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## Sovereign credit ratings and the transnationalization of finance: Evidence from a gravity model of portfolio investment

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**Discussion Paper**

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

*Finn Marten Körner and Hans-Michael Trautwein*

### **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 the hypothesis with regard to 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 and their gradual improvement since the 1970s has affected inward portfolio investment stocks and flows in host countries. At the second stage, the authors examine to which extent sovereign ratings help to predict the degree of investors' home bias, as measured by the share of outward portfolio investment holdings in the home countries' portfolios, 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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**Keywords** Credit rating agencies; portfolio investment; gravity model; home bias

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## 1. Introduction

“Financial globalization” and “financial integration” are the catchwords for the enormous increase in cross-border capital flows and foreign asset holdings that the world has seen in recent decades. Another name for the same process is “transnationalization of finance.” It refers more directly to the key role that transnational corporations (TNCs) and other non-state agents play *both* in carrying out the transactions that increasingly dissolve national boundaries *and* in regulating the process. Most providers of financial services operate across different jurisdictions, largely in complex chains of transactions through onshore and offshore financial centres shaped by network externalities and regulatory arbitrage (Vitali *et al.* 2011). Financial TNCs influence the norms and standards for transnational finance implemented by private ordering and in hybrid systems of public/private co-regulation.

Credit rating agencies (CRAs) are a typical example. They set standards in transnational finance through their core business of providing information, certification and monitoring services. They produce and publicize information about credit risk, which is standardized and signalled through the reduction of (more or less) complex assessments to simple grading scales. The ‘Big Three’ – Standard & Poor’s, Moody’s and Fitch – are large TNCs that together account for roughly 95 per cent of the global rating business (White 2010, SEC 2012). Ratings help to increase capital mobility across borders, since investors rely on ratings as asset quality signals that reduce their information costs. At the level of public governance, the use of ratings is prescribed by state regulations of capital requirements, investment restrictions and risk evaluation in many countries (BIS 2009). The “hard-wiring” of credit ratings into national regulations has evolved together with some “cross-wiring” over the borders, which promoted the transnational business of the CRAs and helped them to set global standards for credit risk assessments (IMF 2010, Gärtner & Griesbach 2012).

The general arguments in favour of credit rating agencies are the gains in efficiency and stability of financial markets that CRAs are believed to produce through their continuous assessment and disclosure of credit risks. In this view, ratings are a part of “functional governance”, contributing to an optimal allocation of global finance. However, the CRAs have come under attack in the contexts of recent financial crises (see, e.g. Reinhart 2002, Pagano and Volpin 2009, de Haan and Amttenbrink 2011). In the aftermath of the collapses of Enron (in 2001) and Lehman Brothers (in 2008) they were criticized for rating corporate debt too positively for too long. They have been found guilty of systematically overrating the structured credit products that caused the U.S. subprime mortgage disaster, which in turn sparked off the great financial crisis in 2007/08. The CRAs have also been accused of acting pro-cyclically by their sovereign ratings in the EMS crisis of 1992/93, the Asian crisis of 1997/98 and the recent Eurozone debt crisis. From the perspective of critics, the business

models of the CRAs and their cross-wiring in financial co-regulation have contributed to excessive volatility of market yields and capital flows. In this view, CRAs magnify rather than mitigate systemic risks that occur with the transnationalization of finance.

Regardless of whether CRAs are seen as contributing to allocative efficiency or to excessive volatility, it is generally taken for granted that credit ratings play a significant role in the evolution of transnational finance. Yet, to our knowledge, this hypothesis has not been tested empirically, even though much work has been done on the impact of ratings on market yields, spreads and other measures of asset prices (Cantor and Packer 1996, Jorion and Zhang 2010, Kaminsky and Schmukler 2001, Kiff *et al.* 2012, Mink and de Haan 2013). In that literature, the focus is generally set on financial market instability; most of the studies are confined to the short-term perspective of particular episodes of boom and bust.

In this paper we take a longer-term perspective and set the focus on the volumes of cross-border transactions and holdings of securities, as our primary interest is to assess the role of CRAs in the transnationalization of finance. We choose a gravity model *cum* home bias analysis as theoretical framework for our study. Credit ratings can be embedded into this structure, even though this has not, to our knowledge, been done consistently before.

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); they appear thus to forgo potentially large gains from diversification achievable through foreign portfolio investment. While ICAPM predicts worldwide diversification and thus a value of the home bias indicator close to zero, the home bias measure for most countries tends to be closer to one, i.e. a complete investment home bias. This phenomenon raises the question which factors may outweigh the forgone gains from diversification. In their survey of the voluminous literature on home bias, Coeurdacier and Rey (2013) argue that *informational frictions* are empirically particularly relevant. 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. Hence, we resort to gravity modelling and home bias analysis, not for explaining the persistence of the phenomenon, but for gauging the impact that credit ratings might have on cross-border capital flows. We estimate a gravity equation that is derived from the model of Okawa and van Wincoop (2012). In our framework, distance varies with information asymmetries and perceptions of risk that are affected by credit ratings.

Looking for empirical evidence of the influence of ratings on the evolution of cross-border capital flows, 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 nations to financial risk assessments and serve as benchmarks for ratings of corporate issuers in the respective nation's realm. They are also part of more general assessments of country risk. Foreign portfolio investment (FPI) comprises domestic residents' transactions and holdings of securities (bonds and equities) in other countries. This is the range of assets most closely affected by sovereign bond issue and country issuer 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 credit ratings on inward FPI in a set of unilateral data for 119 countries over the period 1976-2011. We call this 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 countries of origin (home countries). That stage is named "*home bias cutting*", as we test the hypothesis that sovereign ratings have contributed to a reduction 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 cross-border 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).

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* in them 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 which manifests itself in a quality effect of credit ratings on foreign portfolio investment *inflows*. A better rating is associated with larger net inflows of foreign capital, which we regard as a long-term quality effect.

Our hypothesis on the reduction of home bias for countries with higher 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 bias-reversing quality effect of higher ratings on outward FPI thereafter.

In the estimation of the bilateral gravity model at the stage of “size-making” we do, moreover, see a strongly 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 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.

