THE DETERMINANTS OF U.S. BANKS' INTERNATIONAL ACTIVITIES

JUDIT TEMESVARY

This paper provides a dynamic estimation of U.S. banks' foreign market entry/exit decisions, as well as their foreign loan and deposit choices. The study examines how banks' scope of operations (measured by the Sharpe ratio) and size (measured by total assets), together with various host market characteristics, determine banks' optimal choices of two types: (1) which foreign markets to enter/exit, and (2) the foreign loan/deposit quantities. The roles of these determinants are analyzed by formulating a dynamic model of foreign bank activity, where mean–variance utility maximizing banks can reach foreign markets both via cross–border loans (originating from the U.S.), and through foreign affiliate operations (after paying the setup costs). Applying the Bajari, Benkard, and Levin (2007) two–step estimation method to the framework of the model, forward simulation is used to estimate the determinants of the optimal foreign loan and deposit choices, and banks' and regulators’ risk aversion parameters. Furthermore, fixed setup costs and scrap (liquida- tion) values are estimated for a sample of foreign countries U.S. banks invest in. Using the estimated structural parameters, the study presents simulation exercises to analyze the impact on banks' foreign activities of (1) raising bank risk aversion; (2) increases in the risk aversion of foreign country bank regulators; (3) more risk averse U.S. bank regulators; and (3) increases in bank size (total assets) and bank scope (measured by the Sharpe ratio).

KEYWORDS: Foreign Bank Lending, Foreign Affiliate, Bank Regulation, Dynamic Estimation, Simulation.

1. INTRODUCTION

Understanding the determinants of U.S. commercial banks' international activities is important from the perspectives of both the host countries and banks’ countries of origin. The types and magnitudes of cross–country commercial bank activities have significant implications for the development prospects of the generally less prosperous host countries, as well as macroeconomic consequences for the source countries. Foreign banks are often beneficial for the host economies (Focarelli and Pozzolo, 2005; Goldberg, 2007). The benefits are most felt in the host financial sectors, as foreign banks help to improve the efficiency of host country banks (Bayraktar and Wang, 2005; Claessens, Demirguc-Kunt, and Huizinga, 2000, 2001; Claessens and Lee, 2002). Since financial sector development promotes economic growth, foreign bank entry is likely to be welfare enhancing (Bayraktar and Wang, 2006). In addition to the development benefits, foreign banks also promote host country financial stability. On one hand,
the presence of foreign banks reduces the probability of banking crises (Asli Demirguc-Kunt, Levine, and Min, 1998; Levine, 1999). On the other hand, foreign banks are less sensitive to host market fluctuations, and therefore provide a buffer against financial shocks (Goldberg, 2007).

The internationalization of commercial banking has important consequences from the perspective of the generally more developed source countries as well. On one hand, domestic banks’ foreign activities open a potential channel for the transmission of outside financial shocks. On the other hand, the increasingly foreign focus of banks can have significant consequences for the availability of domestic credit. In fact, the outflow of financial resources from domestic credit markets has increased to unprecedented levels during the past two decades. Looking at the United States, foreign assets of U.S. banks amounted to 900 billion USD by 2002, constituting about 18 percent of total U.S. bank assets and approximately 10 percent of total global bank lending. The foreign exposure of U.S. banks has declined in the past decade, mostly due to banks building up their domestic capital in response to stricter domestic capital rules (Ruud, 2002).

This paper examines the determinants of the international commercial banking activities of the largest U.S. banks. A thorough understanding of these operations is greatly complicated by the fact that there are various channels through which U.S. banks can participate in foreign markets — all with different macroeconomic consequences. In addition to domestic operations, U.S. banks can lend to foreign markets via cross-border loans, originating directly from the U.S. They can also participate in foreign retail loan and deposit markets by building foreign affiliates after paying the setup costs. This paper develops a modeling and dynamic estimation framework to examine how bank size, bank scope and host market traits (such as expected returns, costs and regulations) affect banks’ choice of these foreign activities.

In a dynamic framework of foreign market entry and exit, greater bank size (total assets) encourages broader foreign operations by providing more resources for banks to incur the setup costs of foreign market entry. While previous literature has taken bank size as the sole measure of bank heterogeneity, this study is unique in that it examines the additional role of bank scope in banks’ international activities. The lagged Sharpe ratio on banks’ global portfolio measures bank scope. In a context where returns across markets are correlated, using the Sharpe ratio as the scope measure allows for the capture of the risk-return tradeoff improvement that results from entering new markets. Beyond size and scope, the impacts of market-specific capital and liquidity regulations, and proportional costs and taxes are also studied in this paper. In particular, the question of interest is how these determinants contribute to two types of bank portfolio decisions: (1) the choice of which foreign markets to participate in (entry/exit decision), and (2) banks’ choices of the volumes of cross-border loans, affiliate loans and deposits in these host markets (quantity choices).

This paper moves beyond the existing literature by presenting a theoretical model, a contribution towards building the theoretical micro-foundations of
FOREIGN BANK LENDING

a so–far purely empirical literature. This contribution takes the form of a monopolistic competition model where mean–variance utility maximizing banks make foreign market entry/exit decisions, and cross–border loan, foreign affiliate loan and deposit choices given their existing size, scope and the host market traits. Banks’ goal is to weigh expected returns against portfolio risk in a dynamic framework where entry/exit choices have long-term consequences. The model focuses on interest rate (or market) risk as the only source of portfolio risk. Markets are subject to macro shocks in each country. Portfolio risk originates from the variance caused by fluctuations of the random country–specific interest rates which are globally correlated. However, macro–shocks move together across borders — therefore, banks can also rely on potentially variance–reducing correlations. Overall, banks’ goal is to find the optimal risk–return tradeoff on their global portfolio subject to financing and regulatory constraints in each country.

This paper also contributes by formulating a dynamic framework for estimating the presented theoretical model. Foreign banking is characterized by imperfect competition and frequent market entry/exit, which necessitate the incorporation of dynamics into the analysis. However, previous papers used static econometric methods, which have only very limited ability to address the issues at hand. Furthermore, such static methods do not allow for the analysis of the multi–period effects that policy changes have. The estimation method used in this paper is due to Bajari, Benkard, and Levin (2007). The dynamic estimation method is applied to a panel data set constructed from 46 host countries’ market characteristics and the Federal Financial Institution Examination Council’s Country Exposure Survey quarterly U.S. bank activities data between 1997 and 2005.

In the first stage of the two–step dynamic estimation method, foreign market entry/exit probabilities and loan/deposit quantity choices are estimated as functions of bank size, bank scope and foreign market traits in each period separately. This first stage is equivalent to getting estimates of the policy functions based on all the state variables. Furthermore, this first stage allows for the estimation of transition probabilities for the endogenous states (such as foreign presence), as well as the exogenous states (such as bank size). The second stage of the estimation then uses these first–stage estimates to simulate bank’s optimal discounted sum of utilities forward. The second stage is based on two pillars: the simulation of the values of many alternate paths of action, and the assertion that banks’ observed actions reflect optimal choices. The second step consists of getting estimates of structural parameters that ensure the optimality of banks’ observed actions compared to alternate policy paths. The structural parameters of interest are banks’ and regulators’ risk aversion parameters, the country specific entry costs, as well as the scrap values.

The estimation method is novel in that it examines the determinants of the major types of banks’ foreign portfolio choices — the entry/exit decision, as well as the cross–border loan, affiliate loan and deposit quantity choices — si-
multaneously. This is new in the related literature, since so far there have only been papers (1) examining the type of foreign market participation, treating cross-border loans and foreign affiliates as the two dichotomous alternatives; and (2) focusing exclusively on the quantities of foreign loans, and their determinants.

First stage estimates of banks’ entry/exit and loan/deposit quantity choices show that it is very important to examine these two types of decisions simultaneously. Banks’ decisions of market entry/exit are strongly positively correlated with their choices of loan and deposit volumes – therefore they cannot be examined in isolation. The Heckman selection correction method in fact yields a correlation coefficient of 0.31 between the unobservable terms in the market entry and volume choices. Such strong correlation has major implications for the estimation of the policy functions. For instance, previous literature — which did not control for the role of entry barriers — found that bank size has a strong positive impact on the quantity of foreign affiliate loans banks make. However, controlling for market selection shows that bank size affects foreign lending significantly through the market entry decision as well — large banks are much more likely to acquire affiliates. The impact of bank size on the choice of affiliate volumes, conditional on market entry, is much smaller. The strong correlation of the market presence and loan/deposit quantity equations also indicates the important role of unobserved entry costs in the allocation of foreign activities — an issue that the second stage of the estimation addresses.

Furthermore, the first stage estimates prove that looking at the various types of foreign activities (cross-border loans, affiliate loans and deposits) one by one in a unified framework is important. The results below show that bank regulations, costs and returns have very different effects on cross-border loans, affiliate loans and deposits. These differences — which would be missed by grouping all types of foreign bank loans into one category — can have important policy consequences. Finally, the policy function estimates show that bank scope (captured by the Sharpe ratio) has significant explanatory power, in addition to the well-studied role of bank size. The results indicate that the scope effect is on average over three times as large as the effect of bank size.

The second step of the estimation relies on using the first-step policy function estimates to forward-simulate banks’ optimal discounted sum of expected utility. Structural parameter estimates are obtained so as to ensure the optimality of the observed path of actions in comparison to alternate sub-optimal paths. In particular, this method yields estimates of banks’ and regulators’ risk aversion parameters, as well as the fixed entry costs and scrap values. The estimation controls for total operating (variable) costs (including costs proportional to branch network size). This is important to ensure that the estimates are truly reflective of the fixed entry costs and scrap values only. Accordingly, the cost estimates are moderate with a mean of 1.12 for entry costs and 0.56 for scrap values across countries. The entry cost estimates appear significantly higher in markets that are inefficient, profitable and have a strong government pres-
ence in banking. Scrap value estimates move closely together with entry costs. The second stage of the estimation also yields bank and regulatory risk aversion estimates. Getting an estimate of the bank risk aversion parameter is very important in the mean–variance framework, as it determine the rate at which banks trade risk for return, and hence the role of scope. The estimated bank risk aversion is 0.34, slightly higher than estimates in previous papers. There is great variation in regulatory risk aversion parameters across foreign markets — which are generally higher than bank risk aversion with a cross–country average of 0.52. Regulatory risk aversion appears higher in inefficient markets with a stricter bank–regulatory environment, which nonetheless have low enforcement power.

The paper proceeds as follows. Section 2.2 provides motivation for the theoretical model’s formulation in the context of related literature. Section 2.3 presents the model and characterizes the optimal foreign portfolio choices (entry/exit as well as loan/deposit quantities) as a Markov perfect equilibrium. Section 2.4 describes the econometric and simulation methods used for the estimation, and discusses the data. Section 2.5 presents the estimation results. Section 2.6 consists of simulation exercises. Section 2.7 concludes.

2. MOTIVATION AND RELATED LITERATURE

Banks’ motives for going abroad have several sources. Yannopoulos (1983), applying the eclectic paradigm of Dunning (1977) to multi–national banks, attributes the development and patterns of international bank activities to ownership, locational, and internationalization advantages. Ownership advantages are bank-specific characteristics, such as bank size and bank scope (degree of diversification across markets), which enable a particular bank to move beyond the domestic border. Locational advantages are host–country specific traits, such as profitability, regulatory and cost allowances, which attract foreign banks. In a context where international financial market returns are imperfectly correlated, banks which are diversified across foreign markets can enjoy better risk–return tradeoff on their portfolios than their domestic counterparts (Hymer, 1976). Internationalization advantage is the portfolio risk–return tradeoff improvement that multi–national banks can achieve as a result of the co–movement of international financial market returns. This paper analyzes the roles of the ownership, locational and internationalization advantages simultaneously in banks’ location and loan/deposit quantity choices.

