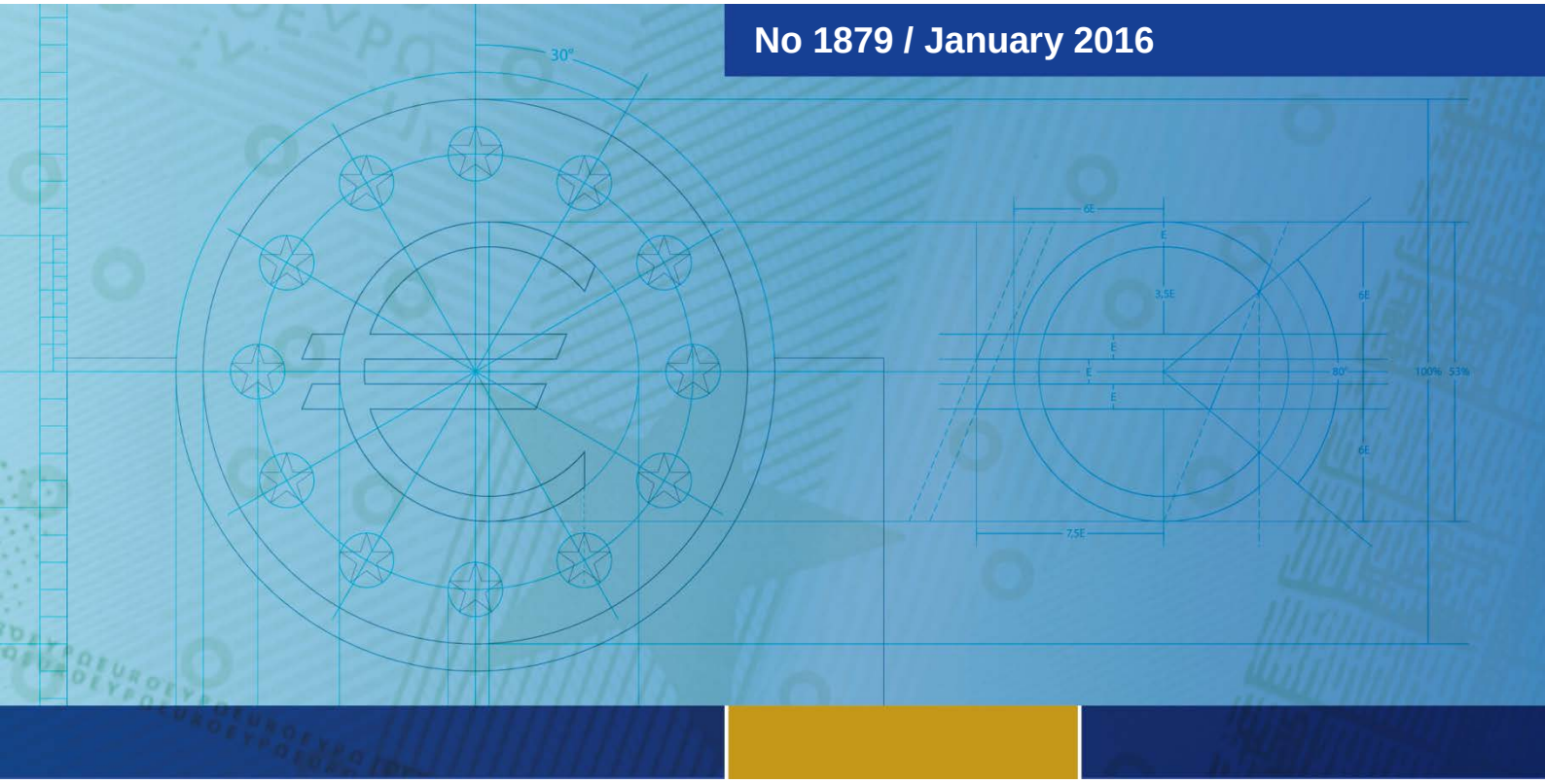
EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

Christiane Hellmanzik
Martin Schmitz

Taking gravity online: the role of virtual proximity in international finance



No 1879 / January 2016

Abstract

This paper analyses international patterns of bilateral portfolio equity and debt investment in a gravity model framework. We contribute to the literature by exploring the role of virtual proximity – measured by bilateral internet hyperlinks between countries – as a novel proxy for cross-border information flows and cultural proximity more generally. Our findings show that bilateral portfolio investment is significantly affected by virtual proximity, indicating that countries which are more closely connected in terms of web content are more integrated financially. The effect is stronger for equity than for debt investment, highlighting the larger information sensitivity of equity investments, and is largest for investments among advanced economies. Moreover, including virtual proximity in estimations reduces the importance of traditionally-used proxies for information asymmetries and cultural proximity.

Keywords: International capital flows, portfolio investment, cultural proximity, hyperlinks, information, internet

JEL Classification: F12, F15, Z10.

Non-technical summary

Research on bilateral investment patterns has grown considerably over the past decade and shows – both empirically and theoretically – that distance and proxies for informational asymmetries between countries, such as common language, colonial ties and currency unions, are crucial in explaining bilateral asset holdings and flows. Thus, asset trade can be estimated by gravity models, implying a proximity bias in international investments due to information asymmetries that are increasing in distance.

We contribute to this literature by exploring the role of virtual proximity – measured by bilateral hyperlinks between countries. The idea is to reflect, for instance, how often British or French internet users set links to websites from the United States. In case this indicator is, *ceteris paribus*, higher for the United Kingdom than for France, we interpret this as British citizens being virtually closer to the United States than the French. The underlying assumption is that virtual proximity of two countries increases with the interest shown in each others' web content. Our virtual proximity measure thus captures global interconnectedness and information flows. As such, virtual proximity is a good measure for the potential information set of international investors. Virtual connectedness should reduce uncertainty about the expected pay-offs of international investment decisions and thus foster international financial integration. In addition, in light of the pivotal role of the internet, web-based measures of revealed proximity can be expected to matter more for cultural closeness than, for example, a common religion.

Our findings show that bilateral portfolio investment is significantly affected by virtual proximity, indicating that countries which are more closely connected in terms of web content are more integrated financially. The effect is stronger for equity than for debt investment, highlighting the larger information-sensitivity of equity investments. The increased need for information in conducting equity rather than debt investment might derive from the more heterogenous nature of equity investments. The largest positive effects of virtual proximity are found for investments among advanced countries. This is indicative of the fact that advanced countries are more open in the virtual sphere and are thus better able to take advantage of the latest information technologies. Moreover, including virtual proximity in our econometric estimations reduces the importance of traditionally-used proxies for information asymmetries and cultural proximity. Overall, our results – which are robust to a host of tests – indicate the important role of interconnectedness and information technologies for international financial integration and thus highlight the growing relevance of the internet for economic transactions.

1 Introduction

This paper analyses bilateral international patterns of portfolio equity and debt investments in a gravity model framework. In particular, we contribute to the literature by exploring the role of virtual proximity – measured by bilateral hyperlinks between countries. Not only does virtual proximity update and complement traditional measures of cultural proximity, it also captures how the internet bridges information asymmetries in international financial linkages.

Our virtual proximity measure captures global interconnectedness and hence information flows, the channel which is arguably most relevant for overcoming potentially prohibitive informational asymmetries in investment decisions. We thus provide new insights into the role of foreign investors' informedness for international investment allocations using OLS and instrumental variables estimation techniques. To this end, we use Chung's (2011) data on bilateral webpage hyperlinks to capture virtual proximity. The idea is to reflect, for instance, how often British or French internet users set links to websites from the United States (say the homepage of the New York Times). In case this indicator is, *ceteris paribus*, higher for the United Kingdom than for France, we interpret this as British citizens being virtually closer to the United States than the French. The underlying assumption is that information flows and virtual proximity of two countries increases with the interest shown in each others' web content. If this is the case, investors will be more likely to invest in countries for which they have more information and to which they feel literally and figuratively connected. We find that bilateral portfolio investment is significantly affected by virtual proximity, indicating that countries which are more closely connected in terms of web content are more financially integrated. The effect is stronger for equity than for debt investment, reflecting the larger information sensitivity of equity investments, and is largest for investments among advanced economies.

