Foreign Competition and Banking Industry Dynamics: An Application to Mexico*

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Abstract

We develop a simple general equilibrium framework to study the effects of global competition on banking industry dynamics and welfare. We apply the framework to the Mexican banking industry, which underwent a major structural change in the 1990s as a consequence of both government policy and external shocks. Given high concentration in the Mexican banking industry, domestic and foreign banks act strategically in our framework. After calibrating the model to Mexican data, we examine the welfare consequences of government policies which promote global competition. We find modest welfare gains for households and substantial gains for business.

1 Introduction

The banking industry in Mexico is extremely concentrated. The top three banks in Mexico held nearly 68% of the loan market share in 1997. Interest rate spreads (the difference between lending and deposit rates) in 2005 were 7.2% in Mexico. External events and government policy interacted to generate wide swings in market share and ownership structure in Mexico's banking system. In 1982, following an oil price shock which brought on a major economic crisis (GDP declined by 4.7%), Mexico nationalized 58 of its 60 existing banks. The number of commercial banks was reduced to 29 in 1983 and in 1990, when the process of full re-privatization started, only 18 of these remained active. Deposit insurance was only established in 1986 and reformed in 1990 as part of the privatization process, unlike its antecedents in the U.S. (in 1934) and Canada (in 1967). Another important characteristic

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of the banking system in Mexico was that even though banks were private, the Mexican banking system was protected from foreign competition. Foreign banks were not allowed to buy Mexican banks whose market share exceeded 1.5% and total participation of foreign banks was restricted to be less than 8%. Another external shock, the Mexican "tequila crisis" in 1994 resulted in a large increase in non-performing loans. Bank insolvency associated with this episode was estimated by Maudos and Solis [20] to cost Mexican taxpayers 19.3% of GDP. At that time, the Mexican government gradually removed restrictions on foreign participation. By the time they were completely removed in December 1998, the largest institutions (Bacomer, Banamex and Serfin) were acquired by foreign groups. Foreign participation rose from 5.5% in 1993 to 52.4% in 1996 and 67.2% in 2000. Figure 1 presents the evolution of the market share of foreign banks in the top 10 (sorted by assets) since 1998 until 2012.[1]

Figure 1: Foreign Market Concentration in Mexico

Note: Commercial bank data from Mexico 1998 - 2012. Source: Bankscope.

More generally, the idea that there are tradeoffs for a domestic economy in the presence of global banking has been taken up by Cetorelli and Goldberg ([9] and [10]). They show that global banks actively allocate funds across their banking organizations, in normal times and in stress periods. When shocks originate within the emerging markets, foreign bank entry into local banking systems can be a stabilizing force. However, during the last financial crisis, a period of distress which originated in the developed economies, loan supply in emerging markets was significantly affected by a contraction in cross-border lending by foreign banks, local lending by foreign banks' affiliates in emerging markets, and a reduction in loan supply by domestic banks.

[1] We use data from Bankscope. Sample period starts in 1998.

Motivated by these facts, our paper explores the welfare consequences of entry of global banks on Mexico's banking industry. The macro banking literature has primarily focused on models with perfect competition (see for example Bernanke, et. al. [3], Carlstrom and Fuerst [8], or Diaz-Gimenez, et. al. [14]). Given high concentration in the Mexican banking data, we apply methods from the IO literature developed by Ericson and Pakes [16]. In particular, we assume that each period national and foreign banks strategically choose the quantity of loans they supply (i.e. we solve a Cournot game each period in the loan market).[2] The key elements of our paper are: (i) domestic and foreign banks can finance their loans through domestic deposits or costly equity issuance; (ii) it is more costly on average for Mexican banks to obtain equity finance than foreign banks, but foreign bank finance is directly subject to shocks in the rest of the world and that when the world is in bad times foreign banks face high equity finance costs: (iii) there is a representative household which supplies deposits and equity to banks. Shocks which affect foreign bank equity finance are intended to capture the "liquidity shocks" in Cetorelli and Goldberg ([9] and [10]). We calibrate the model to current Mexican banking data under the assumption that the government lowered foreign entry costs enough to induce global competition (as in iceberg cost trade models, we interpret the cost as also reflecting policy). We evaluate the effects of competition through a counterfactual where we raise the foreign entry cost sufficiently high such that the foreign bank does not enter. The tradeoff is that while there is less competition, the economy does not face instability due to external shocks to foreign competition. Our question and methodology is much more general and can be applied to other small open economies.

Our paper is also related to the large literature analyzing the relationship between bank competition and bank risk taking (as measured by the likelihood of bank failure. Important theoretical contributions in this literature include Allen and Gale [2] and Boyd and DeNicolo [7]. There is a large empirical literature which tests these predictions. For example, a recent by Beck, De Jonghe, and Schepens [4] finds that more highly concentrated banking industries exhibit less risk taking (as measured by bank failure).[3] Like Martinez-Miera and Repullo [19], we allow shocks to borrower solvency to be correlated across agents unlike Boyd and De Nicolo [7]. In particular, borrower solvency is correlated with the business cycle. The benefit of our analysis is that we pin down this correlation using data from Mexico. We find that in the economy with foreign bank competition, profitability of domestic banks is lower which results in higher exit probabilities. At the estimated parameters, the relation between risk taking and competition is increasing but nonlinear.

2 Model Environment

Our dynamic banking industry model is based upon the static framework of Allen and Gale [2] and Boyd and DeNicolo [7]. In those models, there is an exogenous number of banks that

[2]Models with imperfectly competitive loan markets have also been proposed by Mandelman ([18]), Blas and Russ [13], and Bremus, Buch, Russ and Schnitzer [6]. Unlike these papers, we analyze how banking industry equilibrium varies due to endogenous entry and exit over the business cycle.

[3]This literature is also related to Jayaratne and Strahan [17] and Berger, Demsetz, and Strahan [5] who analyze deregulation interstate banking in the U.S. during the 90's. In Corbae and D'Erasmo [12] we provide a spatial model with imperfect competition in the banking sector and study the effects of the removal of branching restrictions.

are Cournot competitors either in the loan and/or deposit market. We embed the earlier static models into a model of dynamic model which endogenizes entry and exit decisions as in Ericson and Pakes [16]. Clearly, the Mexican banking industry is characterized by substantial imperfect competition.

Time is infinite. Banks intermediate between a unit measure of infinitely lived ex-ante identical entrepreneurs who want a loan to finance a productive project and a unit measure of infinitely lived ex-ante identical households who decide where to deposit their endowment of non-storable goods. Banks diversify idiosyncratic shocks to the entrepreneur's project.

2.1 Households

Each household is endowed with one unit of a perishable good at the beginning of each period. Households have strictly concave preferences each period denoted $u(C_t)$ with discount factor $\beta < 1$ where consumption occurs at the end of the period. Households have access to a risk free short-term (within period) storage technology yielding $1+\overline{r}$ with $\overline{r} \geq 0$ at the end of the period. We denote the amount of goods stored in this technology by $\widehat{a}_t \geq 0$ (where hats (e.g $\widehat{x}_t$) denote a variable at the beginning of period t). The household can also choose to supply their endowment to a bank. If the household deposits $\widehat{d}_t \geq 0$ of its endowment with a bank at the beginning of a period, they receive $(1+r_t^D)\widehat{d}_t \geq 0$ at the end of the period whether the bank succeeds or fails since we assume deposit insurance. Like storage, deposits are "short term" since they do not pass over periods. At the end of the period households pay lump sum taxes τ_t which are used to cover deposit insurance for failing banks. Households can also hold divisible shares of banks, where we use the normalization that each bank issues one share. Shares S_{t+1} are traded at the end of the period at price P_t after dividends are paid.

2.2 Entrepreneurs

Entrepreneurs are infinitely lived, risk neutral agents. They discount the future at rate β. Entrepreneurs demand bank loans in order to fund a project. The project requires one unit of investment at the beginning of period t and returns at the end of the period:

$$\begin{cases} 1 + z_{t+1}R_t & \text{with prob } p(R_t, z_{t+1}) \\ 1 - \lambda & \text{with prob } [1 - p(R_t, z_{t+1})] \end{cases} \tag{1}$$

units of the non storable good in the successful and unsuccessful states respectively. The gross return on the project is given by $1 + z_{t+1}R_t$ in the successful state and by $1 - \lambda$ in the unsuccessful state. Like the household's endowment, we assume that the return on the project is non storable and perishable. The success of the entrepreneur's project, which occurs with probability $p(R_t, z_{t+1})$, is independent across entrepreneurs but depends on the entrepreneur's choice of technology $R_t \geq 0$ and an aggregate technology shock at the end of the period z_{t+1} (the dating convention we use is that a variable which is chosen/realized at the end of the period is dated $t + 1$).

At the beginning of the period when the entrepreneur makes his choice of R_t, z_{t+1} has not been realized. As for the likelihood of success or failure, a firm which chooses to run a project with higher returns has more risk of failure and there is less failure in good times.

Specifically, $p(R_t, z_{t+1})$ is assumed to be decreasing in R_t and $p(R_t, z_g) > p(R_t, z_b)$. While firms are ex-ante identical, they are ex-post heterogeneous owing to the realizations of the shocks to the return on their project.

We assume that the technology shock process $z_{t+1} \in \{z_c, z_b, z_g\}$ is drawn from a three state Markov process which also depends on the state of worldwide shocks $\eta_{t+1} \in \{\eta_g, \eta_b\}$. Thus, besides a domestic "crisis" state (e.g. tequila) there can be good and bad times in both the domestic (Mexican) economy and the world economy. In particular, we assume that the Markov transition matrix for domestic shocks is given by $F(z_t, z_{t+1}, \eta_{t+1})$ and the Markov transition matrix for foreign shocks is given by $G(\eta_t, \eta_{t+1})$.

There is limited liability on the part of the entrepreneurs. If r_t^L is the interest rate on bank loans that firms face, the firm receives $\max\{z_{t+1}R_t - r_t^L, 0\}$ in the successful state and 0 in the failure state. Specifically, in the unsuccessful state the firm receives $1-\lambda$ which must be relinquished to the lender. Table 1 summarizes the risk-return tradeoff that the firm faces.

Table 1: Entrepreneur's Problem

Borrower chooses R	Receive	Pay	Probability
Success	$1 + z_{t+1}R_t$	$1 + r_t^L$	$p(\overbrace{R_t}^{-}, \overbrace{z_{t+1}}^{+})$
Failure	$1-\lambda$	$1-\lambda$	$1 - p(R_t, z_{t+1})$

Every period, entrepreneurs have an outside option (reservation utility) $\omega_t \in [0, \overline{\omega}]$ drawn at the beginning of the period from distribution function $\Omega(\omega_t)$. The draws are iid over both entrepreneurs and time. As in many other dynamic models (e.g. Carlstrom and Fuerst ([8])), we assume that there is inter-period anonymity so that loan contracts are only one period long.

2.3 Banks

We assume there are two types of banks $\theta \in \{n, f\}$ for "national/domestic" and "foreign" respectively. To understand global competition, we will consider variation in entry costs $\Upsilon^f \geq \Upsilon^n \geq 0$. When $\Upsilon^f = \infty$, the banking industry is served only by national banks. Then, we can choose Υ^f such that there is entry by foreign banks generating an endogenous change in the level of competition across banks of different types.

