



Master Degree in Economics and Finance

Gravity in Bank Lending within the European Union

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ABSTRACT IN ENGLISH:

This paper investigates whether and how geographical distance matters for bank lending within and between countries in the European Union. We estimate gravity-type regressions in various specifications, incorporating novel econometric insights which have thus far not been applied in the context of bank lending. Using recently published, disaggregated data on banks' credit exposures from the European Banking Authority, we find the elasticity of lending with respect to distance to be -1.42 in our main specification. Controlling for various factors, the negative relationship remains persistent. We argue that this relationship is largely attributable to information costs, though cultural and historical ties between countries, capital requirements, local competition and cross-border trade also play a role. The analysis highlights the enduring influence of factors which prevent full European financial integration.

ABSTRACT IN CATALAN:

Aquest article investiga si i com la distància geogràfica és important per als préstecs bancaris dins i entre països de la Unió Europea. Estimem les regressions de tipus gravetat en diverses especificacions, incorporant nous coneixements econòmics que fins ara no s'han aplicat en el context dels préstecs bancaris. Utilitzant dades publicades recentment i desglossades sobre les exposicions de crèdit dels bancs de l'Autoritat Bancària Europea, trobem l'elasticitat dels préstecs respecte a la distància a -1.42 en la nostra especificació principal. Controlant diversos factors, la relació negativa continua sent persistent. Argumentem que aquesta relació és en gran part atribuïble als costos d'informació, tot i que els vincles culturals i històrics entre països, els requeriments de capital, la competència local i el comerç transfronterer també tenen un paper. L'anàlisi posa de manifest la influència duradora dels factors que impedeixen la plena integració financera europea.

KEYWORDS IN ENGLISH: Gravity model, international bank lending, European integration.

KEYWORDS IN CATALAN: Model de gravetat, préstecs bancaris internacionals, integració europea.



MASTER PROJECT

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List of Abbreviations

EBA	European Banking Authority
ESC	Eurovision Song Contest
EU	European Union
FDI	Foreign Direct Investment
FE	Fixed Effects
GDP	Gross Domestic Product
LPM	Linear Probability Model
OLS	Ordinary Least Squares
PPML	Poisson Pseudo-Maximum Likelihood

Abstract

This paper investigates whether and how geographical distance matters for bank lending within and between countries in the European Union. We estimate gravity-type regressions in various specifications, incorporating novel econometric insights which have thus far not been applied in the context of bank lending. Using recently published, disaggregated data on banks' credit exposures from the European Banking Authority, we find the elasticity of lending with respect to distance to be -1.42 in our main specification. Controlling for various factors, the negative relationship remains persistent. We argue that this relationship is largely attributable to information costs, though cultural and historical ties between countries, capital requirements, local competition and cross-border trade also play a role. The analysis highlights the enduring influence of factors which prevent full European financial integration.

JEL classification: F34, F36, G21.

Keywords: Gravity model, international bank lending, European integration.

1. Introduction

As 2017 has seen the European Union (EU) mark the 60th anniversary of the Treaty of Rome, the question of whether the proclaimed goal of an ever closer union has been achieved has again gained wide attention in public debate. Despite some precarious developments in the political realm, European financial integration, at least, has broadly returned to its steadily-rising track after the interruption caused by the Eurozone's financial crisis ([European Central Bank, 2017](#)). With national goods, services and financial markets moving closer together, the extent to which geographical distance still acts as a barrier to financial transactions is of great interest to policymakers and academics.

In the light of these considerations, this paper examines whether geographical distance plays a role in determining levels of bank lending within the EU. In addition, it seeks to identify the channels through which distance could affect lending decisions. Key candidates are information costs and institutional, regulatory and cultural differences. The study can thus be seen as shedding light on the current state of integration in the European banking market, and on the reasons for why market segmentation might still prevail.

However, we note that our analysis does not seek to assess potential time trends in the importance of distance to lending, nor do we generalise our results to be a broader commentary on the success of past or present policies related to the overall European financial integration project. Instead, what we will contribute is an evaluation of whether and why distance still restricts lending given the ease of the dissemination of information across Europe and the attempted harmonisation of European financial markets.

Our primary data source is a recently published dataset collected by the European Banking Authority (EBA) as part of its EU-wide transparency exercise in 2016. The data contains detailed information on capital levels, profit and loss metrics, and lending portfolios of major European banks. Of particular interest to us is the data on lending, disaggregated by the type of loan, from each bank to the ten largest countries to which it lends.

We base our empirical approach on a gravity-type regression commonly found in the trade and international finance literature. The general gravity model postulates that bilateral economic activity between two entities, such as trade or capital flows, should be proportional to their size and inversely related to their geographical distance ([Head and Mayer, 2015](#)). Unlike earlier papers on gravity in bank lending, our analysis will incorporate a bank-specific measure of economic size and make use of within-country heterogeneity in the location of bank headquarters.

Our empirical approach can be divided into four key elements. Firstly, we estimate a baseline regression equivalent to the standard gravity model to examine how well the gravity framework fits our data. Secondly, we apply a range of estimation techniques, namely ordinary least squares with fixed effects (OLS-FE), Poisson pseudo-maximum likelihood (PPML), and a linear probability model (LPM), in a variety of specifications, to identify a robust correlation between distance and international bank lending. In particular, we account for recent findings in the literature to adequately deal with problems stemming from inappropriate data transformations and selection bias (c.f. [Santos Silva and Tenreyro, 2006](#)), another factor setting our analysis apart from previous papers on similar questions. Thirdly, we attempt to identify the mechanisms through which distance could affect bank lending by successively introducing variables that proxy for potential channels. Finally, we also perform a similar analysis on different types of lending to examine whether distance has heterogeneous effects depending on the type of lending a bank is

engaging in.

We find that a standard gravity model fits the data reasonably well; in its most basic form, it can explain 70% of the variation in international bank lending in the EU, compared to an R^2 of around 80% generally found in the trade literature (Anderson, 2011). Furthermore, we establish a robust negative correlation between distance and international bank lending. Controlling for country- and bank-specific factors using fixed effects, the elasticity of lending with respect to distance is found to be -1.42 in our main specification.

When we introduce proxies for the potential channels through which distance may matter, we subsequently establish that cultural and historical ties, bilateral goods trade, and regulatory factors in financial markets explain some, but not all, of the relationship between lending and distance. On the other hand, we do not find evidence that loan portfolio diversification and governance quality in the borrowing country are significant motives for cross-border lending. Further analysis suggests that the persistent relationship between distance and lending is to a large extent accounted for by information costs. However, our identification strategy does not allow us to definitively attribute causal interpretation to our findings, as is the case with standard gravity estimations. Thus, we do not hypothesise beyond the strong correlation between distance and level of lending.

The remainder of the paper is structured as follows: Section 2 elaborates on the theoretical underpinnings of our analysis; we discuss potential reasons for which distance might be related to bank lending, introduce the gravity framework, and argue why it is appropriate for our investigations. Section 3 describes our data, while Section 4 details our estimation strategy. Our findings and a discussion of their implications are presented in Sections 5 and 6, before we conclude in Section 7.

2. Literature Review

We begin by synthesizing the literature on the determinants of cross-border lending, before presenting the general theory of the gravity model; finally, we discuss the small number of papers thus far to propose a gravity model in explaining international bank lending.

