Is gravity a cultural artefact?
Culture and distance in foreign portfolio investment

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Abstract

We apply insights from international business on the measurement and effects of culture to generalise existing gravity models of foreign portfolio investment (FPI). We apply our models to explain cross-border holdings of debt and equity FPI using the IMF's CPIS survey for 174 originating and 50 destination countries, and using both panel and annual estimates for 2001-2004. We find that culture and cultural distance operate alongside geographical distance in determining global FPI patterns, and we find strong hitherto unreported cultural effects. Amongst our findings are the following. *First*, cultural distance is a significant deterrent to FPI, with a coefficient one third the size of geographic distance. In this respect, gravity looks like a cultural artefact. *Second* neither common language nor common religion is associated with greater FPI. *Third*, analogously to geographical and cultural distance, Hofstede's power distance in the originating country is negatively related to cross-border debt and equity holdings. *Fourth*, uncertainty avoidance is positively related to cross-border debt holdings. *Fifth,* both masculinity and individuality are positively related to cross-border debt and equity FPI. The last three effects imply that gravity is not a cultural artefact, because these components of culture act to promote rather than to deter FPI. Overall, our paper points to the importance of clearly separating the measurement and effects of gravity and culture - gravity always deters trade, but aspects of culture can encourage trade.

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1. Introduction

The gravity model of international trade is well established in the international business, economics and finance literatures. In international economics, the gravity model has become the dominant empirical model of trade flows, and the extensive literature is surveyed by Deardorff & Frankel, 1998; Feenstra, Markusen & Rose, 2001; Evenett & Keller, 2002; Santos Silva & Tenreyro, 2006; and Fratianni, 2007. In international business, the gravity model has been applied to study patterns of firm-level internationalisation, cross-border mergers and acquisitions (M&A), foreign direct investment (FDI), international strategy, and the effects of culture on human resources, management and marketing (Wei, 2000; Ghemawat, 2001; Leamer & Storper, 2001; Loungani, Mody & Razin, 2002; Globerman & Shapiro, 2003; Bevan & Estrin, 2004; Tihanyi, Griffith & Russell, 2005; Cuervo-Cazurra, 2006; Slangen, 2006; Stein & Daude, 2007; and Daude & Fratzscher, 2008). In international finance, the gravity model has been used to study cross-border equity flows, private and sovereign debt flows, intra-bank credit flows, debt and equity stock holdings, and equity return correlations (see *inter alia*, Portes & Rey, 1998; Grinblatt & Keloharju, 2001; Portes, Rey & Oh, 2001; Flavin, Hurley & Rousseau, 2002; Rose & Spiegel, 2004; Portes & Rey, 2005; Guerin, 2006; Rosati & Secola, 2006; Aviat & Coeurdacier, 2007; and Lane & Milesi-Ferretti, 2008).

It is widely recognised that the distance variable in gravity models, which proxies for a range of information, transaction and other trading costs, does not fully capture the totality of these costs. This contributes to the 'missing trade' problem (Trefler, 1995) whereby the volume of international trade is less than expected, and to the 'home bias' puzzle (Lewis, 1999; Aurelio, 2006) whereby investors hold fewer foreign assets than is justified by the available diversification benefits[1]. It follows that there must be additional costs of international trade in commodities, services and financial assets that are imperfectly captured by the distance variable in gravity models. In searching for these costs, researchers have extended the basic gravity model by including additional variables that could influence the costs of doing business internationally, including the existence of regional trade and investment agreements; property rights, legal enforcements and restrictions; institutional strength, corruption and the

rule of law; country, currency and political risk; security, violence and war; delay effects and governmental controls; and cultural effects such as language, legal system origin and religion.

In this paper, we apply insights from the international business literature on the measurement and effects of cultural factors to advance the literature on the role of culture in gravity models of foreign portfolio investment (FPI). In their review of 180 papers in 40 journals[2], Kirkman, Lowe & Gibson (2006) show that from almost three decades of research, culture is a key dimension in many fields of international business. Focussing on the areas most closely related to FPI, culture has been shown to impact on FDI, M&A, the modality of market entry, managerial control, capital structure, and on the structure of financial systems (Kogut & Singh, 1988; Sekely & Collins, 1988; Harzing & Joseph, 2003; Tihanyi, Griffith & Russell, 2005; Hitt, Franklin & Zhu, 2006; Kwok & Tadese, 2006; Slangen, 2006; Demirbag, Glaister & Tatoglu, 2007; and Kaufmann & O'Neill, 2007). Building on this work and on the wider international business literature on the measurement and effects of culture, we extend the set of cultural variables that has been included in gravity models of FPI. In doing so, we clarify the roles and effects of three sets of variables that have been used more or less interchangeably in existing studies of FPI: the standard gravity variables that proxy for transport and transaction costs; the informational asymmetry variables; and the cultural variables. We control for the standard gravity and informational asymmetry variables including the geographic distance between countries, economic growth differentials, market development, corporate accounting quality, investor protection and country risk. Our cultural variables include language; legal system origin; religion; Hofstede's (2001) uncertainty avoidance, power-distance, masculinity-femininity, and degree of individuality; and Kogut and Singh's (1988) cultural distance based on Hofstede's four cultural characteristics. The first three of these cultural variables have been interpreted in the FPI literature as gravity or informational asymmetry variables, and the latter five have not hitherto been included in FPI models. One of our primary motivations, therefore, is to clarify the importance of recognising the distinct roles played by culture as distinct from gravity in explaining global FPI patterns.

We apply our models to explain cross-border stock holdings of debt and equity using the International Monetary Fund's (IMF) Consolidated Portfolio Investment Survey (CPIS) in

174 originating and 50 destination countries using panel and annual estimates for the years 2001-2004. Consistent with prior research, our gravity models explain between 60 and 90 percent of the total variation in cross-border holdings of debt and equity. Amongst our main findings are that culture and cultural distance operate alongside geographical distance in determining global FPI patterns, and we find strongly significant hitherto unreported cultural effects as follows. *First*, cultural distance is a significant deterrent to FPI, with a coefficient one third the size of geographic distance. In this respect, gravity looks like a cultural artefact. *Second* neither common language nor common religion is associated with greater FPI. *Third*, analogously to geographical and cultural distance, Hofstede's power distance in the originating country is negatively related to cross-border debt and equity holdings. *Fourth*, uncertainty avoidance is positively related to cross-border debt holdings. *Fifth,* both masculinity and individuality are positively related to cross-border debt and equity FPI. The last two effects imply that gravity is not a cultural artefact, because these components of culture act to promote rather than to deter FPI. Overall, our paper points to the importance of clearly separating the measurement and effects of gravity and culture - gravity always deters trade, but aspects of culture can encourage trade. This distinction is important in helping us to more completely understand the patterns and behaviour we observe in international portfolio choice[3], risk management and insurance.

