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The role of lender country factors in cross border bank lending☆

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ABSTRACT

This article considers the cross-border lending stock from 19 advanced countries to European countries using quarterly data for 1999–2016. An extended model based on home and host country characteristics conditioned on distance and mass primarily measured by GDP is used to explain the behaviour of cross-border lending stocks. We focus particularly on the competitive structure of domestic banking markets and on the role of EU integration using indicators from the New Industrial Economics literature. Our results suggest EU integration has had a large effect on cross-border lending, although this has been partly reversed after Euro debt crisis. This reversal probably arises more from the actions of home country bank regulators rather than from the rise in risk premia in host countries. We show that in general lender rather than borrower factors are more important, and that more concentrated or less competitive lender countries do more cross border lending, especially in less concentrated or more competitive borrowers. Our results are robust across a range of specifications.

1. Introduction

Cross border bank lending rose rapidly in the thirty years up until the financial crisis in 2008, as Lane and Milesi-Ferretti (2017) show. They argue that reductions to frictions and in barriers to lending were part of the explanations of this increase, as were changes in domestic bank regulation. Increased lending is often seen as an unambiguously good thing, as it evens out rates of return on investment between countries, and hence raises aggregate output. However, this will depend on reasonable evaluations of the risks involved in cross border lending, and if these are inaccurate the outcome may not be so beneficial. Cross border lending is a source of capital in good times but can propagate risks from home to host and the reverse in bad times. We see cross border lending as a service trade activity, rather than as a portfolio decision, and stress the primacy of lender characteristics over those of borrowers, suggesting supply factors are important in the market for cross border lending. In order to investigate the causes in the rise and then fall in cross border banking over the last twenty years we examine bilateral country-level (consolidated) data available from the Bank for International Settlements (BIS) on cross-border lending from 19 advanced countries, the only source countries in the database, directed toward a group of relatively economically homogenous European countries, using quarterly data for the period 1999–2016.

Our core approach involves using the theoretically well founded gravity model utilised by many researchers in international finance from pioneering analysis by Portes and Rey (2005) through the important theoretical paper by Okawa and van Wincoop (2012) to recent empirical work by Emter, Schmitz, and Tirpák (2018). As we discuss below, this approach extends the simple gravity model including only size and distance to include frictions and facilitations associated with borders, legal institutions, export links and common institutions such as the European Union (EU) and the Euro Area. We wish to evaluate the impacts of European integration on cross border lending, in part to evaluate the success of the process, but also to test hypotheses on which factors or measure have been important in driving the expansion of cross border banking. The integration process was designed to raise output and living standards with an increase competition in markets, generated by increased cross border activity and higher levels of market contestability, where potential competition increases efficiency across borders because of the impact on domestic producers.

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Although gravity model approaches to cross border lending have been useful in explaining some developments in the pattern of international lending, they have often approached the topic as part of the macro-economic analysis of international capital flows. We argue that a more 'New Industrial Economics' approach is likely to be useful, emphasising the capacity of economies to produce. This leads us to extend the approach pioneered by Niepmann (2015) and introduce direct measures of contestability and industrial concentration. This should lead to a richer understanding of the factors driving lending and also a fuller understanding of the policies needed to ensure that it does not increase the fragility of financial systems and the overall economy. We are particularly interested in these issues in a European context.

After the financial crisis in 2008 bank lending became more constrained by regulators in many countries, and after the Euro Area sovereign debt crisis starting in 2011 cross border lending within Europe fell more noticeably than elsewhere. We wish to evaluate the causes of this fall in cross border lending in Europe, some of which are endogenous to the factors we wish to investigate, but some of the fall has been in excess of that which developments in GDP and in other economic factors would suggest. Some of the fall may be the result of higher risk premia in host countries, and this can be investigated using indicators of potential risk such as levels of non-performing loans. However, some the fall in lending could be the result of retrenchment by lending banks, and in particular from pressures from their domestic regulators to reduce their exposure in countries they considered risky, either in currency terms or in potential default risks. We attempt to discriminate between these two hypotheses.

Our key findings are that lending country banking sector efficiency is a primary determinant of the decision to lend to foreigners, and European integration has also been an important factor driving the growth of cross border banking. We utilise market based measures of contestability, focussing on bank concentration, efficiency (Boone) and monopoly power (Lerner), and demonstrate for the first time in the literature that these are significant factors driving lending patterns in advanced economies. Overall conditions in the lender (home) country are probably more significant than those in the borrower (host), with agglomeration economies and institutional freedoms being important, and the size of the domestic banking sector may be a substitute for some of our market conditions indicators, but not for the overall capacity to produce as indexed by country size. Furthermore, our results suggest that the Euro Area sovereign debt crisis has had a strong and long lasting negative impact on cross border lending amongst all members of the EU, and not just those in the Currency Union (CU).

The paper is organised as follows. Section 2 provides a brief review of the empirical literature on cross border banking. Section 3 discusses the core theoretical issues in the recent approach to cross border banking and Section 4 describes the data. Section 5 outlines the econometric methodology. Section 6 discusses the core empirical results on the impact of the Euro Sovereign Debt Crisis and at the role of lender and borrower bank efficiency in determining patterns of lending, and section 7 looks at the robustness of our results. We then conclude.

2. Cross-border banking and bank competition

The key focus of this paper is the impact of domestic institutions, and especially competition and concentration in banking, on patterns of cross border lending amongst high income countries. It is best to focus on this topic using the gravity model that considers the factors that push and pull cross border lending as a conditioning framework. Gravity models have been widely employed in the analysis of portfolios decisions and bank behaviour in international financial markets, and Okawa and van Wincoop (2012) developed a theoretical framework for these studies based on an analysis of the factors affecting portfolio choice. They demonstrate that a sound theoretical basis can be found for the use of a gravity framework for equity portfolios and other risky assets. This basic framework can be used to interpret the results in Lane and Milesi-Ferretti (2017) who look at International Financial Integration since 1970, with a special emphasis on the impacts of the 2007–8 financial crisis. Claessens (2017) stresses similar issues and gives a more theoretical interpretation of recent developments.

International portfolios grew relative to global GDP between 1970 and 2007, as Lane and Milesi-Ferretti (2017) show. They distinguish between three types of assets, those belonging to portfolios of equities and bonds, those associated with Foreign Direct Investment (FDI) and also bank assets. The first category is best analysed using the risk and return approach that is common in finance, and is extended by Okawa and van Wincoop (2012), whilst the remaining categories are best explained by trade related theories. However, approaches to analysing portfolio behaviour and to analysing banking are in many ways linked, as both can be relatively liquid transactions that may be affected by default and capital value risk and exchange rate uncertainty. Lane and Milesi-Ferretti (2017) show that the global asset to GDP ratio effectively levelled off after 2008. This in part reflects a shift of relative output growth to emerging markets who have a lower income elasticity for foreign assets, but it also reflects increased uncertainty after the 2008 financial crisis. In addition, regulatory reforms since the crisis, both internationally and at a national level, have been designed to restrict the growth of bank lending, and this has contributed to a fall in cross border bank assets as a percent of global GDP. This again reflects in part the predominance of international bank activity amongst the advanced economies who are shrinking as a share of global GDP. It also reflects a significant reduction of within banking sector activity across borders, as Gabrieli and Labonne (2018) show for the European Union using data on individual banks that is more granular in the time domain than our data allows. They suggest that sovereign risk as well as risk premia associated with defaults has reduced interbank lending within the EU, and especially to the peripheral countries. Lending to the non-bank private sector has fallen much less as a percent of global and advanced economy GDP. Indeed, toward the end of our period the ECB's negative interest rate policy from June 2014 may well have changed bank's behaviour to lending as compared to wholesale market activity, as Demiralp, Eisenschmidt, and Vlassopoulos (2017) show. Using confidential bank level data for the Euro Area, they show that negative rates appear to have stimulated lending in the Euro Area, with no strong bias against the peripheral countries. We return to the issues of risk premia in peripheral countries below, looking at the issues raised by Gabrieli and Labonne (2018) and Demiralp et al. (2017).

Most papers in the cross-border banking literature either rely conceptually on portfolio theory to explain banks' international linkages or implicitly assume that portfolio diversification drives the decision to operate in markets that are across borders. Bruno and Shin (2015) use the portfolio approach, but do not focus exclusively on gravity factors, but rather emphasise leverage cycles. Most other papers focus on the gravity approach to analysing lending and depositing. Buch, Koch, and Koetter (2014) is a good example of such studies, and the authors look at cross border banking and evaluate a gravity based model where they investigate individual bank decisions on internationalisation and utilise country size and distance apart as gravity variables in the process. They focus on the similarities and differences in language and institutions between countries and how they play a role in determining banks' cross-border activity. These factors may be accounted for by a common official language, a common land border and in part by membership of the European Union. These variables are proxies for both financial, informational and other frictions between the lender country and the borrower, and hence may capture the impacts of factors that are more difficult to measure. In an earlier study Buch and Lipponer (2007) also investigated German banks internationalisation decisions, and they use a similar set of variables for a wider group of hosts. In both of these papers a significant role is found for country size and distance, the core gravity variables. Kerl and Niepmann (2015) use a similar dataset on German banks to look at their internationalisation decision, and stress the role of distance and host GDP, as well as institutional quality, as

determinants of cross border lending. However, these studies use only host GDP and distance from host as gravity like factors, whilst other studies use both home and host gravity factors.

Recent studies that look at cross border bank lending with bilateral (push and pull) gravity like factors such as GDP and distance as well as institutional quality include Herrmann and Mihaljek (2013), Kleimeier, Sander, and Heuchemer (2013) and Sander, Kleimeier, and Heuchemer (2016). Herrmann and Mihaljek (2013) investigate the determinants of cross-border bank lending on a panel dataset comprising 17 advanced and 28 emerging market economies from 1993 to 2008 using a gravity model of financial flows. They investigate the role of the distance between the capitals of countries, the respective GDPs of lender and borrower countries and the nominal interest rate differential and find they are all significant and correctly signed. Kleimeier et al. (2013) utilise confidential data to investigate the determinants of the geography of cross-border deposits and loans. They show that there are clear gravity like effects in both lending and depositing decisions, with distance and size being important determinants of these decisions. Distance appears to have a larger negative effect on depositing, whilst size has a larger positive effect on lending. However, home and host coefficients are assumed to be common. These studies all focus on the impacts of crises on lending.

There have been a number of other studies of the determinants of cross border banking based around the structure of gravity models, stressing the importance of size, as measured by GDP, and distance apart. In recent years there has been a strong focus on the effects of the financial crises on such asset structures. In a gravity based study of international bank lending around the financial crisis in 2008 de Haas and Van Horen (2013) show the greater the distance between the lender and borrower, the larger the reduction in bank claims, and that distance is statistically significant. Sander et al. (2016) investigate cross border bank depositing during stable and crises times. They employ a data set that focuses on Eurozone cross-border depositing during the 1999–2011 period in a gravity-model framework and find that cultural distance limits international financial integration over and above what can be expected from economic trade and transaction costs. Their findings indicate that cultural borders resurged during the 2007/2008 financial crisis and severely limited financial integration after that. However, there are other explanations of the changes we have seen to levels of cross border lending. Emter et al. (2018) use a panel data gravity based approach for the period 2008–2015 to analyse cross border banking in Europe and find a significant negative impact of deteriorating asset quality on cross border lending. They suggest that stricter policies at home may preclude banks from direct lending activities abroad, especially for non-euro area countries in their study. They conclude that the EU cross-border banking retrenchment we have discussed above was driven to a greater extent by source country factors than by borrower characteristics or developments.