Virtual proximity has the useful feature of being a bilateral, bidirectional and potentially asymmetric indicator of information flows between countries. A key advantage of using virtual proximity as a measure of international integration is that internet activities are relatively costless (in particular as they have zero variable trade costs), i.e. with few usage barriers in light of high and rising global internet penetration rates. As such, virtual proximity is a good measure for the potential information set of international investors. Even if it does not measure information directly relevant to a particular investment, it encompasses everything from specific information to more general information on the economy, political events and the investment climate in a country. Hence, virtual connectedness should reduce uncertainty about the expected pay-offs of international investment decisions and thus foster international financial integration. Apart from information flows relevant to international investment decisions, virtual proximity also represents a novel, up-to-date proxy for cultural proximity between countries. Virtual proximity goes beyond mere ease of access to information as it captures information flows directly. In addition, in light of the pivotal role of the internet, web-based measures of revealed proximity can be expected to matter more for cultural closeness and informedness than, for example, a

common religion. Nevertheless, we use linguistic proximity as a control in our estimations because a shared language is perhaps the best way to overcome cross-country access barriers to information. Indeed we find that including virtual proximity in our estimations reduces the importance of traditionally-used proxies for information asymmetries and cultural proximity. In terms of investment decisions, virtual proximity is in all likelihood more targeted in its informational content than religion or language, which are rather more reflective of transaction costs than of actual transmission of information.

In general, information and communication technology has become increasingly important, influencing almost all types of transactions be it in a business or private setting. Most notably, the World Wide Web is becoming the predominant vehicle for accessing and transmitting information globally. In the trade literature, Freund and Weinhold (2004) find a significant effect of the internet (measured by growth in web hosts in a country) on growth of goods exports which is consistent with a theoretical model in which the internet reduces market-specific fixed trade costs. Regarding exports of services, Freund and Weinhold (2002) show that internet development in its partner countries has resulted in increased exports of services to the United States. Using Chung's (2011) data on bilateral webpage hyperlinks, Hellmanzik and Schmitz (2015) find that 'virtually-proximate' countries trade significantly larger amounts of audiovisual services and that virtual proximity has a larger impact on trade in audiovisual services than on total services trade. Based on a sample of US internet users, Blum and Goldfarb (2006) point out that a gravity model also holds digitally, as physical distance has a negative impact on the online consumption of taste-dependent digital products such as music and games.

With respect to the financial sector, Barber and Odean (2001) stress that the internet allows investors to access more data and to trade without intermediaries. Research on the effect of the internet on international investment patterns is, however, relatively sparse. A notable exception is the work by Mondria, Wu and Zhang (2010) who use data on internet search queries to measure the attention allocated to a country. They find – based on information about website visits of a sample of US internet users – that investors endogenously increase their cross-border asset investments in a given country in response to an exogenous increase in the information they have about that country.

In the international finance literature, Lane and Milesi-Ferretti (2008), Portes and Rey (2005) and Aviat and Coeurdacier (2007) show that bilateral distance and proxies for informational asymmetries such as common language, colonial ties and currency unions are crucial in explaining bilateral asset holdings and flows. These empirical gravity-type estimations are based on theoretical models which link bilateral investment patterns to differences in asset transaction costs (Martin and Rey, 2004; Coeurdacier and Martin, 2009; Okawa and van Wincoop, 2012). Transaction costs are derived from differences in information as investors tend to know more about nearby and similar countries. Van Nieuwerburgh and Veldkamp (2009) explain the high weight of domestic assets in portfolios by the greater information and familiarity with domestic

assets. Thus, asset trade can be explained by gravity models that are very similar to models of bilateral trade, implying a home and a proximity bias in international investments.

The proximity bias in the financial sector is linked to information asymmetries that are increasing in distance. Coval and Moskowitz (1999, 2001) show that returns of fund managers in the United States are higher from investing in firms in close physical proximity. In addition, financial analysts tend to be more accurate in their assessments the closer they are located to a firm (Malloy, 2005). Huberman (2001) and Grinblatt and Keloharju (2001) suggest that proximate investments can be explained by a behavioural familiarity bias (such as employees' tendency to own their employers' stocks in their retirement accounts) rather than by information asymmetries.

Portes and Rey (2005) point out that distance constitutes an impediment to economic and cultural exchanges and thus leads to information asymmetries. Investors seek knowledge about various factors such as a host country's institutional and political environment, accounting and legal practices and the structure of financial markets to conduct cross-border portfolio investment. Eichler (2012) shows that increased information – measured by the quality of corporate disclosure standards – reduces investors' equity home bias. Foad (2011) assesses the relationship between immigration and equity home bias and finds that inward migration is positively correlated with increased foreign equity positions and reduced home bias. His results suggest that immigration generates a positive externality of increased information flows for developed countries, but not for developing nations. Aggarwal, Kearney and Lucey (2012) analyse the role of cultural differences across countries for bilateral investment patterns. To this end, they measure cultural distance between countries based on Hofstede's (2013) data on various cultural dimensions and show that part of the negative effect of physical distance on bilateral portfolio holdings can be attributed to cultural distance.[1]

The remainder of the paper proceeds as follows: in Section 2, we present the empirical gravity model and its theoretical foundation. Section 3 introduces the data, while the empirical results are shown in Section 4. Section 5 concludes.

2 Theoretical and empirical framework of the gravity model

Our gravity model framework builds on the theoretical models proposed by Martin and Rey (2004) and Okawa and van Wincoop (2012). Martin and Rey (2004) focus on incomplete asset markets and transaction costs in financial markets. In their model, assets are endogenously created, with larger countries having larger asset markets, while a reduction in financial trade

[1] The empirical literature also examines the relationship between stock market correlations and foreign equity allocations. While Lane and Milesi-Ferretti (2008) find a significantly positive relationship using 2001 data, i.e. more investments in more correlated foreign markets, Coeurdacier and Guibaud (2011), employing an instrumental variable approach, find a significant negative relationship. This is also confirmed by Vermeulen (2013) for the global financial crisis period.

costs leads to more international asset trade. Frictions in asset trade through asymmetric information costs between home and foreign agents induce home bias in cross-border holdings. Okawa and van Wincoop (2012) provide an encompassing formal theoretical framework to justify the use of gravity models in international finance.