The remainder of our paper is structured as follows. In section 2, we review the role of culture in gravity models of commodity, service and financial asset trade. In doing so, we focus particularly on the role attributed to culture in gravity models of FPI. In section 3, we present our data, describe our methodology and formalise our tests. Section 4 contains our findings and section 5 draws together our conclusions.

2. Gravity, culture and FPI

Newton's (1687) gravitational theory specified the gravitational force between two bodies as a constant times the product of their masses divided by the square root of the distance between them[4]. Tinbergen (1962) and Linneman (1966) applied the gravity model to international commodity trade, and Anderson (1979) showed how it can be derived from trade theory. The relation between distance and commodity trade is now one of the best

established empirical regularities in international economics. The first applications of the gravity model to FPI were conducted by Portes & Rey (1998) and Ghosh & Wolf (1999). Portes & Rey (1998) modelled a panel of gross cross-border equity flow transactions (purchases plus sales) between 14 countries from 1989-1996 and found that distance is negatively signed and statistically significant in explaining cross-border equity flows. They interpreted the distance variable as proxying for informational asymmetries, currency risk and institutional differences. Ghosh & Wolf (1999) modelled a cross section of debt, equity, bank loans and FDI stocks for between 19 and 86 countries in 1994 and confirmed that distance is negatively signed and statistically significant. They also interpreted the distance variable as proxying for information asymmetries. Using an expanded dataset from the US Treasury TIC data, Portes, Rey & Oh (2001) modelled a panel of gross cross-border equity, corporate bond and government bond flows between the United States and 40 other countries from 1988-1998. With further developments of the data, Portes & Rey (2005) modelled cross-border bilateral equity flows between 14 countries over the period 1989-1996. Noting that the distance variable in gravity models of commodity trade proxies for transaction and transportation costs, and given that financial assets are weightless with low transaction costs relative to commodities, they surmised that distance should not significantly deter financial asset trade, particularly if investors seek international diversification benefits that generally rise with distance. Recognising that geographically close countries tend to be more familiar with each other because of direct personal contact through business and tourism, because their people tend to learn each other's languages if different, and because of indirect contact through media coverage, they included the number of telephone calls between country pairs to capture the flow of information. They added other variables to capture information asymmetries and the efficiency of transactions, including the number of foreign bank branches, the number of overlap in trading hours, the degree of financial sophistication and insider trading. They confirmed their prior finding that distance is strongly negatively significant in explaining cross-border equity flows, and they also found that it explains the other asset flows. If distance acts as a proxy for such information effects, they conjectured that more finely tuned proxies would lessen the role of distance in their models. They verified this, and concluded that the gravity model performs at least as well in explaining financial asset trade as commodity trade.

Another set of papers explicitly models international asset positions and foreign portfolio investments (FPI) using variants of the gravity model that incorporate the separate and combined effects of geography, information frictions, and the role of culture. It has long been recognised that in addition to geographical distance, familiarity with trading partners, commonality of language, social customs, religion, and political institutions are important influences on commodity trade (Senior, 1827; Cairnes, 1874). The inclusion of these variables in gravity models of commodity trade, however, is more recent. Frankel, Stein and Wei (1997) found that controlling for regional groupings and common borders in their gravity equations, having a common language increases trade by 60 percent. In commenting on this, Anderson (2000) suggested that while the common language variable probably reflects information asymmetries or security of legal arrangements, the distance variable remains too large, implying the continued existence of unmeasured transaction costs. More recently, Lewer & Van den Berg (2007) found that controlling for common language, common border and regional groupings in their gravity equations, common religious culture tends to raise trade. Huang (2007) introduced Hofstede's (2001) uncertainty avoidance into a gravity model and found that exporters from high uncertainty-avoidance countries trade disproportionately less than others as distance increases.

In gravity models of FPI, Flavin, Hurley & Rousseau (2002) included common language, legal origin, colonial links, and the degree of overlap in trading hours in a gravity model of equity market index correlations across 27 countries for 1999. They found limited evidence of significant distance or cultural effects, but consistent with La Porta *et al* (1998) and others, they found significant legal origin effects. Portes & Rey (2005) experimented briefly with common language and found it to be correctly signed and significant in some models (which they did not report). Rosati & Secola (2006) included linguistic similarity and a common border effect alongside market characteristics in their gravity model of European intra-bank flows. They found that a relatively simple specification with distance, linguistic similarity and common borders explains over 80 percent of the variation in large-value intra-bank liquidity over the 1999-2002 period. While these researchers consistently note that distance and the other geographic variables in gravity models of FPI reflect information frictions, Portes and

Rey (2005) are explicit in distinguishing between information asymmetry and transmission, and they explicitly relate this to culture: 'Geographical distance is a barrier to interaction among economic agents and, more broadly, to cultural exchange' (p270).

Aviat & Coeurdacier (2007) include common language, colonial link, legal origin and corruption in a gravity model of banks' cross-border asset stock holdings for 19 countries in 2001. This data, provided by the Bank for International Settlements, does not allow separation of the aggregate asset portfolio into bank loans, debt and equity assets. These researchers estimated a version of their model on CPIS data for the same 19 countries, but this did not include the cultural variables. They note that although the cultural variables are significant in their import equations, they do not solve the 'distance puzzle'.

Daude & Fratzscher (2008) use and CPIS, BIS and UNCTAD data to model cross-border stock holdings of FDI, debt, equity and bank loans for 77 countries for 1999-2003. They incorporate an extensive set of gravity variables; three information friction variables including telephone traffic, trade in newspapers, and the proportion of foreign immigrants in the population; and their cultural variables include common language, legal origin and colonial links. Their benchmark estimates of the distance coefficient for cross-border stocks of FDI, debt, equity and bank loans are -1.2, -.08, -0.7 and -1.2. Their estimated coefficient on common language is greatest for FDI and equity at 0.7 and 0.6 respectively, and it is insignificant for debt and bank loans. The colonial links coefficient is significant only for FDI, and their legal origin coefficient is strongly significant for all assets with values of 0.7, 0.4, 0.6 and 0.4 for FDI, debt, equity and bank loans respectively. They find that adding telephone traffic makes the distance variable insignificant for all assets except bank loans, and it makes the common language and colonial variables insignificant for all asset holdings. They conclude that distance proxies for information frictions. They then substitute their two other information friction variables, trade in newspapers and the proportion of foreign immigrants in the population, for telephone traffic and find them to be statistically significant for all assets, and they also find that a principal component variable for all three information friction variables is significant for all assets. They conclude that FDI and bank loans are 1.5 to 2 times more sensitive to information frictions than are debt and equity.