The inclusion of initial (existing) bank size and bank scope among the determinants of banks’ foreign portfolio choice captures the ownership advantage. As shown by Focarelli and Pozzolo (2000) and others, bank size, bank scope and efficiency are indeed the most important sources of bank ownership advantage. Furthermore, bank scope and bank size together sufficiently proxy for bank efficiency. Bank scope is the rate at which banks trade portfolio risk for return, and is measured using the lagged Sharpe ratio in this study. Bank scope
is an ownership advantage since it is a bank-specific trait that enables banks to move beyond the domestic market. Furthermore, bank scope is also an internationalization advantage as it captures the extent to which banks can take advantage of the co-movement of returns across markets. An important — so far neglected — ownership advantage is bank risk aversion, which this analysis provides structural estimates for.

Initial bank size is defined as the total existing assets of a given bank. Bank size is an ownership advantage for several reasons. Demsetz and Strahan (1995) and Goldberg and Cetorelli (2008) show that greater size increases banks’ propensity to enter new markets. On one hand, greater size enables banks to pay the fixed setup costs of expansion (Ursacki and Vertinsky, 1999). On the other hand, larger banks have an increased need for variance reduction (Pozzolo, 2008). In addition, bank size determines the amount of capitalization parent banks channel to their affiliates via internal capital markets (Goldberg and Cetorelli, 2009) — thereby having an impact on the quantities of banks’ loan and deposit choices. The analysis of this paper in unique in that it examines the roles of bank size and bank scope in banks’ entry/exit and loan/deposit quantity choices simultaneously.

The mean–variance modeling framework employed in this study is in line with the conclusion of Focarelli and Pozzolo (2005) that the most promising context for examining international bank activities is one with portfolio optimization in the presence of fixed costs. In addition, the mean–variance portfolio choice framework (Markowitz, 1987) is useful because it factors the international correlation of market returns into banks’ optimal decisions. Bank scope (defined as the lagged Sharpe ratio on banks’ global portfolio) captures the extent to which banks can take advantage of these correlations to obtain a better risk–return tradeoff. Therefore, it is the mean–variance framework that allows the examination of bank scope as an internationalization advantage. Furthermore, the mean–variance portfolio choice formulation in this paper is realistic, since past empirical research has verified that banks consider both portfolio mean and variance in their foreign activities. With respect to the role of expected returns (mean) in foreign banking, Demirguc-Kunt and Levine (1996) and Miller and Parkhe (1998) show that host country financial sector profitability is positively correlated with foreign bank operations there. Regarding the role of portfolio variance, Buch, Driscoll, and Ostergaard (2005) have shown that greater variance of asset returns is indeed a significant deterrent of banks’ foreign activities.

The locational advantages of foreign banking are captured by including characteristics of host markets in the set of variables. These are measures of expected market return indices, competitiveness, entry barriers, regulations and costs. The importance of locational advantages has been well established in the literature. Looking at foreign banking activity within the United States, several studies (Grosse and Goldberg, 1991; Heinkel and Levi, 1992) have identified the significance of economic and regulatory factors. Papaioannou (2005) confirms
the roles of legal and institutional factors in foreign bank activity. Miller and Parkhe (1998) claim that more stringent host country regulations deter foreign bank operations. Beyond regulations and costs, entry restrictions discourage foreign bank operations by acting as a type of fixed setup cost. Barth, Nolle, and Rice (1996) argue that host market entry restrictions limit the international flow of bank assets by eliminating diversification advantages. Buch, Driscoll, and Ostergaard (2005) show that capital controls in fact significantly reduce banks’ ability to diversify into foreign markets. Furthermore, entry barriers put new entrants at a disadvantage compared to banks already present in the host market (Caves, 1987). This study contributes to the analysis of locational advantages in two ways. First, the analysis in this paper presents structural estimates of each country’s regulator’s risk aversion parameter. Second, banks’ observed behavior are used to estimate country–specific fixed entry costs and scrap values.

Foreign bank market competition is assumed to be monopolistically competitive. This choice is motivated by the fact that relationship banking is an important source of market power for banks. Relationships that banks develop with customers (Gray and Gray, 1981) provide them with informational capital, which translates into differentiated services (relationship banking) and market power. Greater market power is likely to affect both banks’ entry/exit and loan/deposit quantity choices. Indeed, Focarelli and Pozzolo (2005) show that banks tend to expand into less competitive foreign markets. In addition to looking at the effect of market power in the foreign market entry choice, this study contributes to the existing research by examining the role of market power in banks’ loan/deposit quantity choices as well.

The first type of decision this paper addresses is banks’ choices of foreign market entry/exit. Banks’ dynamic foreign market entry/exit decisions shape the pattern of their global operations. As such, there has been extensive literature looking at the discrete entry (and more rarely, exit) choices, albeit in isolation from the volume decisions. In static probit analysis, past research has established the importance of locational factors (Cerutti, Dell’Ariccia, and Peria, 2006; Ferri and Pozzolo, 2008; Houpt, 1999; Miller and Parkhe, 1998; Nigh, Cho, and Krishnan, 1986; Sabi, 1988). Empirical studies have found that banks choose to build foreign affiliates because doing so gives them access to retail markets (Focarelli and Pozzolo, 2005) and hedge them against transfer risk (Cetorelli and Goldberg, 2009). However, previous literature has neglected the fact that static analysis is not adequate to analyze banks’ inherently dynamic entry/exit choices. The analysis in this paper examines these choices in a dynamic setting.

Careful study of the entry/exit decisions is especially important in light of recent global banking trends, showing that foreign operations via affiliates has been on the rise for the past two decades. During the 1990s, the rise in foreign affiliate banking via cross-border mergers and acquisitions was a global phenomenon (Berger, DeYoung, Genay, and Udell, 2001). During this period, U.S. banks’ foreign affiliate assets also increased dramatically, rising from just 7 bil-
lion USD in 1970 to 718 billion USD by 1998. The increasing tendency of multi-
national banks towards affiliate operations has had significant consequences for
the financial structure of many host economies. In some Latin American and
Eastern European countries, over 50 percent of banking assets are now foreign-
controlled (Pozzolo, 2008).

The second type of decision under consideration here is banks’ choice of
the volumes of cross-border loans (generally flowing to sovereigns and multi-
national corporations) and foreign affiliate loans (to retail clients). Both types
have their advantages. On one hand, cross-border loans are advantageous in
that they can draw on parent banks’ capital base, and protect parent banks
from foreign market political risk. Furthermore, Cerutti, Dell’Ariccia, and Peria
(2006) show that banks prefer to make cross-border loans in foreign wholesale
markets, and also to markets where corporate taxes are high. On the other hand,
affiliate lending also has many advantages. Foreign affiliates provide limited li-
ability to parent institutions. Cetorelli and Goldberg (2009) show that operating
via foreign affiliates allows the activation of internal capital markets between
parent banks and affiliates, which insulate banks from liquidity shocks in ei-
ther the home or host countries. Affiliate activities also allow deposit-taking in
foreign markets, which is not possible if lending is via cross-border loans (Saun-
ders and Walter, 1994). Finally, foreign affiliate operations provide banks with
potential tax advantages by delaying income repatriation Scholes and Wolfson
(1992). Data show that U.S. banks have exhibited a striking tendency to move
towards lending via affiliates. The largest U.S. banks’ portfolio share of affiliate
to cross-border loans had risen from 0.78 in 1997 to 1.35 by 2005.

3. MODEL

3.1. Setup and Notation

This section describes the model of banks’ foreign market entry/exit and
loan/ deposit quantity choices. Let \( j = 1 \ldots J \) denote bank \( j \). Each bank \( j \) is
owned by shareholders, whose goal is to maximize the lifetime discounted sum
of mean–variance utilities on the bank portfolio. Shareholders make foreign
market entry/exit, as well as loan/deposit quantity choices at the beginning
of each period \( t \). There are a total of \( T \) periods such that \( t = 1 \ldots T \), and \( I \) coun-
tries such that \( i = 1 \ldots I \). In what follows, the time indices are suppressed. Each
bank \( j \) maintains presence in the domestic market, and chooses the composition
of its foreign operations period by period.

Let subscript \( m \) index each market bank \( j \) participates in. In addition to lend-
ing and taking deposits in the domestic market, there are three markets in each
foreign country \( i \) that bank \( j \) can engage in. These are the cross-border loan
market, the affiliate loan market and the affiliate deposit market. Banks can
make direct cross-border loans to any foreign country \( i \), at the expense of a
fixed cost \( \Gamma_{cb} \). The cross-border loan market \( m = cb \) consists of public and cor-
porate borrowers. Cross-border loans come out of bank $j$’s domestic budget, and are subject to domestic laws and regulations. Banks can also make loans and take deposits in country $i$’s retail market $m = (a; d)$ by building a foreign affiliate in the country, at the expense of a fixed setup cost $\Gamma_i$. Foreign affiliate operations are financed out of each affiliate’s separate budget, and are bound by country $i$’s laws and regulations. The three available markets per country $i$ are therefore $(a; a; cb)$. Since there is no cross-border lending in the domestic market, there are a total of $3 \cdot I - 1$ markets available.

The market specific setup costs are constant across banks and over time. Banks can recover the scrap values $\Psi_m < \Gamma_i$ if they decide to exit market $m$ in country $i$. In the beginning of each period, bank $j$ allocates its initial capitalization $K_j$ across all markets it participates in. Since cross-border loans come out of the domestic budget, we can index initial allocated capital by country. Therefore, we have $K_j = \sum_i K_{ij}$.

Banking clients in each market $m$ demand a composite bundle of banking services from banks of all nationalities. Therefore, banking markets in each market $m$ are monopolistically competitive, such that $\epsilon_i$ is the market–specific loan demand elasticity and $\eta_i$ is the deposit supply elasticity. Banking clients in market $m$ demand loans $l_m$ and rate $r_{lm}$ and supply deposits $d_m$ at rate $r_{dm}$

Loan demand and deposit supply functions have the Dixit–Stiglitz type monopolistically competitive form. Bank shareholders observe the loan demand $l_m$ and deposit supply $d_m$ functions:

$$l_m = \frac{\alpha_m}{r_{lm}^{\epsilon_m}}$$

$$d_m = \frac{\epsilon_m}{r_{dm}^{\eta_m}}$$

$1$Recall that no deposit-taking is possible in the cross-border market.

$2$These random variables are indices of all bank rates in market $m$, given by $\alpha_m = A_m \left( \int \left( r_{lm} \right)^{1+\epsilon_m} d\tilde{m} \right)^{-1}$ with $\epsilon_m > 1$ and $\beta_m = B_m \left( \int \left( r_{dm} \right)^{1+\eta_m} d\tilde{m} \right)$, where $A_m$ and $B_m$ are market-specific constants. The aggregation is over all banks of all nationalities operating in market $m$. Note that the U.S. bank takes these market indices as given.
For each dollar’s worth of loan $l_i$, the bank must incur a proportional (operational) lending cost of $c_i$. Similarly, for each dollar’s worth of deposit $d_i$, the bank takes, it must incur a proportional (operational) cost of $c_i$. Therefore, the per–dollar net interest income on $l_i$ is $(r_i - c_i)$, and the per–dollar deposit expenditure is $(r_i + c_i)$.

