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Margins of International Banking: Is There a Productivity Pecking Order in Banking, Too?

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Margins of International Banking: Is There a Productivity Pecking Order in Banking, Too?

Abstract

Modern trade theory emphasizes firm-level productivity differentials to explain the cross-border activities of non-financial firms. This paper tests whether a productivity pecking order also determines international banking activities. We use a novel dataset of all German banks' international activities to estimate the ordered probability of being present abroad (extensive margin) and the volume of international assets (intensive margin). Methodologically, we enrich the conventional Heckman selection-model to account for the self-selection of banks into different modes of foreign activities based on an ordered probit. Our paper has four main findings. First, as for non-financial firms, we find a productivity pattern order driving bank internationalization. Second, while only a few non-financial firms engage in international trade, many banks hold international assets. Only a few large banks engage in FDI. Third, apart from productivity, risk factors matter for international banking. Fourth, gravity-type variables have an important impact on international banking activities.

1 Motivation

Recent advances in international economics provide us with fairly good information on the patterns of internationalization of firms. Empirically, larger and more productive firms are more likely to export and to engage in foreign direct investment (FDI) than smaller and less productive firms.¹ The explanation for these stylized facts is an interaction between firm-level productivity and the costs of market entry (Melitz 2003; Helpman et al. 2008). Domestic fixed costs are lower than the costs of exporting which, in turn, are lower than the costs of FDI. Exporting entails higher variable costs. Hence, firms self-select themselves into different

¹ See, e.g. Bernard et al. (2006, 2007), Helpman et al. (2004), Tomiura (2007), or Yeaple (2009).

modes of entry. The higher the fixed costs of a mode of entry, the higher the required productivity. The result is a “pecking order of productivity”.²

Relatively little is known, in contrast, about the internationalization of services firms and in particular banks.³ In this paper, we ask whether banks are different. We ask to what extent internationalization decisions of banks are determined by productivity, which factors affect the extensive margin (the foreign investment decision) and the intensive margin (the volume of activities), and which factors affect a particular mode of activities. In contrast to earlier literature,⁴ we explicitly model bank productivity, and we distinguish between different modes of foreign activities (international assets, foreign branches, foreign subsidiaries). In addition, we explicitly distinguish the extensive from the intensive margin.

Our study goes beyond earlier evidence in three regards.

First, we use a novel and comprehensive dataset which provides detailed information on internationalization choices of German banks. The “External Position Report” provided by the *Deutsche Bundesbank* has information on international assets of German banks, their foreign branches, and their foreign subsidiaries, year-by-year, and country-by-country. There have been no minimum reporting thresholds since 2002. Hence, we have detailed information on all domestic and internationally active banks. We find that, in contrast to non-financial firms, many (small) banks hold international assets. In line with evidence for non-financial firms, only a few banks have foreign affiliates.

Second, we model the self-selection of banks into different modes of foreign activities using an ordered probit and thus enrich the conventional Heckman (1979) model by hierarchical categories in the selection equation. We show that the selection into foreign status has a significant impact on the volume of activities. Most previous studies focus on internationally active banks only,⁵ thereby neglecting the selection bias inherent in heterogeneous firm (productivity) models.

² In the international finance literature, the term “pecking order” has also been used to describe the structure of different types of international capital flows (Daude and Fratzscher 2008).

³ Bonfiglioli (2008) provides country-level evidence at the country level that financial integration reflected in liberalization spurs total factor productivity in the economy. The specific role of banks is not analyzed.

⁴ See, for example, Berger et al. (2003), Ruckman (2004), or Buch and Lipponer (2007). Goldberg (2004) discusses links between literature on financial and non-financial firms’ FDI with a focus on the impact on developing countries. Cetorelli and Goldberg (2008) show how differences in the degree of internationalization of banks can have implications for the effects of monetary policy.

⁵ See Berger et al. (2003), Focarelli and Pozzolo (2005), or Cerruti et al. (2007).

Third, we take into account that banks' production processes differ from those of non-financial firms. We estimate bank productivity using an empirical methodology used for non-financial firms in the spirit of Levinsohn and Petrin (2003) and applied to banks by Nakane and Weintraub (2005). To estimate total factor productivity, banking studies often draw on a dual approach by estimating cost or profit functions (Kumbhakar and Lovell 2000) and by analyzing the impact of changes in technology or factor inputs. However, this approach often neglects the bias resulting from the simultaneity between input choices and productivity. With our productivity measures as hand, we find clear evidence for a productivity pecking order in international banking. Productivity is especially important for smaller banks such as savings and cooperative banks.

Fourth, our empirical approach is motivated by a stylized model of an international bank. As in the international trade literature, choosing the optimal mode of foreign activities involves a trade-off between fixed and variable costs. In contrast to the international trade literature, banks also take into account portfolio effects of their international activities. The model yields testable implications concerning the bank-level and country-level factors determining the intensive and the extensive margin. Our empirical results support the importance of risk factors for internationalization strategies.

The remainder of this paper is structured as follows. Section Two provides the theoretical background. Section Three presents our data and descriptive statistics, our empirical model, and our measure of bank productivity. Section Four displays the estimation results, and Section Five concludes.

2 Theoretical Framework

To see how bank-level and host-country factors influence international banking, consider a simple portfolio model of an international bank. We enrich a baseline closed-economy portfolio model (Freixas and Rochet 1998) by modeling banks' choice to service foreign markets. Banks can either hold international assets through their domestic headquarters (Mode 1) or through foreign affiliates (Mode 2).⁶ In addition, we assume that banks invest,

⁶ Our terminology differs from the WTO classification of foreign modes. In the language of the GATS, our focus is on Mode 1 (cross-border supply) and Mode 3 (commercial presence). In the empirical model, we will also allow for the possibility to remain a purely domestic bank, and we will distinguish between foreign branches and subsidiaries. Adding these options would not affect the qualitative results of the theoretical model.

but they do not borrow abroad.⁷ In each period, the bank chooses its optimal portfolio structure. The balance sheet restriction for bank i is given by:

$$(1) \quad W_i + D_i = L_i + L_{i,j}^* + R_i$$

where W_i = initial wealth, D_i = domestic deposits (liabilities), L_i = domestic loans (assets), L_{ij}^* = foreign loans (assets) in country j , and R_i = risk-free assets.

To analyze the bank's choices, consider profits under the two modes of foreign activities. The expected profit of a domestic bank i holding international assets in country j is given by the its returns on domestic and international assets minus its variable costs and the fixed costs of foreign activities:

$$(2) \quad \Pi(1)_{ij} = [r_L - c_{ij,L}(\omega_i)]L(1)_i + [(1 - \tau_j)r_{L,j}^* - c_{ij,L}^*(\omega_i)]L(1)_{ij}^* + r_F R(1)_i - [r_D + c_{ij,D}(\omega_i)]D(1)_i - F(1)_j,$$

where $F(1)_j$ = the fixed costs of Mode 1, r_L, r_D = expected interest rates on (risky) assets and liabilities, r_F = interest rate on the risk-free asset, τ_j = country-specific information costs lowering the return on international assets with $0 < \tau_j < 1$, and $c_{ij,\bullet}$ = variable costs. (1) denotes the bank's choices under Mode 1. Variable costs are modeled in analogy to iceberg transportation costs known from the trade literature, and the fixed and variable costs of international operations vary across host countries. Fixed costs of domestic operations are set to zero.

Raising deposits and granting loans is costly for banks. These costs capture resource inputs in connection with handling loan applications, maintaining a branch network, or performing payments services. We assume that banks differ with regard to their productivity (ω_i), and more productive banks have lower costs:

$$(3) \quad c_{ij,\bullet} = c_{ij,\bullet}(\omega_i) \text{ with } \frac{\partial c_{ij,\bullet}}{\partial \omega_i} < 0.$$

Each bank is thus characterized by a productivity level, which also transfers to its foreign affiliates. The costs of supplying financial services internationally, in turn, are higher than in

⁷ Relaxing these assumptions would leave the main qualitative results of the following analysis unaffected. We also abstract from exchange rate risk.

the domestic context: $c_{ij,L}(\omega_i) < c_{ij,L}^*(\omega_i)$ due to institutional and regulatory differences between financial systems or the lack of familiarity with the pool of foreign borrowers.

Profits of a bank which sets up foreign affiliates (Mode 2) are given by:

$$(4) \quad \Pi(2)_{ij} = \left[r_L - c_{ij,L}(\omega_i) \right] L(2)_i + \left[r_{j,L}^* - c_{ij,L}^*(\omega_i) \right] L(2)_{ij}^* + r_F R(2)_i - \left[r_D + c_{ij,D}(\omega_i) \right] D(2)_i - F(2)_j$$

This specification is similar to equation (2) with two exceptions. First, we assume that the fixed costs of operating under Mode 2 are higher than the fixed costs of Mode 1:

$F(1)_j < F(2)_j$. (For supportive empirical evidence see Cerutti et al. (2007).) Second, information costs are lower under Mode 2 since the bank is operating in the foreign country. Without loss of generality, we set these costs to zero under Mode 2. Our specification thus involves a trade-off between fixed and variable costs of foreign activities, similar to the one known from the trade literature.

So far, our model shares similarities with models of non-financial firms. Yet, the main difference between banks and non-financial firms is that the former also care about the risk of their activities. We follow Rochet (2008, Chapter 8) and assume that the bank's objective function is increasing in expected profits and decreasing in risk:⁸

$$(5) \quad U_{ij} = U_{ij} \left[E(\Pi_{ij}) \sigma^2(\Pi_{ij}) \right] \quad \frac{\partial U_{ij}}{\partial E(\Pi_{ij})} > 0, \quad \frac{\partial U_{ij}}{\partial \sigma^2(\Pi_{ij})} < 0.$$

Under the simplifying assumption that deposits carry no risk, the variance of the portfolio is given by $\sigma^2(\Pi_{ij}) = L_i^2 \sigma^2 + L_{ij}^{*2} \sigma_j^{*2} + 2L_i L_{ij}^* COV_j$ where $\sigma^2(\sigma_j^{*2})$ is the country-specific risk of domestic (foreign) assets, and COV_j is the covariance matrix of domestic and foreign returns.

We can use this model to analyze the intensive and the extensive margin of banks' foreign activities.⁹ Take the extensive margin first. The bank will choose to be active in the foreign country if its expected utility is positive, i.e. if $U_{ij} > 0$ holds. Using equations (3)-(5), it is straightforward to show that the probability of investing abroad is higher (i) the lower the

⁸ This specification holds under certain assumptions in an incomplete markets setting. See Rochet (2008) for details.

⁹ The results of the comparative static analysis are summarized in Table 2.

fixed costs of foreign activity (F_j), (ii) the lower information costs (τ_j), (iii) the higher the productivity of the bank (ω_i), and (iv) the lower the risk of foreign activities (σ_j^{*2}).

Moreover, banks will prefer to choose Mode 2 rather than Mode 1 (v) if their productivity exceeds a threshold ($\bar{\omega}$), such that banks with $\omega_i < \bar{\omega}$ will choose Mode 1, while banks with $\omega_i > \bar{\omega}$ will choose Mode 2 and maintain affiliates abroad, and (vi) if the savings of fixed costs of entering through Mode 2 are small relative to the higher variable costs under Mode 1.