Lane & Milesi-Ferretti (2008) also use the CPIS data to model cross-border stock holdings of equity in 2001 for between 33 and 172 countries depending on alternative samples and specifications. They incorporate an extensive set of gravity variables including distance, imports, time difference, tax treaties, a currency union dummy and a set of correlations in growth rates, equity returns, and the correlation between both to proxy for diversification benefits and institutional similarity. Their cultural variables include common language, legal origin and colonial links. Consistent with Aviat & Coeurdacier (2007), they find that imports are a strongly significant determinant of cross-border equity holdings. Their benchmark estimate of the distance coefficient is -0.6 for OLS and -0.7 for Tobit regressions, and this declines to -0.2 and -0.1 when they add their correlation variables. Their estimated coefficient on common language is statistically significant and equal to 0.3 (OLS) and 0.6 to 0.4 (Tobit). Consistent with Daude & Fratzscher (2008), their colonial links coefficient is insignificant, their legal origin coefficient is strongly significant at 0.3 in both their OLS and Tobit regressions, and their distance coefficient declines greatly to -0.2 (OLS) and -0.1 Tobit), the latter being insignificant, when they add their correlations and legal origin variables. They experimented with both telephone traffic and the proportion of foreign immigrants in the population, but found both to be insignificant when they included imports.

Overall, our review of prior research on the role of culture in gravity models of FPI points to some common findings and outstanding issues. Gravity models are proving to be very successful in explaining cross-border trade in financial assets. This in itself is encouraging, given the newness of the research agenda and the poor coverage of consistent data across many countries. The models to date tend to rely almost exclusively for their motivation on traditional economic and financial explanations of the role of gravity and culture, and this comes at the cost of ignoring the many insights from culture in international business. The role of distance in benchmark specifications is significant, but there is mixed evidence about the extent to which it declines when additional variables to proxy transaction costs and informational asymmetries are added. There is also strong evidence that legal origin is an important determinant, but mixed evidence about the roles of common language and colonial

ties. The role of Hofstede's (2001) cultural characteristics, or of cultural distance have not yet been included, and it is to this that we now turn.

3. Data and Methodology

Data

The definitions and data sources of all variables employed in our empirical tests are provided in Table 1, and Table 2 provides summary descriptive statistics for all variables. Our primary data source is the IMF's annual CPIS survey of the aggregate debt and equity positions of countries and states along with the foreign asset portfolios of reporting entities with respect to each other. The portfolios are measured in $US millions, they are disaggregated into long-term debt, short-term debt, and equity, and the data is available on an end-of-year basis for each of the years 2001-2005. In order to avoid problems with volatile short-term financial flows, we focus on long-term debt and equity, and to provide the largest possible sample, we focus on the years 2001-2004. We eliminated all transactions involving dependent states or entities[5], small offshore financial centres[6], international organizations, confidential transactions, unallocated data, and cases where there was insufficient data[7].

We investigate three sets of variables in explaining global FPI patterns. The *first* set comprises the standard gravity, economic and transactional asymmetry variables including the geographic distance between countries, economic growth differentials, and the degree of bond and equity market development. The *second* group proxies for informational asymmetries which we measure using Bushman, Piotroski & Smith's (2004) corporate accounting quality, Djankov, La Porta, Silanes & Shleifer's (2009) investor protection, and the *Political Risk Services* measure of country risk. The *third* group comprises our cultural variables, some of which are common to bilateral pairs, others that differ between the originating (OC) and destination countries (DC), and one measure of cultural distance. As shown in Table 1, we include the following 8 cultural variables in our gravity models of FPI: common language; legal system origin; common religion; Hofstede's (2001) measures of uncertainty avoidance, power distance, the degree of masculinity and the degree of individuality; and Kogut and Singh's (1988) measure of cultural distance. None of the last five has, to our knowledge, been investigated in gravity models of FPI. There are, of course,

alternative frameworks of measuring national culture and psychic distance, such as the Schwartz measure and the Globe Project (Schwartz & Sagiv, 1995; House, Javidan, Hanges & Dorfman, 2002; Dow & Karunaratna, 2006), but most researchers who have examined national culture have used Hofstede's measures[8].

Methodology

Our empirical testing proceeds in three steps. In *step 1*, we produce four estimates of our benchmark gravity models using cross section data for the years 2001, 2002, 2003 and 2004 separately. The benchmark specification includes the standard gravity, economic and transactional asymmetry proxies. These 13 explanatory variables are geographic distance[9]; economic growth in the originating (OC) and destination (DC) country; bond market development in the OC and DC; stock market capitalisation in the OC and DC; corporate accounting quality in the OC and DC; investor protection in the OC and DC; and country risk in the OC and DC. In addition to these, we add 4 of our cultural variables, the first two of which have been used in previous gravity models of FPI; namely, common language, legal system origin, common religion, and the K-S measure of cultural distance. This benchmark specification with 17 explanatory variables estimated separately over 4 years provides baseline estimates of the coefficients in our gravity models of FPI; it provides information on the robustness of our estimates and the stability of our coefficient estimates over time; and it facilitates comparison with the benchmark estimates obtained in earlier studies. In *step 2*, we form a panel of the 4 years 2001-2005, and we reconfigure our benchmark model by first excluding the K-S measure of cultural distance. We do this for two reasons; many of the proposed gravity variables are available only in proxy form and are typically non-time varying; and the proxies are themselves measured at a particular time and are considered to be relatively stable over time[10]. We then reintroduce the K-S measure of cultural distance to see how the gravity model performs. In *step 3*, we continue with our panel estimation, and we replace the cultural distance measure with Hofstede's four measures of cultural characteristics in the OC. The purpose of this step is to examine the extent to which moving away from the general measure of cultural distance to the four individual characteristics of national culture affects our coefficient estimates.

Given the focus of our paper on the role of culture in gravity models of FPI, we note here our expected signs of the culture-related coefficients to be estimated. They are as follows.

