grade host countries country, which increases by 29 p.p. on average. Countries like Germany, which received its first sovereign issuer credit rating only in 1983, will thus not have benefited as much from rating-induced FPI as, say, Argentina or Brazil, which were both newly rated in 1986. This finding is supported by the fact that the average initial rating in the non-IG sphere was 9.3 (i.e. Ba3/BB-) whereas for newly rated countries receiving investment grade ratings the average was 18 (i.e. Aa3/AA-). We infer that the main effect is driven by a greater degree of uncertainty about lower-rated countries before receiving a rating as compared to investment grade countries.

Looking exclusively at the rating quality (*rating_i*) of the host country, adding the variable does not improve the explanatory power of the model, nor does an interaction term of host ratings for investment grade countries in Model (4). Both Akaike's and the Schwartz-Bayesian information criterion point to Models (3) and (4) as the best combination of parsimony and fit.[17] We conclude that investment holdings in the long sample stretching from 1976 to 2011 are thus mainly affected by the introduction of ratings for non-investment grade countries. This effect is immediately visible in the same year of the rating introduction while a better rating level seems only to exert its positive influence over time.

5.1.2 Portfolio Investment Net Inflows

Next we control for more immediate effects of rating changes visible in changes in net portfolio investment inflows. Table 2 summarizes PPML estimation results with heteroskedasticity-robust standard errors and time fixed effects for *net inflows*

[17] We find models with lagged values of *rtg_1st_i* not to add explanatory power (not reported).

Table 2: Piloting: PPML Panel Estimation of Host Country Investment Net Inflows (1976–2011)

Dependent Variable **Change in host country FPI holdings /** **available foreign capital**	**(1)**	**(2)**	**(3)**	**(4)**	**ΔX_i_W_j**
Change in host country market size	–0.0562	–0.0214	0.0033	–0.0122	ΔS_i
Change in 'Rest of World' market size	0.3382***	0.3212***	0.3245***	0.3053***	ΔA
Rating stage		0.5544***			rtg_stage
Initial host rating			–0.7145		rtg_1st_i
Initial rating x investment grade (IG)			–0.7535		invXrtg_1st_i
Host rating				0.2696**	rating_i
Host rating x investment grade (IG)				–0.0650	invX rating_i
N	2389	2389	1062	1062	
ll	–.784198	–.781177	–.745849	–.744045	
aic	71.5683	73.5623	75.4916	75.4880	
bic	273.820	281.593	259.304	259.300	
Fixed effects	Yes	Yes	Yes	Yes	

Pseudo Poisson Maximum Likelihood estimation using heteroskedasticity-robust standard errors, time fixed effects not reported, more detailed variable descriptions can be found in Appendix A.2. * p<.1; ** p<.05; *** p<.01
Note: Estimating negative values of the dependent (count) variable is not possible in PPML estimation, dropping 418 of 4,403 observations. The number of observations N in Models (4) to (6) is smaller because only the rated years for the 69 countries are used. ll is the maximum of the log-likelihood estimation for the respective model;. aic and bic pertain to the Akaike and Schwartz-Bayesian information criterion respectively. Significance p is denoted at 10%, 5% and 1% levels.

from 1976 until 2011. The dependent variable is the share of World Bank net portfolio investment inflows ($\Delta X_{ij} - \Delta X_{ji}$, data only up to 2009 for some countries) into host country i over available world capital, W_k. Excluding countries with shorter time-series does not change the results qualitatively. Host country market size, ΔS_i, and rest-of-world market size, ΔA, are defined as above, now converted to first differences so as to be comparable to net inflows. They are not denoted in logarithms because of the occurrence of negative values.

In Model (1) changes in the domestic market size of the host country, ΔS_i, are not significant. A doubling of the nominal size of world capital markets, A, leads on average to a strongly significant increase in the net inflows share by 33.8 p.p. This is despite the inclusion of time fixed effects, which already capture the time trend of growth in global capital markets. In Model (2) the rating stage variable is positive and significant at the 1% level. The changes from not being rated to non-investment grade, or from junk status to investment grade, increase the net inflows share by 55.4 p.p. on average, while downgrades from investment grade reduce inflows accordingly. In the flow specification, the initial host rating added in Model (3) is negative but insignificant for both non-investment and investment grade countries. Overall observations are fewer here because only countries with an existing rating are included.

In Model (4) the host country rating level enters positively and is significant for net inflows, in contrast to the coefficient in the FPI holdings model of Table 1. In the flow specification, a one-notch rating increase raises the weighted share of investment inflows the over rest-of-world portfolio by 27 per cent. The effect is around 6.5 percentage points lower for investment grade countries but insignificant. The Schwartz-Bayesian information criterion points to Models (3) and (4) as offering the best fit to the data, while Akaike's IC is less clear.

In the piloting stage, a higher rating level is associated with larger portfolio investment net inflows, but not with significantly higher holdings from abroad. A higher rating level exerts its positive influence on the portfolio share over time. The effect is stronger for non-investment grade countries. The introduction of a new rating leads to significantly larger net inflows as shown in Table 2. This effect is particularly valid for unrated countries because significance of the coefficients for the initial rating (rtg_1st_i) drops when the sample is reduced to only rated countries. For net inflows we observe a quality effect of the rating level: A higher rating leads to more net portfolio investment inflows, especially for non-investment grade countries. Here, too, the effect is weaker for investment grade countries.

5.2 Second Stage: Home Bias Cutting

The hypothesis of a reduction in investors' home bias is tested at the second stage of our empirical approach to the interaction between portfolio investment and credit ratings. The home bias model embodied by Equation (14) is again estimated as a PPML panel fixed effects model with Cameron robust standard errors and time fixed effects. The first four terms represent the gravity model of finance by Okawa and van Wincoop (2012). The remaining terms reflect information frictions proxied by various rating variables. The model is estimated for all countries for which bilateral CPIS data is available from 2001 to 2011 and for which all variables required for the gravity model can be calculated. The CPIS dataset with 76 host and over 200 investing countries is reduced to a symmetric dataset of 76 countries of which only 34 are left, for which sufficient data to calculate τ_{ij} is available. Details on countries and summary statistics of regression variables can be found in Appendix B.2. Results of the Pseudo-Poisson ML estimation of home bias are presented in Table 3.[18]

The baseline home bias estimation using the gravity specification is presented in Column (1). The coefficients for the first three components are extremely small and not significant, whereas the fourth coefficient, which constitutes the home bias normalization in terms of the rest-of-the-world share in the world portfolio, is comparably large and highly significant. Since the first three terms are derived from the underlying choice-theoretical gravity model, we keep them despite the insignificance of their coefficients. We do not, at present, see any alternative way to fit the standard home bias definition consistently into the gravity model.