We denote loans made by bank type θ to borrowers at the beginning of period t by ℓ_t^θ. The bank's feasibility constraint at the beginning of the period is given by:

$$d_t^\theta \geq \ell_t^\theta. \tag{2}$$

We assume that banks pay proportional non-interest expenses (net non-interest income) that can differ across banks of different types, which we denote c^θ. As in models with ex-post verification (e.g. Townsend [23]), we can generally let $c^\theta = \widetilde{c}^\theta + \overline{c}^\theta(1 - p(R_t, z_{t+1}))$. Further, as in the data we assume a fixed cost κ^θ.

Let π_t^θ denote the end-of-period profits (i.e. after the realization of z_{t+1}) of bank type θ as a function of its loans ℓ_t^θ and deposits d_t^θ given by

$$\pi_t^\theta = \Big\{p(R_t, z_{t+1})(1 + r_t^L) + (1 - p(R, z_{t+1}))(1 - \lambda)\Big\}\ell_t^\theta - (1 + r_t^D)d_t^\theta - \Big\{c^\theta \ell_t^\theta + \kappa^\theta\Big\}. \quad (3)$$

The first two terms represent the gross return the bank receives from successful and unsuccessful loan projects respectively, the third represents interest expenses (payments on deposits), and the fourth represents non-interest expenses.

As in Cooley and Quadrini [11], we assume that following the realization of z_{t+1}, and hence ex-post bank cash flow π_t^θ, banks have access to outside funding or equity financing at cost $\xi^\theta(x, \eta_{t+1})$ per x units of funds raised in state η_{t+1}, where $\xi^\theta(x, \eta_{t+1})$ is an increasing function of x. We will assume that the domestic bank has no uncertainty about its access to seasoned equity (so that $\xi^n(x, \eta_{t+1}) = \xi^n(x)$). The benefit of introducing external financing of this form is that it allows us to consider a problem where banks face a dynamic exit decision (i.e. one where the future value of the bank plays a role in the exit decision) without the need to incorporate an extra state variable. A bank that has negative expected continuation value can exit, in which case it receives value zero, or it can continue provided it accesses costly external equity. Bank dividends at the end of the period are

$$\mathcal{D}_t^\theta = \begin{cases} \pi_t^\theta & if \pi_t^\theta \geq 0 \\ \pi_t^\theta(1 + \xi^\theta(-\pi_t^\theta, \eta_{t+1})) & if \pi_t^\theta < 0 \end{cases} \quad (4)$$

There is limited liability on the part of banks. This imposes a lower bound equal to zero in the case that the bank exits. In the context of our model, limited liability implies that upon exit, the bank gets:

$$\max\left\{\{p(R_t, z_{t+1})(1 + r_t^L) + (1 - p(R, z_{t+1}))(1 - \lambda) - c^\theta\}\ell_t^\theta - d_t^\theta(1 + r_t^D) - \kappa^\theta, 0\right\}.$$

As discussed before, entry costs are denoted by $\Upsilon^f \geq \Upsilon^n \geq 0$. These entry costs depend on the distribution of incumbent banks in the economy. As in Pakes and McGuire [22], we assume that these costs become infinite after a certain number of firms of the given type are in the market. In particular, we assume that there will be at most one national bank and one foreign bank, so the industry will be served either by a national monopolist, a foreign monopolist or a duopoly formed by a national and a foreign bank. Every period a potential entrant make the decision to enter the market or not. We assume that each entrant satisfies a zero expected discounted profits condition.

We denote the industry state by

$$\mu_t = \{\mu_t(n), \mu_t(f)\}, \quad (5)$$

where the 2 elements of μ_t are simply counting measures of *active* banks by type (i.e. whether there is an active incumbent bank of type θ or not).

2.4 Information

There is asymmetric information in the loan market. Only firms know the riskiness of the project they choose (R_t) and their outside option (ω_t). As in Carlstrom and Fuerst [8] we assume that any entrepreneur's history of past debt repayment is not observable (i.e. there is interperiod anonymity of entrepreneurs) so that only one period borrowing is feasible. Project success or failure is verifiable only at a cost $\overline{c}^{\theta}$ as in Townsend [23]. All other information is observable.

2.5 Timing

At the beginning of period t,

1. Given the beginning of period state (μ_t, z_t, η_t), entrepreneurs draw ω_t.
2. Banks choose how many deposits to accept and how many loans to extend $(\ell_t^{\theta}, d_t^{\theta})$.
3. Borrowers choose whether or not to undertake a project, and if so a level of technology R_t. Households choose whether to deposit $\widehat{d}_t$ or store $\widehat{a}_t$.
4. Aggregate return z_{t+1} and equity issuance η_{t+1} shocks are realized, as well as idiosyncratic project success shocks .
5. Incumbent banks choose whether to issue equity and/or dividends and whether to exit.
6. Bank entry decisions e_t^{θ} are made.
7. Households choose how many shares to hold of bank stocks S_{t+1}^{θ}, pay taxes τ_t to fund deposit insurance, and consume.

3 Equilibrium

This section presents the equilibrium of the model. We start by describing the solution to the household and entrepreneurs problems, to then move into the solution of bank's problem. For future reference, we let the exogenous shock vector be denoted by $s_t = (z_t, \eta_t)$.

3.1 Households' Problem

The problem of the household is

$$\max_{\{\widehat{a}_t, \widehat{d}_t, S_{t+1}^{\theta}\}_{t=0}^{\infty}} E_0 \left[\sum_{t=0}^{\infty} \beta^t u(C_t) \right]$$

subject to

$$
\begin{aligned}
\widehat{a}_t + \widehat{d}_t &= 1 \qquad (6) \\
& C_t + \sum_\theta [P_t^\theta + I_{\{e^\theta(\mu_{t+1}, z_{t+1})=1\}} \Upsilon^\theta] S_{t+1}^\theta \mu_{t+1}(\theta) \qquad (7) \\
&= \sum_\theta (\mathcal{D}_t^\theta + P_t^\theta) S_t^\theta \mu_t(\theta) + (1+\overline{r})\widehat{a}_t + (1+r_t^D)\widehat{d}_t - \tau_t.
\end{aligned}
$$

Note that the price of equity in the budget constraint P_t^θ must be measurable with respect to the state (μ_t, s_t, s_{t+1}) at the *end of the period* after dividends, which may depend on injections of seasoned equity η_{t+1}, have been distributed. Given (μ_t, s_t, s_{t+1}) and exit and entry decision rules, in cases where a firm has exited, $P_t^\theta = 0$ on the right hand side of the budget constraint, and in cases where a firm has entered $P_t^\theta > 0$ on the left hand side of the budget constraint. To keep the analysis simple, we assume that matching with an entrepreneur is a dominated strategy for any household since it exposes the risk averse household to the idiosyncratic risk faced by entrepreneurs which can be diversified away by a bank. In our previous paper, Corbae and D'Erasmo [12], we derive conditions on parameters such that this is indeed the case. The anonymity assumption on entrepreneurs means that it is a simple static deviation which is suboptimal.

The first order condition for S_{t+1}^θ is:

$$
P^\theta(\mu_t, s_t, s_{t+1}) \cdot u'(C_t) = \beta \cdot E_{s_{t+2}|s_{t+1}} \left[u'(C_{t+1}) \cdot (\mathcal{D}^\theta(\mu_{t+1}, s_{t+1}, s_{t+2}) + P^\theta(\mu_{t+1}, s_{t+1}, s_{t+2})) \right],
$$

This can be written:

$$
P^\theta(\mu_t, s_t, s_{t+1}) = E_{s_{t+2}|s_{t+1}} \left[M_{t,t+1} \cdot (\mathcal{D}^\theta(\mu_{t+1}, s_{t+1}, s_{t+2}) + P^\theta(\mu_{t+1}, s_{t+1}, s_{t+2})) \right] \qquad (8)
$$

where $M_{t,t+1} = \beta E_{s_{t+2}|s_{t+1}}[u'(C_{t+1})/u'(C_t)]$ is the stochastic discount factor. We will derive the expression for the equilibrium price of a share after we present the bank's problem.

3.2 Entrepreneur's Problem

Every period, at a given state $\{r_t^L, s_t, \omega_t\}$ and before observing z_{t+1}, entrepreneurs choose whether to operate the technology or not ($\iota \in \{0,1\}$) and if they do the type of technology to operate R_t to maximize their consumption C_t^e.

$$
\max_{\{c_t^e, \iota_t \in \{0,1\}, R_t\}_{t=0}^\infty} E_0 \left[\sum_{t=0}^\infty \beta^t C_t^e \right] \qquad (9)
$$

subject to

$$
\begin{aligned}
C_t^e &= \iota_t \omega_t + (1-\iota_t)\pi^e(R_t, z_{t+1}) \\
\pi^e(R_t, z_{t+1}) &= \begin{cases} \max\{0, z_{t+1}R_t - r_t^L\} & \text{with prob } p(R_t, z_{t+1}) \\ 0 & \text{with prob } [1 - p(R_t, z_{t+1})] \end{cases}
\end{aligned}
$$

An application of the envelope theorem implies

$$
\frac{\partial E_{s_{t+1}|s_t} \pi^e(R_t, z_{t+1})}{\partial r^{L,j}} = -E_{s_{t+1}|s_t}[p(R_t, z_{t+1})] < 0. \qquad (10)
$$

Thus, participating borrowers are worse off the higher are borrowing rates. This has implications for the demand for loans determined by the participation constraint. In particular, since the demand for loans is given by

$$L^d(r^L, s_t) = B \cdot \int_0^{\overline{\omega}} 1_{\{\omega \leq E_{s_{t+1}|s_t} \pi^e(R_t, z_{t+1})\}} d\Omega(\omega), \tag{11}$$

then (10) implies $\frac{\partial L^d(r^L,s)}{\partial r^L} < 0$.

3.3 Banks' Problem

We use recursive notation to describe the bank problem. An incumbent bank of type θ chooses loans ℓ^θ in order to maximize profits and chooses whether to exit x^θ after the realization of the aggregate shocks $s' = (z', \eta')$. It is simple to see that no bank would ever accept more total deposits than it makes total loans.[4] Further, the deposit rate $r^D = \overline{r}$. Simply put, a bank would not pay interest on deposits that it doesn't lend out and with excess supply of funds, households are forced to their reservation value associated with storage.

Let $\sigma_{-\theta} = (\ell_{-\theta}, x_{-\theta}, e_{-\theta})$ denote the industry state dependent lending, exit, and entry strategies of rival banks. The value function of an incumbent bank of type θ at the beginning of the period is given by

$$V^\theta(\mu, s; \sigma_{-\theta}) = \max_{\{\ell^\theta\}} E_{s'|s}\left[M(\mu, s, s')W^\theta(\mu, s, s'; \sigma_{-\theta})\right] \tag{12}$$

subject to

$$\sum_\theta \ell^\theta(\mu, s; \sigma_{-\theta})\mu(\theta) - L^d(r^L, s) = 0, \tag{13}$$

where $L^d(r^L, s)$ is given in (11). Constraint (13), which is simply the loan market clearing condition, is imposed as a consistency condition that banks take into account since they realize their loan supply will influence the interest rate r^L. Alternatively, one can think of it as a reaction function.