In addition to loans and deposits, bank $j$ can also borrow from other sources at known rates. Let $\Delta_i$ denote non–deposit net borrowing in market $m$ (where $\Delta_{icb} = 0$). The rate $r_i^{\Delta}$ at which the bank can borrow from other sources (such as the interbank market) increases in the amount of such borrowing, and decreases in the amount of initial capital that the bank allocates to market $m$ in country $i$ (never falling below the fixed rate $\bar{r}_i$):

\begin{equation}
(3.4) \quad r_i^{\Delta_m} = r_m \left(1 + \frac{\Delta_i}{K_i} \right)
\end{equation}

The state variables, which the bank observes in the beginning of each period are as follows. First, each bank observes its initial capital $K_j$. Second, the bank observes the vector of presence indicators $P_j = (P_1^{1_a}; P_{1cb}^{1}; P_2^{2_a}; P_{2cb}^{2}; \cdots; P_I^{I_a}; P_{Icb}^{I})$. These presence indicators are defined such that $P_i^{m} = 1$ if the bank already has operations in country $i$’s market $m$ at the beginning of the period, and $P_i^{m} = 0$ otherwise. In addition to size and presence, the bank also brings its existing scope of operations into the current period, which results from its optimal actions in the preceding periods. This scope measures the extent to which the bank is able to trade return for risk, and is captured by the lagged Sharpe ratio $S_j$. Since loan and deposit return indices are random and correlated across markets, this scope measure $S_j$ captures the extent to which the bank can benefit from any new entry/exit and investment choice.

The state variables $(P_j; S_j)$ depend on bank $j$’s previous entry/exit and quantity choices. Since it is assumed that profits are re–distributed to shareholders at the end of each period $t$, total asset size $K_j$ is taken to be exogenous from the bank’s perspective. Further exogenous and known state variables of the model are: the vectors of proportional lending and deposit taking costs; the vector of taxes, capital and liquidity regulations (described below); the joint normal distribution of the return indices; the distribution of banks’ private shocks, and the vectors of entry costs and scrap values, denoted by $\Gamma$ and $\Psi$, respectively. Let $\Pi$ denote the set of all state variables.

Shareholders’ goal is to choose bank $j$’s portfolio so as to maximize mean–variance utility over its end–period capital, denoted by $\tilde{K}_j$. Let $\tilde{K}_j$ denote the end–period capital in country $i$. Due to the random shocks affecting the loan demand and deposit supply functions, the country–specific $\tilde{K}_j$’s are also random variables. In each country $i$, $\tilde{K}_j$ is composed of the initial market capitalization

\footnote{Note that the subscript $a$ refers to both affiliate loan and deposit markets}
expenditures, adjusted for the country–specific income tax \( t_i \).

Recall that cross-border loans come out of bank \( j \)'s domestic operations. Fixed entry costs and scrap values appear in each affiliate’s end–period capital. These fixed costs are relevant only if bank \( j \) enters or exits market \( m \) in the given period. Let \( e_{mj}^e(\Pi) = 1 \) denote bank \( j \)'s decision to enter market \( m \) this period, and \( e_{mj}(\Pi) = -1 \) is the decision to exit, conditional on all the state variables. Then the domestic end–period capital is

\[
\tilde{K}_{mj}^d = (1 - t_i) \cdot \left[ (1 - \omega) \cdot \left( r_{\text{lm}} - c_{\text{lm}} \right) \cdot \left( r_{\text{cd}} \right) - (r_{\text{cd}} + c_{\text{cd}}) \cdot d_{mj}^d - (r_{\Delta} - \Delta_{mj}) \cdot \left( 1 - t_i \right) \cdot \left( 1 - \omega \right) \right] - \\sum_i \Gamma_{ae}^i \left( 1 : e_{ae}^i = 1 \right) + \sum_i \Gamma_{ae}^i \left( 1 : e_{ae}^i = -1 \right)
\]

Foreign affiliate income is repatriated to the bank’s domestic headquarters at the repatriation tax rate of \( \omega \). Then the country \( i \) foreign affiliate’s end–period capital is

\[
\tilde{K}_{ji} = \left( 1 - \omega \right) \cdot \left( 1 - t_i \right) \cdot \left( 1 - \omega \right) \left[ \left( \frac{r_{\text{lm}} - c_{\text{lm}}}{\left( r_{\text{cd}} \right) \cdot \left( 1 - t_i \right) \cdot \left( 1 - \omega \right)} \right) \right] - \Gamma_{ai}^i \left( 1 : e_{ai}^i = 1 \right) + \Gamma_{ai}^i \left( 1 : e_{ai}^i = -1 \right)
\]

After all foreign income is repatriated, bank \( j \)'s end–period aggregate capital is \( \tilde{K}_j = \sum_i \tilde{K}_{ji} \).

Bank \( j \)'s activities are subject to minimum reserve and risk–weighted capital requirements. Domestic and cross–border lending come out of the domestic budget, and are therefore bound by domestic (U.S.) regulations. Foreign affiliate operations are financed out of the budget of each foreign affiliate separately. Therefore, foreign affiliate operations are bound by each foreign country \( i \)'s laws and regulations. Bank \( j \) can only operate (make loans and take deposits) in market \( i \) if it starts with positive initial capitalization \( K_j > 0 \). Let \( \delta \) denotes the required reserve ratio, and \( \tilde{K}^i \) denote the fixed minimum capital ratio in market \( i \). The budget constraints on bank \( j \)'s domestic and foreign affiliate operations are

\[
\tilde{K}_{am}^d + \sum_i \tilde{K}_{cbm}^i \leq K_{mj}^d + \Delta_{mj}^d + (1 - \delta_{mj}^d) \cdot d_{mj}^d
\]

\[
\tilde{K}_{ai}^i \leq K_{ji}^i + (1 - \delta_i) \cdot d_{ji}^i + \Delta_{ji}^i
\]

\( ^4 \)The loan revenue and deposit expenditure functions take the forms \( r_{\text{lm}} \cdot \left( \frac{r_{\text{lm}}}{\left( r_{\text{cd}} \right) \cdot \left( 1 - t_i \right) \cdot \left( 1 - \omega \right)} \right) \) and \( r_{\text{cdm}} \cdot d_{mi} = \left( \frac{r_{\text{cd}}}{\left( r_{\text{cd}} \right) \cdot \left( 1 - t_i \right) \cdot \left( 1 - \omega \right)} \right) \) respectively.
The bank regulator in country $i$ considers banks’ risk-weighted capitalization in its capital requirement. Let $\theta^i$ denote country $i$’s bank regulator’s risk aversion parameter$^5$, and $V^i$ is the variance-covariance matrix of the return indices in country $i$ alone.$^6$ The risk-weighted capital requirements in the U.S. and country $i$ are then

$$ E[\tilde{K}^us_{ij}] - \frac{\theta^us}{2} \cdot (\tilde{K}^us_{ij} V^us \tilde{K}^us_{ij}) \geq \bar{k}^us \cdot \left( \mu^us_{ij} + \sum_i l^us_{ij} \right) $$ (3.9)

$$ E[\tilde{K}^i_{ij}] - \frac{\theta^i}{2} \cdot (\tilde{K}^i_{ij} V^i \tilde{K}^i_{ij}) \geq \bar{k}^i \cdot (\tilde{p}^i_{aj}) $$ (3.10)

The budget and regulatory constraints must hold in each period and each country. At this point it is useful to introduce time notation $t$.

Given the state $\Pi_t \in \Pi$, banks choose actions simultaneously. The two types of actions are the static loan/deposit quantity choices, and the dynamic foreign market entry/exit choices. Recall that $E_j = (e_{j,1} \ldots e_{j,T})$ denotes bank $j$’s actions, and let $E_t = (e_{t,1} \ldots e_{t,T})$ denote the vector of time $t$ actions. Then $E = (E_1 \ldots E_j)$. Before choosing its actions, each bank $j$ receives a private shock $\nu_{jt}$, drawn independently across banks and over time from a distribution $G_j(\cdot | \Pi_t)$ with support $\nu_j$. The private shock might derive from variability in managerial drive for international portfolio diversification. Let the vector $\nu_t = (\nu_{1t}, \ldots, \nu_{Jt})$ denote private shocks of all banks.

Given its private shock, the entry/exit decision vector $e_j$ and the set of state variables $\Pi_t$, bank $j$’s utility takes the mean–variance form in each period $t$:

$$ u(e_j, \Pi_t, \nu_t)_t = E(\tilde{K}_j) - \frac{\lambda}{2} \cdot (\tilde{K}_j V \tilde{K}_j)_t $$ (3.11)

$\lambda$ is the bank’s constant risk aversion, common across all banks. Letting $\gamma < 1$ denote the constant discount factor, we can write bank $j$’s discounted sum of utilities over time as:

$$ E \left[ \sum_{t=0}^{T} \gamma^t u_j(e_j, \Pi_t, \nu_t)_t | \Pi_t \right] $$ (3.12)

The expectation is over bank $j$’s private shock in the current period, as well as future values of the state variables, actions, and private shocks. The final aspect of the model is the transition between states. The state vector at date $t + 1$ is denoted by $\Pi_{t+1}$, and is drawn from a probability distribution $\Lambda(\Pi_{t+1} | e_t, \Pi_t)$. The dependence of this function on $e_t$ means that time $t$ entry/exit decisions

---

$^5$This risk aversion parameter denotes the weight that the regulator puts on the market risk on bank $j$’s portfolio.

$^6$Note that the country-specific variance-covariance matrix of return indices $V^i$ is not the same as the overall variance-covariance matrix on the bank’s portfolio, denoted by $V$ in Equation (3.15).
affect the future strategic environment. However, not all states are influenced by past actions.

The analysis of equilibrium behavior focuses on pure strategy Markov perfect equilibria (MPE). In a MPE, each bank’s behavior depends only on the current state. Formally, a Markov strategy for bank \( j \) is a function \( \omega_j : \Pi \times \nu_j \rightarrow E_j \). A profile of Markov strategies is a vector \( \omega = (\omega_1, \ldots, \omega_J) \) where \( \omega : (\Pi, \nu_1, \ldots, \nu_J) \rightarrow E \). If behavior is given by a Markov strategy profile \( \omega \), bank \( j \)'s expected utility over time, given a state \( \Pi \) can be written recursively:

\[
V_j(\Pi, \omega) = E \left[ u_j(\omega, \Pi, \nu, \nu_j) + \gamma \int V_j(\Pi'; \omega) d\Lambda(\Pi' | \omega, \Pi) \right]
\]

In (3.13), \( V_j \) is bank \( j \)'s ex ante value function in that it reflects expected profits at the beginning of a period before private shocks are realized. The profile \( \omega \) is a Markov perfect equilibrium if, given the opponent profile \( \omega_{-j} \), each bank \( j \) prefers its strategy \( \omega_j \) to all alternative Markov strategies \( \omega'_j \). That is, \( \omega \) is a Markov perfect equilibrium if for all banks \( j \), states \( \Pi \), and Markov strategies \( \omega'_j \),

\[
V_j(\Pi, \omega) \geq V_j(\Pi; \omega'_{j}; \omega_{-j})
\]

It is assumed that all the conditions for the existence of such a MPE are satisfied.