In Model (2), we introduce four variants of a variable for the average rating difference between home and host countries weighted by their bilateral investment relative to total investment of the home country.[19] This variable is interacted consecutively with home and host country investment grade dummies and both dummies simultaneously. Contrary to our hypothesis, we observe a significantly larger home bias when the average investment-weighted difference between home and host country ratings is higher. Countries receiving more capital flowing "uphill" have a larger home bias on average. Home bias of better-rated countries is greater the more they receive investment from lower-rated countries.

[18] Robustness checks using panel fixed effects and clustered OLS estimations as well as estimation of the dependent variable using portfolio investment from equity and debt securities are available in the data repository at http://dx.doi.org/10.7910/DVN/26723; see also Section 6 below.

[19] Since there are no countries without a credit rating in the full sample, the effect of the *rtg_stage* variable used at the piloting stage boils down to a quality effect between investment grade (22 countries in 2011) and non-investment grade (12 countries). We thus cannot use *rtg_stage* for home bias cutting and size-making.

Table 3: Home bias: PPML Panel Estimation of Investor Country Home Bias (2001–2011)

Dependent Variable							
Home Bias	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**HB_j**
Domestic portfolio	–0.000	0.000	–0.000	–0.000	–0.000	–0.005	log(Si/A)
Multilateral resistance	0.010	0.003	–0.013	–0.012	–0.019*	–0.027***	log(W_k/tau_ik
Bilateral resistances	–0.000	–0.000	–0.000	–0.000	–0.000	–0.001	log(tau_ij)
Foreign portfolio share	16.243***	16.840***	18.281***	17.758***	18.486***	18.532***	log(1-A_j/A)
Rating difference		0.025*				0.014	rtgdiff_ij
Rating diff., host is IG		0.084				–0.043***	inv_iXrtgdiff_ij
Rating diff., home is IG		0.000				–0.012***	inv_jXrtgdiff_ij
Rating diff., both are IG		–0.162				–0.062	inv_ijXrtgdiff_i
Home has IG rating			0.241***				invgrade_j
Home rating level				0.030***	0.017***	0.013**	rating_j
Rating level, home is					0.012***	0.012***	invXrtg_j
Home up-graded to IG						–0.152***	invupgrade_j
Home down-graded						0.068***	invdowngrd_ j
N	7820	7820	7820	7820	7820	7820	
ll	–2994.108	–2993.910	–2993.344	–2993.025	–2992.816	–2992.525	
aic	6014.215	6021.821	6014.688	6014.049	6015.632	6027.051	
bic	6104.753	6140.216	6112.190	6111.552	6120.099	6173.304	
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	

Note: Pseudo Poisson Maximum Likelihood estimation using heteroskedasticity-robust standard errors, time fixed effects not reported, more detailed variable descriptions can be found in Appendix A.2. *** p< 0.01, ** p< 0.05, * p< 0.1

Source: Own computation; IMF CPIS, Lane and Milesi-Ferretti (2007), World Bank (2013), S&P, Moody's. N is the number of observations. ll is the maximum of the log-likelihood estimation for the respective model. aic and bic pertain to the Akaike and Schwartz-Bayesian information criterion respectively. Significance p is denoted at 10%, 5% and 1% levels.

When looking only at the investment grade status of a country in Model (3) we find investment grade countries' home bias to be on average 24.1 p.p. larger on average compared with non-IG countries. Non-investment grade countries in the sample have on average a lower home bias of 16.8%, which ranges from 5.5% to 46%, while investment grade countries have an average home bias of 39.8%, ranging from 8% to 96%. Home bias increases by 3.0 p.p. for every higher rating notch (Model 4). The rating effect on home bias, identified in Model (5), is higher when interacted with investment grade countries (2.9 p.p.) than the main effect for non-investment grade countries (1.7 p.p.). In the joint Model (6) we look at the influence of cases of an upgrade to investment grade (7 countries) or a downgrade from investment grade (5 countries). A downgrade of an investing grade country increases its home bias by 6.8 p.p., while an upgrade to investment grade level decreases the home bias by 15.2 p.p. on average for the five affected countries. Both information criteria (*aic* and *bic*) favour Model (4) with just the rating level while *bic* is lowest overall for the baseline model. In the joint model, we find additional evidence that home bias is lower for countries with larger investment-weighted rating differences if either, but not both, have an investment grade rating. Capital flowing "up-hill" thus effectively reduces home bias in both countries.

Table 3 suggests thus that our hypothesis on the reduction of home bias through better ratings finds no support across the complete CPIS sample from 2001 to 2011. However, the global financial crisis, which covers almost a third of that period, may have affected the empirical estimation of the theoretical model by its large valuation effects and volatility of capital flows. We look therefore at pre-crisis and crisis sub-samples.

Table 4 presents PPML panel regression results of a split sample for the periods before and after the outbreak of the global financial crisis in 2008. For comparison with Table 3, we present results for Models (3), (5) and (6) only. In the split sample, we observe a fundamental change in home bias after 2008. Home bias of investment grade countries was lower by 6.8 p.p. on average before the crisis compared to the 2008-11 sample (28.2). Model (5) gives the explanation for this in terms of a negative coefficient for the home country's rating level before the crisis (–3.3 p.p. lower home bias for every rating notch higher), which is turned around for both non-investment grade countries (+9.0%) and marginally less for investment grade countries. Both were significantly negative until 2008. Also, we see a strong swing for those pairs of countries, which are both rated on investment grade level: Before the crisis a larger weighted rating difference from home to host countries led to a reduction of home bias by 70.0 p.p. for the sending country; the effect vanishes almost entirely in the crisis.