The end-of-period value of a bank is given by

$$W^\theta(\mu, s, s'; \sigma_{-\theta}) = \max_{\{x \in \{0,1\}\}} \left\{W^{\theta,x=0}(\mu, s, s'; \sigma_{-\theta}), W^{\theta,x=1}(\mu, s, s'; \sigma_{-\theta})\right\} \tag{14}$$

which in the case where the bank does not exit is given by

$$W^{\theta,x=0}(\mu, s, s'; \sigma_{-\theta}) = \mathcal{D}^\theta(\mu, s, s'; \sigma_{-\theta}) + V^\theta(\mu', s'; \sigma_{-\theta}) \tag{15}$$

where

$$\mathcal{D}^\theta(\mu, s, s'; \sigma_{-\theta}) = \begin{cases} \pi^\theta(\mu, s, s'; \sigma_{-\theta}) & \text{if } \pi^\theta(\mu, s, s'; \sigma_{-\theta}) \geq 0 \\ \pi^\theta(\mu, s, s'; \sigma_{-\theta})[1 + \xi^\theta(-\pi^\theta(\mu, s, s'; \sigma_{-\theta}), \eta')] & \text{if } \pi^\theta(\mu, s, s'; \sigma_{-\theta}) < 0 \end{cases} \tag{16}$$

[4]Suppose not and $d > \ell$. The net cost of doing so is $r^D \geq 0$ while the net gain on $d - \ell$ is zero, so it is weakly optimal not to do so.

and in the case where the bank exits is given by

$$W^{\theta,x=1}(\mu, s, s'; \sigma_{-\theta}) = \max\left\{0, \pi^{\theta}(\mu, s, s'; \sigma_{-\theta})\right\} \tag{17}$$

since only positive dividends can be paid and the bank has no value after exit. The exit decision rule is given by the solution to problem (14) which reflects the choice between continuing (and possibly obtaining outside funding in case of negative profits) or exiting. The value of exit is bounded below by zero due to limited liability.

Now that we presented the problem of the incumbent bank, we can show how the price of bank's shares and the value of a bank are related. After normalizing the number of shares of each bank to 1, the price of a share of bank type θ after dividends have been paid is given by

$$P^{\theta}(\mu, s, s') = W^{\theta}(\mu, s, s') - \mathcal{D}^{\theta}(\mu, s, s').$$

Thus, equation (8) can be written:

$$\begin{aligned} W^{\theta}(\mu, s, s') - \mathcal{D}^{\theta}(\mu, s, s') &= E_{s''|s'}\left[M(\mu', s', s'') \cdot W^{\theta}(\mu', s', s'')\right] \iff \\ W^{\theta}(\mu, s, s') &= \mathcal{D}^{\theta}(\mu, s, s') + E_{s''|s'}\left[M(\mu', s', s'') \cdot W^{\theta}(\mu', s', s'')\right]. \end{aligned} \tag{18}$$

Plugging expression (18) into the bank's objective (12) yields

$$V^{\theta}(\mu, s; \sigma_{-\theta}) = E_{s'|s}\left\{M(\mu, s, s')\left[\mathcal{D}^{\theta}(\mu, s, s') + E_{s''|s'}\left[M(\mu', s', s'') \cdot W^{\theta}(\mu', s', s'')\right]\right]\right\}$$

But equation (12) iterated forward one period can be substituted into the above equation for $W^{\theta}(\mu', s', s'')$ and applying the law of iterated expectations yields the dynamic programming problem of each bank type θ we are solving:

$$V^{\theta}(\mu, s; \sigma_{-\theta}) = E_{s'|s}\left\{M(\mu, s, s')\left[\mathcal{D}^{\theta}(\mu, s, s') + V^{\theta}(\mu', s'; \sigma_{-\theta})\right]\right\}.$$

3.4 Entrant Bank Decision Making

After the realization of s', new banks of type θ can enter the industry by paying the setup cost Υ^{θ}. They will enter the industry if the net present value of entry is nonnegative. Let μ^{e} denote the distribution that would arise if a bank decides to enter (taking as given entry decision by all other banks). Then, a bank of type θ will choose to enter $e^{\theta}\left(\mu^{e}, s'\right) = 1$ if

$$V^{\theta}(\mu^{e}, s'; \sigma_{-\theta}) - \Upsilon^{\theta}[1 + \xi^{\theta}(\Upsilon^{\theta}, \eta')] \geq 0. \tag{19}$$

3.5 Cross-Sectional Distribution

The new distribution of banks after entry and exit μ' is given by

$$\mu' = \{\mu(f) - x^{f}(\mu, s, s') + e^{f}\left(\mu', s'\right), \mu(n) - x^{n}(\mu, s, s') + e^{n}\left(\mu', s'\right)\}. \tag{20}$$

3.6 Definition of Equilibrium

A pure strategy Markov Perfect Equilibrium (MPE) is a set of functions $\iota(\omega, r^L, s)$ and $R(r^L, s)$ describing borrower behavior, $S^\theta(\mu, s, s')$, $\hat{d}(\mu, s)$ and $\hat{a}(\mu, s)$ describing consumer behavior, a set of functions $\{V^\theta(\mu, s; \sigma_{-\theta}), \ell^\theta(\mu, s; \sigma_{-\theta}), x^\theta(\mu, s, s'; \sigma_{-\theta})$, and $e^\theta(\mu, s, s'; \sigma_{-\theta})\}$ describing bank behavior, a loan interest rate $r^L(\mu, s)$, a deposit interest rate $r^D = \overline{r}$, stock prices $P^\theta(\mu, s, s')$, an industry state μ, a tax function $\tau(\mu, s, s')$ and aggregate bank profits $\Pi(\mu, s, s')$ such that:

1. Given a loan interest rate r^L, $\iota(\omega, r^L, s)$ and $R(r^L, s)$ are consistent with borrower's optimization in (9).

2. For any given interest rate r^L, loan demand $L^d(r^L, s)$ is given by (11).

3. At $r^D = \overline{r}$, the household deposit participation constraint is satisfied, so $\hat{d}(\mu, s) + \hat{a}(\mu, s) = 1$ for all $\{\mu, s\}$. At $P^\theta(\mu, s, s')$, households demand for shares equals the supply, i.e. $S^\theta(\mu, s, s') = 1$ for all $\{\mu, s, s', \theta\}$.

4. Given the loan demand function, the value of the bank $V^\theta(\mu, s; \sigma_{-\theta})$, loan decision rules $\ell^\theta(\mu, s; \sigma_{-\theta})$, and exit rules $x^\theta(\mu, s, s'; \sigma_{-\theta})$, are consistent with bank optimization in (12) and (14).

5. The entry decision rules $e^\theta(\mu, s, s'; \sigma_{-\theta})$ are consistent with bank optimization in (19).

6. The law of motion for the industry state (20) is consistent with entry and exit decision rules.

7. Across all states (μ, s, s'), bank profits are given by:

$$\begin{aligned}\Pi(\mu, s, s') &= \sum_\theta \Big[(1 - x^\theta(\mu, s, s'; \sigma_{-\theta}))\mathcal{D}^\theta(\mu, s, s'; \sigma_{-\theta}) \\ &\quad + x^\theta(\mu, s, s'; \sigma_{-\theta}) \max\{0, \pi^\theta(\mu, s, s'; \sigma_{-\theta})\} - e^\theta \Upsilon^\theta\Big].\end{aligned}$$

8. The interest rate $r^L(\mu, s)$ is such that the loan market (13) clears. That is,

$$L^d(r^L, s) = B \cdot \int_{\underline{\omega}}^{\overline{\omega}} 1_{\{\omega \leq E_{z'|z}\pi^e(R, z')\}} d\Omega(\omega) = \sum_\theta \int \ell^\theta(\mu, z, \eta; \sigma_{-\theta})\mu(\theta) = L^s(\mu, s; \sigma_{-\theta}).$$

9. Across all states (μ, s, s'), taxes cover deposit insurance:

$$\tau(\mu, s, s') = \sum_\theta x^\theta(\mu, s, s'; \sigma_{-\theta}) \max\{0, -\pi^\theta(\mu, s, s'; \sigma_{-\theta})\}$$

In equilibrium, aggregate household consumption is given by

$$C(\mu, s, s') = (1 + \bar{r}) + \Pi(\mu, s, s') - \tau(\mu, s, s') \tag{21}$$

while aggregate entrepreneur consumption is given by

$$C^e(\mu, s, s') = \int_0^{\overline{\omega}} \Big[1_{\{\omega > E_{z'|z}\pi^e(R,z')\}}\omega_t + 1_{\{\omega \leq E_{z'|z}\pi^e(R,z')\}}\pi^e(R, z')\Big] d\Omega(\omega). \tag{22}$$

4 Calibration

We calibrate our model parameters to Mexico by minimizing the distance between relevant model moments and those from the data. Besides aggregate data, we also have access to a panel of commercial Mexican banks since 1998, a few years after the bank reform in Mexico. Hence, the model is calibrated to a sample where foreign bank competition is permitted.[5] The data comes from Bankscope, a data set with balance sheet information on banks across the globe. A model period is set to be one year.

The stochastic process for the entrepreneur's project is parameterized as in our previous paper (see Corbae and D'Erasmo [12]). In particular, let $y = \alpha z' + (1-\alpha)\varepsilon_e - bR^{\psi}$ where ε_e is drawn from $N(0, \sigma_\varepsilon^2)$. The entrepreneur's idiosyncratic project uncertainty is iid across agents. We define success to be the event that $y > 0$, so in states with higher z or higher ε_e success is more likely. Then

$$\begin{aligned} p(R, z') &= 1 - prob(y \leq 0 | R, z') \\ &= 1 - prob\left(\varepsilon_e \leq \frac{-\alpha z' + bR^{\psi}}{(1-\alpha)}\right) \\ &= \Phi\left(\frac{\alpha z' - bR^{\psi}}{(1-\alpha)}\right) \end{aligned} \quad (23)$$

where $\Phi(x)$ is a normal cumulative distribution function with mean zero and variance σ_ε^2. As Martinez-Miera and Repullo [19] the parameter α captures the correlation of solvency across borrowers. Further, we let the distribution of the entrepreneur's outside option $\Upsilon(\omega)$ to be a uniform distribution with support defined by $[\underline{\omega}, \overline{\omega}]$.

We let household preferences be given by $u(C_t) = \frac{C_t^{1-\sigma}}{1-\sigma}$ and set the coefficient of relative risk aversion σ to 2, a standard value in the macro literature.

We let the external financing cost for national banks be parameterized as $\xi^n(x, \eta') = \xi_1 x$ while the foreign cost function is given by $\xi^f(x, \eta') = \eta' \xi_1 x$.