The portfolio approach focusses on the trade-off between risk and return for assets that are not capital value certain, and it may not be particularly applicable to bank lending. However, that is not to say that risks are not important in such lending. Some of them are reflected in the costs of borrowing, which we can measure, and some are reflected in risk premium decisions made by lenders, which are harder to evaluate. However, that is not to say we should ignore political risk indicators, and many studies have used them. There are a number of indicators that could represent specific risks, such as those from political systems. The World Governance Indicator produced by the World Bank is shown by Emter et al. (2018), Papaioannou (2009) and Bremus and Fratzscher (2015) to be a significant factor in explaining the scale of lending to host countries in the context of the commonly used gravity framework.[1] The Financial Freedom Index is frequently used as a proxy for other risk factors perceived by the lenders, for instance in Buch and Lipponer (2007) in a single lending country based gravity study and by Niepmann (2015) in a multiple lender country gravity approach to cross border lending activity. This is a measure in the range 0–100 and used in relation to the lender country and borrower country. How this affects cross border lending would appear to be an empirical question with an index for the lender economies that is likely to reflect the domestic business environment and the strength of their legal framework.

Legal frameworks are neither fixed over time, nor are they just individual country structures. The European Union, for instance, has been focused on enhancing cross border banking by forming a single market for financial services. Papaioannou (2009) found that the European integration process encouraged cross-border banking activity between member states, with EU membership being a factor increasing cross-border banking. However, the relative balance of domestic and international regulatory frameworks may change. Cerutti and Claessens (2017) have argued that in recent years international banks have sharply reduced direct foreign lending and lending to domestic affiliated subsidiaries in part because of changes in this balance, and suggest that the Euro Area crisis could have permanent effects as a result.

The analysis of international banking may differ from portfolio-based models because, as Niepmann (2015) and Goodhart (2010) suggest, bank lending is a service activity and not directly a portfolio decision, and we turn to the papers that have taken this approach. Given this, work on cross border bank lending should therefore be more directly related to the pre-existing work on trade in goods (and services) where a solid theoretical foundation already exists for the use of gravity models, as Head and Mayer (2014) have shown. However, there are some interesting features of bank lending that add additional dimensions to the gravity approach. Bilateral trade exists in part because of the great range and variety of goods available, with similar goods moving in both directions. In banking, the products of banks (loans) are similar across banks, whilst the characteristics of the firms involved, and their national environments may differ much more than might be common for goods producers. This should lead us to look at industrial activity indicators reflecting efficiency and other home and host country characteristics, as is suggested by Niepmann (2015). We turn to this issue below.

3. Theoretical approaches to trade in bank lending

We assume that cross border bank lending is a form of services trade, with different suppliers having different endowments and efficiencies, as Niepmann (2015) discusses, and this will give us the traditional gravity factors such as country size and characteristics, as well as include barriers to trade in services which will affect monitoring costs. Niepmann (2015) suggests that there will be a primacy of home country effects, as these drive the decisions of lenders, whilst borrowers are only interested in relative costs, and in market equilibrium costs to customers will be similar (the same) across all lenders, but the willingness to lend will depend on specific lender characteristics. Industry characteristics, such as concentration and efficiency, will also have an important role, and this is what distinguishes these trade-based gravity models of cross border banking from those based just on portfolio theory.

These trade-like features lead naturally to the framework discussed in the Head and Mayer (2014) paper on Gravity Models. The Gravity model was first adopted to analyse international trade flows and then subsequently applied to other applications such as global financial markets. Its advantages are the simplicity of structure and its

[1] Bremus and Fratzscher (2015) focus on regulatory issues, and although they include home and host GDP as well as other frictions, they do not focus on distance as a determinant of cross border banking activity. As such this is not a gravity study.

compatibility with a wide range of theoretical frameworks (Head & Mayer, 2014). Microeconomic foundations were developed by Anderson and van Wincoop (2003) amongst others. The model's flexibility allows for both "push" factors originating in home countries and "pull" factors arising from host economies. These may involve the size of the economy as an indicator of the ability to produce relevant products, the nature of the market there, the efficiency of producers and any legal or cultural barriers or ties that may be present, as discussed in Buch et al. (2014). We may summarise these in a model of bank lending (Y) from country i to country j as.

$$Y_{ij} = Z_i Z_j E_{ij} G_{ij} (X_i)^{a1} (X_j)^{a2} \quad (1)$$

We discuss the home and host indicators Z_i and Z_j first as it is in these areas that our major contribution is made. We then look at the bilateral regulation E_{ij} and the friction variables G_{ij} below. The size of home (X_i) and host countries (X_j) are commonly measured by real GDP in trade studies, and has been used in nearly all empirical studies of trade and FDI. Sander et al. (2016) and the other gravity papers cited above consider that it is also the appropriate measure of productive capacity in studies of bank behaviour but it is possible to investigate both the role of the size of the financial sector and the importance of financial centres defying gravity. We do not impose common coefficients on home and host GDP, although this is common, as we wish to evaluate whether market oriented factors are more important than home size.

Many market oriented factors may be country specific, and are included in Eq. (1) as Z_i and Z_j. There are a wide variety of such characteristics, and many of them are effectively fixed effects or indicator variables derived from surveys or from theory based data analysis. This latter group includes measures of the structure of the banking industries in home (S_i) and host (S_j) countries, and these are a major focus of this paper. There are a number of ways to look at the characteristics of domestic banking industries, and they are discussed in Degryse, Acevedo, and Ongena (2015), along with other indicators of efficiency and competition. We utilise three in this paper. Firstly there are the structural indicators based on data, such as the Three Bank Concentration Ratio (the percent of the market held by the three largest banks in a country) and the Herfindahl Hirschman Index (HHI), which is the average of the squared shares of all banks. Both these measures suffer from being country, rather than market specific, and in Europe in particular the market extends beyond national frontiers, for instance with potential competitors to French banks being located in Luxembourg, Belgium and Switzerland where languages and legal systems are very similar. Hence we use only the Concentration ratio as a measure of the importance of the oligopolistic core of the banking system rather than a whole system indicator such as the HHI. Secondly there are the economic indicators of competition and monopoly based on estimated bank cost and profit functions. The most recent measure is developed in Boone (2008), whilst the others have been in widespread use for decades, as is discussed in Degryse et al. (2015). There are a number of these such as the Lerner Index of price relative to marginal cost, which is a monopoly power indicator which depends directly on prices and costs. The Boone indicator of bank profitability, which is an indicator of competitive pressure, has become popular in studies of banking, as de De-Ramon and Straughan (2016) discuss. These measures take account of the contestability of the market, and will reflect the impact of both domestic and (in our case mainly) European competition and financial regulation. There are other cost function based indicators that we could use, such as the Panzer Ross H statistic, but for brevity, we constrain ourselves to only one of each type of indicator.

The Boone indicator of banking competition measures the effect of efficiency or performance in terms of profits, based on the presumption that more efficient banks achieve higher profits as they are able to expand their output at lower cost than less-efficient firms when competition intensity increases. As competition becomes more intense, less-efficient firms become increasingly unprofitable and leave the market, leaving more efficient firms able to expand output and profitability. The more negative the Boone indicator, the higher the level of competition in the market, which may extend beyond the borders of countries in our sample. It is calculated as the elasticity of profits to marginal costs. We use the World Bank measure where the log of a measure of profits (such as return on assets) is regressed against a log measure of marginal costs calculated from a translog production function for individual banks. It is then aggregated into an economy-wide measure. We use the lender and borrower Boone measures in our regression, and we would expect a negative impact from the borrower country if more competitive markets are easier to enter than less competitive ones, and a positive impact for the lender country if less competition in the lender gave banks a greater opportunity to expand abroad.

We also use the lender and borrower Lerner indices from the World Bank as measures of monopoly or market power in the banking market. The Lerner index is a well-established measure of the degree of pricing and monopoly power in banking. It is defined as the difference between output prices and marginal costs (relative to prices). Prices are calculated as total bank revenue over assets, whereas marginal costs are obtained from an estimated translog cost function with respect to output. Higher values of the Lerner index indicate more pricing power and potential monopoly. We use the Global Financial Development Database for the Lerner Index where estimation follows the methodology described in Demirguc-Kunt and Martínez Pería (2010). The Lerner index has also been used in a number of recent empirical banking sector studies as surveyed by Degryse et al. (2015) and de-Ramon and Straughan (2016). The reasons for its popularity are its straightforward interpretation and its simplicity. Moreover, like the Boone index it is based on bank-specific data and varies over time, allowing comparison of market power amongst banks and/or over the period.

The three different indicators we use catch different aspects of competition and pricing power. The Lerner index measures the average market power in the market rather than the degree of competition, whilst the Boone indicator captures the dynamics of markets and is more relevant when markets are changing, as De-Ramon and Straughan (2016) discuss. Our study includes New Industrial Economics indicators of concentration, competition and efficiency in order that we may focus on industrial structure as well as on macro-economic determinants of patterns of international capital stocks. Both the Boone and Lerner indices are included to capture bank monopoly, competition and efficiency, and we follow Bremus and Fratzscher (2015) amongst others and also include the Bank concentration ratio as it might also indicate monopoly power.

For bank lending the rate of return on the loan net of administration and default costs is important. Banks will look at the Net Interest Margin (NIM) they make on their lending in the home and the potential host countries. However, the NIM covers both the return on assets and the potential default rate in the country where lending takes place, and hence it has to be interpreted with care over a financial crisis. The NIM is directly observed, and it can also serve as a good indirect indicator of efficiency or monopoly power. A more efficient bank has lower costs, and for a given market driven borrowing rate will have a higher NIM. However, a bank with monopoly power, for instance in a region of a country, may use that to raise its lending rate relative to the competitive level and hence it will have a higher NIM. In the relatively open markets we observe in the economies we study the NIM is probably a good indicator of efficiency and a poor indicator of monopoly. Niepmann (2015) uses the NIM as an indicator of relative efficiency, with a higher lender economy NIM being seen as a good indicator of efficiency that would encourage cross border lending whilst a higher borrower economy NIM should reduce cross border lending if it is an efficiency indicator. We include lender and borrower NIMs in our study, although we do not impose common coefficient as it is possible that a higher NIM in a borrower country could attract more cross border

lending to that country if it were the result of borrower country monopoly effects that could be competed away by foreign banks.