In line with these models, we estimate a log-linear gravity equation in which we control for both host and source country fixed-effects. This 'double fixed effect' approach follows Lane and Milesi-Ferretti (2008) and is also derived in Okawa's and van Wincoop's (2012) theoretical model. Hence, we estimate

$$log(Asset)_{ij} = \alpha_i + \alpha_j + \delta log(\mathbf{Z}_{ij}) + e_{ij} \tag{1}$$

We use bilateral portfolio investment holdings $log(Asset)_{ij}$ of country i in country j (in logs of millions US dollars) as the dependent variable and employ a cross-sectional approach – as usually done in the literature – for 2009. We carry out estimations for bilateral holdings of portfolio equity and portfolio debt investment. The estimations include source country (α_i) and host country fixed effects (α_j) as well as transaction costs $\mathbf{Z}_{ij}$ affecting cross-border capital flows. The host and source fixed effects control perfectly for any unobservable country-specific factors affecting international asset holdings. Moreover, by focusing on bilateral factors while controlling for source and host country characteristics, we capture the 'multilateral resistance' term (Coeurdacier and Martin, 2009; Okawa and van Wincoop, 2012). In line with Baldwin and Taglioni (2006), this removes the cross-sectional 'omitted price' bias. Following Coeurdacier and Martin (2009), we assume the following functional form for transaction costs:

$$\begin{aligned}\mathbf{Z}_{ij} = {} & virtual\ proximity_{ij}^{\phi_1} trade_{ij}^{\phi_2} distance_{ij}^{\phi_3} migrants_{ij}^{\phi_4} \\ & + exp(\phi_5 contiguous_{ij} + \phi_6 time_{ij} + \phi_7 common\ law_{ij+...})\end{aligned} \tag{2}$$

The first set of explanatory variables are well-established determinants of bilateral financial holdings (see e.g. Aviat and Coeurdacier, 2007; Coeurdacier and Martin, 2009; Lane and Milesi-Ferretti, 2008): trade is measured as the log of bilateral goods imports (as in e.g. Galstyan and Lane, 2013). Moreover, we include physical distance (*distance*) between two countries' capitals, time zone difference (*time*) and the existence of common borders (*contiguous*). We also use an indicator of the similarity of legal systems as legal fees might be substantially lower if investment takes place in a country with similar legal structures (*common law*). In addition, we control for common colonial history (*colony*) and common currency zones (*common currency*). The latter is likely to foster trade in assets by eliminating transaction costs on foreign exchange markets. The inclusion of these variables is motivated by the observation that similar and more geographically proximate countries share more information with each other.

The main focus of the analysis is to examine the effect of virtual proximity on bilateral in-

ternational investment patterns (see Section 3.3 for details). Our hypothesis is that virtual proximity exerts a positive impact on bilateral asset holdings and that it reduces the coefficient on physical distance and potentially other proxies for information asymmetries as it is a direct measure of information flows between countries. Since virtual proximity measures total bilateral hyperlinks between two countries, it should not be significantly endogenous to financial market activity. Nevertheless, we also run instrumental variable estimations to account for potential endogeneity and reverse causality issues.

We also control for linguistic similarity as interpretation and communication costs should be lower if countries have similar languages (*common language index*). This measure of cultural proximity is crucial for our analysis as it is complementary to virtual proximity in the sense that linguistic capacity is the necessary prerequisite for accessing a country's web information. In addition, we expand the set of explanatory variables as bilateral relationships between countries are likely to be closer and of higher mutual trust if countries' religions are similar (*common religion index*) and bilateral migration stocks are large (*migrants stock*). Immigrants, in particular, can be expected to have more information on their home country, either through the time they spent there or through social networks they maintain after migrating. Moreover, immigrants might spread some of this information to local investors in their new home country. In line with Foad (2011), we thus expect a positive effect of bilateral migration on bilateral cross-border investment positions.

Following Aggarwal, Kearney and Lucey (2012), we also control for the cultural distance between countries. Moreover, we run regressions where we test for the role of bilateral tax treaties. Bilateral tax treaties between countries help investors to avoid 'double' taxation (on interest income and capital gains) in both the host and home countries.

3 The dataset

3.1 CPIS data

Our dependent variables on bilateral portfolio investment holdings (equity and debt) are retrieved from the IMF's Coordinated Portfolio Investment Survey (CPIS). This survey records the amount of portfolio investment (in US dollars at market prices) that country i's residents hold in country j at the end of the year. The CPIS data have been extensively used in the literature, although they suffer from several limitations (see Lane and Milesi-Ferretti, 2008, for further details). For example, the country coverage is not complete (omitting some important emerging market economies such as China). However, Hau and Rey (2009) show – based on micro evidence at the mutual funds level – that the CPIS dataset is representative of international investment patterns.

Our data set focuses on the year 2009 for which our sample contains 52 source and up to 84 host countries. Although the CPIS data include more countries, our sample is restricted

by the availability of our explanatory variables (in particular our virtual proximity measure). Appendix Table I gives a detailed overview of all the variables used in this paper, their sources and descriptive statistics, while the list of source countries is shown in Appendix Table II.

3.2 Gravity model variables

Our explanatory variables are collected from various sources. The level of bilateral goods imports (in natural log form) is retrieved from the IMF's Direction of Trade Statistics database. The standard geographic variables *distance*, *time*, *contiguous* as well as *common law*, *colony* and *common currency* – as introduced in equation (2) – are provided by the CEPII dataset.

Common language index is an aggregate index constructed by Melitz and Toubal (2014). This measure summarises evidence about linguistic influences including common official language, common native language and linguistic proximity. It thus goes beyond traditionally-used measures of common language and Melitz and Toubal (2014) find that it has a strongly positive impact on trade in goods. We also use the measure of religious proximity (*common religion index*) computed by Melitz and Toubal (2014), which is mainly based on the CIA Factbook. The stock of migrants data (*migrants stock*) are obtained from the World Bank International Bilateral Migration Stock database. The cultural distance index is based on Hofstede (2013) and combines different dimensions of the cultural environment, namely individualism, masculinity, power distance and uncertainty avoidance. We construct this variable based on Kogut and Singh's (1988) method of measuring deviations along each dimension between all bilateral country pairs. Data on bilateral tax treaties are collected from UNCTAD.

3.3 Virtual proximity data based on hyperlinks

To capture information flows via the internet, we follow the approach of Hellmanzik and Schmitz (2015) for the case of audiovisual services trade, and use bilateral, inter-domain hyperlinks that internationally connect webpages in country A to webpages in country B. Our main source on hyperlinks data is Chung (2011), who provides data on bilateral hyperlinks for two years (2003 and 2009) for up to 87 countries.[2] Chung conducted his analysis in May 2009 with the help of Yahoo's search function and LexiURL Searcher, a social science web analysis tool developed by Thelwall (2009). At the time, Yahoo had indexed about 47 billion websites, among which Chung found more than 9.3 billion hyperlinks included in 33.8 billion sites from 273 different top-level domains.

Due to the bidirectional nature of the data, bilateral hyperlinks reflect the number of links from websites with domain .xx (i.e. from the country with domain .xx) to domain .yy (i.e. to the country with domain .yy) and vice versa. In 2009, the largest number of bilateral hyperlinks

[2] In addition, we obtained hyperlinks data for a smaller sample of countries referring to the year 1998 as reported by the OECD Communications Outlook 1999.

arose from webpages hosted in the US, which contained about 49 million links to websites in the UK (Appendix Table III), followed by hyperlinks from the US to Japan (44 million) and from the US to Germany (41 million). As long as we are using country top-level domains (ccTLD), such as *.de* for Germany or *.it* for Italy, classifying source and host countries is an easy task. However, determining the host and source countries for non-national domain names, such as *.org* or *.edu*, is technically not straightforward. In particular, how to deal with the popular *.com* domain, which most international businesses use, is a crucial issue and due to the magnitude of the effect, is not negligible.For the year 2009, Chung (2011) developed an attribution method which 'cracks', and thereby uniquely identifies, the host country of a *.com* domain for his sample of 87 countries.[3] This makes the data much richer and allows for a more complete and accurate picture of internet connectivity in light of the popularity of the *.com* domain.[4]

In Table 1, we show the correlation coefficients between our 'benchmark' virtual proximity measure (com-cracked bilateral hyperlinks for 2009) and the other measures of cultural and geographic proximity used in this paper. The correlation coefficients with other indicators of cultural proximity are generally small in magnitude, which highlights the novelty of the new virtual proximity measures. The correlations between virtual proximity and physical distance, common colonial history and common legal origin are negative, while being positive for imports, time-zone difference and common currency. Measures of cultural proximity, such as language, religion and migration are positively correlated with virtual proximity. Equivalently, cultural distance as defined by Hofstede (2013) is negatively correlated with virtual proximity. Moreover, there is a positive correlation between the com-cracked 2009 bilateral hyperlinks measure and the 1998 and 2003 measures of virtual proximity.