The volume of international activities, i.e. the intensive margin can be analyzed by differentiating the objective function with respect to the volume of international risky assets (L_{ij}^*):¹⁰

$$(6) \quad \frac{\partial U_{ij}}{\partial L_{ij}^*} = \frac{\partial U_{ij}}{\partial E(\Pi_{ij})} \left[(1 - \tau_j)_{j,L}^* - c_{ij,L}^*(\omega_i) \right] + 2 \frac{\partial U_{ij}}{\partial \sigma^2(\Pi_{ij})} \left[L_{ij}^* \sigma_j^{*2} + L_i \text{COV}_j \right] = 0.$$

By denoting the degree of the bank's degree of risk aversion with

$$(7) \quad \lambda_i = -\frac{1}{2} \frac{\partial U_{ij}}{\partial E(\Pi_{ij})} \frac{\partial \sigma^2(\Pi_{ij})}{\partial U_{ij}} > 0,$$

the first order condition (6) can be rewritten into

$$(6') \quad \frac{\partial U_{ij}}{\partial L_{ij}^*} = \frac{\partial U_{ij}}{\partial E(\Pi_{ij})} \left\{ (1 - \tau_j)_{j,L}^* - c_{ij,L}^*(\omega_i) - \frac{1}{\lambda_i} (L_{ij}^* \sigma_j^{*2} + L_i \text{COV}_j) \right\} = 0.$$

Based on equation (6'), we obtain comparative static results according to which banks will increase the volume of their international assets (i) the higher the gross return (r_L^*), (ii) the lower information costs (τ_j), (iii) the higher their productivity and thus the lower the variable costs ($c_{ij,L}^*(\omega_i)$), (iv) the lower the risk (σ_j^{*2}), (v) the lower the correlation between domestic and foreign returns (lower COV_j), and (vi) the lower their degree of risk aversion (λ_i).

In sum, our model shows that bank heterogeneity with regard to productivity and risk aversion has an impact on internationalization patterns. It also shows differences and similarities between banks and non-financial firms. For both types of firms, foreign entry becomes more likely the lower fixed costs of foreign activity, the greater the savings of

¹⁰ The qualitative results are the same for the different modes, hence we drop the indices.

variable costs, and the higher productivity. Also, the volume of activities increases in productivity and falls in variable costs. Additionally though, banks take the risk-return trade off of foreign activities into account.

3 Empirical Methodology

3.1 Data on Patterns of Internationalization¹¹

We bring the implications of the above model to the data using bank-level datasets for German banks which have kindly been provided by the *Deutsche Bundesbank*. The main novelty of this paper is that we use a detailed database on banks' international assets. The so-called "External Position Report" provides comprehensive information on the international assets of domestic banks, their foreign branches, and their foreign subsidiaries year-by-year, and country-by-country. We use this database for the years 2002-2006 since reporting thresholds on international assets have been abolished in January 2002. Hence, we have exact information on the extensive margin of banks' foreign operations, and we do not face problems due to truncation or censoring.

To obtain information on the extensive margin of banks' foreign operations, we manually link branches and subsidiaries located in country j to their domestic parent bank i . We obtain information on the intensive margin of banks' foreign operations by aggregating all assets held in country j across the different modes of foreign activity. Note that we use a composite foreign asset and do not distinguish between different types of assets to keep the analysis tractable. Most of the assets we include are interbank assets.

We complement the "External Position Report" with information from annual balance sheets and income statements of all banks operating in Germany between 2000 and 2006. Each bank which holds a German banking license is required to submit these data to the supervisory authority.

We create a dataset which contains observations for each bank ($i = 2,235$), each country ($j = 69$), and each year ($t = 5$). Hence, the full dataset contains $i \cdot j \cdot t = 637,308$ observations. Our dataset covers OECD and non-OECD countries and gives a comprehensive picture of German banks' foreign activities. We distinguish the following modes of operation:

¹¹ Details are given in the Data Appendix.

- purely domestic banks without foreign activities (“Mode 0”),
- banks holding international assets through their domestic headquarters (“Mode 1”),
- banks maintaining foreign branches (“Mode 2a”), and
- banks maintaining foreign subsidiaries and/or foreign branches (“Mode 2b”).

Each bank-year observation is included in only one of these modes. The ranking of the modes is guided by the presumed fixed costs involved. Subsidiaries are legally independent, hold their own equity, and are subject to host-country control. Hence, setting up foreign subsidiaries involves the highest costs in terms of capital requirements and regulatory burden. In addition, foreign subsidiaries are often used for large-scale retail operations, which implies also the highest fixed costs in addition to the regulatory start-up costs (Cerutti et al. 2007).

Tables 1 and 3 highlight five main characteristics of the internationalization patterns of German banks:

First, in Columns 1 and 3 of Table 1, we look at the structure of the full sample which allows for all possible combinations between banks, countries, and years. The allocation of total observations across modes of internationalization is highly dispersed. There are many zeros (almost 80%) in the bilateral matrix of bank-country combinations. Another about 20% of observations is second category, i.e. international assets. The number of observations in Modes 2a and 2b (affiliates) is tiny, accounting for less than 1% of the total. This high degree of dispersion is due to the fact that we allow for *all* possible combinations between banks, countries, and years.

Second, the above data are obviously inflated because we treat each bank in each country as a separate observation. Asking instead whether a particular bank is active abroad at all gives a quite different picture (Columns 3 and 4 of Table 1). On average, only 28 out of a total of 2,235 banks were purely domestic banks, 27 held foreign branches, and 37 held subsidiaries and/or branches. The by far largest group were the banks holding international assets in at least one foreign country (2,143 banks). In this sense, evidence for banks differs from that for manufacturing firms, where only a small sub-set of firms imports or exports.

Third, not even the large banks with international affiliates are present in all countries (Table 1, Column 5). If banks hold international assets, they do so – on average – in 21 countries. Banks in Mode 2a have branches in 12 countries on average; banks in Mode 2b have subsidiaries in 9 countries.

Fourth, considering the volume of international assets, those held through domestic banks and those held through foreign branches are of roughly similar importance (Graph 1). The share of international assets of subsidiaries is small. These relative patterns in the data are similar for mean investments. Comparing the mean and the median investment of banks in each country in each mode shows the substantial amount of heterogeneity across banks. In Mode 1 (international assets), for instance, the mean investment is € 8.6 million – compared to a median of only € 0.14 million.

In sum, our data paint a nuanced picture of the internationalization of German banks. On the one hand, the banking system is highly internationalized as a large number of banks holds international assets in at least one foreign countries. On the other hand, only a few banks maintain foreign affiliates, and investment volumes are dominated by only a few large players.

3.2 *Modeling the Extensive and the Intensive Margin*

Our basic empirical setup is a self-selection model in the spirit of Heckman (1979) where we replace the conventional selection equation by an ordered probit model to mirror the hierarchy of modes of activities. The extensive margin (*EM*) reflects the binary decision of banks whether and through which mode to be present in a foreign market. Our model of bank *i*'s operation in country *j* in year *t* has the following form:

$$(8) \quad \begin{aligned} IM_{ijt} &= \alpha X_{ijt} + \sigma_{IM} u_{ijt} \\ EM_{ijt} &= \beta Z_{ijt} + v_{ijt} \end{aligned}$$

where IM_{ijt} describes the intensive margin and σ_{IM} is the standard error of the intensive margin's error term. The error terms u and v are assumed to follow a standard bivariate normal distribution with mean zero, unit variances and correlation ρ .¹² Errors are independent from the covariates X and Z . Identification of the extensive and the intensive margin is achieved when X is a subset of Z (Wooldridge 2002), and we use dummies for different bank groups as exclusion restrictions. The covariates capture productivity, other bank-level, and host country-specific variables, which will be described below (see

¹² This specification allows applying a standard normal distribution in the correction term and draws on Winkelmann and Boes (2009).

Section 4.1). Since the intensive margin is observed only if $EM_{ijt} > 0$ and since the error terms are correlated, ordinary least square estimates of α suffer from a selection bias.

The extensive margin is modeled as an ordered probit model, which yields consistent coefficient estimates of β as well as threshold values μ_1, μ_2 , and μ_3 which separate the categories from each other. The probability that a bank self-selects into our four ordinaly scaled modes is thus given by:

$$(9) \quad \begin{aligned} \Pr(EM_{ijt} = 0 | Z_{ijt}) &= \Phi(\mu_1 - \beta Z_{ijt}) \\ \Pr(EM_{ijt} = 1 | Z_{ijt}) &= \Phi(\mu_{2a} - \beta Z_{ijt}) - \Phi(\mu_1 - \beta Z_{ijt}) \\ \Pr(EM_{ijt} = 2a | Z_{ijt}) &= \Phi(\mu_{2b} - \beta Z_{ijt}) - \Phi(\mu_{2a} - \beta Z_{ijt}) \\ \Pr(EM_{ijt} = 2b | Z_{ijt}) &= 1 - \Phi(\mu_{2b} - \beta Z_{ijt}) \end{aligned}$$

This exposition underpins the pecking order of different modes of foreign activity, since we must have $\mu_1 < \mu_{2a} < \mu_{2b}$ if the probabilities are positive. Checking whether the threshold parameters μ not only show an ascending order but also differ significantly from each other provides a test for the ordering of the different modes. Besides, the estimated cut-off values can be interpreted as proxies for the fixed costs of foreign activity banks have to cover.

To estimate the determinants of the intensive margin, we need to take into account the bias induced by selection of banks into the different modes. For this purpose, we take conditional expectations of the intensive margin:

$$(10) \quad E[IM_{ijt} | Z_{ijt}, EM_{ijt} = k] = \alpha X_{ijt} + \sigma_{IM} E[u_{ijt} | Z_{ijt}, EM_{ijt} = k]$$

where $k = 1, 2a, 2b$. Using the assumption on the correlation of errors across the margins, the conditional expectations of the error term in equation (10) can be simplified to

$$E[\rho v_{ijt} | EM_{ijt} = k, Z_{ijt}] = \rho E[v_{ijt} | \mu_k - \beta Z_{ijt} < v_{ijt} < \mu_{k+1} - \beta Z_{ijt}]^{13}$$

which resembles the Mills ratio in a standard Heckman model. Since we have replaced the conventional selection equation by an ordered probit model, our corresponding correction term λ_{ijt}^k depends on the specific mode chosen by bank i . The intensive margin thus transforms into:

¹³ See the Technical Appendix 7.1 for details.

$$(10') \quad E \left[IM_{ijt} | Z_{ijt}, EM_{ijt} = k \right] = \alpha X_{ijt} + \sigma_{IM} \rho \lambda_{ijt}^k$$

with

$$\lambda_{ijt}^1 = \frac{\phi(\mu_1 - \beta Z_{ijt}) - \phi(\mu_{2a} - \beta Z_{ijt})}{\Phi(\mu_{2a} - \beta Z_{ijt}) - \Phi(\mu_1 - \beta Z_{ijt})} \quad \text{if } EM_{ijt} = 1$$

$$\lambda_{ijt}^{2a} = \frac{\phi(\mu_{2a} - \beta Z_{ijt}) - \phi(\mu_{2b} - \beta Z_{ijt})}{\Phi(\mu_{2b} - \beta Z_{ijt}) - \Phi(\mu_{2a} - \beta Z_{ijt})} \quad \text{if } EM_{ijt} = 2a$$

$$\lambda_{ijt}^{2b} = \frac{\phi(\mu_{2b} - \beta Z_{ijt})}{1 - \Phi(\mu_{2b} - \beta Z_{ijt})} \quad \text{if } EM_{ijt} = 2b$$

The correction term as specified in equation (10') performs the analogue function of the Inverse Mills Ratio in a conventional sample selection setup (Heckman 1979). Neglecting this term would lead to an omitted variable bias. This follows from the assumption that u and v in Equation (8) are not independent from each other. Instead, they are bivariate normal distributed. Our hierarchical modeling of the extensive margin thus contains information which affects the estimation of the intensive margin.