The competitive environment in which banking firms find themselves, depends in large part on domestic regulations and also on the existence or otherwise of barriers to cross border activity. We denote these factors, which include our New Industrial Economics indicators, as S_i for home and S_j for hosts, and include them in Eq. (2) below. The existence of Financial Freedoms and political risks in a country, and the specific nature of market risk in host countries there will affect the ability and willingness of cross border banks to lend to host country residents, and there are various ways we can measure these factors, which we may call R_i for home country risk and freedoms, and R_j for hosts. These may include default risks that followed on from the Euro Area sovereign debt crisis, for instance. We can therefore write an equation for country specific factors, Z_i (or Z_j) as.

$$Z_i = b_i \, NIM_i^{b1} S_i^{b2} \, R_i^{b3} \tag{2}$$

Bilateral frictions can be related to monitoring costs for lending, much as Niepmann (2015) does for depositing. There are various indicators of monitoring costs, and the most prominently used include distance between home i and host j, DIS_{ij}. Following the work at CEPII, transportation and information costs (which are included in the bilateral variable G_{ij}) are normally measured by a bilateral variable that computes the metric distance between the economic central point of home and host countries.[2] This measure has become common in gravity studies in the last decade (see Head & Mayer, 2014). This gives a smaller, and more accurate, impact than does the simple geographic distance between capital cities of countries that was in previous use. Trade patterns, included in G_{ij}, may also have had a significant effect on the size of Bank Lending. Bilateral trade, $BEXP_{ij}$ and cross border banking have been linked in many studies, and we include it here, although Claessens, Hassib, and Horen (2017) suggest it is less important for our countries than for developing economies. Other frictions have been associated in the literature is Section 2 above with a common border, B_{ij}, and a common official language, La_{ij}, and we can hence write the friction variable as an equation, written multiplicatively for simplicity of exposition.

$$G_{ij} = c_{ij} \, DIS_{ij}^{c1} \, BEXP_{ij}^{c2} \, La^{c3}{}_{ij} \, B^{c4}{}_{ij} \tag{3}$$

There are other institutional factors that may affect home and host at the same time, enhancing competition or changing the structure of risk, and we denote them as E_{ij} in Eq. (1) above. Most of these would be associated with cross border financial regulation or market access controls. Some of these might be associated with membership of the Currency Union by both parties which we might denote CU_{ij}, as there are both different risk factors involved in lending and different regulations to follow once both countries are in the Union. The EU Single Market Act and the subsequent Financial Service Action Plan were in part designed to remove barriers to cross-border movements of capital by harmonising banking law and financial services' regulation. It is however possible that the regulatory response to the sovereign debt crisis starting in 2011 has reversed some of these gains, and reduced competition in the Euro Area. We therefore look at the impacts of European Integration on financial markets, and we include an indicator where both countries are members of the European Union (EU_{ij}), and we record the dates of entry in the Appendix A. We also evaluate the importance of Currency Union (CU_{ij}) membership for cross border lending. We may write a regulatory environmental issues relationship as.

$$E_{ij} = e_{ij} \, EU_{ij}^{e1} \, CU_{ij}^{e2} \tag{4}$$

We can substitute Eqs. (2), (3) and (4) back in to Eq. (1) and produce an extended gravity model that builds on the simple canonical model with only size and distance to include country and environment factors that affect the behaviour of banks and hence also structure the pattern of cross border lending.

4. Empirical design and the data

The dependent variable used for estimation here is the level of bilateral loans by the banking sector of each lender country to the banking and non-banking sectors in each of the borrower countries for the period 1999Q2 to 2016Q4.[3] The BIS's, International Banking Statistics are divided into the Consolidated and the Locational accounts.[4] The consolidated banking statistics we use are appropriate to an investigation of bank lending determinants since they allow us to look at the exposure pattern by lenders and borrowers' nationality and this information is not available from other databases such as the IMF or the World Bank. The “foreign claims” data are drawn from the consolidated banking statistics.[5] The data used are on an immediate risk basis as they cover a longer time horizon and they enable data collection for each country pair.[6] Cerutti and Claessens (2017), amongst others, have used the Consolidated International Banking Statistics to examine bilateral lending between advanced and emerging economies,[7] whilst we are focusing on stocks of lending across a group of advanced economies.

The concentration, efficiency and competitiveness/monopoly indicators we use (Boone, Lerner and Concentration ratio) are based on bank level data and are obtained from the World Bank Global Financial Development Database (based on Bankscope, Bureau van Dijk). There are limited number of missing observations in this data set, and we have used proximate data to fill the gaps, as competition and efficiency are slowly evolving conditions. We also derive our country specific indicators of the NIM from the same source, and we also use the World Bank World Governance Indicators in our analysis.

Our sample covers all the 19 countries for which there are lending data, and we focus on their lending to 29 European countries (see Appendix A). Following Cerutti (2015), the analysis considers exchange rate variations to adjust valuations of stocks. These corrections are critical to achieve a representation of the evolution of banks claims. To eliminate the impact of exchange rate valuation, we calculate quarterly exchange rate-adjusted stocks.[8] Firstly, the original nominal stock is taken for the second quarter of 1999 and then successively the BIS's

[2] See Mayer and Zignago (2011) for details of the widely used measure of distance developed at CEPII. It generally reduces the impact of distance as compared to a capital city to capital city measure common in Gravity studies until around 2010.

[3] A description of the BIS data on international bank lending, along with data definitions and sources can be found in Table 1.

[4] The BIS Locational Banking Statistics benefit from a long time horizon, broad country coverage, and dis-aggregation into assets (i.e. loans) and liabilities (i.e. deposits) vis-à-vis different customer groups. However, the Locational Banking Statistics are either disaggregated by reporting (e.g. bank) country or vis-à-vis for example customer.

[5] Foreign claims comprise cross-border claims of domestic banks and their foreign offices (in domestic and foreign currency), as well as local claims of reporting banks' foreign offices in domestic and foreign currency (BIS, 2003).

[6] A disadvantage of the consolidated BIS data is that they also contain local claims that are denominated in a foreign currency. However, at least for the larger countries in the EU, this issue should not be important. Cerutti and Schmeider (2014) argue that consolidated accounts sometimes hide problems in stress tests.

[7] By comparison, Bruno and Shin (2015) use the Locational International Banking Statistics to analysis aggregate banking flows to emerging and advanced economies.

[8] Banks will be covering exchange rate risks in the same way as retailers, such a Tesco from the UK, do when operating in foreign country with a different currency. The bank will consider its whole risk portfolio and decide whether to take out explicit cover. This issue is not addressed further by Cerutti (2015) and others.

Table 1
Variable definitions and data sources are summarized as following.

Variable	Variable description	Data sources
$L_{i,j,t}$	The log of the exchange-rate adjusted stocks of cross-border loans in millions of US dollar from the lender to the borrower country.	Bank for International Settlements (BIS)
$GDP_{lender,t}$ $GDP_{borrower,t}$	Millions of US dollars, volume estimates, fixed purchasing power parities, OECD reference year 2010, quarterly levels, seasonally adjusted.	OECD
$BEXP_{i,j,t}$	Bilateral exports from the lender to borrower country.	DataStream (Thomson-Reuters)
$DIS_{i,j}$	The geographical distance between economic centres of gravity measured in kilometres.	CEPII Distance Database (www.cepii.fr)
$NIM_{Lender,t}$ $NIM_{borrower,t}$	Bank net interest margin (%), Accounting value of bank's net interest revenue as a share of its average interest-bearing (total earning) assets.	Global Financial Development Database (based on Bankscope and Orbis Bank Focus, Bureau van Dijk (BvD)
$FinFreedom_{lender,t}$ $FinFreedom_{borrower,t}$	An index of financial freedom provided by the Heritage Foundation.	Heritage Foundation www.heritage.org
$Boone_{lender,t}$, $Boone_{borrower,t}$	The lender and borrower Boone competition indices	FRB St Louis FRED database of World Bank Indicators
$Lerner_{lender,t}$, $Lerner_{borrower,t}$	A measure of market power in the banking market. It compares output pricing and marginal costs (that is, markup). An increase in the Lerner index indicates a deterioration of the competitive conduct of financial intermediaries.	Global Financial Development Database (based on Bankscope and Orbis Bank Focus, Bureau van Dijk (BvD)
$Concentration_{lender,t}$, $Concentration_{borrower,t}$	Assets of three largest commercial banks as a share of total commercial banking assets. Total assets include total earning assets, cash and due from banks, foreclosed real estate, fixed assets, goodwill, other intangibles, current tax assets, deferred tax assets, discontinued operations and other assets.	Global Financial Development Database (based on Bankscope, Bureau van Dijk (BvD))
Non-performing $loans_{lender,t}$ Non-performing $loans_{borrower,t}$	Ratio of defaulting loans (payments of interest and principal past due by 90 days or more) to total gross loans (total value of loan portfolio). The loan amount recorded as nonperforming includes the gross value of the loan as recorded on the balance sheet, not just the amount that is overdue.	Financial Soundness Indicators Database (fsi.imf.org), International Monetary Fund (IMF)
Financial sector $size_{lender,t}$ Financial sector $size_{borrower,t}$	Total assets held by deposit money banks as a share of GDP. Assets include claims on domestic real nonfinancial sector which includes central, state and local governments, nonfinancial public enterprises and private sector. Deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.	International Financial Statistics (IFS), International Monetary Fund (IMF)
Political $Stability_{lender,t}$ Political $Stability_{borrower,t}$	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Percentile rank indicates the country's rank amongst all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the WGI.	World Bank: Worldwide Governance Indicators (WGI)
$Border_{i,j}$	Dummy variable that equals 1 when both countries share a common land border, otherwise 0.	World Factbook
$Lang_{i,j}$	Dummy variable that equals 1 when both countries share a common official language, otherwise 0.	www.cepii.fr
$EU_{2011q3\ i,j,t}$	Dummy variable that equals 1 from 2011Q3 when both in EU, otherwise 0. A permanent step dummy.	
$EU_{i,j,t}$	Dummy variable that equals 1 if countries i and j are EU members at time t and 0 otherwise.	(see Appendix A)
$CU_{i,j,t}$	Dummy variable that equals 1 if countries i and j use the same currency (euro) at time t and 0 otherwise.	(see Appendix A)
1999 CU members $_{i,j,t}$	Dummy variable that equals 1 if countries i and j joint the CU in 1999 and 0 otherwise.	(see Appendix A)
1999 CU members $_{2011q3\ i,j,t}$	Dummy variable that equals 1 from 2011Q3 when both joints CU in 1999, otherwise 0.	(see Appendix A)
Post 1999 CU members $_{i,j,t}$	Dummy variable that equals 1 if countries i and j joint the CU after 1999 and 0 otherwise.	(see Appendix A)
Post 1999 CU members $_{2011q3i,j,t}$	Dummy variable that equals 1 from 2011Q3 when both joints CU after 1999, otherwise 0.	(see Appendix A)
Post 1999 CU members + SPI	Dummy variable that equals 1 if countries i and j joint the CU after 1999 (including Spain, Portugal and Ireland) and 0 otherwise.	(see Appendix A)
Post 1999 CU members + $SPI_{2011q3\ i,j,t}$	Dummy variable that equals 1 from 2011Q3 when both joints CU after 1999 (including Spain, Portugal and Ireland), otherwise 0.	(see Appendix A)

Quarterly data for the period 1999–2016.

quarterly exchange rate adjusted changes are added. The BIS reports all stocks and flows in the US dollar independently of the currency in which the initial cross-border loan transactions are denominated. To calculate exchange rate adjusted changes (changes in stocks that are free of exchange rate valuation effects), we first have to convert stocks at the previous quarter (T_0) and the current quarter (T_1) into their local currency by applying the US$ exchange rates, and then convert their changes from the local currency back into the US$ using period average exchange rates (BIS, 2003).