2.1. Distance in International Bank Lending

While no unified theory of the determinants of international banking activities exists, a plethora of papers have proposed various determinants of cross-border lending. The most obvious is the profitability motive, in that banks lend to the markets in which they can generate the most profits. Beyond profitability, the main drivers suggested are economic integration, cultural similarities, institutional characteristics and regulatory restrictions (Focarelli and Pozzolo, 2005). Kerl and Niepmann (2015) provide a theoretical framework in which banks expand internationally because they possess a comparative advantage in efficiency, which makes it easier for them to overcome the fixed costs of entering a new market. Expanding on this, Niepmann (2015) argues that differences in returns to capital as well as differences in the efficiencies of the banking sectors across countries are the main determinants of international bank lending.

With regards to the role of distance, similarly, there exists no economic law which governs its expected effect on international bank lending. There are instead various theoretical explanations offered for why distance should or should not matter in bank lending, indeed, there are factors pulling the relationship in both directions.

Firstly, there is an argument that distance should not factor into banks' international lending decisions. Due to the "weightless" nature of bank loans, there are no transportation costs which could act as a barrier to lending further away from the bank's headquarters or branch (Portes and Rey, 2005). Furthermore, technological progress has contributed to an increase in *arm's length lending*, i.e. loans being extended to clients based on objective and easily accessible facts such as credit scores and balance sheet metrics, accompanied by an increase in the distance between banks and the firms they lend to (Petersen and Rajan, 2002; DeYoung et al., 2007). Under this reasoning, we would expect the role of distance in determining lending to be insignificant.

There is also a plausible argument as to why there could be a positive relationship between distance and the quantity of bank lending to a country, which rests on the idea that the further two countries are from each other, the less should be the correlation between their respective business cycles. If this is the case, banks would be incentivised to lend internationally to diversify their risk exposure; when the domestic economy suffers from a downturn, banks' loan portfolios would benefit from greater international exposure. This draws on the concept of banks behaving consistent with a modern portfolio theory

framework, as discussed in [Buch \(2000\)](#) or [Freixas and Rochet \(2008\)](#); however, empirical evidence for this mechanism is weak (c.f. [Buch, 2005](#); [Portes and Rey, 2005](#)).

The predominant view in the literature, however, is that geographical distance should act as a barrier to international bank lending and hence that there should be a negative relationship between the two. An obvious reason is home bias. Banks may be intrinsically motivated to lend to clients in their home market, due, for example, to common language and general familiarity, which would contribute negatively to the relationship between distance and lending. Beyond home bias, information and monitoring costs are arguably the most important reason as to why distance could reduce lending. Foreign banks face additional informational and agency costs with regard to the *relational* aspect of lending, because the difficulty and thus cost of obtaining credible and verifiable information on potential and existing clients is increasing with distance ([Mian, 2006](#)). There is ample empirical evidence for the role of information costs in international finance. For example, [Buch \(2003\)](#) finds evidence of the existence of informational frictions in international bank lending, while [Portes and Rey \(2005\)](#) report a similar result for portfolio equity flows. It has also been shown that foreign banks are reluctant to make loans which rely on relational contracting where such problems are particularly salient ([Mian, 2006](#)).

Another channel expected to influence the amount of bilateral lending is the cultural similarity between countries. Two distant countries are more likely to have more significant cultural differences, and thus less economic interaction; [Buch \(2003\)](#) and [Portes and Rey \(2005\)](#) both discuss the positive correlation between geographical closeness and cultural similarity. Institutions also impact bank lending. Differential levels of bank regulation and the imposition of additional rules in other countries could reduce the incentive for a bank to lend to those countries; [Buch \(2003\)](#) discusses this channel and provides empirical evidence of its relevance. Distance could proxy for this effect to the extent that more distant countries are less likely to have similar legal systems and regulatory frameworks.

Finally, the quantity of international bank lending might be influenced by the investment activities of firms in the bank's domestic market. The decision of banks to lend internationally tends to be closely related to the internationalisation of non-financial firms, which in turns depends on distance (e.g. [Focarelli and Pozzolo, 2005](#)). When firms begin to export more and engage in foreign direct investment (FDI), their relationship banks should also begin to lend to the countries in which they are operating. This is known as

the *follow-the-client* hypothesis, and has found empirical support in the location decision of banks (Claessens and van Horen, 2014).

In summary, despite the absence of a definitive economic explanation for why distance should matter for international bank lending, there is a multitude of reasons for why it could matter, and tentative evidence that it does matter. Obtaining more detailed evidence on the size of the effect and the exact mechanisms is therefore highly relevant.

2.2. The Gravity Model

The gravity model has long been a prominent framework to analyse the effect of distance on flow variables. Analogous to Newtonian mechanics, the gravity model as applied to economics postulates that bilateral economic activity, such as trade or capital flows between two entities, should be proportional to their size and inversely related to their geographical distance from one another:

$$Y_{ij} = \tilde{\beta}_0 \frac{X_i^{\beta_1} \times X_j^{\beta_2}}{d_{ij}^{\tilde{\beta}_3}} \tilde{\epsilon}_{ij}. \quad (1)$$

where Y_{ij} denotes the flow variable of interest, X_i and X_j represent economic masses, and d_{ij} denotes the distance between entities i and j ; $\tilde{\beta}_0, \beta_1, \beta_2$, and $\tilde{\beta}_3$ are parameters, and $\tilde{\epsilon}_{ij}$ is a stochastic error component generally assumed to have a conditional mean of one, $\mathbb{E}[\tilde{\epsilon}_{ij}|X_i, X_j, d_{ij}] = 1$ (Anderson, 2011; Head and Mayer, 2015).

The gravity model was introduced to economics through its application to international trade. Underpinned by micro-founded, general equilibrium frameworks, it offers a succinct way to infer the effects of trade-impeding factors, captured by the distance term, while at the same time explaining up to 80 percent of the variation in trade flows (Anderson, 2011; Head and Mayer, 2015). More recently, the gravity model has been applied to international capital flows. From a theoretical perspective, Martin and Rey (2004), Coeurdacier and Martin (2009) and Okawa and van Wincoop (2012) provide the structural underpinnings of a gravity model in explaining trade in financial assets. Empirically, a number of studies have shown that a gravity framework performs well in explaining FDI flows (de Ménil, 1999), equity portfolio flows (Portes and Rey, 2005), and equity and bond holdings (Portes et al., 2001; Coeurdacier and Martin, 2009).

Although no explicit theoretical foundation for a gravity-type equation in bank lending exists, its successful application to similar financial flows makes it a natural candidate for analysing the role of distance in international bank lending, in our view.¹ As in the case of financial and trade flows between countries, lending flows from banks to countries are bilateral interactions which can be expected to be multiplicatively proportional to the size of the two entities. Furthermore, distance-related factors such as culture, information costs, and institutional differences may restrict lending flows between a bank and a country, just as they may cause resistance in trade and other capital flows between countries. In empirical work, gravity-type regressions for international bank lending have already been employed by Buch (2005), Papaioannou (2009), and Niepmann (2015), among others. In general, their results have indicated that distance is a significant barrier to lending. These effects are found to be largely attributable to information costs. However, none of these studies has so far exploited within-country variation in distance, nor did they make use of bank-level mass measures. Additionally, their results are mostly based on using OLS as an estimation technique. This study will thus advance on these frontiers.

