Cost leadership at home and abroad in international banking*

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Abstract

We investigate whether contesting banks' *relative* cost advantages vis-à-avis incumbent banks in destination markets can explain the probability of operating foreign affiliates. Informed by a theoretical model adapted from the goods trade literature, we combine detailed proprietary bank-level data on the international activities of all German banks with publicly available bank micro data from possible destination markets. The likelihood of operating foreign affiliates depends on both domestic and relative cost advantages. Less profitable, more risky, and larger banks are more likely to operate affiliates abroad.

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1 Introduction

Irrespective of the financial crisis, international financial services are one of the most important components of services trade.[1] But the formation of international banking presences is not well understood despite their importance for the transmission of monetary policy, financial shocks, and ultimately loan supply (Puri *et al.* 2011, Cetorelli and Goldberg 2012, de Haas and van Horen 2013, Giannetti and Ongena 2013). This paper tests whether *comparative* cost advantages can explain bank internationalization.

We provide empirical evidence on bank lending through foreign affiliates that is informed by firm-level trade theory. We develop a stylized theoretical model of international banking to specify a reduced form equation that explains foreign presence. Like Bernard *et al.* (2003), we consider a Ricardian framework in which the relative cost advantage of a domestic bank compared to incumbents determines foreign market presence.[2] Foreign operations give rise to fixed costs, which only a few very productive home banks can afford. Thereby, we complement earlier evidence which tends to neglect the self-selection of banks into international activities (Berger *et al.* 2003), or competitive conditions in the destination country (Buch *et al.* 2009).

An important novelty is to link individual banks' internationalization strategies to the competitive conditions in foreign destination markets. These are derived from bank micro data in 52 potential destination markets to explicitly test Bernard's *et al.* (2003) prediction that foreign presence is a function of banks' marginal costs relative to those of its destination country competitors. Whereas De Blas and Russ (2013) and Bernard *et al.* (2003) simulate the marginal cost distribution, we estimate the empirical distribution of banks' marginal costs and average revenues at home *and* abroad.

Numerous studies on firms engaged in goods trade show that only few firms export at all. Those that do are typically larger and more productive (Bernard and Jensen,

[1] Financial services trade grew by 32% in 2007, and was the fastest growing segment of the services sector. After 2008/2009, it resumed its upward trend with a growth of 9% in 2010 (WTO 2009, 2011).

[2] See Niepmann (2013a,b) for a Heckscher-Ohlin approach to model comparative advantage. Cost advantages translate into a higher markups, which reflect superior productivity relative to incumbents.

1995; 1999). These stylized facts inspired a rich theoretical literature (e.g. Eaton *et al.* 2004; Helpman *et al.* 2004; Melitz and Ottaviano, 2008), which often emphasizes heterogeneity in productivity across firms. According to Bernard *et al.* (2003) this heterogeneity in productivity results in only firms with a relative cost advantage supplying products to any given market.

Whereas firm-level research on international trade in services remains fairly scarce, Breinlich and Criscuolo (2011) present stylized facts that highlight remarkable similarities with firms that trade goods. Firm-level heterogeneity also matters in services trade. Only a few firms export services and those that do tend to be larger and more productive. They conclude (p. 196) that: "These models [Melitz, 2003; Bernard *et al.*, 2003] would seem, therefore, to provide a good starting point for explaining the basic characteristics of services exporters." We follow up on their suggestion and focus on banks as international financial service providers.

Descriptive evidence by Buch *et al.* (2011) suggests that heterogeneous service models can be applied to international banking as well. They show that only the largest, most productive banks engage in international affiliate lending, which is consistent with findings on affiliate sales from the goods trade literature (e.g Helpman *et al.*, 2004). But whereas only a fraction of non-financial firms trade, almost all banks perform at least some cross-border lending. This renders heterogeneous firm models less suitable to explain banks' cross-border holdings, which is why we focus on lending via affiliates.

Our empirical approach consists of two steps. First, we estimate the marginal cost of German banks and banks in the destination market to derive indicators of comparative advantage. The sample comprises around 109,000 bank-year observations pertaining to 103 countries between 2003 and 2010, based on publicly available Bankscope data. We combine these data with detailed proprietary information about the foreign lending of all German banks and macro information. Specifically, we use the *External Position Report* of *Deutsche Bundesbank*, which reports international assets of German banks held via foreign affiliates by year and country. Second, we specify cost-leadership

indicators of comparative advantage and other factors derived from a theoretical model to explain the likelihood of observing a German (home) bank to operate a foreign affiliate in up to 52 destination markets for which we can collect complete (macro) data.

We find that German banks are more likely to conduct foreign affiliate lending if they exhibit lower marginal costs compared to domestic peers. This is in line with the prediction of Melitz (2003) that more productive domestic firms engage in foreign trade by means of affiliates. In addition to this domestic sorting, relative cost advantages between home and destination markets co-determine the likelihood to operate foreign affiliates. An indicator gauging whether a home market bank is a cost leader relative to the most productive 5% of banks in foreign market j makes affiliate presence significantly more likely.

This comparative advantage is in line with Bernard *et al.* (2003) and most important for commercial banks. Importantly, they are irrelevant for both cooperative and savings banks' foreign affiliate activities. Regarding bank-specific traits, we find that large, unprofitable, and risky banks are more likely to operate affiliates abroad. This effect is most pronounced for (large) savings banks, which is consistent with experiences during the financial crisis. Regional subsamples show that relative cost advantage is mostly relevant for bank internationalization choices in less developed and non-OECD countries. One important exception is a negative effect of cost leadership on foreign affiliate presence in financial centers, such as Luxembourg or the UK, which seems to dependent on other 'strategic' considerations that override comparative advantage considerations. Finally, whereas theoretical proxies on destination market size are statistically not significant to explain the likelihood of bank affiliate presence abroad, they are important determinants of foreign lending volumes. Differences across banking groups persist, indicating that especially savings banks expanded affiliate lending based on foreign market size rather than cost considerations.

The remainder of this paper is organized as follows. In Section 2, we present the

theoretical model and the empirical specifications to estimate foreign presence and bank-specific marginal cost. Section 3 describes bank, foreign activity, and macro data to specify the model. We discuss results in Section 4 and we conclude in Section 5.

2 Methodology

We develop a partial equilibrium framework inspired by Bernard *et al.* (2003), De Blas and Russ (2013), and Niepmann (2013a,b). On this basis, we derive a reduced form to estimate the likelihood of foreign presence conditional on empirical cost advantages. This simple, static model is tractable so as to permit an empirical test of the role played by relative cost advantages between home banks and incumbents abroad.

2.1 Theory

Consider a world economy populated by banks with varying productivity levels. The intermediation technology is identical but bank productivity is heterogeneous. Let parent bank i operate an affiliate to originate loans L_{ij} at rate R^L_{ij} in country j (the destination market). Contrary to cross-border lending, affiliate lending entails the additional fixed cost (F_j) associated with operating in the destination market.[3]

Lending in the destination market is financed by a fraction $1/\gamma$ of parent deposits D_i and a fraction $1/\psi$ of foreign affiliate deposits D_{ij}, such that $(1/\gamma)D_i = \alpha_{ij}L_{ij}$ and $(1/\psi)D_{ij} = (1-\alpha_{ij})L_{ij}$. Parent and affiliate deposit rates are R^D_i and R^D_{ij}, respectively. The former are increased with η_j to capture country-specific costs of transforming parent deposits into foreign affiliate lending.[4] The profits of operating in country j are

[3]Thus, we assume that fixed entry cost are sunk after each period similar to earlier entry studies (Bresnahan and Reiss 1987, 1991). Given our aim to derive an estimable reduced form, we abstain from more recent models of dynamic games in the IO literature, (e.g. Pakes *et al.* 2007, Ryan 2012).

[4]These country specific costs could be currency conversion costs of deposits and the risks associated with that. More broadly η_j is a markup that reflects country-specific funding risk.

defined as:

$$\begin{aligned}\pi_{ij} &= R^L_{ij}L_{ij} - (R^D_i + \eta_j)(1/\gamma)D_i - R^D_{ij}(1/\psi)D_{ij} - F_j \\ &= R^L_{ij}L_{ij} - (R^D_i + \eta_j)\alpha_{ij}L_{ij} - R^D_{ij}(1-\alpha_{ij})L_{ij} - F_j.\end{aligned} \tag{1}$$

Rewriting Equation (1) highlights two sources of bank profits in destination markets:

$$\pi_{ij} = L_{ij}(R^L_{ij} - R^D_{ij}) + \alpha_{ij}L_{ij}(R^D_{ij} - (R^D_i + \eta_j)) - F_j. \tag{2}$$

First, the bank earns a price markup, $M^p_{ij} = R^L_{ij} - R^D_{ij}$, on its total intermediation in the destination market as long as the destination market is imperfectly competitive. Second, the bank profits from a cost markup on the fraction of lending that it finances with parent deposits when $R^D_{ij} > (R^D_i + \eta_j)$. Such cost advantages may arise, for example, from managing liquidity on a global scale (see Cetorelli and Goldberg, 2012).

Next, we specify the cost markup. Bank i produces its output in country j at marginal cost C_{ij}. It has a cost advantage in country j if these costs are lower than C_{2j}, which is the marginal cost of the next best bank in country j. Accordingly, we define the cost markup as $C_{2j}/C_{ij} = R^D_{ij} - (R^D_i + \eta_j)$. It reflects that a more productive bank can originate cheaper destination market loans given parent deposits compared to the next best competitor in country j. This gives us the following profit function:

$$\pi_{ij} = \alpha_{ij}L_{ij}(C_{2j}/C_{ij}) + L_{ij}M^p_{ij} - F_j. \tag{3}$$

The bank is likely to be present in country j if $\pi_{ij} > 0$. This happens if it can compete in country j based on its comparative advantage in funding destination market loans through parent deposits and/or if it earns a positive price markup on intermediation in country j.

To specify a simple loan demand equation for country j, we consider a neoclassical one-sector production function with constant returns to scale in country j. In equilibrium, the rental rate of capital R^*_j equals the marginal product of capital MPK_j.

Aggregate capital income is $MPK_j \times K_j$, where K_j is the capital stock. We assume that $MPK_j \times K_j$ equals the total lending income to the country's lenders $R_j^* \times L_j$[5], of which bank i supplies a fraction β_{ij}. Loan demand for bank i in country j is then:

$$L_{ij} = \beta_{ij} L_j^D = \beta_{ij} \left(\frac{MPK_j \times K_j}{R_j^*} \right). \tag{4}$$

Thus, the rental rate of capital R_j^* equals the loan rate in country j in equilibrium. Melitz and Ottaviano (2008) show that (non-financial) firms in larger markets earn higher profits despite charging lower prices and markups, which predicts a negative relation between foreign presence and loan rates. Alternatively, if loan demand is sufficiently elastic, lending demand is an inverse function of lending rates. Higher prices imply less demand for loans, which depresses profits and implies that loan rates are negatively related to foreign presence. But if loan demand is very inelastic, the price effect on profits is positive. The net effect therefore depends also on competitive circumstances in destination markets, which are captured by the price markup (M_{ij}^p).

2.2 Estimation and measurement

Estimation. Home banks are more likely to be active in destination markets when they have a comparative cost advantage. As in Helpman *et al.* (2008), we define a latent variable Z_{ij} based on $\pi_{ij} > 0$ where the profit function is given in Equation (3) and we use the expression for loan demand in the destination country as in Equation (4).

To derive a log-linearized empirical specification, we formulate a profit function with multiplicative terms and specify the price markup as a scalar transformation of the cost markup: $M_{ij}^p = \mu_{ij}(C_{ij}/C_{2j})$. We proxy the degree to which foreign presence depends on imperfect competition using the net interest margin of the next best competitor in the foreign market, $NIM_j = \mu_{ij}/\alpha_{ij}$. The fewer loans are funded by parent deposits (a lower α_{ij}) and the larger the wedge between the price and the cost markup (μ_{ij}) is,

[5]Hence, in equilibrium the capital stock (K_j) is fully financed by loans, such that $K_j \equiv L_j$.

the more does foreign presence depend on the degree of foreign market competition.

$$Z_{ij} = \frac{(1 + NIM_j)(C_{2j}/C_{ij})\alpha_{ij}\beta_{ij}MPK_jK_j}{F_jR_j^*}. \tag{5}$$

Equation (5) relates variable profits to the fixed costs of operating abroad. Bank i will lend through affiliates in country j if and only if $Z_{ij} > 1$. We assume that the fixed cost F_j is a function of country- and time-fixed effects f_j and ϕ_t. Lower case letters denote the natural logarithm of uppercase letters. We define $n_{jt} = \ln(1 + NIM_{jt})$ and take natural logarithms of α_{ijt} and β_{ijt}. The latent variable $z_{ijt} \equiv \ln Z_{ijt}$ is then:

$$\begin{aligned} z_{ijt} = {} & \gamma_0 + \gamma_1 n_{jt} + \gamma_2 c_{2jt} - \gamma_3 c_{ijt} + \gamma_4 \alpha_{ijt} + \gamma_5 \beta_{ijt} - \gamma_6 r_{jt}^* \\ & + \gamma_7 MPK_{jt} + \gamma_8 K_{jt} - \gamma_9 f_j - \gamma_{10}\phi_t + \varepsilon_{ijt}, \end{aligned} \tag{6}$$

where ε_{ijt} is i.i.d. and all parameters exhibit expected signs. Note that the directions of γ_6 and γ_7 are ambiguous because the former gauges both supply and demand effects and the latter is subject to diminishing returns to physical capital.