To summarise the discussion of the variables, Table 1 below displays the definition of all variables that are considered here, whilst Table 1a provides some summary statistics for our variables, and most are self-explanatory. The categorical variables are worth mentioning in more detail. Around 8% of our sample observations have common borders or a common official language, whilst 5 of our home countries (Australia, Canada, Japan, Switzerland and the US) are not members of the EU throughout our sample. At the start of our data period 14 or our home countries and 15 of our hosts were members of the EU.[9] As 13 host countries joined the EU at some point during our sample (see Appendix

[9] Unfortunately there are no 'home' data for Luxembourg.

Table 1a
Summary statistics of the variables.

Variable	Obs	Mean	Std.Dev	Min	Max
$L_{i,j,t}$ (Log)	31,534	7.433	2.985	0	13.719
$GDP_{lender,t}$ (Log)	38,592	13.651	1.192	11.763	16.652
$GDP_{borrower,t}$ (Log)	38,592	12.156	1.596	8.271	15.087
$BEXP_{i,j,t}$ (Log)	38,541	19.203	2.231	9.014	24.515
$DIS_{i,j}$ (Log)	38,592	7.542	1.006	4.127	9.801
$NIM_{Lender,t}$	38,592	1.64	0.856	0.12	6.73
$NIM_{borrower,t}$	38,592	2.405	1.581	0.12	14.58
$FinFreedom_{lender,t}$	38,592	71.74	14.395	30	90
$FinFreedom_{borrower,t}$	38,592	70.256	14.1	30	90
$Boone_{lender,t}$	38,592	−0.026	0.142	−0.74	0.97
$Boone_{borrower,t}$	38,592	−0.059	0.204	−1.57	1.91
$Lerner_{lender,t}$	38,592	0.191	0.246	−2.56	0.58
$Lerner_{borrower,t}$	38,592	0.22	0.169	−1.75	0.71
$Concentration_{lender,t}$	38,592	67.788	21.825	8.17	100
$Concentration_{borrower,t}$	38,592	67.065	20.612	8.17	100
Non-performing $loans_{lender,t}$	38,256	3.814	5.191	0.1	36.647
Non-performing $loans_{borrower,t}$	36,552	5.95	6.94	0.1	48.676
Financial sector $size_{lender,t}$	37,664	120.668	37.664	38.875	225.792
Financial sector $size_{borrower,t}$	38,592	94.147	44.219	10.812	222.204
Political $Stability_{borrower,t}$	38,592	75.268	15.832	30.288	100
Political $Stability_{lender,t}$	38,592	77.699	16.121	30.288	100
$Border_{i,j}$	38,592	0.084	0.277	0	1
$Lang_{i,j}$	38,592	0.078	0.269	0	1
$EU_{2011q3\ i,j,t}$	38,592	0.306	0.461	0	1
$EU_{i,j,t}$	38,592	0.585	0.493	0	1
$CU_{i,j,t}$	38,592	0.277	0.447	0	1
1999 CU members $_{i,j,t}$	38,592	0.187	0.39	0	1
1999 CU members $_{2011q3\ i,j,t}$	38,592	0.057	0.232	0	1
Post 1999 CU members $_{i,j,t}$	38,592	0.088	0.284	0	1
Post 1999 CU members $_{2011q3i,j,t}$	38,592	0.049	0.216	0	1
Post 1999 CU members + SPI	38,592	0.184	0.387	0	1
Post 1999 CU members + $SPI_{2011q3\ i,j,t}$	38,592	0.078	0.268	0	1

A) around 58% of the pairs we observe are EU member with EU member, as we can see from Table 1a. Membership of the Monetary Union is a subset of this set. We have 10 of the initial members on the Monetary Union in our home country set and all 11 in our host set, and we have 10 host countries who remained outside the Monetary Union throughout the period, and 8 who joined at various times in our sample. Hence, we have around 28% of our sample where there are Monetary Union home and host countries. The correlation between EU and Euro Area membership is 0.5, as the overlap is noticeable, but no more. We further break this down in to home and host both members in 1999, stocks amongst members where the home is in monetary union and host in monetary union after 1999.

It is common in the empirical bilateral trade literature to discuss zeros amongst the observations, as these can account for up to 50% of possible pairs, and the reasons for their absence have to be investigated separately from the determinants of levels of stocks, as Head and Mayer (2014) emphasise. Our data set has 38,592 observations, but only 633 of these are zero, with 272 in the Australian lending data (out of 2088 possibles) and 100 in the Canadian data. We do not consider that these zeros will cause biases in our results as they represent just under 2% of the total observations. However, there are 7058 observations that are not available, with the largest number in Ireland where around 65% of the potential observations are not available, with around half of the potential observations being absent in Canada and Finland. These countries account for almost 50% of missing and not reported observations. If one looks at the same data sets in the locational (unconsolidated) BIS database, it is clear that lending has taken place. However, consolidation makes the data potentially commercially sensitive, and it is not reported. This is clearly a problem in a small country with a concentrated banking sector, such as Ireland, and in larger countries with high levels of concentration such as Canada.[10] In order to investigate the effect of the commercial in confidence problem, we repeat our final results omitting Ireland, Canada and Finland one at a time and then all of them together.

5. Econometric methodology

The variables considered above are incorporated within the specification of the Gravity model, and we would substitute Eq. (2) on frictions, Eq. (3) on domestic environments and Eq. (4) on international environments into Eq. (1) to produce a full explanation of cross border lending. In addition to the push and pull factors considered in the previous literature, we include a number of indicators to capture country specific financial efficiency are important determinants of cross-border lending. Underlying the model there is a set of country specific variables that capture the gravitational effects related to Eq. (1). Several of the variables are dummies that operate like classic fixed effects when the data are pooled across country transactions. A single model specification with the addition of such variables would capture country specific heterogeneity in this way. The primary Gravity model specification is presented in Eq. (5) below.

$$\begin{aligned}\mathrm{Log}(L)_{i,j,t} = {} & a_{i,j} + b_1\mathrm{LogGDP}_{lender,t} + b_2\mathrm{LogGDP}_{borrower,t} + b_3\mathrm{LogBEXP}_{i,j,t} \\ & + b_4\mathrm{LogDIS}_{i,j} + b_5\mathrm{NIM}_{i,t} + b_6\mathrm{NIM}_{j,t} + b_7\mathrm{finfreedom}_{lender,t} \\ & + b_8\mathrm{finfreedom}_{borrower,t} + b_9\mathrm{border}_{i,j} + b_{10}\mathrm{Lang}_{i,j} + b_{11}\mathrm{EU}_{i,j,t} \\ & + b_{12}\mathrm{CU}_{i,j,t} + b_{13}\mathrm{EU}_{2011\ q3,i,j,t} + b_{14}\mathrm{Boone}_{lender,t} \\ & + b_{15}\mathrm{Boone}_{borrower,t} + b_{16}\mathrm{Lerner}_{lender,t} + b_{17}\mathrm{Lerner}_{borrower,t} \\ & + b_{18}Concentration_{lender,t} + b_{19}Concentration_{borrower,t} + \varepsilon_{i,j,t.}\end{aligned} \tag{5}$$

In terms of right-hand side variables in Eq. (5), the fundamental drivers of cross border lending are accounted by the lender and borrower factors that are discussed in the previous section. Note (*i*) and (*j*) indicate the "lender" and "borrower" country respectively and *t* denotes the time dimension of the sample in quarters. Log denotes the natural logarithm. The dependent variable $L_{i,j,t}$ is the exchange rate-adjusted stock of cross-border loans in quarter *t* from banks in lender country (*i*) to the borrower country (*j*). *GDP* appears in Eq. (5) separately for lender country (*i*) and borrower country (*j*) to determine the relative effect of the size of a country on the capacity to produce and absorb cross border lending. $BEXP_{i,j,t}$ measures bilateral exports from the lender to borrower country and $DIS_{i,j}$ is the CEPII distance indicator. $\mathrm{finfreedom}_{lender,\ t}$ is the financial freedom index for the lender country and $\mathrm{finfreedom}_{borrower,\ t}$ for the borrower country. The following dummy variables take values 0 or 1: $Lang_{i,j}$ captures a common official language, $border_{i,j}$ a common land border, $EU_{i,j,t}$ membership of the EU by both countries, and $CU_{i,\ j,\ t}$ membership of the Euro Area by both countries. We add dummy variables for the EU Sovereign Debt crisis, denoted $EU_{2011\ q3,\ i,\ j,\ t}$. The variables $NIM_{i,\ t}$, $NIM_{j,\ t}$ are the Bank net interest margin separately for lender country (*i*) and borrower country (*j*) and we also include the indicators of competitiveness for lender and borrower countries, denoted Boone, Lerner, and Concentration.

It is common to use random effects estimators in large panels but this can lead to standard errors for parameters that are implausibly low. Following Wooldridge (2003) we use a Variance Component Estimator (VCE) to compute the standard errors after controlling for clustering and thus account for cross-sectional dependence. Clustering, in the context of panel data, involves computing standard errors and test statistics that are robust to any form of cross sectional (or spatial) serial correlation and heteroscedasticity. Even were random effects

[10] In our dataset here are 7 pairs which are completely missing for all time periods, with 2 in Canadian data and 5 in Dutch data reflecting the limited number of banks that operate abroad from these countries.

estimation adequate to control for clustering at the country-pair level, robust and cluster-robust VCE estimators are useful. When borrower-country clustering is controlled for, in most cases higher standard errors are obtained.[11] This occurs as there is a trade-off between bias and a loss of precision in the calculation of robust standard errors, and it may be better to adjust the error at the country-pair level, as we do in this paper.[12] The Lagrange multiplier (LM) test due to Breusch and Pagan (1980) is also employed to test for the appropriateness of our model specification and further discriminate between a random effect specification and OLS.

6. Empirical findings

Our primary focus is on the direct effect of the factors affecting the stocks of cross border lending to European Markets from advanced economies.[13] The results summarized in Table 2 initially relate to the conventional Gravity model. Column 1 contains just distance, Net Interest Margins, trade, each country's GDP, membership of the currency union as well as the financial freedom indicators, and all except borrower country financial freedom and membership of the currency union are significant. We can test for common coefficients, with GDP effects the same, and NIMs and Financial Freedom effects equal and opposite in sign, and we find that we could impose commonality here with a chi^2 (3) of 6.13 (prob = 0.105). There is little multicollinearity in this regression, and hence each coefficient can be interpreted as free from influence from others.[14] In column 2 we look at indicators particularly relevant to our European focus, with common borders, common official languages and membership of the EU as explanatory variables. The border effect is negative but not significant. The effects of the EU and of common official language are significant, and positive, raising cross border lending. The addition of these variables means that we can no longer impose on the core model the commonality we saw in column 1, as the chi^2 (3) is 13.13 (prob = 0.004).