3. Data

At the core of our analysis is a comprehensive dataset on bank lending recently published by the EBA, collected as part of its 2016 EU-wide transparency exercise (European Banking Authority, 2016). It contains stock data on the original credit exposures (*exposure at default*) of banks to the ten countries they lend most to, disaggregated by exposure type and reported for mid-year 2016, which we use as a measure of nominal lending.² The four main categories of borrowers are retail, governments and central banks, financial institutions, and corporations, to whom more than 94 percent of lending is made; these are the categories we will focus on for our analysis by type of lending. The data covers 131 banks from 24 countries of the EU and other member states of the European Economic Area

¹In fact, Head and Mayer (2015) assert that gravity equations “can be applied to a range of other bilateral flows and interactions [and] be estimated using the same techniques that are appropriate for trade flows” (p. 150).

²We note that our data pertain to the exposure *stock* in mid-year 2016, although strictly speaking, the gravity model would require *flow* data. We consider this to only be a minor problem, because modern financial markets provide banks with ample opportunities to adjust their loan portfolio via the packaging and reselling of loans.

at their highest level of consolidation.³ After adjustments, the final dataset contains 99 banks.⁴ Data on 66 of these banks is truncated, while the lending of the other 33 banks to each EU member state is fully documented.⁵ There is considerable heterogeneity in the location of these banks both within and between countries. Our final dataset includes banks headquartered in 20 of the 28 EU member states and, as an example, the 20 German banks in our dataset are headquartered in 11 different cities. Descriptive statistics of our lending and distance data are reported in Table 5 in Appendix A.1.

Traditional gravity estimation requires measures of banks' and countries' economic sizes. For this purpose, we will use banks' total original credit exposure, as reported by the [European Banking Authority \(2016\)](#), and EU member states' gross domestic product (GDP) obtained from [Eurostat \(2016a\)](#). Our measure of distance is calculated as the number of kilometers between a bank's headquarters and the population-weighted average location of the largest urban areas in the borrower country ([Eurostat, 2016b](#)).⁶ We argue that the latter is a good proxy for the economic centre of a country, as most economic and financial activity takes place in urban areas. Another measure of distance will also be used, where we abstract from the location of a bank's headquarters within a country and instead measure the distance between the bank's home country, computed as above as the population-weighted average location of the largest urban areas, and the debtor country. For the 33 banks where lending to each EU member state is fully documented, EU countries to which a bank is not lending are included in the analysis.

³The sample contains the largest banks in each country and covers c.70% of the total assets of the EU banking sector ([European Banking Authority, 2015](#)). We caveat that the data is not fully representative of the entire EU banking sector, as smaller banks not included in our dataset are likely to operate more locally.

⁴Of the 131 banks in the dataset, assets in foreign countries of 30 banks amount to less than ten percent of their total assets. As the EBA does not require them to disaggregate their assets by country, those banks will be excluded from our analysis. Furthermore, two banks in the original dataset are headquartered outside the EU.

⁵For the former 66 banks, we only have data on the countries to which they lend the most, as they either lend to more than ten countries or provide information on lending to a group of "other countries", meaning that their lending to several EU member states cannot be inferred from the dataset. Moreover, the original dataset comprises lending to non-EU member states as well, which we exclude for our purposes.

⁶The number of urban areas included for each country is the minimum of i) ten, or ii) the number of urban areas for which Eurostat data is available. For most countries, the urban areas included are home to the majority of the country's population.

Cultural and historical closeness between the country of a bank and a borrowing country will be proxied for by the propensity of the two countries to vote for each other in the Eurovision Song Contest (ESC) in the 1994-2016 period (Eurovision, 2016). A construction of that measure was introduced by Felbermayr and Toubal (2010) and we follow their approach to a large extent.⁷ To account for the *follow-the-client* argument, we use trade flows as a proxy variable, computed as the sum of exported and imported goods from a bank's home country to the borrower country in 2013 (European Commission, 2016), as a ratio of the GDP of the bank's country.⁸ To capture the portfolio diversification motive in bank lending, we use the correlation of annual GDP growth between a bank's home country and a borrower country during the 2005-2016 period (cf. Buch, 2005; Portes and Rey, 2005).

Other potential explanatory factors of lending will be country specific measures such as interest rates on government bonds (International Monetary Fund, 2017), governance indicators published by the World Bank (2015), and survey results on bank regulations (World Bank, 2012). The governance indicators we use pertain to government effectiveness, rule of law and regulatory quality. We measure bank regulation with the level of national capital regulation, while the share of foreign ownership in the banking sector and the government ownership share are used to proxy for the general attractiveness of a foreign market to a bank. A complete description of the variables and data sources used in our estimations is provided in Table 6 in Appendix A.2.

⁷In each ESC edition, all participating countries award points to ten of their competitors. Scoring is therefore censored at zero, which makes it appropriate to estimate a Tobit model for every country. The dependent variable is the number of points to a single country from each of its competitors in each edition of the competition in 1994-2016, including semi-finals. In the model, scores to the country in question are regressed on competitor country dummies and edition fixed effects. The coefficients for the competitor country dummies are demeaned and divided by their standard deviation. Since each pair will have two measures of cultural closeness coming from each country's Tobit model, an average of the two will serve as the final index for the pair. Luxembourg did not participate in the ESC in the 1994-2016 period. Its values are calculated as the mean of the values of the countries it borders: France, Germany, and Belgium.

⁸Trade also proxies for FDI flows, for which coherent data is not available (c.f. Aizenman and Noy, 2006; Claessens and van Horen, 2014).

4. Empirical Strategy

The first stage in our empirical analysis is to examine whether a standard gravity framework fits the data. For this purpose, we estimate a log-linearized version of equation (1),

$$\log(Y_{ij}) = \beta_0 + \beta_1 \log(X_i) + \beta_2 \log(X_j) + \beta_3 \log(d_{ij}) + \epsilon_{ij}, \quad (2)$$

where $\beta_0 \equiv \log(\tilde{\beta}_0)$, $\beta_3 \equiv -\tilde{\beta}_3$, and $\epsilon_{ij} \equiv \log(\tilde{\epsilon}_{ij})$. Y_{ij} is our proxy for aggregate bank lending from bank i to country j , X_i is the economic size of the bank, X_j is the economic size of the borrowing country j , and d_{ij} is distance between the headquarters of bank i and country j . We estimate this simple gravity equation (2) by OLS as it has historically been the most widely-used estimation technique in the gravity setting (cf. Anderson, 2011). Standard errors are clustered at the bank level to account for heteroskedasticity and serial correlation at the bank level.

Next, in order to consistently estimate the correlation between distance and bank lending, we augment our regression model with variables that are likely to be correlated with the regressors in the traditional gravity equations, but which do not belong to the class of mechanisms presented in Section 2.1, which we consider to be the actual channels of the effect of distance on bank lending. As pointed out by Anderson (1979) and Anderson and Wincoop (2003), bilateral flows between two countries are not only determined by bilateral distance but also by the *multilateral resistance* of a country. This concept captures factors such as the overall distance of a country to other countries, as a measure of how easily flows can be redirected to alternative destinations. In order to deal with this issue, the literature recommends introducing borrower and lender fixed effects (Head and Mayer, 2015).⁹ In our setting, introducing fixed effects has the additional advantage of controlling for many factors that contribute to shifts of the overall level of bank lending to a country, including government policies, growth potential, and the presence of financial centers.¹⁰ In addition, we explicitly control for whether the home country of bank i and the borrowing

⁹Head and Mayer (2015) provide related evidence from Monte Carlo simulations in the context of structural gravity models in trade. Empirical papers following the fixed effects approach when estimating gravity models in international finance include Coeurdacier and Martin (2009) and Niepmann (2015).