We do not observe z_{ijt}, but do observe if a bank lends through a foreign affiliate. That is, $z_{ijt} > 0$ when parent bank i lends to country j via an affiliate and $z_{ijt} = 0$ if not. Note that we therefore do not estimate the probability of German bank entry in foreign markets, but the likelihood of lending via affiliates.[6] This approach is consistent with the static, yet tractable model that we chose. It essentially implies the assumption that fixed costs of operating the affiliate are incurred in each period and in each destination market.[7] When fixed operating costs differ between destination markets and banks can only adjust them slowly, it makes sense to compare the affiliate activities of different parents within countries. Therefore we model fixed operating costs as country fixed

[6] To measure the effect of cost advantages on *entry* choices, one would have to observe costs in the year prior to setting up the affiliate. Our data shows that all affiliates were already in operation in 2003, the starting period of our sample, which renders such an approach infeasible. So we cannot preclude that over time German banks become more cost efficient in the destination market, but partially control for this using time-fixed effects in all specifications.

[7] For example, because of having to staff a country desk for a specific market each year anew, incur licensing cost to acquire country-specific ratings and other market information, or allocate resources to apply for (re-)chartering and interaction with destination market regulators.

effects. This serves our objective to explain why for the same country j some parents lend via affiliates while other do not. To the extent that marginal costs and fixed operating costs do change over time, we use time-fixed effects to control for that.

We use a probit model to estimate our latent variable (z_{ijt}) and define an indicator variable T_{ijt} to equal 1 when bank i lends through an affiliate in country j at time t and 0 otherwise. Let ρ_{ijt} be the probability that bank i lends through an affiliate in country j at time t. We divide (6) by the standard deviation σ_ε and specify:

$$\begin{aligned}\rho_{ijt} &= \Pr(T_{ijt} = 1|\text{observed variables}) \\ &= \Phi(\gamma_0^* + \gamma_1^* n_{jt} + \gamma_2^* c_{2jt} - \gamma_3^* c_{ijt} + \gamma_4^* \alpha_{ijt} + \gamma_5^* \beta_{ijt} - \gamma_6^* r_{jt}^* + \gamma_7^* mpk_{jt} + \gamma_8^* k_{jt} \\ &\quad - \gamma_9^* f_j - \gamma_{10}^* \phi_t),\end{aligned} \tag{7}$$

where $\Phi(.)$ is the cdf of the unit-normal distribution and starred coefficients equal the original coefficients divided by σ_ε. To avoid simultaneity by construction, all covariates are lagged by one period. We cluster standard errors at the bank-country level throughout. Country- and time-fixed effects approximate the fixed operating cost f_j and ϕ_t. We also consider alternative variables below.

In sum, home banks are more likely to lend through affiliates abroad if the net interest margin of cost leaders in the foreign market is high (γ_1), the marginal cost of cost leaders in destination countries are high (γ_2), the domestic bank is productive and has low marginal cost (γ_3), a higher fraction of destination country lending is financed with parent deposits (γ_4), the bank captures a higher fraction of destination market lending (γ_5), loan rates are low in destination markets (assuming the demand effect of loan rates dominates the supply effect) (γ_6), the demand for financial funds is large (γ_7 and γ_8), and if the fixed cost of operating in destination market j are low (γ_9 or γ_{10}).

Measurement. We measure the variables in Equation (7) as follows.[8] The net interest margin n_{jt} equals the 5^{th} percentile of the distribution of NIM in each country j in

[8]Descriptive statistics and sources are discussed in Section 3.

year t.[9] The net interest margin, NIM_{jt}, is the difference between interest rate revenue relative to gross loans and interest expenses relative to customer deposits.

The main variables of interest gauge relative cost advantages of banks relative to incumbents abroad and peers at home. The cost of the second best competitor abroad, c_{2jt}, equals the 5^{th} percentile of the marginal cost distribution in country j at time t. Parent bank marginal cost c_{ijt} are obtained for each bank-year individually. We follow an abundant empirical banking literature and specify a total operating cost function TOC_{it} (e.g. Berger and Humphrey (1997) or Koetter *et al.* (2012)). Marginal cost estimates of both home and destination country banks equal the total derivative of TOC_{it} of bank i with respect to outputs y. We also include a vector z_{it} to adjust for differences in relative risk and performance. Covariates and estimation details are described in Appendix A. We perform bilateral OLS estimations to estimate bank-specific marginal costs from cost functions that are specific to each pairing of destination markets j and Germany. Thereby, we allow for systematic differences across sampled countries while at the same time following the assumption in Bernard *et al.* (2003) that banks' intermediation technologies at home and abroad are identical. Finally, we also specify a cost-leadership dummy $I(c_{ijt} < c_{2jt})$ to capture relative cost advantages more directly. It equals one when a bank's marginal costs are smaller than those of the second best competitor in the destination country and zero otherwise.

Due to data availability constraints, we are not able to measure the fraction of destination country lending financed with parent deposits (α_{ijt}) at the bank level. As a proxy we use the ratio of local liabilities to local claims provided by the Bank for International Settlements for each country j, that is $1 - \alpha_{jt}$.

Claessens and van Horen (2013a) show that location choices also depend on the competition from other banks that are active in foreign markets. The expected fraction of destination country lending the bank could capture, β_{ijt}, is measured by the percentage

[9] We use percentiles instead of e.g. the second best NIM or marginal costs in markets j to reduce the effect of outliers. We change thresholds in increments of 50 basis points up to the 10^{th} percentile of each variable's distribution in destination j. Results are unaffected and available upon request.

of foreign banks that are active in the destination country (β_{jt}). We assume that a higher fraction of foreign banks implies a lower fraction of destination country lending.

Loan rates in destination markets, r^*_{jt}, are measured by dividing foreign bank revenues by total assets. The marginal productivity of capital (mpk_{jt}) and the capital stock (k_{jt}) in destination countries are obtained from the Penn World Tables and are described in Section 3.2 below.

Contrary to the goods trade literature that inspired our model, risk-return considerations are likely to be important drivers of internationalization decisions in banking. Therefore, we also include controls for *credit risk*, bank stability as measured by the *z-score*, the *cost-to-income ratio*, *return on equity* and *size*. These variables are also specified in the cost function to obtain marginal costs and described in Appendix A.

3 Data and sampling

We describe here the three samples to combine: bank-level, macro, and affiliate data.

3.1 Bank data

To estimate banks' marginal costs and prices, we use Bankscope data from unconsolidated financial statements in all available countries. We select commercial, savings, and cooperative banks to match the so-called 'three-pillar' taxonomy of Deutsche Bundesbank (2013) between 2003 and 2011.[10] We drop entries with missing or negative data for the three factors prices, three outputs, costs, equity, total assets, and risk controls and deflate all monetary volumes to 2005 prices using country-specific consumer price

[10]The German banking system distinguishes three pillars. Banks must not merge across pillars, have different ownership structure, and pursue different business models with respect to the regional and product scope. Deutsche Bundesbank (2013) distinguishes privately owned large and regional commercials from government owned central (*Landesbanken*) and local savings banks as opposed to mutually owned central and regional cooperatives. The annual report of the German Council of Economic Experts (2013) describes in greater detail market structure, performance, and competition across these pillars.

indices. Factor prices are winsorized at the 1% level to control for outliers. After this culling, we estimate marginal costs for bilateral Germany-country j samples of banks in 103 countries with 108,704 bank-year observations in total. Descriptive statistics are shown in Table B.1 of Appendix B.

3.2 Macroeconomic data

To estimate Equation (7), we need to specify macroeconomic variables that gauge loan demand, the foreign funding share, the openness of foreign markets, and fixed operating costs. Given our focus to account for the self-selection of banks into destination markets based on comparative advantage, we avoid (as for the banking data) to constrain the set of potential foreign markets ex ante. The rationale is that German banks are in principle free to setup affiliates in any country j. The maximum number of countries with complete observations for macro and bank covariates is 52 between 2003 and 2010. Table B.2 in Appendix B summarizes the data for this unbalanced country-year panel.

The availability of theoretically required macro data is the binding constraint for the estimation sample. A caveat associated with the sample reduction to countries with available macro data is that the control group of no foreign affiliate lending in Equation (7) may be underrepresented and could therefore bias estimates of comparative advantage variables. As it turns out, the countries with available bank data that are not matched are primarily countries where the majority of German banks exhibit lower marginal cost compared to low-cost leaders abroad. Similarly, the vast majority of countries without sufficient bank data to estimate marginal costs are developing countries with poorly developed financial systems.[11] As such, our estimates can be considered conservative and unlikely to overstate the role of comparative advantage.

As in Caselli and Feyrer (2007), we calculate the marginal product of capital as $MPK = \alpha Y/K$, where α is the capital share, Y is real GDP, and K is the capital stock at current PPPs. The capital share is one minus the labor share. Data on Y,

[11] Compared to the 103 countries with bank data, the United Nations has 193 member states.

K, and the labor share are obtained from the Penn World Tables (PWT 8.0, Feenstra, Inklaar, and Timmer (2013)). We use Worldbank data on land and natural-resource wealth to adjust for differences in reproducible capital shares of total capital income.

As a proxy for β_{jt}, the share of foreign lending captured by bank i in country j, we use the percentage of foreign banks active in country j. We use the bank ownership database of Claessens and van Horen (2013b) to calculate this variable. This database contains foreign ownership information for 1995-2009. We assume that foreign ownership in 2010 equals that in 2009.[12] Because we do not observe the share of parent deposit financing (a_{jt}) directly, we measure instead $1 - a_{jt}$ as the total fraction of local currency liabilities on local residents relative to local currency claims on local residents for destination country j in year t. Accordingly, data are obtained from the Bank for International Settlement's consolidated banking statistics, Tables 9A:L and 9A:M.

We use four alternative fixed cost measures associated with operating in destination countries. The first is geographical *Distance* between Germany and the host country in thousands of kilometers (CEPII, Paris) in the vein of melting iceberg transportation cost. Second, international banks may follow their customers. Therefore, we include the aggregate volume of foreign direct investment (FDI) of German non-financial firms, *German FDI*, in millions of euros. The data are from the Microdatabase on FDI (MiDi) of *Deutsche Bundesbank*. It resembles a negative fixed operating cost. Third, *capital regulation* is a combined measure of overall and initial capital stringency. *Activity restrictions* indicate whether banks are restricted from engaging in securities underwriting, insurance underwriting and selling, real estate investments, management, and development. Both variables are obtained from Barth and Levine (2001). Higher scores indicate more stringency and restrictions. We expect negative signs.

[12] Which seems reasonable given that foreign ownership is fairly persistent over time.

3.3 Foreign affiliate data

We obtain data on the international assets of German banks' branches and subsidiaries, affiliates for short, from the *External Position Report* of *Deutsche Bundesbank*. The data covers the period 2003-2010 and comprise end-of-year amounts of loans and advances by affiliates to foreign enterprises, households, and general government of each bank in each destination markets j.[13] The raw data at our disposal cover 81 countries to which German banks had at least once an exposure.[14] We first match this data with the available macro data, which reduces the number of countries accordingly to 52.

Next, we manually link macro-augmented foreign status and Bankscope data and are able to match 1,550 out of the 2,143 German banks reporting to the foreign status database. Only 43 banks are active with foreign presences in the 52 countries with complete bank and macro variables.[15] These banks are identical to those in Buch *et al.* (2011). Hence, we capture all large international players, the attrition due to non-matched banks concerns only very small banks, and the sample therefore seems to accurately describe internationalization patterns of German banks. Descriptive statistics of foreign activities in this sample are shown in Table 1.

–Table 1 around here–

Table 1 shows that most of the 43 banks with affiliates are commercial banks.[16] Those from the savings and cooperative banking sector are mostly, but not exclusively, the large head institutions, so-called Landesbanken and Central Cooperative Banks. Across all sectors, the average international bank operates affiliates in about 22 countries. The

[13] We exclude interbank lending since demand arises in our model from financing physical capital.