4 Empirical analysis

4.1 Equity vs. debt investment

In line with the literature, we carry out our analysis in separate regressions for equity and debt holdings (Table 2). First, we focus on equity and find bilateral imports and a common colonial history to have a positive impact on bilateral portfolio holdings, while distance has a negative effect with a coefficient of -0.57 (column 1). Moreover, we include similarity indices for language and religion. These two measures of cultural proximity show very significant positive coefficients, highlighting their importance in terms of overcoming informational asymmetries between countries.

[3] For the United States, usually the sum of the domains *.edu, .us, .mil and .gov* has been used (Barnett, Chon and Rosen, 2001) in the literature. In previous studies (e.g. Barnett and Sung, 2005), the *.com* domain had either been disregarded or completely attributed to the United States.

[4] An alternative approach would be to use bilateral data on internet bandwidth, for example provided by TeleGeography. However, bandwidth data often reflect the fact that countries act as internet hubs and hence do not qualify as a good measure of virtual proximity.

In column 2, we add the bilateral stock of migrants in line with Foad (2011). This variable exhibits a highly significant positive coefficient, suggesting that a 1% increase in the number of migrants (from the host country) in the source country increases the source country's portfolio equity investment holdings in the host country by 0.13%. Controlling for migrants slightly reduces the negative effect of distance and the positive role of colonial relationships, while also decreasing somewhat the impact of language and religious similarity.[5]

Our virtual proximity measure of 'com-cracked' bilateral hyperlinks (in logs, measuring how many hyperlinks are set from the source to the host country) enters the equation with a highly significant, positive coefficient of 0.39 (column 3). Hence, a 1% increase in the level of bilateral hyperlinks set from the host country to the source country is associated with a roughly 0.4% increase in bilateral portfolio equity holdings. In line with our priors, the impact of distance is further reduced, with the coefficient falling to -0.33. Moreover, it is particularly striking that controlling for virtual proximity and migration reduces the coefficient on language similarity from 2.2 to 1.3. This underlines the importance of controlling more explicitly for information flows via virtual proximity next to the traditional measures of cultural proximity such as language similarity. This is in line with our assumption that linguistic similarity is a necessary prerequisite for accessing and exchanging information on investment, rather than a proxy for the volume of bilateral information flows. The important role of virtual proximity reveals that increased information on a destination country is equivalent to lower effective transaction costs, while at the same time more information should reduce the uncertainty about the expected pay-off of cross-border investments.

Regarding portfolio debt investment (columns 4 to 6), we find that distance has a larger negative impact than on equity (in line with Coeurdacier and Martin, 2009) and common currency becomes significant. The coefficients on imports, common colonial history and migration are of similar magnitude and significance as in the equity estimations.

Focusing on virtual proximity, its impact on debt is smaller than on equity securities, with a coefficient of 0.25 (column 6). This suggests that the information sensitivity for equity investment is larger than for debt instruments. The larger need for information in conducting equity rather than debt investment might derive from the more heterogenous nature of equity investments. In particular, equity investments tend to require more research and information regarding the earnings potential of a specific company, while the prospects of investments in fixed income products (in particular sovereign bonds) are often easier to evaluate. Moreover, Barber and Odean (2002) find that investors who trade online tend to pursue more speculative strategies, which would be in line with investing in shares rather than in bonds. The degree of information sensitivity might also explain why the coefficients on language and religious similarity are larger (and only significant in the case of language) for equity. Using binary dummy

[5] Thus, we do not support Foad's (2011) suggestion that a common language might merely be a proxy for migration, but acknowledge that controlling for migration reduces the economic significance of linguistic similarity between countries.

variables, similar findings are obtained by Daude and Fratzscher (2008) for common language and Aggarwal, Kearney and Lucey (2012) for common religion.

4.2 Instrumental variables estimation

In the previous subsection, virtual proximity and portfolio investment are both measured for 2009. Thus, implicitly, the estimation treats internet connectivity as exogenous, which might raise concerns as individuals and firms (including investors) choose the number of hyperlinks. This should be mitigated by the fact that virtual proximity measures total bilateral hyperlinks between two countries, but we nevertheless run instrumental variable estimations to account for potential endogeneity issues and reverse causality. In line with Hellmanzik and Schmitz (2015) we employ lagged virtual proximity to address the potential reverse causality problem. In particular, we use the 2003 and 1998 (non 'com-cracked') virtual proximity measures as instruments for the 2009 virtual proximity measure, thus exploiting the time dimension of our virtual proximity data to estimate the effect of an exogenous change in virtual proximity. It is reasonable to assume that past bilateral hyperlinks (i.e. from 2003 and 1998) are pre-determined and unaffected by future shocks to bilateral investment patterns. This implies that current shocks in the gravity equation are uncorrelated with lagged virtual proximity values and thus qualify as valid instruments.

In Table 3 (columns 1 and 2) we repeat our OLS estimations for portfolio equity and debt, respectively, while reporting the 2SLS instrumental variable estimation (IV) results using the 2003 virtual proximity measure as an instrument in columns 3 and 4. The IV estimation actually increases the size of the coefficients on both equity (0.75 compared to 0.39 in the OLS estimation) and debt (0.39 compared to 0.25). The coefficients increase further to 1.3 (column 5 for equity) and 0.80 (column 6 for debt) when 1998 bilateral hyperlinks data are employed. In the later case, however, only the coefficient for equity is significant (at the 10% level), while the sample size is significantly reduced. Overall, the IV results strongly support the contemporaneous impact of virtual proximity on bilateral portfolio investment both in terms of significance and magnitude.

4.3 Advanced vs. emerging countries

Next, we split our sample into advanced and emerging source countries (Table 4) vis-a-vis the total sample of host countries. Strikingly, virtual proximity is only significant for the advanced country sample, which drives the overall results for both equity and debt. This is indicative of the fact that advanced countries are more open in the virtual sphere, and are thus better able to take advantage of the latest information technologies.[6]

[6]The only variables that are significant for both equity and debt in the case of the sample of emerging source countries are imports, distance and the stock of migrants (all with larger coefficients than for the advanced countries). For equity, time zone difference (in line with Lane and Milesi-Ferretti, 2008) and a common border are also

In Table 5, we further decompose the sample by splitting equity and debt investment into all possible combinations of advanced and emerging source and host countries. The largest positive coefficients on virtual proximity are found if both the source and host countries are advanced economies, while significant positive coefficients are also obtained if the source countries are advanced and the hosts are emerging countries. Among the emerging source countries, the only significant coefficient on virtual proximity is found for equity investment in advanced host countries. Apart from information on advanced economies being more accessible, it is also conceivable that it is less costly in terms of time and opportunity costs to obtain information within the sphere of the more homogenous developed countries. Moreover, investment into emerging markets often takes place in the form of FDI, which requires specific project-related information rather than more general market information that might be obtained via the internet.

