FDI in the Banking Sector: Why borrowing costs fall while spread proxies increase

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Abstract

It is a well known quandry that when countries open their financial sectors, foreign-owned banks appear to bring superior efficiency to their host markets but also charge higher markups on borrowed funds than their domestically owned rivals. We construct a general equilibrium model of foreign direct investment (FDI) in the banking sector to capture this dichotomy, assessing its welfare implications for opening the financial sector to foreign participation. Using heterogeneous, imperfectly competitive lenders, the model illustrates that FDI can cause markups (the net interest margins commonly used to proxy lending-to-deposit rate spreads) to increase and at the same time cause the interest rates banks charge borrowers to fall. The phenomenon is especially relevant for less developed countries where it can be harder to implement the parent's technology and for countries where there are more limitations on entry by domestic banks. In the model, borrowing costs fall on average under liberalization due to improved efficiency among lenders, increasing consumption and welfare in both countries.

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1 Introduction

The financial industry is highly concentrated: the largest 15 multinational banks supply more than 20% of the world's private lending.[1] When countries contemplate liberalizing their banking sector to allow foreign participation, a natural tension therefore arises. There is the hope that foreign participation will reduce interest rates charged to borrowers through superior technical efficiency or increased competition, combined with the concern that large foreign banks will amass enormous market power in their host country and end up increasing rates. Brock and Rojas-Suarez (2000) put it most succinctly when discussing liberalization, including entry by foreign banks, in Latin America:

> " ...while the process of financial market liberalization is fully supported by policymakers in the region, there is a certain degree of disappointment with the results. In particular, policymakers expected that interest rate spreads would converge to international levels... high spreads are usually interpreted as an indicator of inefficiency, which adversely affects domestic real savings and investment (p.114)."

A number of studies have sought an empirical resolution to this question by testing the impact of foreign mergers and acquisitions on the net interest margin, the virtually universal proxy for the spread between the interest rate charged on loans and the one paid on deposits.[2] The authors have formed a well known puzzle: Though foreign entry generally seems to improve loan quality and reduce costs among active banks– two characteristics of increased competitive pressures– it is often associated with increased net interest margins. Several of these studies also demonstrate the importance of imperfect competition and heterogeneity among banks when considering the impacts of opening the banking sector to foreign entry, a combination missing from current theories of financial liberalization.

In this paper, we study foreign direct investment (FDI) in the financial sector in a model with imperfect competition and heterogeneous banks, so that we can capture the

[1] The 15 largest banks according to asset size are listed in the *Euromoney* August 2006 issue's "Bank Atlas." Lending is computed from 2006 "net loans" (loans minus loan loss provisions) in the Bankscope database. World lending is computed as the sum of "net loans" in 2006 for all banks in the database.

[2] To be precise, the log of the markup is the net interest margin, which is commonly used as a measure of interest rate spreads.

facts described above. The model generalizes the framework of Bernard, Eaton, Jensen and Kortum (2003, hereafter BEJK) to include foreign direct investment[3] and pinpoints the importance of the number of potential entrants, called "contestability" in the context of the banking sector by Claessens and Laeven (2004).

The model here contributes to several literatures examining financial and trade liberalization. It complements empirical work by Dages, Goldberg, and Kinney (2000), Reinhardt and Tokatlidis (2001), Buch, Cartensen, and Schertler (2005), Arena, Reinhart, and Vasquez (2006), Stebunovs (2006), Ghironi and Stebunovs (2007), and Cetorelli and Goldberg (2008) linking foreign participation in the banking sector to macroeconomic outcomes. Whereas those papers (with the exception of Dages, Goldberg, and Kinney, 2000) focus principally on output volatility and the transmission of shocks after liberalization, we focus on the distribution of markups, costs, and lending rates to bridge the macroeconomic analysis with a branch of empirical literature that considers the impact of foreign participation on these three variables. This branch includes Buch (2000), Claessens, Demirgüç-Kunt, and Huizinga (2001), Demirgüç-Kunt, Laeven, and Levine (2003), Claessens and Laeven (2004), and Martinez-Peria and Mody (2004), as well as others discussed in Section 2 below.

Heterogeneity in bank efficiency causes liberalization toward foreign participation to generate efficiency gains that reduce costs and consequently reduce the average interest rate for borrowers. In our model, liberalization policies always reduce the mean interest rate, but can actually increase the average net interest margin. An endogenous markup mechanism in our framework replicates the main stylized fact shown here and in existing micro-level empirical studies– that bank mergers often increase markups. The mechanism is based on the BEJK model, which allows for heterogeneity among industry participants while still incorporating a type of duopolistic competition akin to that embodied in the Salop model often used for analyses of the banking sector. The intuition is straightforward: A bank can charge a higher markup if it is more efficient than its next best domestic rival. If it is taken over by a foreign parent with superior technology, the bank becomes even more efficient than its next best rival. We also find a new conceptualization of contestability. A market with few potential entrants into the banking system is much more likely to see reduced average markups after opening itself to either foreign loans (loan liberalization) or foreign direct investment in the banking sector. Finally, we are able to demonstrate that

[3] Though quite different, our approach was inspired in part by Ramondo's (2007) expansion of the Ricardian framework with *perfect competition* in Eaton and Kortum (2002) to analyze bilateral flows of FDI in manufacturing industries.

the effects of foreign participation through takeovers are quite different from those of loan liberalization when technology transfer is not seemless.

The paper is structured as follows. Section 2 describes the empirical evidence on banks and international takeovers. The model, distributions and equilibrium are analyzed in Sections 3, 4 and 5, respectively. Section 6 discusses the effects of financial liberalization on markups, costs of funds, and welfare. The paper concludes with Section 7.

2 Banks and Foreign Takeovers: Empirical evidence

The most salient fact emerging from studies of liberalization in the banking sector is that common measures of lending-to-deposit rate spreads in local banks taken over by foreign financial institutions do not fall, in part due to an increase in market power. Claessens, et al. (2001) find that foreign owned banks have higher net interest margins and profits than domestic banks in developing countries but not in industrialized countries.[4] Our model below is consistent with these high net interest margins among foreign-owned banks. Furthermore, the different behavior of spreads in foreign-owned banks in industrialized versus developing countries can be explained if, for example, one supposes that it is easier for foreign banks to transfer their know-how over time and in industrialized countries or if pre-liberalization entry by domestic banks is more restricted in developing countries.