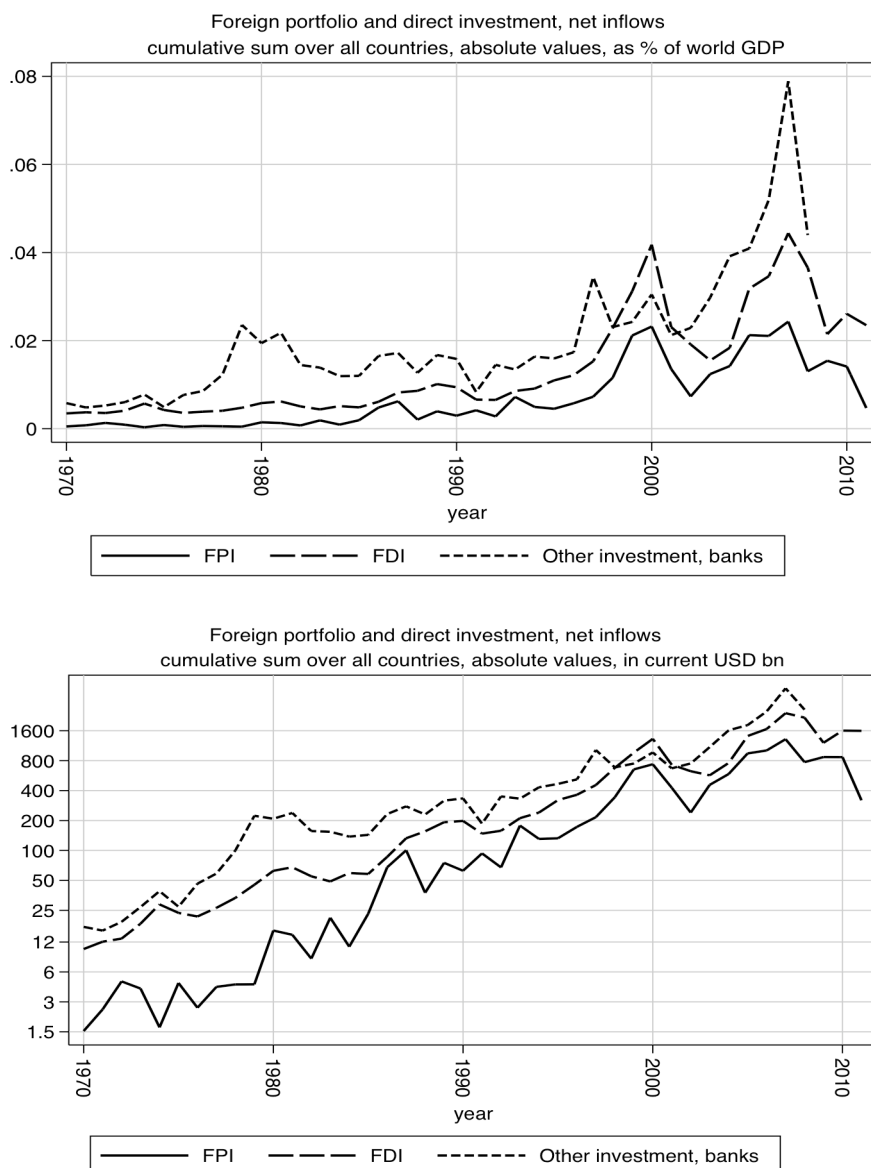
The structure of this paper is as follows. Section 2 describes the relevant aspects of transnational finance and credit rating. Section 3 reviews the relevant literature on information-based explanations of home bias and on the use of gravity models to test for its determinants; it is demonstrated how credit ratings can be embedded in the theoretical and empirical frameworks. Section 4 describes and compares the data used for the three stages of estimations. Sections 5 to 7 present the results of our study at the stages of *piloting*, *home bias cutting* and *size-making*, respectively. Section 8 provides the conclusions.

## **2. Portfolio investment and sovereign credit ratings**

The transnationalization of finance is frequently understood as a process of *disintermediation*, since direct bank lending, the traditionally predominant form of external finance in most countries, has lost ground to market-based finance. However, the notion of disintermediation is misleading. The supply chains of finance have not become shorter, but rather longer and more complex (Allen and Santomero 1997, Allen *et al.* 2011). Within these chains, credit rating agencies provide judgments of the ability and willingness of issuers to meet their debt obligations. 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 credit 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 keeping 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

Figure 1 Cross-border bank lending, FDI and FPI (1970-2011)



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

functions of the banking business: the screening of investment opportunities and delegated monitoring (Gorton & Winton 2003). It is in this respect that 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 by such trilateral market governance, banks too 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 (e.g. within the Basel II regime). 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 signalling role in a longer-term perspective on 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<sup>1</sup> 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. It is also evident from *Figure 1* that all three types of capital flows are very volatile, with strong fluctuations around the peaks in the years 2000 and 2007. The contractions are explained by the *dot-com* crisis in the first case, and a combination of the Great Recession and the Eurozone debt 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 even with the recent financial crisis, it is plausible to assume that the latest contractions are temporary setbacks, not breaks in the trend.<sup>2</sup>

The purpose of this paper is to analyse the co-evolution of cross-border capital flows and credit ratings. We set the focus on portfolio investment data, i.e. on FPI flows and stocks. FDI data, too, may contain relevant information about foreign portfolio investment, insofar as issuer ratings underly decisions about the equity and fund share 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. Where, on the other hand, the FDI-defining control motives apply, investors should generally have access to inside information about credit risks that would make ratings redundant. 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 governments and other foreign entities (BIS 2000). However, the available data in the “other investment” category of the financial accounts do not permit to discriminate between such cases and the banks’ use of internal risk assessment and other modes of evaluation.

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<sup>1</sup> See the BoP item “Other investment, banks” in the IMF *International Financial Statistics* and IMF (2009: 111).

<sup>2</sup> Furthermore, it should be noted that the figures relate to *net* inflows of capital in the sense of netting the credit and debit entries for the same assets (IMF 2009: 134). The strong contraction of FPI net inflows after 2007 may rather reflect a global slump in the issuance of securities than a reversal in transnationalization.



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.<sup>3</sup> 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 the debt instruments recorded in the FPI statistics. The same applies to shares of fixed-income funds, another item in FPI statistics.

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" (Alsakka & ap Gwilym 2010: 2615).