3.3 Measuring Bank Productivity

The availability of an unbiased measure of bank-level productivity (ω_{it}) is key to our empirical model. A number of banking studies measure total factor productivity using a dual approach, which implies estimating cost or profit functions and attributing productivity changes to factor accumulation, technological change, or changes in efficiency (Kumbhakar and Lovell 2000). We use a more direct approach based on a production function. As argued in Olley and Pakes (1996) and Levinsohn and Petrin (2003), this avoids the violation of the (often implicit) independence assumption between productivity and factor input choices of banks.¹⁴ This approach has been used less widely in the banking literature with the exception of a study by Nakane and Weintraub (2005) for Brazilian banks.

Given the ongoing debate in the literature on bank production, our choice of banks' inputs and outputs is inevitably heuristic. We follow Nakane and Weintraub (2005) and recent theoretical contributions by Martín-Oliver and Salas-Fumás (2008). The latter suggest a model of bank production rather than following an abundant literature dealing with the

¹⁴ See the Technical Appendix 7.2 for details.

specification of multi-product cost and profit models. Our decision is additionally motivated by two main considerations. First, in order to make our results comparable to the literature on non-financial multinational firms, such as Greenaway et al. (2007), we use a similar measure of productivity. Second, we use a parsimonious measure of productivity which focuses on the volume of financial services provided. We also include covariates to control for risk characteristics of banks captured by the CAMEL concept (capitalization, asset quality, managerial skill, earnings, and liquidity).

We specify the aggregate lending volume of a bank as its output (Nakane and Weintraub 2005). Since banks act as intermediaries between savers and investors (Martín-Oliver and Salas-Fumás 2008), the volume of borrowing and lending is used as bank output. The first variable input is the sum of deposits and of other debt liabilities. The second input is banks' staff. In addition to human capital, banks require physical facilities, such as branches and offices as well as IT and back-office infrastructure, to provide loans. Since these variables cannot be adjusted quickly, we include fixed assets as a state variable.

To obtain unbiased measures of bank productivity, we also need to specify intermediate inputs that perform two functions. First, they have to be informative regarding productivity and, second, they need to affect output through their impact on factor accumulation. This is a more subtle choice for banks compared to non-financial firms. Levinsohn and Petrin (2003) suggest specifying intermediate inputs, such as materials or electricity that are subtracted from gross value added but that contribute to the production process and depend on productivity. In our application to banking, equity capital fulfils the key requirements of such an intermediate input. Equity is rarely used to fund loans (Mester 1997). It serves as an indicator of a bank's riskiness to markets and regulators (Berger 1995) and thus determines funding cost. Equity capital directly affects banks' factor demand because of its dual role as a direct source of lending and because of the signaling role regarding the funding cost of banks. As the determination of optimal levels of (costly) equity capital under regulatory constraints is a key task of bankers, it should be correlated with bank productivity.

Table 3a summarizes the descriptive statistics for the variables used to estimate bank productivity. Table 3b reports the parameter estimates for the production functions. These estimates are fairly similar to those reported in Nakane and Weintraub (2005) for Brazilian banks. We reject constant returns to scale ($\beta_1 + \beta_2 + \beta_3 = 1$). Our productivity estimates indicate slightly decreasing returns to scale, which is in line with indirect evidence from dual

approaches to estimate scale cost economies in German banking. For comparison, the right-hand panel of Table 3b reports results from basic OLS regressions, which highlights the severe bias in parameters when neglecting the simultaneity of production choices and bank productivity. The OLS intercept can be interpreted as a Solow productivity residual. Since the estimate of productivity (ω_i) is bank-specific, the left-hand panel lacks this entry. Note that the parameter estimate of the intermediate input (equity) in the Levinsohn-Petrin specification is not reported because equity is an ancillary parameter required only to obtain unbiased estimates of productivity.

Table 4 reports bank productivity and bank-level covariates for the different modes of internationalization. Considering the CAMEL-variables, the patterns in the data are quite clear. More complex and more costly modes of international operations are associated with a lower degree of capitalization, lower reserve holdings, lower loan-loss provisions, lower cost income ratios, lower return on equity, and lower liquidity. These stylized facts are in line with the hypothesis that more productive banks are more likely to be active internationally and in more complex modes. Hence, they are consistent with a productivity pecking order. In addition, banks with a lower revealed degree of risk aversion are more active internationally.

4 Data and Empirical Results

4.1 Explanatory Variables

The internationalization decision of banks should, according to our theoretical model, depend on a number of bank-level and country-level parameters, which we specify as follows.¹⁵

Bank-level variables

Bank productivity: Our main measure of bank *productivity* is derived from a production function approach as described in Section 3.3. We expect a positive impact. To account for additional aspects of bank productivity, we include the *cost-income ratio* (expected sign: negative), a bank's *return on equity* (positive), and an indicator variable running from 1 through 5 indicating the quintile of the *size* distribution of the bank's assets (positive).¹⁶

¹⁵ See also the Data Appendix and Table 2 for a summary of the expected signs. All variables except the dummy variables and those expressed in percentages are in logs.

¹⁶ See Greenaway et al. (2007) for a similar specification.

Degree of risk aversion: A bank's degree of risk aversion cannot be observed directly. Yet, four indirect measures of bank risk are included in the CAMEL profile. Banks with a low degree of *capitalization*, low *hidden reserves*, high *non-performing loans*, and low *loan-loss provisions* have a high revealed level of risk and, ceteris paribus, a low degree of risk aversion.

Additional control variables: Dummy variables capture the heterogeneity across banks in terms of the different banking groups and of location. A 0/1-dummy for banks located in Eastern Germany accounts for the lower degree of international integration of this region compared to the German average. In the selection equation, we additionally include *banking group* dummies in the selection equation to distinguish large banks, commercial banks, and savings banks from cooperative banks as the omitted category.

Country-level variables¹⁷

Market size: Larger and more developed markets make countries more attractive destinations for international banks, hence the expected sign on market size (*GDP*) and *GDP per capita* is positive. Since international banking is closely related to the international activities of non-financial firms, we include total *German FDI* as a proxy for real integration and the demand for financial services by German firms abroad. The expected impact is positive.

Information costs: In the international finance literature, the geographical *distance* between two countries has become a standard proxy for information costs. (See, e.g., Portes and Rey (2005), Aviat and Coeurdacier (2007), or Daude and Fratzscher (2008).) Providing financial services to more distant markets or setting up foreign affiliates there should be more costly than doing business in nearby markets. Hence, the expected sign on distance is negative. As an additional proxy for information costs, we specify a composite index for the level of *institutional quality* as in Beck et al. (2006), which comprises six dimensions of indices constructed in Kaufman et al. (1999). A higher value of this index indicates better institutional quality, and we expect a positive sign.

In the international trade (or banking) literature using bilateral data, additional dummies such as the presence of a common border or a common language are typically included. Here, we do not include such variables since we use information for one source country of

¹⁷ Descriptive statistics are given in Table 5.

international assets only. Therefore, language or border dummies are highly collinear with country fixed effects or geographic distance.

Portfolio effects: We proxy macroeconomic, country-specific risks using the standard deviation of GDP growth (*growth volatility*) in each host country j , computed over the past five years.¹⁸ We expect a negative sign. The correlation between domestic and foreign returns is measured by the *growth correlation* of German and foreign GDP growth rates for rolling windows of 5-year periods. The expected sign is negative since higher correlations imply less potential for diversification. A 0/1-dummy for countries in the *Euro Area* is included to proxy the (absence of) exchange rate risk.

Fixed costs of foreign activity: Our first proxy for the fixed costs of foreign activities are *activity restrictions* faced by banks. This is a discrete measure which indicates restrictions on services and products that banks are allowed to offer, and restrictions on non-financial firm ownership and control (Beck et al. 2006). The expected sign is negative because tighter activity restrictions deter foreign activity. A similar reasoning applies to more stringent *capital restrictions*, which is the sum of initial and overall capital stringency requirements per country.

Additional control variables: We include the *concentration* of the host banking market. The expected sign is not clear a priori. On the one hand, higher concentration could stimulate entry if it indicates high return. On the other hand, higher concentration could indicate the presence of implicit barriers to entry. Finally, we include three 0/1-dummy variables indicating whether a country is an *offshore* destination, a *developing country* according to the income taxonomy of the Worldbank, or whether it hosts a *financial center*.

4.2 Baseline Regression Results

Table 6 presents the baseline results using five different specifications of the extensive and the intensive margin: (i) a baseline model only including bank productivity, (ii) the baseline model plus individual bank-level covariates, (iii) the baseline model plus bank- and country-level covariates (excluding regulations), and (iv) the baseline model plus bank- and all country-level covariates (including regulations). F-tests reported in Table 6 show that all

¹⁸ We compute growth volatility and growth correlations based on the residual of GDP growth regressed on a full set of time fixed effects to account for general macroeconomic developments affecting GDP growth.

groups of variables are jointly significant. We lag all variables by one year to mitigate reverse causality concerns.

Country-level covariates are split into two sub-groups because regulatory variables are not available for all countries. Our preferred specification is the full specification given in columns 4 and 8 since this specification also captures the fixed costs of entry. Adding the country-level variables significantly increases the explanatory power, in particular for the extensive margin. In the specification including productivity only, the R^2 is 0.01 for the extensive margin (intensive margin: 0.10). This number increases as we add the bank-level covariates and dummies (0.13 and 0.21) and the country-level variables (0.40 and 0.29).

Is There a Productivity Pecking Order?

Our results support the existence of a productivity pecking order in international banking for four reasons:

First, all cut-offs for the extensive margin are significantly different from zero. This supports a hierarchy of internationalization modes, with higher fixed costs of more complex activities abroad being reflected by higher cut-off values. Simple t -tests show the first-stage cut-offs to be significantly different from each other.

Second, the estimated cut-offs increase more in absolute terms moving from Mode 1 to Mode 2a than moving from Mode 2a to Mode 2b. Considering the interval length relative to a particular coefficient, for instance the one on productivity $(\mu_{k+1} - \mu_k) / \alpha_{Prod}$, shows by how much productivity has to increase in order for a bank to reach the adjacent category. According to our estimates, opening a subsidiary does not require much higher productivity, given that the bank already maintains a branch in a specific country. Yet, the required additional productivity is considerable if a bank moves from Mode 1 (international assets held domestically) to Modes 2a or 2b: $(\mu_{2a} - \mu_1) / \alpha_{Prod} > (\mu_{2b} - \mu_{2a}) / \alpha_{Prod}$.

Third, the correction term in the outcome equation varies by mode of activity and thus captures the hierarchy of cut-offs. This selection into a particular mode of internationalization is not taken into account by previous studies focusing on only internationally active banks.

Fourth, productivity has a positive and significant impact on both margins. Paired with the significant cut-offs, this is evidence of a productivity pecking order. This finding is robust to adding further bank-level variables related to productivity. *Size* and *return on equity* have the expected positive effect. Generally, the finding that larger and more profitable banks go

abroad is in line with the earlier literature on international banking (Focarelli and Pozzolo 2005, Buch and Lipponer 2007). We additionally show the joint impact of productivity on the extensive *and* the intensive margin. The *cost-income ratio* has a positive effect for the extensive and a negative effect for the intensive margin. The negative effect is in line with expectations. The positive impact for the extensive margin could reflect competitive pressure a particular bank is exposed to on the home market, which increases the probability of investing abroad.