Interestingly, among advanced countries distance fails to be significant both for equity and debt (columns 1 and 2), providing evidence that cross-border investment among advanced countries is better explained by structural factors such as a common currency (most importantly the euro) and virtual and cultural proximity (in particular migration and religious similarity). Moreover, it is interesting that language similarity only exerts a positive effect on bilateral portfolio investment from advanced countries into emerging markets. Thus, a common language seems to be a gate-opener for investors from advanced countries to undertake investments into 'new' markets. Also in this case virtual information flows are highly significant.[7]

4.4 Robustness estimations

In Table 6, we explicitly control for cultural factors by including data on cultural distance from Hofstede (2013), as for example employed by Aggrawal, Harmon and Lucey (2012) for portfolio investment and Davies, Ionascu and Kristjansdottir (2008) for foreign direct investment. Aggrawal, Harmon and Lucey (2012) find – by including an interaction term of cultural with physical distance – that part of the negative effect of physical distance on bilateral portfolio holdings can be attributed to cultural distance.[8] In contrast to Aggrawal, Harmon and Lucey (2012), we do not interact this variable with distance, but investigate its direct impact on bilateral portfolio investment. In these estimations, we do not find a significant effect of this variable on portfolio holdings (columns 1 and 2). This also does not change once we exclude virtual proximity from the estimation (in unreported regressions). Thus, our findings highlight the important role of information for international investment decisions – even when controlling for cultural distance between countries.

significant.

[7] The relatively low explanatory power of the independent variables for emerging market source countries might also arise from the comparatively small number of observations.

[8] Aggrawal, Harmon and Lucey (2012) also analyse different subcomponents of the cultural distance index between countries as well as the individual countries' cultural characteristics.

Second, we control for double taxation agreements (in columns 3 and 4) which could spur international investment. The inclusion of this variable does not affect our main findings nor is it significant. This might be due to two off-setting effects as explained by Blonigen and Davies (2004) for foreign direct investment: an agreement should in principle encourage foreign investment, while at the same time the larger difficulty to evade taxes on capital gains and interest income may discourage investment.

Third, the dominance of the United States with respect to the internet and international finance might affect our findings. Hence, we repeat our benchmark regressions excluding the United States both as a source and host country (columns 5 and 6). The results show that the coefficients on virtual proximity and all other coefficients are very much in line with the previous estimations. Consequently, there is no evidence that the United States is driving the results of our analysis.

Fourth, in columns 7 and 8, we re-estimate our benchmark regressions using the Poisson quasi-maximum likelihood estimation method (PPML) as proposed by Santos Silva and Tenreyro (2006), which includes portfolio investment holdings in levels rather than in log form. Silva and Tenreyro (2006) point out that PPML estimators perform better in the presence of heteroskedasticity as OLS estimators are not efficient in this case. Moreover, PPML estimations also include country pairs that report bilateral investment holdings with a value of zero and thus disappear in conventional logarithmic OLS specifications. The PPML estimations confirm our previous results, with the coefficients on bilateral hyperlinks becoming slightly smaller compared to the benchmark OLS results.

Finnaly, in unreported regression, we conduct estimations for earlier episodes for which bilateral hyperlinks data were collected, i.e. 1998 and 2003 (albeit for smaller samples and not in 'com-cracked' form). The results confirm the positive impact of virtual proximity on portfolio investment.

5 Conclusion

Our analysis shows that bilateral portfolio investment is significantly affected by 'virtual proximity' – a variable that not only captures cultural proximity but also information flows between two countries – implying that countries which are more closely connected in terms of web content are more integrated financially. As such, it is not surprising that virtual proximity is rather powerful in terms of its impact on international investments – even when controlling for traditional measures of cultural proximity – since it is based on actual internet preferences around the globe.

This is further underpinned by the fact that the effect of virtual proximity is stronger for equity than for debt investment, with the former being a more information intensive-investment class. The increased need for information in conducting equity rather than debt investment

might derive from the more heterogenous nature of equity investments. The largest positive effects of virtual proximity are found for investments among advanced countries. This is indicative of the fact that advanced countries are more open in the virtual sphere and are thus better able to take advantage of the latest information technologies. Moreover, our analysis suggest that a common language is a gate-opener for investors from advanced countries to undertake investments into 'new' markets, while actual information flows via the internet. Including virtual proximity in our econometric estimations also reduces the importance of traditionally-used proxies for information asymmetries and cultural proximity. Overall, our results – which are robust to a host of tests – indicate the important role of interconnectedness and information technologies for international financial integration and thus highlight the growing relevance of the internet for economic transactions.

References

[1] Aggarwal, R., Kearney, C., Lucey, B. 2012. 'Gravity and culture in foreign portfolio investment'. *Journal of Banking and Finance*, 36(2): 525-538.

[2] Aviat, A., Coeurdacier, N. 2007. 'The geography of trade in goods and asset holdings'. *Journal of International Economics*, 71(1): 22-51.

[3] Baldwin, R., Taglioni, D. 2006. 'Gravity for Dummies and Dummies for Gravity Equations'. NBER Working Papers No. 12516, National Bureau of Economic Research, Inc.

[4] Barber, B., Odean, T. 2001. 'The internet and the investor'. *Journal of Economic Perspectives*, 15(1): 41-54.

[5] Barber, B., Odean, T. 2002. 'Online investors: do the slow die first?'. *Review of Financial Studies*, 15(2): 455-488.

[6] Barnett, G., Chon, B., Rosen, D. 2001. 'The Structure of the Internet Flows in Cyberspace'. Network and Communication Studies NETCOM, 15(2): 61-80.

[7] Barnett, G., Sung, E. 2005. 'Culture and the Structure of the International Hyperlink Network'. *Journal of Computer-Mediated Communication*, 11(1): 217-238.

[8] Blonigen, B., Davies, R. 2004. 'The Effects of Bilateral Tax Treaties on U.S. FDI Activity'. *International Tax and Public Finance*: 11(5): 601-622.

[9] Blum, B. S., Goldfarb, A. 2006. 'Does the internet defy the law of gravity?'. *Journal of International Economics*, 70(2): 384-405.

[10] CEPII 2006. GeoDist Database, Paris, France.

[11] Chung, J. 2011. 'The Geography of Global Internet Hyperlink Networks and Cultural Content Analysis'. Dissertation, University at Buffalo.

[12] Coeurdacier, N., Guibaud, S. 2011. 'International portfolio diversification is better than you think'. *Journal of International Money and Finance*, 30(2): 289-308.

[13] Coeurdacier, N., Martin, P. 2009. 'The geography of asset trade and the euro: Insiders and outsiders'. *Journal of The Japanese and International Economies*, 23(2): 90-113.

[14] Coval, J. D., Moskowitz, T. J. 1999. 'Home bias at home: local equity preference in domestic portfolios'. *Journal of Finance*, 54(6): 2045-2073.

[15] Coval, J. D., Moskowitz, T. J. 2001. 'The geography of investment: informed trading and asset prices'. *Journal of Political Economy*, 109(4): 811-841.

[16] Davies, R., Ionascu, D., Kristjansdottir, H. 2008. 'Estimating the Impact of Time-Invariant Variables on FDI with Fixed Effects'. *Review of World Economics*, 144(3): 381-407.

[17] Daude, C., Fratzscher, M. 2008. 'The pecking order of cross-border investment'. *Journal of International Economics*, 74: 94-117.

[18] Eichler, S. 2012. 'Equity home bias and corporate disclosures'. *Journal of International Money and Finance*, 31(5): 1008-1032.

[19] Foad, H. 2011. 'Immigration and equity home bias'. *Journal of International Money and Finance*, 30(6): 982-998.

[20] Freund, C., Weinhold, D. 2002. 'The Internet and International Trade in Services', *The American Economic Review*, 92(2): 236-240.

[21] Freund, C., Weinhold, D. 2004. 'The effect of the Internet on international trade', *Journal of International Economics*, 62(1): 171-189.

[22] Galstyan, V., Lane, P. R. 2013. 'Bilateral portfolio dynamics during the global financial crisis'. *European Economic Review*, 57: 63-74.

[23] Grinblatt, M., Keloharju, M. 2001. 'How Distance, Language, and Culture Influence Stockholdings and Trades'. *Journal of Finance*, 56(3): 1053-1073.