Common language: Portes & Rey (2005) and Daude & Fratzscher (2008) found mixed results, with the latter's estimated coefficient for equity being significant at 0.6 and insignificant for debt. Lane & Milesi-Ferretti (2008) found it to be significant in the range of 0.4 to 0.6, while Aviat & Coeurdacier (2007) found it to be insignificant. We expect common language to be positively signed.

Legal origin: Aviat & Coeurdacier (2007) found the legal origin variable to be consistent with estimated coefficients of between 0.5 to 0.7, and Daude & Fratzscher's (2008) legal origin coefficient is also significant for all assets with values of 0.4 and 0.6 for debt and equity respectively. This is close to Lane & Milesi-Ferretti's (2008) legal origin coefficient which is strongly significant at 0.3. We therefore expect the same positive sign.

Common religion: While prior research on gravity models of FPI, has not considered religion to be an important explanatory variable, religion and finance share deep-rooted relationships. The mediaeval conflicts between Christian teaching on usury and the growth of European banking, and the present-day requirements of Islamic finance in relation to interest bearing instruments (Errico & Sundararajan, 2002; Jobst, 2007) are testament to this. In their study of financial market development, Stulz & Williamson (2003) conclude that civil law can explain equity market development, and religion can explain credit market development. We include religion as a novel variable in models of FPI and expect a positively signed coefficient.

Cultural distance: Boyacigiller (1990) notes that cultural differences can be interpreted as a transactions cost. It follows that investors seeking to minimize such costs will attempt to minimise cultural distance. We consequently expect a negative relation between cultural distance and FPI. We also expect that this effect will be stronger for equity than for debt, because the value of the former is based on more uncertain future cash flows, and because insolvency ranks debt obligations as primary and equity as the residual.

Uncertainty avoidance: De Jong and Semenov (2002) find that a cultural appetite for risk (which proxies for the inverse of Hofstede's uncertainty avoidance) is associated with greater stock market depth. Using the cultural measures of Schwartz & Sagiv (1995), Chui, Lloyd &

Kwok (2002) find that higher degrees of 'conservatism' (which could approximate Hofstede's uncertainty avoidance) is associated with lower corporate debt ratios. Gleason, Mathur & Mathur (2000) argue that because higher debt leads to greater risks of corporate bankruptcy, higher uncertainty avoidance should lead to lower levels of debt in corporate capital structures. In the context of FPI, however, debt is less risky than equity, so we expect a positive sign for debt and a negative sign for equity. The latter is less clear-cut, however, because a diversified equity portfolio could deliver reduced risk on most occasions.

Power distance: Chui, Lloyd & Kwok (2002) find that higher degrees of Schwartz & Sagiv's (1995) 'mastery' (which could approximate Hofstede's power distance) are associated with lower debt ratios. We expect a negative coefficient.

Degree of masculinity: De Jong and Semenov (2002) note that the degree of masculinity predicts support for competitive processes and outcomes, and that it is consequently associated with greater stock market depth. If this carries over to FPI, we would expect the degree of masculinity to be associated with greater holdings of cross-border equity.

Degree of individuality: Gleason, Mathur & Mathur (2000) argue from Hirshleifer & Thakor (1992) that a culture of high individuality will be associated with management taking riskier decisions in their desire for success rather than protecting shareholder value, and that this will lead to less debt in corporate capital structure. If this carries over to FPI, high individualism should be associated with greater holdings of cross-border equity than debt.

We estimate our models using ordinary least squares (OLS) (with White corrected standard errors). We also estimate all our models with TOBIT to account for endogenous censoring of the data. As expected, the results are qualitatively the same as for the OLS approach. We do not include them here, but they are available on request. We do not include country-pair fixed effects because the distance variable, by construction fixed, will capture these effects.

4. Results

Step 1: cross section estimates

Table 3 presents our results from *step 1*, which produces four estimates of our benchmark gravity models for both debt and equity cross-border bilateral holdings using cross section

data for each of the years 2001-2004. The equations for debt and equity in all years are well specified and stable over time, with R^2 statistics lying within a tight range explaining between 60 and 66 percent of the variation in cross-border FPI holdings. Looking across the rows of the Table, the coefficient estimates along with their levels of significance are consistent for most variables in the equations for debt and equity. Of all the explanatory variables, only country risk demonstrates instability in the equations for either or both assets across the years. We conclude that our benchmark estimates are robust and stable. With this in mind, we now examine the individual explanatory variables, focussing first on the gravity, economic and transactional asymmetry variables (geographic distance between countries, economic growth differentials, and the degree of bond and equity market development). We then discuss the informational asymmetry variables (corporate accounting quality, investor protection and country risk). We finally discuss our results in relation to the cultural variables (common language, legal system origin, common religion, and K-S cultural distance).

Looking first at the distance variable, it is correctly signed and strongly statistically significant in the equations for both assets, ranging from about -1.1 for debt to about -0.9 for equity. This is consistent with, but somewhat larger than Daude & Fratzscher (2008) whose benchmark estimates of the distance coefficient for debt and equity are -0.8 and -0.7, and Lane & Milesi-Ferretti (2008) whose distance coefficient on equity holdings is -0.6. We find that a doubling of geographic distance leads to a 110 percent reduction in debt holdings and to a 90 percent reduction in equity holdings. The other significant gravity, economic and transactional asymmetry variables are economic growth in the originating and destination countries, bond market development in the originating but not the destination country, and equity market capitalisation in the originating country for equity holdings and in the destination country for debt holdings. Looking next at the informational asymmetry variables, we find that corporate accounting quality in the destination country is positively signed and strongly significant for both debt and equity FPI, and in the originating country for equity. Corporate accounting quality in the destination country does not seem to be an important determinant of cross-border debt holdings, although investor protection in the origin country is significant for equity. Investor protection in the destination country is not significant for either debt or equity. Country risk is not consistently significant.

Looking finally at the cultural variables, we find that common language, legal origin and culture are all statistically insignificant determinants of FPI in our cross section models. In stark contrast to this, the K-S measure of cultural distance is negatively signed at about -0.3 and is statistically significant in both the debt and equity equations. This implies that a doubling of cultural distance leads to a 30 percent reduction in cross-border holdings of both debt and equity. Combining this with our estimated coefficients, we can see that to reduce cross-border bilateral debt holdings by 10, 50 or 100 percent requires an increase in geographic distance of 11, 56 or 111 percent, or an increase in K-S cultural distance of 33, 167 or 333 percent. To reduce cross-border bilateral equity holdings by 10, 50 or 100 percent requires an increase in geographic distance of 9, 45 or 91 percent, or an increase in K-S cultural distance of 33, 167 or 333 percent. In this respect, gravity is a cultural artefact – it encompasses a range of proxies for information asymmetries, transaction costs, cultural effects and other as yet unidentified effects that reduce trade.