The Impact of Risk Aversion

The productivity pecking order reveals similarities between banks and non-financial firms. But an important difference between these firms is that banks take the risk of their foreign activities explicitly into account. Our results confirm that the degree of risk aversion is indeed important. Recall that we take high capitalization, high reserves, high loan-loss provisions, and low non-performing loans as indications of a high degree of risk aversion. Following this interpretation, we find that banks willing to take on higher risks are more likely to be active internationally – the sign on capitalization and reserves are negative and significant for the extensive margin. Signs on loan loss provisions and non-performing loans would be consistent with this interpretation, but these variables are not significant in our (preferred) full specification.

The picture is different for the intensive margin. Here, the positive signs on capitalization and loan-loss provisions and the negative sign on non-performing loans paint the picture of less risk-averse (more stable) banks to do more business. This can be interpreted as a demand-side effect. Recall that our dependent variable is a composite asset which is dominated by interbank activities. On interbank markets, trust in the stability of market participants is an important determinant of lending relationships.¹⁹

Overall, our results tell that the decision to venture abroad is positively affected by a low degree of risk aversion. Once being abroad, more stable banks generate higher volumes of business.

¹⁹ The negative sign on hidden reserves is not inconsistent with this story. Hidden reserves partly reflect peculiar features of the German accounting system, which may be difficult to verify for foreign partners.

Additional Bank-Level Variables

The dummy variables for the *banking groups* are significant. Large and commercial banks are more likely to go abroad than the cooperative banks as the omitted category; savings banks are less likely to do so. Banks headquartered in *East Germany* are significantly less active in international markets.

Country-Level Variables: Market Size

Turning next to the country-level variables which capture the size of foreign markets, we consistently find a positive impact of market size for the extensive margin. *GDP*, *GDP per capita*, and total *German FDI* are positive and significant. The impact of *GDP per capita* and *German FDI* on the intensive margin is positive and significant as well. The volume of foreign assets is negative correlated with market size (*GDP*) which is due to the fact that we control for the volume of *FDI*. Dropping *FDI*, as we have done in unreported regressions, gives a positive and significant coefficient. In this sense, our results confirm earlier studies showing a link between trade and financial integration (see, e.g., Aviat and Courdacier 2007, or Kalemli-Ozcan et al. 2009).

Country-Level Variables: Information Costs

Our main measure of information costs – geographic *distance* – has the expected negative sign for the extensive margin. An increase in distance increases by 1 percent is compensated by an increase in *GDP* by about 1.7 percent ($-\hat{\beta}_{Dist} / \hat{\beta}_{GDP}$) for a bank to choose the same mode of entry. The positive coefficient of distance for the intensive margin is, again, due to the fact that we include *FDI* as our measure for real integration. Once *FDI* is excluded, distance has a negative impact also for the intensive margin.

The index of *institutional quality* is insignificant for the extensive and negative for the intensive margin. Recall that we expect to find a positive sign. We indeed find the positive sign for the cooperatives. For these banks with limited international experience, a good information environment is more important than for the larger banks (Table 8).

Country-Level Variables: Macroeconomic Portfolio Effects

Portfolio and risk effects at the country level are measured by the *volatility of foreign GDP* growth and the cross-country *correlation of GDP growth* with Germany.²⁰ Generally, our results are in line with earlier studies using similar data and empirical approaches in the sense that we find positive impacts of volatility and correlation and thus a “correlation puzzle” (See, e.g., Portes and Rey (2005) for an application to equity markets, or Aviat and Courdacier (2007) for an application to banking.). While, both, volatility and correlations should have a negative impact on both margins, we find this only for the impact of volatility on the extensive margin.

Lower exchange rate risk has increased German banks’ exposures to Euro Area countries. The impact on the extensive margin is positive as well if we do not control for country-level covariates. It is negative in our full specification. German banks have a below-average presence in Euro Area countries, presumable because these countries can be served from the home market due to small distances. Hence, the positive impact of the Euro on cross-border banking found in previous studies using aggregated data (see, e.g., Kalemli-Ozcan et al. 2009) might cloud different adjustments along the extensive and the intensive margin.

Country-Level Variables: Fixed Costs of Foreign Activity

Tighter activity restrictions and capital regulations have the expected negative impact on the extensive margin. This supports our interpretation of these variables as proxies for fixed costs. The impact of regulatory restrictions on the volume of activities is positive though, i.e. banks that have entered a particular foreign market have larger activities there. Table 8 shows that this positive effect is driven by the large banks in the sample. For the other banking groups, activity and capital restrictions also have a negative impact on the volume of activities. Moreover, for these banks, the effect of activity restrictions is larger.

Additional Country-Level Control Variables

Results for *concentration* confirm the ambiguous theoretical expectation. Higher concentration in foreign banking markets increases the probability of foreign activity of German banks but lowers the volume. In our baseline specification, we find a negative sign for the *offshore* dummy. Splitting the sample by banking group shows that this effect is driven

²⁰ Similar measures have been used in the literature. See, e.g., Portes and Rey (2005).

by the cooperative banks (see Table 8). For the large banks, the offshore dummy has the expected positive sign. The signs for *developing countries* (negative) and *financial centers* (positive) are in line with expectations.

Finally, to put coefficient estimates into perspective, Table 7 also gives marginal effects for the extensive and the intensive margin. Since we use an ordered response model with discrete outcomes to model the extensive margin, marginal effects differ across modes. Marginal effects indicate by how much the probability of choosing one distinct mode changes in reaction to a change in one particular explanatory variable (at the mean). Table 7 shows that macroeconomic variables such as GDP and distance have a key impact on bank internationalization, and they are more important than many of the bank-level variables. In this sense, our results confirm previous literature for non-financial firms. Note that marginal effects for Mode 2a are insignificant because Modes 2a and 2b are very similar.

In sum, we find evidence for a productivity pecking order in international banking and an impact of bank-level risk on internationalization. Banks with a lower revealed degree of risk aversion are more internationally oriented, but the volume of activity is lower, *ceteris paribus*. In addition, banks' foreign activities increase in market size, low information costs, and low entry barriers. The impact of macroeconomic volatility is not clear-cut, which is consistent with the "correlation puzzle" (Aviat and Courdacier 2007) found in previous literature.

4.3 Robustness Tests

We perform several robustness tests by exploring the panel dimensions of our data and by estimating the model for different banking groups. Unreported results are available upon request. All results reported below confirm the pecking order: (i) The estimated cut-offs are significant and increase for more complex modes of foreign activity, (ii) the interval-length relative to the productivity coefficient declines for more complex modes of activities and, (iii) productivity and size have a positive and significant impact.

Panel dimension: So far, we have ignored the panel dimension of our dataset by pooling all observations across years and including time fixed effects. Estimating the same model as before year-by-year gives stable results, for most variables and in particular for those testing the pecking order. We also clustered standard errors at the bank-level, at the country-level, and at the bank-country-level, and we have bootstrapped the standard errors to take into account that productivity is a generated regressor. Our findings are robust.

We also use a bank-country fixed effects panel for the intensive margin. In this model, the bank-specific productivity measure becomes insignificant because there is relatively little within-sample variation of bank productivity, which is picked up by the fixed effects. Results for the size measure and the correction term are not affected (both are positive and significant).

We also conducted the test suggested by Semykina and Wooldridge (2005). They propose a procedure to account for endogenous regressors in the primary equation as well as heterogeneously distributed and serially dependent error terms in the selection and primary equation. We adapt their method to our setup, and we estimate the extensive margin year-by-year while adding time-averages of bank-level variables. Then, we compute the correction term separately for each year and include all of them in the equation for the intensive margin. Productivity, core bank-level and macro-level covariates preserve their significance and are qualitative identical to those reported above.

By banking group: One objection to our analysis could be that we pool together banks which have different traditions concerning internationalization. We thus split the sample into the different banking groups – large banks, commercial banks, savings banks, and cooperatives. Results are reported in Table 8. Our findings for country-level covariates are similar, and we have already alluded to differences across banking groups above.

Our focus here is on productivity and risk. One argument could be that the smaller (savings and cooperative) banks are not active internationally despite being highly productive either because they are legally prevented from operating abroad or because they have access to international markets through their head institutions (the *Landesbanken* in the case of the savings banks). Our results confirm this expectation only partly. We find a similar pecking order for the small and for the large banks in qualitative terms. At the same time, an increase in productivity has a much larger impact, both on the extensive and on the intensive margin, for the small than for the large banks. The only banking group for which productivity has a negative impact are the commercial banks. This banking group comprises private banks, some of which focus on specific segments of the German domestic banking market.

Turning next to the results on risk, one could again argue that the smaller banks are different because, for instance, the savings banks are under public ownership and thus covered by implicit or explicit state guarantees. Here, our results do not confirm the prior that the degree of risk aversion of publicly-owned and privately-owned banks has a systematically

different impact on internationalization patterns. In anything, more risk averse large banks are more likely to enter foreign markets but have lower volumes of activities. For the remaining banking groups, risk features matter, but there is not clear link between the degree of risk aversion and the pattern of activities.

OECD versus non-OECD: Pooling across countries at very different stages of development might affect our results. To account for this, we have re-estimated the model for OECD countries. Unreported regressions show that the main results for the OECD countries and for the full country sample are similar, in particular as regards the bank-level variables and productivity effects. If anything, the impact of some country-level variables such as market size and regulations differs.

5 Conclusions

Size, productivity, and internationalization decisions of firms are obviously related. Yet, while there is a vibrant literature explaining the “productivity pecking order” for non-financial firms, relatively little is known about services firms and in particular banks. Bridging this gap and testing whether banks are different has been the purpose of this paper.

From a theoretical point of view, we expect determinants of banks’ international activities to be similar to those for non-financial firms. Higher fixed costs deter foreign activity, and banks face a trade-off between fixed and variable costs when comparing different modes of entry. More productive banks should be more likely to invest abroad and to hold higher international assets. In addition, bank-specific preferences for risk should affect internationalization decisions.

To analyze the link between productivity, risk, and internationalization patterns empirically, we use a novel bank-level dataset which provides detailed information on the extensive and the intensive margin of foreign activity. Our data allow distinguishing purely domestic banks, banks which hold international assets, banks with foreign branches, and banks with foreign subsidiaries *and* branches.

We model the internationalization decision of banks in a two-step empirical model. In a first step, we estimate bank-level productivity by applying the model of Levinsohn and Petrin (2003) to the banking industry. In a second step, we model the extensive and the intensive

margin of foreign activity using an ordered probit model for the selection equation. Our correction for selection explicitly accounts for the selection into different modes.

Our results show similarities and differences between the internationalization patterns of banks and non-financial firms. As regards the similarities, only the largest banks engage in complex modes of internationalization and set up foreign affiliates. As in the non-financial sector, only a few and large firms engage in FDI. Our findings provide robust support for the pecking order hypothesis. More complex and more costly modes of internationalization require higher productivity. Hence, more productive banks are more likely to engage internationally than less productive banks, and they hold higher international assets. Selection into foreign status has a significant impact on the volume of activities. For banks (as for non-banks), gravity variables are of key importance. Larger distances discourage international banking, larger and more developed markets promote international banking, and activity restrictions deter banks.

While international banking shares similarities with the internationalization of non-financial firms in terms of the importance of productivity and gravity, there are also two noteworthy differences. First, risk factors at the bank-level affect foreign activities. More risk averse banks are less likely to be present abroad but have larger volumes of activities. Risk factors at the country-level matter as well, but the signs are not always in line with expectations, mirroring the “correlation puzzle” found in previous literature. Second, small, non-financial firms are typically domestically oriented and do not trade or engage in FDI. Small banks, in contrast, typically hold foreign assets in at least one market. This is due to the smaller fixed costs of holdings international assets than selling or sourcing abroad. It is also due to the fact that the motive for internationalization differs, and that portfolio considerations play an important role for banks.