[24] Hau, H., Rey, H., 2009. 'Global Portfolio Rebalancing under the Microscope.' Mimeo London Business School. Revision of NBER Working Paper No. 14165.

[25] Hellmanzik, C., Schmitz, M. 2015. 'Virtual proximity and audiovisual services trade.' *European Economic Review*: 77: 82-101.

[26] Hofstede, G., 2013. Cultural dimensions data retrieved from $http : //www.geert - hofstede.com$.

[27] Huberman, G. 2001. 'Familiarity breeds investment'. *Review of Financial Studies*, 14(3): 659-80.

[28] International Monetary Fund 2012a. Coordinated Portfolio Investment Survey, Washington D.C.

[29] International Monetary Fund 2012b. Direction of Trade Statistics, Washington D.C.

[30] Kogut, B., Singh, H., 1988. 'The effect of national culture on the choice of entrymode.' *Journal of International Business Studies*, 19: 411-432.

[31] Lane, P. R., Milesi-Ferretti, G. M. 2008. 'International Investment Patterns'. *The Review of Economics and Statistics*, 90(3): 538-549.

[32] Malloy, C. J. 2005. 'The geography of equity analysis'. *Journal of Finance*, 54(6): 2045-2073.

[33] Martin, P., Rey, H. 2004. 'Financial Super-Markets: Size Matters for Asset Trade'. *Journal of International Economics*, 64(2): 335-361.

[34] Melitz, J., Toubal, F. 2014. 'Native Language, Spoken Language, Translation and Trade'. *Journal of International Economics*, 93(2): 351-363.

[35] Mondria, J., Wu, T., Zhang, Y. 2010. 'The determinants of international investment and attention allocation: Using internet search query data'. *Journal of International Economics*, 82(1): 85-95.

[36] OECD 1999. 'OECD Communications Outlook 1999'. OECD Publishing.

[37] Okawa, Y., van Wincoop, E. 2012. 'Gravity in International Finance'. *Journal of International Economics*, 87(2): 205-215.

[38] Portes, R., Rey, H. 2005. 'The Determinants of Cross-Border Equity Flows'. *Journal of International Economics*, 65(2): 269-296.

[39] Santos Silva, J.M.C. and Tenreyro, S. 2006. 'The Log of Gravity', *Review of Economics and Statistics*, 88(4): 641-658.

[40] Thelwall, M. 2009. Introduction to Webometrics. New York: Morgan & Claypool.

[41] Van Nieuwerburgh, S., Veldkamp, L. 2009. 'Information immobility and the home bias puzzle.' *Journal of Finance*, 64(3): 1187-1215.

[42] Vermeulen, R. 2013. 'International diversification during the financial crisis: A blessing for equity investors?'. *Journal of International Money and Finance*, 35(4): 104-123.

Table 1: Correlation coefficients of different proximity measures

	Bilateral hyperlinks 2009 (.com cracked)
Imports (log)	0.74
Distance (log)	-0.06
Common border	0.17
Time zone difference	0.11
Common legal origin	-0.02
Common colony	-0.20
Common currency	0.16
Common language index	0.08
Common religion index	0.01
Migrants (log)	0.52
Bilateral hyperlinks 2003 (log)	0.76
Bilateral hyperlinks 1998 (log)	0.70
Cultural distance (Hofstede)	-0.25

Table 2: Determinants of bilateral equity and debt portfolio investment holdings

Ln (asset holdings)	(1)	(2)	(3)	(4)	(5)	(6)
	Equity	Equity	Equity	Debt	Debt	Debt
Imports (ln)	0.273	0.227	0.213	0.229	0.195	0.175
	[0.063]***	[0.064]***	[0.064]***	[0.054]***	[0.054]***	[0.054]***
Distance (ln)	-0.568	-0.477	-0.329	-0.706	-0.641	-0.537
	[0.108]***	[0.109]***	[0.111]***	[0.109]***	[0.110]***	[0.112]***
Common border	0.043	-0.067	-0.138	-0.030	-0.157	-0.163
	[0.208]	[0.202]	[0.197]	[0.204]	[0.199]	[0.193]
Time zone difference	-0.009	-0.004	-0.015	0.012	0.016	0.010
	[0.024]	[0.024]	[0.024]	[0.025]	[0.025]	[0.025]
Common legal origin	0.127	0.036	-0.009	0.020	-0.029	-0.056
	[0.124]	[0.123]	[0.122]	[0.115]	[0.115]	[0.115]
Common colony	1.435	1.310	1.317	1.484	1.419	1.484
	[0.386]***	[0.378]***	[0.370]***	[0.398]***	[0.399]***	[0.403]***
Common currency	0.273	0.298	0.243	1.124	1.121	1.072
	[0.176]	[0.172]*	[0.169]	[0.182]***	[0.179]***	[0.178]***
Common language Index	2.165	1.855	1.134	1.171	0.863	0.359
	[0.374]***	[0.372]***	[0.370]***	[0.312]***	[0.309]***	[0.335]
Common religion	1.788	1.736	1.849	0.799	0.734	0.828
	[0.326]***	[0.324]***	[0.323]***	[0.294]***	[0.287]**	[0.285]***
Migrants (ln)		0.154	0.142		0.129	0.121
		[0.030]***	[0.030]***		[0.029]***	[0.029]***
Bilateral hyperlinks (ln)			0.389			0.249
			[0.077]***			[0.063]***
Source country fixed effects	yes	yes	yes	yes	yes	yes
Host country fixed effects	yes	yes	yes	yes	yes	yes
Observations	1602	1602	1602	1692	1692	1692
R-squared	0.82	0.82	0.83	0.80	0.80	0.80

Notes: The dependent variable is bilateral portfolio investment assets (in natural log form); the explanatory variables are bilateral imports of goods (in natural log form), distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks (com-cracked, in natural log form), dummy variables for common border, common legal origin, common colonial relationship, common currency and similarity indices for religion and languages. The estimation uses source and host country fixed effects. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 3: Determinants of portfolio investment holdings - IV estimations

Ln (asset holdings)	(1)	(2)	(3)	(4)	(5)	(6)
	Equity	Debt	Equity	Debt	Equity	Debt
	OLS	OLS	IV	IV	IV	IV
Imports (ln)	0.213	0.175	0.193	0.382	0.352	0.293
	[0.064]***	[0.054]***	[0.066]***	[0.069]***	[0.108]***	[0.129]**
Distance (ln)	-0.329	-0.537	-0.061	-0.194	0.091	0.024
	[0.111]***	[0.112]***	[0.116]	[0.131]	[0.224]	[0.197]
Common border	-0.138	-0.163	0.206	-0.217	0.199	0.059
	[0.197]	[0.193]	[0.214]	[0.205]	[0.268]	[0.229]
Time zone difference	-0.015	0.010	-0.064	-0.056	0.060	-0.043
	[0.024]	[0.025]	[0.026]**	[0.029]*	[0.049]	[0.044]
Common legal origin	-0.009	-0.056	0.224	0.166	-0.327	0.158
	[0.122]	[0.115]	[0.121]*	[0.131]	[0.214]	[0.191]
Common colony	1.317	1.484	0.496	1.573	0.000	0.000
	[0.370]***	[0.403]***	[0.383]	[0.451]***	[0.000]	[0.000]
Common currency	0.243	1.072	0.045	0.739	0.515	0.634
	[0.169]	[0.178]***	[0.164]	[0.182]***	[0.179]***	[0.197]***
Common language Index	1.134	0.359	-0.740	-0.426	-0.949	-0.967
	[0.370]***	[0.335]	[0.462]	[0.411]	[0.484]*	[0.457]**
Common religion	1.849	0.828	1.262	0.533	0.957	0.518
	[0.323]***	[0.285]***	[0.339]***	[0.324]	[0.260]***	[0.233]**
Migrants (ln)	0.142	0.121	0.143	0.104	0.019	0.080
	[0.030]***	[0.029]***	[0.034]***	[0.038]***	[0.050]	[0.057]
Bilateral hyperlinks (ln)	0.389	0.249	0.753	0.389	1.299	0.803
	[0.077]***	[0.063]***	[0.170]***	[0.149]***	[0.679]*	[0.500]
Source country fixed effects	yes	yes	yes	yes	yes	yes
Host country fixed effects	yes	yes	yes	yes	yes	yes
Observations	1602	1692	1170	1130	566	561
R-squared	0.83	0.80	0.86	0.83	0.89	0.88