The EU coefficient estimate is economically and statistically highly significant; this implies that cross border banking between member states has been much higher than we would expect given the normal determinants of cross border banking. This would indicate that there are substantial gains to integration for the banking sector, and that integration in the banking sector would appear to have taken the form of increased cross-border lending and rather than acquisitions and mergers as occurs in the US. In all experiments the currency union membership indicator is not significant, suggesting that it is membership of the Single Market and not the Euro Area that has raised cross border lending in Europe. Our sample of non-Euro Area countries is large enough that the correlation between these categories is only 0.5, and hence our standard errors can be seen as reliable. We return to the issue of insignificant inclusions in our robustness section. In column 3 we add a (0 1) step dummy for the sovereign debt crisis in Europe starting in 2011q3, with zeros before that date, and 1 from then on. It is negative and significant, indicating that some of the gains from integration were permanently reversed, and across all specifications in the table it looks like around 40% of the gains from integration were lost as a result of the 2011 sovereign debt crisis. Once again in column 3 common coefficients on the pairs of gravity variables cannot be imposed, with a chi^2 (3) of 19.79 (prob = 0.000).

We then add our lender and borrower competitiveness indicators, with the Boone indicator added in column 4, the three bank concentration ratio replacing it in column 5, and the Lerner index is used on its own in column 6. Both Boone coefficients are significant, whilst the concentration ratio coefficients are not, so in column 7 we add the Boone indicators to the Lerner index where one coefficient was significant in column 6. This is our preferred explanation of the determinants of cross border lending in our sample. In none of these cases was it possible to impose common coefficients on the initial three pairs of home and host variables and the new pairs of indicators. In column 4 the test has a chi^2 (4) of 43.94, in column 5 the test has a chi^2 (4) of 20.69, in column 6 a chi^2 (4) of 25.22 and in column 7 a chi^2 (5) of 46.05, in each case with (prob = 0.000). Our preferred specification is column 7, with higher net interest margins in the lender country reducing lending abroad, whilst higher NIMs in the borrower raise it, albeit not significantly.[15] In both cases it appears that banks wish to lend more abroad the lower the returns at home and the higher they are abroad, suggesting a general search for returns in lending across borders. Higher Boone indicators can indicate less competitive markets, and the lender coefficient is positive and significant, suggesting that less competitive lender markets do more lending abroad, whilst the borrower Boone coefficient is negative and significant, indicating that more foreign bank lending takes place in more competitive borrower markets. This interpretation is strengthened by the significant positive coefficient on the lender Lerner indicator, suggesting as monopoly increases in the lender market more cross border lending takes place. Generally, competition reduces cross border lending from lender countries and raises cross border borrowing in hosts (or borrowers), and there is a search for returns by home lenders. The concentration ratio is not significant, which supports the view that it is a poor indicator of monopoly and efficiency, as it does not pick up potential competition from smaller banks and from abroad.

Our other results are similar across these experiments, and they are consistent with the theory discussed above. We find that although both push and pull factors had an impact on cross border lending during the period of study, in general lender factors dominated over borrower factors, suggesting that the simple gravity model approach did not explain all of the patterns we observe, which reflect the impact of relative efficiency and lender institutions in giving some banks a comparative advantage in foreign markets. For all the regressions, the size variable for both the lender and borrower GDP is a positive and significant determinant of cross-border lending. This is not inconsistent with Papaioannou (2009) as well as with the results in Niepmann (2015).

It is noticeable that economic size for the lender country is more important than that of the borrower country for cross-border lending for all the empirical results in Table 2, and in general it is a fifth larger. This suggests that the size of the lender countries may be a stronger determinant in explaining cross-border lending from advanced economies to European markets because of agglomeration and efficiency effects of scale in banking in the home, or lender countries. Financial freedom, seen as a proxy for efficiency in lender and borrower financial systems is positively related to cross border lending. The coefficient is larger, and only significant, in lender countries. Domestic financial institutions clearly matter in giving lender countries relative advantage, as Niepmann (2015) suggests.

With respect to the other factors, the regression results show bilateral exports have a positive and statistically significant effect on cross-border banking between lending and borrowing countries,

[11] Greene (2012) p 430 gives an example of a random effects model where clustered, or robust standard errors are four times larger than those in a simple random effects regression.

[12] Amongst others, the following authors have investigated this: Cerutti and Claessens (2017), De Haas and Van Horen (2013), Reinhardt and Riddiough (2015), and Acharya, Eisert, Eifinger, and Hirsch (2015).

[13] All estimations were undertaken in STATA 14.0.

[14] The Variance Inflation Factor (VIF), a widely used descriptive measure of common correlation, is only noticeable for exports, distance and the GDP variables, with values marginally above the commonly used threshold of 3.0. Our standard errors are low, and hence multicollinearity is not causing us a problem.

[15] In this regression there is multicollinearity between our EU and CU variables, with a few VIF indicators well above 3.00. However, this is inevitable as these are overlapping categorical variables, and we can still distinguish which of them matters, in part because they are not stochastic variables.

Table 2
Determinants of cross border lending stocks.
This table presents the results for the determinants of cross border lending stocks from advanced to EU countries taking into account both push and pull factors.

Variables	Column (1)	Column (2)	Column (3)	Column (4)	Column (5)	Column (6)	Column (7)
$LogGDP_{lender,t}$	0.9648***	0.9417***	1.2151***	1.2013***	1.2231***	1.2116***	1.1965***
	(0.1701)	(0.1722)	(0.1447)	(0.1433)	(0.1452)	(0.1419)	(0.1398)
$LogGDP_{borrower,t}$	1.0762***	0.8894***	0.9850***	0.9511***	0.9796***	0.9800***	0.9458***
	(0.1219)	(0.1196)	(0.1201)	(0.1183)	(0.1207)	(0.1191)	(0.1169)
$LogBEXP_{i,j,t}$	0.2840***	0.2475***	0.2468***	0.2493***	0.2464***	0.2509***	0.2531***
	(0.0562)	(0.0550)	(0.0556)	(0.0545)	(0.0554)	(0.0557)	(0.0546)
$LogDIS_{i,j}$	−1.0391***	−0.8989***	−1.0271***	−1.0126***	−1.0238***	−1.0242***	−1.0087***
	(0.1328)	(0.1478)	(0.1377)	(0.1375)	(0.1376)	(0.1365)	(0.1361)
$NIM_{Lender,t}$	−0.0780**	−0.0931***	−0.1179***	−0.1177***	−0.1152***	−0.1179***	−0.1176***
	(0.0310)	(0.0308)	(0.0301)	(0.0300)	(0.0305)	(0.0301)	(0.0301)
$NIM_{borrower,t}$	0.0263	0.0632**	0.0565**	0.0495*	0.0555*	0.0563**	0.0491*
	(0.0291)	(0.0283)	(0.0280)	(0.0276)	(0.0284)	(0.0279)	(0.0275)
$FinFreedom_{lender,t}$	0.0095***	0.0084**	0.0084***	0.0078**	0.0084***	0.0091***	0.0084***
	(0.0033)	(0.0033)	(0.0032)	(0.0032)	(0.0032)	(0.0033)	(0.0032)
$FinFreedom_{borrower,t}$	0.0041	0.0043*	0.0025	0.0032	0.0025	0.0025	0.0032
	(0.0026)	(0.0025)	(0.0025)	(0.0026)	(0.0025)	(0.0025)	(0.0025)
$CU_{i,j,t}$	−0.0409	−0.1911	−0.1009	−0.0924	−0.0976	−0.1006	−0.0919
	(0.1496)	(0.1466)	(0.1469)	(0.1463)	(0.1476)	(0.1464)	(0.1456)
$Border_{i,j}$		−0.0182	−0.3920	−0.3694	−0.3870	−0.3850	−0.3601
		(0.3024)	(0.3102)	(0.3086)	(0.3102)	(0.3079)	(0.3059)
$Lang_{i,j}$		1.2298***	1.2455***	1.3245***	1.2437***	1.2382***	1.3171***
		(0.3125)	(0.3160)	(0.3149)	(0.3153)	(0.3151)	(0.3138)
$EU_{i,j,t}$		0.5840***	0.5945***	0.6544***	0.5946***	0.5907***	0.6500***
		(0.0957)	(0.0949)	(0.0946)	(0.0951)	(0.0958)	(0.0956)
$EU_{2011,q3\ i,j,t}$			−0.2454***	−0.2556***	−0.2458***	−0.2469***	−0.2560***
			(0.0483)	(0.0485)	(0.0483)	(0.0482)	(0.0484)
$Boone_{lender,t}$				0.5073***			0.4781***
				(0.1619)			(0.1646)
$Boone_{borrower,t}$				−0.6397***			−0.6373***
				(0.1384)			(0.1377)
$Concentration_{lender,t}$					0.0010		
					(0.0023)		
$Concentration_{borrower,t}$					−0.0005		
					(0.0024)		
$Lerner_{lender,t}$						0.1931***	0.1772***
						(0.0503)	(0.0518)
$Lerner_{borrower,t}$						−0.0832	−0.0724
						(0.0975)	(0.0958)
Constant	−17.8830***	−16.0447***	−19.6946***	−19.3049***	−19.7855***	−19.7469***	−19.3353***
	(1.8859)	(1.8415)	(1.6561)	(1.6425)	(1.7231)	(1.6321)	(1.6131)
Observations	31,532	31,532	31,532	31,532	31,532	31,532	31,532
R^2	0.5238	0.5343	0.5350	0.5345	0.5352	0.5357	0.5353
R^2 - within	0.1493	0.1604	0.1705	0.1786	0.1705	0.1720	0.1799
R^2 - between	0.5853	0.5951	0.5979	0.5955	0.5980	0.5997	0.5974
LM test $\sim\chi^2(1)$	5000***	5000***	5000***	5000***	4900***	5000***	4900***

Note: The dependent variable is the log of exchange-rate adjusted volume of cross-border loans in millions of US dollar between the lender-borrower country. For each independent variable, the second row shows the standard error, which is heteroskedasticity robust and clustered by country pair. LM test for random effect. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. All regressions have 530 country pairs'.

suggesting trade and banking links remain important even in our set of high income countries. The bilateral distance coefficient is negative and significant at the 1% level across all regressions indicating a decrease in the volume of lending with distance between lender and borrower countries, suggesting distance makes it more difficult to monitor borrowers because of increasing transaction costs. We should note that the distance coefficient is larger than the borrower country size effect, but smaller than the lender country effect. In our preferred explanation in column 7 of Table 2, for instance, a 1% increase in lender, or home, country size raises lending by 1.20%, whilst a 1% increase in distance reduces lending by 1.01%, and an increase in borrower country size raises borrowing by 0.95%. We have shown above that lender factors have significantly different coefficients from the equivalent borrower coefficients, with many of the lender effects larger in absolute size than the equivalent borrower effects.

7. Robustness of empirical findings

We undertake four sets of robustness tests, with the first covering the problem of missing observations in our pairs of countries, and we also look at the effect of varying the date frame for our regressions, as the last year has weaker data than earlier periods. The second set of robustness tests involves looking at the biases induced by the inclusion of insignificant variables that are not orthogonal to other variables in the data set. The third set involves investigating alternative definitions of risk and of the pattern of lending in the Euro area especially to countries where loan defaults rose after 2008, whilst our fourth set involves looking at the role of financial centres reflected in the size of the home and host financial sector as alternative determinants of cross border lending.