Table 1 shows summary statistics for net interest margins, the ratio of overhead expenses to total interest earning assets, and the ratio of personnel expenses to total interest earning assets for a panel of 80 countries. The data are split by whether there was a surge in foreign takeovers in the financial sector between 2000 and 2006 for any length of time.[5] All countries saw both net interest margins and costs drop by more than 10% between 2000 and 2006. However, in countries for which there is some evidence of a surge during the sample period, the drop in the mean of average costs was between 40 and 180 percent bigger than the drop for net interest margins. This is in contrast to countries exhibiting no evidence of a surge, where the mean for the net interest margin and for costs dropped at about the same rate.

To illustrate, Figure 1 shows the obvious upswing in foreign takeovers beginning in 2000

[4] Similar facts are reported in Martinez-Peria and Mody (2004), Vera, Zambrano-Sequin, and Faust (2007), Manzano and Neri (2001), Barajas, Steiner and Salazar (1999), among others.

[5] We run break tests, described in the Appendix, to identify a surge in foreign takeovers in the financial industry recorded in the Thomson SDC database. In the table we split the data by whether there is at least one test indicating the existence of a surge.

	Year	No.Obs.	Mean	St.Dev.	Skew	Min	Max
No M&A surge after 1999 (69 countries)							
Net Interest Margins							
	2000	2355	3.61	2.74	2.48	-1.33	23.21
	2006	2304	3.20	2.51	2.49	-1.28	21.65
	% change		-11.34	-8.61	0.44	-3.76	-6.72
$\frac{\text{Overhead Costs}}{\text{Total Earning Assets}}$							
	2000	2361	0.05	0.08	6.34	0.00	1.00
	2006	2306	0.04	0.08	6.67	0.00	0.87
	% change		-11.22	-4.05	5.13	4.85	-12.87
$\frac{\text{Personnel Costs}}{\text{Total Earning Assets}}$							
	2000	2210	0.02	0.04	6.79	0.00	0.48
	2006	2195	0.02	0.03	6.16	0.00	0.41
	%change		-12.01	-17.86	-0.09	16.78	-14.74
M&A surge after 1999 (11 countries)							
Net Interest Margins							
	2000	337	4.44	5.01	1.83	-1.31	22.99
	2006	425	3.52	3.14	2.32	-1.19	20.48
	% change		-20.79	-37.24	27.23	-9.16	-10.92
$\frac{\text{Overhead Costs}}{\text{Total Earning Assets}}$							
	2000	346	0.05	0.06	2.77	0.00	0.42
	2006	436	0.04	0.04	5.89	0.00	0.53
	% change		-28.37	-25.26	112.41	-12.40	27.82
$\frac{\text{Personnel Costs}}{\text{Total Earning Assets}}$							
	2000	174	0.03	0.03	2.52	0.00	0.20
	2006	276	0.02	0.02	4.07	0.00	0.21
	% change		-37.47	-36.96	61.66	-8.82	6.19

See App. A for description of data and methodology

Table 1: Summary Statistics

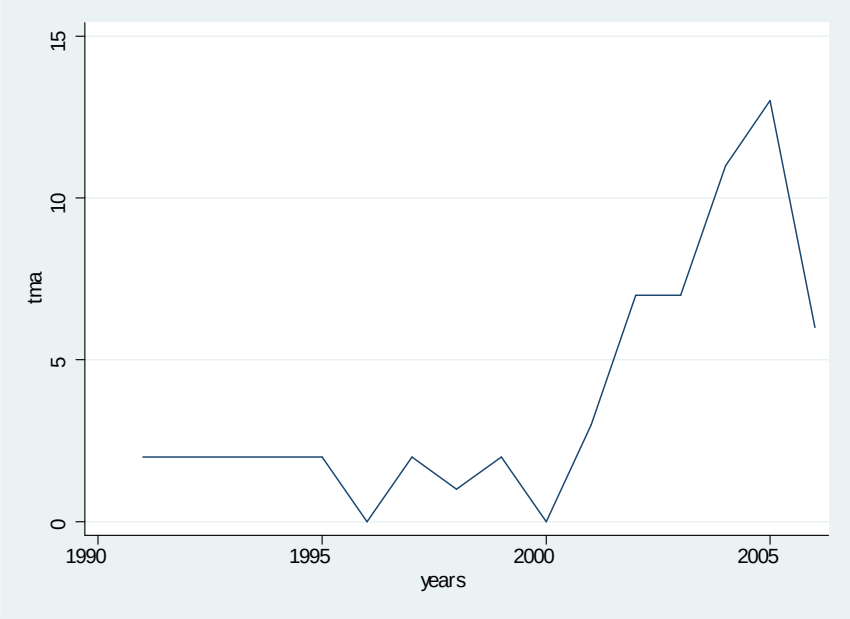

Figure 1: Cross-border M&As in China's Financial Sector

in China (we identify the surge as beginning in 2003), while Figure 2 shows the evolution of markups and costs during that period. The distribution for markups transforms from a rather flat form to one notably more hump-shaped. A look at the cumulative distribution functions for markups and costs in 2000 and 2006 (Figures 3 and 4) shows that the CDF for our markup proxy rotates counterclockwise in 2006 crossing the 2000 CDF while the CDF for costs shifts left, meaning on average a reduction in costs but an ambiguous change in the mean markup.[6]

Several additional stylized facts also emerge from the empirical literature. Heterogeneity is important in a model of mergers and acquisitions in the banking sector (Vennet, 2002; Buch, 2000; and Goldberg, 2007). The role of heterogeneity in lending behavior and in determining which banks become acquirors or targets has not yet been inculcated into theoretical models of the banking sector. However, it corresponds well with the empirical analysis (Arnold and Javorcik, 2005) and theoretical modelling of foreign direct investment

[6] We formalize the analysis of distributional shifts between 2000 and 2006 using the test for first-order stochastic dominance discussed by Barrett and Donald (2003). The results for country-specific tests for first-, second- and third- order dominance are collected Appendix A.