The full set of parameters of the model are divided into two groups. The first group of parameters can be estimated directly from the data (i.e. they can be pinned down without solving the model). This set includes the following parameters

$$\Theta^1 = \{\overline{r}, \tilde{c}^f, \tilde{c}^n, \overline{c}^f, \overline{c}^n, F(z, z', \eta'), G(\eta, \eta')\}$$

Since the only source of external funding is equity, we relate changes in the cost of equity issuance for foreign banks to changes in the corporate cost of borrowing in the US. We use data on the spread between a 10 year U.S. BAA corporate bond and a 10 year constant maturity US Treasury bond (from 1970 to 2012) and identify periods with $\eta_t = \eta_g$ as periods where the spread is below its mean and periods with $\eta_t = \eta_b$ as periods where the spread is above one standard deviation from its mean. Then, the transition matrix for η is estimated via maximum likelihood, where G_{jk}, the $(j, k)th$ element of the transition matrix, is the ratio of the number of times the indicator on η switched from state j to state k to the number of

[5] See the appendix for a detailed description of sources and variables.

times the spread was observed to be in state j. The estimated transition matrix is

$$G(\eta,\eta') = \left[\begin{array}{c|cc} & \eta'_g & \eta'_b \\ \hline \eta_L & 0.93 & 0.07 \\ \eta_H & 0.25 & 0.75 \end{array}\right] \tag{24}$$

The support of $G(\eta,\eta')$ is included in the set of parameters to be calibrated using moments from the banking sector.

To calibrate the process of z_t we use information on real Mexican GDP (in 1985 US$ from World Bank via Haver Analytics 1970-2012). In particular, we identify periods with $z_t = z_c$ as periods where H-P detrended real Mexican GDP is below one standard deviation from its mean, periods with $z_t = z_b$ as periods where H-P detrended real Mexican GDP is below its mean but above one standard deviation from the mean, and periods with $z_t = z_g$ as periods where H-P detrended real Mexican GDP is above its mean. The transition matrix is estimated using the same maximum likelihood approach used to estimate the transition for η but taking into account that the domestic business cycle is correlated with the foreign state of the economy. While providing information about almost all combination of shocks, the short length of the sample prevents us from observing transitions into $z' = z_c$ when $\eta' = \eta_b$. For this reason, we set $F(z_c, z'_g, \eta'_b) = 0$ and calibrate $F(z_c, z'_c, \eta'_b) = \phi^b_{cc}$ and $F(z_b, z'_c, \eta'_b) = \phi^b_{bc}$ together with other parameters in the model. Note that given the estimated value for $F(z_b, z'_b, \eta'_b) = 0.66$ and the fact that probabilities add up to 1, the values of ϕ^b_{cc} and ϕ^b_{bc} pin down $F(z_c, z'_b, \eta'_b) = 1 - \phi^b_{cc}$ and $F(z_b, z'_g, \eta'_b) = 1 - 0.66 - \phi^b_{bc}$.

The estimated transition matrix when $\eta' = \eta_g$ is

$$F(z,z',\eta'_g) = \left[\begin{array}{c|ccc} & z'_c & z'_b & z'_g \\ \hline z_c & 0.57 & 0.43 & 0.0 \\ z_b & 0.12 & 0.65 & 0.23 \\ z_g & 0.0 & 0.09 & 0.91 \end{array}\right] \tag{25}$$

and the estimated transition matrix when $\eta' = \eta_b$ is

$$F(z,z',\eta'_b) = \left[\begin{array}{c|ccc} & z'_c & z'_b & z'_g \\ \hline z_c & \phi^b_{cc} & 1-\phi^b_{cc} & 0.0 \\ z_b & \phi^b_{bc} & 0.66 & 1-0.66-\phi^b_{bc} \\ z_g & 0.0 & 0.36 & 0.64 \end{array}\right] \tag{26}$$

We normalize the value of $z_g = 1$ and we include z_b and z_c in the set of the parameters to calibrate.

Once those parameters in set Θ^1 are pinned down, a second group is calibrated by minimizing the weighted difference between model moments and data moments. After normalizing $z_g = 1$, this group includes the following parameters

$$\Theta^2 = \{z_b, z_c, \phi^b_{cc}, \phi^b_{bc}, \alpha, b, \sigma_\epsilon, \psi, \overline{\varpi}, \beta, \lambda, \kappa^n, \kappa^f, \zeta^1, \eta_g, \eta_b, \Upsilon^f, \Upsilon^n\}$$

We identify banks in our model as banks in the top 10 of the asset distribution in Mexico in any given year, so all averages reported are computed using banks in this group.[6] As we

[6] Top 10 banks banks hold, on average, well above 80% of total assets and total loans in Mexico during the period analyzed.

described in detail in the appendix, ownership information is constructed using Bankscope as the main source but complemented with other sources.[7]

We estimate $\bar{r} = r^D$ using the ratio of interest expenses on customer deposits to total customer deposits. The nominal interest rate is converted to a real interest rate by using the consumer price index in Mexico. The average for the period 1998-2012 is equal to 1.94%. After estimating the average charge off rate (Net Charge Offs divided by Gross Loans) and the average default frequency (Non-Performing Loans divided by Gross Loans) to be 4.01% in our data, the parameter λ can be set to 0.20 since the model counterpart of the charge off rate is equal to $(1-p)\lambda$.

The marginal cost of making a loan is estimated using data from non-interest expenses and income. More specifically, c^θ is calibrated using marginal net non interest expenses defined as personnel expenses minus total non-interest operating income divided by total assets. We estimate the relationship between marginal costs and past-90 days and non-accrual loans to be non-significant, so we set $\bar{c}^f = \bar{c}^n = 0$. Then, we let $\tilde{c}^f = 0.0202$, the average for foreign banks in the top ten of the asset distribution and $c^n = 0.0241$, the average for national banks in the top ten of the asset distribution in Mexico.

To estimate Θ^2, a set with 15 parameters, we minimize the distance between data moments and moments generated from the simulated model. That is, the parameters are chosen to minimize

$$J(\Theta^2) = [\mu^d - \mu^s(\Theta)]W[\mu^d - \mu^s(\Theta)]' \tag{27}$$

with respect to parameters Θ^2, where μ^d are the moments from the data, $\mu^s(\Theta^2)$ are the moments from the simulated model at parameters Θ^2 and W is some positive definite matrix.[8] We implement the calibration using W equal to the identity matrix.

All the moments generated by the model depend on the full set of parameters. However, we discuss our identification strategy by explaining which moment we understand as most useful in identifying each parameter. In order to calibrate z_b and z_c we use information on default frequency (equal to 1.94%) and average equity return (18.98%).[9] To help with the calibration of the transition probability parameters ϕ^b_{cc} and ϕ^b_{bc} we use the standard deviation of the asset return for foreign and national banks respectively. The parameters α and b are identified with information from average asset return (3.0%) and the loan return (7.84%) estimated from our sample of banks as the real interest return on loans (interest income on loans divided by gross loans deflated using the consumer price index) minus the charge off rate (net charge offs over gross loans). The standard deviation of the borrower shock σ_ϵ is linked to the volatility of equity return (2.12%) in Mexico. To calibrate ψ and $\overline{\omega}$ we use information on dividend to asset ratio for foreign and national banks. The charge off rate (2.12%) allows us to discover the loss after default λ. The discount factor β is estimated using information on the loan market share of foreign banks. We estimate $\kappa^\theta/\ell^\theta$ to match total non interest expenses minus personnel expenses over total assets for the top

[7]Bankscope provides information on the nationality of the controlling shareholder and the history of ownership. When data was missing or incomplete we complemented Bankscope with information from the official websites of each bank, banking publications and country experts.

[8]For every set of parameters, we simulate eighteen panels of banks for 7,000 periods. To compute the moments, we discard the initial 2,000 periods and average over all the panels created.

[9]The average equity return and its volatility are taken from Diebold and Yilmaz [15] that study the evolution of the equity markets across countries from 1992 to 2007.

ten Mexican foreign and domestic banks. We obtain values equal to 1.58% for foreign banks and 4.24% for domestic banks. The value of ζ_1 is chosen to match the loan interest margin (equal to 6.94%). The values of η_g and η_b are set so the model reproduces the average equity issuance by foreign (3.65%) and national banks (2.83%). The entry cost parameters are pinned down using information on the exit rate of foreign and domestic banks (2.29% and 3.78% respectively). We also incorporate the average entry rate for banks in the top ten (2.66%) in the set of moments to be matched, so effectively we have an over-identified model.

Table 2 presents the parameters of the model where parameters above the line correspond to Θ^1 and parameters below the line Θ^2.

Table 2: Model Parameters

Parameter		Value	Target
Dep. preferences	σ	2.00	standard value
Agg. shock in good state	z_g	1.00	normalization
Deposit interest rate (%)	$\bar{r}$	1.94	cost deposits
Net. non-int. exp. f bank	$\tilde{c}^n$	2.02	net non-interest expense
Net. non-int. exp. n bank	$\tilde{c}^r$	2.41	net non-interest expense
Agg. shock in bad state	z_b	0.95	Default Frequency %
Agg. shock in crisis state	z_c	0.86	Borrower Return %
Transition prob.	ϕ^b_{cc}	0.67	Std dev. Asset Return Foreign %
Transition prob.	ϕ^b_{bc}	0.10	Std dev. Asset Return Domestic %
Weight agg. shock	α	0.92	Asset Return %
Success prob. param.	b	3.74	Loan return %
Volatility borrower's dist.	σ_ϵ	0.06	Std. Dev. Borrower Return %
Success prob. param.	ψ	0.94	Dividend / Asset Foreign %
Max. reservation value	$\overline{\omega}$	0.24	Dividend / Asset Domestic %
Charge-off rate	λ	0.20	Charge off Rate %
Discount Factor	β	0.88	Loan Market Share Foreign %
Fixed cost n bank	κ^n	0.004	Fixed Cost over Assets Foreign %
Fixed cost f bank	κ^f	0.003	Fixed Cost over Assets Domestic %
External finance param.	ζ_1	0.06	Loan Interest margin %
External finance shock	η_g	0.30	Avg. Equity issuance Foreign %
External finance shock	η_b	1.05	Avg. Equity issuance Domestic %
Entry Cost Foreign	Υ^f	0.042	Exit Rate Foreign %
Entry Cost National	Υ^n	0.041	Exit Rate Domestic %
			Entry Rate %

Table 3 presents the model moments and a comparison with the moments from the data. The moments in the upper portion of the table correspond to those targeted in the calibration and those in the lower portion of the table are some additional and informative moments.