Our paper has been a first step towards an exploration of the extensive and intensive margins of foreign banking, and our results have implications for different literatures. As regards the international finance and macroeconomics literature, it would be interesting to further explore to what extent adjustment along the different margins affects banks’ responses to macroeconomic shocks and thus the persistence of shocks. For the banking literature, it would be interesting to explore how the endogenous sorting of banks into different modes of internationalization, which is driven by bank productivity, affects the size distribution and productivity of the banking industry as a whole. This would, ultimately, also have

implications for the current discussion on the optimal regulation of banks and in particular large banks. We leave these issues for future research.

6 References

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7 Technical Appendix

7.1 Deriving the Correction Term

Deriving the correction term as depicted in Equation (10') draws on the standard bivariate normality of error terms in those equations describing the extensive and the intensive margin. The starting point is Equation (10), which is repeated for convenience:

$$(A.1) \quad E[IM_{ijt} | Z_{ijt}, EM_{ijt} = k] = \alpha X_{ijt} + \underbrace{\sigma_{IM} E[u_{ijt} | Z_{ijt}, EM_{ijt} = k]}_{\text{where } k = 1, 2a, 2b}$$

The focus now lies on the conditional expectations of the error term $\sigma_{IM} E[u_{ijt} | Z_{ijt}, EM_{ijt} = k]$, i.e. the last part of Equation (10). Correlation of the errors between extensive and intensive margins allows restating this term as $\sigma_{IM} E[\rho v_{ijt} | Z_{ijt}, EM_{ijt} = k]$. We can further simplify the conditioning part to obtain

$$\sigma_{IM} \rho E[v_{ijt} \mu_k - \beta Z_{ijt} < v_{ijt} < \mu_{k+1} - \beta Z_{ijt}].$$

Making use of the assumption that the error term v_{ijt} follows a conditional standard normal distribution, we can explicitly write the conditional expectation as:

$$(A.2) \quad E[v_{ijt} | \mu_k - \beta Z_{ijt} < v_{ijt} < \mu_{k+1} - \beta Z_{ijt}] = \frac{\int_{\mu_k - \beta Z_{ijt}}^{\mu_{k+1} - \beta Z_{ijt}} v_{ijt} f(v_{ijt} | \mu_k - \beta Z_{ijt} < v_{ijt} < \mu_{k+1} - \beta Z_{ijt}) dv_{ijt}}{\int_{\mu_k - \beta Z_{ijt}}^{\mu_{k+1} - \beta Z_{ijt}} f(v_{ijt} | \mu_k - \beta Z_{ijt} < v_{ijt} < \mu_{k+1} - \beta Z_{ijt}) dv_{ijt}}$$

Rewriting the conditional expectation while applying the definition of a conditional density function yields a ratio of the density $\phi(v_{ijt})$ and the cumulative density function, (A.2) can be re-written into:

$$= \frac{1}{\Phi(\mu_{k+1} - \beta Z_{ijt}) - \Phi(\mu_k - \beta Z_{ijt})} \int_{\mu_k - \beta Z_{ijt}}^{\mu_{k+1} - \beta Z_{ijt}} \phi(v_{ijt}) dv_{ijt}$$

Now, it is possible to integrate and exploit the fact that $\phi'(v_{ijt}) = -v_{ijt} \phi(v_{ijt})$:

$$= \frac{-\phi(\mu_{k+1} - \beta Z_{ijt}) - (-\phi(\mu_k - \beta Z_{ijt}))}{\Phi(\mu_{k+1} - \beta Z_{ijt}) - \Phi(\mu_k - \beta Z_{ijt})} = \frac{\phi(\mu_k - \beta Z_{ijt}) - \phi(\mu_{k+1} - \beta Z_{ijt})}{\Phi(\mu_{k+1} - \beta Z_{ijt}) - \Phi(\mu_k - \beta Z_{ijt})}$$

Thereby, we have obtained three distinct correction terms (λ_{op}^k) which address the selection bias. Their particular shape and conditionality on realized modes (categories 0, 1, 2a or 2b) of the extensive margin level distinguish our ordered probit model from Heckman's conventional selection equation. The conditional error term of the intensive margin $\sigma_{IM}E[\rho v_{ijt} | Z_{ijt}, EM_{ijt} = k]$ transforms to:

$$\begin{aligned}\sigma_{IM}\rho\lambda_{ijt}^1 &= \sigma_{IM}\rho \frac{\phi(\mu_1 - \beta Z_{ijt}) - \phi(\mu_{2a} - \beta Z_{ijt})}{\Phi(\mu_{2a} - \beta Z_{ijt}) - \Phi(\mu_1 - \beta Z_{ijt})} \quad \text{if } EM_{ijt} = 1 \quad \text{for international lending} \\ \sigma_{IM}\rho\lambda_{ijt}^{2a} &= \sigma_{IM}\rho \frac{\phi(\mu_{2a} - \beta Z_{ijt}) - \phi(\mu_{2b} - \beta Z_{ijt})}{\Phi(\mu_{2b} - \beta Z_{ijt}) - \Phi(\mu_{2a} - \beta Z_{ijt})} \quad \text{if } EM_{ijt} = 2a \quad \text{for branches} \\ \sigma_{IM}\rho\lambda_{ijt}^{2b} &= \sigma_{IM}\rho \frac{\phi(\mu_{2b} - \beta Z_{ijt})}{1 - \Phi(\mu_{2b} - \beta Z_{ijt})} \quad \text{if } EM_{ijt} = 2b \quad \text{for subsidiaries and branches}\end{aligned}$$

which gives the correction term. In the equation for the intensive margin, $\sigma_{EM}\rho$ will be part of the coefficient to estimate while the regressor λ_{ijt}^k carries information on the different cut-offs characterizing the extensive margin.

7.2 Estimating Bank Productivity

Our estimates of bank productivity are based on a production function approach in the spirit of Levinsohn and Petrin (2003). The advantage of this approach compared to the estimator proposed by Olley and Pakes (1996) is that it can be applied to an unbalanced panel such as ours and that it does not require information about the entry and exit of banks. To illustrate the problem, consider a log-linear Cobb-Douglas production function for bank i in year t :

$$(A.3) \quad \ln Y_{it} = \beta_0 + \beta_X \ln X_{it} + \beta_K \ln K_{it} + \beta_Z \ln Z_{it} + \omega_{it} + \eta_{it}.$$

In this general exposition, we denote bank output as Y , variable input factors by X , production factors that are fixed in the short-run by K , and intermediate inputs required in the production process by Z .

Note the two error components, of which ω_{it} denotes unobservable productivity and η_{it} is a random error term. Only the latter is uncorrelated with banks' input choices. While widely discussed in the empirical literature on production functions, the issue is neglected in virtually

all bank productivity studies.²¹ Banks that experience a positive productivity shock expand their production. This increases their input demand. A negative productivity shock, in turn, reduces input demand. This interdependency of factor choices and (unobservable) productivity leads to biased estimates of ω_{it} (Levinsohn and Petrin, 2003). Put differently, productivity is a state variable that influences a bank's input decision, which leads to simultaneity problems when estimating production functions. The same problem arises for their dual functions, i.e. cost and profit optimization problems.

Using the estimation approach of Levinsohn and Petrin (2003), we obtain unbiased estimates of production functions and productivity parameters by exploiting the relationship between banks' demand for intermediate inputs Z and their productivity ω_{it} . We allow for the fact that Z depends on both state variables of a bank: temporarily fixed factors K and unobservable productivity ω . Assuming that the demand for Z increases monotonously in productivity, Levinsohn and Petrin (2003) invert the demand function for the intermediate good to obtain:

$$(A.4) \quad \omega_{it} = \omega_{it}(K_{it}, Z_{it}).$$

Productivity then depends on two observable inputs such that production can be rewritten as:

$$(A.5) \quad \ln Y_{it} = \beta_X \ln X_{it} + \phi_{it}(\ln K_{it}, \ln Z_{it}) + \eta_{it},$$

$$\text{where } \phi_{it} = \beta_0 + \beta_K \ln K_{it} + \omega_{it}(\ln K_{it}, \ln Z_{it}).$$

With certain limitations, Equation (A.5) can be estimated by OLS to obtain consistent estimates for the variable input parameters (Olley and Pakes 1996).²² However, we cannot separate the impact of state variables on intermediate inputs from their impact on output. We thus need a second step to estimate the coefficient of the state variable K and of the parameters determining productivity (ω_{it}). To identify β_K , Levinsohn and Petrin (2003) assume that productivity follows a first-order Markov process:

$$(A.6) \quad \omega_{it} = E[\omega_{it} | \omega_{it-1}] + \xi_{it}.$$

²¹ A study of Brazilian bank productivity by Nakane and Weintraub (2005) is the exception.

²² The limitation is that OLS yields consistent estimates only for the variable input parameter, which is sufficient in the two-stage procedure outlined in this section.

The term ζ represents productivity innovations and is assumed to be independent of K . In line with Martín-Oliver and Salas-Fumás (2008), we assume that a bank's state variable K comprises fixed capital, primarily branch networks and other tangible assets, such as IT and other back-office equipment. In contrast, ζ may well be correlated with variable factors of bank production. We specify these factors as funds borrowed from depositors and other debt obligations as well as full-time equivalent employees. This potential (contemporaneous) correlation of productivity innovations ζ with factor demand gives rise to the simultaneity problem discussed by Nakane and Weintraub (2005), which we need to take into account when estimating productivity.

The assumption that historical intermediate input choices are uncorrelated with contemporaneous innovations in productivity permits the estimation of β_Z . As described in Petrin et al. (2004), estimation proceeds as follows. First, we estimate Equation (A.3) by OLS while replacing $\phi(\cdot)$ with a third-order polynomial expansion in $\ln K$ and $\ln Z$:

$$(A.7) \quad \ln Y_{it} = \beta_0 + \beta_X \ln X_{it} + \sum_{n=0}^3 \sum_{m=0}^{3-n} \beta_{nm} \ln K^n_{it} \ln Z^m_{it} + \eta_{it}.$$

This provides us with consistent estimates of β_X and ϕ_{it} (Levinsohn and Petrin 2003). The second stage of the estimation procedure identifies β_K (see equation (A.5)), using the estimate of ϕ_{it} obtained from:

$$(A.8) \quad \hat{\phi}_{it} = \ln \hat{Y}_{it} - \hat{\beta}_X \ln X_{it} = \hat{\beta}_0 + \sum_{n=0}^3 \sum_{m=0}^{3-n} \hat{\beta}_{nm} \ln K^n_{it} \ln Z^m_{it} - \hat{\beta}_X X_{it}.$$

For given starting values of β_K^* obtained, for instance, from basic OLS, we can estimate productivity as $\hat{\omega}_{it} = \hat{\phi}_{it} - \beta_K^* \ln K_{it}$. This yields a consistent, non-parametric approximation of the expectation in Equation (A.6) as:

$$(A.9) \quad \hat{\omega}_{it} = \gamma_0 + \gamma_1 \hat{\omega}_{it-1} + \gamma_2 \hat{\omega}_{it-2}^2 + \gamma_3 \hat{\omega}_{it-3}^3 + \varepsilon_{it}.$$

The model is estimated by a generalized method of moments approach. We compute the parameters' standard errors using bootstrapping methods, which draw on sampling from the panel of bank i with replacement.

8 Data Appendix

All bank data are obtained from unconsolidated balance sheets, profit and loss accounts, and audit reports reported annually by all banks to the German central bank (Deutsche Bundesbank). Variables used for both the productivity estimation and the CAMEL vector are corrected for outliers by truncating at the 1st and 99th percentiles, respectively. Level variables are deflated with the consumer price index. Country specific variables are from various sources indicated below.