Steps 2 and 3: panel estimates

The results of *steps 2* and *3* of our empirical strategy are presented in Table 4, which provides panel estimates of the gravity models for debt in columns 1 to 3, and for equity in columns 4 to 6. Columns 1 and 3 present the baseline specification of our panel estimates for the debt and equity equations, incorporating the gravity, economic and transactional asymmetry variables (geographic distance between countries, economic growth differentials, and the degree of bond and equity market development), the informational asymmetry variables (corporate accounting quality, investor protection and country risk) and the cultural variables (common language, legal system origin and common religion). Columns 2 and 5 add the K-S measure of cultural distance to the specifications in columns 1 and 4, so these are identical to our benchmark specification in *step 1* and Table 3. In columns 3 and 6, we replace the K-S measure of cultural distance with Hofstede's (2001) uncertainty avoidance, power distance, degree of masculinity, and degree of individuality.

Having already estimated our benchmark model using cross section data for 4 separate years, it is interesting to examine our results from the panel estimation using the data for all 4 years

together. Looking at all specifications for both debt and equity in columns (1) to (6), the R-squared statistics lie between 0.65 and 0.71, showing that our relatively simple gravity models can explain between 65 and 71 percent of the variation in cross-border holdings of debt and equity. Looking now at the gravity, economic and transactional asymmetry variables in our baseline specification in columns (1) and (4), we can see that the coefficient on distance is negatively signed and strongly significant, with estimated coefficients of -1.2 and -1.0 for debt and equity respectively. Economic growth is highly significant in all model specifications in the originating and destination countries. Bond market development in the originating country is highly significant in most cases, while interestingly, it is generally not significant in the destination countries. Equity market capitalisation in the originating countries is strongly significant in all specifications for both debt and equity, and is significant in the destination countries for debt but not all specifications for equity. Turning next to consider our variables that proxy for information asymmetry, corporate accounting quality in the originating country is significant in all specifications for both debt and equity and in the destination country for equity. This is an interesting finding insofar as it implies that corporate accounting quality in destination countries does not significantly impact on debt holdings in those countries. Turning next to investor protection, this is significant in the originating countries for equity. Country risk significantly determines holdings of debt in both the originating and destination countries and does not generally impact on cross-border equity holdings in either the originating or destination countries. Turning finally to our cultural variables, we can see from columns (1) and (4) that common language, legal system origin and common religion are not significant in either the debt or equity equations.

We now consider the specifications in columns (2) and (5) when we add the K-S measure of cultural distance to the baseline models in columns (1) and (4). The coefficients on cultural distance in both the debt and equity equations are equal to -0.3 and are both strongly significant. This result is robust to that obtained in *step 1*. When this variable is added, there is an insignificant reduction in the coefficient on geographic distance from -1.2 to -1.1 in the case of debt, and from -1.0 to -0.9 for equity. These coefficients are also robust to those obtained in *step 1*, and the same applies to the coefficients on the other variables. Including or excluding the K-S measure of cultural distance, therefore, does not have any implications for

the significance of common language, legal system origin or common religion in either the debt or equity FPI equations.

Our results for *step 3* are in columns (3) and (6) for the debt and equity equations, in which we replace the K-S measure of cultural distance with Hofstede's (2001) cultural characteristics in the originating countries. Before examining the individual Hofstede coefficients, it is worth noting that the other geographic distance coefficient recovers the amount it lost when we introduced cultural distance. Other coefficients remain broadly similar with two exceptions. *First*, investor protection is now strongly significant in both the origin and destination countries for both debt and equity holdings. *Second*, legal system origin is now positively signed and statistically significant in the equity equation, although it remains insignificant in the debt equation.

Our findings in relation to common language in columns (1) to (6) are consistent with Portes & Rey (2005), Aviat & Coeurdacier (2007) and Daude & Fratzscher (2008) who found either mixed results or no effect, and are contrary to Lane & Milesi-Ferretti (2008). In relation to legal origin, our finding in columns (3) and (6) that it is positively signed and statistically significant for equity with a coefficient of 0.4 (but not significant for debt), is consistent with Aviat & Coeurdacier's (2007) estimate of between 0.5 to 0.7, with Lane & Milesi-Ferretti's (2008) estimate for equity of 0.3, and with Daude & Fratzscher's (2008) estimate for equity of 0.4, although the latter also found a significant effect for debt.

Hofstede's cultural characteristics and FPI

Hofstede's uncertainty avoidance in columns (3) and (6) is positively signed with a coefficient of 1.8 and strongly significant in the equation for debt, and it is much smaller and statistically insignificant in the equation for equity. This is consistent with De Jong and Semenov's (2002) finding of a positive relation between risk appetite and equity market depth, but is contrary to both Chui, Lloyd & Kwok (2002) and Gleason, Mathur & Mathur (2000) in the context of corporate capital structure. We provisionally conclude that the uncertainty avoidance argument applies differently in the areas of corporate capital structure and FPI, insofar as higher uncertainty avoidance could lead to a preference for less corporate

debt than equity to mitigate corporate bankruptcy risks, and to more debt than equity in FPI to avoid the greater uncertainties, risks and informational asymmetries. Our result implies that country A with a 10 percent higher measure of Hofstede's uncertainty avoidance than country B will tend to hold 18 percent more cross-border debt than country B and *vice versa*.

Looking next at Hofstede's power distance in columns (3) and (6) of Table 4, this variable is negatively signed and strongly significant with coefficients of -1.0 and -0.9 in the debt and equity equations respectively. This is strong result, implying that, *ceteris paribus*, countries with high power distance tend to hold significantly less cross-border debt and equity assets. This is consistent with Chui, Lloyd & Kwok (2002) who found that higher degrees of Schwartz & Sagiv's (1995) 'mastery' are associated with lower debt ratios, but our finding in relation to FPI applies more generally to both debt and equity assets across a wide sample of countries. Our result implies that country A with a 10 percent higher measure of Hofstede's power distance measure than country B will tend to hold 10 (9) percent less cross-border debt (equity) assets than country B and *vice versa*.