3.2. Optimal Choices

Income from lending activities is redistributed to shareholders at the end of each period. Therefore, bank \( j \)'s loan and deposit quantity choices can be analyzed in a static, period by period setting. Accordingly, in each period \( t \) bank \( j \) chooses its loan and deposit quantities to solve

\[
\max_{e_j, i, \nu_j} u_j(e_j, \Pi, \nu, \nu_j) = E \left( \tilde{K}_j \right) - \lambda - \frac{1}{2} \left( \tilde{K}_j' \tilde{V}_j \right)_t
\]

subject to the budget and regulatory constraints described in Equations (3.7) through (3.10). Banks make optimal foreign market entry and exit decisions that solve

\[
\max_{e_{j(i), \ldots, \omega_j}} E \left[ \sum_{t=0}^{T} \gamma^t u_j(e_j, \Pi, \nu_j) \right] | \Pi_t
\]

Given the vector of fixed entry costs \( \Gamma \) and scrap values \( \Upsilon \), the optimal market entry and exit choices for a bank not in market \( i \) are as follows:

\[
\begin{cases}
\text{Enter} & \text{if } V_j(a_{mj} = 1; a_{-mj}, \Pi, \omega) - \Gamma_m \geq V_j(a_{mj} = 0; a_{-mj}, \Pi, \omega); \\
\text{Stay out} & \text{if otherwise.}
\end{cases}
\]
For a bank present in market $i$, the optimal decision rule is:

$$
\begin{align*}
\text{Exit} & \quad \text{if } V_j \left(e^i_{mj} = -1; e^i_{-mj}, \Pi, \omega \right) + \gamma_m \geq V_j \left(e^i_{mj} = 0; e^i_{-mj}, \Pi, \omega \right) \\
\text{Stay} & \quad \text{otherwise.}
\end{align*}
$$

This concludes the characterization of bank $j$’s optimal behavior. The next section describes how to use the structure presented above to estimate the determinants of banks’ optimal decisions.

4. ESTIMATION

The purpose of this section is to use the model described above to estimate how banks’ choices of foreign loans, as well as their market entry/exit decisions depend on bank and market–specific characteristics. The goal is to recover the model’s structural parameters. These parameters are: the utility function $u(\cdot)$, the discount factor $\gamma$, the transition probabilities $\Lambda(\cdot)$, the regulatory and bank risk aversion parameters $(\lambda, \theta)$, the tax rates and return indices $(t, R)$, and the proportional and fixed costs/scrap values $(\Gamma, \Upsilon)$.

In what follows, it is assumed that the unknown structural parameters are the risk aversion parameters $(\lambda, \theta)$ and the fixed entry costs/scrap values $(\Gamma, \Upsilon)$. Let $\Theta$ denote the set of unknown structural parameters such that $\Theta = (\Gamma, \Upsilon, \lambda, \theta)$. The goal of the following estimation is to recover these structural parameters from the model. The estimation strategy follows the Bajari, Benkard, and Levin (2007) (BBL) method of estimating dynamic games of imperfect competition. This method can estimate banks’ dynamic strategic choices in this model without having to solve the dynamic optimization problem. The BBL method is based on two underlying assumptions. First is the assumption that the model described above represents banks’ true behavior. Second, it is conjectured that the loan quantity and entry choices observed in the data result from banks’ utility–maximizing actions, given the bank and country–specific characteristics (the state variables).

The estimation method consists of two parts. The first stage estimates bank $j$’s optimal loan, deposit and entry/exit choices (the policy functions) as functions of the set of time $t$ state variables. That is, the first stage estimates:

$$
(l^*; d^*; e^*)_j = f (\Pi_t)
$$

where the $^*$ superscript denotes observed optimal choices, and $\Pi_t$ is the set of state variables as of time $t$. The regression in Equation (4.1) yields policy function estimates $(\hat{l}; \hat{d}; \hat{e})$ for any state variable $\Pi_t$. Plugging these estimates into $u_t (\cdot)$ produces the period by period value function. Transition probabilities for the state variables are also needed. The entry/exit estimate $\hat{e}$ is in fact the transition probability for bank $j$’s presence vector $P$. Transition probabilities of the exogenous state variables can be estimated using observed data. As a result, state transition probability function estimates $\hat{\Lambda}(\Pi_{t+1} | \Pi_t)$ are obtained.
The second step uses the policy function estimates \( \hat{l}; \hat{d}; \hat{e} \) together with the transition probability estimates \( \hat{\Lambda} (\Pi_{t+1} | \Pi_t) \) to forward-simulate values for the discounted sum of utilities in (3.12). Recall that these estimates correspond to banks’ optimal choices. Therefore, the resulting simulated value function corresponds to the value of banks’ optimal behavior. Importantly, the resulting simulated values are still functions of the model’s unknown structural parameters, such that \( \hat{V}_j (\Pi; \omega; \Theta) \).

Given \( \hat{l}; \hat{d}; \hat{e} \) together with \( \hat{\Lambda} (\Pi_{t+1} | \Pi_t) \), forward simulation can also be used to evaluate any other (alternate) bank strategy \( \omega'_j \), with corresponding simulated values \( \hat{V}_j (\Pi; \omega'; \Theta) \). Based on the assertion that strategy \( \omega_j \) is bank \( j \)'s optimal behavior (described in Equation (3.14) above), the following inequality must hold at the true values of the structural parameters.

\[
(4.2) \quad \hat{V}_j (\Pi; \omega; \Theta_0) \geq \hat{V}_j (\Pi; \omega'; \Theta_0)
\]

The second stage of the estimation then aims to find structural parameter estimates \( \hat{\Theta} \) that minimize deviations from Equation (4.2). The detailed process of getting the policy function estimates \( \hat{l}; \hat{d}; \hat{e} \) and the structural parameter estimates \( \hat{\Theta} \) is described in the following subsections.

4.1. First Step: Policy Functions and Transition Probabilities

As described above, the first step consists of estimating banks’ policy functions as functions of the period-specific state variables. The policy functions of interest are the discrete entry/exit choices, and the continuous loan and deposit quantity choices. Substituting estimates of these policy functions into the utility function reflects on how the value of bank operations depend on state variables.

Estimation of the loan/deposit quantity choices and the foreign market entry/exit decisions can be achieved in one step, via the Heckman selection-bias-corrected Maximum Likelihood, or MLE estimation method. The advantage of using a maximum likelihood formulation is that it allows for estimating the policy functions in one step. Applying the Heckman selection correction method is important to ensure that the bias arising from correlation of the error terms in the entry/exit and loan/deposit quantity policy equations is accounted for. The MLE estimation consists of two equations. On one hand, Equation (4.3) estimates the probability that bank \( j \) is present in market \( i \) as functions of all the state variables at time \( t \). Equation (4.4) estimates the loan and deposit quantity choices as functions of the time \( t \) state variables, conditional on bank \( j \) being present in country \( i \) at time \( t \). Let \( \Phi (\cdot) \) denote the CDF of the normal distribution, and \( \Sigma_m \) denotes market characteristics at time \( t \). Recall that \( K_{jt} \) and \( S_{jt} \) are bank \( j \)'s initial capital and scope at time \( t \), respectively. Then the estimable
policy functions are:

\[
\text{Prob}\left(P_{mjt}^i = 1\right) = \text{Prob}\left(k_0 \cdot K_{jt} + k_1 \cdot S_{jt} + k_2 \cdot \Sigma_{mjt}^i + k_3 \cdot \Gamma_m + \varepsilon_{mjt}^i > 0\right)
\]

\[
\text{Prob}\left(P_{mjt}^i = 1\right) = \Phi \left[k_0 \cdot K_{jt} + k_1 \cdot S_{jt} + k_2 \cdot \Sigma_{mjt}^i + k_3 \cdot \Gamma_m\right]
\]

\[
\begin{cases}
\bar{f}_{ajt} = \pi_{a0} \cdot K_{jt} + \pi_{a1} \cdot \Sigma_{ajt}^i + \pi_{a2} \cdot S_{jt} + \pi_{a3} \cdot \theta^i + \bar{u}_{ajt}^i \\
\bar{f}_{cbjt} = \pi_{cb0} \cdot K_{jt} + \pi_{cb1} \cdot \Sigma_{cbjt}^i + \pi_{cb2} \cdot S_{jt} + \pi_{cb3} \cdot \theta^i + \psi^i \\
\bar{d}_{ajt} = \pi_{d0} \cdot K_{jt} + \pi_{d1} \cdot \Sigma_{ajt}^i + \pi_{d2} \cdot S_{jt} + \pi_{d3} \cdot \theta^i + \bar{u}_{ajt}^i
\end{cases}
\]

if \(P_{jt}^i = 1\)

\[
\begin{cases}
\bar{f}_{jt} = 0 \\
\bar{f}_{cbjt} = \pi_{cb0} \cdot K_{jt} + \pi_{cb1} \cdot \Sigma_{cbjt}^i + \pi_{cb2} \cdot S_{jt} + \pi_{cb3} \cdot \theta^i + \psi^i \\
\bar{d}_{ajt} = 0
\end{cases}
\]

if \(P_{jt}^i = 0\),

In these policy equations, \((k, \pi, \Sigma, \theta, \varepsilon)\) are vectors of estimable coefficients, and \((u, \psi, \varepsilon)\) are vectors of i.i.d error terms. Estimating this system of equations yields coefficient estimates \(\hat{\theta} = (\hat{k}, \hat{\pi}, \hat{\Sigma}, \hat{\theta}, \hat{\varepsilon})\). These estimates can be used to derive predicted optimal entry/exit, loan and deposit quantity choices for any combination of state variables \(\Pi\). This is equivalent to obtaining estimates of the optimal strategies \(\hat{\omega}(\Pi; \nu_t)\).

Estimation of the transition probabilities of the state variables in \(\Pi\) still remains. Recall from above that the \(e^i_{jt}\) and \(\bar{e}^i_{jt}\) denote bank \(j\)’s decision to enter and exit market \(i\) at time \(t\), respectively. From Equation (4.3), it is straightforward to get transition probability estimates such that

\[
\text{Prob}\left(e_{mjt}^i = 1\right) = \text{Prob}\left(P_{mjt}^i = 1 \mid P_{mjt-1}^i = 0\right) = \Phi \left(P_{mjt-1}^i = 0\right)
\]

Estimates for the exogenous transition probabilities of bank capital \(K_j\) can also be obtained from the empirical distribution. The distribution of \(K_j\) is normal. Therefore, Monte Carlo simulation with a normal target distribution can simulate values for initial capital \(K\).

The next section describes how to get estimates of the unknown structural parameters \(\Theta\) using the second step.

4.2. Second Step: Structural Parameter Estimates

Recall from above that the unknown structural parameters of interest are \(\Theta = (\Gamma, \Psi, \lambda, \theta)\). Estimates \(\hat{\Theta}\) are obtained from the second step of the estimation.
FOREIGN BANK LENDING

The process of recovering these structural parameters goes as follows. Using the estimated optimal strategies \( \hat{\omega}(\Pi; \nu) \) from the first step:

\[
\hat{V}_j(\Pi; \omega; \Theta) = E \left[ \sum_{t=0}^{T} \gamma^t u_j(\hat{\omega}(\Pi; \nu), \Pi, \nu; \Theta) \mid \Pi_0 = \Pi; \Theta \right].
\]

Estimate \( \hat{V}_j(\Pi; \omega; \Theta) \) of the optimal value function can be obtained by forward-simulation using the estimated transition probabilities \( \hat{\Lambda}() \) as follows. Let \( N \) denote the total number of simulations. Based on the first-stage policy function estimates, bank \( j \)'s corresponding estimated optimal entry/exit decisions and loan and deposit quantity choices — denoted by \( (\hat{l}; \hat{d}; \hat{e}) \) — are calculated and plugged into \( u_j() \). These steps are repeated for each of \( T \) periods, using the estimated transition probabilities to govern state transitions. Bank \( j \)'s discounted sum of utilities is then averaged over the many simulated paths \( (n = 1 \ldots N) \) to yield the optimal value estimate \( \hat{V}_j(\Pi; \omega; \Theta) \).