[14] Thus, also securities from a country, interbank credit, and cross-border instead of affiliate lending are considered when sampling the data.

[15] Compared to the raw data from the *External Position Report* available to us, the number of countries with foreign affiliate activity for which we have either no macro or no bank data available is just 4. The remaining $81 - 4 - 52 = 25$ countries record only cross-border exposures, primarily in other than non-financial lending product categories, which we consider. The matched data account for more than 95% of foreign non-financial lending through affiliates across all countries reporting to the *External Position Report*.

[16] Due to missing matches with Bankscope data, the number of banks is significantly lower in 2003 compared to the remaining years in the sample. We therefore conducted all analyses below also without the year 2003. Results are qualitatively identical and available upon request.

volume of international activities, in turn, is by far the largest among international commercial banks, scoring at around 58 million euro as opposed to less than 4 million euro on average for cooperative banks. Figure 1 visualizes the average number of German banks with affiliates in each country of the world for our estimation sample in 2003-2010. German bank presence is concentrated in the developed world.

– Figure 1 around here –

Table 2 shows summary statistics of marginal costs at home and in destination markets, a cost-leadership dummy, imputed loan rates, net interest margins, risk and return controls, and the volume of foreign lending by German banks. The descriptives are shown at the bank-country-year level (ijt) for banks with and without affiliates and by pillar. The rightmost columns covering all banks vividly illustrates that only very few intermediaries venture into relatively few of the possible 52 countries, namely 3,610 out of 398,390 ijt-observations, resembling a mere 0.9%. There exist substantial differences across banking sectors regarding internationalization patterns. Whereas the unconditional likelihood for a commercial bank to lend via affiliates is around 10%, it equals virtually zero for the numerous, but smallest cooperative banks.

–Table 2 around here–

Comparing marginal costs across rows confirms that banks with affiliates abroad exhibit significantly lower marginal cost compared to peers at home without foreign affiliates, e.g. 2.9% versus 3.8% for the full sample. This difference is somewhat larger for savings and cooperative banks than for commercial banks. Banks that are abroad exhibit also lower prices. This observation is consistent with the international trade literature (e.g. Bernard *et al.*, 2003; Melitz and Ottaviano, 2008) and supports the notion that competitive banks are attracted to competitive markets where they are still able to realize positive margins. Surprisingly, net interest margins abroad are virtually identical for banks with foreign affiliates compared to those without. Net interest margins therefore do not drive the probability of affiliate activity abroad.

The comparison of marginal costs of home and destination country banks also illustrates that contesting banks are not necessarily always cost leaders. For the full sample, mean marginal costs of incumbents abroad (c_{2jt}) are 2.4% and thus somewhat lower compared to the 2.9% of German banks that compete in these markets. Comparing across banking groups, cooperatives abroad are on average cost leaders (1.9% versus 2.4%), savings banks have no significant cost advantage (2.9% versus 2.4%), and commercial banks have a similar cost disadvantage compared to destination market competitors (3.0% versus 2.5%). The cost-leadership dummy confirms these patterns.

To assess the overall impact together with other bank- and country-specific variables on the likelihood of foreign affiliate activity, we turn next to the regression approach reflected by Equation (7).

4 Results

4.1 The probability of foreign affiliate activity

Table 3 presents the marginal effect estimates of Equation (7), using country fixed effects to proxy the fixed operating costs. Standard errors are clustered at the bank and country level. We also include year dummies throughout. The fit of this selection equation is good as reflected by pseudo-R^2 ranging between 15% and 55%. Likewise, discriminatory power is very good as indicated by areas under the receiver operating characteristics curve (AROC) larger than 0.8.

– Table 3 around here –

In line with theory, higher marginal costs of German banks significantly reduce the probability that bank i lends via a foreign affiliate in country j at time t in column (1). An increase in marginal cost by 1% reduces this likelihood by 2.6%. This magnitude is economically significant in light of the unconditional likelihood of foreign presence

of 0.9% for the full sample (see Table 2). A reduction in the probability by 0.026 is comparable to a shift of the fitted probability from the 5^{th} to the 95^{th} percentile.

The second main variable of interest, the marginal cost of cost leaders abroad, is in contrast to theoretical predictions significantly negative in the parsimonious model in column (1). But it turns statistically insignificant when adding bank-specific controls. Thus, for this sample of German banks the cost levels of the most productive foreign competitors is not the main driver of foreign affiliate lending choices. The cost leadership dummy, in turn, captures more directly whether a particular bank has a relative cost advantage. Table 2 shows that for only around 18% of all observations, German banks qualify as cost leaders in the various possible destination markets, i.e. exhibit marginal costs below those of the 5^{th} percentile in country j at time t. Such cost-leadership increases the likelihood of having a foreign affiliate by 0.5%, which is still substantial.

Other theoretical effects predicted in Section 2 are not statistically significant, at least after accounting for other bank-specific characteristics. Apparently, destination market traits in terms of competitiveness, i.e. marginal cost and loan rates charged, have little influence on banks' internationalization choices. Insignificant estimates for the net interest margins, credit demand proxies such as the capital stock and the marginal product of capital, and foreign market openness confirm this notion. Whereas the foreign funding share proxy is significantly positive in the parsimonious model in column (1), it turns insignificant in richer specifications.

In column (2), we specify banking group dummies to address the substantial heterogeneity across banking pillars alluded to in Table 2.[17] The increase in goodness-of-fit (R^2 from 15% to 29%) and classification accuracy (AROC from 0.81 to 0.93) is substantial. The negative effect of an increase by 1% of parent bank i's marginal cost on the probability of operating a foreign affiliate is still significant, but reduced to 1.5%. Likewise, cost leadership still renders entry more likely, but with a lower magnitude.

[17] We generate one group indicator for large banks from all pillars as classified by Bundesbank (2013) and three remaining indicators for regional banks per pillar.

Other results remain qualitatively identical.

Columns (3) through (7) augment the model with bank-specific controls for differences in risk-return preferences. We include one-by-one the return on equity (column 3), the z-score of Laeven and Levine (2009) (column 4), loan impairment charges over gross loans as a proxy for credit risk (column 5), cost-to-income (CI) ratios (column 6), and size (column 7). Each covariate is individually significant. Therefore, bank-specific rather than destination country factors seem to dominate (German) banks' internationalization choices. Previous results regarding marginal costs and the importance of cost leadership are unaffected though.

The individual coefficients on bank-specific controls show specifically that less profitable banks with higher insolvency risk (lower z-score) are more likely to operate an affiliate in a given country. The result for credit risk, however, also shows that banks with less credit risk are more likely to lend abroad via an affiliate. Less efficiently managed banks, as proxied by CI ratios, are less likely to operate arguably more complex, international banking operations. In line with Buch et al. (2011), larger banks are significantly more likely to be active abroad.

The joint specification of all bank-specific controls in column (8) confirms most results. A decrease of parents' marginal costs by 1% increases the likelihood of foreign presence with 0.37% and being a cost leader further increases this likelihood with 0.16%. These effects seem reasonable given an unconditional probability of foreign presence of 0.9%. Note that accounting for bank-specific traits simultaneously yields the result that banks with more credit risk are more likely to operate affiliates. In conjunction with a positive effect of higher insolvency risk and lower profitability, this result corroborates the notion that especially risk-inclined banks venture abroad, possibly amplifying the propagation of shocks in the vein of Cetorelli and Goldberg (2011).

Overall, these results suggest that for German banks productivity advantages, as measured by marginal costs, relative to both domestic *and* destination market incumbents matter for the decision to conduct foreign lending activities through affiliates.

Thereby, the empirical evidence supports the two main predictions of the theoretical model. We do not find support though for predictions regarding traits of destination markets related to loan demand, openness, foreign funding shares, and the like. Bank-specific controls for risk, return, and size are in turn highly significant. Specifically, large banks that are less profitable and more risky are more likely to operate affiliates.

4.2 Alternative fixed operating cost

A potential reason for the absence of some of the theoretically predicted effects may relate to the brute-force approximation of foreign fixed operating cost by means of fixed effects. Therefore, we specify in Table 4 *German FDI*, *Distance* as well as *Capital* and *Activity restrictions* as alternative proxies of the fixed operating cost.

– Table 4 around here –

Whenever significant, the marginal effects of these variables are in line with theory and the literature. First, consistent with the finding that German banks follow their customers (Buch, 2000), the probability of a foreign bank presence is positively related to German FDI. Second, higher activity restrictions lower the probability of a foreign presence when controlling for banking-group dummies and bank-specific risk-return traits. This result confirms that regulation matters for foreign bank presence (Buch, 2003). Distance and capital restrictions do not exhibit statistically significant effects.

The marginal effect of marginal costs at home remains significantly negative. Likewise, the cost leadership indicator remains significantly positive as predicted. However, statistical significance is weaker and disappears completely when specifying the full vector of bank-specific controls. The results for the foreign loan demand proxies, the capital stock and the marginal product of capital, as well as foreign market pricing and openness proxies remain insignificant.

In contrast to Table 3, the openness of the foreign market (β_{jt}) is now significant in every specification. Recall that it approximates the loan market share German banks

can expect to gain in Equation (7). The negative marginal effect estimate is in line with expectations. A large share of foreign banks that are already present in destination market j leaves little room for German banks to capture market share.

In sum, the main effects of domestic marginal cost and cost leadership on foreign affiliate activity are confirmed when specifying alternative controls for the fixed cost of foreign operations. Nonetheless, the statistical significance of cost leadership is sensitive to the specification of risk, return, and size factors. We continue to use fixed effects as proxies for the fixed cost to investigate differences across different types of foreign affiliates, banking groups, and destination country groups.

4.3 Modes of entry: branches versus subsidiaries

Buch *et al.* (2011) emphasize that banks can operate in foreign banking markets in different modes: branches or subsidiaries. Branches tend to be less independent and more integrated with the parent's organizational structure, for example because parent banks remain responsible for the safety of deposits in foreign markets. In contrast, subsidiaries are legally separate entities, chartered in the destination country, and independently capitalized. They are subject to host country prudential and tax regulation and covered by (deposit) insurance schemes abroad.

Cerutti *et al.* (2007) argue accordingly that the fixed operating costs may differ between these international activity modes, for example in terms of regulatory capital requirements. Such differences could influence, in turn, the marginal effects of the remaining theoretical variables on the probability of foreign affiliate activity.

Table 5 therefore reproduces the results from Table 3 including country, year-, and banking group-specific fixed effects to explain the presence of branches (columns 1-6) and subsidiaries (columns 7-12) separately.

– Table 5 around here –

The main effects of domestic marginal cost and cost leadership in Table 3 are confirmed to explain the likelihood of lending through branches when bank traits are specified individually as in columns (1) through (4). Columns (5) and the joint specification in column (6) show, however, that relative cost advantage variables turn insignificant. The significance of both, parent banks marginal costs and the cost leadership indicator disappears in particular when controlling for size. In line with Buch *et al.* (2011), size therefore seems a key determinant for foreign affiliate activity in general and that of foreign branches in particular.

The effects of bank-specific traits remain significant though and confirm most of the baseline results. Branches are more likely to operate abroad if the bank is less profitable, less stable, and less efficiently managed. An exception is the effect of credit risk, which exhibits a negative effect on branch activity and thus opposes results for the full sample.

One explanation could be that according to Cerutti *et al.* (2007) banks enter markets with subsidiaries when they want to penetrate regional retail markets. Foreign branches, in turn, appear to be more attractive for non-retail activities, which may be pursued mostly by parent banks that generally pursue less credit intensive business models, which therefore also involve less credit risk.

The result for subsidiaries, in turn, confirms all of the main results in Table 3. Also for the subsidiary mode of foreign lending activity, bank-specific risk, return, and size traits are crucial explanatory factors. As for the full sample, credit risk now exhibits the familiar positive effect, corroborating that especially large, less profitable, less stable, and more (credit) risky banks operate subsidiaries abroad. Contrary to the results for branches, column (12) confirms also the statistical and economic significance of marginal cost of the parent as well as cost leadership relative to destination markets to explain the likelihood of foreign lending through affiliates.

In sum, the main effects of domestic marginal cost and cost leadership on foreign affiliate activity are confirmed, although they are less significant for branches. Except

for credit-risk, bank-specific controls have the same effect as in the main results. Differences in sign and significance of some variables likely reflect the different types of operations of branches compared to those of subsidiaries.

4.4 Country groups

Figure 1 showed that most international affiliates of German banks operate in industrialized economies. Some important country(-group) effects may still drive our results, for instance a common currency in the European Monetary Union (EMU) or favorable regulatory and tax regulation in financial offshore markets.