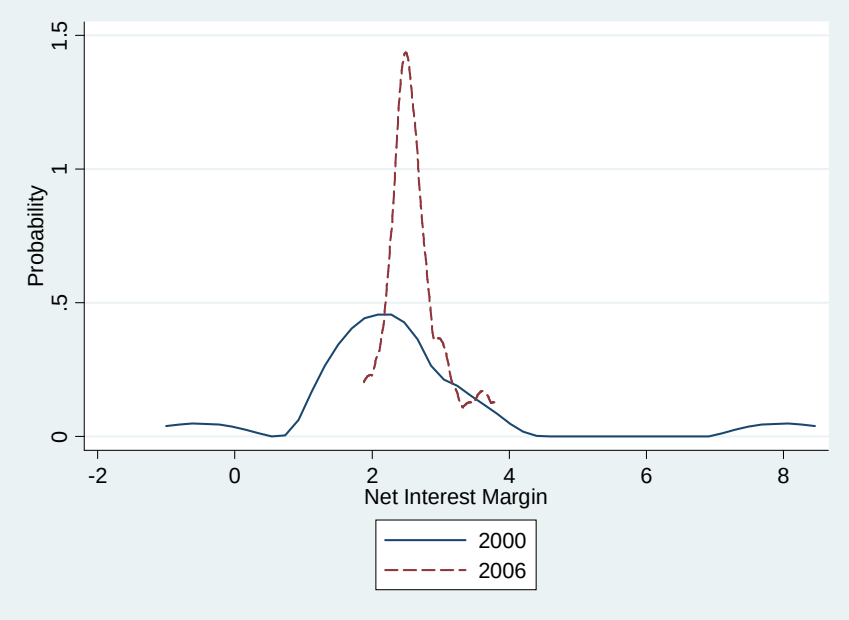

Figure 2: Probability Densities for Net Interest Margins in China, 2000 and 2006

in the trade and open economy macroeconomic literature (Helpman, Melitz, and Yeaple, 2003; Nocke and Yeaple, 2007; and Russ, 2007). The disconnect is likely because competition between banks is often modelled using the Salop framework.[7] Salop's (1979) seminal work features monopolistic competition among firms located symmetrically along a circle, which derives in duopolistic competition between the two closest firms. In equilibrium all firms behave symmetrically, and charge the same price to consumers. Only one author has introduced heterogeneity among many competitors' efficiency levels in a Salop model in general equilibrium, Vogel (2007a and b).[8] Here, we focus on heterogeneous efficiency levels– expanding the degree of heterogeneity beyond that allowed in Vogel's work, while preserving the endogenous markups that emerge from Salop's duopolistic competition between neighboring banks, via the BEJK setup. If there is "too much" disparity between competitors' efficiency levels in a Salop model, the more efficient competitor may absorb the entire market. The BEJK framework allows a full continuum of heterogeneity between

[7] See for example Andrés and Arce (2009) and Cordella and Yeyati (2002).

[8] Croft and Spencer (2004, revision forthcoming) also succeed in introducing heterogeneous Salop-type transaction costs in a study of ATM charges.

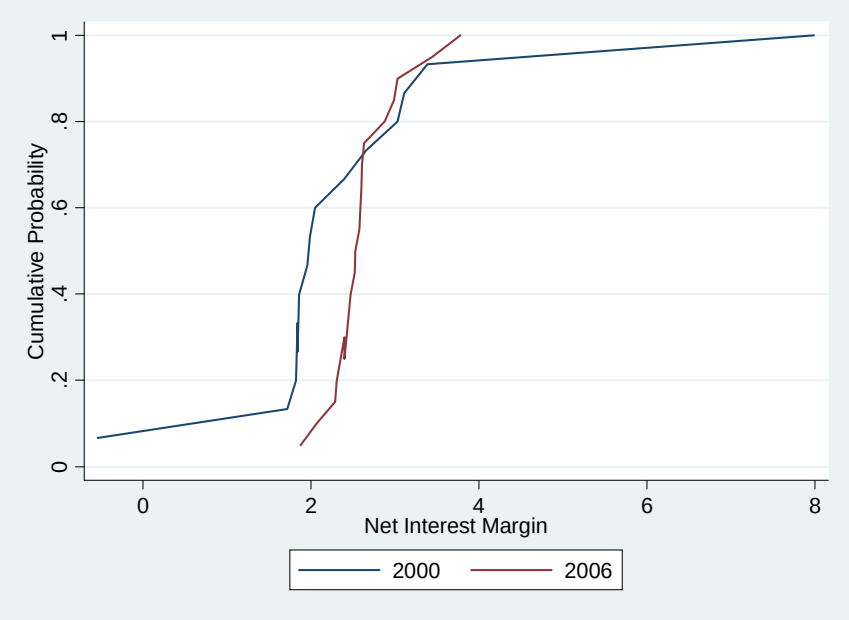

Figure 3: Cumulative Densities for Net Interest Margins in China, 2000 and 2006

competitors and preserves the duopolistic competition by limiting market share through a CES[9] desire for variety.[10]

Second, efficiency correlates with bank size in the same way as in studies of manufacturing firms by Bernard and Jensen (1999) and Bernard, Redding and Schott (2007). In particular, Demirgüç-Kunt, Laeven, and Levine (2003) find using individual bank balance sheet data that large banks have lower non-interest expenses, including personnel costs. Thus, when cross-border mergers and acquisitions (M&As) take place, one can expect that they will involve a larger, more efficient foreign bank taking over a smaller, less efficient domestic bank.

Third, despite the potentially positive effect on market power and markups, Focarelli

[9] Constant elasticity of substitution–in BEJK this is the bundling of goods in the utility function. Below, it is the need for different types of credit bundled into the representative firm's credit constraint.

[10] Mandelman (2006) endogenizes this upperbound of the market share in a model of heterogeneous banks using an elegant mechanism design technique motivated by geographic segmentation of the credit market within a closed economy. Since our focus is on the impact of foreign participation, we turn to the BEJK framework where the market shares are limited by customers' need for a variety of types of different kinds of credit, but duopolistic competition still generates an endogenous markup.

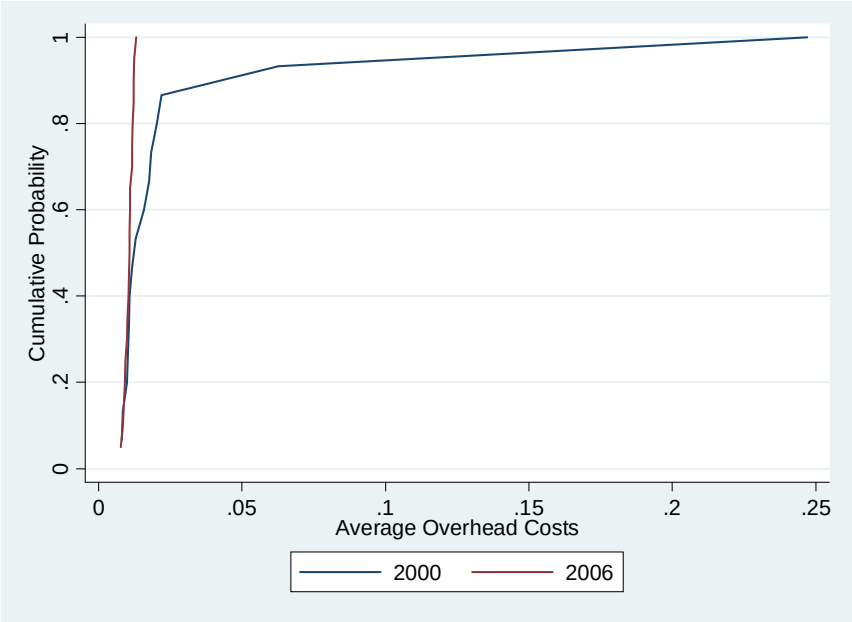

Figure 4: Cumulative Densities for Average Overhead Costs in China, 2000 and 2006

and Panetta (2003) find long-run efficiency gains following domestic bank mergers. Their study focuses on the market for bank deposits, using data on actual deposit rates paid to borrowers, rather than the net interest margin. They argue that the long-run efficiency gains, which match the efficiency gains from liberalization in our model below, eventually generate more favorable deposit rates, outweighing the short-run impact of increases in market power, which are also quantified by Hannan and Prager (1998). We do not capture cost-cutting behavior by domestic banks, but foreign entry does select out the higher-cost domestic banks in the model.