We have expressed some concern about the missing members of our panel that result from reporting restrictions, although we are not concerned about zeros in the panel as they represent under 2% of our total observations. The reporting problem is particularly severe for Ireland, Finland and Canada, and we eliminate them from the data set and test to see if the coefficients are unchanged. Around a fifth of the missing observations are in the Irish data, whilst Finland and Canada have more than a thousand missing observations. In column 1 of Table 3 we repeat

Table 3
Robustness tests-missing observations.

This table presents the results on the gravity model in cross border lending from advanced to EU countries covering the problem of missing observations, the last column shows the effect of varying the date frame for our regressions.

Variables	Without Ireland	Without Canada	Without Finland	Without the three countries	Data stopping in 2015Q4
$LogGDP_{lender,t}$	1.3697***	1.2004***	1.2238***	1.3972***	1.2954***
	(0.1418)	(0.1420)	(0.1423)	(0.1491)	(0.1397)
$LogGDP_{borrower,t}$	0.9375***	0.9523***	0.9583***	0.9582***	0.9658***
	(0.1186)	(0.1220)	(0.1184)	(0.1254)	(0.1198)
$LogBEXP_{i,j,t}$	0.2194***	0.2721***	0.2459***	0.2300***	0.2375***
	(0.0540)	(0.0583)	(0.0550)	(0.0584)	(0.0541)
$LogDIS_{i,j}$	−1.1293***	−0.9381***	−1.0300***	−1.0766***	−1.0800***
	(0.1370)	(0.1415)	(0.1375)	(0.1454)	(0.1373)
$NIM_{Lender,t}$	−0.0755***	−0.1134***	−0.1355***	−0.0866***	−0.1082***
	(0.0287)	(0.0315)	(0.0314)	(0.0316)	(0.0291)
$NIM_{borrower,t}$	0.0507*	0.0518*	0.0474*	0.0512*	0.0341
	(0.0276)	(0.0279)	(0.0276)	(0.0282)	(0.0253)
$FinFreedom_{lender,t}$	0.0040	0.0091***	0.0107***	0.0070**	0.0086***
	(0.0032)	(0.0033)	(0.0033)	(0.0033)	(0.0032)
$FinFreedom_{borrower,t}$	0.0038	0.0028	0.0032	0.0033	0.0021
	(0.0025)	(0.0026)	(0.0025)	(0.0026)	(0.0025)
$CU_{i,j,t}$	−0.0890	−0.1010	−0.0663	−0.0739	−0.0666
	(0.1464)	(0.1460)	(0.1480)	(0.1491)	(0.1416)
$Border_{i,j}$	−0.5218*	−0.2760	−0.4217	−0.4789	−0.4707
	(0.3053)	(0.3200)	(0.3085)	(0.3178)	(0.3148)
$Lang_{i,j}$	1.3624***	1.1274***	1.3024***	1.1319***	1.3070***
	(0.2806)	(0.3717)	(0.3177)	(0.3334)	(0.3159)
$EU_{i,j,t}$	0.6502***	0.6341***	0.6941***	0.6760***	0.6526***
	(0.0960)	(0.0962)	(0.0952)	(0.0963)	(0.0921)
$EU_{2011,q3\ i,j,t}$	−0.1904***	−0.2605***	−0.2794***	−0.2145***	−0.2413***
	(0.0470)	(0.0494)	(0.0496)	(0.0493)	(0.0469)
$Boone_{lender,t}$	0.3155**	0.4885***	0.8845***	0.6348***	0.3742**
	(0.1580)	(0.1664)	(0.2257)	(0.2222)	(0.1549)
$Boone_{borrower,t}$	−0.6337***	−0.6689***	−0.6426***	−0.6750***	−0.4693***
	(0.1380)	(0.1429)	(0.1432)	(0.1492)	(0.1057)
$Lerner_{lender,t}$	0.1594***	0.2358***	0.1891***	0.2454***	0.1546***
	(0.0513)	(0.0711)	(0.0573)	(0.0867)	(0.0460)
$Lerner_{borrower,t}$	−0.0761	−0.0634	−0.0686	−0.0607	−0.0247
	(0.0940)	(0.0968)	(0.0978)	(0.0976)	(0.0770)
Constant	−19.8454***	−20.3452***	−19.6677***	−21.1737***	−20.0028***
	(1.6591)	(1.6449)	(1.6772)	(1.7653)	(1.6279)
Observations	30,819	30,458	30,636	28,849	29,647
R^2	0.5280	0.5332	0.5346	0.5229	0.5324
R^2 - within	0.1818	0.1831	0.1921	0.1960	0.2047
R^2 - between	0.5867	0.5953	0.5958	0.5771	0.5876
Country pairs	502	502	502	466	530
LM test $\sim\chi^2(1)$	4900***	4800***	4900***	4700***	4700***

Note: As Table 2. All regressions cluster country pairs.
***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

our analysis from column 7 of Table 2 and omit Ireland completely. A Wald test, based on our prior that the missing observations are statistical problem not a structural one, of the equality of coefficients across the with Ireland and without Ireland equations was passed with a Chi^2 (17) of 5.49 (prob. 0.9960). We also experimented with similar tests for Canada and Finland, the other countries with a large number of stocks that are not reported, and the results are reported in columns 2 and 3 of Table 3, whilst column 4 excludes the three countries. The Wald test for the similarity of coefficients for Canada and Finland respectively are Chi^2 (17) of 2.63 with a probability of 1.0000 and Chi^2 (17) of 10.33 with a probability of 0.8893. Even when we exclude the three countries together the overall coefficient set is statistically no different from the full sample, with a Chi^2 (17) of 0.00 with a probability of 1.0000. We conclude that our results are robust to the absence of data for confidentiality reasons. Data quality also declines at the end of our sample,[16] as is common, so in column 5 of Table 3 we repeat our analysis in column 7 of Table 2, but with data stopping in 2015Q4. The Wald test for the similarity of coefficients is Chi^2 (17) of 3.56 with a probability of 0.9998.

We have three variables that are never significant, $FinFreedom_{borrower}$ Index, Currency Union dummy and common Border, and these may bias our results as they are not necessarily orthogonal to other included variables such as membership of the EU. As Greene (2012, p183) notes, omitting a relevant variable will cause biases to the coefficients on the remaining variables unless the omitted variable is orthogonal to the included one. He also notes that is also true that including a variable that is irrelevant to the model in question which is not orthogonal to other regressors will induce biases in the coefficients on the other included variable. One therefore needs a method to assess relevance. Theory or our understanding may tell us which variables to include, and although we can see a case for including $FinFreedom_{borrower}$, a Currency Union indicator and Borders, they are not significant. As we can see from Table 4, omitting these variable one at a time in columns 1, 2 and 3 does not change the results of our regression, with Chi^2 (16) = 0.12 (prob 1.000) test for the similarity of the other coefficients to those in column 7 of Table 2 for column 1, Chi^2 (16) = 0.62 (prob 1.000) for column 2 and Chi^2 (16) = 0.10 (prob 1.000) for column 3. In particular, Border and Currency Union may not be orthogonal to EU membership, but their omission does not change the size and significance of our EU indicators. Even when we eliminate

[16] A significant number of the observations of the indicators of bank competition and efficiency are missing in 2016.

Table 4
Robustness tests-excluding irrelevant and insignificant variables.
This table presents the results on the gravity model in cross border lending from advanced to EU countries excluding irrelevant and insignificant variables from the determinants of cross border lending stocks.

Variables	Column (1)	Column (2)	Column (3)	Column (4)
$LogGDP_{lender,t}$	1.2054***	1.1887***	1.2045***	1.2063***
	(0.1406)	(0.1385)	(0.1404)	(0.1400)
$LogGDP_{borrower,t}$	0.9602***	0.9435***	0.9411***	0.9532***
	(0.1155)	(0.1164)	(0.1159)	(0.1142)
$LogBEXP_{i,j,t}$	0.2547***	0.2531***	0.2501***	0.2514***
	(0.0546)	(0.0546)	(0.0548)	(0.0548)
$LogDIS_{i,j}$	−1.0183***	−0.9731***	−1.0115***	−0.9810***
	(0.1366)	(0.1266)	(0.1363)	(0.1272)
$NIM_{Lender,t}$	−0.1159***	−0.1177***	−0.1167***	−0.1147***
	(0.0301)	(0.0301)	(0.0302)	(0.0303)
$NIM_{borrower,t}$	0.0456	0.0489*	0.0475*	0.0433
	(0.0279)	(0.0275)	(0.0275)	(0.0281)
$FinFreedom_{lender,t}$	0.0085***	0.0084***	0.0082**	0.0083***
	(0.0032)	(0.0032)	(0.0032)	(0.0032)
$FinFreedom_{borrower,t}$		0.0032	0.0034	
		(0.0025)	(0.0025)	
$CU_{i,j,t}$	−0.1035	−0.0926		
	(0.1455)	(0.1456)		
$Border_{i,j}$	−0.3968		−0.3772	
	(0.3091)		(0.3066)	
$Lang_{i,j}$	1.3266***	1.1719***	1.3180***	1.1593***
	(0.3162)	(0.2829)	(0.3126)	(0.2857)
$EU_{i,j,t}$	0.6482***	0.6516***	0.6339***	0.6316***
	(0.0957)	(0.0953)	(0.0969)	(0.0970)
$EU_{2011,q3\ i,j,t}$	−0.2626***	−0.2552***	−0.2610***	−0.2678***
	(0.0485)	(0.0484)	(0.0480)	(0.0481)
$Boone_{lender,t}$	0.4751***	0.4777***	0.4780***	0.4744***
	(0.1649)	(0.1646)	(0.1649)	(0.1653)
$Boone_{borrower,t}$	−0.6273***	−0.6376***	−0.6392***	−0.6293***
	(0.1372)	(0.1377)	(0.1382)	(0.1376)
$Lerner_{lender,t}$	0.1759***	0.1774***	0.1770***	0.1758***
	(0.0521)	(0.0518)	(0.0519)	(0.0522)
$Lerner_{borrower,t}$	−0.0815	−0.0717	−0.0731	−0.0821
	(0.0958)	(0.0958)	(0.0961)	(0.0961)
Constant	−19.3542***	−19.4899***	−19.3175***	−19.5184***
	(1.6163)	(1.6396)	(1.6119)	(1.6435)
Observations	31,532	31,532	31,532	31,532
R^2	0.5351	0.5357	0.5361	0.5364
R^2 - within	0.1795	0.1799	0.1796	0.1791
R^2 - between	0.5970	0.5977	0.5986	0.5986
LM test $\sim\chi^2(1)$	4900***	4900***	4900***	5000***

NOTE: As Table 2. All regressions cluster country pairs.
***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

all three variables, as we do in column 4, there are no significant changes as is indicated by the Chi^2 (14) = 0.82 (prob 1.000) for this test of the similarity between the core coefficients in column 7 of Table 2 and this regression. We can see that the inclusion of insignificant variables has not influenced our results but has rather allowed us to test hypotheses on the importance of these three indicators, none of which seem to impact in any way on cross border lending.