Bank-level variables

Borrowed funds: Sum of deposits and other debt liabilities in million of euro.

Capitalization: Core capital in per cent of gross total assets.

Cost-income ratio: Personnel expenditure in per cent of total administrative cost.

Employees: Measured in full-time equivalents.

Equity: Gross total equity in millions of euro.

Lending: Total customer loans in millions of euro.

Loan-loss-provisions: Stock of loan-loss provisions in per cent of gross total loans.

Non-performing loans: Loans with latent risks according to central bank auditors in per cent of total audited loans.

Physical capital: Fixed assets including IT-capital stock in millions of euro.

Productivity: Results from Levinsohn-Petrin (2003) estimates of bank productivity. See Section 3.3 in the main text and the Technical Appendix 7.2 for details.

Reserves: Hidden reserves according to §340f of the German commercial code in per cent of gross total assets.

Return on equity (ROE): Operating result including net interest, fee, commission and trading income in per cent of equity capital.

Total assets: Gross total assets.

Definition of banking groups: 'Large' banks comprise the head institutions of the savings ('Landesbanken') and cooperative bank sector as well as the largest commercial banks. Commercial banks are privately owned, but not necessarily publicly listed banks. Savings banks are (local) government owned regional banks. Cooperative banks are mutually owned regional banks.

Country-level variables

Activity restrictions: Activity restrictions on banks indicate whether banks are restricted to engage in securities underwriting, insurance underwriting and selling, and from real estate

investment, management, and development. Higher values indicate more restrictions. Source: Beck et al. (2006)

Concentration: Fraction of total assets held by the three largest banks in the economy. Source: World Bank

Capital regulation: Capital regulation is a combined measure of overall and initial capital stringency. It ranges from 0 to 9, with a higher value indicating greater stringency. Source: Beck et al. (2006)

Developing country: Indicator variable equal to 1 if the country is not a high-income country according to the income taxonomy of the Worldbank. Source: WDI, Worldbank.

Distance: Geographic distance between Germany and host country j . Source: CEPII, Paris.

Economic freedom: Composite of 10 factors measuring institutional quality and policies pertaining to trade, government finances, government interventions, monetary policy, capital flows and foreign investment, banking and finance, wages and prices, property rights, regulation, and black market activity. Higher values indicate better institutions. Source: Beck et al. (2006)

FDI: Aggregate volume of FDI in host country. Source: Microdatabase Foreign Direct Investment (MiDi) (Deutsche Bundesbank)

Financial center: Indicator variable equal to 1 for Luxembourg, Switzerland, and the UK including the channel islands following the definition of the External Position Report. Source: Deutsche Bundesbank.

GDP per capita: Gross domestic product in millions of US dollar (2000 = 100).

GDP-growth correlations: Correlation of German and destination country GDP in the preceding five years.

Institutional quality: Institutional quality is defined as in Beck et al. (2006), and it comprises the six dimensions of indices constructed in Kaufman et al. (1999) voice and accountability, government effectiveness, political stability, regulatory quality, rule of law, and control of corruption.

Offshore destination: Indicator variable equal to 1 for Hong Kong, Singapore, and the Philippines following the definition of the External Position Report. Source: Deutsche Bundesbank.

Volatility: Volatility of growth rate residuals net of cyclical effects in the preceding five year period.

External Position Report

Data on the international assets of German banks are taken from the External Position report (*Auslandsstatus*) of the Deutsche Bundesbank. They are confidential and can be used on the premises of the Deutsche Bundesbank only.

International assets: Loans and advances to banks, companies, governments, bonds and notes, foreign shares and other equity, participation abroad, denominated or converted into euro.

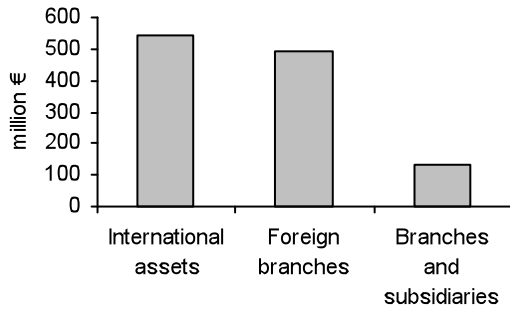
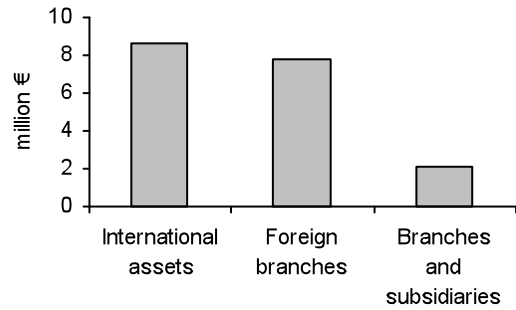
Branches and subsidiaries: Foreign affiliates of German parent banks. Branches do not enjoy independent legal status, whereas subsidiaries do. We attribute assets held by affiliates to the country in which they are located.

List of countries: United Arab Emirates, Netherlands Antilles, Argentina, Austria, Australia, Bosnia, Belgium, Bulgaria, Brazil, Canada, Switzerland, Cote d'Ivoire, Chile, China, Colombia, Cyprus, Czech Republic, Denmark, Estonia, Egypt, Spain, Finland, France, Greece, Hong Kong, Croatia, Hungary, Indonesia, Ireland, Israel, India, Italy, Jordan, Japan, South Korea, Cayman Islands, Sri Lanka, Lithuania, Luxemburg, Latvia, Morocco, Malta, Mauritius, Mexico, Malaysia, Netherlands, Norway, New Zealand, Panama, Peru, Philippines, Pakistan, Poland, Portugal, Qatar, Romania, Russia, Saudi Arabia, Sweden, Singapore, Slovenia, Slovakia, Thailand, Turkey, Taiwan, Ukraine, United Kingdom, United States, Uruguay, Vietnam, South Africa.

Table 1: Modes of Internationalization

	(1)	(2)	(3)	(4)	(5)
	Number of bank-year-country observations	%	Number of banks	%	Average number of foreign countries
Mode 0 (No foreign activities)	507,947	79.70	28	1.25	-
Mode 1 (International assets)	128,262	20.13	2,143	95.88	21
Mode 2a (Foreign branches)	640	0.10	27	1.21	13
Mode 2b (Foreign branches and subsidiaries)	459	0.07	37	1.66	9

Notes to Table 1: Data in this Table are based on the full dataset comprising a total of 2,235 banks, 69 countries, and 5 years (2002-2006). Columns 1 and 2 are based on the full expanded dataset using all bank-country-year combinations, Columns 3 and 4 on a dataset that has been collapsed by banks, and Column 5 gives the average number of countries in which banks in each Mode are active.

Graph 1: Volumes of Investment**(a) Total Volume****(b) Mean Volume**

Notes to Graph 1: Total volume is in million € and gives the total international assets of all banks in a specific Mode, aggregated across countries. Mean volume is in million € and gives the mean international assets of banks.

Table 2: Theoretical Predictions and Measurement

Parameter	Measurement	Expected signs		
		Extensive margin	Intensive margin	Mode 2 ⤵ Mode 1?
<u>Bank-level</u>				
Bank productivity ω_i	Productivity, cost-income ratio, return on equity, size	+	+	+
Bank risk aversion λ_i	<u>High risk aversion:</u> Capitalization, reserves, loan-loss provisions	—	—	—
	<u>Low risk aversion:</u> Non-performing loans			
<u>Country-level</u>				
Fixed costs of foreign activity $F_j(\cdot)$	Activity restrictions, capital restrictions	—	0	—
Expected returns r_L^*	GDP, GDP per capita, German FDI	+	+	+
Information costs τ_j	Distance, institutional quality	—	—	+
Country risk σ_j^*	GDP growth volatility	—	—	—
Return correlations	Correlation between domestic and foreign GDP growth	—	—	—

Table 3: Bank Productivity Estimates**a) Descriptive Statistics Bank Production Variables**

Variable		Mean	s.d.	Percentiles		
				1st	50th	99th
Lending	Y	1,333.6	11,666.6	5.1	197.4	18,939.7
Borrowed funds	X_1	1,257.9	10,329.0	5.9	233.7	13,023.9
Employees	X_2	270.6	1,188.4	5.4	92.0	2,593.0
Equity	Z	106.0	722.0	1.3	19.2	1,506.1
Physical capital	K	14.9	56.1	0.1	5.1	140.6

b) Production Function Estimates

	Levinsohn-Petrin			OLS		
	Coefficient	s.d.	p-value	Coefficient	s.d.	p-value
In Employees	0.176	0.049	0.000	0.577	0.010	0.000
In Borrowed funds	0.404	0.067	0.000	0.526	0.007	0.000
In Physical capital	0.240	0.032	0.000	-0.035	0.007	0.000
Constant				-0.129	0.030	0.000
	Chi ²		<i>p-value</i>	F-test		<i>p-value</i>
$H_0: \beta_1 + \beta_2 + \beta_3 = 1$	17.4		0.000	345.8		0.000
R^2				0.597		

Notes to Table 3: In Table 3a, data are based on 12,569 observations for 2,439 banks between 2000 and 2006. All monetary volumes are in millions of euro. Employees are measured in full-time equivalents. Borrowed funds are the sum of deposits and other debt liabilities. In Table 3b, Estimates are based on 12,569 bank-year observations for the years 2000-2006. Time-specific fixed effects are included but not reported. Bootstrapped standard errors are reported for estimates following Levinsohn and Petrin (2003); robust standard errors in OLS. See Section 3.3 and the Technical Appendix 7.2 for details.

Table 4: CAMEL Profile and Productivity by Internationalization Mode

	Domestic		International assets		Foreign branches		Subsidiaries		All banks	
	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.
Capitalization	5.85	3.11	5.42	2.62	4.10	3.40	3.78	4.46	5.76	3.02
Cost-income ratio	44.10	9.17	41.07	10.56	25.65	14.69	26.23	12.09	43.45	9.58
Hidden reserves	1.41	1.04	1.34	1.05	0.17	0.29	0.16	0.24	1.39	1.04
Loan-loss provisions	5.40	7.83	5.17	10.61	2.94	4.20	2.54	2.88	5.35	8.46
Non-performing loans	0.96	1.21	0.97	1.03	0.81	0.86	0.66	0.61	0.96	1.18
Productivity	11.78	25.63	19.66	33.99	115.53	60.76	112.29	61.60	13.56	28.13
Return on Equity	10.52	16.32	10.98	14.58	7.50	17.76	5.69	14.63	10.61	15.98

Notes to Table 4: The Table shows descriptive statistics of bank-specific variables. All variables are measured in percent except productivity which is measured as explained in the main text (Section 3.3). Variable definitions are given in the data Appendix.