Fourth, using bank-level data on lending and deposit rates, Brock and Franken (2003) find that net interest margins are positively correlated with bank concentration,[11] whereas actual spreads are negatively correlated with concentration. This suprising finding is explained in our model because efficient banks charge lower spreads, giving them a larger market share, but can also potentially charge larger markups over their next-best competitor.

[11] The positive correlation between net interest margins and concentration is also observed in the euro area by Corvoisier and Gropp (2002).

Fifth, Claessens and Laeven (2004), working with a panel of 50 countries, find that foreign entry increases the degree of competition in the banking industry, but that domestic restrictions on bank participation are up to ten times more influential on the overall competitiveness of the environment. They call the ease of domestic participation in various credit niches "contestability" and, generalizing the BEJK framework, we also find that it has a big influence over how likely foreign entry is to reduce markups and the average lending rate.

Finally, several papers indicate that increasing distance between countries–whether geographic, linguistic, or cultural–reduces both cross-border mergers and acquisisions in the banking sector and banks' holdings of net foreign assets, (Buch, 2005; and Buch, Driscoll and Ostergaard, 2005). In the model below, the distance variable plays a big role in differentiating between the impact of FDI versus liberalization toward foreign loans. If parent banks can seemlessly transfer their technology to their overseas targets, then the two types of liberalization have exactly the same impact on the distribution of markups and interest rates, yielding identical welfare effects.

3 A Model of Heterogeneous Banks in Financial Autarky

The model economy is composed of consumers, firms, and banks. For simplicity, there is no depreciating physical capital and any potential shocks that could affect demand or production in a particular period are already realized at the time agents make their decisions. Thus, we omit discussion of time subscripts except when describing the consumer's savings behavior below.

Our objective is to analyze the general equilibrium effects of financial openness in three different scenarios: financial autarky (our benchmark); free access to foreign loans (what we call loan liberalization); and entry of foreign banks via mergers and acquisitions (foreign direct investment). We begin the description of the economy under financial autarky, with special emphasis on the banking sector.

3.1 Households

There is a continuum of households in the interval $[0, 1]$. Individuals in this economy consume and work at the firms. They have funds each period that are deposited at the bank in return of some interest. Households are assumed to own both firms and banks, so

at the end of every period they receive dividends from these activities.

The utility function of the representative consumer is the following:

$$u(q_t, \mathtt{h}_t) = \frac{q_t^{1-\rho}}{1-\rho} - \frac{\mathtt{h}_t^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}},$$

where q_t is consumption and $\mathtt{h}_t$ is labor supply in period t. The exogenous parameters ρ and γ are, respectively, the coefficient of relative risk aversion and the elasticity of labor supply. Each consumer maximizes utility by choosing consumption, labor supply and deposits

$$\max_{q_t, \mathtt{h}_t, d_{t+1}} \sum_{t=0}^{\infty} \beta^t u\left(q_t, \mathtt{h}_t\right)$$

subject to the following budget constraint:

$$d_{t+1} + q_t \leq (1 + \bar{r}_t) d_t + w_t \mathtt{h}_t + \pi_t^F + \pi_t^B,$$

where d_t are one-period deposits at the banks, w_t are real wages, $\bar{r}_t$ is the market interest rate on deposits, and π_t^F and π_t^B are profits from firms and banks, respectively. Consumers are indifferent with regard to the banks where they deposit their funds, so they simply divide total deposits, d_t.

3.2 Firms

There is a continuum of perfectly competitive firms in the interval $[0, 1]$ that produce the final good devoted to consumption. They need to hire workers in order to start production, but do not have funds until after the goods are sold, so they must borrow this working capital.

Let the aggregate price level of the homogeneous domestically produced final good ($p \equiv 1$) be the numeraire. Technology is given by $y = Ah^{1-\alpha}$. The representative firm maximizes profits

$$\max_h \pi^F$$

subject to

$$\pi^F = Ah^{1-\alpha} - wh - rl^d$$

and

$$l^d = wh \ ,$$

where l^d is the total amount of loans borrowed by the firm, h is labor demand, w is the unit input cost, taken as given by firms, and A is an aggregate productivity parameter. The first order condition with respect to labor gives the labor demand by the representative firm

$$h = \left(\frac{(1-\alpha)\, A}{(1+r)w} \right)^{\frac{1}{\alpha}} .$$

For simplicity and because firms often have a portfolio of loans with slightly different purposes and associated services (mortgages, car loans, small business loans, corporate credit, trade credit, etc.), we assume that the representative firm demands a portfolio of loans, with loans of different types combined using a constant elasticity of substitution, $\sigma > 1$. Given that there are thousands of firms in any particular country, it is reasonable to assume that a representative firm assembles a basket of J different types of loans and may substitute between them based on the terms (interest rate charges) of each type.[12]

The representative firm chooses the optimal demand for loans from bank j, $l^d(j)$, by solving the following cost minimization problem:

$$\min_{l^d(j)} \ r l^d - \sum_{1}^{J} r(j) l^d(j)$$

subject to

$$l^d = \left[\sum_{1}^{J} l^d(j)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} .$$

The demand for loans in each market niche j by firms in a particular country is given by

$$l^d(j) = \left(\frac{r(j)}{r} \right)^{-\sigma} wh \ ,$$

where the aggregate market interest rate, r, comes from minimizing the cost of one bundle

[12] The differences between each type of loan can arise due to geographic segmentation of the market, or to a demand for different types of credit services in which banks might specialize, or even due to preferences regarding superficial aspects of customer service like the training and behavior of the loan officers or the format of online services. In fact, there is quite a bit of empirical evidence documenting that firms typically take out loans from multiple banks (Udell, 2007; Bannier, 2005; Shikimi, 2005; and Escudero, 2003).

of loans to the representative firm, is given by

$$r = \left[\frac{1}{J} \sum_{1}^{J} r(j)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}.$$

3.3 The banking sector

Banks in this economy are distributed in niches indexed by j, with a total of $[1, J]$ niches. Within each niche, banks draw an individual cost parameter that characterizes the calibre of their management and technology.[13] Let $C_k(j)$ denote the overhead cost parameter of the kth most efficient bank in sector j of a particular country. The overhead cost parameter represents per-unit non-interest expenditures (for instance, on personnel and facilities), or expenditures on deposits that are not immediately converted to loans due to inefficiency. The bank's cost per dollar of loans supplied is then $\bar{r}C_k(j)$, with $\bar{r}$ being the risk-free rate paid to depositors.