Table 4: Home Bias: Split Sample PPML Panel Estimation of Home Bias (2001-07/2008-11)

Dependent Variable	**(3)**	**(5)**	**(6)**	**(3)**	**(5)**	**(6)**	
Home Bias	**2001-07**	**2001-07**	**2001-07**	**2008-11**	**2008-11**	**2008-11**	**HB_j**
Domestic portfol. share	0.000	0.000	0.001	0.000	0.001	0.000	log(Si/A)
Multilateral resistance	–0.009	–0.004	–0.010	0.064***	–0.052***	–0.061***	log(W_k/ tau_ik*A)
Bilateral resistances	–0.000	–0.000	–0.001	–0.000	–0.000	–0.000	log(tau_ij)
Foreign portfolio share	24.123***	21.629***	20.517***	–4.651***	–5.558***	–5.636***	log(1-A_j/A)
Home has IG rating	0.214***			0.282***			invgrade_j
Home rating level		–0.033***	–0.020***		0.090***	0.088***	rating_j
Rating level, home is IG		0.008**	–0.001		-0.001	–0.004	invXrtg_j
Rating difference			–0.004			0.041*	rtgdiff_ij
Rating diff., host is IG			–0.028			0.273**	inv_iXrtgdiff
Rating diff., home is IG			–0.009**			–0.012	inv_jXrtgdiff
Rating diff., both are IG			–0.698***			0.097	inv_ijXrtgdif
Home upgraded to IG			–0.016			0.022	invupgrade_j
Home downgraded from IG			0.038*			0.038*	invdowngrd_j
N	5130	5130	5130	2515	2515	2515	
ll	–1795.154	–1795.036	–1794.893	–570.617	–568.922	–568.881	
aic	3610.308	3612.073	3623.786	1157.234	1155.843	1167.762	
bic	3675.737	3684.044	3735.014	1203.874	1208.313	1255.213	
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	

Pseudo Poisson Maximum Likelihood estimation using heteroskedasticity-robust standard errors, time fixed effects not reported, more detailed variable descriptions can be found in Appendix A.2. *** p< 0.01, ** p< 0.05, * p< 0.1

Source: own computation; IMF CPIS, Lane and Milesi-Ferretti (2007), World Bank (2013), S&P, Moody's. N is the number of observations. ll is the maxiumum of the log-likelihood estimation for the respective model;. aic and bic pertain to the Akaike and Schwartz-Bayesian information criterion respectively. Significance p is denoted at 10%, 5% and 1% levels.

Hypothesis 2 postulates that home bias decreases for better-rated countries. This is confirmed in the pre-crisis sample, where home bias is significantly lower the better a country's rating. However, due to a lack of data on non-rated countries, we cannot extend this finding to a comparison between non-rated and rated countries. After the crisis, the home bias cutting effect of higher ratings is reversed.

Even this finding can be explained by the model since massive downgrades of crisis-stricken countries induced investors to withdraw funds from these countries, leading on average to a lower foreign investment share in better rated countries.

5.3 Third Stage: Size-making

At the last stage of our three-stage procedure we aim at identifying the extent to which ratings influence *bilateral* portfolio investment holdings. We estimate Equation (15) with the truly bilateral investment share as dependent variable calculated from cross-border portfolio investment holdings relative to all worldwide available portfolio assets.

Table 5 summarizes results of the PPML estimation with panel fixed effects and Cameron heteroskedasticity robust standard errors for the bilateral investment holdings dataset from 2001 to 2011. The gravity Model (1) performs even better than in the first two stages. Coefficients are positive for the domestic market share, and negative and strongly significant at the 1% level for average multilateral and bilateral frictions.[20] The rating difference in Column (2) is significantly negative when neither country has an investment grade rating (–6.5 p.p.). Otherwise it is insignificant and close to zero for all variants except when both countries have an investment grade rating (+21.0 p.p.). This indicates that bilateral holdings are larger the larger on average their rating differential, as long as neither country is below investment grade. In Model (3), the transition from not being rated and from non-investment grade to investment grade increases bilateral investment holdings share by 16.9 p.p. for the rated host country and by 6.4 p.p. for the home country. Neither coefficient is significant.

Looking at the rating level in Model (4), every rating notch higher has a positive influence on international portfolio investment holdings for both home and host countries. The effect dominates, again, for the host country, for which a one-

[20] Compared with clustered OLS and panel fixed effects estimation available in the data repository at http://dx.doi.org/10.7910/DVN/26723, we see a slightly lower value for bilateral frictions but a larger one for multilateral frictions (-0.60) compared with either OLS (–0.31) or panel FE (–0.43). This finding is likely to be induced by the Poisson MLE technique, which performs better at the zero-bound in gravity specifications.

Table 5: Size-making: PPML Panel Estimation of Investment Holdings (2001–2011)

Dependent Variable **Bilateral portf. holdings share**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**X_ij_W_j**
Domestic portfol. share	0.507	0.525*	0.505	0.510*	0.509*	0.523*	log(Si/A)
Multilateral resistance	–0.601***	–0.612***	–0.600***	–0.613***	–0.612***	–0.626***	log(W_k/tau_ik*A)
Bilateral resistances	–0.971***	–0.988***	–0.969***	–0.962***	–0.960***	–0.971***	log(tau_ij)
Rating difference		–0.065**				–0.006	rtgdiff_ij
Rating diff., host has IG		0.039				0.011	inv_iXrtgdiff
Rating diff., home IG		–0.009				0.023	inv_jXrtgdiff
Rating diff., both IG		0.210				0.270	inv_ijXrtgdif
Host has IG			0.169				invgrade_i
Home has IG			0.064				invgrade_j
Host rating				0.051**	0.064*	0.078**	rating_i
Home rating				0.029*	0.018	–0.018	rating_j
Host rating, if IG					–0.013	–0.006	invXrtg_i
Home rating, if IG					0.010	0.037*	invXrtg_j
Host upgraded to IG						0.086	invupgrade_i
Home upgraded to IG						0.046	invupgrade_j
Host downgrad. from IG						–0.178	invdowngrd_i
Home downgrad. fr. IG						–0.066	invdowngrd_j
N	7885	7885	7885	7885	7885	7885	
ll	–205.106	–205.037	–205.104	–205.059	–205.054	–204.945	
aic	436.212	444.073	440.208	440.117	444.109	459.889	
bic	526.857	562.610	544.798	544.708	562.645	634.207	
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	

Pseudo Poisson Maximum Likelihood estimation using heteroskedasticity-robust standard errors, time fixed effects not reported, more detailed variable descriptions can be found in Appendix A.2. *** p<0.01, ** p<0.05, * p<0.1

Source: own computation; IMF CPIS, Lane and Milesi-Ferretti (2007), World Bank (2013), S&P, Moody's. N is the number of observations. ll is the maxiumum of the log-likelihood estimation for the respective model;. aic and bic pertain to the Akaike and Schwartz-Bayesian information criterion respectively. Significance p is denoted at 10%, 5% and 1% levels.

notch increase is associated with a significant increase by 5.1 p.p. of the weighted foreign investment share for the investing country and by 2.9 p.p. for the investing country significant at the 10% level. Model (5) underlines that the rating effect becomes stronger for non-investment grade host countries. The interaction term for investment grade host countries is negative (–1.3 p.p.), while the coefficient for non-investment grade countries is 6.4 p.p.

In the full Model (6), an upgrade to investment grade level has a positive effect for bilateral investment holdings of home and host countries, but neither is significant. For downgrades, both coefficients are negative, thus reducing bilateral holdings for host countries by 17.8 p.p. and for home countries by 6.6 p.p.; again neither is significant.