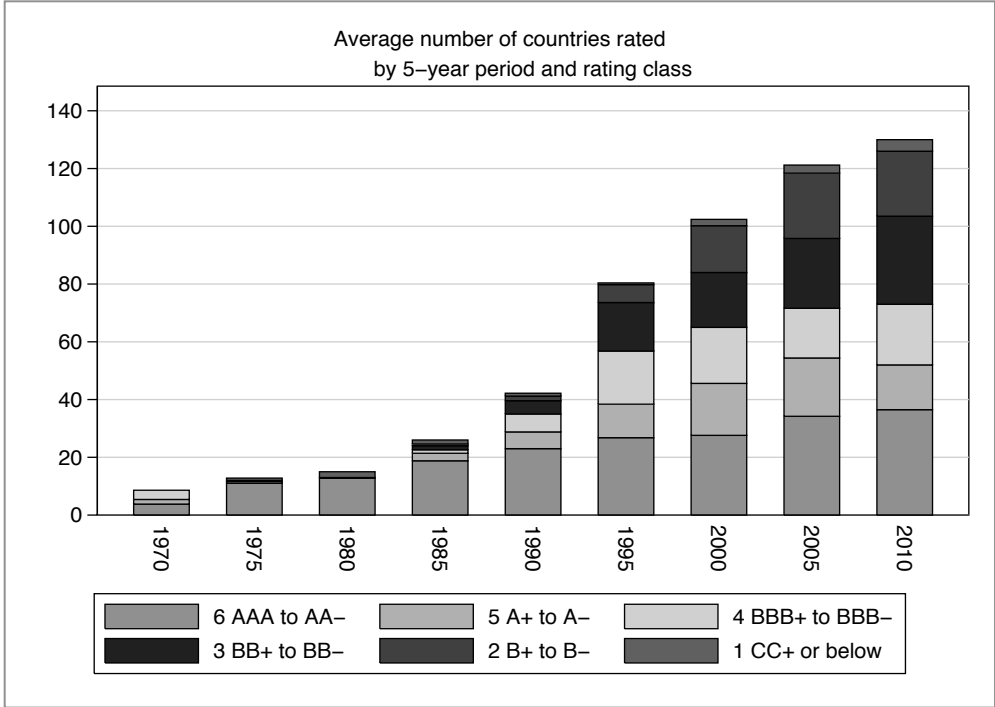
*Figure 2* shows (in combination with *Figure 1*) that the sovereign ratings business has developed largely in line with FPI flows. The (average) number of countries covered by sovereign ratings rose sharply from a mere 15 in the mid-1980s to over 130 in 2011.<sup>4</sup> The figure illustrates also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

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<sup>3</sup> Derivatives are, despite their spectacular growth rates, beyond the scope of this paper, as their time series are rather short, scant and not sufficiently compatible with the data we use in our longer-term perspective.

<sup>4</sup> The averages in *Figure 2* relate only to the sovereign ratings of Moody's and Standard & Poor's. Fitch did not resume to rate sovereigns until 1994 and rated far less countries in the first years than the other two. For a longer-term history of sovereign ratings see Gaillard (2012: ch.2).

Figure 2 Average number of rated sovereign issuers by five-year period (1970-2011)



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

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. However, 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 essentially on similar criteria (Gaillard 2012: ch.6). This consensus, in turn, forces governments to take the CRAs’ rating criteria into account in their economic policies, whether or not they are deemed to make sense in the specific situation of the country in question. 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. They should thus be 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. This implies that the aggregate portfolio holdings in all countries are identical and that their recorded FPI stocks should directly correspond to the size of all foreign financial markets. 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:

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

A value of  $HB_j = 1$  is associated with no foreign assets and thus full home bias while  $HB_j = 0$  is the theoretically ideal case of full diversification. In the latter case, domestic assets are exactly equal to the world market portfolio share of the respective country. As noted before, Coeurdacier and Rey (2013) stress in particular informational frictions of domestic investors as a detriment to achieving full international diversification.

Credit ratings should help to reduce informational frictions, since the sets of solicited ratings by the "issuer pays" principle and unsolicited ratings make private and local information

about credit risk available worldwide at no cost (for the ratings *per se*) or relatively low cost (for further information). Accordingly, we would expect ratings to contribute to the decline in home bias, a tendency that is indeed observable. Despite its persistence, home bias shows a falling trend in most economies (at least) since the early 1990s and concurrent with the sharp increase in the number of sovereign ratings displayed in *Figure 2*.<sup>5</sup>

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*” due to credit ratings serving to attract foreign investment into a country.

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, ratings act as a “*door-opener*” from an investor’s perspective. 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.<sup>6</sup> 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 by at least one of the agencies since the late 1990s or the early 2000s. We look at different categories of rating quality as a set of explanatory factors for 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 assess the influence of credit ratings on changes in cross-border portfolio holdings is to estimate a gravity equation, a framework widely used in the

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<sup>5</sup> 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).

<sup>6</sup> In addition, the reliance on credit ratings by regulators 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).

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 should apply to shifts from speculative grade to investment grade and to rating upgrades in general, whereas distance would grow and FPI would 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).<sup>7</sup> 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: 207-10) develop a theoretical gravity equation from a simple static framework of portfolio choice, but they also 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 gravity analysis. 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

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<sup>7</sup> 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 will be made in the following sections and bibliography of this paper.

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 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  $Q_j K_j$ , with  $K$  as the asset supply and  $Q$  as the asset price. 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*  $R_j^p$ :

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

Summing up to 1, the portfolio shares are  $\alpha_{ij}$  for investments in country  $i$  assets (foreign portfolio investment if  $j \neq i$ ),  $\alpha_{gj}$  for the global asset, and  $\alpha_{fj}$  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:

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

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  $\tau_{ij} > \tau_{ji}$  when  $j \neq i$ ” (*ibidem*). By solving the model they obtain the following expression for the *risky asset portfolio shares*  $\alpha_{ij}$ :

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

The next step is to define the RHS of equation (4) *without* the informational friction component  $\tau_{ij}$  as  $1/p_i$ , where  $p_i$  represents 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  $\alpha_{ij}$  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:

$$X_{ij} = \frac{P_j}{\tau_{ij} p_i} \quad (5)$$

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 for the *global asset market*,  $A = S$ , the country-specific market clearing condition gives the following solution for the *relative price of  $i$ 's assets*  $p_i$ :

$$p_i = \frac{S}{S_i \Pi_i} \quad (6)$$

where  $\Pi_i$  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  $i$ :

$$X_{ij} = \frac{S_i A_j \Pi_i P_j}{A \tau_{ij}} \quad (7)$$

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  $\tau_{ij}$ , to the so-called “*multilateral resistance variables*”  $\Pi_i$  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).<sup>8</sup> If the specific friction  $\tau_{ij}$  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.

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<sup>8</sup> For given values of bilateral frictions ( $\tau_{ij}$ ), asset supplies ( $S_i$ ) and wealth in the source countries ( $W_j$ ), the model can be solved for  $A_j$ ,  $P_j$  and  $\Pi_i$ ; see Okawa and van Wincoop (2012: 209).

### 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:

$$\frac{X_{ij}}{W_j} = \frac{S_i \Pi_i}{A \tau_{ij}} \quad (8)$$

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  $i$ :

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

Equation (10) 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<sup>9</sup> and the bilateral friction in relation to the average financial friction that investor country  $j$  faces relative to all destinations. Bilateral frictions can be calculated as follows in equation (10) and used as inputs in equation (9) with  $\tau_{ii}$  set to 1.<sup>10</sup>

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

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:

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

<sup>9</sup> Remember from Section 3.2 that globally  $S=A$ .