Within each niche, banks compete by strategically setting their interest rates, so that only the bank charging the lowest interest rate– the bank with the lowest cost for a particular type of loan– supplies loans in that market segment. The unit cost function for the supplier in niche j is thus $\bar{r}C_1(j)$, with $C_1(j) = \min\{C_k(j)\}$. As described in BEJK, this low-cost supplier can not charge more than the marginal cost of the second-lowest cost firm. Otherwise it will be undersold by this next most efficient competitor. It would like to charge the maximum markup possible, the standard Dixit-Stiglitz markup, $\bar{m} = \frac{\sigma}{\sigma-1}$, but can only do this if the cost of its next-best competitor exceeds its own unit cost times the maximum markup, or $C_2(j) > \bar{m}C_1(j)$. This duopolistic competition between banks implies that the lending-to-deposit rates spread is ultimately endogenous. Thus, we have the interest rate on loans in niche j given by

$$r(j) = \min\left\{ \frac{C_2(j)}{C_1(j)} \left[\bar{r}C_1(j)\right], \bar{m}\left[\bar{r}C_1(j)\right] \right\},$$

with variable profits for the niche-j bank supplier equal to

$$\pi^B(j) = r(j)l^s(j) - \bar{r}d(j),$$

[13] We can assume that each bank competes in only one niche or that all banks draw a separate i.i.d. cost parameter for each of the J niches, but with no economies of scope.

where $d(j)$ represents the amount of deposits the bank collects to make the loans and cover non-interest expenses incurred before loans are repaid.[14] Since households are indifferent regarding where to deposit, the amount of deposits held in any particular bank, $d(j)$, differs across banks only due to differences in banks' demand for deposits to make loans. These differences arise entirely due to the particular cost parameters randomly drawn in period 0 by the first- and second- most efficient banks in each niche j. We assume that the number of credit "niches," J, is large enough that each bank takes the aggregate interest rate and the aggregate demand for loans as given. The amount the bank loans out, $l^s(j)$, must equal the amount of deposits it holds, less the amount it must use to cover its noninterest expenses (or interest on deposits stuck as "net inventory" as an inefficient bank takes extra time to transform incoming deposits into loan contracts), $\frac{d(j)}{C_1(j)}$, with $C_n(j) > 1$ for all n and j by an assumption built into the cumulative distribution underlying $C_n(j)$.

Many studies have used net interest rate margins as a proxy for markups when analyzing the impact of financial sector liberalization on borrowing costs due to data constraints. That is, few authors have had access to actual data on lending and deposit rates and instead rely on measures of the net interest margin, which we do here. However, using the model we can still map the distribution of markups into the distribution of net interest margins. In particular, it is simple to show that the log of the markup is approximately equal to the net interest margin. The log markup is given by

$$\begin{aligned} \log m(j) &= \log r(j) - \log \bar{r} C_1(j) \\ &\approx [1 + r(j)] - [1 + \bar{r} C_1(j)] \\ &= r(j) - \bar{r} C_1(j). \end{aligned}$$

The "wide" net interest margin,[15] equal to total interest revenues minus total interest expenditures divided by assets equals

$$\begin{aligned} NIM &= \frac{r(j) l^s(j) - \bar{r} d(j)}{l^s(j)} \\ &= r(j) - \bar{r} C_1(j), \end{aligned}$$

[14] We assume for simplicity that bank working capital is thus drawn from deposits, but the same cost structure would result even if working capital was derived from the funds of bank owners, since the opportunity cost of putting up the funds would be the rate of interest on deposits.

[15] This is definition 4w in Brock and Rojas-Suarez (2000, p.122) and is also used by Claessens et al. (2001), among numerous others.

where we have used $d(j) = C_1(j)l^s(j)$. Thus, the model's depiction of markups is easily reconciled with existing empirical research.

4 Distributions for cost parameters and the markup

Each bank in niche j draws its cost parameter from an identical, independent Weibull function,

$$F(c) = 1 - e^{-T(c-1)^\theta},$$

with positive support over $[1, \infty)$,[16] that is, the probability that a bank can loan out funds for less than the rate of interest on deposits (i.e., $c < 1$) is zero. Given n potential entrants in the niche, let c_1 represent the efficiency level of the most efficient (n^{th} lowest-cost) lender and c_2 the efficiency level of the second most efficient ($(n-1)^{th}$ lowest-cost) lender. Then, one can derive the joint density for the two lowest record values, $g_{n,n-1}(c_1, c_2)$ as a function of the hazard rate and the density of the underlying distribution (Ahsanullah, 2004)

$$\begin{aligned}
g_{n,n-1}(c_1, c_2) &= \frac{[H(c_2)]^{(n-1)-1}}{(n-2)!} h(c_2) f(c_1) \\
&= \left(\frac{[-\ln(F(c_2))]^{n-2}}{(n-2)!} \right) \left(-\frac{d}{dc_2} [-\ln(F(c_2))] \right) \frac{d}{dc_1} [F(c_1)] \\
&= \left(\frac{\left[-\ln(1 - e^{-T(c_2-1)^\theta}) \right]^{n-2}}{(n-2)!} \right) * \\
&\quad \frac{d}{dc_2} \left\{ -\ln\left(1 - e^{-T(c_2-1)^\theta}\right) \right\} T\theta \, (c_1 - 1)^{\theta-1} \, e^{-T(c_1-1)^\theta} \\
&= \left(\frac{e^{-[T(c_2-1)^\theta](n-1)}}{(n-2)!} \right) \frac{1}{1 - e^{-T(c_2-1)^\theta}} * \\
&\quad (T\theta)^2 \, (c_2 - 1)^{\theta-1} \, (c_1 - 1)^{\theta-1} \, e^{-T(c_1-1)^\theta},
\end{aligned}$$

[16] This is akin to assuming that banks draw an efficiency parameter z from a Fréchet distribution of the form $F(z) = 1 - e^{-Tz^{-\theta}}$ with support over $(0, 1]$, with unit cost given by $c\bar{r} = \frac{\bar{r}}{z}$. The Weibull function used here implies that the marginal cost of loaning one dollar is greater than or equal to the gross deposit rate ($c > 1$). Because it is not obvious how to formulate a Fréchet distribution bounded from above, but it is straightforward to formulate a Weibull distribution bounded from below, we start discussion of the bank's problem with the Weibull-distributed cost function.