Again, we suspect that the global financial crisis may have brought about a change in the nature of portfolio investment flows. Table 6 splits the sample into a pre-crisis and a crisis period and compares the results with those of the full sample period. Let us first turn to the left block, where the dependent FPI variable is defined in terms of debt securities only. The first column is identical with Model (6) of Table 5. Comparing the baseline gravity variables reveals that the coefficients including bilateral frictions, *tau_ij*, are larger in the crisis, while average multilateral frictions are lower. However, the changes here are rather small. We see a much stronger size effect in the coefficient for the domestic portfolio share, which is markedly higher after 2008 (around 1.3) than before (0.2). This is likely to reflect the redirection of capital held in smaller (emerging) financial markets to large nations like the US, the UK, Germany or Japan.

As to ratings variables, the largest effect is observable when the home country is downgraded from investment grade. In this case, the bilateral portfolio holdings share goes significantly down by 56.7 p.p. The individual home rating level is negative (–5.2 p.p. per rating notch), but insignificant in the crisis.

On the whole, looking at the influence of ratings on bilateral holdings of *debt securities*, we see only few coefficients that are significant (at the 5 and 10% levels). The picture changes, if we use *total FPI (debt and equity)* as dependent variable. In principle, there is a closer correspondence between debt securities and sovereign ratings, as the latter are confined to debt instruments. In the CPIS database we can distinguish between debt securities (long- and short-term) and equity.

Table 6: Size-making: PPML Panel Estimations of Investment Holdings of Debt Securities only (Left) and Debt Securities and Equities (Right) for the Full and Split Sample (2001-07/2008-11)

Dependent Variable **Bilateral portfolio holdings share**	**Portfolio investment holdings (debt securities only)**			**Portfolio investment holdings (debt securities + equity)**			**X_ij_W_j**
	(2001-11)	**(2001-07)**	**(2008-11)**	**(2001-11)**	**(2001-07)**	**(2008-11)**	
Domestic portf. share	0.523*	0.187**	1.293***	0.504**	0.210**	1.281***	log(Si/A)
Multilateral resistance	–0.626***	–0.731***	–0.610***	–0.611***	–0.714***	–0.608***	log(W_k/ tau_ik*A)
Bilateral resistances	–0.971***	–0.955***	–1.063***	–0.970***	–0.947***	–1.058***	log(tau_ij)
Rating difference	–0.006	0.003	-0.003	–0.011	0.042	–0.006	rtgdiff_ij
Rtg Diff (host is IG)	0.011	–0.019*	0.184	0.015	–0.009	0.207	inv_iXrtgdiff
Rtg Diff (home is IG)	0.023	0.027**	0.013	0.008	0.011	0.011	inv_jXrtgdiff
Rtg Diff (both are IG)	0.270	0.053	0.326	0.185	–0.036	0.364	inv_ijXrtgdif
Host rating	0.078**	0.032	0.051	0.044*	–0.014	0.069	rating_i
Home rating	–0.018	0.003	–0.052	–0.024	–0.009	–0.047	rating_j
Host rating (if IG)	–0.006	0.021	–0.003	–0.006	0.011*	0.011	invXrtg_i
Home rating (if IG)	0.037*	–0.008	0.017	0.030**	–0.036	0.364	invXrtg_j
Home upgraded to IG	0.086	–0.004	0.034	–0.017	–0.107	0.159	invupgrade_i
Host upgraded to IG	0.046	–0.050**	0.159	0.020	–0.076**	0.192	invupgrade_j
Home downgraded	–0.178	–0.065	–0.567**	–0.256*	–0.056	–0.549**	invdowngrd_i
Host downgraded	–0.066	–0.017	0.076	0.010	–0.02	0.155	invdowngrd_j
N	7885	5001	2801	7885	5001	2801	
ll	–204.945	–102.82	–49.909	–204.961	–102.825	–49.902	
aic	459.889	247.640	135.819	459.9302	247.651	135.804	
bic	634.207	384.506	242.698	634.2481	384.516	242.683	
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	

Pseudo Poisson Maximum Likelihood estimation using heteroskedasticity-robust standard errors, time fixed effects not reported, more detailed variable descriptions can be found in Appendix A.2. *** p< 0.01, ** p< 0.05, * p< 0.1

Source: own computation; IMF CPIS, Lane and Milesi-Ferretti (2007), World Bank (2013), S&P, Moody's. N is the number of observations. ll is the maximum of the log-likelihood estimation for the respective model;. aic and bic pertain to the Akaike and Schwartz-Bayesian information criterion respectively. Significance p is denoted at 10%, 5% and 1% levels.

So we have run our estimations at stages 2 and 3, as presented in Tables 3–5, with debt securities data in the dependent variables.

However, since we have only aggregate (debt and equity) FPI data for the estimations at stage 1, we have also run estimations for stages 2 and 3 with the corresponding aggregates, in order to be consistent.[21] Comparing the results for Model (6) at the size-making stage, as an example, we can see that the rating variables in the 'total FPI' section (columns on the right) perform better than in the 'debt-only' counterparts. While the negative effect of a downgrade of the home country has about the same size (54.9 p.p.), it is more strongly significant. For both debt only and debt+equity estimations, the coefficient for the host country rating is lower before the crisis than afterwards (.032 and .051 for the former and –.014 and .069 for the latter respectively). We interpret this as yet another sign that the crisis led to a flight to quality assets and credit ratings provide a measure to assess the quality of these investments.

The relatively good fit of the equity-enriched FPI models can be interpreted as evidence in favour of our hypotheses. The influence of sovereign ratings apparently extends beyond bonds and other debt securities. It may even be stronger for equity, because ratings tend to receive much attention in stock portfolio analysis, whereas a large part of bonds are held independently of ratings as foreign exchange reserves and hedges against exchange-rate risks (which do not fully coincide with default risks).

6 Comparing with Alternative Specifications

As indicated in Section 4, we have estimated the gravity model of finance using different specifications before deciding for the Pseudo-Poisson Maximum Likelihood (PPML) approach as the most promising one. In the online data repository for this paper, there are two sets of regressions with specifications identical to our main regressions in Tables 1–6. We first estimated the model using pooled OLS regressions as the simplest approach; it is, however, likely to produce biased results, as explained in Section 4.2. Panel regressions using fixed or random effects

[21] Results of all these runs can be found in the online data repository at http://dx.doi.org/10.7910/DVN/26723.

are also error-prone in theory, even when they include heteroskedasticity robust standard errors, and even though the results in our estimations are not far from the PPML results. Given the comparison between these estimation techniques, we favour the latter in terms of least biased estimators.