Notes: The dependent variable is bilateral portfolio investment assets (in natural log form); the explanatory variables are bilateral imports of goods (in natural log form), distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks (com-cracked, in natural log form), dummy variables for common border, common legal origin, common colonial relationship, common currency and similarity indices for religion and languages. The estimation uses source and host country fixed effects. Instrumental variables estimation (2SLS) in columns 3 to 6. Bilateral hyperlinks for 2009 (com-cracked) are instrumented by bilateral hyperlinks for 2003 (columns 3 and 4) and bilateral hyperlinks for 1998 (columns 5 and 6). Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 4: Determinants of bilateral equity and debt portfolio investment holdings

Ln (asset holdings)	(1)	(2)	(3)	(4)
	Equity	Debt	Equity	Debt
Source country	Adv	Adv	EME	EME
Host country	All	All	All	All
Imports (ln)	0.183	0.082	0.336	0.267
	[0.055]***	[0.055]	[0.142]**	[0.152]*
Distance (ln)	-0.214	-0.450	-0.746	-0.567
	[0.117]*	[0.129]***	[0.268]***	[0.221]**
Common border	0.264	-0.059	-1.078	-0.459
	[0.175]	[0.189]	[0.484]**	[0.457]
Time zone difference	0.007	-0.021	-0.118	-0.025
	[0.023]	[0.028]	[0.050]**	[0.047]
Common legal origin	0.018	0.170	0.058	-0.027
	[0.114]	[0.128]	[0.253]	[0.245]
Common colony	0.424	1.709	0.857	0.232
	[0.552]	[0.592]***	[0.570]	[0.635]
Common currency	0.347	0.794	-1.586	-0.648
	[0.157]**	[0.169]***	[1.007]	[1.003]
Common language Index	0.254	0.272	1.274	-0.363
	[0.357]	[0.367]	[0.888]	[0.889]
Common religion	1.199	0.516	1.008	0.850
	[0.369]***	[0.320]	[0.752]	[0.599]
Migrants (ln)	0.116	0.097	0.170	0.136
	[0.029]***	[0.033]***	[0.064]***	[0.068]**
Bilateral hyperlinks (ln)	0.396	0.245	0.036	0.028
	[0.106]***	[0.094]***	[0.126]	[0.120]
Source country fixed effects	yes	yes	yes	yes
Host country fixed effects	yes	yes	yes	yes
Observations	1113	1177	489	515
R-squared	0.88	0.84	0.70	0.65

Notes: The dependent variable is bilateral portfolio investment assets (in natural log form); the explanatory variables are bilateral imports of goods (in natural log form), distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks (com-cracked, in natural log form), dummy variables for common border, common legal origin, common colonial relationship, common currency and similarity indices for religion and languages. The estimation uses source and host country fixed effects. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 5: Determinants of bilateral equity and debt portfolio investment holdings

Ln (asset holdings)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt
Source country	Adv	Adv	Adv	Adv	EME	EME	EME	EME
Host country	Adv	Adv	EME	EME	Adv	Adv	EME	EME
Imports (ln)	0.232	0.340	0.200	0.066	0.198	0.129	0.484	0.293
	[0.071]***	[0.093]***	[0.072]***	[0.061]	[0.210]	[0.204]	[0.218]**	[0.231]
Distance (ln)	0.061	0.048	-0.696	-0.858	-1.029	-0.783	-0.862	-0.048
	[0.140]	[0.178]	[0.186]***	[0.207]***	[0.386]***	[0.353]**	[0.494]*	[0.316]
Common border	0.414	-0.154	-0.140	-0.175	-0.869	0.836	-1.226	0.063
	[0.188]**	[0.201]	[0.309]	[0.393]	[1.259]	[0.550]	[0.675]*	[0.680]
Time zone difference	-0.023	-0.078	0.066	0.064	-0.092	-0.077	-0.190	0.121
	[0.033]	[0.043]*	[0.028]**	[0.039]	[0.058]	[0.059]	[0.109]*	[0.085]
Common legal origin	-0.016	0.360	0.022	0.043	0.398	0.144	-0.399	0.132
	[0.108]	[0.165]**	[0.204]	[0.189]	[0.317]	[0.275]	[0.452]	[0.536]
Common colony	0.754	2.339	0.041	1.781	0.274	-0.279	0.273	0.739
	[0.611]	[0.546]***	[1.070]	[0.864]**	[0.624]	[0.945]	[0.847]	[1.175]
Common currency	0.537	0.669	0.007	-1.159	-1.846	-0.945	0.000	0.000
	[0.163]***	[0.194]***	[0.719]	[0.899]	[0.972]*	[0.572]*	[0.000]	[0.000]
Common language Index	-0.471	-0.172	2.319	2.082	1.116	0.465	1.370	1.473
	[0.404]	[0.491]	[0.744]***	[0.755]***	[1.474]	[1.434]	[1.691]	[1.781]
Common religion	0.776	0.460	1.555	0.684	0.245	0.221	2.007	1.160
	[0.243]***	[0.293]	[0.631]**	[0.494]	[0.814]	[0.654]	[1.552]	[1.357]
Migrants (ln)	0.142	0.102	0.027	0.043	0.055	0.183	0.073	0.203
	[0.036]***	[0.055]*	[0.042]	[0.044]	[0.086]	[0.085]**	[0.134]	[0.146]
Bilateral hyperlinks (ln)	0.468	0.307	0.417	0.249	0.468	-0.004	-0.254	0.089
	[0.128]***	[0.124]**	[0.177]**	[0.124]**	[0.274]*	[0.257]	[0.215]	[0.178]
Observations	583	571	530	595	308	321	181	194
R-squared	0.91	0.87	0.84	0.76	0.73	0.67	0.76	0.72

Notes: The dependent variable is bilateral portfolio investment assets (in natural log form); the explanatory variables are bilateral imports of goods (in natural log form), distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks (com-cracked, in natural log form), dummy variables for common border, common legal origin, common colonial relationship, common currency and similarity indices for religion and languages. The estimation uses source and host country fixed effects. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Table 6: Robustness estimations on portfolio investment holdings