where $H(c_2) = -\ln(F(c_2))$ and $h(c_2)$ is $\frac{dH(c_2)}{dc_2}$. The last equality follows from using the approximation $\ln(1+x) \approx x$ on the expression $\ln(1 - e^{-T(c_2-1)^\theta})$.[17]

Notice that the implied marginal density for c_2 is influenced by the number of rivals in the niche n:

$$g_2(c_2) = \int_1^\infty g(c_1, c_2)dc_1 = \left(\frac{e^{-\left[T(c_2-1)^\theta\right](n-1)}}{(n-2)!}\right)\frac{T\theta\,(c_2-1)^{\theta-1}}{1-e^{-T(c_2-1)^\theta}}.$$

Eaton and Kortum (2007) assume that this number of potential suppliers is Poisson distributed, a very realistic assumption for their examination of trade in goods across many different industries. With the special functional forms in their study, the number of rivals elegantly averages out into a function of the parameters governing the distribution of unit cost parameters (Eaton and Kortum 2007, Chapter 4 Appendix). In the specific case of the banking industry, government policy could bear an enormous impact on the number of potential entrants in each segment of the lending market. Thus, we use the parameter n to embody the concept of contestability examined empirically in the cross-country banking study by Claessens and Laeven (2004).

The markup charged by any particular supplier is $M(j) = \frac{r(j)}{\bar{r}}$. Since the lowest-cost bank wants to charge the highest markup possible subject to the cost of its next most efficient competitor in the niche and the elasticity of firms' demand for loans, the markup it charges is given by

$$m = \min\left\{\frac{C_2(j)}{C_1(j)}, \bar{m}\right\}.$$

We assume that bank efficiency levels are constant over time, making the markup a constant unless there is an influx of new competitors due to liberalization. Following BEJK, one

[17] Savvy readers may note that this density is a bit different than the joint density derived by Eaton and Kortum (2007) and BEJK, of the form $g(c_1, c_2) = h(c_1)f(c_2)$. This is because they start by deriving the joint density of the upper record values for firm efficiency, then substitute for efficiency using the unit cost function. The difference arises because we start by deriving the lower record values of the cost function, and because we do not integrate over n (see below). The results that follow are not qualitatively affected by this difference because our simulations use only $F(c)$.

can compute the cumulative distribution for the markup as

$$\begin{aligned}
\Pr\left[\frac{C_2(j)}{C_1(j)} \leq m' | C_2(j) = c_2\right] &= \Pr\left[\frac{C_2(j)}{m'} \leq C_1(j) \leq c_2 | C_2(j) = c_2\right] \\
&= \frac{\int_{(\frac{c_2}{m'})}^{c_2} g(c_1, c_2) dc_1}{\int_1^{c_2} g(c_1, c_2) dc_1} \\
&= \frac{(c_2 - 1)^\theta - (\frac{c_2}{m'} - 1)^\theta}{(c_2 - 1)^\theta} \\
&= 1 - \left(\frac{\frac{c_2}{m'} - 1}{c_2 - 1}\right)^\theta
\end{aligned}$$

If there were no lower bound for the cost, then the cumulative distribution would reduce to the expression in BEJK, which is entirely independent of c_2, $H(m) = 1 - m^{-\theta}$. A simple simulation demonstrates that we obtain a distribution with a pdf of roughly Pareto shape, shown in Figure 5. The simulation is done by first taking 100 draws (i.e. $n \equiv 100$) from a transform of $F(c)$ based on a uniformly distributed variable y, with $T = 5$ and $\theta = 6$. We then take $C_1(j) = c_1$, the lowest c drawn from this sample of 100 and $C_2(j) = c_2$, the second lowest draw. Then the markup is computed as $\min\left\{\frac{C_2(j)}{C_1(j)}, \bar{m}\right\}$, where $\bar{m}$ is calibrated using the maximum net interest margin in the Bankscope sample described above (the calibration implies $\sigma = 5.24$, so we choose $\sigma = 6$). The process is repeated to calculate the markup for 100 niches. Finally, the entire distribution is simulated 1000 times. The x-axis of Figure 5 is the markup value, and the y axis the probability that any of the markups is within a particular interval (of width 0.002) of markup values.

Notice that we have set the number of potential rivals equal to 100 in this example. Because the distribution of markups here is not separable from the distribution of c_2, it also depends on the level of contestability in the market (as seen in the formula for $g(c_2)$ above). To illustrate, Figure 6 shows the distribution of markups if the level of contestability in each niche is extremely low, so that $n = 2$. The number of banks in the entire banking industry charging very low markups (near 1) is dramatically curtailed, while the fraction of all banks charging the upperbound, $\bar{m} = \frac{\sigma}{\sigma - 1}$, more than doubles to nearly 12 percent. Due to its impact on the distribution of markups, increasing contestability (an increase in n) on average reduces the aggregate interest rate.

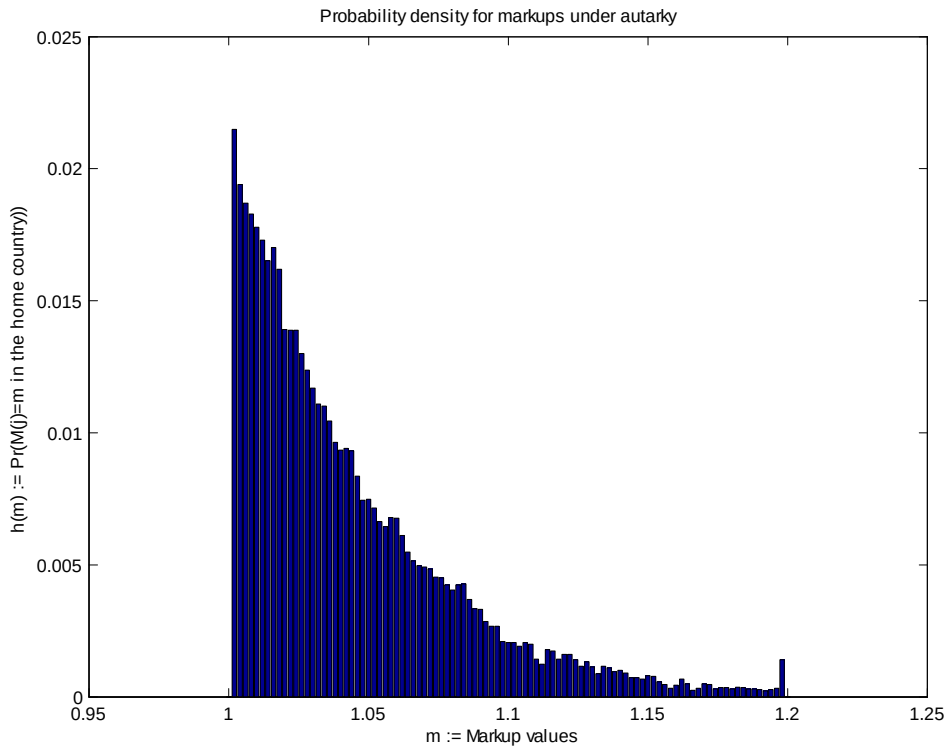

Figure 5: Probability density for markups in the Home country under autarky with many rivals in each niche