The same process can simulate values for a number of sub-optimal strategy paths \( \omega' \). Let \( \hat{V}_j(\Pi; \omega'; \Theta) \) denote the value estimates corresponding to these alternate strategies. The final step is to use the value estimates \( \hat{V}_j(\Pi; \omega; \Theta) \) and \( \hat{V}_j(\Pi; \omega'; \Theta) \) to set up inequalities which ensure that the observed bank actions have the highest value. From Equation (4.2), it follows that

\[
\hat{V}_j(\Pi; \omega_j; \omega_{-j}; \Theta_0) \geq \hat{V}_j(\Pi; \omega'; \omega_{-j}; \Theta_0)
\]

The goal is to obtain estimates \( \hat{\Theta} \) to minimize violations of this set of inequalities. It is assumed that all conditions ensuring point identification are satisfied. If the set of inequalities characterizing the optimal choices is large enough and letting \( x \) denote the equilibrium conditions, the following function captures deviations from the set of inequalities in Equation (4.8):

\[
g(x; \Theta; \hat{\phi}) = \hat{V}_j(\Pi; \omega_j; \omega_{-j}; \Theta; \hat{\phi}) - \hat{V}_j(\Pi; \omega'; \omega_{-j}; \Theta; \hat{\phi})
\]

Let \( g_{n}(x; \Theta; \hat{\phi}) \) be the value of this difference for the \( n \)'th simulation, when the first-stage policy function parameter estimates are \( \hat{\phi} \). Let \( n_I \) denote the number of sub-optimal policy paths examined (i.e. the number of inequalities) for each simulation, and \( X_k \) denotes the \( k \)'th inequality. Recall that \( N \) is the total number of simulations. Then define

\[
Q_n(\Theta) = \frac{1}{n_I} \cdot \sum_{k=1}^{n_I} \left( \min \left[ g\left(X_k; \Theta; \hat{\phi}\right), 0 \right] \right)^2
\]

The best estimates of the structural parameters \( \Theta \) are such that

\[
\hat{\Theta} := \arg \min_{\Theta} Q_n(\Theta; \hat{\phi})
\]
All conditions which ensure that this estimator is consistent and asymptotically normal are assumed to be satisfied.

The goal of the second stage estimation is to get country-specific estimates for the fixed entry costs $\Gamma$, scrap values $\Upsilon$ and regulatory risk aversion terms $\theta$. Furthermore, the goal is to get one constant estimate for the bank risk aversion parameter $\lambda$. The following example gives an idea of the estimation process. If bank $j$ exits country $i$ at time $t$, the optimal value of this action is simulated. Then the values of all other exit possibilities are simulated, i.e. the value the bank would have obtained if it had exited at time $t = 0, 1, \ldots, T$. For each bank-country pair and each simulation $n$, this yields the values of a total of $n_I = 32$ sub-optimal paths. The country $i$-specific $Q_{jm}^i(\cdot)$ function for each simulation $n$ is then calculated, yielding a 32 by 1 vector for each bank. Then variation across banks and simulation draws are used to obtain country-specific estimates $(\hat{\Gamma}_i; \hat{\Upsilon}_i; \hat{\theta}_i)$. The bank risk aversion parameter $\lambda$ enters all countries’ $Q_{jm}^i(\cdot)$ function. Thus line search is used to obtain the estimate $\hat{\lambda}$ from all the $Q_{jm}^i(\cdot)$ functions jointly.

It is important to take account of the fact that the first-stage policy functions are already functions of the unknown structural parameters that the second stage estimates. This difficulty is handled iteratively, as follows. At first, the second-stage set of inequalities are solved using the observed loan and deposit quantities and entry/exit decisions as inputs (as opposed to first-stage estimates). The resulting preliminary estimates of the structural parameters are then used as explanatory variables in the first-stage policy function regressions. The resulting policy function estimates are then used in the second stage to re-estimate the structural parameters. The process is repeated until the parameter estimates converge.

4.3. Data

The model’s equations are estimated on a panel data set constructed from quarterly data on activities of U.S. banks in 46 foreign markets. The data cover the period between 1997 Q4 to 2005 Q4, a total of 33 quarters. Data on U.S. Banks’ foreign claims and liabilities are from the Federal Financial Institutions Examination Council (FFIEC) Country Exposure Surveys. This quarterly survey reports on the foreign activities of U.S. banks with foreign exposure over 30 million USD broken down by host country. Data are reported separately for three bank size groups: Money Center Banks (large); Other Large Banks (medium) and All Other Banks (small). Data were collected from these surveys on U.S. banks’ (1) domestic (U.S.) claims; and for each host country separately: (2) cross-border claims; (3) foreign affiliate claims, and (4) foreign affiliate liabilities.\footnote{The reported survey data were converted into millions of USD, using 2005 Q4 as the base for inflation adjustment.}
do not take account of cross-country risk transfers. For each bank size category, the reported total claims and liabilities were divided by the number of banks to obtain the average loan and deposit quantities. This is necessary since the number and total asset size of reporting banks change significantly over time within the panel.

With respect to the model parameters, data were collected on bank size (total assets) from the FFIEC Surveys described above. Data on the market-specific model parameters for the 46 host markets were gathered from various sources, including the International Monetary Fund (1997-2005)’s International Financial Statistics, Organisation for Economic Co-operation and Development (1997-2005)’s Statistics, the Economist Intelligence Unit (1997-2005)’s Country Data and the World Bank (1997-2005)’s Bank Regulation and Supervision database.

Initial values of the second stage estimation described in the earlier sections use bank and regulatory risk aversion parameter value estimates from the related literature. Previous papers have reported banks’ risk aversion parameter (captured by $\lambda$) to be in the 0.20 (Nishiyama, 2007) to 0.29 (Kühn, 2006) range. For the entry costs, starting values come from regressing total costs on the total volume of activities for each country. The constant term from this regression provides a good initial value of the entry cost.

5. ESTIMATION RESULTS

5.1. Market Entry/Exit Choices and Loan/Deposit Quantities

This section describes the results of the static policy function estimations, which correspond to the first stage described above. The policy choices of interest are the affiliate loans, cross-border loans and deposits, as well as the entry and exit decisions in each country. The results of the Maximum Likelihood policy function estimation with the Heckman selection correction are presented in Tables I and II.

The foreign market entry and exit results in Table I show that higher expected returns encourage entry and discourage exit. Furthermore, higher taxes, costs and stricter foreign market regulations discourage entry and increase the probability that banks leave the market. Both bank size and bank scope have strong positive impacts on the probability of entry, and significantly discourage exit. However, it is interesting to note that the scope effect is more than twice as large as the size effect. Regulatory risk aversions only have small and insignificant impacts on the entry/exit choices of banks. Higher entry costs significantly discourage entry, and greater scrap values increase the probability that banks exit the market.

The policy function estimates corresponding to the first stage of the estimation give strong confirmation of the importance of the selection bias in banks foreign activities. The correlation of the error terms of the selection and volume (quantity) equations is significant and positive with $\rho = 0.31^{***}(0.02)$. This
result implies that on average, banks lend 32.98 percent more in selected markets, compared to a random sample of countries. This significant and positive correlation, together with the fact that most explanatory variables impact both the entry/exit, as well as the volume choices, implies that the coefficient estimates suffer from serious upward bias. Specifically, running ordinary least squares regressions on the loan and deposit volumes (ignoring the selection bias) would lead us to overstate the impact of model variables. For instance, greater bank size makes banks more likely to enter a new market, and also increases the loan and deposit volumes, once there. OLS regression would therefore assign bank size a large coefficient, combining the impacts of size on entry and volume, conditional on entry. For comparison, the OLS coefficient estimate for the impact of bank size on affiliate loan volumes is 1.42, which is 12.7 percent higher than the true coefficient of 1.26 shown in Table I. On average, affiliate loan volume coefficient estimates suffer from an upward selection bias of 12.72 percent, while the average bias in deposit coefficients is 12.47 percent.

Table II shows the bias-corrected coefficient estimates for banks’ choices of cross–border loan, foreign affiliate loan and deposit volumes. Higher expected returns encourage banks to increase their loan volumes. Higher deposit financing costs have strong negative effects on deposit and affiliate loan volumes. This latter result confirms the importance of deposit–financing for affiliate loans. Stricter capital regulations have significant negative impacts on all foreign activities, with the strongest discouraging effect on affiliate loans. As expected, more competitive loan markets tend to increase loan volumes. It is surprising that deposit volume decreases as banks face more elastic deposit supply curves. Both bank size and bank scope have strong positive impacts on loan and deposit volumes. It is interesting that bank scope has over three times as large an impact as bank size. This difference is most expressed for cross–border loan volumes, where the scope effect is over eight times the size of the bank size effect.

In what follows, the transition probabilities for the presence vector $P$ are constructed using coefficient estimates from Table I. The paths for bank asset size $K_j$ are constructed using Monte Carlo draws from the empirical normal distribution with the following bank size–specific moments. For small banks, the empirical distribution is characterized by $N(10, 0.07)$. For the medium-size category, the distribution is $N(10.8, 0.17)$, and for large banks it is $N(13.7, 0.12)$.
### Table I
**Foreign Market Entry & Exit Probabilities: Elasticities.**

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Entry Probability</th>
<th>Exit Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp Affil Loan Rate</td>
<td>0.86*(.49)</td>
<td>−0.03*(.02)</td>
</tr>
<tr>
<td>Exp Deposit Rate</td>
<td>−0.32 (1.01)</td>
<td>0.01 (.04)</td>
</tr>
<tr>
<td>Income Tax Rate</td>
<td>−2.57***(.49)</td>
<td>0.10***(.02)</td>
</tr>
<tr>
<td>Lending Cost</td>
<td>−0.08**(.04)</td>
<td>0.01**(.00)</td>
</tr>
<tr>
<td>Minimum Capital Ratio</td>
<td>−1.44***(.31)</td>
<td>0.05***(.01)</td>
</tr>
<tr>
<td>Required Reserve Ratio</td>
<td>−0.01 (.04)</td>
<td>0.01 (.00)</td>
</tr>
<tr>
<td>Lagged Bank Size</td>
<td>0.73***(.04)</td>
<td>−0.03***(.00)</td>
</tr>
<tr>
<td>Affil Loan Demand Elast</td>
<td>0.28***(.05)</td>
<td>−0.01*(.00)</td>
</tr>
<tr>
<td>Deposit Supply Elast</td>
<td>−0.08***(.04)</td>
<td>0.01**(.00)</td>
</tr>
<tr>
<td>Lagged Sharpe Ratio</td>
<td>1.70*(.78)</td>
<td>−0.06**(.03)</td>
</tr>
<tr>
<td>Regulatory Risk Aversion</td>
<td>−0.01 (.05)</td>
<td>0.01 (.00)</td>
</tr>
<tr>
<td>Fixed Entry Cost</td>
<td>−0.20***(.09)</td>
<td>0.01**(.00)</td>
</tr>
<tr>
<td>Fixed Scrap Value</td>
<td>0.06*(.04)</td>
<td>0.01***(.00)</td>
</tr>
</tbody>
</table>