<sup>10</sup> In the trade literature  $\tau_{ii}$  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.



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:

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

The values obtained for  $\tau_{ij}$  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  $\tau_{ij}$  in the set of variables  $z$  measuring information asymmetries. Sovereign ratings are among the variables thought of affecting financial market frictions and particularly information frictions. Grade changes in sovereign ratings can be thought of condensing information and reducing 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 & 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

We examine the relation between sovereign credit ratings and the transnationalization of finance. In the 1970s and 1980s the number of countries rated by one or more of the then two global agencies 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. We label the three stages “piloting”, “home bias cutting” and “size-making”, with the first using only unilateral data, the second creating average data from bilateral holdings, and the third using a large dataset of bilateral investment data.

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 credit rating agencies 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 equity and debt 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. *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”. 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.

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. 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 and benchmark 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).

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 and consequently also  $\tau_{ij}$ . In these instances we use level data for the variables, which can be straightforwardly interpreted in the multiplicative Poisson 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 14 (BBB or Baa, 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.2 and 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 & Wolf (2013), in estimating the gravity model in a multiplicative framework using a Pseudo Poisson Maximum Likelihood estimator (PPML). The estimation equation (8) for size making is estimated with  $\alpha_0$  to  $\alpha_4$ ,  $\theta_i$  and  $\theta_j$  as parameters and  $d_i$  and  $d_j$  as host and home country dummies, respectively:

$$\frac{X_{ij}}{W_j} = \alpha_0 S_i^{\alpha_1} A^{\alpha_2} \Pi_i^{\alpha_3} \tau_{ij}^{\alpha_4} e^{\theta_i d_i + \theta_j d_j + \theta_k d_{ij}} \quad (13)$$

For PPML estimators, the interpretation of coefficients differs from standard regression models (Santos Silva & 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 (*ibid*: 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.<sup>11</sup> 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.

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<sup>11</sup> 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*.

## Piloting

The first stage estimation is a simplified unilateral version of the gravity model. In this stage, we relate the share of the sum of foreign investment from all countries in country  $i$ ,  $X_i$ , in the host country's portfolio  $W_j$  only to asset supply and average frictions  $\Pi_i$  for investment in this country. Due to a lack of bilateral data, we cannot estimate  $\tau_{ij}$  directly; we use average financial frictions contained in  $\Pi_i$  instead. The country  $j$  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:

$$\frac{X_{ij}}{W_j} = \alpha_0 S_i^{\alpha_1} A^{\alpha_2} \Pi_i^{\alpha_3} e^{\theta_i d_i} \quad (14)$$

## 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 measure congruent with the standard definition. Home bias equation (12) can be estimated as:

$$HB_j = \alpha_0 (S_i/A)_i^{\alpha_1} (W_k/\tau_{ik}A)^{\alpha_2} (1 - A_j/A)_i^{\alpha_3} \tau_{ij}^{\alpha_4} e^{\theta_i d_i + \theta_j d_j} \quad (15)$$

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

## 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 as in equation (13). We reformulate it explicitly in terms of the multilateral financial frictions of the host country  $\Pi_i = \sum_{k=1}^N (W_k/\tau_{ik}A)$ :

$$\frac{X_{ij}}{W_j} = \alpha_0 (S_i/A)^{\alpha_1} (W_k/\tau_{ik}A)^{\alpha_2} \tau_{ij}^{\alpha_3} e^{\theta_i d_i + \theta_j d_j + \theta_k d_{ij}} \quad (16)$$

Additional explanatory variables include the set of variables  $z_{ij}^m$ , which measures information asymmetries between countries  $i$  and  $j$ . As these tend to reduce cross-border

holdings, they enter with a negative expected coefficient into the estimation equation.  $S_i$  measures the available asset supply in country  $i$ .  $\Pi_i$  is a measure of the multilateral resistance of investment in  $i$  in relation to world asset demand.  $A_j$  is the investing country's asset demand and  $P_j$  a measure of the average friction of FPI incurred by investors from country  $j$ . For the unobservable friction  $\Pi_i$  for incoming investment we use the same simplification as for the home bias derivation yielding  $\Pi_i = \sum_{k=1}^N \frac{W_k}{\tau_{ik}A}$ . Estimation results are presented in Section 5.3.

## 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 as summarized in Appendix A.2. We start by describing the piloting stage.

### 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. 68 countries from this sample were either rated by 1976 or received a rating thereafter (see Appendix B.1). These countries are rather heterogeneous in terms of origin and economic development comprising industrialized countries with well-developed financial markets but also developing countries in Latin America, Africa and Asia.

#### 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 available foreign capital  $W_j$ . This share is regressed on the variables from the gravity model of Okawa and van Wincoop (2012). Additional variables used are described in Appendix 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). The results are presented in *Table 1*.<sup>12</sup>

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<sup>12</sup> Robustness checks using ordinary panel fixed effects and clustered OLS estimations for all three estimation stages are available from the authors upon request.

**Table 1** Piloting: PPML panel estimation of host country investment holdings (1976-2011)

Dep. Var. $x_{i,w,j-1}$	(1)	(2)	(3)	(4)
$\log(S_i)$	0.7385***	0.7598***	0.8150***	0.7951***
$\log(A)$	-0.8032***	-0.8075***	-0.8442***	-0.8221***
$rtg\_stage$		-0.0782		
$rtg\_1st\_i$			0.2907***	
$invXrtg\_1st$			-0.2607**	
$rating\_i$				0.0283
$invXrtg\_i$				-0.0039
N	4282	4282	1653	1653
ll	-80.2461	-80.2301	-64.5838	-64.5817
aic	232.4923	234.4602	205.1677	205.1634
bic	461.5306	469.8607	410.7608	410.7566
Fixed effects	Yes	Yes	Yes	Yes

Robust standard errors, fixed effects not reported

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

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.

The coefficients in the baseline model (1) are of the expected sign and strongly significant. Host country assets  $S_i$  enter positively, which indicates a larger foreign asset share the larger the domestic market. The global market size  $A$ , representing all alternative investment opportunities, has a negative coefficient. More foreign investment opportunities lead *c.p.* to a relative decrease in foreign investment in the host country. Both coefficients are below unity, which is in line with other estimations of gravity models using PPML techniques (e.g. Santos Silva and Tenreyro 2006, Westerlund and Wilhelmsson 2009, Behrens *et al.* 2012).

The variable  $rtg\_stage$  in model (2) is an indicator variable of the rating stage of the host country. It receives 0 if it 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 portfolio holdings may be lower on average for unrated countries, several countries with large market volumes and high sovereign ratings (e.g. Germany, Italy, Spain, the Netherlands and Belgium) were rated (again) only in the mid-1980s; in conjunction with the mostly later dates of first ratings for smaller and weaker candidates this may render the resulting coefficient negative and insignificant.<sup>13</sup>

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

<sup>13</sup> The same is true in isolation (not reported) for the indicator variable of being rated,  $rtg\_1st\_i$ , which is 1 in the first year of being rated by Standard & Poor's or Moody's.