– Table 6 around here –

Table 6 therefore shows five different sample splits to test the robustness of our main results. The first two columns distinguish less developed countries (LDC), which reacted particularly sensitive to the transmission of financial shocks through international financial institutions (Cetorelli and Goldberg, 2011). We classify LDC according to the Worldbank taxonomy. The results confirm that higher domestic marginal cost of banks reduce the likelihood of operating an affiliate in either type of economy by the same magnitude. Cost leadership is, in turn, only significantly positive in the LDC sample. This result is in line with earlier literature, which finds that foreign banks are only more efficient than domestic banks in LDC (Berger, 2007). The significance of other bank-specific traits remains intact and exhibits similar magnitudes and identical direction of effects in either sample.

Columns (3) and (4) consider if membership in the EMU alters the empirical predictions. Intra-EMU foreign direct investment in the banking industry by means of affiliates occurs independent of cost considerations. Affiliate activity in non-EMU countries is more likely for more productive banks and those that are cost-leaders relative to destination markets. Bank-specific controls, in turn, exhibit the same effects as for the complete sample. This result highlights important differences of international

trade theories to explain internationalization patterns of financial and non-financial firms. In a harmonized regulatory area, risk-return considerations and mere size are most important to explain internationalization choices of banks. But outside the common currency area, theoretical variables borrowed from international trade theory do help to explain international banking patterns.

The distinction between OECD and non-OECD countries in columns (5) and (6) results in a mirror image pattern of LDC and non-LDC results in columns (1) and (2). Higher bank-specific marginal cost reduce the probability to operate affiliates in both OECD and non-OECD countries. The magnitude of this effect is statistically significantly larger for OECD countries. The larger effect in column (6) mimics the effect of marginal cost on non-LDC countries reported in column (1). Vice versa, the lower magnitude in column (5) for non-OECD countries corresponds with that for LDC countries in column (2). Cerutti *et al.* (2007) note that political country risk is another determinant of foreign bank activities. Whereas we control for country-fixed effects, lower magnitudes of the cost advantage effect in markets with presumably higher political risk (LDC and non-OECD) may indicate that banks need additional incentives to venture abroad into these countries. Accordingly, the effect of the cost leadership dummy is only significant for non-OECD (and LDC) countries. Affiliate activity in these markets thus seem to require in addition to absolute cost advantage at home also relative cost advantages with regards to destination market incumbents. Other bank-specific traits exhibit identical effects as the baseline results.

The last two pairs of columns further test the robustness of our main results towards the role of financial offshore destinations and financial centres as classified by the Bundesbank.[18] Excluding either group of countries from the sample does not alter the main effects as shown in columns (7) and (9). For both offshore and financial centres, bank-specific variables continue to indicate that less profitable, less stable, less well managed, and larger banks are more likely to operate foreign affiliates. Neither

[18]Offshore destinations included in the estimation sample are the Philippines, Singapore, and Hong Kong. Included financial centres are Luxembourg, Switzerland, and the United Kingdom.

domestic costs nor relative cost advantages affect the likelihood of foreign operations in offshore destinations. But they do for financial centres. Importantly, in contrast to the theoretically expected negative effect of higher marginal costs at home, cost-*dis*advantages render it *more* likely for German banks to operate affiliates in financial centres. Consequently, operations in arguably important hubs of financial intermediation, namely Luxembourg, Switzerland, and the UK, violate theoretical predictions and might follow instead very different 'strategic' considerations of banks.

4.5 Banking groups

During the financial crisis of 2007/2008, a number of German banks with extensive international operations failed, in part because of poor management and governance.[19] Both the ability and the incentives of different types of German banks to engage in and manage international operations may differ systematically. Therefore, Table 7 shows marginal effects for banking pillar subsamples – commercials, savings, and cooperatives – with and without the large banks as defined in Deutsche Bundesbank (2013).

– Table 7 around here –

Marginal costs do not significantly explain the presence of international affiliates of commercial banks. This result may reflect a smaller subsample size, but also less cost dispersion among privately owned commercial banks. These banks seem to base their internationalization choices in particular on whether they possess a cost leadership advantage relative to destination markets. Regarding bank-specific variables, we confirm that less profitable, better managed, and larger commercial banks are more likely to operate affiliates. Contrary to the full sample, risk variables have no significant effects.

Savings and cooperative banks exhibit the same negative marginal cost effect on foreign affiliate probability as for the entire sample. Cost leadership among cooperatives and savings exhibits in turn no significant influence on the likelihood of affilia-

[19]Such as for example Sachsen LB or West LB, see for example Bloomberg Businessweek (2012).

tions abroad. In addition, savings banks are also more likely to operate in destination markets where credit demand is associated with a high marginal product of capital. Likewise, cooperative banks are more likely to venture into markets where incumbent banks are unproductive, as measured by high marginal costs abroad, and where loan rates are low. All these effects confirm theoretical predictions.

Bank-specific covariates highlight further differences across banking pillars regarding the likelihood of operating foreign affiliates. Across all groups, less profitable, more efficiently managed, and larger banks are more likely to internationalize.[20] Foreign presence is more likely for credit risky savings banks. One important difference concerns the stability (z-score) of banks. For commercials the probability of foreign affiliate lending is unrelated to the z-score. More stable savings banks are less likely, while more stable cooperatives are more likely to lend through foreign affiliates. These results might indicate that especially those savings banks with less abundant equity buffers to absorb shocks and without cost advantages were most likely to venture abroad by means of affiliates.

Within each pillar, the Deutsche Bundesbank (2013) distinguishes large and smaller peers, for instance the Landesbanken compared to regional savings banks. To assess whether the pillar-specific effects differed within each banking sector, the remaining three columns of Table 7 show marginal effect estimates for the large banks per pillar only. Among large commercial banks, the main result of significantly negative effects of higher marginal cost is confirmed. Likewise, larger stability and lower cost-income ratios are associated with a higher likelihood of foreign affiliate lending. This result therefore suggests that among large commercial banks the more productive, efficiently managed, and stable banks are most likely active abroad.

In contrast, for both large savings banks and large cooperative banks neither domestic costs nor relative cost advantages exhibit significant effects. For large cooperatives, we only find a significantly negative effect on foreign activities via affiliates for the z-score.

[20]For some groups the size indicator is multi collinear and cannot be estimated.

For large savings banks, we find the familiar effects of bank-specific covariates that less profitable, less stable, and more risky banks are more likely to operate affiliates. In addition, and in line with theory, both higher capital stocks as well as higher marginal products of capital render a large savings bank affiliate in destination markets more likely. The result that for this subsample neither relative nor absolute cost advantages are significant for internationalization choices and that it is more likely a group of less profitable and less stable banks venturing abroad bodes ill.

4.6 Volume of foreign affiliate lending

Finally, we investigate the volume of foreign affiliate activities. Whereas the theoretical model in Section 2 does not derive explicit predictions, we consider Equation (7) the selection equation to adjust for the possible bias when explaining (log) lending volumes (Helpman *et al.* 2008, Buch *et al.*, 2009).[21] Table 8 shows according estimates where we specify in column (1) *distance* as exclusion restriction and country-fixed effects in column (2) to explain the log of total foreign lending through affiliates.

– Table 8 around here –

German banks' international affiliates increase foreign lending if destination markets are larger, as proxied by the marginal product of capital and the capital stock, and more profitable, as indicated by larger net interest margins, in countries j. Loan portfolios are also larger if local market rates are high and foreign bank market shares are overall low, leaving enough room for German contestants to undercut incumbents prices and gain market share.

In contrast to the selection equation, bank-specific variables of either kind, accounting-based risk and return proxies as well as theoretical absolute and relative cost advantage variables, are less important to explain lending volumes. We only find a statistically negative effect of z-scores on foreign lending, indicating that more stable banks lend

[21] We use a two-stage Heckman approach and adjust standard errors for the estimated Mills ratio.

less through affiliates. Thus, whereas bank-specific risk, return, and size traits are relevant in addition to domestic and relative cost advantages to explain the likelihood of affiliate activity abroad, banks' choices how much credit exposure to hold in country j depends primarily on country-specific loan market traits.

Columns (3) to (5) shows marginal effect estimates for lending volumes per banking group. In line with anecdotal evidence from the financial crisis, we find that larger marginal cost of the parent savings banks at home *increase* credit engagements whereas they reduce the volume of foreign lending of cooperatives significantly. In terms of destination market characteristics, it is mostly the size of the foreign market that drives savings banks' lending. Commercial banks behave more in line with cost advantage because we find that marginal costs abroad increase the volume of their lending. Commercial and savings banks are similar in terms of positive effects of destination market capital stocks, and lower degrees of market penetration by other foreign banks.

Other bank-specific traits other than z-scores bear little predictive power for affiliate lending volumes. Two exceptions are a large negative impact of profitability on cooperative bank leading abroad and a reduction of foreign lending for savings banks with high cost-income ratios.

In sum, especially German savings banks' affiliates violate the presumption that unproductive banks should lend less. Irrespective of absolute or relative cost advantages, savings banks expand lending if foreign credit markets are merely large. Paired with a positive relationship with parent marginal cost, this international lending pattern does not indicate an efficient international allocation of credit.

5 Conclusions

We adapt a trade model to heterogeneous international banks and develop a reduced form specification to explain the likelihood of affiliate lending activity abroad. Theoretical predictions are tested using a novel sample of 1,590 German banks that are

both internationally active and inactive between 2003 and 2010. We match proprietary international bank-level information with public micro data of local competitors in 52 potential destination markets. Thereby, we empirically test the importance of banks' *relative* cost advantages to explain foreign bank presence.

We find that banks are more likely to operate affiliates in foreign markets if parents have low marginal cost relative to domestic peers and if they are cost leaders in terms of their marginal cost relative to destination market incumbents. A reduction of parents' marginal costs by 1% increases this likelihood by 0.37%. Being a cost-leader in destination markets further increases the likelihood by 0.16%. These effects are economically significant given an unconditional affiliate activity likelihood of 0.9%. Thus, both domestic and relative cost advantages matter for bank internationalization.

In addition to (marginal) cost-leadership considerations, bank-specific controls are important determinants of banks' internationalization choices. Banks that are less profitable, exhibit larger insolvency and credit risk, are more efficiently managed, and are larger exhibit a higher likelihood of operating affiliates abroad. These results underline the importance of both *relative* cost advantages as well as risk and return traits specific to financial firms to explain internationalization choices in banking.

Separating the mode of foreign entry, subsidiaries versus branches, confirms the importance of theoretical cost advantage proxies after controlling for bank-specific risk traits. However, differences regarding the significance of cost effects and selected bank-specific traits suggest that future research on the type of business models pursued by different internationalization modes seems warranted.

Results across country group subsamples show that cost advantages are of particular importance when destination markets are increasingly different from the German home market. Absolute and relative cost advantage effects are amplified in non-OECD, less developed countries (LDC), and markets outside the European Monetary Union. But country heterogeneity is not the sole driver of significant cost advantage effects. Baseline results hold also for more homogenous country samples. Importantly, affili-

ates in financial centres (Luxembourg, Switzerland, the UK) are more likely for banks with cost *dis*advantages. Potentially, 'strategic' considerations other than costs are important determinants of banks' decisions to venture into these markets.

Finally, the empirical results highlight significant differences across so-called banking pillars. Especially large savings banks appear to operate foreign affiliates irrespective of high domestic marginal cost. For these banks, the size of destination markets seems important. Results explaining the volume of lending conditional on the likelihood of foreign presence confirm that these banks are lured to markets that are larger, allow for large net interest margins, and are generally less open to foreign banks.

References

Aviat, A. and Coeurdacier, N. (2007). The geography of trade in goods and asset holdings, Journal of International Economics, 71, 22–51.

Barth, G.C. Jr. and Levine, R. (2001). The regulation and supervision of banks around the world - A new database, World Bank Policy Research Working Paper, 2588.

Berger, A.N. (2007). Obstacles to a global banking system: "Old Europe" versus "New Europe", Journal of Banking and Finance, 31, 1955–1973.

Berger, A.N. and Humphrey, D.B. (1997). Efficiency of financial institutions: International survey and directions for future research, European Journal of Operational Research, 98, 175–212.

Berger, A.N., Dai, Q., Ongena, S., Smith, D.C. (2003). To what extent will the banking industry be globalized? A study of bank nationality and reach in 20 European nations, Journal of Banking and Finance, 27, 383–415.

Bernard, A.B., Eaton, J., Jensen, B.J. and Kortum, S.K. (2003). Plants and productivity in international trade, American Economic Review, 93, 1268–1290.

Bernard, A.B., Jensen, J.B. (1995). Exporters, jobs, and wages in U.S. manufacturing: 1976-1987, Brookings Papers on Economic Activity: Microeconomics, 67–119.

Bernard, A.B. Jensen, J.B. (1999). Exceptional exporter performance: cause, effect, or both? Journal of International Economics, 47, 1–25.