Table 3: Model and Data Moments

Moment		Data	Model
Default Frequency %	$1-p$	4.01	6.13
Borrower Return %	$pz'R$	18.98	18.68
Std dev. Asset Return Foreign %		5.18	5.63
Std dev. Asset Return National %		1.4	3.51
Asset Return %	$\mathcal{D}^\theta/\ell^\theta$	3.00	3.21
Loan return %	$pr^L-(1-p)\lambda$	7.84	8.49
Std. Dev. Borrower Return %		2.76	4.79
Fixed Cost over Assets Foreign %	κ^f/ℓ^f	1.58	2.15
Fixed Cost over Assets National %	κ^n/ℓ^n	4.24	1.47
Charge off Rate %	$(1-p)\lambda$	2.12	1.21
Loan Market Share Foreign %	ℓ^f/L^s	69.49	56.63
Dividend / Asset Foreign %	$\max\{\pi^f,0\}/\ell^f$	4.15	3.94
Dividend / Asset National %	$\max\{\pi^n,0\}/\ell^n$	2.07	4.11
Loan Interest margin %	pr^L-r^D	6.94	7.76
Avg. Equity issuance Foreign %	$\max\{-\pi^f,0\}/\ell^f$	3.65	0.83
Avg. Equity issuance National %	$\max\{-\pi^n,0\}/\ell^n$	2.83	0.30
Exit Rate Foreign %	$\sum_t x_t^f/T$	2.29	2.72
Exit Rate Domestic %	$\sum_t x_t^n/T$	3.78	3.98
Entry Rate %	$\sum_t \sum_\theta e_t^\theta/\sum_\theta \mu(\theta)$	2.66	5.66
Exit Rate %		0.67	3.89
Equity Issuance All		3.34	1.00
Loan Interest Rate %	r^L	8.40	10.39
Frequency Equity Issuance all %		15.33	3.61
Frequency Equity Issuance Foreign %	$\sum_t I_{\{\pi_t^f<0\}}/T$	21.11	2.94
Frequency Equity Issuance Domestic %	$\sum_t I_{\{\pi_t^n<0\}}/T$	6.66	1.12
Std Dev Equity Issuance all %		3.34	5.19
Std Dev Equity Issuance Foreign %		3.65	4.75
Std Dev Equity Issuance Domestic %		2.83	2.83
Asset Return Foreign %		3.57	3.09
Asset Return Domestic %		1.93	3.79
Std Dev Asset Return all %		3.67	6.21
Dividend / Asset %		3.51	4.24

Note: Moments in the upper portion of the table (i.e. above the line) correspond to those targeted in the calibration. Data moments are computed using commercial bank level data from Mexico from 1998 to 2012. Source: Bankscope.

The model does a good job in matching the moments from the data. We note that the model underpredicts the charge off rate, fixed costs for domestic banks, and the level of equity issuance. The model also overpredicts the default frequency, the standard deviation of borrower return, the standard deviation of asset return for domestic banks, and the entry rate.

5 Equilibrium Characterization

Given the parameters of the model in Table 2, we can summarize the entry and exit decision rules (both on and off the equilibrium path) by foreign and domestic banks as follows[10]:

1. Foreign Entry:
   (a) If there are no competitors (i.e. $\mu = \{0, 0\}$), then enter when
      i. $\eta = \eta_g$ (i.e. whenever foreign external funding is cheap), or
      ii. $\eta = \eta_b$ and $z = z_g$ (foreign external funding is expensive but Mexico is in a boom).
   (b) If there is a domestic competitor (i.e. $\mu = \{0, 1\}$), then enter when $z = z_g$ (i.e. when Mexico is in a boom).
   (c) Do not enter otherwise.
2. Domestic Entry:
   (a) If there are no competitors (i.e. $\mu = \{0, 0\}$), then enter when
      i. $\eta = \eta_g$ and $z = z_g$ (i.e. foreign external funding is cheap but Mexico is in a boom), or
      ii. $\eta = \eta_b$ (i.e. foreign external funding is expensive).
   (b) If there is a foreign competitor (i.e. $\mu = \{1, 0\}$), then enter when $z = z_g$ (i.e. when Mexico is in a boom).
   (c) Do not enter otherwise.
3. Foreign Exit:
   (a) If the Mexican economy goes into a crisis $z' = z_c$ from $z = z_b$ the foreign bank exits if
      i. there is no domestic competitor (i.e. $\mu = \{1, 0\}$)
      ii. there is a domestic competitor (i.e. $\mu = \{1, 1\}$) and $\eta = \eta_b$ (i.e. financing conditions are more favorable for the competitor)
   (b) Do not exit otherwise.
4. Domestic Exit:
   (a) If the Mexican economy goes into a crisis $z' = z_c$ from $z = z_b$ the domestic bank exits if
      i. there is no foreign competitor (i.e. $\mu = \{0, 1\}$)

[10] We do not report decision rules for zero probability events (i.e. Recall that for $G(z, z', \eta')$ in equations (25) and (26), the probability of transiting from z_g to z_c is zero.

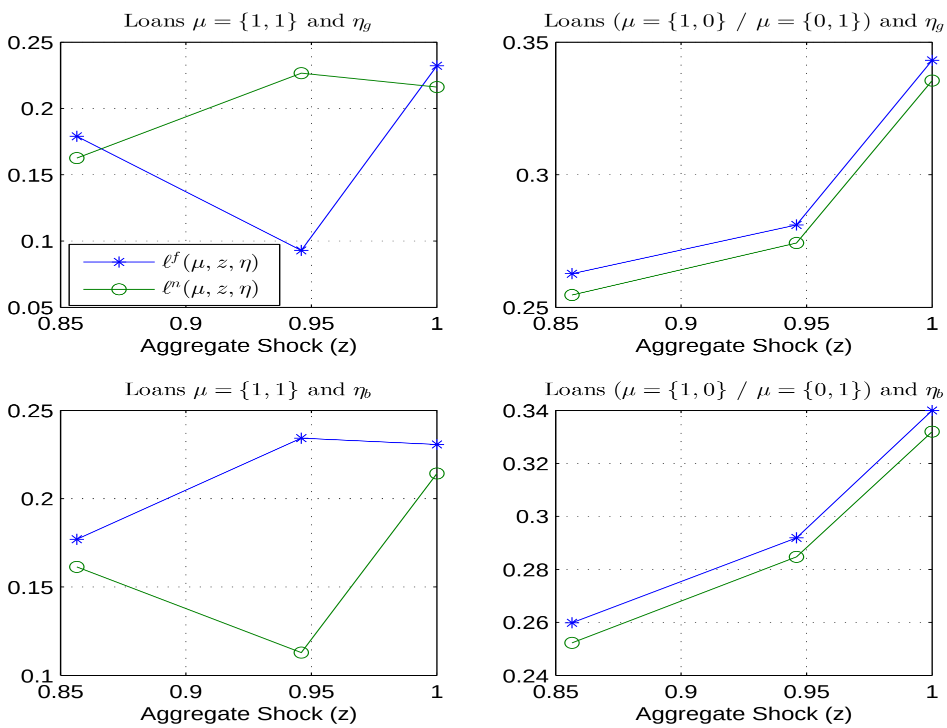
ii. there is a foreign competitor (i.e. $\mu = \{1,1\}$) and $\eta = \eta_g$ (i.e. financing conditions are more favorable for the competitor)

(b) Do not exit otherwise.

In summary, the exit decision rules imply that when the Mexican economy enters a crisis, there is exit by domestic banks and under certain conditions, by foreign banks as well. If the crisis leads to no incumbent banks at the end of the period (due to excessive losses of loans made in better times), then there will be entry by at least one type of bank.

To better understand entry and exit decisions, we need to examine incumbent loan decision rules since these (made in state (μ, s)) along with the shocks s, determine whether banks make profits or losses. Figure 2 shows the loan decision rules as a function of the industry and aggregate states. The left panels are decision rules when both domestic and foreign banks are present (i.e. $\mu = \{1,1\}$) when foreign external funding is cheap (top left) and expensive (bottom left). The right panels are decision rules when only one bank is in the market (i.e. $\mu = \{1,0\}$ or $\mu = \{0,1\}$) when foreign external funding is cheap (top right) and expensive (bottom right). It is important to note that not all the points in the figure are realized in equilibrium.

Figure 2: Loan Decision Rules $\ell^{\theta}(\mu, z, \eta)$



Note: Each quadrant corresponds to a combination of μ and η and the $x-$axis corresponds to each possible value of z. Left panels are decision rules when both domestic and foreign banks are present (i.e. $\mu = \{1,1\}$). The right panels are decision rules when only one bank is in the market (i.e. $\mu = \{1,0\}$ or $\mu = \{0,1\}$).

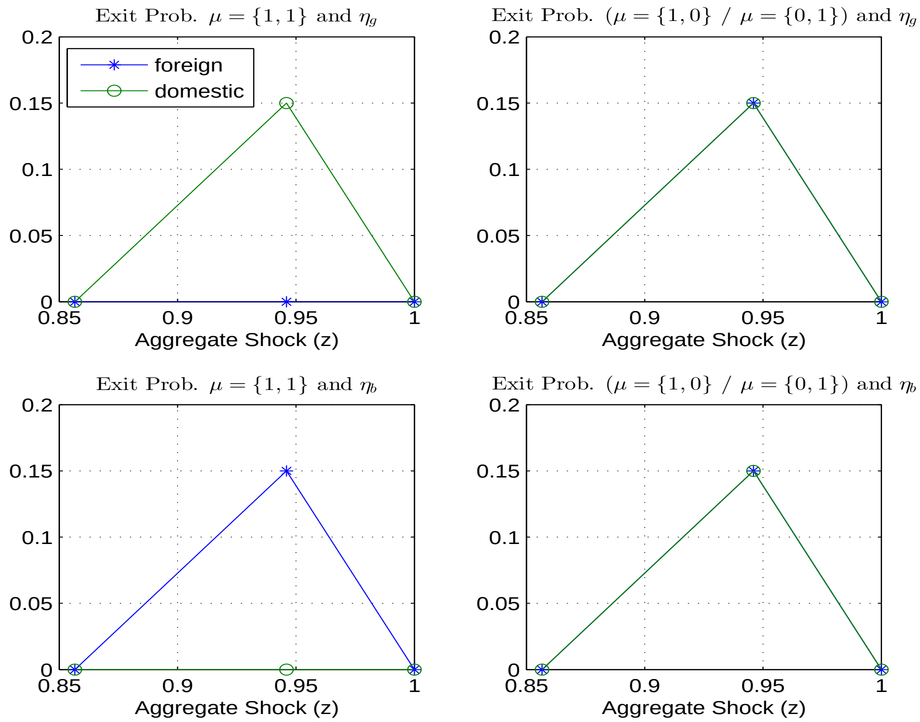
We see that when both banks are present, foreign banks make more loans than domestic banks in good times and in crisis states (the latter case is off-the-equilibrium path). We also note that there are big differences in lending practices in bad domestic times depending on global conditions. Recall that the probability of going into $z' = z_c$ is only positive when $z = z_b$. In particular, we see domestic banks making more loans (i.e. taking on more risk) while foreign banks make less loans (taking on less risk) when global conditions are favorable. The opposite is true when external funding for the foreign bank is expensive. The intuition is as follows. When global conditions are favorable, the foreign bank is able to finance potential losses if the economy enters into a domestic crisis (in which case the domestic bank exits), so it reduces its exposure to the Mexican economy to the point where continuation is viable. When global conditions are such that external funding is expensive for the foreign bank, financing negative profits if the economy enters into a crisis has a negative expected value, so it is optimal to take on more risk and maximize expected profits for the current period (the probability of staying in a global crisis and entering into a domestic crisis is only 6%). In this case, the domestic bank reduces its exposure to a domestic crisis in order to guarantee it will be able to continue operating and take advantage of being a monopoly in the case the crisis realizes and the foreign bank exits. If there is only one bank present (i.e., they are in a monopoly position), we see foreign banks are more cautious in bad times when external funding is cheap and extend less loans than in bad times when external funding is expensive.