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  $invgrade$  (1 for investment grade) indicator is negative and significant ( $invXrtg\_1st$  captures the additional effect for  $invgrade=1$ ). The share of foreign investment in the host country's portfolio  $X_i/W_j$  of 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–.26). Investment increases on average by 3 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 neither improves the explanatory power of the model nor do either  $invXrtg\_i$  or  $rating\_i$  become significant 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; we find models with lagged values of  $rtg\_1st\_i$  not to add explanatory power (not reported). 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 the rating level seems only to exert its positive influence over time.

### **Portfolio investment net inflows**

We now turn to net inflows to control for more immediate effects of rating changes visible in changes in net portfolio investment inflows. *Table 2* summarizes pseudo Poisson maximum likelihood estimation results with heteroskedasticity-robust standard errors and time fixed effects for *net inflows* from 1976 until 2011. The dependent variable is the share of World Bank net inflows ( $\Delta X_{ij} - \Delta X_{ji}$ , data only up to 2009 for some countries) into host country  $i$  over available world capital  $W_j$ . Altogether excluding countries with shorter time-series does not change the results qualitatively. Variables  $\Delta S_i$  and  $\Delta A$  are the same as above, but



converted in first differences to be comparable to net inflows. They are not denoted in logarithms because of the occurrence of negative values.

*Table 2* Piloting: PPML panel estimation of host country investment net inflows (1976-2011)

Dep. Var.	(1)	(2)	(3)	(4)
$\Delta X_{i,w_j}$				
$\Delta S_i$	-0.0562	-0.0197	0.0032	-0.0232
$\Delta A$	0.3382***	0.3297***	0.3245***	0.3010***
<i>rtg_stage</i>		0.5789***		
<i>rtg_1st_i</i>			-0.7160	
<i>invXrtg_1st</i>			-0.8928	
<i>rating_i</i>				0.1912**
<i>invXrtg_i</i>				-0.0299
N	2389	2389	1063	1063
ll	-0.7842	-0.7810	-0.7454	-0.7449
aic	71.5684	73.5619	75.4908	75.4897
bic	273.8205	281.5926	259.3382	259.3372
Fixed effects	Yes	Yes	Yes	Yes

legend: \* p<.1; \*\* p<.05; \*\*\* p<.01

*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.*

In model (1) changes in the domestic market size of the host country,  $\Delta S_i$ , 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 *rtg\_stage* variable is positive and significant at the 5% level. The changes from not being rated to non-investment grade, or from junk status to investment grade, increase the net inflows share by 57.8 p.p. on average while downgrades from investment grade reduce inflows accordingly. In the flow specification, the introduction of a rating shown in model (3) is negative but insignificant for both non-investment and investment grade countries, while it is again lower for investment grade countries. Overall observations are lower here because only countries with an existing rating can be included.

In model (4) the rating level (*rating\_i*) enters positively and is significant for net inflows, in contrast to the coefficient in the portfolio investment holdings model in *Table 2*. For them, a one-notch rating increase raises the weighted share of investment inflows by 19 p.p. The effect is around 3 percentage points lower for investment grade countries but insignificant. The Schwartz-Bayesian information criterion points to models (3) and (4) as the most parsimonious ones offering the best fit to the data.

In the piloting stage, a higher rating level is associated with larger portfolio investment net inflows, but not with higher holdings from abroad. 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 *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 (15) 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 & 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  $\tau_{ij}$  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*.<sup>14</sup>

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.<sup>15</sup> This variable is interacted consecutively with home and

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<sup>14</sup> Robustness checks using panel fixed effects and clustered OLS regressions are available from the authors.

<sup>15</sup> 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.

host country investment grade dummies and both dummies simultaneously. Contrary to our hypothesis, we observe a significantly larger home bias when the investing country's rating is higher compared to the average host country rating within the investment and non-investment grade groups, but not across grades. Home bias of better-rated countries is, on average, greater when a larger share of their portfolio is invested in lower-rated countries of the same group. The effect is confirmed in model (3) for the investment grade indicator (*invgrade\_j*); the coefficient signals a 9.0 p.p. larger home bias on average.

**Table 3** Home bias: PPML panel estimation of home bias (2001-2011)

Dep. Var. HB <sub>j</sub>	(1)	(2)	(3)	(4)	(5)	(6)
log(S <sub>i</sub> /A)	-0.0003	0.0094	-0.0003	-0.0004	-0.0004	-0.0026
log(W <sub>k</sub> /tau <sub>ik</sub> *A)	0.0094	-0.0010	0.0020	-0.0113	-0.0112	-0.0156*
log(tau <sub>ij</sub> )	-0.0001	-0.0001	-0.0001	-0.0000	-0.0000	-0.0002
log(1-A <sub>j</sub> /A)	16.2094***	16.4865***	16.2832***	17.7816***	17.8794***	17.4493***
rtgdif <sub>ij</sub>		0.0973***				0.0529***
inv <sub>i</sub> Xrtgdif		0.2348***				-0.0501
inv <sub>j</sub> Xrtgdif		0.0153*				-0.0050
inv <sub>ij</sub> Xrtgdif		0.0718**				0.0604*
invgrade <sub>j</sub>			0.0904***			
rating <sub>j</sub>				0.0318***	0.0346***	0.0252***
invXrtg <sub>j</sub>					-0.0016	0.0020
invupgrade <sub>j</sub>						-0.1139***
invdowngrd <sub>j</sub>						0.0624***
N	7820	7820	7820	7820	7820	7820
ll	-2994.1091	-2993.6098	-2993.8796	-2992.9478	-2992.9381	-2992.7358
aic	6014.2182	6021.2195	6015.7593	6013.8955	6015.8761	6027.4716
bic	6104.756	6139.615	6113.2615	6111.3977	6120.3427	6173.7248
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors, fixed effects not reported

\*\*\* 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.

Non-investment grade countries in the sample have on average a lower home bias of 16.6%, which ranges from 7% to 46%, while investment grade countries have an average home bias of 43.5%, ranging from 8% to 96%. Home bias increases by 3.2 p.p. for every higher rating notch (4). The results in model (5) are similar, but slightly lower in the interacted term for investment grade countries (3.30 p.p.) than for non-investment grade countries (3.46 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 6.2 p.p., while an upgrade to investment grade

level decreases the home bias by 11.4 p.p. on average for the five affected countries. Both AIC and BIC favour model (4) with just the rating level  $rating_j$  while BIC is lowest overall for the baseline model.