Beyond estimation methods, we have also checked the robustness of our results in terms of alternative specifications of gravity model, which we present in the following.

6.1 Standard Variables of Gravity Models

Gravity models in the trade literature are often estimated using spatial concepts and derivatives thereof, such as borders, common language or trade agreements. In our gravity model of finance, we use ratings as a proxy for informational distance as well as multilateral and bilateral friction variables. When comparing our results from Section 5 to the standard approach for the estimation of gravity models of finance (e.g., Daude and Fratzscher 2008; Okawa and van Wincoop 2010; Vanpée and De Moor 2012), it becomes apparent that the baseline model with multilateral and bilateral frictions performs very well. Estimating our model with common gravity variables from the above-cited papers using clustered OLS (panel fixed effects estimations would drop constant variables like border adjacency or language) does not affect our results significantly. Adding gravity variables only marginally adds explanatory power to the model. Results are shown in Table 7.

Gravity coefficients and rating variables remain almost unchanged in terms of significance and economic size compared to Table 5. This remains true even if we include all six proxies for distance, which are common to the above-mentioned studies: merchandise trade, geographic distance, common language, border adjacency, colonial links and the existence of bilateral trade agreements, nor are the coefficient values for those standard proxies significant. The only positive and significant effect shows up with the introduction of the Chinn-Ito measure of capital account openness (*kaopen*) in Model (3). However, the Chinn-Ito index loses significance as soon as rating variables are included, as in Model (5). The host rating level becomes negative and significant for non-investment grade countries. We conclude that in the joint model, it is mainly rating variables that add explanatory power to the baseline gravity model of finance while the commonly used gravity variables do not.

Table 7: Size-making: Ad-hoc Gravity Specification using Clustered OLS of Size-making with Bilateral Portfolio Holdings over Home Country Portfolio as Dependent Variable (2001–2011)

Dependent variable Bilateral portfolio holdings share	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**X_ij_W_j**
Domestic portfolio share	0.379***	0.383***	0.390***	0.308***	0.313***	log(Si/A)
Multilateral re-sistance	–0.309***	–0.325***	–0.316***	–0.220***	–0.225***	log(W_k/tau_ik*A)
Bilateral resistances	–1.005***	–0.984***	–0.985***	–0.995***	–0.990***	log(tau_ij)
Host Rating		0.014**			–0.009**	rating_i
Home Rating		0.030			0.025	rating_j
Host Rating (IG)		0.009***			0.007**	invXrtg_i
Home Rating (IG)		–0.004			0.004	invXrtg_j
Host Chinn-Ito			0.077***		0.013	kaopen_i
Home Chinn-Ito			0.083**		0.024	kaopen_j
Bilateral trade				–0.051	–0.070	log(trade)
Geogr. distance				–0.011	0.007	log(distance)
Common language				0.059	0.078	comlang
Border adjacency				0.080	0.164	border
Colonial heritage*				(omitted)	(omitted)	colonial
Trade agreement				–0.002	0.035	trade_agr
Constant	–0.551***	–1.649***	–0.935***	0.537	0.006	Constant
Obs.	7915	7915	7915	3945	3945	
R2	0.977	0.979	0.978	0.984	0.985	
Fixed effects	Yes	Yes	Yes	Yes	Yes	

Multi-way clustering with OLS estimation, time fixed effects not reported, more detailed variable descriptions can be found in Appendix A.2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: own computation; IMF CPIS, Lane and Milesi-Ferretti (2007), World Bank (2013), S&P, Moody’s. Standard errors are robust using the estimation technique developed by Cameron et al. (2011). The dummy for common colonial is dropped due to lack of observations in the CPIS sample. The choice of variables is distilled from Daude and Fratzscher (2008), Okawa and van Wincoop (2010) and Vanpée and De Moor (2012).

* Colonial heritage does not change in our sample and does therefore not yield any results in a fixed effects set-up.

6.2 Heterogeneity between Countries

We capture heterogeneity between countries by bilateral and multilateral frictions as well as the gravity variables for the respective country's financial market size. However, there may be non-linearity in country heterogeneity in terms of one group of countries exhibiting a fundamentally different behaviour in terms of our model than other groups.

To control for this, we first define heterogeneity between countries based on the Chinn-Ito of capital account openness. We continue with an estimation that takes account of heterogeneity by way of the debt securities share in total FPI, which is lower for most developing countries and financial centres. The Chinn-Ito index is an index measure of capital account openness ranging from –1.16 to 2.44 in our sample period. Higher values account for greater capital account openness. We split our sample at an index value of 2.0 into an EU+G7 plus Switzerland and Singapore part with very open capital accounts and a rest-of-world sample having a mean Chinn-Ito value of –0.03.[22] Results of split sample estimations are presented in Table 8.

The gravity model variables have similar coefficient values for both samples. Coefficients of multilateral resistance are somewhat higher (at –.67) for less open economies, which fits with the definition of the Chinn-Ito index. We find rating difference to be a strong driver for cross-border investment holdings of less open economies. Rating variables have, by and large, similar coefficients for both groups. Countries with low capital account openness tend also to have lower ratings (on average 12.0 compared to 20.1 for the peer group with a Chinn-Ito index above 2.0). Nonetheless, host country ratings have a similarly positive effect for both groups; only the home country having an investment grade rating is markedly higher for the group with higher capital account openness (24.5*) than otherwise (2.2).

When splitting the sample of countries using the share of debt securities in total FPI, the resulting sample of countries is very similar to the above-described one using the Chinn-Ito index. We thus refrain from presenting estimation results here.

22 Higher split values at 2.43 or below produce qualitatively similar results due to the dispersion of the index.

Table 8: Size-making: PPML Estimation of Split Samples According to the Chinn-Ito Index of Capital Account Openness below aValue of 2.0 (Left) or above 2.0 (Right) (2001–2011)