To expand even further on the analysis of bank risk taking, Figure 3 present the probability of bank exit, where the exit probability is defined as follows:

$$\rho^{\theta}(\mu, z, \eta) = \sum_{z', \eta'} x(\mu, z, \eta, z', \eta') G(\eta, \eta') F(z, z', \eta') \tag{28}$$

Figure 3 makes clear that, on average, banks take on more risk when the industry is more concentrated and that risk-taking depends not only on the industry state but also on external funding conditions. We observe that when there is competition between foreign and domestic banks (i.e., right panels when $\mu\{1, 1\}$), foreign banks take on more risk when global conditions are bad and domestic banks take on more risk when global conditions are good (i.e. competitors are strong). The intuition behind this result has to do with whether the foreign bank finds profitable to pay the cost of external funding and continue or exit if a domestic crisis realizes. The foreign bank takes the least amount of risk when global conditions are favorable when facing a domestic competitor because, it understands that if a domestic crisis materializes the domestic bank will exit making him into a monopolist. It is also important to note, that when global conditions are bad and banks act as monopolists, the probability of entry of a competitor is highest.

Figure 3: Bank Risk Taking and Exit Prob. $\rho^{\theta}(\mu, z, \eta)$



Note: Each quadrant corresponds to a combination of μ and η and the $x-$axis corresponds to each possible value of z. Left panels are exit prob. when both domestic and foreign banks are present (i.e. $\mu = \{1, 1\}$). The right panels are exit prob. when only one bank is in the market (i.e. $\mu = \{1, 0\}$ or $\mu = \{0, 1\}$).

Our model makes predictions for cyclical properties of financial and real variables. In particular, intermediated output in the model is given by:

$$Y = \{p \cdot (1 + z'R) + (1 - p) \cdot (1 - \lambda)\} \cdot L^s. \tag{29}$$

Using this definition, Table 4 presents a set of relevant business cycle correlations. We see that loans are procyclical and less so for foreign banks than domestic banks. Interest rates and default frequencies are countercyclical. Entrepreneurial risk taking is procyclical. Finally, entry is procyclical and exit is countercyclical.

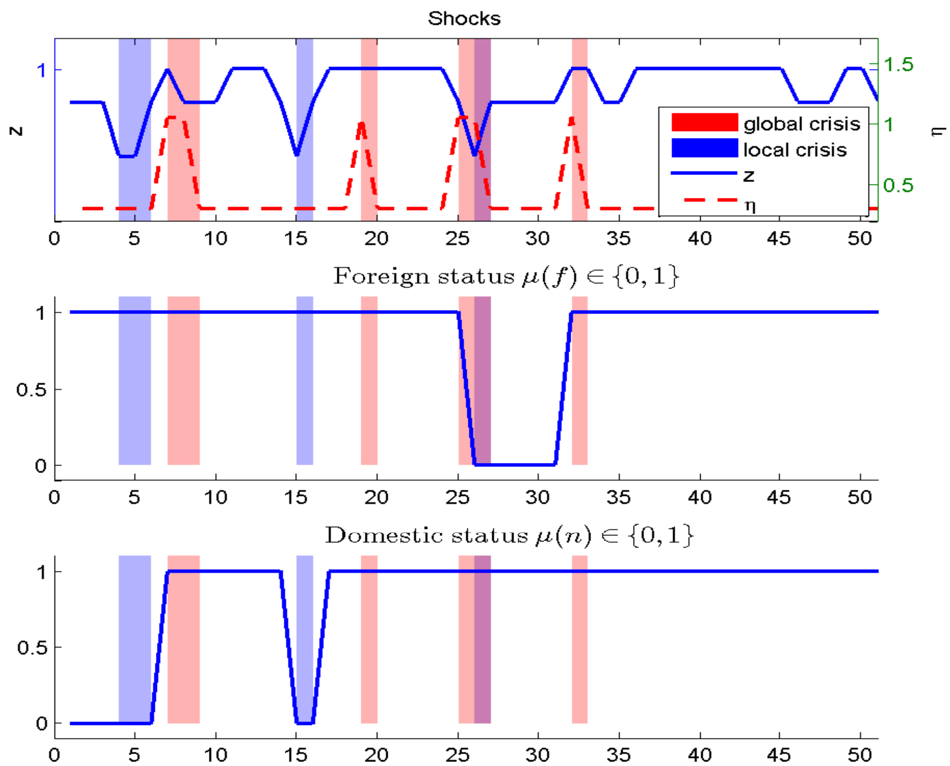
Table 4: Model Business Cycle Correlations

Moment	
Corr(Y, L^s)	0.963
Corr(Y, ℓ^f)	0.289
Corr(Y, ℓ^n)	0.550
Corr(Y, r^L)	-0.781
Corr$(Y, (1-p))$	-0.445
Corr(Y, R)	0.518
Corr$(Y, entry)$	0.031
Corr$(Y, exit)$	-0.430

To further illustrate the workings of the model, we simulate the model and Figure 4 presents the evolution of the banking industry during 50 representative periods. The top panel of this figure presents the evolution of the shocks. We use shaded bars to represent periods where there is a domestic crisis or a global crisis. In particular, periods where $z = z_c$ are presented with blue bars, periods where $\eta = \eta_b$ are presented with red bars and periods where both $z = z_c$ and $\eta = \eta_b$ occur together are presented in purple bars. The top panel of the figure shows the evolution of the shocks to make the connection between the bars and the value of the shocks clearer. The middle panel presents the indicator function that shows whether the foreign bank is active or not and the bottom panel presents the active indicator for the national bank.

Figure 4 shows that when the level of competition is high (i.e., we have foreign and domestic banks competing in the loan market) a global crisis alone does not generate bank exit (periods 7/8). On the other hand, when a domestic crisis hits the economy (period 15) we observe national bank exit. This creates room for the foreign bank to operate as a monopoly. As we will explain in detail below, the model propagates the crisis via endogenous changes in competition. Figure 4 also shows that when competition is high, if a global crisis together with a local crisis hit (period 26) the foreign bank exits. This is the result of bank risk taking as a function of domestic conditions. When the domestic economy is not in a crisis but external funding is costly, the foreign bank is willing to take on more risk since the probability of leaving the global crisis is 50%. We observe that even after the exogenous forces improve, the economy faces a highly concentrated industry for several periods (from period 16 to period 33) and this causes interest rates to rise and output to fall even further.

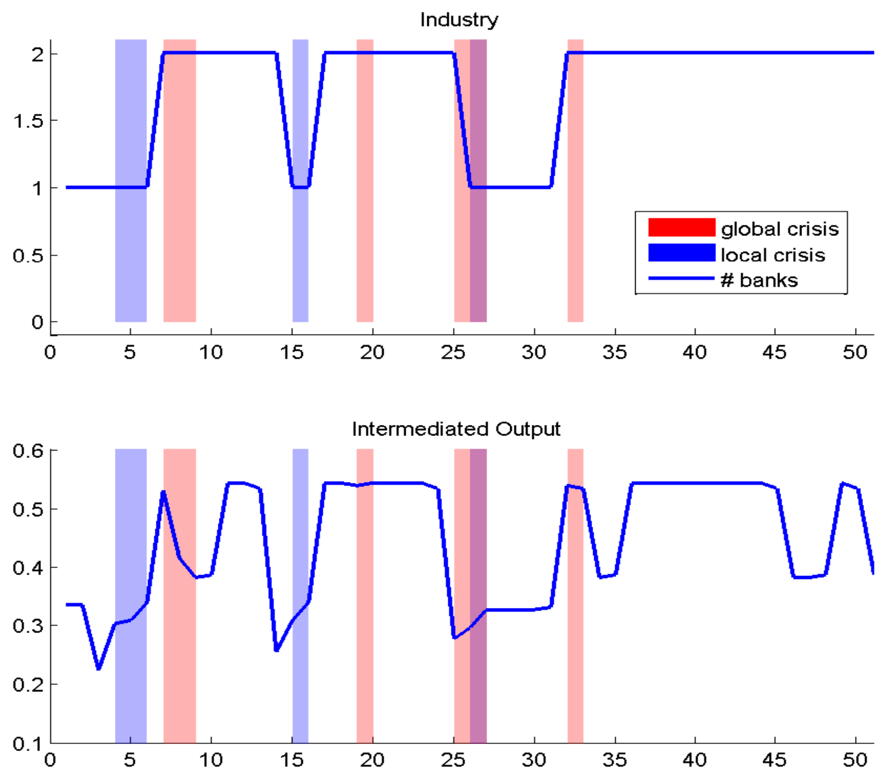
Figure 4: Industry Evolution



Note: periods where $z = z_c$ are represented with blue bars, periods where $\eta = \eta_b$ are represented with red bars and periods where both $z = z_c$ and $\eta = \eta_b$ occur together are presented in purple bars.

Figure 5 presents the evolution of the number of banks (top panel) and intermediate output (bottom panel) together with the bars representing the different shocks the economy faces. Figure 5 makes clear the amplification effect of the model. It is evident that the level of output remains low (periods 25 to 32) even after exogenous domestic and global conditions improve provided concentration in the industry stays high. Output returns to a higher level than during these periods after competition increases (periods 33 and beyond).

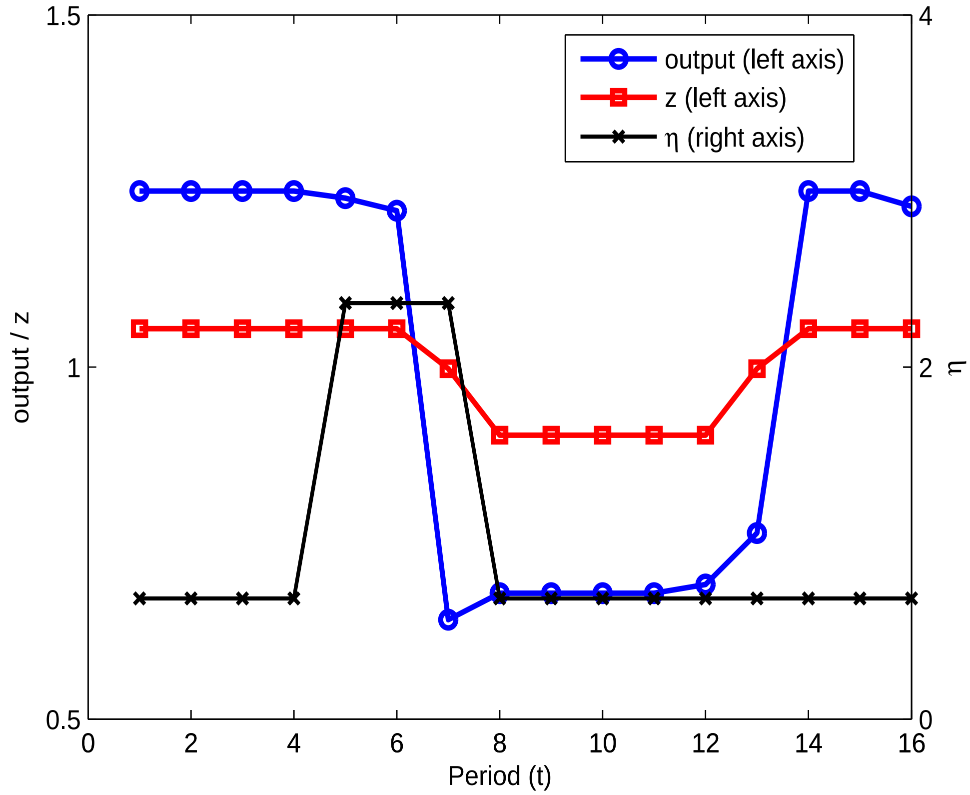
Figure 5: Evolution output and propagation mechanism



Note: periods where $z = z_c$ are represented with blue bars, periods where $\eta = \eta_L$ are represented with red bars and periods where both $z = z_c$ and $\eta = \eta_L$ occur together are presented in purple bars.