Bloomberg Businessweek (2013). Ending too big to fail may invite failure. Retrieved November 26, 2013 from http://www.businessweek.com/articles/2012-06-07/ending-too-big-to-fail-may-actually-create-failure

Breinlich, H. and Criscuolo, C. (2011). International trade in services: A portrait of importers and exporters, Journal of International Economics, 84, 188–206.

Bresnahan, T. and Reiss, P. (1987). Do entry conditions vary across markets?, Brookings Papers on Economic Activity, 1, 833–882.

Bresnahan, T. and Reiss, P. (1991). Entry and competition in concentrated markets, Journal of Political Economy, 99, 977–1009.

Buch, C.M. (2000). Why do banks go abroad?—Evidence from German data, Financial Markets Institutions, and Instruments, 9, 33–67.

Buch, C.M. (2003) Information or regulation: What drives the international activities of commercial banks?, Journal of Money, Credit and Banking, 35, 852–869.

Buch, C.M., Koch, C.T. and Koetter, M. (2009) Margins of international banking: Is there a productivity pecking order in banking, too? CESIfo Working paper 2891.

Buch, C.M., Koch, C.T. and Koetter, M. (2011) Size, productivity, and international banking, Journal of International Economics 85, 329–334.

Caselli, F. and Feyrer, J. (2007) The marginal product of capital, Quarterly Journal of Economics, 122, 535–568.

Cerutti, E., Dell'Ariccia, G., Martinez-Peria, M.S. (2007). How banks go abroad: Branches or subsidiaries?, Journal of Banking and Finance, 31, 1669–1692.

Cetorelli, N. and Goldberg, L. (2011). Global banks and international shock transmission: Evidence from the crisis, International Monetary Fund Economic Review, 59(1), 41-76.

Cetorelli, N. and Goldberg, L. (2012). Banking globalization and monetary transmission, Journal of Finance, 67, 1811–1843.

Claessens, S. and van Horen, N. (2013a). Location Decisions of Foreign Banks and Competitor Remoteness. Journal of Money, Credit, and Banking, forthcoming.

Claessens, S. and van Horen, N. (2013b). Foreign banks: Trends and Impact. Journal of Money, Credit, and Banking, forthcoming.

De Blas, B. and Russ, K.N. (2013). All banks great, small, and global: Loan pricing and foreign competition, International Review of Economics and Finance, 26, 4–24.

de Haas, R., and N. van Horen (2013). Running for the exit? International bank lending during a financial crisis, Review of Financial Studies, 26, 244–285.

Deutsche Bundesbank (2013). Bankenstatistik – Statistisches Beiheft 1 zum Monatsbericht, 2013, Frankfurt am Main.

Eaton, J., S. Kortum, and F. Kramarz (2004). Dissecting trade: Firms, industries, and export destinations, American Economic Review 94, 150–154.

Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2013) The next generation of the Penn World Table, available for download at www.ggdc.net/pwt.

German Council of Economic Experts (2013). Against a backward-looking economic policy. Annual Report 2013/14. Wiesbaden.

Giannetti, M. and Ongena S. (2013). "Lending by example": Direct and indirect effects of foreign banks in emerging markets. Journal of International Economics, 86, 167–180.

Helpman, E., Melitz, M. and Rubinstein, Y. (2008). Estimating trade flows: Trading partners and trading volumes, Quarterly Journal of Economics, 73, 441–487.

Helpman, E., Melitz, M.J., and S. Yeaple (2004). Exports versus FDI with heterogeneous firms. American Economic Review, 94, 300–316.

Koetter, M., Kolari, J.W. and Spierdijk, L. (2012). Enjoying the quiet life under deregulation? Evidence from adjusted Lerner indices for U.S. banks, Review of Economics and Statistics, 94, 462–480.

Laeven, L., and Levine, R. (2009). Bank governance, regulation, and risk taking. Journal of Financial Economics, 93, 259–275.

Melitz, M.J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity, Econometrica, 71, 1695–1725.

Melitz, M.J. and Ottaviano, G.I.P (2008). Market size, trade, and productivity, Review of Economic Studies, 75, 295–316.

Mester, L.J. (1996). A study of bank efficiency taking into account risk-preferences, Journal of Banking and Finance, 20, 1025-1045.

Niepmann, F. (2013a). Banking across borders. CESIfo Working Paper 4120.

Niepmann, F. (2013b). Banking across borders with heterogeneous banks. Federal Reserve Bank of New York Staff Reports 609.

Pakes, A., Ostrovsky, M., Berry, S. (2007). Simple estimators for the parameters of discrete dynamic games (with entry/exit examples), RAND Journal of Economics, 38, 373–399.

Puri, M., Rocholl, J., Steffen, S. (2011). Global retail lending in the aftermath of the US financial crisis: Distinguishing between supply and demand effects, Journal of Financial Economics, 100, 556–578.

Ryan, S. P. (2012). The costs of environmental regulation in a concentrated industry, Econometrica, 80, 1019–1061.

Sealey, C. W., Jr. and Lindley, J.T. (1977). Inputs, outputs, and theory of production cost at depository financial institutions, Journal of Finance, 32, 1251–1266.

WTO (2009) International trade statistics 2009. World Trade Organization: Geneva.

WTO (2011) International trade statistics 2009. World Trade Organization: Geneva.

Table 1: Summary statistics for foreign affiliates and lending abroad

Variable	Group	2003	2004	2005	2006	2007	2008	2009	2010	All
Number of banks	Commercials	27	59	67	67	70	70	69	70	104
	Savings	195	409	419	423	420	414	408	404	468
	Cooperatives	183	539	555	567	876	879	864	868	1,018
	All	405	1,007	1,041	1,057	1,366	1,363	1,341	1,342	1,590
Number of banks abroad	Commercials	5	11	14	14	15	14	17	17	24
	Savings	2	9	11	10	11	10	10	10	13
	Cooperatives	0	2	3	3	4	6	6	6	6
	All	7	22	28	27	30	30	33	33	43
Number of countries with affiliate	Commercials	30	36	38	45	48	48	47	50	52
	Savings	14	32	36	44	46	47	45	48	51
	Cooperatives	0	18	26	34	41	41	39	43	49
	All	30	36	38	45	48	48	48	50	52
Average number of countries with affiliate	Commercials	16.67	19.18	18.69	22.69	22.15	22.79	19.92	22.43	21.05
	Savings	9.00	14.17	17.29	23.33	23.29	28.00	26.38	26.75	22.78
	Cooperatives	0.00	12.50	25.00	34.00	40.00	24.00	24.50	28.50	25.27
	All	14.75	16.89	18.52	23.45	23.38	24.48	22.57	24.38	21.91
Average loans and advances per bank	Commercials	51.20	54.60	62.90	66.60	76.30	54.60	55.50	57.20	57.80
	Savings	14.70	12.70	16.30	17.90	23.10	25.30	17.70	13.60	16.90
	Cooperatives	2.27	1.71	4.62	5.06	4.05	4.81	3.80	3.18	3.65
	All	34.80	36.60	42.60	45.10	51.40	40.70	37.00	36.90	39.10
Average loans and advances per country	Commercials	16.00	17.70	19.10	20.40	23.40	17.10	15.80	16.40	17.60
	Savings	14.70	16.50	19.50	21.10	21.80	15.70	13.60	14.30	16.50
	Cooperatives	16.50	21.10	22.50	21.80	21.30	16.30	15.30	13.30	17.70
	All	15.60	17.50	19.50	20.80	22.70	16.60	14.90	15.40	17.20

Notes: This table reports summary statistics for each year and for all years 2003–2010 in the final column *All*. It reports the unique *Number of banks* that are in the regression sample. Of these banks it reports the unique *Number of banks abroad*. The *Number of countries with affiliate* is the number of unique countries that have at least one affiliate. The *Average number of countries with affiliate* is the mean number of countries within a group (commercials, savings, cooperatives, and all) where banks operate affiliates. Finally, we report *Average loans and advances per bank* and *per country* in millions of euro.

Table 2: Summary statistics ijt-dimension according to presence abroad

	Commercials			Savings			Cooperatives			All		
Domestic	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*
Bank marginal costs (c_{ijt})	0.040	0.021	20,014	0.037	0.007	134,288	0.038	0.007	240,478	0.038	0.008	394,780
Marginal costs abroad (c_{2jt})	0.026	0.021	20,014	0.026	0.021	134,288	0.025	0.020	240,478	0.025	0.021	394,780
Cost leadership ($I(c_{ijt} < c_{2jt})$)	0.243	0.429	20,014	0.187	0.390	134,288	0.170	0.375	240,478	0.179	0.384	394,780
Price of capital abroad (r^*_{jt})	4.484	3.416	20,014	4.486	3.412	134,288	4.416	3.295	240,478	4.443	3.341	394,780
Net interest margin (n_{jt})	1.025	0.037	20,014	1.025	0.037	134,288	1.025	0.039	240,478	1.025	0.039	394,780
Return on equity (roe)	16.227	16.678	20,014	19.437	6.823	134,288	16.180	6.397	240,478	17.290	7.566	394,780
Z-score (zs)	24.308	25.996	19,787	36.900	19.048	134,195	32.066	18.086	239,955	33.323	19.136	393,937
Credit risk (cr)	0.953	1.495	20,014	0.951	0.670	134,288	0.855	0.687	240,478	0.893	0.745	394,780
Cost-to-income ratio (cit)	40.426	22.583	20,014	36.325	5.785	134,288	42.327	7.670	240,478	40.189	8.996	394,780
Total assets	3.463	1.511	20,014	4.031	1.003	134,288	2.352	1.212	240,478	2.979	1.408	394,780
Abroad												
Bank marginal costs (c_{ijt})	0.030	0.018	2,040	0.029	0.012	1,254	0.019	0.006	316	0.029	0.015	3,610
Marginal costs abroad (c_{2jt})	0.025	0.020	2,040	0.024	0.020	1,254	0.024	0.018	316	0.024	0.019	3,610
Cost leadership ($I(c_{ijt} < c_{2jt})$)	0.390	0.488	2,040	0.291	0.454	1,254	0.513	0.501	316	0.366	0.482	3,610
Price of capital abroad (r^*_{jt})	4.279	3.187	2,040	4.207	3.206	1,254	4.162	3.042	316	4.244	3.181	3,610
Net interest margin (n_{jt})	1.025	0.044	2,040	1.024	0.042	1,254	1.025	0.048	316	1.024	0.044	3,610
Return on equity (roe)	12.611	14.072	2,040	18.765	16.391	1,254	5.815	6.606	316	14.154	14.959	3,610
Z-score (zs)	15.166	12.028	2,040	15.690	9.202	1,254	22.775	11.159	316	16.014	11.245	3,610
Credit risk (cr)	0.681	1.112	2,040	0.506	0.642	1,254	0.848	0.747	316	0.635	0.950	3,610
Cost-to-income ratio (cit)	32.801	14.516	2,040	14.229	6.679	1,254	14.921	6.936	316	24.784	14.910	3,610
Total assets	4.968	0.257	2,040	5.000	0.000	1,254	4.949	0.283	316	4.978	0.211	3,610
Loans and advances abroad	1481.425	10300.000	2,040	412.216	1470.636	1,254	86.571	315.720	316	987.918	7800.031	3,610
All												
Bank marginal costs (c_{ijt})	0.039	0.021	22,054	0.037	0.007	135,542	0.038	0.007	240,794	0.038	0.009	398,390
Marginal costs abroad (c_{2jt})	0.026	0.021	22,054	0.026	0.021	135,542	0.025	0.020	240,794	0.025	0.021	398,390
Cost leadership ($I(c_{ijt} < c_{2jt})$)	0.256	0.437	22,054	0.188	0.391	135,542	0.170	0.376	240,794	0.181	0.385	398,390
Price of capital abroad (r^*_{jt})	4.465	3.396	22,054	4.483	3.410	135,542	4.415	3.294	240,794	4.441	3.340	398,390
Net interest margin (n_{jt})	1.025	0.038	22,054	1.025	0.037	135,542	1.025	0.039	240,794	1.025	0.039	398,390
Return on equity (roe)	15.892	16.488	22,054	19.431	6.972	135,542	16.166	6.408	240,794	17.262	7.670	398,390
Z-score (zs)	23.453	25.164	21,827	36.703	19.089	135,449	32.054	18.082	240,271	33.166	19.149	397,547
Credit risk (cr)	0.928	1.466	22,054	0.947	0.671	135,542	0.855	0.687	240,794	0.890	0.748	398,390
Cost-to-income ratio (cit)	39.720	22.072	22,054	36.121	6.168	135,542	42.291	7.733	240,794	40.049	9.184	398,390
Total assets	3.602	1.506	22,054	4.040	1.003	135,542	2.355	1.215	240,794	2.998	1.414	398,390
Loans and advances abroad	1481.425	10300.000	22,054	412.216	1470.636	135,542	86.571	315.720	240,794	987.918	7800.031	398,390

Notes: This table reports summary statistics on the estimated marginal costs, prices and control variables per banking group. Each group includes the large and central as well as the regional banks. *SD* indicates standard deviation, *N* indicates the number of observations. All marginal costs follow from the sum of the derivatives of the cost function w.r.t to outputs y_1, y_2, and y_3. All prices follow from average revenues. We take the 5^{th} percentile of the distribution of prices and costs in each destination country i at time t or in Germany at time t. Loans and advances abroad are given in thousands of euros. Cost leadership is a dummy that equals one when $c_{ijt} < c_{2jt}$ and zero otherwise.