Banks face default and write down risks across all countries they operate in, and these vary across countries and over time. For instance, after the financial crisis in 2007–2008 non-performing loans rose markedly in Spain, Greece, Ireland and the other smaller counties of Eastern and Southern Europe. This development is stressed by Emter et al. (2018), and they acknowledge that associated risk premia will also have risen. We can investigate this latter effect by looking at our core regressions and adding variables to them. In Table 5, columns 1 to 3 we add Euro Area dummies to or core regression in column 7 of Table 2. We first add a pair of dummies to see if the Euro Area members as of 1999 (see Appendix A) differ from the rest of the EU members. The first dummy is 1 for the 1999 members, and 0 otherwise, whilst the second dummy covers the same group but is zero before 2011q3 and 1 thereafter. As we can see, there is no evidence that this group was different from the rest in the core regression, and a Chi^2 (17) of the equality of coefficients between this regression and column 7 of Table 2 is 0.38 (prob = 1.000). In column 2 we undertake the same test for the post-1999 members, which includes Greece, and in column 3 Spain, Portugal and Ireland move in to this group, and we again test to see if the intercept dummy and the break dummy are significant. As we can see there is evidence that lending fell more to these countries than would have been anticipated after 2011q3, although there were no significant differences before that date. Hence banks either applied a risk premium to lending to these countries, or faced pressure from domestic regulators to pull back from them. In each case we test to see if the core coefficients change, and we find they do not. In neither case are the coefficients of the core regression different from column 7 of Table 2, with a Chi^2 (17) of 9.12 (prob 0.936) for column 2 and Chi^2 (17) of 10.98 (prob 0.858) for column 3. These coefficients could either indicate banks were placing a higher risk premium on lending to these countries, or that there was pressure from domestic regulators to reduce their risky lending to periphery countries. It is useful to test between these hypotheses, and we do so below.

Clearly the periphery countries suffered more in the wake of the crisis, with larger falls in lending than other countries. However, as our tests for common coefficients indicate, our core explanation still holds, even though either risk premia associated with lending or regulatory

Table 5
Robustness tests-the Euro area periphery.

This table presents the results on the gravity model in cross border lending from advanced to EU countries by investigating alternative definitions of risk and of the pattern of lending in the Euro area especially to countries where loan defaults rose after 2008.

Variables	Column (1)	Column (2)	Column (3)
$LogGDP_{lender,t}$	1.1988***	1.0824***	1.0892***
	(0.1398)	(0.1439)	(0.1437)
$LogGDP_{borrower,t}$	0.9391***	0.8975***	0.9090***
	(0.1180)	(0.1163)	(0.1156)
$LogBEXP_{i,j,t}$	0.2538***	0.2596***	0.2581***
	(0.0544)	(0.0546)	(0.0544)
$LogDIS_{i,j}$	−0.9960***	−0.8937***	−0.9197***
	(0.1348)	(0.1390)	(0.1377)
$NIM_{Lender,t}$	−0.1161***	−0.1233***	−0.1186***
	(0.0300)	(0.0298)	(0.0293)
$NIM_{borrower,t}$	0.0507*	0.0493*	0.0533*
	(0.0272)	(0.0272)	(0.0272)
$FinFreedom_{lender,t}$	0.0087***	0.0087***	0.0089***
	(0.0032)	(0.0032)	(0.0032)
$FinFreedom_{borrower,t}$	0.0034	0.0031	0.0032
	(0.0026)	(0.0025)	(0.0025)
$CU_{i,j,t}$	−0.1061	0.6077*	0.6352
	(0.1483)	(0.3495)	(0.3991)
$Border_{i,j}$	−0.4166	−0.4049	−0.4201
	(0.3095)	(0.3198)	(0.3198)
$Lang_{i,j}$	1.3170***	1.3317***	1.2452***
	(0.3148)	(0.3187)	(0.3230)
$EU_{i,j,t}$	0.6462***	0.6633***	0.6525***
	(0.0954)	(0.0962)	(0.0963)
$EU_{2011,q3\ i,j,t}$	−0.2346***	−0.1921***	−0.1597***
	(0.0517)	(0.0510)	(0.0493)
$Boone_{lender,t}$	0.4607***	0.4566***	0.4128**
	(0.1616)	(0.1633)	(0.1608)
$Boone_{borrower,t}$	−0.6500***	−0.6234***	−0.6575***
	(0.1379)	(0.1373)	(0.1388)
$Lerner_{lender,t}$	0.1801***	0.1766***	0.1856***
	(0.0513)	(0.0513)	(0.0513)
$Lerner_{borrower,t}$	−0.0709	−0.0670	−0.0611
	(0.0958)	(0.0958)	(0.0951)
1999 CU members $_{i,j,t}$	0.2730		
	(0.2660)		
1999 CU members $_{2011q3\ i,j,t}$	−0.0864		
	(0.1362)		
Post 1999 CU members $_{i,j,t}$		−0.4200	
		(0.3742)	
Post 1999 CU members $_{2011q3i,j,t}$		−0.5436***	
		(0.1486)	
Post 1999 CU members + SPI			−0.5508
			(0.4260)
Post 1999 CU members + $SPI_{2011q3\ i,j,t}$			−0.4069***
			(0.1474)
Constant	−19.4773***	−18.3363***	−18.3280***
	(1.5919)	(1.6168)	(1.6766)
Observations	31,532	31,532	31,532
R^2	0.5363	0.5378	0.5361
R^2 - within	0.1801	0.1855	0.1859
R^2 - between	0.5987	0.5998	0.5960
LM test $\sim\chi^2(1)$	4900***	4900***	4900***

***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

constraints clearly rose in relation to these countries. It is possible to test between these two sources of constraint, and it appears that the regulatory argument may be more powerful. In column 1 of Table 5a we add a more general indicator of political risk using the World Governance Indicators measure of Political Stability. As we can see, neither the home nor host indicators are significant, and the core model coefficients are similar to those in column 7 Table 2, with a Chi^2 (17) of 0.09 (prob 1.000) and hence we do not need to amend our model of lending from advanced countries to a group of relatively stable European countries. In column 2 of Table 5a we add data on the proportion of non-performing loans in the banking sector in each of our countries, and we note that they are not significant and a test for the similarity of

Table 5a
Robustness tests-political risks and the Euro area periphery.

Variables	Column (1)	Column (2)
$LogGDP_{lender,t}$	1.1767***	1.1747***
	(0.1385)	(0.1498)
$LogGDP_{borrower,t}$	0.9541***	0.8733***
	(0.1181)	(0.1181)
$LogBEXP_{i,j,t}$	0.2563***	0.2696***
	(0.0547)	(0.0537)
$LogDIS_{i,j}$	−0.9946***	−0.9237***
	(0.1359)	(0.1411)
$NIM_{Lender,t}$	−0.1210***	−0.1034***
	(0.0294)	(0.0323)
$NIM_{borrower,t}$	0.0493*	0.0347
	(0.0277)	(0.0277)
$FinFreedom_{lender,t}$	0.0086***	0.0106***
	(0.0033)	(0.0033)
$FinFreedom_{borrower,t}$	0.0031	0.0034
	(0.0025)	(0.0028)
$CU_{i,j,t}$	−0.0939	0.6105
	(0.1459)	(0.4036)
$Border_{i,j}$	−0.3574	−0.4455
	(0.3077)	(0.3253)
$Lang_{i,j}$	1.3428***	1.2088***
	(0.3189)	(0.3162)
$EU_{i,j,t}$	0.6604***	0.6803***
	(0.0960)	(0.1065)
$EU_{2011,q3\ i,j,t}$	−0.2624***	−0.1655***
	(0.0467)	(0.0508)
$Boone_{lender,t}$	0.4679***	0.4049**
	(0.1633)	(0.1672)
$Boone_{borrower,t}$	−0.6305***	−0.6675***
	(0.1390)	(0.1408)
$Lerner_{lender,t}$	0.1791***	0.1681***
	(0.0532)	(0.0512)
$Lerner_{borrower,t}$	−0.0723	−0.0828
	(0.0959)	(0.0926)
Post 1999 CU members + SPI		−0.5235
		(0.4329)
Post 1999 CU members + $SPI_{2011q3\ i,j,t}$		−0.4167***
		(0.1459)
$Political\ Stability_{lender,t}$	0.0019	
	(0.0022)	
$Political\ Stability_{borrower,t}$	−0.0031	
	(0.0026)	
$Non\text{-}performing\ loans_{borrower,t}$		−0.0046
		(0.0054)
$Non\text{-}performing\ loans_{lender,t}$		0.0081
		(0.0060)
Constant	−19.2541***	−19.3654***
	(1.8096)	(1.7049)
Observations	31,532	29,862
R^2	0.5349	0.5515
R^2 - within	0.1805	0.1710
R^2 - between	0.5958	0.5940
Country pairs	530	527
LM test $\sim\chi^2(1)$	4900***	4100***

***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

the core coefficients is passed with Chi^2 (17) equal to 11.78 (prob 0.813). The additional risks posed by defaults in these countries are clearly best measured by a dummy variable that can cover a large range of possible indicators. This may reflect the primacy of lender driven factors, such as the impact of stronger regulation by home country authorities, as Emter et al. (2018) suggest.

Not all countries are equal, and not all countries contributions to international financial integration are best measured by their GDP. There are a number of other ways to look at home country size, and we look at home country banking sector size, and add an indicator of this to our regression to investigate whether other coefficients in our regression are little changed from those in Table 2, column 7. We measure the size of the financial sector by the assets of deposit taking banks as a share of GDP. Just before the financial crisis (2006) his varied between 58% in the US and 178% in Denmark in our countries, with the UK, Japan and

Table 6
Robustness tests-testing for financial centre effects.

This table presents the results on the gravity model in cross border lending, looking at the role of financial centres reflected in the size of the home and host financial sector as alternative determinants of cross border lending from advanced to EU countries.