5 Equilibrium

The next step is to define equilibrium and the properties of the steady state. An equilibrium under autarky in this economy is defined by a set of quantities and prices such that households, firms, and banks solve their maximization problems, and markets clear, $\{q, p, w, h, y, r, \bar{r}, l, d, l(j), d(j), r(j)\}$. The equilibrium conditions emerge from the consumer's intertemporal optimization (derived Appendix C); the firm's demand for labor and loans; banks' price setting; the goods, deposit, and loan market clearing conditions; and the definition of the aggregate interest rate. These are shown for the steady state in Table 2. Closing the model requires one to specify the distribution of costs for banks, which allows one to calculate the distribution for markups and r. Given the duopolistic setup, the interest rate charged by any given bank will depend on the second most efficient

Consumers		
Labor supply	$q^{\rho} = w\mathtt{h}^{-\frac{1}{\gamma}}$	(1)
Euler condition	$\bar{r} = \frac{1-\beta}{\beta}$	(2)
Budget constraint	$q = w\mathtt{h} + \pi^{F} + \pi^{B} + d\bar{r}$	(3)
Firms		
Technology	$y = Ah^{1-\alpha}$	(4)
Optimal labor demand	$h = \left(\frac{(1-\alpha)A}{(1+r)w}\right)^{\frac{1}{\alpha}}$	(5)
Demand for loans	$l(j) = \left(\frac{r(j)}{r}\right)^{-\sigma} wh$	(6)
Banks		
Lending rate	$r(j) = \min\left\{\bar{r}C_2(j), \bar{m}\left[\bar{r}C_1(j)\right]\right\}$	(7)
Loan supply	$l(j) = \frac{d(j)}{C_1(j)}$	(8)
Market Clearing and Aggregation		
Loan market clearing	$l \equiv \sum_{1}^{J} l(j)$	(9)
Deposit market clearing	$d \equiv \sum_{1}^{J} d(j)$	(10)
Goods market clearing	$y \equiv q$	(11)
Aggregate interest rate	$r = \left[\frac{1}{J}\sum_{1}^{J} r(j)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$	(12)
Labor market clearing	$\mathtt{h} \equiv h$	(13)

Table 2: Model specification under autarky

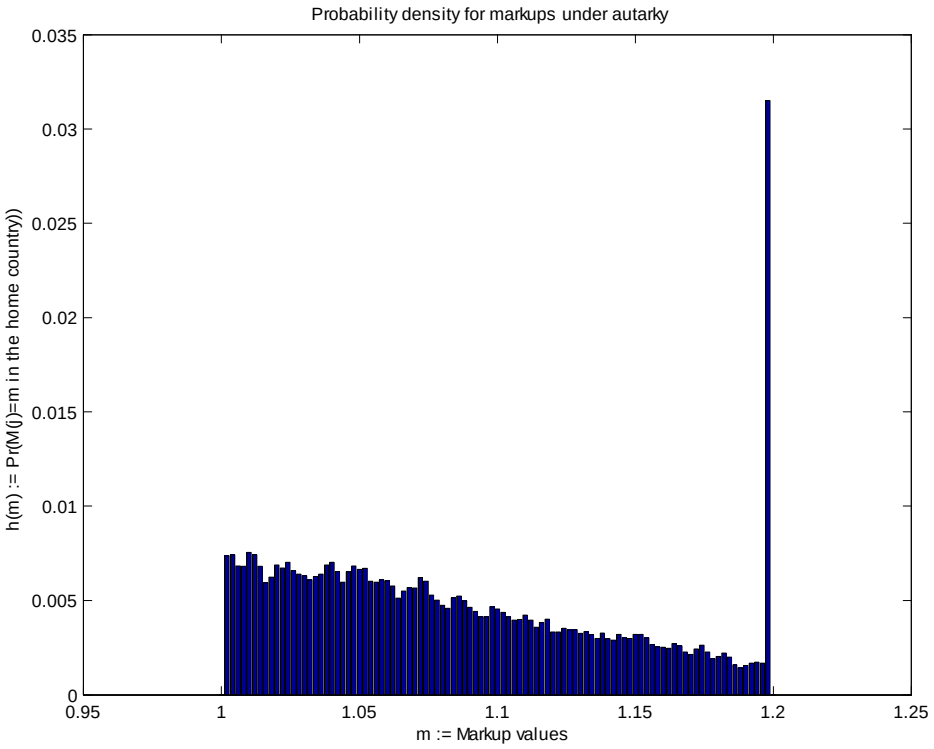

Figure 6: Probability density for markups in the Home country under autarky, with two rivals in each niche (low contestability)

competition in its niche. Due to the nonseparability issue described above, no closed-form solution for the distribution of markups or interest rates exists and we rely on simulations of the model to analyze the evolution of the spreads and all associated macro outcomes.

6 The markup, financial sector liberalization, and the cost of funds

From this point, the characterization of financial sector liberalization is important to predict the impact of liberalization on interest rate spreads. If liberalization is defined as the ability to borrow from banks located overseas, "importing" bank loans from abroad, then it can be shown numerically that the distribution of markups retains a roughly Pareto-like shape. Using data from the simulation technique above repeated for two identical

countries, Figure 7 shows that under this type of loan liberalization, the distribution of markups is quite similar to that under autarky in Figure 5. We will show below that in