Ln (asset holdings)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt
Imports (ln)	0.300	0.266	0.215	0.172	0.201	0.162	0.198	0.107
	[0.066]***	[0.060]***	[0.064]***	[0.054]***	[0.066]***	[0.055]***	[0.055]***	[0.062]*
Distance (ln)	-0.173	-0.317	-0.325	-0.532	-0.344	-0.523	0.010	-0.092
	[0.109]	[0.116]***	[0.112]***	[0.113]***	[0.114]***	[0.115]***	[0.080]	[0.070]
Common border	0.042	-0.058	-0.139	-0.146	-0.127	-0.179	0.506	-0.018
	[0.206]	[0.195]	[0.197]	[0.194]	[0.202]	[0.200]	[0.126]***	[0.086]
Time zone difference	-0.054	-0.034	-0.017	0.008	-0.007	0.016	0.000	-0.071
	[0.025]**	[0.027]	[0.024]	[0.025]	[0.026]	[0.027]	[0.019]	[0.019]***
Common legal origin	0.207	0.125	-0.008	-0.058	0.005	-0.088	-0.100	0.367
	[0.126]	[0.121]	[0.122]	[0.115]	[0.127]	[0.119]	[0.094]	[0.082]***
Common colony	0.386	1.542	1.333	1.494	1.338	1.505	1.451	1.576
	[0.399]	[0.538]***	[0.368]***	[0.403]***	[0.376]***	[0.409]***	[0.330]***	[0.437]***
Common currency	0.152	0.906	0.254	1.079	0.267	1.074	0.573	0.789
	[0.159]	[0.171]***	[0.169]	[0.178]***	[0.177]	[0.184]***	[0.140]***	[0.126]***
Common language Index	0.056	-0.682	1.147	0.367	1.350	0.362	-0.583	0.038
	[0.403]	[0.364]*	[0.369]***	[0.337]	[0.385]***	[0.350]	[0.327]*	[0.244]
Common religion	1.193	0.123	1.847	0.831	1.856	0.909	0.910	0.144
	[0.353]***	[0.284]	[0.323]***	[0.285]***	[0.337]***	[0.294]***	[0.230]***	[0.161]
Migrants (ln)	0.104	0.111	0.140	0.122	0.140	0.130	0.050	0.045
	[0.031]***	[0.033]***	[0.030]***	[0.029]***	[0.031]***	[0.030]***	[0.028]*	[0.024]*
Bilateral hyperlinks (ln)	0.466	0.354	0.390	0.240	0.371	0.271	0.324	0.182
	[0.089]***	[0.064]***	[0.077]***	[0.063]***	[0.078]***	[0.065]***	[0.074]***	[0.078]**
Cultural distance (Hofstede)	0.011	-0.034						
	[0.039]	[0.041]						
Bilateral tax treaty			-0.145	-0.048				
			[0.143]	[0.143]				
Source country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Host country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	1380	1441	1599	1680	1493	1580	1644	1744
R-squared	0.85	0.82	0.83	0.80	0.81	0.79	0.97	0.95

Notes: The dependent variable is bilateral portfolio investment assets (in natural log form); the explanatory variables are bilateral imports of goods (in natural log form), distance between capitals (in natural log form), time zone difference (in hours), the bilateral stock of migrants (in natural log form), bilateral hyperlinks (com-cracked, in natural log form), dummy variables for common border, common legal origin, common colonial relationship, common currency and similarity indices for religion and languages as well as a cultural distance indicator (columns 1 and 2) and a dummy variable for a double taxation agreement (columns 3 and 4). In columns 5 and 6, all observations on the United States are excluded. Columns 7 and 8 are estimated by PPML. The estimation uses source and host country fixed effects. Robust standard errors in brackets. * significant at 10% level; ** significant at 5% level, *** significant at 1% level.

Appendix

Table I: Variables, definitions, data sources and summary statistics

Variable	Definition/unit	Source	Obs.	Mean	Stand. Dev.
Portfolio investment, equity	Portfolio investment by country x in country y, equity, in natural log	IMF CPIS	1602	4.70	3.51
Portfolio investment, debt	Portfolio investment by country x in country y, debt, in natural log	IMF CPIS	1692	5.00	3.38
Imports	Bilateral goods import, in natural log	IMF DOTS	1906	20.34	2.22
Distance	Bilateral physical distance between two countries' capitals (in kilometre), in natural log	CEPII dataset	1906	8.33	1.02
Common border / contiguous	Dummy = 1, if countries share a common border	CEPII dataset	1906	0.05	0.23
Time zone difference	Time zone differences between two countries, in hours	CEPII dataset	1906	3.92	3.31
Common law	Dummy =1, if countries share a common legal origin	CEPII dataset	1906	0.29	0.46
Common Colony	Dummy =1, if countries have common colonial history	CEPII dataset	1906	0.02	0.15
Common currency	Dummy =1, if countries share common currency	CEPII dataset	1906	0.06	0.24
Common language index	Similarity index - measure summarising linguistic influences	Melitz and Toubal (2012)	1906	0.20	0.21
Common religion	Similarity index - measure of religious proximity	Melitz and Toubal (2012) / CIA Factbook	1906	0.20	0.24
Migrants stock	Stock of migrants data, in natural log	World Bank International Bilateral Migration Stock database	1906	7.55	2.78
Cultural distance	Index based on Hofstede (2013)	Hofstede (2013)	1604	2.30	1.56
Bilateral hyperlinks 2003	Bilateral data for 2003, number of inter-domain hyperlinks from .xx to .yy and vice versa	Chung (2011)	1258	11.55	2.19
Bilateral hyperlinks 2009 (.com cracked)	Bilateral inter-domain hyperlinks for 2009 with uniquely identified host country of .com domain	Chung (2011)	1906	11.85	2.39
Bilateral hyperlinks 1998	Bilateral hyperlink data for 1998	OECD Communication Outlook 1999	588	7.55	1.58
Bilateral tax treaty	Dummy =1, if countries have signed a double taxation treaty	UNCTAD (2013)	1906	0.72	0.45

Notes: The summary statistics refer to 2009 values for the time-varying variables (conditional on availability of the main explanatory variables).

Table II: Source country sample

Advanced economies				
Australia	Denmark	Ireland	Netherlands	Spain
Austria	Finland	Israel	Norway	Sweden
Belgium	France	Italy	Portugal	Switzerland
Canada	Germany	Japan	Singapore	United Kingdom
Czech Republic	Greece	Korea	Slovak Republic	United States
Emerging economies				
Argentina	Egypt	Kuwait	Poland	Ukraine
Bahrain	Estonia	Malaysia	Romania	Uruguay
Brazil	Hungary	Mexico	Russia	Venezuela
Chile	India	Pakistan	South Africa	
Colombia	Indonesia	Panama	Thailand	
Costa Rica	Kazakhstan	Philippines	Turkey	

Table III: Top 10 bilateral hyperlinks

	Country	Partner	Bilateral hyperlinks 2009 (in millions, .com cracked)
1	United States	United Kingdom	48.9
2	United States	Japan	43.9
3	United States	Germany	40.8
4	Japan	United States	34.1
5	United States	China	32.5
6	United Kingdom	United States	31.3
7	United States	Italy	22.1
8	France	United States	21.0
9	Germany	United Kingdom	20.8
10	United States	Spain	20.5

Acknowledgements
We are grateful to an anonymous referee of the ECB Working Paper series, Michael Fidora, Elisa Gamberoni, Maurizio Habib, Danielle Kedan, Philip Lane, Peter McQuade and Robert Vermeulen as well as conference participants at the INFINITI conference 2015 (Ljubljana) and EEFS conference 2015 (Brussels) for helpful comments and insightful discussions. We thank Benjamin Jakob for excellent research assistance. We are very thankful to Chung Joo for sharing his data on bilateral hyperlinks. The views expressed are those of the authors and do not necessarily reflect those of the European Central Bank.

Christiane Hellmanzik
University of Hamburg, Department of Economics, von-Melle-Park 5, 20146 Hamburg, Germany.
e-mail: christiane.hellmanzik@wiso.uni-hamburg.de

Martin Schmitz
European Central Bank, Sonnemannstr. 20, 60314 Frankfurt, Germany,
e-mail: Martin.Schmitz@ecb.in

Postal address	60640 Frankfurt am Main, Germany
Telephone	+49 69 1344 0
Website	www.ecb.europa.eu

ISSN	1725-2806 (online)
ISBN	978-92-899-1692-9
DOI	10.2866/551541
EU catalogue No	QB-AR-15-119-EN-N