### Table II
**Loan & Deposit Quantity Choices: Elasticities.**

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>CB Loan</th>
<th>Affil. Loan</th>
<th>Deposit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp Affil Loan Rate</td>
<td>2.80***(.72)</td>
<td>1.37***(.37)</td>
<td>0.34(0.34)</td>
</tr>
<tr>
<td>Exp Deposit Rate</td>
<td>0.05**(.02)</td>
<td>−3.35***(.63)</td>
<td>−3.55***(.59)</td>
</tr>
<tr>
<td>Income Tax Rate</td>
<td>−1.60***(.29)</td>
<td>−1.66***(.13)</td>
<td>1.66***(.13)</td>
</tr>
<tr>
<td>Lending Cost</td>
<td>−0.11***(.03)</td>
<td>−0.41***(.05)</td>
<td>−2.08(4.02)</td>
</tr>
<tr>
<td>Deposit Cost</td>
<td>−0.73 (0.74)</td>
<td>−2.80 (3.81)</td>
<td>−0.25**(.05)</td>
</tr>
<tr>
<td>Minimum Capital Ratio</td>
<td>−0.72***(.31)</td>
<td>−0.91***(.30)</td>
<td>−0.04(.31)</td>
</tr>
<tr>
<td>Required Reserve Ratio</td>
<td>−0.27***(.02)</td>
<td>0.51***(.07)</td>
<td>0.22***(.06)</td>
</tr>
<tr>
<td>Lagged Bank Size</td>
<td>0.81***(.05)</td>
<td>1.26***(.13)</td>
<td>1.25***(.14)</td>
</tr>
<tr>
<td>Affil Loan Demand Elast</td>
<td>0.20***(.08)</td>
<td>0.12***(.03)</td>
<td>0.04(.03)</td>
</tr>
<tr>
<td>Deposit Supply Elast</td>
<td>−0.48***(.05)</td>
<td>−0.13***(.03)</td>
<td>−0.04(.03)</td>
</tr>
<tr>
<td>Lagged Sharpe Ratio</td>
<td>6.53***(.04)</td>
<td>3.30(2.00)</td>
<td>3.91***(.03)</td>
</tr>
<tr>
<td>Regulatory Risk Aversion</td>
<td>0.38***(.04)</td>
<td>−0.17***(.06)</td>
<td>−0.04(.07)</td>
</tr>
</tbody>
</table>
5.2. Risk Aversion, Market Entry Costs and Scrap Values

This subsection describes the estimation results for the remaining structural parameters of the model. These parameters are: banks’ constant risk aversion parameter $\lambda$ (common across all banks), the country-specific regulatory risk aversion parameters $\theta_i$, and the country-specific entry costs $\Gamma_i$ and scrap values $\Upsilon_i$ (which are common across banks and constant over time). The estimates presented in the following tables result from the second stage of the estimation.

It is important to emphasize that the estimation aims to capture entry costs and scrap values that are fixed — i.e. fundamentally independent of the scope and scale of banks’ activities in each market. However, costs associated with branch network building are inherently proportional to the scale of banks’ activities. Therefore, proportional total operating costs (including branch network costs) are subtracted from interest revenue, in order to make the fixed cost estimates scale-independent. The estimate for the bank risk aversion parameter is $\lambda = 0.34^{***(.00)}$. Table III presents the fixed entry cost, scrap value and regulatory risk aversion parameter estimates for each country in the sample, and Table IV examines how estimates correlate with economic and regulatory measures.

As shown in Table V, scale-independent entry costs and scrap values are moderate with averages of 1.12 and 0.56 million USD, respectively. Entry costs and scrap values show clear regional patterns. Table III shows that entry costs appear to be the highest in the Eastern European countries — notably in Hungary, the Czech Republic and Russia. These costs are also above average in the South-East Asian economies, and appear low in most European countries and the rest of the developed world. The scrap values are consistently lower than the entry cost estimates, as expected. Scrap values are positively correlated with entry costs in the OECD states. In developing countries, however, higher entry costs are accompanied by average scrap values. Scrap values are generally higher in markets where market exit was observed, highlighting the positive relationship between scrap values and market exit (also documented in Table I).

Table III also presents the estimated regulatory risk aversion parameters. Table V shows that with a mean risk aversion parameter estimate of 0.52, regulators are generally more risk averse than banks. Regulatory risk aversion estimates are the highest in the South American states, while European and North American regulators appear to have risk aversions below average.

Table III shows that for the South American countries in the sample, variation in the simulated data was not sufficient to provide entry cost estimates. The forward simulation was successful in getting estimates for most countries’ regulatory risk aversion and scrap values.

Table IV correlates the parameter estimates with numerous empirical indicators of bank profitability, efficiency, economic openness and political and regulatory background. Estimated entry costs are significantly higher in markets
that are inefficient, profitable, risky, have a greater share of government ownership, and where the banking sector is less developed. Scrap values show the same pattern. It is interesting that the gap between entry costs and scrap values is greater in markets that are more profitable with less developed banking sectors. The regulatory risk aversion estimates are significantly higher in markets that are inefficient and less developed. Higher overhead costs in markets with more risk averse regulators might be due to a greater burden of compliance. Furthermore, regulatory risk aversion estimates are strongly positively correlated with other measures of bank regulations, such as minimum capital ratios and liquidity regulations. Regulators appear more risk averse in markets where

<table>
<thead>
<tr>
<th>Country</th>
<th>Entry Cost</th>
<th>Scrap Value</th>
<th>Reg. Risk Aversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>–</td>
<td>0.94***(.03)</td>
<td>1.19***(.29)</td>
</tr>
<tr>
<td>Australia</td>
<td>0.87***(.03)</td>
<td>0.09***(.01)</td>
<td>0.31***(.11)</td>
</tr>
<tr>
<td>Austria</td>
<td>0.29***(.01)</td>
<td>–</td>
<td>0.35***(.06)</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.77***(.10)</td>
<td>0.44(.23)</td>
<td>0.25***(.14)</td>
</tr>
<tr>
<td>Brazil</td>
<td>–</td>
<td>1.29***(.42)</td>
<td>0.40(.43)</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>0.70***(.03)</td>
<td>0.60***(.02)</td>
<td>0.78***(.18)</td>
</tr>
<tr>
<td>Canada</td>
<td>0.85***(.10)</td>
<td>0.31(.57)</td>
<td>0.24(.41)</td>
</tr>
<tr>
<td>Chile</td>
<td>–</td>
<td>0.79(.74)</td>
<td>0.70***(.22)</td>
</tr>
<tr>
<td>China</td>
<td>0.43***(.03)</td>
<td>0.04(.03)</td>
<td>0.75(.56)</td>
</tr>
<tr>
<td>Columbia</td>
<td>–</td>
<td>0.41***(.01)</td>
<td>0.79(.71)</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>4.23***(.10)</td>
<td>0.64***(.06)</td>
<td>0.01***(.00)</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.90***(.03)</td>
<td>–</td>
<td>0.51***(.06)</td>
</tr>
<tr>
<td>Finland</td>
<td>0.93***(.03)</td>
<td>0.12***(.01)</td>
<td>0.50***(.06)</td>
</tr>
<tr>
<td>France</td>
<td>0.85***(.05)</td>
<td>0.77***(.02)</td>
<td>0.70***(.14)</td>
</tr>
<tr>
<td>Germany</td>
<td>1.12***(.08)</td>
<td>0.11***(.02)</td>
<td>0.43***(.12)</td>
</tr>
<tr>
<td>Greece</td>
<td>–</td>
<td>0.88***(.14)</td>
<td>0.52(.30)</td>
</tr>
<tr>
<td>Hungary</td>
<td>2.05***(.16)</td>
<td>0.65***(.02)</td>
<td>0.03(.24)</td>
</tr>
<tr>
<td>Iceland</td>
<td>–</td>
<td>1.60***(.08)</td>
<td>0.59(.63)</td>
</tr>
<tr>
<td>India</td>
<td>1.59***(.17)</td>
<td>1.20***(.14)</td>
<td>0.20***(.07)</td>
</tr>
<tr>
<td>Indonesia</td>
<td>–</td>
<td>1.12***(.24)</td>
<td>0.42(.28)</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.93***(.04)</td>
<td>0.26***(.01)</td>
<td>0.45***(.06)</td>
</tr>
<tr>
<td>Israel</td>
<td>–</td>
<td>0.71***(.04)</td>
<td>0.49(.58)</td>
</tr>
<tr>
<td>Italy</td>
<td>0.87***(.03)</td>
<td>0.83***(.03)</td>
<td>0.52***(.06)</td>
</tr>
<tr>
<td>Japan</td>
<td>0.94***(.08)</td>
<td>0.13***(.03)</td>
<td>0.40***(.12)</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>1.01***(.09)</td>
<td>0.11***(.02)</td>
<td>0.33***(.10)</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.30***(.01)</td>
<td>0.02***(.01)</td>
<td>0.90(.60)</td>
</tr>
<tr>
<td>Mexico</td>
<td>0.85***(.04)</td>
<td>0.12***(.01)</td>
<td>0.68***(.12)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.30***(.01)</td>
<td>0.03***(.01)</td>
<td>0.63(.68)</td>
</tr>
</tbody>
</table>
TABLE III
(CONTINUED)

<table>
<thead>
<tr>
<th>Country</th>
<th>Entry Cost</th>
<th>Scrap Value</th>
<th>Reg. Risk Aversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>0.98***(.06)</td>
<td>0.11***(.01)</td>
<td>0.42***(.09)</td>
</tr>
<tr>
<td>Norway</td>
<td>0.89***(.03)</td>
<td>0.13***(.01)</td>
<td>0.49***(.06)</td>
</tr>
<tr>
<td>Philippines</td>
<td>–</td>
<td>1.19***(.06)</td>
<td>0.64***(.10)</td>
</tr>
<tr>
<td>Poland</td>
<td>–</td>
<td>0.98***(.05)</td>
<td>0.56***(.13)</td>
</tr>
<tr>
<td>Portugal</td>
<td>–</td>
<td>1.10***(.30)</td>
<td>0.42 (.39)</td>
</tr>
<tr>
<td>Romania</td>
<td>–</td>
<td>0.96***(.09)</td>
<td>0.60***(.19)</td>
</tr>
<tr>
<td>Russia</td>
<td>5.16***(.39)</td>
<td>0.89**(.29)</td>
<td>1.06 (1.21)</td>
</tr>
<tr>
<td>Slovakia</td>
<td>–</td>
<td>0.97***(.08)</td>
<td>0.64***(.19)</td>
</tr>
<tr>
<td>South Africa</td>
<td>–</td>
<td>0.88***(.15)</td>
<td>0.57* (.33)</td>
</tr>
<tr>
<td>South Korea</td>
<td>1.05***(.08)</td>
<td>0.11***(.02)</td>
<td>0.36***(.10)</td>
</tr>
<tr>
<td>Spain</td>
<td>0.87***(.03)</td>
<td>0.10 (.01)</td>
<td>0.46***(.06)</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.88***(.04)</td>
<td>0.13***(.00)</td>
<td>0.48***(.06)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.80***(.02)</td>
<td>0.09***(.00)</td>
<td>0.54 (.38)</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.17***(.01)</td>
<td>0.04***(.01)</td>
<td>0.71 (1.14)</td>
</tr>
<tr>
<td>Turkey</td>
<td>–</td>
<td>1.12***(.22)</td>
<td>0.43 (.31)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.86***(.07)</td>
<td>0.14***(.03)</td>
<td>0.50***(.14)</td>
</tr>
<tr>
<td>United States</td>
<td>–</td>
<td>–</td>
<td>3.91 (13.6)</td>
</tr>
</tbody>
</table>