The coefficient on Hofstede's masculinity index of the origin country, presented in columns (3) and (6) of Table 4, is positively signed and strongly significant in the equations for both debt and equity, with coefficients of 0.5 and 0.7 respectively. This is consistent with De Jong & Semenov (2002). More generally, it implies that country A with a 10 percent higher measure of Hofstede's power distance will tend to hold 5 (7) percent more cross-border debt (equity) assets than country B and *vice versa*. Looking finally at Hofstede's individuality index in the origin country, once more it is strongly significant and positively signed in the equations for both debt and equity, with coefficients of 0.9 and 0.8 respectively. This is consistent with, but more general than Gleason, Mathur & Mathur (2000). It implies that country A with a 10 percent higher measure of Hofstede's individuality index will tend to hold 9 (8) percent more cross-border debt (equity) assets than country B and *vice versa*.

Overall, we find that adding Hofstede's cultural characteristics and the K-S measure of cultural distance provides useful insights to our understanding of global FPI patterns. This implies that culture, in addition to the well-researched variables such as transaction costs,

taxes, information asymmetries, currency and political risk, legal restrictions and other controls, impacts on the home bias phenomenon (Lewis, 1999). Our findings are consistent with Tesar & Werner (1995) and subsequent researchers who show that geographical proximity, language compatibility and trade links are more important than correlation structures for international portfolio investors. Our work also implies that although countries cannot physically move so that geographical gravity is immutable, and although cultural characteristics are slow to change over time, even with rapid migration, countries can take steps to evolve their economic, political and risk profiles. In order to raise both debt and equity investment to destination countries, we find that corporate accounting quality and investor protection would appear to be the most effective ways, with a greater effect expected on equity. Increasing the depth of the private bond market would also attract debt investment.

5. Summary and Conclusions

Gravity models have been recently used to examine the patterns of foreign direct investment (FDI), to explain the internationalisation processes of MNCs, and to investigate many aspects of their operations. In international finance, Portes & Rey (1998) and subsequent researchers have shown that while information frictions curtail the internationalisation of asset holdings, the role of distance remains significant. Despite these contributions, however, and although there exists a coherent and well-developed theory of within-country portfolio optimisation, the determinants of international portfolio allocations remain less well understood. Responding to this, we apply an extended version of the gravity models that have become important in the international business, trade, and finance literatures to investigate the determinants of cross border international debt and equity portfolio investments.

We applied our models to explain cross-border stock holdings of debt and equity using the International Monetary Fund's (IMF) Consolidated Portfolio Investment Survey (CPIS) in 174 originating and 50 destination countries using panel and annual estimates for the years 2001-2004. Our gravity models explain between 60 and 90 percent of the total variation in cross-border holdings of debt and equity. Amongst our main findings are that culture and cultural distance operate alongside geographical distance in determining global FPI patterns, and we find strongly significant hitherto unreported cultural effects as follows. *First*, cultural

distance is a significant deterrent to FPI, with a coefficient one third the size of geographic distance. In this respect, gravity looks like a cultural artefact. *Second* neither common language nor common religion is associated with greater FPI. *Third*, analogously to geographical and cultural distance, Hofstede's power distance in the originating country is negatively related to cross-border debt and equity holdings. *Fourth*, uncertainty avoidance is positively related to cross-border debt holdings. *Fifth,* both masculinity and individuality are positively related to cross-border debt and equity FPI. The last two effects imply that gravity is not a cultural artefact, because these components of culture act to promote rather than to deter FPI.

Overall, our paper points to the importance of clearly separating the measurement and effects of gravity and culture - gravity always deters trade, but aspects of culture can encourage trade.

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Table 1
Data definitions and sources

Dependent variable – debt: Portfolio equity instruments issued by originating country (OC) and held by destination country (DC) residents, in $USm averaged over 2001- 2004. Source: IMF Coordinated Portfolio Investment Survey (CPIS), available at http://www.imf.org/external/np/sta/pi/geo.htm.

Dependent variable – equity: Portfolio long term debt instruments issued by OC and held by DC residents, in $USm averaged over 2001-2004. Source: as above.

Geographic distance: Physical (great circle) distance in kilometres between the capital cities of country pairs. Source: CEPII, available at http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

Economic growth: Arithmetic average of current price GDP growth over the 4-year period 2001-2004. Source: http://humandevelopment.bu.edu.

Bond market development: The value of domestic debt securities in $USm issued by financial institutions and corporations as a percentage of GDP. Source: Beck, Demirguc-Kent et al (2000), updated to 2004.

Equity market capitalisation: The average value of equity market capitalization in $USm over the period 2001-2004. Source: World Federation of Exchanges, http://www.world-exchanges.org.

Corporate accounting quality: A composite index of overall disclosure quality and intensity, covering accounting and financial data in annual and periodic corporate communications. Source: Bushman, Piotroski et al. (2004), Appendix B.

Investor protection: The aggregate 'investor protection' index, an average of indices measuring transparency of transactions, liability for self-dealing, and shareholders' ability to sue officers and directors for misconduct. Source: Djankov, La Porta et al (2009).

PRS measure of risk: A composite measure of economic, financial and political country risk. Source: Political Risk Services, www.prsgroup.com.

Commonality of language: A dummy variable reflecting commonality of the major languages of country pairs, equal to 1 if there is commonality and 0 otherwise. Source: Rose and Spiegel (2004).

Commonality of legal system: A dummy variable reflecting commonality of the legal origins of country pairs, equal to 1 if there is commonality and 0 otherwise. Source: Stulz and Williamson (2003) and Rose and Spiegel (2004).

Commonality of religion: A dummy variable reflecting commonality of the major religions of country pairs, equal to 1 if there is commonality and 0 otherwise. Source: Rose and Spiegel (2004).

K-S measure of cultural distance: A composite index of cultural distance constructed as per Kogut and Singh (1988) from the Hofstede indices. Source: our calculations.

Uncertainty avoidance index: The Hofstede measure. Source: http://www.geert-hofstede.com.

Power distance index: As above.

Masculinity index: As above.

Individuality index: As above.

Variables are described in the order they appear in Tables 3 and 4. Except where noted, variables are measured in logarithims.