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 Home bias: Split sample PPML panel estimation (2001-2007/2008-11)

Dep. Var. HB <sub>j</sub>	2001-07			2008-11		
	(3)	(5)	(6)	(3)	(5)	(6)
log(S <sub>i</sub> /A)	0.0000	-0.0000	-0.0015	-0.0000	-0.0001	-0.0055
log(W <sub>k</sub> /tau <sub>ik</sub> *A)	-0.0079	-0.0118	-0.0135	0.0708***	-0.0497***	-0.0469***
log(tau <sub>ij</sub> )	-0.0000	0.0000	0.0000	0.0000	0.0002	0.0003
log(1-A <sub>j</sub> /A)	23.3746***	20.4939***	20.5600***	-8.5021***	-8.9730***	-8.4647***
rtgdif <sub>ij</sub>			0.0196			0.0432**
inv <sub>i</sub> Xrtgdif			0.0254			0.2056***
inv <sub>j</sub> Xrtgdif			-0.0062			-0.0043
inv <sub>ij</sub> Xrtgdif			0.0357***			0.0089
invgrade <sub>j</sub>	-0.0805***			0.2092***		
rating <sub>j</sub>		-0.0278***	-0.0338***		0.1022***	0.1083***
invXrtg <sub>j</sub>		-0.0019**	-0.0002		-0.0092***	-0.0129***
invupgrade <sub>j</sub>			-0.1205***			0.1385***
invdowngrd <sub>j</sub>			0.0783***			-0.0229
N	5130	5130	5130	2515	2515	2515
ll	-1795.18	-1795.0459	-1794.9533	-570.5506	-568.7369	-568.6930
aic	3610.36	3612.0919	3623.9066	1157.1012	1155.4738	1167.3860
bic	3675.7886	3684.0633	3735.1353	1203.7414	1207.9441	1254.8364
Fixed effects	6113.2615	Yes	Yes	Yes	Yes	Yes

Robust standard errors, fixed effects not reported

\*\*\* 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.

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 was lower on average for investment grade countries before the crisis (-8.0 p.p.), but we see a large swing to (+20.9 p.p.) for the sample 2008-11. Model (5) shows that the negative coefficient before

the crisis (-2.8 p.p. for every rating notch higher) is turned around for both non-investment grade countries (+10.2%) and slightly less for investment grade countries (+9.3%). Both were significantly negative until 2008.

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. Across the board home bias is lowered for 2.97 p.p. for every notch up on the rating scale (*rating<sub>j</sub>* combined with the additive term *invXrtg<sub>j</sub>*). 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

The last stage of our three-stage procedure estimates equation (16), which aims at identifying the extent to which ratings influence *bilateral* portfolio investment holdings. We estimate equation (16) 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 pseudo Poisson maximum likelihood 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 and weakly significant for the domestic market share, and negative and strongly significant at the 1% level for average multilateral and bilateral frictions.<sup>16</sup> The rating difference in column (2) is close to zero for all variants except when both countries have an investment grade rating (+13.5 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 50.8 p.p. for the rated host country (strongly significant) and by 8.7 p.p. for the home country (weakly significant).

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<sup>16</sup> Compared with clustered OLS and panel fixed effects estimations (available upon request), we see a slightly lower value for unilateral frictions but a significantly 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)

Dep. Var. $x_{ijW_j}$	(1)	(2)	(3)	(4)	(5)	(6)
$\log(S_i/A)$	0.5069*	0.4989**	0.4860*	0.5031*	0.4908*	0.4856**
$\log(W_k/\tau_{ik} * A)$	-0.6003***	-0.6173***	-0.6098***	-0.6049***	-0.6100***	-0.6210***
$\log(\tau_{ij})$	-0.9711***	-0.9862***	-0.9701***	-0.9632***	-0.9638***	-0.9693***
$rtgdiff_{ij}$		-0.0037				-0.1138***
$inv_{iXrtgdiff}$		0.0376				0.0086
$inv_{jXrtgdiff}$		-0.0568*				0.0289
$inv_{ijXrtgdiff}$		0.1347*				0.2211*
$invgrade_i$			0.5078***			
$invgrade_j$			0.0874*			
$rating_i$				0.0418	-0.0008	0.0091
$rating_j$				0.0279**	0.0197	-0.0068
$invXrtg_i$					0.0315*	0.0387***
$invXrtg_j$					0.0047	0.0253**
$invupgrade_i$						0.0699
$invupgrade_j$						0.0372
$invdowngrade_i$						-0.2272*
$invdowngrade_j$						0.1005*
N	7885	7885	7885	7885	7885	7885
ll	-205.1047	-205.0610	-205.0773	-205.0662	-205.0518	-204.9651
aic	436.2095	444.1220	440.1545	440.1324	444.1036	459.9302
bic	526.8548	562.6582	544.7453	544.7231	562.6398	634.2481
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors, fixed effects not reported

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

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.

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-notch increase is associated with slight, yet insignificant increase by 4.2 p.p. of the weighted foreign investment share for the investing country and by 2.8 p.p. for the investing country significant at the 5% level. Model (5) underlines that this effect becomes stronger for investment grade countries. The interaction term  $invXrtg_j$  makes up almost the entire effect for the host country (+3.1 p.p.), while reducing the coefficient for non-investment grade countries. Only the interaction effect for the host country is significant, though. 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 significant at the 5% level reducing bilateral holdings for host countries by 22.7 p.p. while increasing them for home countries by 10.0 p.p.

Table 6 splits the sample into a pre-crisis and a crisis period. Comparing the baseline gravity variables reveals that the coefficients including bilateral frictions  $\tau_{ij}$  are larger in the crisis (1.03 vs. 0.95) while average frictions  $\tau_i$  are lower (0.57 vs. 0.72). In addition, we see a much stronger size effect, as the  $S_i/A$  coefficient is markedly higher after 2008 (around 1.3) than before (0.2). This is likely to reflect the repatriation of capital held abroad to large nations like the US, the UK, Germany or Japan. In columns (3) the effect of an investment grade rating is smaller after the crisis than before; smaller investment grade countries lose relatively to larger nations. Columns (5) show that in non-investment grade countries FPI holdings are reduced more than in investment grade countries. Their weighted bilateral portfolio investment decreases by 2.7 p.p., compared to 1.8 p.p. for investment grade countries. Higher rated home countries have therefore reduced their foreign portfolio investment more strongly in the crisis than lower rated ones.