TABLE IV
CORRELATIONS WITH ECONOMIC AND REGULATORY MEASURES.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Entry Cost</th>
<th>Scrap Value</th>
<th>Entry-Scrap</th>
<th>Reg. Risk A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry Cost</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scrap Value</td>
<td>0.55</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry Minus Scrap</td>
<td>0.96***</td>
<td>0.29</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Reg. Risk Aversion</td>
<td>–0.07</td>
<td>0.06</td>
<td>–0.05</td>
<td>1.00</td>
</tr>
<tr>
<td>Cap-Acct Open-Index</td>
<td>–0.22</td>
<td>–0.35**</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Distance from U.S.</td>
<td>–0.04</td>
<td>–0.06</td>
<td>–0.03</td>
<td>–0.02</td>
</tr>
<tr>
<td>Common Language</td>
<td>–0.05</td>
<td>–0.07</td>
<td>–0.10</td>
<td>–0.22</td>
</tr>
<tr>
<td>Average Total Costs</td>
<td>0.40**</td>
<td>0.05</td>
<td>0.42**</td>
<td>–0.28*</td>
</tr>
<tr>
<td>Avg Overhead Costs</td>
<td>0.52***</td>
<td>0.47***</td>
<td>0.53***</td>
<td>0.43***</td>
</tr>
<tr>
<td>Total Banking Cost</td>
<td>–0.14</td>
<td>–0.13</td>
<td>–0.16</td>
<td>–0.13</td>
</tr>
<tr>
<td>ICRG Comp Risk</td>
<td>–0.36**</td>
<td>–0.60***</td>
<td>–0.21</td>
<td>–0.28*</td>
</tr>
<tr>
<td>ICRG Fin. Risk</td>
<td>–0.12</td>
<td>–0.55***</td>
<td>–0.07</td>
<td>–0.16</td>
</tr>
<tr>
<td>Govt ownership Share</td>
<td>0.49***</td>
<td>0.52***</td>
<td>0.37*</td>
<td>0.12</td>
</tr>
</tbody>
</table>
they have less corrective power with respect to existing regulations.

6. SIMULATION EXERCISES

This section conducts four types of exercises. Subsection 2.6.1 examines the effect on banks’ optimal behavior of gradually increasing the bank risk aversion parameter $\lambda$, while holding all countries’ regulatory risk aversion parameters constant at their estimated values. Subsection 2.6.2 examines the effects of increasing all foreign countries’ risk aversion parameters simultaneously, holding the bank risk aversion $\lambda$ and the U.S. regulatory risk aversion constant at their estimated values. Subsection 2.6.3 analyzes the impact of gradual increases in the U.S. regulator’s risk aversion parameter, while holding $\lambda$ and all other markets’ regulatory risk aversion constant. Recall that bank risk aversion is the weight banks put on the variance of their global portfolios. Furthermore, foreign regulatory risk aversion is the weight each country’s bank regulator puts on the variance of banks’ country-specific portfolios. Finally, U.S. regulatory risk aversion is the weight the U.S. bank regulator attaches to the variance of U.S. banks’ domestic portfolios.
6.1. Increasing Bank Risk Aversion

Figures 1 through 4 show the effects of raising the bank risk aversion parameter $\lambda$ from 0.001 to 4, holding all regulatory risk aversion parameters constant at their estimated values. For each $\lambda$, the value of the banks’ problem is evaluated at the corresponding fixed entry costs and scrap values.

Figure 1 shows that $\lambda$ has a strong negative impact on the value of the bank’s global operations. As $\lambda$ increases from 0.001 to 4, the bank’s simulated value falls 12 percent. Figure 2 depicts the effect of increases in $\lambda$ at the average country level. Figure 2 shows that both the value of banks’ U.S. operations, and the average value of foreign country–specific operations are negatively affected. As $\lambda$ increases from 0.001 to 4, the value of U.S. operations falls 5.1 percent, while the average value of foreign country operations falls 5 percent. It is interesting to take note of Figure 3, which shows the effect of increases in $\lambda$ on the share of foreign assets that the bank chooses in its portfolio. Figure 3 shows that as $\lambda$ increases from 0.001 to 4, the share of foreign assets in the bank’s portfolio rise 15.1 percent. A potential explanation for this result is that as banks become more risk averse, they become more reluctant to take on riskier U.S. loans. Instead, banks look towards the less risky foreign assets. Within foreign assets, Figure 4 shows that banks move towards cross-border loans relative to affiliate loans as they become more risk averse. The graph shows that as $\lambda$ increases from 0.001 to 4,
the ratio of affiliate to cross-border loans falls 1.5 percent. This makes sense in light of the fact that cross-border loans generally target multi-national corporations and sovereigns — characterized by lower risk than the retail and smaller corporate clients that affiliate loans target.

![Figure 2](image1.png)

**Figure 2.**— Values of Bank’s U.S. Operations (Left Scale) and Average Foreign Country Operations (Right Scale) as Function of Bank Risk Aversion.

![Figure 3](image2.png)

**Figure 3.**— Share of Foreign Assets in Bank’s Portfolio as Function of Bank Risk Aversion.
FIGURE 4.— Ratio of Affiliate Loans to Cross-border Loans in Bank’s Portfolio as Function of Bank Risk Aversion.

FIGURE 5.— Average Estimated Fixed Entry Costs and Scrap Values as Function of Bank Risk Aversion.
Figure 5 is an interesting reflection on the suitability of the model for analyzing bank behavior far from equilibrium values. The graph depicts the effect of increases in $\lambda$ on the estimated average fixed costs of entry and scrap values. The graph shows that these estimated costs and scrap values remain constant until $\lambda$ reaches 2.4, and increase sharply thereafter. As $\lambda$ increases from 2.4 to 4, average estimated fixed entry costs rise 23 percent, and scrap values increase by 65 percent. In light of the fact that there is no reason to expect fixed costs and scrap values to vary with $\lambda$, Figure 5 shows that the model behaves well up to approximately eight times the equilibrium value of $\lambda = 0.34$. Beyond that, however, the model produces unreliable results.

6.2. Increasing Foreign Regulatory Risk Aversion

Regulatory and bank risk aversion work through different channels; bank risk aversion through the objective function and regulatory risk aversion through a constraint. This subsection explores the effects of varying all foreign markets’ regulatory risk aversions simultaneously, while keeping the bank risk aversion and U.S. regulatory risk aversion parameters constant at their estimated values.

Figure 6 shows that as all foreign markets’ regulatory risk aversions increase from 0.001 to 4, the value of global operations increases moderately by 1.3 percent.
Figure 7 shows that a similar increase in foreign \( \theta \) causes the value of the bank’s U.S. operations to increase slightly by 1.9 percent, and the value of the average foreign country operation to fall by 3.6 percent. Figure 8 depicts the strong negative relationship between foreign \( \theta \) and the share of foreign assets in the bank’s portfolio. As foreign \( \theta \) increases from 0.001 to 4, the share of foreign assets falls by 21.4 percent. Therefore, stricter foreign bank regulations cause U.S. banks to adopt a much more domestic focus.

Figure 7.— Values of Banks’ U.S. Operations (Right Scale) and Average Foreign Country Operations (Right Scale).

Figure 9 depicts the effect of increases in foreign \( \theta \) on the ratio of affiliate loans to cross-border loans in the bank’s portfolio. As foreign \( \theta \) rises up to 4, this ratio decreases significantly by 40.3 percent. Therefore, while stricter foreign regulations lower foreign participation of U.S. banks altogether, foreign affiliate assets take a much greater hit relative to cross-border loans. This result is likely due to the fact that affiliate loans are generally under foreign regulators’ supervision, while the regulation of cross-border loans is often shared by the U.S. and foreign regulators. Therefore, a stricter foreign regulatory framework affects affiliate assets to a greater extent.
FOREIGN BANK LENDING

Figure 8.— Share of Foreign Assets in Banks’ Portfolio as Function of Foreign Regulatory Risk Aversion.

Figure 9.— Ratio of Affiliate Loans to Cross-border Loans in Banks’ Portfolio as Function of Foreign Regulatory Risk Aversion.
6.3. Increasing U.S. Regulatory Risk Aversion

This paper focuses on the behavior of U.S. banks exclusively. Therefore, it is particularly interesting to analyze how banks’ optimal behavior changes, as the U.S. regulators become more risk-averse. This subsection explores the effects of increasing the risk aversion of U.S. regulators on banks’ optimal behavior. In this exercise, bank risk aversion and all other markets’s regulatory risk aversions are held constant at their estimated values. Figure 10 shows the relationship between the simulated value of the bank’s global operations as the U.S. regulatory risk aversion $\theta$ increases from 0.001 to 4. This increase in U.S. $\theta$ causes the value of the bank’s global operations to fall by 5.5 percent. Figure 11 focuses on the country–specific effects of the increase in U.S. $\theta$, depicting the results for the value of U.S. operations and the value of the average foreign country operations. The increase in U.S. $\theta$ from 0.001 to 4 causes the value of U.S. operations to fall by 8.2 percent, and the value of the average foreign country operation rises by 7.9 percent.

It is interesting to note Figure 12’s depiction of the strong positive relationship between the share of foreign assets in the bank’s portfolio and U.S. $\theta$. As U.S. $\theta$ increases from 0.001 to 4, the share of foreign assets in the bank’s global portfolio increases by 38 percent. Therefore, a stricter U.S. bank regulatory environment causes U.S. banks to take a more international focus. An increase in U.S. $\theta$ from 0.001 to 4 does not have a notable impact on the ratio of affiliate
loans to cross-border loans in the bank’s global portfolio.

It is also insightful to compare and contrast how U.S. banks’ foreign focus responds to changes in U.S. versus foreign regulatory strictness. Based on the last two simulation exercises, it appears that stricter U.S. regulations encourage U.S.
banks’ foreign participation to a greater extent than stricter foreign regulations discourage them. However, foreign regulations have a very strong impact on the composition of U.S. banks’ foreign portfolio (greatly discouraging affiliate lending), while U.S. regulations play only a very small role in these considerations.

7. SUMMARY

This paper examines the determinants of U.S. banks’ international portfolio choices, with the goal of recovering the underlying structural parameters that shape these decisions. It presents a dynamic model of mean–variance utility maximizing monopolistically competitive bank behavior. Banks make period–by–period choices of optimal domestic, cross–border and foreign affiliate loan and deposit quantities. In addition, banks make foreign market entry/exit decisions considering their lifetime utility. All these decisions are bound by budget and regulatory constraints, and depend on period–specific state variables such as bank characteristics (initial size and scope) and market traits (return indices, correlations, proportional costs, taxes, regulations, etc.).