Table 5: Country-Specific Variables

Variable	Unit	Mean	S.d.	Percentiles		N
				<i>1st</i>	<i>99th</i>	
Activity restrictions	Score	8.89	2.53	4.00	14.00	174
Capital regulation	Score	5.50	1.55	2.00	8.00	174
Concentration of banking market	%	64.24	20.54	22.73	99.32	304
Developing destination	0/1 indicator	0.52	0.50	0.00	1.00	304
Distance	Kilometers	4.92	4.55	0.28	18.12	304
Financial center destination	0/1 indicator	0.05	0.22	0.00	1.00	304
Foreign direct investment (FDI)	Bn EUR	11.60	30.90	0.01	212.00	304
GDP growth correlations	%	35.44	49.63	-80.33	98.79	304
Gross domestic product (GDP)	Bn USD	597.00	1,610.00	5.25	10,900.00	304
Institutional quality	Score	3.53	0.52	2.18	4.50	174
Offshore destination	0/1 indicator	0.05	0.22	0.00	1.00	304
GDP per capita (log)	Tsd USD	16.54	16.71	0.57	71.87	304
Volatility of foreign GDP	%	1.91	1.58	0.36	7.74	304

Table 6: Baseline Estimation Results for the Extensive and Intensive Margin

	Extensive margin				Intensive margin			
	Productivity	Micro	Macro	Regulation	Productivity	Micro	Macro	Regulation
<i>Productivity and selection</i>								
Correction term					3.9406*** (0.0548)	-	-	-
Productivity	0.0048*** (0.0000)	0.0004*** (0.0001)	0.0006*** (0.0001)	0.0005*** (0.0001)	0.0346*** (0.0003)	0.4161*** (0.0397)	0.2836*** (0.0301)	0.5669*** (0.0372)
Size		0.2791*** (0.0019)	0.4124*** (0.0024)	0.4356*** (0.0030)		0.0128*** (0.0003)	0.0146*** (0.0003)	0.0155*** (0.0003)
						0.1862*** (0.0107)	0.4252*** (0.0099)	0.5262*** (0.0116)
<i>Bank-specific variables</i>								
Cost-income ratio		0.0047*** (0.0003)	0.0069*** (0.0003)	0.0071*** (0.0004)		0.0598*** (0.0011)	0.0591*** (0.0011)	-0.0561*** (0.0013)
Return on equity		0.0015*** (0.0002)	0.0021*** (0.0002)	0.0016*** (0.0002)		-0.0003 (0.0007)	0.0011* (0.0006)	0.0017** (0.0008)
Capitalization		-0.0129*** (0.0008)	-0.0185*** (0.0010)	-0.0188*** (0.0012)		0.0279*** (0.0035)	0.0195*** (0.0033)	0.0212*** (0.0038)
Hidden reserves		-0.0068*** (0.0022)	-0.0131*** (0.0026)	-0.0095*** (0.0032)		0.1803*** (0.0089)	0.2281*** (0.0084)	-0.2346*** (0.0098)
Non-performing loans		0.0053** (0.0023)	0.0061** (0.0027)	0.0035 (0.0033)		0.1177*** (0.0114)	0.1006*** (0.0108)	-0.0805*** (0.0125)
Loan-loss provisions		-0.0005* (0.0002)	-0.0004 (0.0003)	-0.0002 (0.0003)		0.0143*** (0.0010)	0.0147*** (0.0009)	0.0131*** (0.0011)
<i>Country-specific variables</i>								
Gross domestic product (GDP)			0.1833*** (0.0028)	0.1980*** (0.0054)			0.4378*** (0.0112)	-1.0102*** (0.0212)
GDP per capita			0.3570*** (0.0046)	0.1343*** (0.0094)			0.1860*** (0.0206)	0.6595*** (0.0438)
German FDI			0.1996*** (0.0026)	0.2881*** (0.0042)			0.7133*** (0.0114)	0.9179*** (0.0165)
Growth correlations			0.2469*** (0.0066)	0.1278*** (0.0099)			-0.0526* (0.0290)	-0.0247 (0.0388)
Growth volatility			-0.0074*** (0.0019)	-0.0740*** (0.0026)			0.1523*** (0.0084)	0.1303*** (0.0122)
Distance			-0.1757*** (0.0029)	-0.3426*** (0.0043)			0.1656*** (0.0119)	0.3885*** (0.0172)
Concentration			0.6128*** (0.0135)	0.1565*** (0.0211)			1.6782*** (0.0502)	-3.9171*** (0.0825)
Activity restrictions				-0.0876*** (0.0019)				0.0244*** (0.0070)
Capital restrictions				-0.1109*** (0.0021)				0.0361*** (0.0078)
Institutional quality				0.0096 (0.0142)				-0.2245*** (0.0565)
<i>Intercepts and fixed effects</i>								
East German banks		-0.2115*** (0.0072)	-0.3270*** (0.0087)	-0.3510*** (0.0108)		0.7536*** (0.0326)	0.6434*** (0.0308)	0.4145*** (0.0357)
Large banks		1.6847*** (0.0204)	2.3272*** (0.0232)	2.3492*** (0.0319)				
Commercial banks		0.2607*** (0.0084)	0.4064*** (0.0097)	0.3578*** (0.0125)				
Savings banks		-0.1059*** (0.0057)	-0.1421*** (0.0068)	-0.1628*** (0.0086)				
Euro Area		0.8850*** (0.0047)	-0.1416*** (0.0063)	-0.4961*** (0.0095)		1.9278*** (0.0305)	1.7396*** (0.0214)	2.2315*** (0.0359)
Offshore destination			-0.3893*** (0.0147)	-0.1526*** (0.0192)			0.9356*** (0.0684)	-0.7185*** (0.0912)
Developing destination			-0.3778*** (0.0106)	-0.3885*** (0.0194)			0.1888*** (0.0501)	-1.0713*** (0.0943)
Financial center destination			0.8502*** (0.0106)	0.3274*** (0.0159)			0.3207*** (0.0290)	1.1554*** (0.0414)
Constant					-1.2847*** (0.0788)	5.8681*** (0.1010)	6.6187*** (0.3484)	10.5808*** (0.5585)
Cut-off 1	0.8998*** (0.0019)	2.0056*** (0.0172)	12.4399*** (0.0638)	8.7965*** (0.1201)				
Cut-off 2	3.0711*** (0.0103)	4.6935*** (0.0226)	16.0496*** (0.0683)	12.7090*** (0.1230)				
Cut-off 3	3.3637*** (0.0149)	5.0845*** (0.0267)	16.4922*** (0.0700)	13.2597*** (0.1253)				

<i>Observations and diagnostics</i>								
Observations	632,835	618,786	608,964	343,770	128,745	126,964	126,885	94,329
McFadden R^2	0.0133	0.1347	0.4028	0.4125	0.1015	0.2096	0.2922	0.2893
<u>F-tests: All equal to zero</u>		86,490	256,636	170,327		2,246	2,096	1,372
Micro		25,434	35,476	24,818		619.6	995.2	798.5
Macro			114,927	63,585			1,419	938.4
Regulation				5,299				16.27
Banking groups		8,648	12,732	6,942				

Note to Table 6: This Table reports coefficient estimates of the extensive and the intensive margin of German banks between 2002 to 2006. The selection equation (Extensive Margin) is estimated as ordered probit model (Section 3.1.) and includes unreported dummies for banking groups as exclusion restrictions. The dependent variable is the mode of foreign presence. The equation for the intensive margin is estimated with OLS. The dependent variable is the log volume of international assets. Standard errors in brackets, time fixed effects are included but not reported. Productivity is obtained with the method proposed by Levinsohn and Petrin (2003) (Section 3.3. and Appendix 7.2). For further variable descriptions see the data appendix. standard ***, **, * = significant at the 1%, 5%, 10%-level.

Table 7: Marginal Effects

	Extensive margin					Intensive margin	
	β	$d\ln y/\delta \ln x_{m=0}$	$d\ln y/\delta \ln x_{m=1}$	$d\ln y/\delta \ln x_{m=2a}$	$d\ln y/\delta \ln x_{m=2b}$	β	$d\ln y/\delta \ln x$
<i>Productivity and selection</i>							
Correction term						0.5669*** (0.0372)	0.0823*** (0.0054)
Productivity	0.0005*** (0.0001)	-0.0020*** (0.0004)	0.0101*** (0.0020)	0.0341 (0.0731)	0.0379*** (0.0074)	0.0155*** (0.0003)	0.0614*** (0.0013)
Size	0.4356*** (0.0030)	-0.3911*** (0.0028)	1.9687*** (0.0150)	6.6097 (14.1391)	7.3497*** (0.0692)	0.5262*** (0.0116)	0.3958*** (0.0087)
<i>Bank-specific variables</i>							
Cost-income ratio	0.0071*** (0.0004)	-0.0922*** (0.0055)	0.4643*** (0.0275)	1.559 (3.3237)	1.7335*** (0.1034)	-0.0561*** (0.0013)	0.4837*** (0.0109)
Return on equity	0.0016*** (0.0002)	-0.0051*** (0.0007)	0.0258*** (0.0036)	0.0867 (0.1858)	0.0965*** (0.0133)	0.0017** (0.0008)	0.0039** (0.0017)
Capitalization	-0.0188*** (0.0012)	0.0324*** (0.0021)	-0.1629*** (0.0104)	-0.5469 (1.1718)	-0.6081*** (0.0390)	0.0212*** (0.0038)	0.0240*** (0.0043)
Hidden reserves	-0.0095*** (0.0032)	0.0039*** (0.0013)	-0.0198*** (0.0068)	-0.0665 (0.1445)	-0.0740*** (0.0253)	-0.2346*** (0.0098)	0.0659*** (0.0027)
Non-performing loans	0.0035 (0.0033)	-0.001 (0.0010)	0.0051 (0.0048)	0.017 (0.0398)	0.0189 (0.0179)	-0.0805*** (0.0125)	0.0163*** (0.0025)
Loan-loss provisions	-0.0002 (0.0003)	0.0004 (0.0005)	-0.0018 (0.0028)	-0.006 (0.0160)	-0.0067 (0.0103)	0.0131*** (0.0011)	0.0142*** (0.0012)
<i>Country-specific variables</i>							
Gross domestic product (GDP)	0.1980*** (0.0054)	-1.5465*** (0.0429)	7.7850*** (0.2141)	26.1368 (55.4173)	29.0633*** (0.8149)	-1.0102*** (0.0212)	5.6980*** (0.1202)
GDP per capita	0.1343*** (0.0094)	-0.3716*** (0.0260)	1.8706*** (0.1310)	6.2803 (13.3213)	6.9835*** (0.4903)	0.6595*** (0.0438)	1.3861*** (0.0921)
German FDI	0.2881*** (0.0042)	-1.2747*** (0.0181)	6.4166*** (0.0974)	21.5428 (46.2447)	23.9548*** (0.3836)	0.9179*** (0.0165)	3.1511*** (0.0571)
Growth correlations	0.1278*** (0.0099)	-0.0155*** (0.0012)	0.0781*** (0.0061)	0.2621 (0.5598)	0.2915*** (0.0227)	-0.0247 (0.0388)	-0.0033 (0.0052)
Growth volatility	-0.0740*** (0.0026)	0.0436*** (0.0016)	-0.2194*** (0.0077)	-0.7366 (1.5826)	-0.8191*** (0.0292)	0.1303*** (0.0122)	0.0392*** (0.0037)
Distance	-0.3426*** (0.0043)	0.8283*** (0.0110)	-4.1697*** (0.0533)	-13.9991 (29.9672)	-15.5666*** (0.2166)	0.3885*** (0.0172)	0.5976*** (0.0265)
Concentration	0.1565*** (0.0211)	-0.0308*** (0.0041)	0.1552*** (0.0210)	0.5209 (1.0798)	0.5793*** (0.0782)	-3.9171*** (0.0825)	0.5304*** (0.0112)
Activity restrictions	-0.0876*** (0.0019)	0.2323*** (0.0051)	-1.1693*** (0.0257)	-3.9257 (8.3913)	-4.3652*** (0.0987)	2.2315*** (0.0359)	0.1565*** (0.0025)
Capital restrictions	-0.1109*** (0.0021)	0.1815*** (0.0034)	-0.9136*** (0.0174)	-3.0672 (6.5596)	-3.4106*** (0.0675)	0.0244*** (0.0070)	0.0400*** (0.0115)
Institutional quality	0.0096 (0.0142)	-0.0101 (0.0150)	0.0507 (0.0755)	0.1703 (0.3968)	0.1894 (0.2817)	0.0361*** (0.0078)	0.0424*** (0.0092)
<i>Intercepts and fixed effects</i>							
East German banks	-0.3510*** (0.0108)	0.0097*** (0.0003)	-0.0488*** (0.0015)	-0.164 (0.3508)	-0.1823*** (0.0058)	0.4145*** (0.0357)	0.0070*** (0.0006)
Large banks	2.3492*** (0.0319)	-0.0065*** (0.0001)	0.0327*** (0.0004)	0.1098 (0.2348)	0.1221*** (0.0020)		
Commercial banks	0.3578*** (0.0125)	-0.0075*** (0.0003)	0.0376*** (0.0013)	0.1264 (0.2705)	0.1405*** (0.0050)		
Savings banks	-0.1628*** (0.0086)	0.0118*** (0.0006)	-0.0593*** (0.0031)	-0.199 (0.4259)	-0.2212*** (0.0117)		
Euro Area	-0.4961*** (0.0095)	0.0338*** (0.0007)	-0.1703*** (0.0033)	-0.5718 (1.2261)	-0.6359*** (0.0127)	-0.2245*** (0.0565)	0.1774*** (0.0447)
Offshore destination	-0.1526*** (0.0192)	0.0026*** (0.0003)	-0.0131*** (0.0017)	-0.044 (0.0945)	-0.0489*** (0.0062)	-0.7185*** (0.0912)	0.0023*** (0.0003)
Developing destination	-0.3885*** (0.0194)	0.0729*** (0.0037)	-0.3668*** (0.0184)	-1.2316 (2.6047)	-1.3695*** (0.0689)	-1.0713*** (0.0943)	0.1998*** (0.0176)
Financial center destination	0.3274*** (0.0159)	-0.0056*** (0.0003)	0.0281*** (0.0014)	0.0943 (0.2022)	0.1049*** (0.0052)	1.1554*** (0.0414)	0.0445*** (0.0016)
Constant						10.5808*** (0.5585)	
Cut-off 1	8.6399*** (0.1176)						
Cut-off 2	12.5524*** (0.1206)						
Cut-off 3	13.1031*** (0.1229)						