Table 3: Cost leadership and the probability of foreign affiliate activity: Main estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank marginal cost (c_{ijt})	−0.0258***	−0.0145***	−0.0139***	−0.0106***	−0.0144***	−0.0110***	−0.0094***	−0.0037***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Marginal costs abroad (c_{2jt})	−0.0034***	−0.0022*	−0.0023*	−0.0019	−0.0023*	−0.0012	−0.0023*	−0.0012
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Cost leadership dummy ($I(c_{ijt} < c_{2jt})$)	0.0047***	0.0028***	0.0027***	0.0021***	0.0028***	0.0022***	0.0028***	0.0016**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Price of capital abroad (r^*_{jt})	0.0022	0.0016	0.0017	0.0014	0.0016	0.0007	0.0016	0.0009
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Net interest margin (n_{jt})	0.0044	0.0035	0.0030	0.0035	0.0034	0.0056	0.0030	0.0038
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
Capital stock (k_{jt})	−0.0010	−0.0001	−0.0002	0.0000	−0.0003	0.0003	0.0001	0.0003
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Marginal product of capital (mpk_{jt})	0.0017	0.0016	0.0015	0.0016	0.0015	0.0012	0.0015	0.0011
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Foreign funding share (α_{jt})	0.0012**	0.0007	0.0008	0.0007	0.0008	0.0004	0.0007	0.0005
	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Openess foreign market (β_{jt})	0.0029	0.0025	0.0026	0.0026	0.0026	0.0014	0.0029	0.0024
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
Return on equity			−0.0168***					−0.0275***
			[0.003]					[0.002]
Z-score				−0.0070***				−0.0042***
				[0.000]				[0.000]
Credit risk					−0.0054***			0.0015***
					[0.001]			[0.001]
Cost-to-income ratio						−0.0196***		−0.0146***
						[0.001]		[0.001]
Size							0.0183***	0.0119***
							[0.002]	[0.001]
Country fixed effects (f_j)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects (ϕ_t)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank group dummies	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	398,390	398,390	398,390	397,547	398,390	398,390	398,390	397,547
$\hat{\rho}$ p5	0.0009	0.0002	0.0002	0.0001	0.0002	0.0000	0.0000	0.0000
$\hat{\rho}$ p95	0.0230	0.0288	0.0276	0.0291	0.0267	0.0212	0.0368	0.0217
R-squared	0.1519	0.2888	0.2927	0.3205	0.2928	0.4407	0.4275	0.5482
AROC	0.8078	0.9342	0.9351	0.9472	0.9347	0.9747	0.9703	0.9858

Notes: This table reports the marginal effects of estimating the probit model in equation (7) for the years 2003 to 2010. The dependent variable is an indicator equal to one if bank i lends to country j through an affiliate at time t. We consider loans to non-finance firms, households, and government. All explanatory variables are lagged by one period. We include country and year fixed effects. $\hat{\rho}$ p5 and $\hat{\rho}$ p95 indicate the 5^{th} and 95^{th} percentiles of the fitted values of the Probit. AROC indicates the area under the receiver operating characteristic curve. Standard errors are clustered at the bank-country level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Alternative fixed operating cost proxies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bank marginal cost (c_{ijt})	-0.0260^{***}	-0.0144^{***}	-0.0139^{***}	-0.0106^{***}	-0.0143^{***}	-0.0109^{***}	-0.0094^{***}	-0.0037^{***}
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Marginal costs abroad (c_{2jt})	0.0034	0.0021	0.0019	0.0017	0.0021	0.0022	0.0016	0.0011
	[0.003]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Cost leadership dummy ($I(c_{ijt} < c_{2jt})$)	0.0029^{***}	0.0017^{**}	0.0016^{**}	0.0012	0.0018^{**}	0.0013^{*}	0.0018^{**}	0.0008
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Price of capital abroad (r^*_{jt})	−0.0045	−0.0027	−0.0025	−0.0021	−0.0027	−0.0026	−0.0022	−0.0013
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.002]	[0.002]	[0.002]
Net interest margin (n_{jt})	0.0077	0.0019	0.0014	−0.0000	0.0022	0.0021	0.0019	−0.0002
	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.012]	[0.011]
Capital stock (k_{jt})	−0.0003	−0.0003	−0.0004	−0.0004	−0.0003	−0.0003	−0.0003	−0.0004
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Marginal product of capital (mpk_{jt})	−0.0004	−0.0005	−0.0005	−0.0004	−0.0005	−0.0005	−0.0005	−0.0006
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Foreign funding share (α_{jt})	0.0010	0.0007	0.0007	0.0006	0.0007	0.0005	0.0005	0.0003
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Openness foreign market (β_{jt})	-0.0043^{***}	-0.0039^{**}	-0.0039^{**}	-0.0038^{**}	-0.0038^{**}	-0.0035^{**}	-0.0037^{**}	-0.0035^{***}
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
German FDI (f_{jt})	0.0019^{***}	0.0018^{***}	0.0018^{***}	0.0017^{***}	0.0018^{***}	0.0016^{***}	0.0017^{***}	0.0016^{***}
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Distance (f_j)	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Capital restrictions (f_j)	−0.0007	−0.0006	−0.0006	−0.0005	−0.0006	−0.0005	−0.0005	−0.0004
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Activity restrictions (f_j)	−0.0013	−0.0021	−0.0022	-0.0025^{*}	−0.0021	-0.0022^{*}	-0.0024^{*}	-0.0030^{**}
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Return on equity			-0.0169^{***}					-0.0273^{***}
			[0.003]					[0.002]

Table 4: Alternative fixed operating cost proxies (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Z-score				-0.0070^{***}				-0.0043^{***}
				[0.000]				[0.000]
Credit risk					-0.0056^{***}			0.0012^{**}
					[0.001]			[0.001]
Cost-to-income ratio						-0.0194^{***}		-0.0144^{***}
						[0.001]		[0.001]
Size							0.0185^{***}	0.0120^{***}
							[0.002]	[0.001]
Country fixed effects (f_j)	No	No	No	No	No	No	No	No
Year fixed effects (ϕ_t)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank group dummies	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	371,394	371,394	371,394	370,607	371,394	371,394	371,394	370,607
$\hat{\rho}$ p5	0.0010	0.0002	0.0002	0.0001	0.0002	0.0000	0.0000	0.0000
$\hat{\rho}$ p95	0.0219	0.0282	0.0269	0.0284	0.0257	0.0208	0.0330	0.0194
R-squared	0.1420	0.2826	0.2866	0.3150	0.2870	0.4333	0.4217	0.5421
AROC	0.7937	0.9316	0.9323	0.9459	0.9323	0.9733	0.9695	0.9853

Notes: This table reports the marginal effects of estimating the probit model in equation (7) for the years 2003 to 2010. The dependent variable is an indicator equal to one if bank i lends to country j through an affiliate at time t. We consider loans to non-finance firms, households, and government. All explanatory variables are lagged by one period. We include year fixed effects. Instead of country fixed effects, we approximate fixed cost of operating abroad by alternative variables German FDI, distance, capital restrictions, and activity restrictions. $\hat{\rho}$ p5 and $\hat{\rho}$ p95 indicate the 5^{th} and 95^{th} percentiles of the fitted values of the Probit. AROC indicates the area under the receiver operating characteristic curve. Standard errors are clustered at the bank-country level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Modes of foreign affiliate activity: branches vs. subsidiaries

	Branches						**Subsidiaries**					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Bank marginal cost (c_{ijt})	−0.0022***	−0.0010**	−0.0021***	−0.0013***	−0.0003	0.0002	−0.0103***	−0.0085***	−0.0109***	−0.0092***	−0.0052***	−0.0026***
	[0.001]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]	[0.000]	[0.000]
Marginal costs abroad (c_{2jt})	−0.0005	−0.0003	−0.0005	−0.0002	−0.0005	−0.0001	−0.0019	−0.0015	−0.0017	−0.0011	−0.0017	−0.0014
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Cost leadership dummy $I(c_{ijt} < c_{2jt})$	0.0010**	0.0007	0.0010**	0.0007	0.0008*	0.0005	0.0017***	0.0014**	0.0018***	0.0015***	0.0017***	0.0009*
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Price of capital abroad (r_{jt})	0.0003	0.0002	0.0003	−0.0000	0.0002	−0.0001	0.0015	0.0012	0.0012	0.0008	0.0013	0.0012
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Net interest margin (n_{jt})	0.0030	0.0033	0.0030	0.0029	0.0024	0.0028	−0.0003	0.0002	0.0006	0.0026	0.0001	0.0003
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.006]
Capital stock (k_{jt})	−0.0003	−0.0004	−0.0004	−0.0006	−0.0003	−0.0006	−0.0002	0.0001	−0.0002	0.0002	−0.0001	0.0000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Marginal product of capital (mpk_{jt})	0.0001	−0.0000	0.0000	−0.0002	−0.0000	−0.0002	0.0017	0.0018	0.0017	0.0016	0.0017	0.0016
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Foreign funding share (α_{jt})	0.0006*	0.0006*	0.0006*	0.0005	0.0005*	0.0004	0.0004	0.0003	0.0003	0.0002	0.0003	0.0002
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Openness foreign market (β_{jt})	0.0021	0.0020	0.0021	0.0026	0.0025	0.0031	0.0015	0.0012	0.0012	0.0001	0.0016	0.0013
	[0.002]	[0.003]	[0.002]	[0.002]	[0.002]	[0.002]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.003]
Return on equity	0.0033*					−0.0028**	−0.0171***					−0.0189***
	[0.002]					[0.001]	[0.002]					[0.001]
Z-score		−0.0023***				−0.0012***		−0.0045***				−0.0023***
		[0.000]				[0.000]		[0.000]				[0.000]
Credit risk			−0.0029***			−0.0015***			−0.0027***			0.0034***
			[0.000]			[0.000]			[0.000]			[0.000]
Cost-to-income ratio				−0.0081***		−0.0061***				−0.0121***		−0.0076***
				[0.001]		[0.000]				[0.001]		[0.000]
Size					0.0031***	0.0014***					0.0109***	0.0084***
					[0.000]	[0.000]					[0.001]	[0.000]
Observations	398,390	397,547	398,390	398,390	398,390	397,547	398,390	397,547	398,390	398,390	398,390	397,547
$\hat{\rho}$ p5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
$\hat{\rho}$ p95	0.0103	0.0105	0.0103	0.0062	0.0159	0.0070	0.0160	0.0174	0.0161	0.0138	0.0251	0.0127
R-squared	0.1650	0.1904	0.1705	0.3853	0.3029	0.4373	0.3337	0.3521	0.3274	0.4255	0.5097	0.5746
AROC	0.8892	0.9165	0.8924	0.9648	0.9563	0.9750	0.9591	0.9599	0.9557	0.9788	0.9857	0.9908

Notes: This table reports the marginal effects of estimating the probit model in equation (7) for the years 2003 to 2010. Columns (1)—(6) indicate the estimates for branches and (7)—(12) those for subsidiaries. The dependent variable is an indicator equal to one if bank i lends to country j through an affiliate at time t. We consider loans to non-finance firms, households, and government. All explanatory variables are lagged by one period. We include but do not report country, year, and banking group fixed effects. $\hat{\rho}$ p5 and $\hat{\rho}$ p95 indicate the 5^{th} and 95^{th} percentiles of the fitted values of the Probit. AROC indicates the area under the receiver operating characteristic curve. Standard errors are clustered at the bank-country level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Cost advantages across country groups