Table 6 Size-making: PPML panel estimation of investment holdings (2001-07/2008-11)

Dep. Var. $x_{ij\_w\_j}$	(2001-07)			(2008-11)		
	(3)	(5)	(6)	(3)	(5)	(6)
$\log(S_i/A)$	0.2035***	0.1742*	0.1745**	1.3012***	1.3535***	1.3336***
$\log(W_k/\tau_{ik}A)$	-0.7211***	-0.7230***	-0.7205***	-0.5404***	-0.5701***	-0.6011***
$\log(\tau_{ij})$	-0.9564***	-0.9595***	-0.9560***	-1.0106***	-1.0278***	-1.0516***
$rtgdiff_{ij}$			-0.0831*			-0.0780**
$inv\_iXrtgdiff$			-0.0097			0.0719
$inv\_jXrtgdiff$			0.0405***			0.0616**
$inv\_ijXrtgdif$			0.0006			0.2029**
$invgrade\_i$	0.2967***			0.1667***		
$invgrade\_j$	-0.0354			0.0039		
$rating\_i$		0.0037	-0.0092		0.0590	0.0649
$rating\_j$		0.0092	0.0098**		-0.0266***	-0.0519**
$invXrtg\_i$		0.0202***	0.0334***		-0.0012	0.0161*
$invXrtg\_j$		-0.0027*	-0.0013		0.0083***	0.0180**
$invupgrade\_i$			-0.0597			0.3202
$invupgrade\_j$			-0.0138			0.0151
$invdowngrd\_i$			-0.0569			-0.2743
$invdowngrd\_j$			-0.0278*			0.3222***
N	5001	5001	5001	2801	2801	2801
ll	-102.8269	-102.8255	-102.8244	-49.9343	-49.9215	-49.9114
aic	227.6537	231.6510	247.6487	115.8685	119.8431	135.8229
bic	299.3450	316.3771	384.5140	163.3704	179.2204	242.7020
	227.6537	231.6510	247.6487	115.8685	119.8431	135.8229
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors, fixed effects not reported

\*\*\* 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.

Overall, the quality effect of ratings becomes most strongly visible in the size-making estimation. Here, ratings in all their variants have significant coefficients in some or all specifications. An investment grade level of the host country is associated with a 29.7 p.p. higher foreign investment share while the rating level as a qualitative indicator is only weakly positive and insignificant. For investing countries, every rating notch is associated with a 0.9 p.p. higher investment share while investment grade level brings no additional benefit. In the split sample, rating stages or in levels enter significantly for home and host countries depending on the sample period. The positive effect of a better rating is mainly reflected in higher home country holdings abroad while the host country rating is a significant driver of portfolio investment only in the pre-crisis period until 2007.

When comparing our results 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 does not affect our results significantly. Results are shown in *Table 7*.

*Table 7* Size-making: Ad-hoc gravity clustered OLS results of size-making (2001-2011)

Variable	X <sub>ij</sub> W <sub>j</sub> (1)	X <sub>ij</sub> W <sub>j</sub> (2)	X <sub>ij</sub> W <sub>j</sub> (3)	X <sub>ij</sub> W <sub>j</sub> (4)	X <sub>ij</sub> W <sub>j</sub> (5)
log(Si/A)	0.3792***	0.3854***	0.3900***	0.3082***	0.3172***
log(W <sub>k</sub> /tau <sub>i</sub> k*A)	-0.3090***	-0.3309***	-0.3161***	-0.2194***	-0.2304***
log(tau <sub>ij</sub> )	-1.0053***	-0.9840***	-0.9854***	-0.9953***	-0.9905***
rating <sub>i</sub>		-0.0030			-0.0188***
rating <sub>j</sub>		0.0301			0.0368
invXrtg <sub>i</sub>		0.0208***			0.0140***
invXrtg <sub>j</sub>		-0.0026			-0.0002
kaopen <sub>i</sub>			0.0767***		0.0094
kaopen <sub>j</sub>			0.0834***		0.0123
log(trade)				-0.0508	-0.0732
log(distance)				-0.0116	0.0049
comlang				0.0591	0.0786
border				0.0801	0.1699
colonial				(omitted)	(omitted)
trade <sub>agr</sub>				-0.0025	0.0369*
Constant	-0.5505***	-1.5533***	-0.9338***	0.5375	0.0479
N	7915	7915	7915	3945	3945
r2	0.9771	0.9790	0.9783	0.9842	0.9853
Fixed effects	Yes	Yes	Yes	Yes	

Robust standard errors, fixed effects not reported

\*\*\* 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.

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. Only introducing the Chinn-Ito measure of capital account openness (*kaopen*) has a positive and significant effect. In model (5), the rating level *rating<sub>i</sub>* becomes negative and significant for non-investment grade home countries while the formerly positive effect on cross-border holdings for higher-rated investment grade countries of +0.018 p.p. (-0.03+0.0208) is reduced to almost zero (-0.188+0.014). We conclude that in the joint model, it is mainly rating variables that add explanatory power to the baseline gravity model of finance while other gravity variables do not.

## 6. 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;<sup>17</sup> a control group of non-rated countries could thus be observed only with unilateral data from longer-ranging databases. Moreover, there is a serious lack of comparable data on capital flows from, to and between many financial centres and offshore hubs.

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<sup>17</sup> Of the 35 countries newly rated after 2000 (shown in Figure 2), none is in the reporting set of the CPIS.

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 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

<b>CEPII</b>	CEPII dataset on distances and cultural proximity <a href="http://www.cepii.fr/francgraph/bdd/distances.htm">http://www.cepii.fr/francgraph/bdd/distances.htm</a>
<b>CPIS</b>	International Monetary Fund Coordinated Portfolio Investment Survey (CPIS) <a href="http://cpis.imf.org">http://cpis.imf.org</a>
<b>EWN</b>	Extern Wealth of Nations database (Lane & Milesi-Ferretti 2007) <a href="http://www.philiplane.org/EWN.html">http://www.philiplane.org/EWN.html</a>
<b>IFS</b>	International Monetary Fund International Financial Statistics (IFS) <a href="http://elibrary-data.imf.org/">http://elibrary-data.imf.org/</a>
<b>Moody's</b>	Moody's ratings data on sovereign long-term foreign currency issuers <a href="http://www.moodys.com">http://www.moodys.com</a>
<b>OECD</b>	OECD.StatExtracts for national accounts, Main Economic Indicators and debt data <a href="http://stats.oecd.org">http://stats.oecd.org</a>
<b>NaturalEarth</b>	NaturalEarth 1:110m Cultural Vectors for country coordinates and mapping <a href="http://www.naturalearthdata.com/downloads/110m-cultural-vectors/">http://www.naturalearthdata.com/downloads/110m-cultural-vectors/</a>
<b>Rose</b>	Bilateral and multilateral trade datasets (Rose 2004) <a href="http://faculty.haas.berkeley.edu/arose/RecRes.htm#Trade">http://faculty.haas.berkeley.edu/arose/RecRes.htm#Trade</a>
<b>S&amp;P</b>	Standard & Poor's ratings data on sovereign issuers <a href="http://www.globalcreditportal.com">http://www.globalcreditportal.com</a>
<b>World Bank</b>	World Bank global financial development (GFD) indicators and "Financial Sector" <a href="http://data.worldbank.com/indicator/">http://data.worldbank.com/indicator/</a>