Notes to Table 7: This Table reports marginal effect estimates calculated as elasticities of the extensive and the intensive margin of German banks between 2002 to 2006. The selection equation (Extensive Margin) is estimated as ordered probit model (Section 3.1.) and includes unreported dummies for banking groups as exclusion restrictions. The dependent variable is the mode of foreign presence. The equation for the intensive margin is estimated with OLS. The dependent variable is the log volume of international assets. Time fixed effects are included but not reported. Productivity is obtained with the method proposed by Levinsohn and Petrin (2003) (Section 3.3. and Appendix 7.2). For further variable descriptions see the data appendix. ***, **, * = significant at the 1%, 5%, 10%-level.

Table 8: Results per Banking Group

	Extensive margin					Intensive margin				
	All	Large	Com'cl	Savings	Coop's	All	Large	Com'cl	Savings	Coop's
<i>Productivity and selection</i>										
Correction term						0.567***	1.178***	2.478***	3.634***	6.071***
						(0.037)	(0.072)	(0.098)	(0.107)	(0.103)
Productivity	0.000***	0.004***	-0.001***	0.031***	0.027***	0.015***	0.011***	0.006***	0.101***	0.112***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.003)	(0.003)
Size	0.436***	0.390***	0.515***	0.253***	0.296***	0.526***	0.626***	1.483***	0.710***	1.309***
	(0.003)	(0.032)	(0.009)	(0.006)	(0.004)	(0.012)	(0.044)	(0.040)	(0.020)	(0.020)
<i>Bank-specific variables</i>										
Cost-income ratio	0.007***	0.050***	0.008***	-0.007***	0.009***	-0.056***	0.014**	0.034***	-0.050***	0.021***
	(0.000)	(0.004)	(0.001)	(0.002)	(0.001)	(0.001)	(0.006)	(0.002)	(0.005)	(0.002)
Return on equity	0.002***	-0.001	0.002***	0.002**	0.005***	0.002**	0.014***	0	0.003	0.022***
	(0.000)	(0.003)	(0.000)	(0.001)	(0.000)	(0.001)	(0.005)	(0.001)	(0.002)	(0.001)
Capitalization	-0.019***	0.103***	-0.010***	-0.034***	-0.023***	0.021***	-0.128**	0.002	-0.183***	-0.060***
	(0.001)	(0.037)	(0.001)	(0.007)	(0.003)	(0.004)	(0.058)	(0.005)	(0.020)	(0.010)
Hidden reserves	-0.009***	-0.243	0.005	-0.010*	0.020***	-0.235***	-0.173	0.316***	0.116***	0.017
	(0.003)	(0.172)	(0.016)	(0.005)	(0.005)	(0.010)	(0.253)	(0.049)	(0.015)	(0.015)
Non-performing loans	0.004	0.103	-0.013***	0.055***	0.074***	-0.081***	0.086	0.137***	-0.04	0.324***
	(0.003)	(0.095)	(0.004)	(0.019)	(0.008)	(0.012)	(0.145)	(0.015)	(0.053)	(0.024)
Loan-loss provisions	0	0.047**	0.001***	-0.012***	-0.011***	0.013***	-0.055*	0.014***	0.008	-0.073***
	(0.000)	(0.019)	(0.000)	(0.003)	(0.001)	(0.001)	(0.028)	(0.001)	(0.009)	(0.004)
<i>Country-specific variables</i>										
GDP	0.198***	-0.131***	0.153***	0.328***	0.139***	-1.010***	0.308***	0.012	0.022	-1.019***
	(0.005)	(0.048)	(0.018)	(0.011)	(0.007)	(0.021)	(0.073)	(0.062)	(0.039)	(0.027)
GDP per capita	0.134***	0.125*	0.135***	0.295***	0.045***	0.659***	1.477***	0.544***	2.067***	1.162***
	(0.009)	(0.075)	(0.028)	(0.017)	(0.013)	(0.044)	(0.115)	(0.113)	(0.074)	(0.061)
German FDI	0.288***	0.402***	0.175***	0.234***	0.357***	0.918***	0.782***	0.749***	1.063***	2.475***
	(0.004)	(0.034)	(0.013)	(0.008)	(0.006)	(0.017)	(0.051)	(0.045)	(0.028)	(0.030)
Growth correlations	0.128***	0.008	-0.153***	-0.080***	0.313***	-0.025	-0.064	-0.273**	-0.641***	1.527***
	(0.010)	(0.086)	(0.031)	(0.018)	(0.014)	(0.039)	(0.127)	(0.110)	(0.060)	(0.056)
Growth volatility	-0.074***	-0.002	-0.030***	-0.041***	-0.100***	0.130***	0.009	0.067**	0.051***	-0.180***
	(0.003)	(0.021)	(0.008)	(0.005)	(0.004)	(0.012)	(0.032)	(0.031)	(0.019)	(0.019)
Distance	-0.343***	-0.056	-0.300***	-0.457***	-0.298***	0.388***	0.355***	0.695***	-0.573***	-0.379***
	(0.004)	(0.041)	(0.014)	(0.008)	(0.006)	(0.017)	(0.059)	(0.051)	(0.036)	(0.027)
Concentration	0.157***	0.199	0.109	0.380***	0.100***	-3.917***	2.122***	2.573***	-2.725***	-3.663***
	(0.021)	(0.180)	(0.068)	(0.041)	(0.028)	(0.083)	(0.276)	(0.234)	(0.137)	(0.107)
Activity restrictions	-0.088***	0.046***	-0.040***	-0.112***	-0.088***	0.024***	0.076***	0.078***	-0.163***	-0.317***
	(0.002)	(0.017)	(0.006)	(0.004)	(0.002)	(0.007)	(0.026)	(0.020)	(0.013)	(0.010)
Capital restrictions	-0.111***	0.004	-0.011	-0.113***	-0.129***	0.036***	0.067**	0.033	-0.267***	-0.368***
	(0.002)	(0.019)	(0.007)	(0.004)	(0.003)	(0.008)	(0.029)	(0.023)	(0.013)	(0.012)
Institutional quality	0.01	0.218*	0.066	-0.236***	0.128***	-0.224***	0.906***	0.758***	-0.790***	0.544***
	(0.014)	(0.114)	(0.043)	(0.026)	(0.019)	(0.057)	(0.174)	(0.156)	(0.092)	(0.072)
<i>Intercepts and fixed effects</i>										
East German banks	-0.351***	-0.395***	-0.163***	-0.005	-0.245***	0.414***	1.701***	0.601***	0.871***	-0.226***
	(0.011)	(0.098)	(0.050)	(0.024)	(0.017)	(0.036)	(0.147)	(0.169)	(0.067)	(0.052)
Euro Area	-0.496***	-0.188*	-0.027	-0.420***	-0.621***	2.231***	0.624***	0.640***	1.574***	0.345***
	(0.009)	(0.098)	(0.032)	(0.019)	(0.012)	(0.036)	(0.136)	(0.105)	(0.059)	(0.058)
Offshore destination	-0.153***	0.576***	0.149***	0.072**	-0.412***	-0.718***	0.883***	-0.025	0.253*	-3.298***
	(0.019)	(0.143)	(0.055)	(0.034)	(0.029)	(0.091)	(0.219)	(0.216)	(0.141)	(0.140)
Developing country	-0.389***	0.137	-0.222***	-0.734***	-0.254***	-1.071***	-0.254	-0.194	-4.291***	-2.575***
	(0.019)	(0.155)	(0.059)	(0.036)	(0.027)	(0.094)	(0.235)	(0.243)	(0.159)	(0.131)
Financial center	0.327***	0.703***	0.257***	0.234***	0.379***	1.155***	1.505***	1.428***	1.747***	0.577***
	(0.016)	(0.149)	(0.053)	(0.036)	(0.020)	(0.041)	(0.221)	(0.145)	(0.070)	(0.049)
Constant						10.581***	-3.113**	7.036***	-23.471***	-23.504***
						(0.559)	(1.549)	(1.485)	(1.120)	(0.988)
Cut-off 1	8.640***	5.351***	7.288***	9.619***	8.223***					
	(0.118)	(1.032)	(0.377)	(0.231)	(0.157)					
Cut-off 2	12.552***	9.313***	10.337***	14.642***	12.945***					
	(0.121)	(1.047)	(0.381)	(0.253)	(0.174)					
Cut-off 3	13.103***	10.247***	10.867***	14.812***						
	(0.123)	(1.048)	(0.383)	(0.262)						
Observations	343,770	3,185	24,080	83,300	233,205	94,329	2,839	9,131	28,874	53,471
R ²	0.412	0.375	0.326	0.407	0.43	0.29	0.656	0.315	0.251	0.356

Notes to Table 8: This Table reports coefficient estimates of the extensive and the intensive margin of German banks per banking group. Large banks comprise the largest commercial banks, Landesbanken and central cooperatives. Commercial banks are privately owned banks, while savings and cooperatives are regionally operating small banks either owned mutually or by (regional) governments. The selection equation (Extensive Margin) is estimated as ordered probit model (Section 3.1.) and includes unreported dummies for banking groups as exclusion restrictions. The dependent variable is the mode of foreign presence. The equation for the intensive margin is estimated with OLS. The dependent variable is the log volume of international assets. Time fixed effects are included but not reported. The sample spans the period 2002 to 2006. Productivity obtained with the method proposed by Levinsohn and Petrin (2003) (Section 3.3. and Appendix 7.2). For further variable descriptions see the data appendix. ***, **, * = significant at the 1%, 5%, 10%-level.