In Figure 6, we illustrate how global crisis are "imported" into Mexico when there is a foreign bank presence. We provide a sample realization from our model economy where we have normalized shocks and output to fit on the same graph.

Figure 6: "Importing" a global crisis



In period 5 of Figure 6, we see that the domestic productivity shock is unchanged, but the foreign external finance shock rises (i.e. external financing becomes costly) which induces a drop in output that continues in period 6 as well. This illustrates how opening up to foreign banks can increase domestic exposure to financial shocks. The drop that happens in period 7 is the result of a bad economic conditions domestically and abroad. We also note that as global conditions improve in period 8, output rises even though local conditions continue to deteriorate.

While foreign banks provide competition for domestic banks, the fact that their external funding is itself subject to fluctuations in the rest of the world can induce variability in loan supply (in the next sections we will see this can be substantial).

6 Counterfactual: No Foreign Bank Competition

As we described in the introduction, one important characteristic of the banking system in Mexico was that, prior to 1998, the Mexican banking system was protected from foreign competition. Foreign banks were not allowed to buy Mexican banks whose market share exceeded 1.5% and total participation of foreign banks was restricted to be less than 8%.

To study the effects of such restrictions on welfare and the evolution of the economy, we compute a counterfactual experiment where we raise Υ^f to a prohibitively high level. Table 5 presents those results.

Table 5: Model and Data Moments

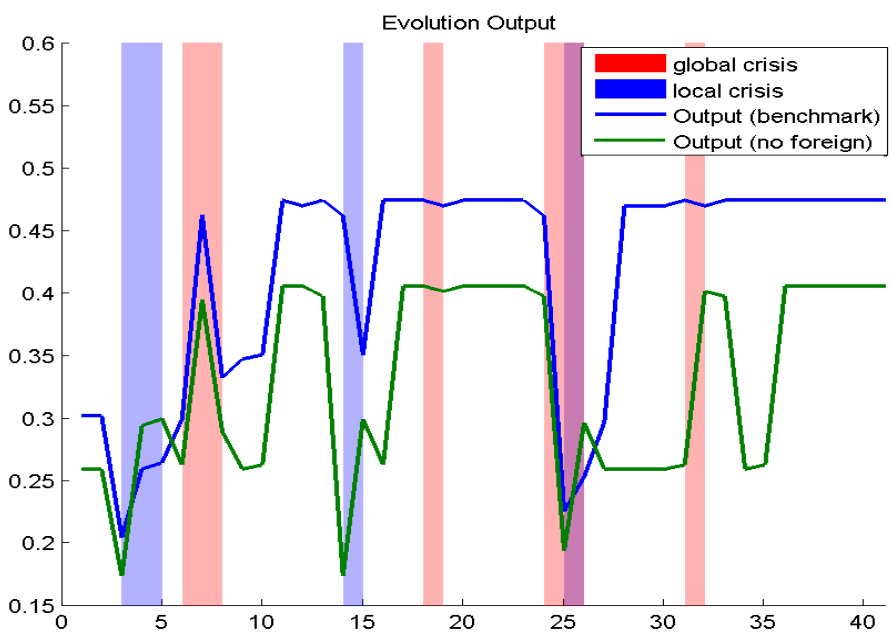
Moment	Data	Model	$\Upsilon^f = \infty$
Default Frequency %	4.01	6.13	6.31
Borrower Return %	18.98	18.68	18.66
Std dev. Asset Return Foreign %	5.18	5.63	-
Std dev. Asset Return National %	1.4	3.51	7.91
Asset Return %	3.00	3.21	5.03
Loan return %	7.84	8.49	10.58
Std. Dev. Borrower Return %	2.76	4.79	4.79
Fixed Cost over Assets Foreign %	1.58	2.15	-
Fixed Cost over Assets National %	4.24	1.47	1.11
Charge off Rate %	2.12	1.21	1.25
Loan Market Share Foreign %	69.49	56.63	0.00
Dividend / Asset Foreign %	4.15	3.94	-
Dividend / Asset National %	2.07	4.11	6.56
Loan Interest margin %	6.94	7.76	9.89
Avg. Equity issuance Foreign %	3.65	0.83	-
Avg. Equity issuance National %	2.83	0.30	1.44
Exit Rate Foreign %	2.29	2.72	-
Exit Rate Domestic %	3.78	3.98	0.00
Entry Rate %	2.66	5.66	0.00
Exit Rate %	0.67	3.89	0.00
Equity Issuance All	3.34	1.00	1.44
Loan Interest Rate %	8.40	10.39	12.69
Frequency Equity Issuance all %	15.33	3.61	5.65
Frequency Equity Issuance Foreign %	21.11	2.94	-
Frequency Equity Issuance Domestic %	6.66	1.12	5.65
Std Dev Equity Issuance all %	3.34	5.19	5.90
Std Dev Equity Issuance Foreign %	3.65	4.75	-
Std Dev Equity Issuance Domestic %	2.83	2.83	5.90
Asset Return Foreign %	3.57	3.09	-
Asset Return Domestic %	1.93	3.79	5.03
Std Dev Asset Return all %	3.67	6.21	7.91
Dividend / Asset %	3.51	4.24	6.56

Note: Data moments are computing using commercial bank level data from Mexico from 1998 to 2012. Source: Bankscope

Restricting foreign entry has two effects: it lowers competition for domestic banks (in our model this translates to giving the bank monopoly power) as well as insulating it from external funding crises. The most important difference we see is that given higher profitability of domestic banks (e.g. interest margins nearly double), there is no exit at all. This is partially accomplished by domestic banks issuing more equity. Since interest rates are higher and there is limited liability, entrepreneurs take on more risk which leads to higher default frequencies. The higher profitability of banks also leads them to issue more dividends.

Figure 7 presents the evolution of output under both scenarios: the benchmark economy where foreign bank competition is possible and the counterfactual economy where creating a foreign bank is prohibitively expensive. The sequence of exogenous shocks is the same in both cases. This figure makes evident that, on average, output is higher when there is foreign bank competition. Importantly, credit expansions are more pronounced when when foreign banks are present and concentration is lower than in the counterfactual economy with no foreign banks. We also note that when confronted with the same exogenous changes in productivity or global conditions, output drops are more pronounced in the no foreign bank economy than in the economy with foreign banks. In summary, output is higher and credit expansions are more pronounced when there is foreign bank competition than when there is not and credit contractions are more pronounced when foreign competition is no possible. At the calibrated parameters, this results in output (and consumption) being higher and more volatile in the benchmark than in the counterfactual economy. This has important welfare implications that we explore in what follows.

Figure 7: Foreign Bank Competition and Evolution of Output



Note: periods where $z = z_c$ are represented with blue bars, periods where $\eta = \eta_b$ are represented with red bars and periods where both $z = z_c$ and $\eta = \eta_b$ occur together are presented in purple bars. "(No F)" denotes the economy with no foreign bank competition. "no foreign" corresponds to the case where Υ^f is prohibitively high (i.e., no foreign bank competition is allowed).

6.1 Welfare Analysis

In order to assess the welfare consequences of the Mexican government's policy of restricting foreign bank competition prior to 1998, here we ask the question "What would households and entrepreneurs be willing to pay (or be paid) to loosen the restrictions on foreign bank competition?"

To answer this question, we calculate consumption equivalents for each type of agent in each possible state of the world. Specifically, we let $V_h^{bench}(\mu, z, \eta)$ and $V_h^{count}(\mu, z, \eta)$ denote the value for the household of being the benchmark economy with foreign bank competition and the counterfactual economy without foreign banks, respectively.[11] Similarly, $V_e^{bench}(\mu, z, \eta)$ and $V_e^{count}(\mu, z, \eta)$ are the corresponding values for the entrepreneurs. Then the household's consumption equivalent when the economy is in state $\{\mu, z, \eta\}$ is

$$\alpha_h(\mu, z, \eta) = \left\{ \frac{V_h^{bench}(\mu, z, \eta)}{V_h^{count}(\mu, z, \eta)} \right\}^{\sigma-1} - 1$$

and the consumption equivalent for entrepreneurs is given by

$$\alpha_e(\mu, z, \eta) = \left\{ \frac{V_e^{bench}(\mu, z, \eta)}{V_e^{count}(\mu, z, \eta)} \right\} - 1.$$

Since there is a unit mass of households and entrepreneurs, the aggregate consumption equivalent in state $\{\mu, z, \eta\}$ is given by

$$\alpha(\mu, z, \eta) = \alpha_h(\mu, z, \eta) + \alpha_e(\mu, z, \eta).$$

We denote the frequency our economy visits each state by $f(\mu, z, \eta)$ (i.e. the fraction of periods that the equilibrium visits each state) and use it to calculate an ex-ante consumption equivalent. In the case of households, this is given by

$$\overline{\alpha}_h = \sum_{\mu,z,\eta} \alpha_h(\mu, z, \eta) f(\mu, z, \eta),$$

while for entrepreneurs it is

$$\overline{\alpha}_e = \sum_{\mu,z,\eta} \alpha_e(\mu, z, \eta) f(\mu, z, \eta).$$

In this case, the aggregate is

$$\overline{\alpha} = \overline{\alpha}_h + \overline{\alpha}_e.$$

Table 6 presents the results. Since the economy with only domestic banks has no exit, the model transits only through states with $\mu = \{0, 1\}$. We obtain that aggregating household and entrepreneurs, they will be willing to pay 6.326% of consumption in order to allow for foreign bank competition. The bulk of this value is coming from entrepreneurs since households will be willing to pay 0.799% of consumption each period compared to 5.527% for entrepreneurs in order to move to an economy with foreign bank competition. The results

[11] We assume that households can only hold shares in domestic banks.

can be explained by looking at how foreign bank competition affects the evolution of key aggregates. One one hand, the introduction of foreign banks increases loan supply (+31.29%) that also results in a higher level of output (31.35%) with lower interest rates and default frequency. It also results in the need of collecting higher taxes (1.572% of output) since there is bank exit. On the other hand, the introduction of foreign bank competition introduces a new source of fluctuations in the economy. First, fluctuations in the world economy have an impact on the loan supply of the foreign bank by affecting its costs of funds. Second, the increase in competition generates endogenous entry and exit. In the economy with foreign bank competition, the exit rate is 4.108% compared with no exit in the economy without foreign banks. The overall effect is an increase in the volatility (measured using the coefficient of variation) of loan supply and output of 12.91% and 10.11% respectively. This volatility effect counterbalances the level effect and explains the differences in consumption equivalents between households (that are risk averse) and entrepreneurs (that are risk-neutral). In summary, while opening up to foreign banking competition is a welfare benefit for both workers and entrepreneurs, it is a big boon for business.