¹⁰Using fixed effects comes at the cost of no longer being able to identify the coefficients on the mass terms X_i , β_1 , and X_j , β_2 . As our interest lies in the estimation of the coefficient on distance, β_3 , we do not consider this a major problem.

country j are both in the Eurozone.¹¹

We proceed by using three different estimation techniques to identify the correlation between distance and bank lending. All of the following regressions make use of the disaggregated structure of our data, which is why we include the additional index k for the type of bank lending. First, to be in line with the existing literature on gravity in international bank lending, we apply OLS to the estimating equation

$$\log(Y_{ijk}) = \beta_0 + \beta_3 \log(d_{ij}) + \text{controls} + \alpha_i + \alpha_{jk} + \epsilon_{ijk}. \quad (3)$$

where α_i and α_{jk} represent bank and country-lending type fixed effects. Standard errors continue to be clustered at the bank level.

Recent advances in the literature have pointed out two severe problems with estimating a log-linearized specification by least squares estimators (Santos Silva and Tenreyro, 2006). First, OLS results are likely to be biased in the presence of heteroskedasticity in the errors $\tilde{\epsilon}_{ijk}$. A nonlinear transformation such as log-linearization will make the conditional expectation of the transformed errors ϵ_{ijk} , $\mathbb{E}[\epsilon_{ijk}|\mathbf{X}_{ijk}] = \mathbb{E}[\log(\tilde{\epsilon}_{ijk})|\mathbf{X}_{ijk}]$, in general depend on the moments of the conditional distribution of $\tilde{\epsilon}_{ijk}$. In the case of heteroskedasticity in $\tilde{\epsilon}_{ijk}$, $\text{Var}[\tilde{\epsilon}_{ijk}|\mathbf{X}_{ijk}]$ and thus $\mathbb{E}[\epsilon_{ijk}|\mathbf{X}_{ijk}]$ are functions of the regressors, so generally $\mathbb{E}[\epsilon_{ijk}|\mathbf{X}_{ijk}] \neq 0$. The second problem stems from the fact that lending to a specific sector in a specific country is often equal to zero. These observations are dropped in a log-linear transformation of the gravity equation as in equation (2) or (3). When the presence of zero bank lending is systematically correlated with any of the explanatory variables, this will lead to a selection bias. To deal with the problems of heteroskedasticity and data truncation, Santos Silva and Tenreyro (2006, 2011) suggest to estimate the gravity equation in its multiplicative form by a PPML estimator.^{12,13}

¹¹Having a common currency is *a priori* likely to affect bank lending, and being member of the Eurozone could be correlated with distance due to the fact that Eurozone members tend to be located in the center of the EU.

¹²See Appendix A.3 for a description of the PPML estimator.

¹³Comparing the performance of several alternatives in Monte Carlo simulations, Santos Silva and Tenreyro (2006, 2011) suggest that the PPML estimator is the only known estimation technique which yields unbiased and robust results both in the presence of heteroskedasticity in $\tilde{\epsilon}_{ijk}$ and of many zeros in the dependent variable. Monte Carlo evidence by Head and Mayer (2015) gives a similar but slightly more nuanced view. They conclude that “rather than selecting the Poisson PML as the single “workhorse” estimator of gravity equations, it

In our dataset, lending from a bank to a specific sector in a specific country is very often zero (c.82% of the observations, see Table 5). Inspection of the results of our OLS-FE estimations also suggests that there is indeed substantial heteroskedasticity in the error terms $\tilde{\epsilon}_{ijk}$. Consequently, our second estimation technique is to apply the PPML estimator to equation (1), with country fixed effects instead of country-lending type fixed effects. This empirical strategy sets our paper apart from earlier studies on the relationship of distance and international bank lending, which almost exclusively rely on OLS estimations of log-linearized specifications. However, as explained in Section 3, data for a substantial portion of the banks in our sample remain truncated even in the PPML estimations. In our setting, applying PPML thus ameliorates, but does not completely eliminate, problems arising from data truncation.¹⁴

Third, we look at the extensive margin of lending to investigate how distance is related to whether bank i lends to sector k in country j at all. We therefore create a binary dependent variable from our exposure data, which we regress on log-distance, bank fixed effects, and country-lending type fixed effects in a LPM. Although this estimating equation is not directly derived from a theoretical gravity equation, it closely resembles the above framework and ensures that we can adequately compare the effect of distance at the intensive and extensive margin.

In order to identify a possible mechanism through which distance might matter, we successively include proxy variables for each of the candidate channels presented in Section 2.1 and analyse the change in the estimated coefficient of distance; those are a same-country dummy, its interaction term with distance, our Eurovision proxy for cultural closeness, GDP growth correlation, and trade flows. Covariates that vary only at the country level are collinear with country and country-lending type fixed effects, hence we also estimate a model without such fixed effects but with a full set of control variables. In particular, we are now able to include interest rate differentials, governance indicators for the borrowing country, measures of bank regulation in the borrower country and local banking competition. The prominent remaining theoretical explanation for why distance matters

should be used as part of a robustness-exploring ensemble that also includes OLS [...]” (Head and Mayer, 2015, pp. 176-177).

¹⁴It should also be noted that standard tools for dealing with truncated data, such as the Tobit estimator, are not useful in our context since the truncation boundary is heterogeneous across observations. When lending is disaggregated across sectors as well as countries, the truncation boundary does not even directly depend on any of our variables.

is information and monitoring costs. We do not explicitly incorporate a proxy variable for information and monitoring costs into our regressions due to data limitation, but instead regard them as the most plausible interpretation for any residual correlation of distance and bank lending.

Lastly, we estimate a reduced specification including the same country dummy, its interaction term with distance, and the Eurozone dummy as regressors, separately by lending type. The goal is to examine whether there are heterogeneous effects depending on the type of lending the bank engages in.

5. Results

This section presents our empirical findings, firstly, on the relationship between distance and bank lending within the EU, and subsequently on the reasons that distance impacts lending.

5.1. Gravity Relationship in Bank Lending

Table 1 reports estimation results on the gravity relationship in bank lending. Column (1) relates to the simple gravity equation (2), estimated by OLS without fixed effects. All variables are in logs, so the coefficients can be interpreted as elasticities. As the OLS estimation excludes all zero bank-country observations of lending by type, the estimates pertain to the intensive margin of lending: how much a bank lends, conditional on lending at all. We find the elasticity of lending with respect to distance to be -0.76, suggesting that a one percent increase in distance is associated with a decrease in lending by 0.76 percent. This coefficient estimate on distance is of a similar magnitude to those in the trade literature (see a summary of previous empirical results in [Buch \(2005\)](#) and [Head and Mayer \(2015\)](#)). Moreover, while bank and country size alone explain approximately 55% of the variation in cross-border bank lending in the EU (result not reported), adding distance to the regression increases the R^2 to 70%. This number is of roughly the same size as in related gravity models in trade and international finance ([Anderson and Wincoop, 2003](#); [Anderson, 2011](#); [Head and Mayer, 2015](#)). Overall, these results suggest that analysing the role of distance in bank lending within a gravity framework is appropriate.