Table 2
Summary statistics

	No. obs.	*Mean*	*Median*	*Standard deviation*	*Skewness*	*Kurtosis*
Common sample:						
Debt	742	4.02	3.63	3.38	0.35	1.87
Equity	742	3.59	3.57	3.10	0.25	1.74
Geographic distance	742	8.65	9.08	0.98	-1.05	2.99
Economic growth in OC	742	4.08	3.67	2.06	0.70	2.83
Economic growth in DC	742	4.21	3.79	2.20	0.71	2.63
Bond market development in OC	742	-1.04	-0.98	0.48	0.58	3.54
Bond market development in DC	742	-1.05	-0.99	0.47	0.65	3.66
Equity market capitalization in OC	742	13.00	13.59	1.35	-0.03	2.17
Equity market capitalization in DC	742	13.01	13.40	1.33	-0.04	2.25
Accounting quality in OC	742	4.25	4.26	0.12	-0.36	1.98
Accounting quality in DC	742	4.26	4.28	0.12	-0.45	2.01
Investor protection in OC	742	1.73	1.79	0.28	-0.75	3.20
Investor protection in DC	742	1.74	1.79	0.29	-0.63	3.08
K-S measure of cultural distance	742	2.09	1.83	1.41	0.97	4.04
Uncertainty avoidance index in OC	742	4.12	4.17	0.40	-0.66	2.67
Power distance index in OC	742	3.87	3.99	0.49	-1.02	4.09
Masculinity index in OC	742	3.77	4.03	0.66	-1.85	6.03
Individuality index in OC	742	3.85	4.01	0.50	-0.81	2.67
Individual sample:						
Debt	11,927	0.81	0.00	2.01	2.87	11.08
Equity	11,923	0.61	0.00	1.79	3.41	14.68
Geographic distance	9,265	8.74	8.96	0.80	-1.28	4.74
Economic growth in OC	11,927	4.04	3.90	3.55	1.26	5.46
Economic growth in DC	11,927	4.20	4.00	4.80	4.17	34.58
Bond market development in OC	6,566	-1.00	-0.98	0.56	0.90	4.10
Bond market development in DC	2,268	-0.98	-0.96	0.58	0.71	3.42
Equity market capitalization in OC	7,068	12.73	12.38	1.45	0.19	1.95
Equity market capitalization in DC	2,502	12.62	12.46	1.73	-0.07	2.74
Accounting quality in OC	6,665	4.26	4.29	0.11	-0.55	2.20
Accounting quality in DC	2,150	4.26	4.28	0.11	-0.57	2.32
Investor protection in OC	11,927	1.69	1.74	0.30	-0.32	2.77
Investor protection in DC	11,809	1.57	1.61	0.33	-1.53	8.84
K-S measure of cultural distance	1,636	2.12	1.96	1.39	0.81	3.67
Uncertainty avoidance index in OC	7,675	4.11	4.17	0.39	-0.60	2.50
Power distance index in OC	7,675	3.84	4.01	0.51	-0.97	3.62
Masculinity index in OC	7,675	3.77	3.99	0.62	-1.80	6.06
Individuality index in OC	7,675	3.74	3.93	0.61	-0.65	2.16

Variables are described in the order they appear in Tables 3 and 4. Except where noted, variables are measured in logarithims.

Table 3
Gravity and cultural distance in FPI, yearly 2001-2004

		Debt				***Equity***			
		2001	2002	2003	2004	2001	2002	2003	2004
	Number of Observations	777	749	732	777	786	786	786	786
	R-squared	0.659	0.653	0.661	0.648	0.66	0.652	0.654	0.597
(1)	Geographic distance	-1.033	-1.218	-1.186	-1.143	-0.792	-0.894	-0.908	-1.083
		(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
(2)	Economic growth in OC	-0.600	-0.747	-0.696	-0.752	-0.735	-0.854	-0.945	-0.812
		(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
(3)	Economic growth in DC	-0.266	-0.351	-0.412	-0.380	-0.249	-0.257	-0.244	-0.215
		(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
(4)	Bond market development in OC	1.011	0.826	0.898	0.842	0.674	0.504	0.405	0.480
		(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
(5)	Bond market development in DC	0.344	0.298	0.093	0.185	-0.010	0.024	-0.125	-0.169
		(.05)	(.13)	(.65)	(.29)	(.95)	(.88)	(.47)	(.37)
(6)	Equity market capitalization in OC	-0.215	-0.150	-0.179	-0.208	-0.260	-0.297	-0.192	-0.414
		(.01)	(.11)	(.07)	(.03)	(.00)	(.00)	(.03)	(.00)
(7)	Equity market capitalization in DC	-0.433	-0.270	-0.259	-0.369	-0.168	-0.075	-0.077	-0.103
		(.00)	(.01)	(.01)	(.00)	(.05)	(.37)	(.00)	(.30)
(8)	Accounting quality in OC	2.217	5.077	4.583	3.769	6.624	7.673	9.059	6.131
		(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
(9)	Accounting quality in DC	-0.659	1.351	1.344	0.950	4.022	4.274	4.004	3.333
		(.42)	(.09)	(.12)	(.24)	(.00)	(.00)	(.00)	(.00)
(10)	Investor protection in OC	0.587	0.022	-0.268	0.230	1.049	1.062	0.731	2.153
		(.05)	(.94)	(.041	(.38)	(.00)	(.00)	(.00)	(.00)
(11)	Investor protection in DC	0.613	0.332	0.152	0.439	0.502	0.302	0.257	0.471
		(.04)	(.31)	(.66)	(.14)	(.05)	(.24)	(.32)	(.10)
(12)	PRS measure of risk of OC	4.294	0.786	2.092	0.549	1.164	-1.447	-2.148	-0.800
		(.00)	(.27)	(.01)	(.43)	(.26)	(.02)	(.00)	(.32)
(13)	PRS measure of risk of DC	3.761	0.668	0.310	0.212	1.816	0.721	0.804	1.326
		(.00)	(.36)	(.70)	(.79)	(.05)	(.23)	(.24)	(.11)
(14)	Commonality of language	-0.068	-0.254	0.000	-0.129	0.133	-0.070	-0.076	0.113
		(.83)	(.48)	(.99)	(.70)	(.69)	(.83)	(.82)	(.75)
(15)	Commonality of legal system	-0.284	-0.195	-0.189	-0.221	-0.045	-0.026	-0.042	0.013
		(.10)	(.32)	(.33)	(.21)	(.78)	(.88)	(.82)	(.95)
(16)	Commonality of religion	0.043	-0.004	0.071	0.065	-0.078	-0.183	-0.239	-0.099
		(.80)	(.98)	(.72)	(.71)	(.63)	(.26)	(.17)	(.60)
(17)	K-S cultural distance	-0.332	-0.241	-0.228	-0.264	-0.363	-0.359	-0.332	-0.244
		(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)	(.00)

Notes. Definitions of all variables and data sources are provided in Table 1. 'OC' and 'DC' denote, respectively, originating and destination country. All regressions are performed on annual data for each of the years 2001–2004 using OLS with White-corrected standard errors to allow for heteroscedasticity.