The model is estimated with the two–step Bajari, Benkard, and Levin (2007) estimation method for dynamic models of imperfect competition. The first stage of this method consists of estimating the optimal loan/deposit quantity and entry/exit choices period by period. The second stage then relies on these estimates to simulate the value of banks’ optimal actions forward, as well as the values of alternate policy paths. Setting up inequalities using these simulated policy functions makes possible the estimation of the unknown structural parameters. These estimable parameters are country–specific fixed entry costs and scrap values, and the weights that capital regulators assign to the risk on bank portfolios. In addition, an estimate of banks’ constant risk aversion parameter is obtained.

The estimation uses U.S. regulatory data spanning 3 bank size categories, 33 time periods between 1997 Q4 and 2005 Q4, and 46 countries. The estimation results for the policy functions (corresponding to the first step) show that controlling for selection bias in lending choices is important: banks lend on average 32.98 percent more to selected markets compared to a random sample of markets (corresponding to a correlation coefficient of 0.31 between the market presence and loan/deposit quantity equations). Selection causes upward bias in the coefficient estimates of over 12 percent. Furthermore, bank size (defined as total assets) and bank scope (defined as the lagged Sharpe ratio) have strong explanatory power in U.S. banks’ foreign lending behavior, while market characteristics appear much less important. Scope has a stronger impact relative to size: results show that bank scope’s effect is over three times as large as the size effect in the market entry and exit, as well as the loan and deposit quantity choices. In addition, cross–border loans and affiliate loans are shown to have very different sensitivities to bank and market traits — underlining the impor-
Estimation of the unknown structural parameters (corresponding to the second stage of the estimation) yields strongly significant estimates for the entry costs, scrap values and risk aversion parameters. In order to avoid estimates that depend on the scale of banks’ operations in each country, banks’ net interest income is adjusted for the scale–dependent operating costs (including branch network expenses). Simulated estimation results show that banks’ constant, common absolute risk aversion parameter \( \lambda \) is 0.34 — somewhat higher than the previously estimated risk aversion parameters (e.g. Nishiyama 2007). Furthermore, estimates of regulators’ risk aversion parameters vary greatly across countries. Bank regulators are generally more risk averse than banks, with an average risk aversion parameter of 0.52.

Correlations show that there is a strong positive relationship between estimates of entry costs and scrap values — indicating that countries which are more costly to enter also offer the possibility of greater scrap values. Correlation of the parameter estimates with empirical measures of location, economic strength and regulatory strictness (such as risk ratings, etc) reveals strong patterns. In particular, estimated entry costs appear higher in foreign markets that are inefficient, have greater government ownership in banks and are more profitable. Entry costs appear significantly higher in the Eastern European countries, and above average in Asian economies. Estimated regulatory risk aversions are higher in inefficient markets with stricter, but less effective, bank regulatory environments.

Simulation exercises are conducted to examine the effects on banks’ optimal behavior of perturbing the bank risk aversion parameter, all foreign countries’ risk aversions, and the U.S. regulator’s risk aversion. These simulation exercises measure the effects of the perturbations on the overall value of banks’ global operations; the value of U.S. operations, as well as the value of the average foreign country operation; the share of foreign assets in banks’ portfolio, and the ratio of affiliate loans to cross-border loans. Table VI summarizes the results of these simulation exercises.
and deposit costs, respectively. Cross-border lending cost is measured as the affiliate loan and deposit volumes used as measures of proportional lending and deposit volumes and a constant in each market. The coefficients on the expectation of these values.

\[ \alpha \]
do not hallucinate.

Intelligence Unit (1997-2005)'s Country Data . Averages of these \[ \beta \]'s and \[ i \] in-

log of million USD. 

8. APPENDIX

Initial Capitalization. Data on Initial capitalization come from the FFIEC Country Exposure Surveys. For each bank size category, the reported Total Assets are divided by the number of banks to get a value for the average bank representative of the given bank size category. The data are reported in million USD, and are converted into real terms using 2005 Q4 as the base. Values are in log of million USD.

Expected Loan and Deposit Rate Indices. Data used for the variables \( \alpha_i \) and \( \beta_i \) are market–specific loan and deposit rate indices, collected from \textit{Economist Intelligence Unit (1997-2005)}'s Country Data . Averages of these \( \alpha \)'s and \( \beta \) indices are taken over a 3–quarter rolling window, in order to represent the bank’s expectation of these values.

Proportional Lending and Deposit Costs. Total Costs are regressed on loan and deposit volumes and a constant in each market. The coefficients on the affiliate loan and deposit volumes are used as measures of proportional lending and deposit costs, respectively. Cross–border lending cost is measured as the coefficient on cross–border loans in the U.S. Total Cost regression.

Proportional Income Tax Rates and Basic Borrowing Costs. Since data on
TABLE VIII

LOAN & DEPOSIT AVERAGES BY TIME PERIOD ACROSS COUNTRIES (LOG MILLIONS OF 2005 Q4 USD).

<table>
<thead>
<tr>
<th>Time</th>
<th>Aff Loans</th>
<th>CB Loans</th>
<th>Deps</th>
<th>Time</th>
<th>Aff Loans</th>
<th>CB Loans</th>
<th>Deps</th>
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<td>02/03</td>
<td>4.15</td>
<td>3.98</td>
<td>4.21</td>
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<td>4.29</td>
<td>3.65</td>
<td>4.43</td>
<td>02/06</td>
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<td>3.96</td>
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<td>3.74</td>
<td>4.13</td>
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<td>4.09</td>
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<td>04/06</td>
<td>4.46</td>
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<td>4.09</td>
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<td>3.80</td>
<td>3.81</td>
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<td>05/06</td>
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<td>05/12</td>
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<td>3.98</td>
<td>3.11</td>
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</table>

TABLE IX

SUMMARY OF EXPLANATORY VARIABLES.

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Note</th>
<th>Empirical Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-Border Loan in i</td>
<td>$\ell_{ij}$</td>
<td>Bank’s CB claims in i, mill 2005 USD</td>
</tr>
<tr>
<td>Affiliate Loan in i</td>
<td>$\ell_{ij}$</td>
<td>Bank’s claims in i, mill 2005 USD</td>
</tr>
<tr>
<td>Foreign Aff Dep’ in i</td>
<td>$d_{ij}$</td>
<td>Bank’s FA liabs in i, mill 2005 USD</td>
</tr>
<tr>
<td>Bank Scope</td>
<td>$S_{ij}$</td>
<td>Lagged Sharpe Ratio</td>
</tr>
<tr>
<td>Initial Bank Capital</td>
<td>$K_{ij}$</td>
<td>Bank’s Total Assets, mill 2005 USD</td>
</tr>
<tr>
<td>Expected Aff</td>
<td>$\bar{a}_{ij}$</td>
<td>Mean of predicted aff loan</td>
</tr>
<tr>
<td>Loan market return in i</td>
<td>$\bar{m}_{ij}$</td>
<td>mkt return in i over 3-qtr window</td>
</tr>
<tr>
<td>Expected Deposit</td>
<td>$\bar{\beta}_{ij}$</td>
<td>Mean of predicted deposit</td>
</tr>
<tr>
<td>market return in i</td>
<td>$\bar{m}_{ij}$</td>
<td>mkt return in i over 3-qtr window</td>
</tr>
<tr>
<td>Expected CB Loan</td>
<td>$\bar{a}_{ij}$</td>
<td>Mean of predicted CB loan</td>
</tr>
<tr>
<td>market return in i</td>
<td>$\bar{m}_{ij}$</td>
<td>mkt return in i over 3-qtr window</td>
</tr>
<tr>
<td>Lending Cost</td>
<td>$\ell_{ij}$ Stock mkt Return in i - ROA</td>
<td></td>
</tr>
<tr>
<td>Deposit-taking cost</td>
<td>$c_{ij}$</td>
<td>Deposit rate - money mkt rate</td>
</tr>
<tr>
<td>Income Tax Rate</td>
<td>$r$</td>
<td>Corporate Tax Rate in i</td>
</tr>
<tr>
<td>Req. Reserve Ratio in i</td>
<td>$\delta$</td>
<td>Required Reserve Ratio in i</td>
</tr>
<tr>
<td>Bank’s Risk Aversion</td>
<td>$\lambda_{ij}$</td>
<td>Estimated from Model</td>
</tr>
<tr>
<td>Capital Adequacy</td>
<td>$k_{ij}$</td>
<td>Minimum Cap. Ratio in i</td>
</tr>
<tr>
<td>Basic Cost of Other</td>
<td>$\lambda_{ij}$</td>
<td>Basic ‘riskless’ interest rate set by</td>
</tr>
<tr>
<td>Borrowing in i</td>
<td>$\ell_{ij}$ Stock mkt Return in i - ROA</td>
<td>the monetary authority in i</td>
</tr>
<tr>
<td>Loan Deman Elast.</td>
<td>$\epsilon_{ij}$</td>
<td>Estimated Coefficient</td>
</tr>
<tr>
<td>Deposit S. Elast in Deposit</td>
<td>$\eta_{ij}$</td>
<td>Estimated Coefficient</td>
</tr>
<tr>
<td>Regulator’s Risk Avers. in i</td>
<td>$\theta_{ij}$</td>
<td>Estimated from Model</td>
</tr>
<tr>
<td>Entry Cost &amp; Scrap Value in i</td>
<td>$\Gamma_{ij}$</td>
<td>Estimated from Model</td>
</tr>
</tbody>
</table>
tax rates applicable to bank income are not available, these tax rates are approximated with corporate income tax rates taken from the Organisation for Economic Co-operation and Development (1997-2005)'s database. The basic cost of non-deposit borrowing is measured using the country-specific equivalent of the federal funds rate, set by the monetary authority in market $i$ (the equivalent of the federal funds rate). Data on these interest rates are collected from the International Monetary Fund (1997-2005)'s International Financial Statistics.

**Required Reserve Ratio and Minimum Capital Ratio.** Data on market-specific required reserve ratios and minimum capital ratios are collected from the World Bank (1997-2005)'s Bank Regulation and Supervision database. Where not available, the ratios are directly taken from national central banks’ websites.

**Data on Loan Demand and Deposit Supply Elasticities.** Taking logs of the Dixit-Stiglitz form of the loan demand equation yields:

\[
\log l_{im} = \log \alpha_{im} - \epsilon_{im} \cdot r_{lm}
\]

where $r_{lm}$ is the lending rate in market $m$. The coefficient $\epsilon_{im}$ from this regression is used as loan demand elasticity. Similarly, the deposit supply equation is

\[
\log d_{i} = \log \beta_{i} + \eta_{i} \cdot r_{id}
\]

from which the deposit supply elasticity in country $i$ is measured as the coefficient $\eta_{i}$.

**Bank Scope.** Initial bank scope is measured as the lagged Sharpe ratio.

**Loan & Deposit Volumes.** Tables VII and VIII present averages of the loans & deposits by country and by time period, respectively. Table IX summarizes notation and empirical measures used for the explanatory variables in this paper.

**Summary Statistics.** Table X presents summary statistics.

<table>
<thead>
<tr>
<th>Name</th>
<th>Min</th>
<th>25p</th>
<th>50p</th>
<th>75p</th>
<th>Max</th>
<th>Std Dev</th>
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<td>4.25</td>
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<td>9.06</td>
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<td>6.70</td>
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<tr>
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<td>3.59</td>
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<td>13.30</td>
<td>97.7</td>
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<td>7.75</td>
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<td>34</td>
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<td>Min Capital Ratio</td>
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<td>8 8</td>
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<td>1.45</td>
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<td>8.26</td>
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<td>1.27</td>
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<td>3.70</td>
<td>3.78</td>
<td>0.27</td>
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FOREIGN BANK LENDING

REFERENCES


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