Table 1: Gravity in Bank Lending within the EU

	OLS (1)	OLS-FE (2)	PPML (3)	LPM (4)
Dependent variable	Log lending	Log lending	Lending	I(Lending>0)
Observations included	Lending>0	Lending>0	All	All
Level of aggregation	Country	Country-sector	Country-sector	Country-sector
Log distance	-0.763*** (0.079)	-1.274*** (0.117)	-1.417*** (0.130)	-0.101*** (0.009)
Log bank size	0.948*** (0.043)			
Log GDP	0.225*** (0.044)			
Eurozone		1.124** (0.528)	0.790** (0.357)	0.0469* (0.027)
Bank FE	No	Yes	Yes	Yes
Country FE	No	No	Yes	No
Country-lending type FE	No	Yes	No	Yes
Number of Observations	547	3,794	20,430	20,835
Adjusted R^2	0.700	0.388	0.166	0.273

Notes: Table 1 reports the results on the postulated gravity relationship in bank lending within the EU. Standard errors (reported in parentheses) are clustered at the bank level. Column (1) shows the OLS estimation results of the simple gravity equation (2). Column (2) pertains to the augmented gravity equation (3) estimated by OLS including fixed effects. Column (3) reports PPML results. Column (4) refers to the extensive margin analyzed in a LPM. ***, **, and * indicate statistical significance at the 1 %, 5 %, and 10 % level.

Columns (2) to (4) pertain to the more robust gravity equations including fixed effects and a Eurozone dummy. Column (2) shows that on the intensive margin, the elasticity of lending with respect to distance increases in absolute terms to -1.27. Our main specification is in Column (3), which reports estimates using the PPML estimator that accounts for both the intensive and extensive margins of lending. The point estimate of elasticity increases in absolute terms, to -1.42, and remains highly significant. We note that both estimates of the elasticity are larger than the estimates generally found in the literature, e.g. [Buch \(2005\)](#) reports a coefficient of -0.65 using an OLS specification. Column (4) reports estimates for the extensive margin of lending using a LPM. Ceteris paribus, a 10 percent increase in distance is associated with a one percentage point decrease in the probability of lending to a given type of borrower in a given country, which is of a slightly lower magnitude than the coefficient found by [Niepmann \(2016\)](#) in a similar extensive margin analysis.

5.2. Distance Effects in Bank Lending

Extending our analysis, [Table 2](#) reports results from specifications in which we successively add proxies for the potential determinants of the distance effect to our previous estimations. The elasticity of lending with respect to distance remains negative and significant across all model specifications for both the intensive and extensive margin. In [Column \(15\)](#), the most saturated specification of the PPML model, the estimated elasticity is -0.60. As an illustration, holding everything else constant, this coefficient suggests that a Spanish bank headquartered in Madrid can be expected to lend 13% less to Germany than to France since German entities are on average 70% further from Madrid than French entities.

The first step is to add a dummy variable for within-country lending. As expected, banks appear to make a significant distinction between within-border and cross-border lending. [Column \(1\)](#) shows that on the intensive margin, banks lend 15 times more to entities within their own country, controlling for distance and membership in the Eurozone.¹⁵ Interestingly, Eurozone membership is insignificant across all specifications and estimation techniques once the same country dummy is included. This suggests that the significant coefficients of Eurozone in [Table 1](#) actually capture the home bias effect that is now

¹⁵The increase is computed as $(\exp(2.761) - 1) \times 100\%$.

explicitly controlled for; on top of this, common currency does not seem to be correlated with bank lending.

When we include the interaction term of distance and the same country dummy, we allow for a differential relationship between distance and lending across within-country and cross-border lending. This analysis reveals that the gravity relationship in cross-border lending is larger in magnitude than when cross-border and within-country lending are considered jointly. The PPML result in column (12) suggests that the distance of the headquarters of a bank to its home country's economic centre matters much less than distance in cross-border lending, while the OLS-FE results in column (2) suggest that within-country lending is not sensitive to this distance.¹⁶ Column (7) shows that unsurprisingly, the same holds for the probability that a bank is lending to its own country, as banks can in general be expected to lend to the country where they are headquartered.

Cultural and historical closeness, as proxied by bilateral point-giving in the ESC, is a significant predictor of the quantity of lending and of the decision to lend to a given borrower type in a given country. *Ceteris paribus*, the PPML point estimate in column (13) suggests that a one standard deviation increase in bilateral point-giving between countries is associated with 24% more lending. Moreover, in all three estimation frameworks, the coefficient on distance decreases in size by c.20% when the Eurovision variable is introduced. Bilateral trade in goods does not enter significantly into our regressions. Yet, the inclusion of the trade variable reduces the size of the coefficient of distance by approximately one tenth in the OLS-FE and c.15% in the PPML estimation; in the LPM estimations, the coefficient remains unchanged. Furthermore, economic growth correlation between countries is not found to be associated with lending, nor does it affect the coefficient on distance.

To further control for factors which are correlated with the distance between countries, other than those included above, we use the distance between the economic center of a bank's home country and that of the borrower country. Column (16) shows that this alternative distance variable is not significantly associated with lending. The distance between a bank and a country decreases in significance, but remains significant at a 10% confidence level. This further establishes that the gravity relationship is due to the

¹⁶This can be seen by adding the coefficient on the log of distance and the coefficient on the interaction term.

Table 2: Relationship between Bank Lending and Distance (including country and country-lending type FE)

Dependent variable Observations included	OLS-FE					LPM					PPML						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
	I(Lending > 0)																
Log distance	-0.327** (0.145)	-0.601*** (0.157)	-0.500*** (0.166)	-0.506*** (0.167)	-0.462** (0.185)	-0.0587*** (0.013)	-0.0845*** (0.014)	-0.0722*** (0.015)	-0.0720*** (0.015)	-0.0741*** (0.016)	-0.395** (0.173)	-0.835*** (0.173)	-0.688*** (0.181)	-0.687*** (0.185)	-0.597** (0.243)	-0.565* (0.341)	
Log distance*Same country		0.573*** (0.170)	0.473** (0.181)	0.469** (0.179)	0.457** (0.198)	0.0858*** (0.024)	0.0736*** (0.025)	0.0747*** (0.025)	0.0855*** (0.026)	0.0855*** (0.026)	0.639*** (0.161)	0.472*** (0.160)	0.471*** (0.162)	0.420** (0.202)			
Eurozone	0.183 (0.537)	0.0619 (0.540)	-0.0327 (0.541)	-0.00561 (0.549)	0.382 (0.583)	0.0167 (0.032)	0.0101 (0.032)	0.00431 (0.032)	0.00401 (0.031)	0.0247 (0.036)	-0.163 (0.415)	-0.313 (0.437)	-0.567 (0.446)	-0.589 (0.478)	0.269 (0.335)	-0.0389 (0.347)	
Same country	2.761*** (0.323)	-0.354 (0.922)	0.396 (1.034)	0.498 (1.036)	0.623 (1.231)	0.196*** (0.035)	-0.243* (0.125)	-0.156 (0.129)	-0.167 (0.133)	-0.202 (0.145)	2.159*** (0.381)	-1.628* (0.965)	-0.430 (1.021)	-0.464 (0.964)	-0.199 (1.393)		
Eurovision		0.157* (0.089)	0.168* (0.090)	0.168* (0.090)	0.14 (0.098)		0.0152*** (0.005)	0.0148*** (0.006)	0.0137** (0.006)	0.0137** (0.006)		0.238*** (0.076)	0.233*** (0.080)	0.233*** (0.080)	0.298*** (0.096)	0.232** (0.092)	
Growth correlation				-0.253 (0.371)	0.0132 (0.411)			0.0162 (0.022)	0.0162 (0.022)	0.0274 (0.023)			0.112 (0.572)	0.112 (0.572)	0.833 (0.654)	1.528* (0.896)	
Trade/GDP					0.0128 (0.021)				0.000899 (0.001)						-0.00161 (0.033)	0.004 (0.032)	
Log country distance																0.0321 (0.458)	
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Country FE	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	
Country-lending type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Number of Observations	3,794	3,794	3,794	3,794	3,527	20,835	20,835	20,835	20,835	19,125	20,430	20,430	20,430	20,430	18,765	15,465	
Adjusted R ²	0.415	0.417	0.418	0.418	0.413	0.284	0.288	0.289	0.289	0.296	0.178	0.178	0.179	0.179	0.183	0.133	

Notes: Table 2 reports estimates with fixed effects, including further covariates as proxies for channels through which distance may affect lending. Standard errors (reported in parentheses) are clustered at the bank level. Columns (1) to (5) are estimated by OLS. Columns (6) to (10) pertain to the LPM estimations. PPML estimations are reported in columns (11) to (16). ***, **, * and * indicate statistical significance at the 1 %, 5 %, and 10 % level.

distance from the headquarters of a bank to a borrowing country, rather than the general distance from the country of the bank to the borrowing country.