Table 6: Consumption Equivalents for Households, Entrepreneurs and Aggregate (in %)

	z_c		z_b		z_g	
	η_g	η_b	η_g	η_b	η_g	η_b
$f(\mu = \{0,1\}, z, \eta)$	10.72	2.81	30.02	9.90	38.65	7.90
$\alpha_h(\mu = \{0,1\}, z, \eta)$	0.54	0.52	0.72	0.73	0.93	0.96
$\overline{\alpha}_h$	0.799					
$\alpha_e(\mu = \{0,1\}, z, \eta)$	4.09	3.89	5.44	5.27	6.11	5.87
$\overline{\alpha}_e$	5.527					
$\alpha_e(\mu = \{0,1\}, z, \eta)$	4.63	4.42	6.17	6.00	7.04	6.83
$\overline{\alpha}_e$	6.326					

6.2 Decomposing the effects of Higher Competition vs Foreign Competition

In this section, we study how much of the overall effect is coming from a pure increase in competition vs allowing foreign banks (i.e. we try to understand how much of the welfare effects are due to the fact that in our main counterfactual we move from one domestic bank economy to one where there are potentially up to two banks, one national and one foreign). We compute the welfare effects of allowing foreign bank competition against a counterfactual with up to two domestic banks.

In order to implement this counterfactual, as before, we raise Υ^f to a prohibitively high level and assume that there can be up to tow domestic banks in the market. Domestic banks are ex-ante identical (they have the same cost structure) and fully own by the domestic consumers. Since profitability of both banks is exactly the same, multiple of equilibra can arise. We assume that if at the exit stage there is more than one equilibrium (for example where one bank stays if the other exits and vice versa) we select the equilibrium where one of the active banks stays.[12]

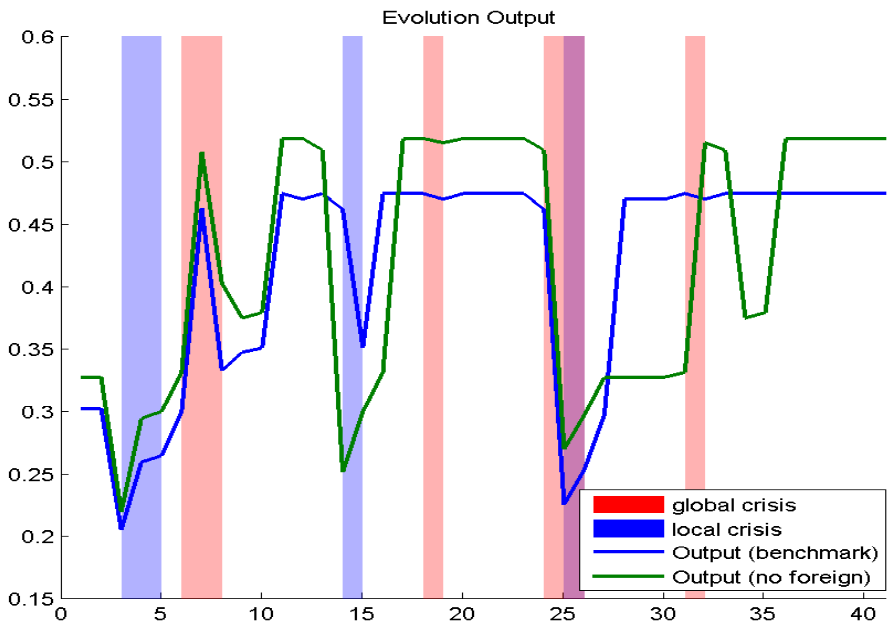
Table 7: Consumption Equivalents for Households, Entrepreneurs and Aggregate (in %)

	z_c		z_b		z_g	
	η_g	η_b	η_g	η_b	η_g	η_b
$f(\mu = \{0,1\}, z, \eta)$	0.80	0.70	1.11	0.47	0.00	0.00
$f(\mu = \{1,0\}, z, \eta)$	9.92	2.11	11.12	2.47	0.00	0.00
$f(\mu = \{1,1\}, z, \eta)$	0.00	0.00	17.79	6.96	38.65	7.90
$\alpha_h(\mu = \{0,1\}, z, \eta)$	0.11	0.13	0.14	0.23	0.11	0.41
$\alpha_h(\mu = \{1,0\}, z, \eta)$	0.60	0.74	0.38	0.66	0.78	0.74
$\alpha_h(\mu = \{1,1\}, z, \eta)$	0.48	0.48	0.49	0.52	0.69	0.64
$\overline{\alpha}_h$	0.577					
$\alpha_e(\mu = \{0,1\}, z, \eta)$	1.21	0.94	1.66	0.97	1.06	0.94
$\alpha_e(\mu = \{1,0\}, z, \eta)$	0.73	0.71	0.84	0.82	0.98	0.93
$\alpha_e(\mu = \{1,1\}, z, \eta)$	0.85	0.82	0.86	0.80	1.11	1.04
$\overline{\alpha}_e$	0.960					
$\alpha_e(\mu = \{0,1\}, z, \eta)$	1.32	1.07	1.80	1.20	1.16	1.34
$\alpha_e(\mu = \{1,0\}, z, \eta)$	1.33	1.45	1.21	1.48	1.76	1.67
$\alpha_e(\mu = \{1,1\}, z, \eta)$	1.32	1.30	1.35	1.31	1.80	1.68
$\overline{\alpha}_e$	1.537					

Table 7 presents the results separating welfare gains by state and across households and entrepreneurs. Table 7 shows that while welfare benefits are smaller than the case analyzed in Table 6, the main message of the paper does not change. Agents in the economy will be willing to pay up to 1.537% of permanent consumption in order to move to an economy with foreign banks. As Figure 8 shows, output is higher in an economy with foreign bank competition (3.75%). We also note that the welfare gains for entrepreneurs are not as high in this case since the increase in average output is smaller than when comparing to the case with only one domestic bank plus the exit rate is higher when foreign banks are allowed to compete resulting in higher taxes to pay for deposit insurance. Welfare gains are smaller for consumers as well since volatility is higher in the benchmark case than in the counterfactual without foreign banks (the coefficient of variation of output is 3.47% higher).

[12] An alternative is one where the selection of equilibrium is given by nature.

Figure 8: National Duopoly vs National/Foreign Duopoly and Evolution of Output



Note: periods where $z = z_c$ are represented with blue bars, periods where $\eta = \eta_b$ are represented with red bars and periods where both $z = z_c$ and $\eta = \eta_b$ occur together are presented in purple bars.

Figure 8 shows that output in the benchmark results to be higher than in the economy with two domestic banks since the later economy is more affected by domestic shocks. Drops in output and credit due to a domestic crisis (like in period 14) are more pronounced. This is mostly due to differences in the access to outside funding by foreign banks. We also see that when a global crisis hits together with with a local crisis (period 25) the drop in output is larger in the economy with foreign banks but the recovery in this economy is much faster recovering in only two periods as opposed as to the seven periods that it takes output to recover in the economy only with domestic banks.

7 Concluding Remarks

We provide a general equilibrium model where national banks coexist in equilibrium with foreign banks with better access to external funding. A contribution of our model is that the market structure is endogenous and imperfect competition amplifies the business cycle. We apply the framework to the Mexican banking industry, which underwent a major structural change in the 1990s as a consequence of both government policy and external shocks. In particular, we analyze the welfare consequences of allowing foreign bank competition. Our model shows that a more competitive environment (due to entry of foreign banks) induces output and aggregate loan supply increase resulting in lower interest rates and default by borrowers. However, bank exit, taxes and volatility are higher. We find that the effect coming from level changes in output dominates generating modest welfare gains for households and substantial gains for business.

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8 Data Appendix

Banking sector variables are from Bureau Van Dijks Bankscope dataset. To create our sample, we first screen for location, focusing on Mexico, and then we screen for the banks specialization, i.e. commercial banks. We consider "active" and "inactive" banks at the moment of downloading the data to incorporate banks which may have existed in the sample but are currently inactive. This leaves us with a sample of 61 banks.[13] Our sample starts in 1998 and goes to 2012, the earliest date available through Bankscope to the most recent date with consistent data. For balance sheet variables as well as income statement variables, we censorize the top and bottom 1% of the sample.

We use real Mexican GDP data from World Bank via Haver Analytics. We convert the data to United States Dollars (Thousands) with each periods closing date exchange rate.

8.1 Identifying Ownership

We follow Mico et al. [21] when coding ownership. This is time-consuming because there is no ownership identifier in the data. There is a field with a brief history of each institution that allows to track ownership changes. We also gathered information from individual bank websites as well as performed several internet searches, business week company profiles, Wikipedia and consulted country experts. For this reason, we focus on the the 10 largest banks in Mexico. The top 10 banks represent, on average, more than 80% of total assets in the industry.

Bankscopes Ownership Database shows an active banks organization hierarchy, the percentage of the bank owned by the parent, and the country where the parent is headquartered, all through time. For example, if Bank A is owned domestically by Bank B, which is ultimately owned by a foreign bank, Bank C, Bankscope will provide either the exact percentage of Bank A owned by Bank B and of Bank B owned by Bank C; or it will show if Banks A and B were wholly owned or majority owned. Looking through time, this allows us to check whether a bank is foreign or domestically held. Its worth noting that this data largely goes back only to 2002. We then complement the data with the "bank history" variable, which expounds on the banks story and explains if it was merged, liquidated, or altered in some way. As we explained above, we complement this with other sources.

In cases where Bankscope does not have complete information, we determine foreign/domestic ownership status by looking at total foreign ownership as a percentage of all information available. For example, in the case of Banco Del Bajio is owned by Temasek Holdings (13.3%), Banco De Sabadell SA (20%), International Finance Corporation (10%), and a number of foreign entities whose combined reported ownership is 85.3%. Foreign institutions hold 50.7% of the reported total, allowing us to designate Banco Del Bajio as a foreign institution. Banco Azteca SA, was the final case where ultimate ownership was unclear. Here, Bankscope reports 3 individuals as owning 72% of Banco Azteca SA, and 2 of those 3 individuals are Mexican. As such, we designate the bank as being domestic.

[13] An important point to note here is how Bankscope treats consolidation of subsidiaries. We set our search settings to primarily pull consolidated statements, and if those are unavailable for a subset, pull unconsolidated statements. This avoids duplication issues if a bank is a subsidiary of another bank.