Dependent Variable	**(3)**	**(5)**	**(6)**	**(3)**	**(5)**	**(6)**	
Bilateral portfolio holdings share	**Home country Chinn-Ito index ≤ 2.0**			**Home country Chinn-Ito index > 2.0**			**X_ij_W_j**
Domestic portf. share	0.430***	0.410***	0.395***	0.491	0.511	0.556*	log(Si/A)
Multilateral resistance	–0.673***	–0.688***	–0.670***	–0.561***	–0.546***	–0.607***	log(W_k/tau_ik*A)
Bilateral resistances	–0.962***	–0.961***	–0.936***	–0.939***	–0.894***	–0.951***	log(tau_ij)
Host has IG rating	0.215***			0.197			invgrade_i
Home has IG rating	0.022			0.245*			invgrade_j
Host rating		0.042***	0.036**		0.057	0.113**	rating_i
Home rating		–0.000	0.005		0.108*	–0.023	rating_j
Host rating (if IG)		0.006	0.009		–0.009	–0.002	invXrtg_i
Home rating (if IG)		0.002	0.001		–0.014	0.034	invXrtg_j
Rating difference			0.007			0.053*	rtgdiff_ij
Rtg Diff (host is IG)			–0.027***			0.278	inv_iXrtgdiff
Rtg Diff (home is IG)			0.044***			0.045*	inv_jXrtgdiff
Rtg Diff (both are IG)			–0.039			0.811	inv_ijXrtgdif
Home upgrade to IG			0.120*			0.144	invupgrade_i
Host upgrade to IG			–0.017			0.237	invupgrade_j
Home downgraded			–0.186***			–0.153	invdowngrd_i
Host downgraded			0.001				invdowngrd_j
N	2598	2598	2598	5239	5239	5239	
ll	–29.797	–29.795	–29.793	–173.347	–173.206	–172.991	
aic	89.594	93.590	109.586	376.695	380.412	393.983	
bic	177.531	193.253	256.148	475.153	491.999	551.516	
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	

Pseudo Poisson Maximum Likelihood estimation using heteroskedasticity-robust standard errors, time fixed effects not reported, more detailed variable descriptions can be found in Appendix A.2. *** p< 0.01, ** p< 0.05, * p< 0.1

Note: The Chinn-Ito index is a measure of capital account openness ranging from -1.16 to 2.44 with higher values indicating greater capital account openness of a country (cf. Appendix A.1 Data Sources).

Source: own computation; IMF CPIS, Lane and Milesi-Ferretti (2007), World Bank (2013), S&P, Moody's. N is the number of observations. ll is the maxiumum of the log-likelihood estimation for the respective model;. aic and bic pertain to the Akaike and Schwartz-Bayesian information criterion respectively. Significance p is denoted at 10%, 5% and 1% levels.

We conclude, more generally, that heterogeneity of countries has a limited impact on the coefficients for rating variables. The impact of different country samples on the estimated gravity coefficients is moderate; it is only for multilateral resistance that a clear distinction can be made between countries with different degrees of financial development.

6.3 International Financial Reporting Standards

It might be argued that there is an omitted variables bias, if credit ratings are used as the only measures of reducing informational asymmetries in transnational finance. Thus it has been shown in a gravity framework and other empirical studies that increasing comparability and transparency by the introduction of the International Financial Reporting Standards (IFRS) has fostered cross-border investments.[23] Positive effects are indeed documented, though not unequivocally, in Daske et al. (2008) and Horton et al. (2013). Márquez-Ramos (2011) implements IFRS in a gravity framework and also finds a transparency enhancing effect. IFRS adoption is singular insofar as its introduction is a one-off event. Capturing this means introducing an indicator value for those countries introducing it for the financial year ending in 2005 (except for Singapore, which introduced IFRS mandatorily in 2003). From a technical point of view, this translates into a level shift for all IFRS countries – unfortunately with a large overlap with the years spanning the global financial crisis (2007-09) and the European debt crisis (after 2010). In contrast to ratings, IFRS adoption is not a categorical variable measured on a scale, but only an indicator variable.

We test for effects from IFRS introduction econometrically in our setting, following Daske et al. (2008) who differentiate in their methodology between IFRS announcement and IFRS adoption.[24] Our main findings are that IFRS introduction leads to a decrease in FPI holdings and to stronger home bias in countries with investment grade ratings. For non-investment grade countries, results are not unanimous. In the presence of the credit ratings, and compared with their effects,

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[23] This comment has been posted by an anonymous reader of our discussion paper. We gratefully acknowledge the impulse to follow up on this suggestion.

[24] A summary of all IFRS countries and the respective dates as well as all regression results are presented in our online reply on www.economics-ejournal.org/economics/discussionpapers/2014-31.

IFRS introduction seems to have resulted in lower rather than higher outward FPI. We therefore regard our point as strengthened that, in particular in the period prior to the global financial crisis, it was mainly the credit quality of host countries, as signalled by credit ratings, which led to higher portfolio investments and lower home bias of investing countries.

7 Conclusions

Looking at the stylized facts and debates about the transnationalization of finance, it is fairly obvious that credit rating agencies are deeply embedded in the present architecture of global financial markets (see Section 2). The rationale for this is given by their function of providing public information about credit risk. Even if conceding to critics that rating signals set by the CRAs have, to some degree, been misleading, mistimed or otherwise inefficient, it is hardly contested that they contribute to reducing information asymmetries between domestic and foreign financial investors. In a general sense, it can be conjectured that credit ratings, in particular sovereign ratings, have contributed to the observable rise of cross-border capital flows in recent decades, in particular in the segment of foreign portfolio investment.

Yet it is a long way from casual observation and conjectures about the CRAs' role in financial transnationalization to finding "hard evidence" in the data based on a generally accepted theoretical framework. The Okawa/van Wincoop framework used in this paper provides a choice-theoretical foundation for gravity modelling of cross-border finance, but it is of course a heavily stylized model. There is certainly some incongruence between the variables in its structural form and the observed aggregates of foreign investment, market size etc. that are used as proxies. Apart from the usual risks of the "as if" approach (… as if the data were exclusively generated by portfolio choice), we have faced various limitations in the availability of data. Bilateral FPI data, which are required for full-scale gravity analysis, are available only for the period after 2001, when all reporting countries in the relevant dataset (CPIS) already had ratings;[25] a control group of non-rated countries could thus be observed only with unilateral data from longer-ranging

[25] Of the 35 countries newly rated after 2000 (cf. Figure 2), none is in the reporting set of the CPIS.

databases. Moreover, there is a lack of comparable data on capital flows from, to and between many financial centres and offshore hubs.

Given these difficulties, we think that our adaptation of the Okawa-van Wincoop framework to a gravity model has fared fairly well in the tests for the piloting, home bias cutting and size-making effects of sovereign credit ratings. Our study permits the conclusion that credit rating agencies play a significant role in the transnationalization of finance. We have found evidence in the data for strongly positive relationships between sovereign ratings and foreign portfolio investment that conforms with our hypotheses at all three stages. The baseline model with bilateral and multilateral financial frictions performs well, and the addition of rating variables increases the information content with regard to frictions and their reduction. In particular prior to 2008, it was mainly the rating quality of host countries that led to higher portfolio investments and lower home bias of investing countries. In comparison with the standard proxies for distance in the literature on gravity in finance, rating variables appear to add more explanatory power.