The results in Table 3 pertain to the specifications that exclude country and country-lending type fixed effects but instead include country-specific variables such as interest rate differentials, governance and capital regulation indicators.¹⁷ In the OLS-FE and LPM specifications, the coefficient on distance is not sensitive to introducing all of these country-specific variables. However, the coefficient drops significantly between the baseline PPML specification in Column (5) and the saturated specification in Column (6). While interest rate differentials and governance indicators are insignificant in all regressions (with the exception of rule of law in the LPM), the results suggest that gravity in lending is partly explained by capital regulatory requirements in the country of a borrower, at least for the intensive margin.¹⁸ An interesting difference emerges between the intensive and extensive margins in this respect; the ownership share of foreigners and the government in the banking sector of a borrowing country are primarily only significant on the extensive margin. Despite their high statistical significance, these latter effects are quite small in economic terms. For example, a 10 percentage point increase in the ownership share of foreigners in the banking system of a country is associated with a 0.8 percentage point lower probability of a bank lending to that country.

Table 4 shows disaggregated results for selected specifications by type of lending. We focus on the four main types of borrowers: public sector entities, financial institutions, corporate borrowers, and retail borrowers (individuals). Interestingly, the negative and significant coefficient on distance varies greatly in magnitude across these lending types. On the intensive margin, it ranges from -0.41 for financial institutions to -1.17 for retail borrowers. The OLS and LPM models suggest that on both margins, distance matters less in cross-border lending to governments and financial institutions than in corporate and retail lending. The results of the PPML estimations, however, suggest that distance matters less in lending to financial institutions and retail customers than in lending to corporates and the public sector.

In a series of robustness checks, the above results prove largely robust in the sense that

¹⁷As country and country-lending type fixed effects are not included in the regressions in Table 3, the coefficients on distance should not be directly compared to those in Table 2.

¹⁸Introducing these variables separately in the regression, rather than jointly, supports this interpretation.

Table 3: Relationship between Bank Lending and Distance (without country and country-lending type FE)

	OLS-FE		LPM		PPML	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Log lending		I(Lending>0)		Lending	
Observations included	Lending > 0		All		All	
Log distance	-0.359** (0.146)	-0.388** (0.177)	-0.0598*** (0.013)	-0.0733*** (0.015)	-0.614** (0.252)	-0.367 (0.311)
Log distance*Same country	0.470** (0.201)	0.598*** (0.218)	0.0730*** (0.024)	0.0804*** (0.025)	0.504** (0.250)	0.338 (0.294)
Interest rate differential		-0.0594 (0.074)		-0.00153 (0.003)		0.0755 (0.125)
Government effectiveness		0.477 (0.582)		0.0348 (0.025)		-0.111 (0.657)
Rule of law		-0.318 (0.490)		-0.0566* (0.030)		0.541 (1.057)
Regulatory quality		-0.247 (0.792)		0.0544 (0.040)		-0.351 (1.132)
Capital regulatory requirements		-0.102** (0.048)		-0.00136 (0.002)		-0.168*** (0.064)
Share of foreign ownership		-0.00542 (0.007)		-0.000804*** (0.000)		0.0213* (0.013)
Share of government ownership		0.0107 (0.009)		-0.00120*** (0.000)		-0.00352 (0.009)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	No	No	No
Country-lending type FE	No	No	No	No	No	No
Number of Observations	3,527	2,957	19,125	15,105	18,765	14,220
Adjusted R^2	0.054	0.051	0.088	0.093	0.180	0.194

Notes: Table 3 reports estimates with full controls but no country fixed effects or country-lending type fixed effects. Standard errors (reported in parentheses) are clustered at the bank level. Further controls (log GDP, log population, Eurozone, same country, Eurovision, growth correlation and trade/GDP) are included in all regressions but not reported for sake of brevity. Columns (1) and (2) are estimated by OLS with bank fixed effects. Columns (3) and (4) pertain to the LPM estimations. PPML estimations are reported in columns (5) and (6). ***, **, and * indicate statistical significance at the 1 %, 5 %, and 10 % level.

Table 4: Relationship between Bank Lending and Distance by Type of Lending

Dependent variable Observations included Type of Lending	OLS-FE				LPM				PPML			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Public	Financial	Corporate	Retail	Public	Financial	Corporate	Retail	Public	Financial	Corporate	Retail
Log distance	-0.528** (0.261)	-0.414** (0.169)	-0.845*** (0.201)	-1.166*** (0.276)	-0.108*** (0.021)	-0.150*** (0.026)	-0.159*** (0.026)	-0.154*** (0.026)	-1.023*** (0.202)	-0.760*** (0.155)	-1.020*** (0.168)	-0.852*** (0.293)
Log distance*same country	0.376 (0.265)	0.365** (0.161)	0.766*** (0.211)	1.132*** (0.299)	0.121*** (0.038)	0.0823** (0.039)	0.106** (0.042)	0.120*** (0.042)	0.850*** (0.203)	0.620*** (0.180)	0.781*** (0.147)	0.755*** (0.288)
Eurozone	-0.252 (0.952)	0.302 (0.506)	0.0338 (0.567)	0.473 (1.014)	0.00846 (0.046)	0.0635 (0.048)	0.046 (0.049)	0.0539 (0.047)	-0.595 (0.399)	-0.903** (0.406)	-0.228 (0.397)	-0.247 (0.862)
Same country	0.397 (1.511)	-0.401 (0.950)	-1.922 (1.171)	-1.625 (1.643)	-0.323 (0.202)	-0.405* (0.212)	-0.492** (0.225)	-0.575*** (0.214)	-2.970** (1.172)	-2.037* (1.093)	-2.860*** (0.859)	-1.322 (1.616)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country or country-lending type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	881	533	506	446	4,167	1,389	1,389	1,389	4,086	1,362	1,362	1,184
Adjusted R ²	0.372	0.348	0.368	0.425	0.278	0.192	0.180	0.158	0.378	0.891	0.881	0.901

Notes: Table 4 reports estimation results of our main specifications by lending type (public, financial, corporate, retail). Standard errors (reported in parentheses) are clustered at the bank level. Columns (1)-(4) are estimated by OLS. Columns (5)-(8) refer to the LPM. Columns (9)-(12) report PPML results. All specifications include bank fixed effects and country or country-lending type fixed effects. ***, **, * and * indicate statistical significance at the 1 %, 5 %, and 10 % level.

the coefficient on distance remains negative and significant. The robustness checks are described in Appendix [A.4](#).