Table 4
Gravity, culture and cultural distance in FPI, average 2001-2004

		Debt			*Equity*		
		(1)	(2)	(3)	(4)	(5)	(6)
	Number of Observations	726	726	726	786	786	786
	R-squared	0.67	0.69	0.71	0.65	0.67	0.68
(1)	Geographic distance	-1.196	-1.087	-1.267	-0.986	-0.870	-0.983
		(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
(2)	Economic growth in OC	-0.559	-0.556	-0.527	-0.695	-0.666	-0.650
		(.00)	(.00)	(.00)	(.00)	(.00)	(.00)
(3)	Economic growth in DC	-0.315	-0.289	-0.206	-0.281	-0.247	-0.195
		(.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
(4)	Bond market development in OC	0.803	1.020	0.962	0.430	0.665	0.258
		(.00)	(.00)	(.00)	(.00)	(.00)	(.11)
(5)	Bond market development in DC	0.089	0.302	-0.026	-0.284	-0.047	-0.343
		(0.62)	(0.10)	(0.88)	(.08)	(.77)	(.03)
(6)	Equity market capitalization in OC	-0.210	-0.188	-0.201	-0.346	-0.334	-0.393
		(.02)	(.03)	(0.01)	(.00)	(.00)	(.00)
(7)	Equity market capitalization in DC	-0.380	-0.370	-0.457	-0.103	-0.093	-0.172
		(.00)	(.00)	(.00)	(.22)	(.26)	(.04)
(8)	Accounting quality in OC	2.194	2.198	4.508	6.344	6.064	6.174
		(.02)	(.01)	(.00)	(.00)	(.00)	(.00)
(9)	Accounting quality in DC	-0.088	-0.282	-1.466	4.057	3.773	3.093
		(.92)	(.74)	(.13)	(.00)	(.00)	(.00)
(10)	Investor protection in OC	0.475	0.592	1.396	1.265	1.417	1.504
		(0.16)	(.07)	(.00)	(.00)	(.00)	(.00)
(11)	Investor protection in DC	0.301	0.444	0.650	0.288	0.447	0.595
		(.34)	(.15)	(.04)	(.26)	(.07)	(.03)
(12)	PRS measure of risk of OC	4.815	5.508	2.863	1.212	2.407	0.297
		(.00)	(.00)	(.02)	(.25)	(.02)	(.79)
(13)	PRS measure of risk of DC	2.342	3.385	3.150	0.340	1.567	1.151
		(.01)	(.00)	(.00)	(.70)	(.08)	(.17)
(14)	Commonality of language	0.085	-0.084	-0.231	0.273	0.041	-0.086
		(.79)	(.79)	(.45)	(.42)	(.90)	(.77)
(15)	Commonality of legal system	-0.072	-0.250	0.095	0.151	-0.054	0.427
		(.67)	(.15)	(.58)	(.37)	(.75)	(.01)
(16)	Commonality of religion	0.060	0.005	-0.238	-0.079	-0.155	-0.263
		(.73)	(.98)	(.18)	(.63)	(.34)	(.10)
(17)	K-S measure of cultural distance		-0.299			-0.354	
			(.00)			(.00)	
(18)	Uncertainty avoidance index in OC			1.829			0.325
				(.00)			(.14)
(19)	Power distance index in OC			-0.959			-0.932
				(.00)			(.00)
(20)	Masculinity index in OC			0.487			0.562
				(.00)			(.00)
(21)	Individuality index in OC			0.881			0.812
				(.00)			(.00)

Notes. Definitions of all variables and data sources are provided in Table 1. 'OC' and 'DC' denote, respectively, originating and destination country. All regressions are performed on annual data for the average of the years 2001–2004 using OLS with White-corrected standard errors to allow for heteroscedasticity. Marginal significance levels are provided in brackets.

Endnotes

[1] Aurelio (2006) documents how US foreign investments have grown at over twice the pace of household net worth during the two decades to 2005, and although the share of foreign stock holdings in total foreign assets has grown strongly from 5 percent to 28 percent of total assets, the 12 percent of equity portfolios held in foreign stocks remains inexplicably below the 41 percent minimum variance portfolio that would deliver significantly greater returns with lower risk.

[2] It is noteworthy that their sample concludes in 2002, and since then over two dozen papers have been published according to Econlit, which under represents business journals.

[3] Information frictions and the costs of gathering information across linguistic or cultural boundaries are commonly alluded to as a major element in the persistence of the home bias puzzle, see Karolyi & Stulz, 2002; Bellalah & Aboura, 2006; and Covrig, Defond & Hung, 2007.

[4] The first applications of gravity theory to spatial interactions emerged in the mid-19th century when 'bodies' were reinterpreted as locations or areas and 'gravitational force' was reinterpreted as the extent of interaction between them. In the mid-20th century, 'mass' was reinterpreted as population, 'distance' was reinterpreted as travel time, and the gravity exponent was estimated empirically. Early applications of the gravity model include Schneider (1959) on transportation, Isard (1960) on regional analysis, and Greenwood and Sweetland (1972) on migration. Roy and Thill (2004) provide further details.

[5] These included American Samoa, British Indian Ocean Territory, Christmas Island, Falkland Islands (Malvinas) , French Southern Antarctic territories, Gaza Strip, Greenland, International organizations, Norfolk Island, Other countries (confidential data), Other countries (unallocated), Pitcairn, Timor-Leste, Tokelau, Tuvalu, United States Minor Outlying Islands, United States Minor Outlying Islands, Vatican City, Virgin Islands, British, Virgin Islands, and the West Bank.

[6] Aruba, The Bahamas, Bahrain, Bermuda, The Cayman Islands, Cyprus, Guernsey, The Isle of Man, Jersey, Lebanon, Luxembourg, Macao SAR, Malta, Mauritius, the Netherlands Antilles, Panama, and Vanuatu.

[7] There are some data collection and definitional problems with the CPIS, discussed by Lane and Milesi-Ferretti (2008), section IV. These are not generally perceived to be severe.

[8] More recently there has been a fifth measure collected for some countries, Long Term Orientation. This metric however is still not as widely collected or as robustly analysed as the other measures.

[9] In some cases (e.g., China) the capital city and the city with greatest financial depth and power are not the same. For consistency across all bilateral pairs, we hold to the capital-capital distance.

[10] As an example, the data on trust from the world value surveys are measured in 2003 and the Hofstede culture indices are collected over various earlier periods.