Our study has its limitations, though. We wish to look at the relationships between sovereign ratings and foreign portfolio investment in a long-term perspective, but beyond the piloting stage the time horizons of the available data are rather short (so far). At the home bias-cutting and size-making stages we even had to split the sample in order to discern the effects of the great financial crisis. Moreover, it is difficult to discriminate between the effects of the information value added by sovereign ratings (as compared to their absence) and the quality signals of the specific rating grades. Even though our hypothesis of a reduction in home bias was not rejected, the results of the estimations are probably affected by such ambiguities.

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Appendix

A.1 Data Sources

CEPII	CEPII dataset on distances and cultural proximity http://www.cepii.fr/francgraph/bdd/distances.htm
Chinn-Ito	Chinn-Ito index of capital account openness (kaopen) http://web.pdx.edu/~ito/Chinn-Ito_website.htm
CPIS	International Monetary Fund Coordinated Portfolio Investment Survey (CPIS) http://cpis.imf.org
EWN	Extern Wealth of Nations database (Lane & Milesi-Ferretti 2007) http://www.philiplane.org/EWN.html
IFS	International Monetary Fund International Financial Statistics (IFS) http://elibrary-data.imf.org/
Moody's	Moody's ratings data on sovereign long-term foreign currency issuers http://www.moodys.com
OECD	OECD.StatExtracts for national accounts, Main Economic Indicators and debt data http://stats.oecd.org
Rose	Bilateral and multilateral trade datasets (Rose 2004) http://faculty.haas.berkeley.edu/arose/RecRes.htm#Trade
S&P	Standard & Poor's ratings data on sovereign issuers http://www.globalcreditportal.com
World Bank	World Bank global financial development (GFD) indicators and "Financial Sector" http://data.worldbank.com/indicator/ http://data.worldbank.org/data-catalog/global-financial-development

A.2 Variable Descriptions

Variable	Source	Description (labels used in results tables in bold)
Piloting		
X_i_W_j	L&MF (2007), World Bank Global Financial Development Indicators (2013)	**Host country FPI holdings /available foreign capital** (1) Foreign portfolio holdings in host country *i* (debt+equity, L&MF 2007) and (2) **Change in …** Portfolio investment, net inflows (World Bank) over the domestic portfolio *W_j* calculated as the sum of domestic stock market capitalization and private and public bond market capitalizations *plus* domestic portfolio investment held abroad *minus* foreign portfolio investment in the domestic country (A_j + sumi_X_ij - sumi_X_ji)
log(S_i)	World Bank GFD	**Host country market size** (1) log of the sum of domestic stock market capitalization and private and public bond market capitalizations (2) Change in y-o-y value
log(A)	World Bank GFD	**Rest-of-the-World market size** (1) log of world market capitalization (sum of domestic market capitalizations) (2) Change in y-o-y value
Home bias cutting		
HB_j	World Bank GFD, IMF CPIS	**Home bias** Index value (0,1) = 1 - (1 - sumi_X_ij / W_j) / (1 - A_j / A) for bilateral investment holdings with *X_ij* the sum of of investing country *j*'s foreign portfolio investment (CPIS) and *W_j* (World Bank GFD) and normalization term *(1-A_j/A)* using (World Bank GFD))
log(Si/A)	World Bank GFD	**Domestic portfolio share** log of the domestic market size (S_i from World Bank GFD) in world market capitalization (A from World Bank GFD)
log($\sum_k W_k/\text{tau}_{ik} * A$)	World Bank GFD, IMF CPIS	**Multilateral resistance** log of average multilateral financial frictions sumk((W_k) / (tau_ik * A))
log($\sum_i$ tau_ij)	World Bank GFD, IMF CPIS	**Bilateral resistances** log of the sum of bilateral frictions tau_ij = ((X_ii / A_i) / (X_ii / A_i))^(-1)
log(1-A_j/A)	World Bank GFD, IMF CPIS	**Foreign portfolio share** log of total foreign market capitalization calculated as 1 minus domestic market size over total world market capitalization
Size-making		
X_ij_W_j	CPIS, World Bank GFD	**Bilateral portf. holdings share** Bilateral portfolio holdings (CPIS) over the sum of stock market capitalization plus private and public bond market capitalizations (World Bank GFD)

Variable	Source	Description (labels used in results tables in bold)
log(Si/A)	World Bank GFD, IMF CPIS	**Domestic portfol. share** log of the domestic market share in the world
$\log(\sum_k W_k/\text{tau}_{ik} * A)$	World Bank GFD, IMF CPIS	**Multilateral resistance** log of average multilateral financial frictions sumk((W_k) / (tau_ik * A))
log(tau_ij)	World Bank GFD, IMF CPIS	**Bilateral resistances** log of bilateral frictions ((X_ii / A_i) / (X_ii / A_i))^(-1)
Rating variables		
rtg_stage	Moody's, S&P	**Rating stage**: 0 not rated, 1 non-investment grade, 2 investment grade
rtg_1st_i	Moody's, S&P	**Initial host rating**: 1 in the first year of being rated by S&P and/or Moody's
invXrtg_1st	Moody's, S&P	**Initial host rating x investment grade** 1 in the first year of being rated by either S&P or Moody's and first rating is investment grade
rtg_1stXinvgr_i	Moody's, S&P	**Initial host rating x investment grade**: 1 in the first year of being rated by S&P and/or Moody's and directly rated investment grade
invgrade_i	Moody's, S&P	**Home has IG rating** Indicator variable 1 if host country rating is 12 or better (BBB-/Baa3) on the 20-notch scale
invggrade_j	Moody's, S&P	**Host has IG rating** Indicator variable 1 if home country rating is 12 or better (BBB-/Baa3) on the 20-notch scale
rtgdiff_ij inv_iXrtgdiff inv_jXrtgdiff inv_ijjXrtgdiff	Moody's, S&P Moody's, S&P Moody's, S&P Moody's, S&P	**Rating difference** Average difference between home and host country ratings (in notches) weighted by the share of investment in (non) investment grade countries. **Rating diff., host/home/both is IG** Interacted with invgrade_i, invgrade_j and both. Calculated as groupwise means: rtgdiff_ij = mean over group of ((rating_j - rating_i)*inv_share)
rating_i	Moody's, S&P	**Host rating** Rating of host country (20-notch scale, AAA/Aaa=21)
rating_j	Moody's, S&P	**Home rating** Rating of home country (20-notch scale, AAA/Aaa=21)
invXrtg_i	Moody's, S&P	**Host rating x investment grade** Rating of host country if investment grade
invXrtg_j	Moody's, S&P	**Home rating x investment grade** Rating of home country if investment grade
invupgrade_i invupgrade_j	Moody's, S&P Moody's, S&P	**Home/Host up-graded to IG** 1 if rating upgraded to investment grade in this year or past year
invdowngrade_i invdowngrade_j	Moody's, S&P Moody's, S&P	**Home/Host down-graded from IG** 1 if rating downgraded from investment grade in this year or past year