### A.2 Variable descriptions

Variable	Source	Description
<b>Piloting</b>		
$X_{i,W_j}$	L&MF (2007), WB GFD	(1a) Foreign portfolio holdings in host country $i$ (debt+equity, L&MF 2007) and (1b) Portfolio investment, net inflows (World Bank) over the sum of stock market capitalization and private and public bond market capitalizations (L&MF 2007)
$\log(S_i)$	L&MF (2007)	log of domestic stock market capitalization and private and public bond market capitalizations
$\log(A)$	L&MF (2007)	log of world market capitalization
<b>Home bias cutting</b>		
$HB_j$	L&MF (2007), WB GFD, CPIS	Home bias index (0,1) for bilateral investment holdings with the sum of of investing country $j$ 's $X_{ij}$ (CPIS) and $W_j$ (L&MF 2007) and normalization term $(1-A_j/A)$ using L&MF (2007)
$\log(S_i/A)$	L&MF (2007)	log of the domestic market share in the world
$\log(\sum_k W_k/\tau_{ik} * A)$	L&MF (2007), CPIS	log of average multilateral financial frictions (Okawa & van Wincoop 2012)
$\log(\sum_i \tau_{ij})$	L&MF (2007), CPIS	log of the sum of bilateral frictions (Okawa & van Wincoop 2012)
$\log(1-A_j/A)$	L&MF (2007)	log of total foreign market capitalization

Variable	Source	Description
<b>Size-making</b>		
X <sub>ij</sub> W <sub>j</sub>	CPIS, L&MF (2007)	Bilateral portfolio holdings (CPIS) over the sum of stock market capitalization and private and public bond market capitalizations (L&MF 2007)
log(S <sub>i</sub> /A)	L&MF (2007), CPIS	log of the domestic market share in the world
log( $\sum_k W_k / \tau_{ik} * A$ )	L&MF (2007), CPIS	log of average multilateral financial frictions (Okawa & van Wincoop 2012)
log( $\tau_{ij}$ )	L&MF (2007), CPIS	log of bilateral frictions (Okawa & van Wincoop 2012)
<b>Rating variables</b>		
rtg <sub>stage</sub>	Moody's, S&P	0 not rated, 1 non-investment grade, 2 inv' grade
rtg <sub>lst_i</sub>	Moody's, S&P	1 in the first year of being rated by either S&P or Moody's
invgrade <sub>i</sub>	Moody's, S&P	1 if host country rating is 14 or better (BBB/Baa)
invgrade <sub>j</sub>	Moody's, S&P	1 if home country rating is 14 or better (BBB/Baa)
rtgdif <sub>ij</sub>	Moody's, S&P	Average difference between home and host country ratings (in notches) weighted by the share of total investment. Interacted with invgrade <sub>i</sub> , invgrade <sub>j</sub> and both.
inv <sub>i</sub> Xrtgdif	Moody's, S&P	
inv <sub>j</sub> Xrtgdif	Moody's, S&P	
inv <sub>ijj</sub> Xrtgdif	Moody's, S&P	
invXrtg <sub>lst</sub>	Moody's, S&P	1 in the first year of being rated by either S&P or Moody's and first rating is investment grade
L* <sub>rtg<sub>lst_i</sub></sub>	Moody's, S&P	lagged value of rtg <sub>lst_i</sub>
rating <sub>i</sub>	Moody's, S&P	Rating of host country (20-notch scale, AAA/Aaa=21)
rating <sub>j</sub>	Moody's, S&P	Rating of home country (20-notch scale, AAA/Aaa=21)
invXrtg <sub>i</sub>	Moody's, S&P	Rating of host country if investment grade
invXrtg <sub>j</sub>	Moody's, S&P	Rating of home country if investment grade
invupgrade <sub>i</sub>	Moody's, S&P	1 if rating upgraded to investment grade in this year or past year
invupgrade <sub>j</sub>	Moody's, S&P	
invdowngrade <sub>i</sub>	Moody's, S&P	1 if rating downgraded from investment grade in this year or past year
invdowngrade <sub>j</sub>	Moody's, S&P	
<b>Gravity variables</b>		
kaopen <sub>i</sub>	Chinn & Ito (2007)	Capital account openness index of host country
kaopen <sub>j</sub>	(2007)	Capital account openness index of home country
log(trade)	Rose (2004)	log of bilateral trade (in 1999)
log(distance)	Rose (2004)	log of geographic distance (capitals)
comlang	Rose (2004)	1 if countries share an official language
border	Rose (2004)	1 if countries have a common border
colonial	Rose (2004)	1 if colonial ties between the countries exist
trade <sub>agr</sub>	Rose (2004)	1 if countries are in a regional trade agreement

## B.1 Piloting

Table 8 Summary statistics of variables for piloting estimation (holdings and net inflows)

Variable	Obs	Mean	Std. Dev.	Min	Max
<b>Holdings</b>					
X <sub>i</sub> W <sub>j</sub>	4283	.007161	.0245988	0	.244198
ln <sub>S</sub> <sub>i</sub>	4282	-5.263153	2.920806	-12.79536	3.088273
ln <sub>A</sub>	4284	2.693552	1.206754	.5199777	4.606447
rtg <sub>stage</sub>	4403	.5766523	.8036265	0	2
rtg <sub>lst</sub>	4403	.0174881	.1310959	0	1
<b>Net Inflows</b>					
$\Delta X_{iW_j}$	3523	.0000621	.0003704	-.0060461	.0072033
$\Delta X_{iW_j} \geq 0$	3105	.0000802	.0003692	0	.0072033
$\Delta S_i$	4164	.0236421	.1621853	-1.951454	4.042233
$\Delta A$	4284	-.0471233	2 0.30934	-116.866	21.15468
<b>Rating variables</b>					
rtg <sub>stage</sub>	4403	.5766523	.8036265	0	2
rtg <sub>lst</sub>	4403	.0174881	.1310959	0	1
invXrtg <sub>lst</sub>	21	1	0	1	1
rating <sub>i</sub>	1655	14.60731	5.606858	0	21
invXrtg <sub>i</sub>	920	19.10895	2.30659	14	21

Note: Observations for invXrtg<sub>lst</sub> and invXrtg<sub>i</sub> apply only to investment grade countries. Values for dotX<sub>iW\_j</sub> 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 9 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 10 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).

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