	LDC		**Euro**		**OECD**		**Offshore**		**Financial center**	
	no	yes	no	yes	no	yes	no	yes	no	yes
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Bank marginal cost (c_{ijt})	−0.0029***	−0.0026***	−0.0028***	−0.0027	−0.0026***	−0.0029***	−0.0030***	−0.0019	−0.0027***	−0.0097***
	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.004]
Marginal costs abroad (c_{2jt})	−0.0012	−0.0017	−0.0005	−0.0028	0.0005	−0.0025	−0.0014	0.0043	−0.0014	0.0003
	[0.001]	[0.002]	[0.001]	[0.004]	[0.002]	[0.002]	[0.001]	[0.007]	[0.001]	[0.010]
Cost leadership dummy ($I(c_{ijt} < c_{2jt})$)	0.0012	0.0019*	0.0012*	0.0029	0.0015**	0.0013	0.0014**	0.0032	0.0017***	−0.0212***
	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.007]
Price of capital abroad (r^*_{jt})	0.0009	0.0013	0.0001	0.0022	−0.0008	0.0019	0.0011	−0.0049	0.0010	−0.0007
	[0.001]	[0.002]	[0.001]	[0.004]	[0.002]	[0.002]	[0.001]	[0.008]	[0.001]	[0.011]
Net interest margin (n_{jt})	0.0096	0.0031	0.0079	0.0027	0.0059	−0.0014	0.0033	−0.1835	0.0031	0.1187
	[0.007]	[0.012]	[0.007]	[0.017]	[0.007]	[0.012]	[0.007]	[0.236]	[0.007]	[0.124]
Capital stock (k_{jt})	0.0006	−0.0001	0.0006	−0.0002	−0.0018	0.0022	0.0005	−0.0016	0.0003	−0.0037
	[0.003]	[0.004]	[0.002]	[0.009]	[0.002]	[0.004]	[0.002]	[0.005]	[0.002]	[0.015]
Marginal product of capital (mpk_{jt})	−0.0013	0.0012	0.0008	0.0001	−0.0012	0.0024	0.0015	−0.0047	0.0015	−0.0040
	[0.002]	[0.003]	[0.002]	[0.006]	[0.002]	[0.003]	[0.002]	[0.020]	[0.002]	[0.009]
Foreign funding share (α_{jt})	−0.0004	0.0008	0.0001	0.0012	−0.0004	0.0008	0.0005	−0.0258	0.0006	−0.0019
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.000]	[0.028]	[0.000]	[0.002]
Openness foreign market (β_{jt})	−0.0007	0.0005	0.0045	−0.0122	0.0016	0.0038	0.0033	−0.0122	0.0033	−0.0298
	[0.005]	[0.008]	[0.004]	[0.011]	[0.004]	[0.008]	[0.004]	[0.149]	[0.004]	[0.082]
Return on equity	−0.0176***	−0.0310***	−0.0215***	−0.0368***	−0.0172***	−0.0328***	−0.0252***	−0.0186**	−0.0242***	−0.0363***
	[0.002]	[0.003]	[0.002]	[0.006]	[0.002]	[0.004]	[0.002]	[0.008]	[0.002]	[0.013]
Z-score	−0.0030***	−0.0042***	−0.0036***	−0.0038***	−0.0034***	−0.0038***	−0.0037***	−0.0041***	−0.0036***	−0.0045**
	[0.000]	[0.001]	[0.000]	[0.001]	[0.000]	[0.001]	[0.000]	[0.001]	[0.000]	[0.002]
Credit risk	0.0020***	0.0029***	0.0023***	0.0037**	0.0020***	0.0034***	0.0026***	0.0017	0.0022***	0.0072***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.003]
Cost-to-income ratio	−0.0087***	−0.0171***	−0.0113***	−0.0207***	−0.0092***	−0.0175***	−0.0133***	−0.0125***	−0.0127***	−0.0222***
	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.003]
Size	0.0059***	0.0086***	0.0070***	0.0087***	0.0074***	0.0082***	0.0073***	0.0094***	0.0069***	0.0127***
	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.003]	[0.001]	[0.003]
Observations	185,062	212,485	320,026	77,521	209,612	187,935	383,940	13,607	374,343	23,204
$\hat{\rho}$ p5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
$\hat{\rho}$ p95	0.0123	0.0337	0.0173	0.0420	0.0121	0.0351	0.0228	0.0134	0.0200	0.0501
R-squared	0.5622	0.5689	0.5690	0.5649	0.5788	0.5609	0.5676	0.5993	0.5669	0.5779
AROC	0.9891	0.9848	0.9881	0.9822	0.9903	0.9837	0.9866	0.9905	0.9869	0.9833

Notes: This table reports the marginal effects of estimating the probit model in equation (7) for the years 2003 to 2010. LDC indicates less developed countries as defined by the Worldbank. Euro countries are members of the European Monetary Union as of the respective admission data. OECD indicates sample splits for member countries of the Organization of Economic Cooperation and Development. Offshore and financial center countries contained in the estimation sample are classified following the Bundesbank. The former are the Phillippines, Singapore, and Switzerland. The latter are Luxembourg, Switzerland, and the United Kingdom. The dependent variable is an indicator equal to one if bank i lends to country j through an affiliate at time t. We consider loans to non-finance firms, households, and government. All explanatory variables are lagged by one period. We include but do not report country, year, and banking group fixed effects. $\hat{\rho}$ p5 and $\hat{\rho}$ p95 indicate the 5^{th} and 95^{th} percentiles of the fitted values of the Probit. AROC indicates the area under the receiver operating characteristic curve. Standard errors are clustered at the bank-country level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Foreign affiliate activity across banking groups

	Commercials	**Savings**	**Cooperatives**	**Large Commercials**	**Large Savings**	**Large Cooperatives**
	(1)	(2)	(3)	(4)	(5)	(6)
Bank marginal cost (c_{ijt})	−0.0077	−0.0106***	−0.0047***	−0.8745***	−0.0559	−0.2071
	[0.005]	[0.003]	[0.000]	[0.140]	[0.075]	[0.225]
Marginal costs abroad (c_{2jt})	−0.0193	−0.0003	0.0011*	0.4599	−0.0919	0.2418
	[0.016]	[0.005]	[0.001]	[0.491]	[0.093]	[0.219]
Cost leadership dummy ($I(c_{ijt} < c_{2jt})$)	0.0273***	−0.0019	−0.0000	0.0821	−0.0427	0.0548
	[0.009]	[0.002]	[0.000]	[0.086]	[0.035]	[0.048]
Price of capital abroad (r^*_{jt})	0.0115	0.0018	−0.0012*	−0.6149	0.1324	−0.3019
	[0.017]	[0.005]	[0.001]	[0.532]	[0.099]	[0.232]
Net interest margin (n_{jt})	−0.0223	0.0435	−0.0005	−0.8000	0.2207	−0.1525
	[0.087]	[0.034]	[0.003]	[0.791]	[0.541]	[0.672]
Capital stock (k_{jt})	−0.0066	0.0075	−0.0004	0.6438	0.2825*	−0.0731
	[0.028]	[0.009]	[0.001]	[0.549]	[0.151]	[0.211]
Marginal product of capital (mpk_{jt})	0.0001	0.0119*	−0.0007	0.1256	0.2167*	−0.1144
	[0.023]	[0.007]	[0.001]	[0.536]	[0.120]	[0.192]
Foreign funding share (α_{jt})	0.0077	−0.0010	0.0002	−0.1028	−0.0007	0.0244
	[0.007]	[0.002]	[0.000]	[0.146]	[0.043]	[0.072]
Openness foreign market (β_{jt})	−0.0054	0.0150	0.0026	−0.3532	−0.0037	0.0857
	[0.050]	[0.016]	[0.002]	[0.681]	[0.266]	[0.334]
Return on equity	−0.2107***	−0.0819***	−0.0062***	−0.3746	−1.0624***	−0.2607
	[0.020]	[0.008]	[0.001]	[0.402]	[0.119]	[0.543]
Z-score	−0.0060	−0.0204***	0.0004***	0.3258***	−0.1833***	−0.3338**
	[0.004]	[0.002]	[0.000]	[0.078]	[0.031]	[0.138]
Credit risk	0.0032	0.0029*	−0.0000	−0.3327	0.3789***	0.0621
	[0.007]	[0.002]	[0.000]	[0.261]	[0.064]	[0.144]
Cost-to-income ratio	−0.0121*	−0.0457***	−0.0012***	−0.6646***	−0.2462***	0.4123
	[0.007]	[0.002]	[0.000]	[0.193]	[0.059]	[0.424]
Size	0.1350***		0.0005***			
	[0.015]		[0.000]			
Observations	21,827	53,876	223,091	264	2,715	544
$\hat{\rho}$ p5	0.0000	0.0000	0.0000	0.0963	0.0544	0.0000
$\hat{\rho}$ p95	0.3583	0.0723	0.0000	0.9895	0.9109	1.0000
R-squared	0.2987	0.6580	0.8481	0.3011	0.2253	0.6968
AROC	0.8864	0.9841	0.9986	0.8325	0.7996	0.9749

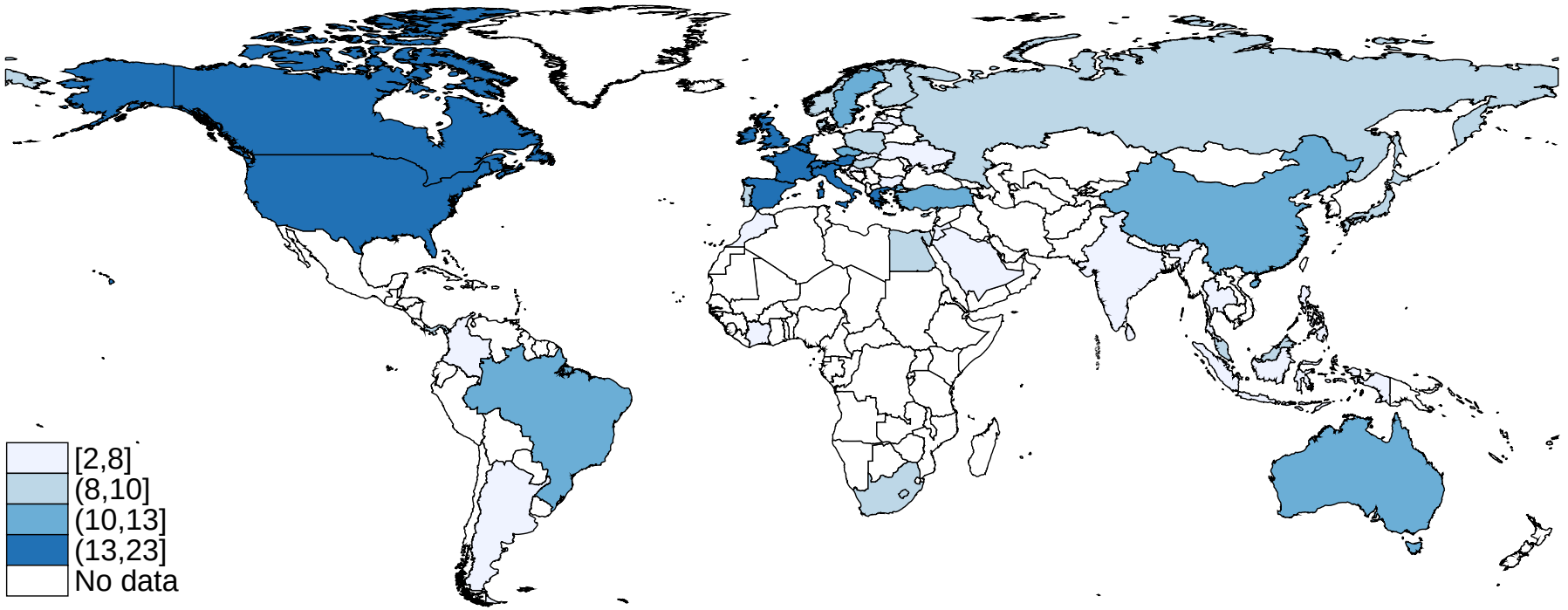
Notes: This table reports the marginal effects of estimating the probit model in equation (7) for the years 2003 to 2010. Banking groups are defined as in Deutsche Bundesbank (2013) according to large and small banks within each of the three pillars commercial, savings, and cooperative banks. The dependent variable is an indicator equal to one if bank i lends to country j through an affiliate at time t. We consider loans to non-finance firms, households, and government. All explanatory variables are lagged by one period. We include country and year fixed effects. $\hat{\rho}$ p5 and $\hat{\rho}$ p95 indicate the 5^{th} and 95^{th} percentiles of the fitted values of the Probit. AROC indicates the area under the receiver operating characteristic curve. Standard errors are clustered at the bank-country level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Cost leadership and the amount lent abroad