6. Discussion

Overall, our robust set of results indicates that distance remains a significant barrier to bank lending within the EU. To establish why distance matters, we have controlled for as many identifiable channels through which distance could function as a hindrance to lending as possible, and the effect remains pronounced: it appears that geographical distance itself impacts the decisions of internationally-operating banks. As previously discussed, information and agency costs are one of the key avenues through which distance becomes relevant, and as we are constrained in our ability to control for these in our analysis, we postulate that we can attribute the residual impact of distance to this channel. The fact that we also find that it is not the general distance between the two countries that matters, but rather the distance from the actual headquarters of the bank, implies that it is not simply international differences that deter lending, but pure physical distance. This supports the information costs hypothesis, as it indicates that a bank being positioned near a border, which should facilitate easier transmission of information across that border, is associated with an increase in cross-border lending.

Our analysis of the disaggregated data on various types of lending also appears to support this conclusion. Information costs are lower when information on the borrower is publicly available or easily obtained. Thus, we would expect them to be especially low for lending to public institutions, which primarily includes governments and central banks, and to other financial institutions, for all of whom credit ratings agencies often publish comprehensive reports. In the OLS-FE and LPM estimations, the coefficients on distance we obtain for these borrowers are far smaller in magnitude than those for corporate and retail lending, which is consistent with the information cost hypothesis. Our results thus suggest that despite technological advancements, the Single Market and the availability of more arm's-length-type lending to a broader client base, banks today continue to face significant costs in obtaining information on and monitoring their lending clients.

One of the other most prominent elements of our results, although not unexpected, is the large and significant home bias found. Banks have a considerable preference to lend

to clients within their own country. Moreover, we find the effect of distance to be less pronounced for within-country lending. This result could be due to national branch networks, whereby a bank has an extensive branch network within its home country through which it conducts lending, as opposed to primarily from the headquarters.

Of all the other channels whose impact on lending we examined, cultural and historical ties, capital requirements, goods trade and local banking competition consistently appear to account for some of the initial gravity relationship we observe. The cultural factor is anticipated and is in line with the general expectation that countries have closer financial ties with countries who are culturally similar. The negative impact of capital requirements in the borrowing country on lending suggests that, despite broad harmonisation of intra-EU regulation, national financial regulators have maintained differences in the stringency of their rules, for example in the implementation of Basel III. Although goods trade between countries is not significant in any of our regressions, the introduction of this variable leads to a noteworthy reduction in the size of the distance coefficient. This suggests that the observed gravity relationship in bank lending within the EU is partly accounted for by trade, or by FDI flows, which are closely correlated with trade. On the extensive margin, we find that the share of both foreign and government ownership in local banking markets have a significant negative impact on foreign lending. This is also a reasonable result: banks will consider the competition they would face if they entered a foreign market, and the presence of government support and foreign (and thus likely larger) banks would both likely deter entry, however, once the bank has a presence in that market, the type of competition they encounter should matter less in their lending decisions. This aside, our results on the intensive and extensive margins are broadly similar, indicating that, in general, the same factors determine both the decision to lend and the quantity of lending.

Furthermore, governance quality in the borrowing country and interest rate differentials do not appear to account for any of the observed gravity relationship in lending. That the governance indicators are insignificant could be explained by the fact that our sample consists of only EU countries who all possess relatively strong governance and legal institutions. Thus, any marginal difference in regulation across countries would not be enough to deter lending. We also do not obtain evidence of portfolio diversification in bank lending, which suggests that banks do not simply follow a pure portfolio theory approach to their lending assets.

Almost two decades after its inception, the Eurozone does not appear to significantly facilitate cross-country bank lending, as membership of the Eurozone is insignificant across all our specifications once the same-country dummy is introduced. As the Eurozone is arguably the greatest single attempt at market integration that Europe has undertaken, this result is striking. One interpretation is that currency differences do not deter banks from lending, perhaps because the high liquidity of non-euro European currencies facilitates easy hedging of exchange rate risk. However, it also implies that perhaps the creation of the Eurozone itself has not necessarily lead to higher levels of international lending beyond what EU membership already achieves.

A limitation of our analysis is that we have not been able to consider the role of bank subsidiaries in cross-border lending. Due in part to data restrictions, our focal point has been on the role of the location of bank headquarters in cross-border lending flows. However, many of the banks in our sample have substantial physical operations in countries outside that of their headquarters, meaning that the mechanism by which they acquire information about potential borrowers is not necessarily sensitive to the distance between headquarters and borrower. Thus, a potential criticism of our strategy is that it remains impossible to attribute the residual relationship between distance and lending to information costs. However, given that banks with international operations will find it easier to acquire information about foreign borrowers, the fact that we still find a negative relationship between lending and distance from bank headquarters to borrower is all the more interesting. Although we claim that information costs remain the most plausible explanation for this phenomenon, further analysis of the role of subsidiaries in explaining gravity in bank lending would be valuable. This, and the derivation of a theoretical underpinning of the established gravity relationship in bank lending, provide a promising avenue for future research.

7. Conclusion

The broad narrative that emerges from our analysis is that a combination of deeply-entrenched and policy-based factors determine international bank lending. Firstly, issues that have historically either hindered or facilitated lending - the prohibiting effect of distance in gathering information about potential or current borrowers, and the ties between

societies brought about by cultural closeness, trade or direct investment - remain significant predictors of banks' current stocks of outstanding loans within the EU. Secondly, some of the issues that have recently been under close scrutiny by European policymakers - capital requirements and market competition - also impact lending decisions.

Our analysis has important implications. Although we have not tested directly for the current state of financial integration in the banking sector in the EU, our results imply that a borderless single market for bank loans has not yet been achieved. Despite the progression of financial market integration across the EU, distance continues to be a deterrent to international bank lending on the European level. While some of the underlying mechanisms, particularly cultural and historical ties, are difficult to address politically, others provide scope for intervention by policymakers seeking to further progress the European integration project.

Although technological advancements may have improved transparency and eased the procurement of information and communication between bank and client, it seems they have not yet eliminated information costs in banking. There is room for new technologies that would further reduce the cost of verifying and monitoring clients to allow banks to underwrite more loans internationally. Although it is beyond the scope of this paper to provide a normative analysis of optimal EU policy, we have shown that both government ownership of competing banks and differences in national capital requirements act as deterrents to lending. The key areas we have identified could be targeted to advance the goal of further financial integration in bank lending across the EU.

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A. Appendix

A.1. Descriptive Statistics: Bank Lending and Distance

Table 5: Descriptive Statistics: Bank Lending and Distance

Number of banks					99
Number of borrower countries					28
Number of exposure types					15
Total number of observations					20,880
Number of cross-border observations					19,410
Number of observations with credit exposure > 0					3,823
Total credit exposure amount, in millions of euros					19,506,436
		Mean	St. Dev.	Min	Max
Credit exposure amount (lending), in millions of euros	934	9,697	0	470,245	
Credit exposure amount (lending) > 0, in millions of euros	5,102	22,189	≈ 0	470,245	
Distance between bank and borrower country, in kilometers	1,255	832	0	3,803	

Notes: Table 5 provides descriptive statistics of our data on bank lending, taken and adapted from [European Banking Authority \(2016\)](#), and on distance.

A.2. Variable Definitions and Data Sources

See Table 6.