Variable	Source	Description (labels used in results tables in bold)
Gravity variables		
kaopen_i	Chinn & Ito	**Host Chinn-Ito** Capital account openness index of host country
kaopen_j		**Home Chinn-Ito** Capital account openness index of home country
log(trade)	Rose (2004)	**Bilateral trade** log of bilateral trade (in 1999)
log(distance)	Rose (2004)	**Geogr. distance** log of geographic distance (capitals)
comlang	Rose (2004)	**Common language** 1 if countries share an official language
border	Rose (2004)	**Border adjacency** 1 if countries have a common border
colonial	Rose (2004)	**Colonial heritage** 1 if colonial ties between the countries exist
trade_agr	Rose (2004)	**Trade agreement** 1 if countries are in a regional trade agreement

B.1 Piloting

Table 9: Summary Statistics of Variables for Piloting Estimation (Holdings and Net Inflows)

Variable	Obs	Mean	Std. Dev.	Min	Max
Holdings					
X_i_W_j	4283	.007161	.0245988	0	.244198
ln_S_i	4282	–5.263153	2.920806	–12.79536	3.088273
ln_A	4284	2.693552	1.206754	.5199777	4.606447
rtg_stage	4403	.5766523	.8036265	0	2
rtg_1st	4403	.0174881	.1310959	0	1
Net Inflows					
ΔX_i_W_j	3523	.0000621	.0003704	–.0060461	.0072033
ΔX_i_W_j>=0	3105	.0000802	.0003692	0	.0072033
ΔS_i	4164	.0236421	.1621853	–1.951454	4.042233
ΔA	4284	–.0471233	2 0.30934	–116.866	21.15468
Rating variables					
rtg_stage	4403	.5766523	.8036265	0	2
rtg_1st	4403	.0174881	.1310959	0	1
invXrtg_1st	21	1	0	1	1
rating_i	1655	14.60731	5.606858	0	21
invXrtg_i	920	19.10895	2.30659	14	21

Note: Observations for *invXrtg_1st* and *invXrtg_*i apply only to investment grade countries. Values for *dotX_iW_j* are non-negative for Poisson estimations (418 observations dropped due to negative values).

Countries and Ratings

Rating indicates the year the respective country was first rated by either S&P or Moody's; values for 1970 (e.g. CAN, USA) indicate that the country had first been rated in 1970 or before. N captures the number of non-missing observations. 0 values may reflect "no flows" or flows below $100,000 rounded to zero. Some countries report only zero values and are excluded. The full set includes 119 countries with the following ISO-codes:
ARE ARG AUS AUT BDI BEL BEN BFA BGD BHR BLZ BOL BRA BWA CAF CAN CHE CHL CIV CMR COD COG COL CRI CYP DEU DNK DOM DZA ECU EGY ESP ETH FIN FJI FRA GAB GBR GHA GIN GMB GNQ GRD GTM GUY HND HTI IDN IND IRL IRN ISL ISR ITA JAM JOR JPN KEN KOR KWT LBN LBR LBY LCA LKA LSO MAR MDG MEX MLI MLT MMR MRT MUS MWI MYS NER NGA NIC NLD NOR NPL NZL OMN PAK PHL PNG POL PRT PRY QAT RWA SAU SDN SEN SGP SLE SLV SUR SWE SWZ SYR TCD TGO THA TTO TUN TUR TZA UGA URY USA VCT VEN VUT WSM ZAF ZMB ZWE.

B.2 Home Bias Cutting: Summary Statistics

Table 10: Summary Statistics of the Home Bias Variable

Non-investment grade countries

Variable	Obs	Mean	Std. Dev.	Min	Max
HB_j	3743	.1655699	.066108	.0552749	.4599831
ln_Si_A	3140	–4.715801	1.380264	–7.590662	–.6619452
ln_W_j_tau_A	3197	–7.162118	1.051702	–9.149226	–4.754447
ln_Etau_ij	2843	12.06533	4.092184	5.925811	26.56531
Aj_A	3743	–.0053733	.0059587	–.0277745	–.0005053

Investment grade countries

Variable	Obs	Mean	Std. Dev.	Min	Max
HB_j	8347	.4301961	.2288571	.0805978	.9632046
ln_Si_A	7002	–4.704935	1.37814	–7.590662	–.6619452
ln_W_j_tau_A	6943	–4.964393	1.399754	-8.92076	–2.463775
ln_Etau_ij	6359	12.06276	4.119871	5.925811	26.56531
Aj_A	8347	–.0175634	.0155742	–.054359	–.0020091

Note: Values for HB_j and logs have to be non-negative (some observations dropped due to negative values).

B.3 Size-making: Summary Statistics

Table 11: Summary Statistics of Gravity Variables for Size-making Estimation (2001-2011)

Variable	Obs	Mean	Std. Dev.	Min	Max
X_ij_W_j	10309	.0078217	.072186	–3.526323	1.744732
ln_X_ij_W_j	9925	–7.379693	3.406512	–26.09699	.5566012
ln_Si_A	10392	–4.695677	1.414182	–7.590662	–.6619452
ln_W_j_tau_A	9522	–6.192807	2.616763	–11.55399	–1.40477
ln_tau_ij	8228	6.443826	3.578484	–1.029536	26.56528
rating_j	12168	17.31465	4.909503	0	21
rating_i	12168	16.7361	5.060162	0	21
invgr_i	12168	.7326594	.4425897	0	1
invgr_j	12168	.7693951	.4212373	0	1
invXrtg_i	12168	14.23173	8.820304	0	21
invXrtg_j	12168	15.14495	8.506489	0	21
rtgdiff_ij	10309	.1254464	1.249147	–8.87671	16.61742
inv_iXrtgdiff	10309	–.1119968	.5646987	–8.87671	.822863
inv_jXrtgdiff	10309	.2115287	1.09863	–7	16.61742
inv_ijXrtgdiff	10309	–.0268687	.220964	–7	.822863
invupgrade_i	12168	.0188199	.135894	0	1
invdowngra~i	12168	.0259698	.1590516	0	1
invupgrade_j	12168	.0191486	.1370528	0	1
invdowngra~j	12168	.0178337	.132352	0	1

Note: Observations for *invXrtg_1st* and *invXrtg* apply only to investment grade countries. Values for X_ij_W_j and log values have to be non-negative (some observations dropped due to negative values).