	Distance (1)	**Fixed effects** (2)	**Commercials** (3)	**Savings** (4)	**Cooperatives** (5)
Bank marginal cost (c_{ijt})	−0.1024	−0.0359	−0.0475	0.8948***	−5.0498***
	[0.143]	[0.143]	[0.143]	[0.327]	[1.665]
Marginal costs abroad (c_{2jt})	0.2203	0.2567	0.7289*	−0.3873	−0.0365
	[0.283]	[0.286]	[0.411]	[0.393]	[1.299]
Cost leadership dummy ($I(c_{ijt} < c_{2jt})$)	0.1108	0.0827	0.0032	0.1349	−0.4348
	[0.090]	[0.088]	[0.153]	[0.116]	[0.359]
Price of capital abroad (r^*_{jt})	−0.2351	−0.2571	−0.8597*	0.4129	0.9020
	[0.304]	[0.306]	[0.441]	[0.425]	[1.387]
Net interest margin (n_{jt})	3.0798*	3.8211*	5.4175**	−4.5514	
	[1.598]	[1.593]	[2.238]	[2.404]	[6.045]
Capital stock (k_{jt})	0.9564***	1.0442***	1.0851**	0.8479**	1.4756
	[0.254]	[0.257]	[0.424]	[0.340]	[1.243]
Marginal product of capital (mpk_{jt})	0.6690**	0.6943**	0.4331	0.8851**	0.5250
	[0.307]	[0.307]	[0.439]	[0.436]	[1.356]
Openness foreign market (β_{jt})	−1.8977***	−1.9270***	−2.4535**	−2.1579**	3.8385
	[0.713]	[0.715]	[0.986]	[1.077]	[3.097]
Return on equity	−0.6311	−0.2774	1.0891	−0.8076	−8.0250**
	[0.505]	[0.479]	[0.692]	[0.597]	[3.509]
Z-score	−0.3048***	−0.2501**	−0.3774***	−0.5713***	−0.3326
	[0.116]	[0.113]	[0.135]	[0.165]	[1.271]
Credit risk	−0.1115	−0.1264	−0.1759	−0.1968	0.2374
	[0.095]	[0.095]	[0.123]	[0.164]	[0.517]
Cost-to-income ratio	−0.3332	−0.1550	0.0641	−0.6634*	1.5579
	[0.254]	[0.247]	[0.181]	[0.368]	[1.301]
Size	0.0293	−0.2353	−0.7325	0.4951	1.4892
	[0.693]	[0.685]	[0.802]	[1.008]	[2.240]
Observations	3,610	3,610	2,040	1,254	316
Inverse Mill's ratio	0.1724	−0.0919	−0.7008	0.5411	0.9760

Notes: This table reports coefficient estimates for the outcome equation of a Heckman selection model. The selection equation corresponds to the probit model in equation (7) for the years 2003 to 2010 and is not reported. The dependent variable in the outcome equation is the log level of loans lent abroad in country j at time t via affiliates. We consider loans to non-finance firms, households, and government. All explanatory variables are lagged by one period. We include but do not report country-year fixed effects. Column (1) indicates the full sample with *Distance* as exclusion restriction. Column (2) indicates the full sample with country fixed effects as exclusion restrictions. Standard errors are adjusted for the fact that the inverse Mills ratio in the outcome equation is a generated variable. All explanatory variables are lagged one period. Standard errors are clustered at the bank-country level and are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Figure 1: Average number of German banks present abroad per country



A Appendix: Estimating Marginal Costs and Prices

To specify a cost function, we follow the intermediation approach (Sealy and Lindley, 1977). Banks demand three factors (deposits, labor, and physical capital) in complete factor markets at prices w_{pit}, where $p = 1, 2, 3$, to generate three outputs y_{qit}, where $q = 1, 2, 3$ (securities, loans and off-balance sheet activities). We also include a vector of covariates z_{it} to adjust for differences in relative risk and performance described below. A translog total cost function for bank i at time t including a time trend T is:

$$\begin{aligned}\log TOC_{it} = \alpha + \sum_{p=1}^{3} \beta_p \log w_{pit} + \sum_{q=1}^{3} \beta_q \log y_{qit} + \delta \log(z_{it}) + \sum_{p=1}^{3} (\zeta/2)(\log w_{pit})^2 \\ + \sum_{p<k} \sum \eta_{pk} \log w_{pit} \log w_{kit} + \sum_{q=1}^{3} (\theta/2)(\log y_{qit})^2 + \sum_{q<l} \sum \eta_{ql} \log y_{qit} \log y_{lit} \\ + \sum_{p=1}^{3} \sum_{q=1}^{3} \lambda_{pq} \log w_{pit} \log y_{qit} + \sum_{k=1}^{2} \nu_k T^k + \sum_{p=1}^{3} \xi_p \log w_{pit} T + \sum_{p=1}^{3} \omega_q \log y_{qit} T + \varepsilon_{it},\end{aligned} \tag{8}$$

We impose homogeneity of degree one on input prices and assume that production technologies are identical across banks within each bilateral sample of German banks and banks from country j. This approach permits a comparison of marginal costs. Given parameter estimates of Equation (8), we calculate the marginal costs for each bank i in country j and Germany in each year t as the sum of partial cost derivates of (8) with respect to the three outputs:

$$C_{ijt} = \sum_{q=1}^{3} \frac{TOC_{qijt}}{y_{qijt}} \frac{\partial \log TOC}{\partial \log y_{qijt}}. \tag{9}$$

Cost function variables are defined as follows. Total operating cost TOC cover all operating expenses of the bank including interest expenses. We obtain total bank revenues by adding profits before tax PBT. The price of fixed assets w_1 is the ratio of expenses for fixed assets to fixed assets. The cost of labor w_2 equals the ratio of personnel expenses to the total number of employees. Funding costs are approximated

by the ratio of interest expenses to total deposits. We specify three outputs: securities (y_1), gross loans (y_2) and off-balance sheet activities (y_3).

The vector of risk and return controls z_{it} is important in at least two ways. First, banks that have superior productivity could have lower marginal costs because they are better able to manage risk. Second, risk motives, like diversification, could be important to determine banks' decisions to operate in foreign destination markets.

Therefore, we first follow Mester (1996) and include *equity*. To adjust for differences in risk-adjusted performance, we include two risk proxies: *credit risk* is measured as loan impairment charges over gross loans and the *z-score*, which measures insolvency risk (Laeven and Levine 2009). It equals is the sum of return on assets (RoA) and the capital ratio (Equity/total assets, TA) divided by the standard deviation of return on assets over the sample period. Z-scores reflect the number of standard deviations that a bank's RoA must fall below its expected value before equity is depleted. Lower z-scores therefore indicate riskier banks. We use two relative performance measures: the *cost-to-income ratio* is the sum of personnel expenses and other operating expenses over total revenues, and *return on equity* is pre-impairment operating profit divided by equity. Finally we follow the example of Aviat and Coeurdacier (2007) and specify a quintile indicator to measure bank *size*. We allocate banks to one of five groups based on the distribution of total assets at home in each year.[22]

Table B.1 in Appendix B summarizes cost and profit frontier variables, separating German (home) banks from destination market bank data.

[22]Note that we also specified total assets and log total assets, which resulted in unreasonable marginal cost estimates

B Appendix: Tables

Table B.1: Summary statistics marginal cost and price estimation

Full sample	mean	sd	p5	p95	N
y_1 (in millions)	870.30	13523.78	0.67	1072.12	108,704
y_2 (in millions)	1425.34	12826.23	9.00	2910.68	108,704
y_3 (in millions)	795.98	15627.98	0.31	449.37	108,704
w_1 (in %)	185.39	400.55	28.68	630.77	108,704
w_2 (in thousands)	45.48	19.56	22.96	78.68	108,704
w_3 (in %)	2.37	1.36	0.37	4.57	108,704
Z (in millions)	178.44	1729.23	2.15	376.58	108,704
TOC (in millions)	119.45	1165.94	0.96	228.93	108,704
PBT (in millions)	31.32	365.76	−0.18	63.90	108,704
cr (in%)	0.61	0.97	0.00	2.33	108,704
cit (in%)	47.36	19.35	23.18	77.53	108,704
zs	35.81	28.02	6.06	89.36	108,704
roe (in%)	14.16	11.06	−2.53	31.67	108,704
Assets (in millions)	3019.68	33111.56	19.51	5262.90	108,704
Germany					
y_1 (in millions)	1373.51	14482.50	8.28	1672.61	11,365
y_2 (in millions)	2115.27	14726.69	29.64	3719.23	11,365
y_3 (in millions)	635.58	6301.62	1.86	417.70	11,365
w_1 (in %)	139.86	329.93	34.14	492.25	11,365
w_2 (in thousands)	51.84	15.86	37.21	81.29	11,365
w_3 (in %)	2.75	0.93	1.68	3.88	11,365
Z (in millions)	168.29	1012.21	4.33	343.40	11,365
TOC (in millions)	215.73	1498.64	3.24	319.85	11,365
PBT (in millions)	25.06	181.34	0.40	62.70	11,365
cr (in%)	0.91	0.87	−0.01	2.27	11,365
cit (in%)	40.08	10.78	23.20	53.88	11,365
zs	33.24	20.03	11.66	65.58	11,365
roe (in%)	17.37	8.11	6.63	30.26	11,365
Assets (in millions)	5132.04	46585.34	60.49	6724.81	11,365
All other countries					
y_1 (in millions)	811.26	13405.67	0.55	955.18	97,339
y_2 (in millions)	1344.40	12582.10	8.54	2789.70	97,339
y_3 (in millions)	816.16	16430.65	0.25	456.24	97,339
w_1 (in %)	190.73	407.70	28.13	646.05	97,339
w_2 (in thousands)	44.74	19.81	21.98	78.41	97,339
w_3 (in %)	2.33	1.39	0.32	4.64	97,339
Z (in millions)	179.63	1794.67	2.05	382.20	97,339
TOC (in millions)	108.15	1119.92	0.90	213.42	97,339
PBT (in millions)	32.06	381.59	−0.25	64.10	97,339
cr (in%)	0.57	0.97	0.00	2.34	97,339
cit (in%)	48.22	19.94	23.18	79.07	97,339
zs	36.11	28.80	5.83	91.58	97,339
roe (in%)	13.78	11.30	−3.41	31.91	97,339
Assets (in millions)	2771.88	31142.28	18.50	5033.37	97,339

Notes: This table represent summary statistics for the estimation of marginal costs and prices. Sd indicates standard deviation, N indicates the number of observations and p5 and p95 are the 5th and 95th percentile, respectively. We estimate separate cost functions for each country j-German banks sample pair. All data are from Bankscope. w_1 is operating expenses over assets, w_2 is personnel expenses over number of employees, and w_3 is interest expenses over total deposits. y_1 is total securities, y_2 is gross loans, and y_3 is the sum of managed securitized assets, other off balance sheet exposures, guarantees, acceptances and documentary committed credit lines. We also report total equity (Z), pre-impairment operating profit (PBT) and total operating costs (TOC): the sum of interest expenses, loan impairment charges, personnel expenses and other operating expenses, credit risk (cr): loan impairment charges over gross loans, cost-to-income ratio (cit): the sum of personnel expenses and other operating expenses over total revenues, the z-score (zs): the sum of return on assets and the capital ratio over the standard deviation of return on assets, return on equity (roe): pre-impairment operating profit over equity and total assets (Assets) in millions of euros.

Table B.2: Summary statistics macro variables j,t dimension

	Mean	SD	p5	p95	N
Capital Stock (K_{jt})	3.182	7.278	0.048	17.958	207
Marginal productivity of capital (MPK_{jt})	0.083	0.033	0.029	0.141	207
Foreign funding share (α_{jt})	0.274	0.290	−0.240	0.687	207
Openness foreign market (β_{jt})	0.354	0.268	0.000	0.867	207
German FDI	14,324	33,301	37	51,316	207
Distance	4.006	4.018	0.515	10.766	207
Capital regulations	5.082	1.796	2.000	8.000	194
Activity restrictions	10.015	2.229	7.000	14.000	198

Notes: This table reports summary statistics on the macro-economic variables to control for the loan supply, the foreign funding share, the openness of foreign markets, and destination country fixed operating costs. Sd indicates standard deviation, N indicates the number of observations and p5 and p95 are the 5th and 95th percentile, respectively. The marginal product of capital is calculated as the capital share × (PPP-adjusted GDP/Capital Stock) (Caselli and Feyrer 2007). Data on GDP, capital stock, and relative prices are from version 8.0 of the Penn World Tables. (PWT, Feenstra, Inklaar and Timmer (2013)). The capital share is one minus the labor share and adjusted for differences in reproducible capital's share of total capital income. The foreign funding share (α_{jt}) is approximated using data from the Bank for International Settlement's consolidated banking statistics, Tables 9A:L and 9A:M. The openness of foreign markets (β_{jt}) equals the percentage of foreign-owned banks active in country j (Claessens and van Horen, 2013b). German FDI is the aggregate volume in millions of euros (Deutsche Bundesbank). Distance between Germany and the host country in thousands of kilometers (CEPII, Paris). Capital regulation is a combined measure of overall and initial capital stringency, ranging from zero to nine, with a higher value indicating greater stringency. Activity restrictions indicate whether banks are restricted from enganging in securities underwriting, insurance underwriting and selling, real estate investments, management, and development. Higher values indicate more restrictions. Both measures are from Barth and Levine (2001).