Table 6: Variable Definitions and Data Sources

Variable	Definition	Data Source
Bank lending	Bank's original exposure (nominal value) to a country, prior to any value adjustments, provisions, effects due to credit risk mitigation techniques or credit conversion factors; disaggregated by exposure class; mid-year 2016 and end-of-year 2015.	European Banking Authority (2016)
Distance (v.1)	Geographical distance in kilometers between a bank's headquarters and the population-weighted average of up to the ten largest urban areas in the debtor country; latest available year, 2014-2016.	Eurostat (2016b), own calculations
Distance (v.2)	Geographical distance in kilometers between the bank's home country and the debtor country; if these are the same, zero is imputed; latest year available, 2014-2016.	Eurostat (2016b), own calculations
Country size	GDP in debtor country, 2016.	Eurostat (2016a)
Bank size	Bank's total original exposure by bank, mid-year 2016.	European Banking Authority (2016)
Eurozone	Dummy variable for Eurozone (=1 if both country of bank and debtor country are in the Eurozone, =0 otherwise).	
Potential Channels of Distance Effect		
Home country	Dummy variable for same country (=1 if headquarters of bank are located in the debtor country, =0 otherwise).	
Cultural closeness	All scores from the Eurovision Song Contest editions 1994 till 2016, including finals and semi-finals. Bilateral score giving between countries was used to construct a cultural closeness index for each pair of countries.	Eurovision (2016), own calculations
Business cycle correlations	Correlation of annual GDP growth between bank's home country and the borrower country over the period 2005-2016.	Eurostat (2016a), own calculations
Trade	Sum of exports and imports between bank's home country and debtor country, as a ratio of GDP in bank's home country; 2013.	European Commission (2016), own calculations
Country Specific Indicators		
Interest rate differences	Difference in interest rates on government bonds between the home country of the bank and the debtor country; average of annual values, 2007-2016.	International Monetary Fund (2017), own calculations
Government Effectiveness	Subindex of World Governance Indicators reflecting perceptions of the quality of government services, its independence and credibility in debtor country; ranges from -2.5 (weak) to 2.5 (strong) governance performance; 2015.	World Bank (2015)
Rule of law	Subindex of World Governance Indicators reflecting perceptions of the extent to which agents have confidence in and abide by the rules of society in debtor country; ranges from -2.5 (weak) to 2.5 (strong) governance performance; 2015.	World Bank (2015)
Regulatory Quality	Subindex of World Governance Indicators reflecting perceptions of the ability of the government to permit and promote private sector development in debtor country; ranges from -2.5 (weak) to 2.5 (strong) governance performance; 2015.	World Bank (2015)
Regulatory capital	Index of tightness of capital regulations in debtor country; range 0-10, higher values indicate greater stringency; 2012.	World Bank (2012)
Foreign ownership share	Share of banking system's assets in debtor country that are owned by foreign entities, in percent; 2012.	World Bank (2012)
Government share	Share of banking system's assets in debtor country owned by the country's government, in percent; 2012.	World Bank (2012)

Notes: Table 6 contains information on the definition of all variables, the data source, and the period of measurement.

A.3. The Poisson Pseudo-Maximum Likelihood Estimator

Pseudo-maximum likelihood estimation refers to the estimation of a parameter vector β by maximizing the joint density function of the data as a function of β , however under a misspecified density $f(\mathbf{y}|\mathbf{X}, \beta)$. In general, maximum likelihood estimation under misspecification of the underlying data generating process yields inconsistent estimates. In the special case of $f(\mathbf{y}|\mathbf{X}, \beta)$ being from a linear exponential family, [Gourieroux et al. \(1984a\)](#) show that pseudo-maximum likelihood estimation yields consistent and asymptotically normal estimates under some additional assumptions. The Poisson distribution falls in the class of linear exponential families.

The PPML estimator is often used with count data (non-negative integers), but the dependent variable does not need to be integer-valued. It is defined as

$$\operatorname{argmax}_{\beta} \sum_{i=1}^N \{y_i \mathbf{x}'_i \beta - \exp(\mathbf{x}'_i \beta) - \log y_i!\},$$

yielding the first-order conditions

$$\sum_{i=1}^N \{y_i - \exp(\mathbf{x}'_i \beta)\} \mathbf{x}_i = \mathbf{0}.$$

Here, the crucial assumption for consistency is a correct specification of the conditional mean, i.e. the underlying data generating process must be such that $\mathbb{E}[y_i|\mathbf{x}_i] = \exp(\mathbf{x}'_i \beta_0)$.¹⁹ This implies that the data do not need to be generated by a Poisson process for the PPML to be consistent, as long as the above condition on the conditional mean is fulfilled ([Gourieroux et al., 1984b](#)).

We implement the PPML estimator using robust standard errors, as recommended by ([Santos Silva and Tenreyro, 2006](#)).

¹⁹In our basic gravity setting, the conditional mean assumption becomes $\mathbb{E}[Y_{ij}|X_i, X_j, d_{ij}] = \tilde{\beta}_0 \frac{X_i^{\beta_1} \times X_j^{\beta_2}}{d_{ij}^{\beta_3}}$, which is equivalent to assuming $\mathbb{E}[\tilde{\epsilon}_{ijk}|X_i, X_j, d_{ij}] = 1$.

A.4. Robustness Checks

Four robustness tests were implemented. In all exercises we estimated selected specifications equivalent to those in Tables 1 to 3 with a special focus on the coefficient of distance.

In the first exercise, we use a different cross-section of the EBA transparency exercise data from end-of-year 2015 (European Banking Authority, 2016), which, after adjustments, includes exactly the same banks as our final dataset for mid-year 2016. When doing so, the coefficient on distance in column (16) of Table 2 is no longer significantly different from zero (p-value: 0.105). In the five other specifications that were tested, the distance coefficient remained negative and significant.

Secondly, we exclude the truncated banks which equates to excluding a third of our observations. Thirdly, we drop within-country observations which are approximately seven percent of total observations. Finally, we use bootstrapped standard errors for the OLS and LPM estimations of our most saturated specifications reported in columns (2) and (4) of Table 3. The coefficient on distance remains negative and significant at a confidence level of at least ten percent in all of these exercises.

Date June 2017.

ABSTRACT IN ENGLISH (100 words):

This paper investigates whether and how geographical distance matters for bank lending within and between countries in the European Union. We estimate gravity-type regressions in various specifications, incorporating novel econometric insights which have thus far not been applied in the context of bank lending. Using recently published, disaggregated data on banks' credit exposures from the European Banking Authority, we find the elasticity of lending with respect to distance to be -1.42 in our main specification. Controlling for various factors, the negative relationship remains persistent. We argue that this relationship is largely attributable to information costs, though cultural and historical ties between countries, capital requirements, local competition and cross-border trade also play a role. The analysis highlights the enduring influence of factors which prevent full European financial integration.

ABSTRACT IN CATALAN (100 words):

Aquest article investiga si i com la distància geogràfica és important per als préstecs bancaris dins i entre països de la Unió Europea. Estimem les regressions de tipus gravetat en diverses especificacions, incorporant nous coneixements econòmics que fins ara no s'han aplicat en el context dels préstecs bancaris. Utilitzant dades publicades recentment i desglossades sobre les exposicions de crèdit dels bancs de l'Autoritat Bancària Europea, trobem l'elasticitat dels préstecs respecte a la distància a -1.42 en la nostra especificació principal. Controlant diversos factors, la relació negativa continua sent persistent. Argumentem que aquesta relació és en gran part atribuïble als costos d'informació, tot i que els vincles culturals i històrics entre països, els requeriments de capital, la competència local i el comerç transfronterer també tenen un paper. L'anàlisi posa de manifest la influència duradora dels factors que impedeixen la plena integració financera europea.

KEYWORDS IN ENGLISH (3): Gravity model, international bank lending,

European integration.

KEYWORDS IN CATALAN (3): Model de gravetat, préstecs bancaris

internacionals, integració europea.