Variables	Column (2)	Column (1)	Column (3)
$LogGDP_{lender,t}$	1.1236***	1.2174***	1.1606***
	(0.1406)	(0.1325)	(0.1332)
$LogGDP_{borrower,t}$	0.9646***	0.9209***	0.9354***
	(0.1170)	(0.1195)	(0.1188)
$LogBEXP_{i,j,t}$	0.2304***	0.2308***	0.2159***
	(0.0544)	(0.0544)	(0.0545)
$LogDIS_{i,j}$	−0.9984***	−0.9951***	−0.9845***
	(0.1343)	(0.1324)	(0.1312)
$NIM_{Lender,t}$	−0.1071***	0.0101	0.0149
	(0.0302)	(0.0290)	(0.0290)
$NIM_{borrower,t}$	0.0808***	0.0523*	0.0752***
	(0.0261)	(0.0281)	(0.0271)
$FinFreedom_{lender,t}$	0.0074**	0.0052	0.0047
	(0.0032)	(0.0032)	(0.0032)
$FinFreedom_{borrower,t}$	0.0015	0.0027	0.0014
	(0.0025)	(0.0024)	(0.0024)
$CU_{i,j,t}$	−0.0160	−0.0546	0.0003
	(0.1465)	(0.1397)	(0.1402)
$Border_{i,j}$	−0.3262	−0.2733	−0.2494
	(0.3059)	(0.3026)	(0.3022)
$Lang_{i,j}$	1.2868***	1.3822***	1.3548***
	(0.3171)	(0.3129)	(0.3155)
$EU_{i,j,t}$	0.6287***	0.5512***	0.5387***
	(0.0962)	(0.0942)	(0.0943)
$EU_{2011,q3\ i,j,t}$	−0.2755***	−0.3154***	−0.3277***
	(0.0481)	(0.0477)	(0.0475)
$Boone_{lender,t}$	0.4835***	0.5768***	0.5786***
	(0.1633)	(0.1530)	(0.1529)
$Boone_{borrower,t}$	−0.5582***	−0.5949***	−0.5385***
	(0.1378)	(0.1369)	(0.1375)
$Lerner_{lender,t}$	0.1774***	0.0870	0.0942
	(0.0513)	(0.0682)	(0.0678)
$Lerner_{borrower,t}$	−0.1108	−0.0279	−0.0570
	(0.0963)	(0.0906)	(0.0916)
Financial sector $size_{lender,t}$		0.0103***	0.0099***
		(0.0010)	(0.0010)
Financial sector $size_{borrower,t}$	0.0043***		0.0032***
	(0.0011)		(0.0010)
Constant	−18.5060***	−20.0670***	−19.4387***
	(1.6631)	(1.6013)	(1.6405)
Observations	31,532	31,049	31,049
R^2	0.5456	0.5318	0.5407
R^2 - within	0.1864	0.2153	0.2189
R^2 - between	0.6078	0.5989	0.6078
Country pairs	530	522	522
LM test $\sim\chi^2(1)$	4800***	5000***	4900***

NOTE: As Table 2. All regressions cluster country pairs.
***, **, and * indicate significance at the 1%, 5% and 10% level, respectively.

Switzerland having persistently high levels, along with Ireland, Portugal and Spain in the run up to and in the immediate aftermath of the crisis. This ratio is high for many of the home countries Lane and Milesi-Ferretti (2017) describe as financial centres. In column 1 we add host country banking sector size, and it is significant. However, our base regression is little altered, and if we test the differences between the coefficients in column 1 from those of column 7 of Table 2 we find a Chi^2 (17) of 6.23 (prob 0.992). As we can see in column 2 of Table 6, the higher the assets of the home banking system as a percent of GDP the more cross border banking it undertakes, and we should note that its coefficient is significant and more than twice the size of the host country effect. We then add both indicators of financial sector size to our model, and once again the variables are significant, but they would not lead us to change our underlying model very much. The addition of home country asset size in columns 2 and 3 does change the core coefficients, with a Chi^2 (17) of 32.52 (prob 0.013) for column 2 and Chi^2 (17) of 40.96 (prob 0.001) for column 3. Clearly home banking sector size matters. However, it impacts almost entirely on the structural competition indicators, the Boone and Lerner indices and the NIM, and if we exclude these from our test of the similarity of parameters to column 7 of Table 2 we find the other, core gravity model parameters are statistically the same with a Chi^2 (11) of 11.25 (prob 0.422), This result reinforces our conclusion that the characteristics of the home banking market and the home country are more important than the characteristics of the host country.

8. Conclusion

In this paper we shed light on the main drivers of cross-border banking directed toward the EU over the period 1999–2016 using a model based on the gravity approach to international financial transaction that has been common in the literature at least since Portes and Rey (2005). Our main findings show that there is clear evidence of lender country advantages helping to drive cross border lending. In addition, less competitive lender markets appear to have an advantage over more competitive borrowers, with less competitive, and larger, home markets doing more foreign lending than their size and other factors would suggest. More competitive host markets do more foreign borrowing than other factors would suggest. The effects of size are more important in lender countries, and increased scale may make cross border lending more profitable. In general, we would conclude that we should discuss our model as one describing markets, rather than as a simple application of the general principle of gravity.

Simple gravity models work, but are clearly mis-specified. Home and host similarity can be imposed. Theory based gravity models suggest these models are not well adumbrated and suggest adding extra frictions. We find that adding EU and Language indicators significantly change the model, with home characteristics becoming more dominant. In addition, the EU indicator is significant, whilst the Euro Area indicator is not, even when included on its own. Many of our EU observations are not Euro Area pairs, and the correlation is only 0.5. Hence, we can argue that the model can distinguish between the two, and it is the existence of the Single Market in Financial Services that matters for increasing cross border lending, and not the existence of a common currency. Almost two decades after its inception, the Euro Area does not appear to significantly facilitate cross country lending, as membership of the Euro Area is insignificant across all our specifications.

The conclusion on the importance of the EU is strengthened by our investigation of the impacts of the 2011 Euro Area sovereign debt crisis on patterns of lending, when a significant fall in lending took place. The crisis led to increased default rates in periphery economies such as Spain, Portugal, Greece and Ireland and also to a significant drop in lending to these countries from others. In our robustness analysis we look at the impact of increased risk on lending, first by investigating the role of country specific effects, which might reflect increased risk premia in hosts or increased regulatory constraints in home countries. We showed that host country specific factors were not significant, first by adding a political risk indicator that rose in importance over time, and then by adding an indicator of non-performing loans. In neither case were these hosts' specific indicators significant, although we would have expected them to be if the major cause of the decline in lending was the result of higher risk in host countries. We conclude therefore that domestic regulators had a significant impact on home country lenders, constraining them from lending to countries that were considered risky.

The role of home countries in deriving the scale of cross border lending is shown by our core results, which suggest home country capabilities, as measured by GDP, are 20% more important than host country size. In addition, only home country capacities, as measured by Financial Freedom indicators are significant. Home country returns are also more important than those in the host, at least as measured by net interest margins, with higher home returns reducing the level of cross border lending. Host margins are often not significant. It would appear domestic capacities plus a search for returns are major factors driving lending. In additions frictions such as distance and facilitating factors

such as a common language and the importance of bilateral trade have significant impacts on levels of lending between home and host. Most of these patterns are repeated throughout our robustness checks, and remain in place even when we add new indicators of home and host capacities.

A major focus of the paper concerns the role of market contestability and domestic competition on cross border lending. As such our paper has a 'New Industrial Economics' focus, rather than a macroeconomic one. We look at the impact of industrial structure, as measured by a concentration ratio, and at measures of industrial efficiency and competition and monopoly. We find no role for simple concentration ratios in our analysis, but our measure of competition, the Boone index, is significant in both home and host economies. Our measure of monopoly power, the Lerner index is significant only in home economies. The impacts of industrial structure are clear, with more monopolise, less competitive home markets being more likely to penetrate more competitive host markets.

Industrial structure affects industry capacity, and these factors may interact. Although GDP is considered generally the best indicator of the capacity to produce products, it is not the only one we consider. We also look at the size of the domestic banking industry, as indicated by the assets of deposit taking banks as a share of GDP. Some countries, such as the UK and Switzerland, have significant levels of banking sector activity, and this measure should pick out such centres. As we would expect, including host country banking sector size indicators has an impact, but does not change our underlying parameters significantly. However, home country banking sector size has a positive impact on the level of cross border lending, but it leaves the explanation by the core gravity variables, distance, export links, capacity to produce as indicated by GDP and international factors such as the EU unchanged. However, the size of the home banking sector draws some of the explanation provided by other sector specific indicators such as the NIM and the Lerner index, but it also leaves the importance of the Boone competition indicator unchanged.

Our results have clear policy implications both for the EU and for individual countries. Cross border lending has both positive and negative effects, increasing efficiency of capital allocation in good times and propagating risks from home to host and from host to home in bad times. A combination of both more careful regulation of cross border activities and an increase in competition in home economies could reduce the level of lending and increase its quality. If combined with the reduction in barriers to cross border lending that are associated with legal system and other institutional characteristics this could lead to both more and better judged lending across borders. Some of these features may be encouraged in the Euro Area by the slow move toward common regulation of banks by the European Central Bank, which should enhance efficiency and increase competition without threatening financial stability.

European integration and increased market contestability has been a major factor in increasing cross border banking. In particular, the membership of the European Union's Single Market, rather than membership of the Currency Union, has raised cross border lending significantly, and we would estimate that by 2016 it had raised market integration significantly, and lending stocks within the market were around 40% more than could be expected given other economic and cultural factors. Ignoring a specific role for the European integration agenda and its effects will bias academic results in the area. It is also clear that gains in integration can be reversed. We show clear evidence that the Euro Area sovereign debt crisis that followed on from the Greek debt problem may have permanently reduced cross border banking in the European Union, and especially to the initial Euro Area periphery countries Ireland, Spain and Portugal as well as too the periphery countries that joined subsequently. The decline in cross border lending probably removing two fifths of the gains from integration in this market that were made over the previous decade.

All academic studies are limited by data constraints, and we can only analyse lending from 19 lender countries. It would be useful to know if our results on the primacy of lender characteristics and the importance of relative efficiency hold in other borrower markets, and not just in those in advanced European Economies.

Appendix A. Countries included in the sample.

Lender countries (19)	EU countries (accession dates)	Currency union (dates)	European borrower countries	EU countries (accession dates)	Currency union (dates)
Australia	–	–	Austria	1995-Q1	1999-Q1
Austria	1995-Q1	1999-Q1	Belgium	1958-Q1	1999-Q1
Belgium	1958-Q1	1999-Q1	Bulgaria	2007-Q1	–
Canada	–	–	Croatia	2013-Q3	–
Denmark	1973-Q1	–	Cyprus	2004-Q2	2008-Q1
Finland	1995-Q1	1999-Q1	Czech Republic	2004-Q2	–
France	1958-Q1	1999-Q1	Denmark	1973-Q1	–
Germany	1958-Q1	1999-Q1	Estonia	2004-Q2	2011-Q1
Greece	1981-Q1	2001-Q1	Finland	1995-Q1	1999-Q1
Ireland	1973-Q1	1999-Q1	France	1958-Q1	1999-Q1
Italy	1958-Q1	1999-Q1	Germany	1958-Q1	1999-Q1
Japan	–	–	Greece	1981-Q1	2001-Q1
Netherlands	1958-Q1	1999-Q1	Hungary	2004-Q2	–
Portugal	1986-Q1	1999-Q1	Ireland	1973-Q1	1999-Q1
Spain	1986-Q1	1999-Q1	Italy	1958-Q1	1999-Q1
Sweden	1995-Q1	–	Latvia	2004-Q2	2014-Q1
Switzerland	–	–	Lithuania	2004-Q2	2015-Q1
United Kingdom	1973-Q1	–	Luxembourg	1958-Q1	1999-Q1
United States	–	–	Malta	2004-Q2	2008-Q1
			Netherlands	1958-Q1	1999-Q1
			Poland	2004-Q2	–
			Portugal	1986-Q1	1999-Q1
			Romania	2007-Q1	–
			Slovakia	2004-Q2	2009-Q1
			Slovenia	2004-Q2	2007-Q1
			Spain	1986-Q1	1999-Q1
			Sweden	1995-Q1	–
			Switzerland	–	–
			United Kingdom	1973-Q1	–

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