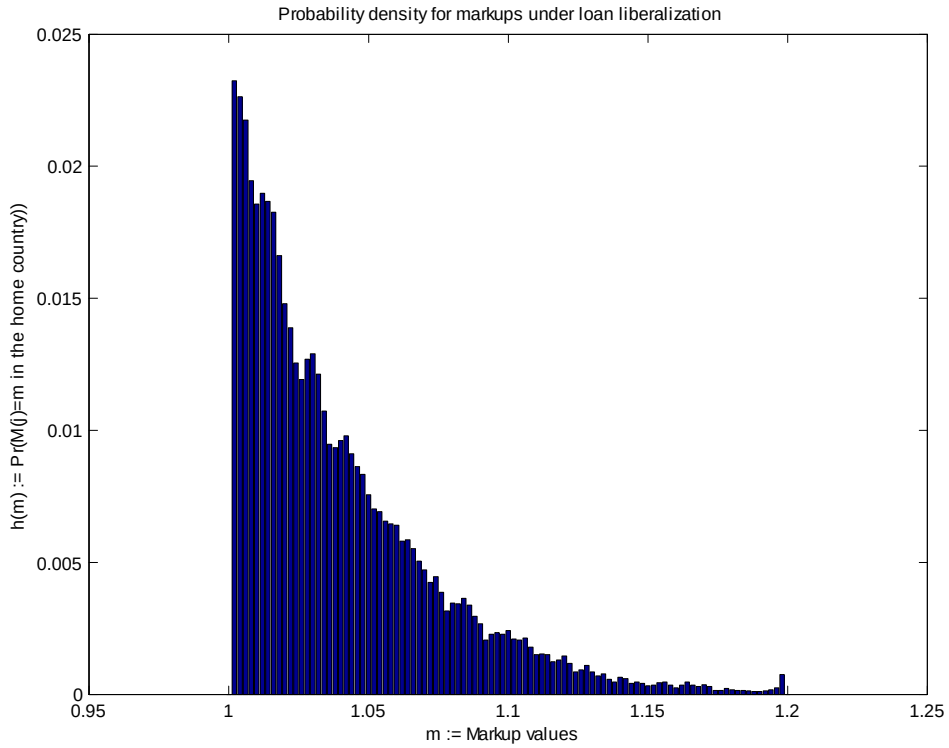

Figure 7: Distribution of markups in the Home country under loan liberalization

this benchmark setup with no geographic frictions, the distribution of markups and interest rates charged to borrowers under loan liberalization is, on average, stochastically dominated by the distribution under autarky: the average markup and interest rate fall under cross-border loan liberalization. One might define the average markup in the home country as an arithmetic mean, $\frac{1}{J}\sum_{j=1}^{J} m(j)$, or a market-share-weighted mean, $\left[\frac{1}{J}\sum_{j=1}^{J} m(j)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$, where J represents the number of market niches, equal to 100 in each iteration. In the simulation exercise here, both measures of the average markup fall under loan liberalization for 87 percent of the trials. This is largely because the expected markup is not separable from the cost parameter of the second-lowest-cost supplier and allowing firms to borrow from foreign banks has an effect similar to increasing contestability. Futher, the average interest rate, r, falls in all 1000 trials.

We can also compute the fraction of niches that will be supplied by foreign loans. When both countries are identical, the fraction is one half on average. If one country has lower contestability (n) or a lower technology parameter (the scale parameter, T), it will naturally experience higher rates of foreign participation.

Buch (2000) finds that the foreign asset holdings of banks fall with geographic distance. The loan liberalization in Figure 7 presumes that there is no extra cost involved in supplying loans to overseas firms. Suppose that the unit cost to foreign banks supplying loans to home firms is not $C_1(j)$, but $\delta_{loan}C_1(j)$, with $\delta_{loan} > 1$. This distance factor could represent all sorts of frictions, from added costs involved in locating and advertising to potential borrowers overseas to the cost of hedging exchange rate risk. As δ increases, fewer and fewer foreign banks supply credit to home firms and the distribution of markups under liberalization converges to the home distribution under autarky. Figure 8 shows that

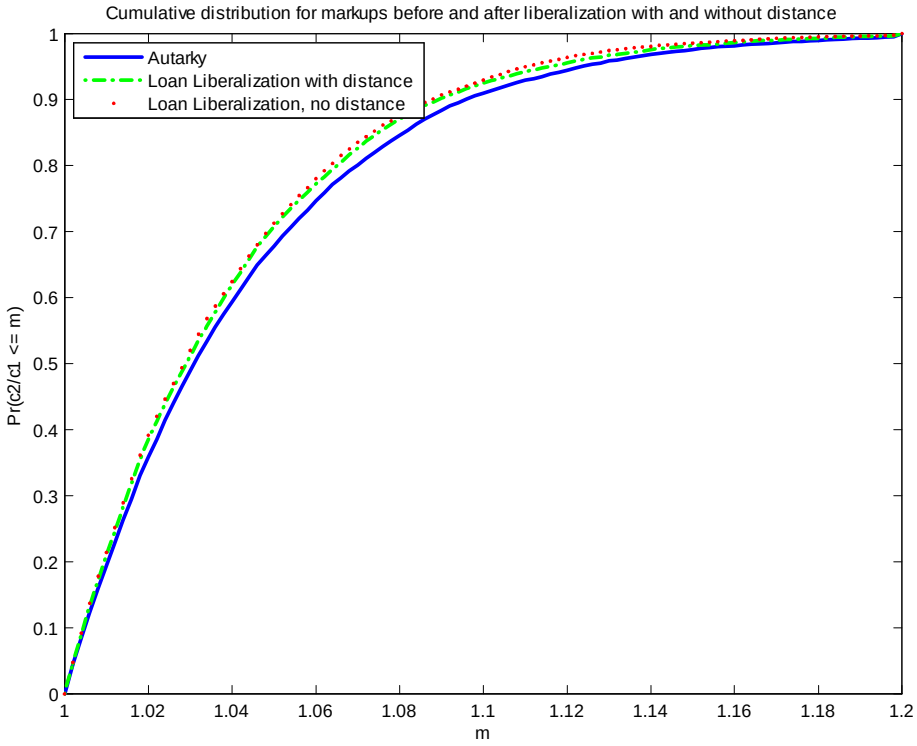

Figure 8: Loan liberalization and geographic frictions

the cdfs under liberalization (with and without distance) still do not cross the cdf under

autarky. Indeed, as the distance factor increases, limiting the number of foreign sources of credit, the cdf under liberalization simply converges to the distribution seen under autarky. Thus, the autarkic distribution of markups always first-order stochastically dominates or closely overlaps with the distribution after loan liberalization–i.e., loan liberalization almost always reduces the average markup and is most likely to do so when costs arising from distance are small. Below, we elaborate on this result and contrast it with openness to FDI in the financial sector.

6.1 FDI in the banking sector

Expanding the model to allow foreign takeovers of home banks provides a theoretical reason for why spreads may actually increase among banks taken over by a foreign parent, as documented in developing countries by Claessens, Demirgüç-Kunt, and Huizinga (2001). The intuition is straightforward and hinges on heterogeneous levels of efficiency among banks. First, consider a world where banks can buyout overseas banks only in their own niche through a bidding process. Buch (2000) reports evidence suggesting that parent banks are more efficient than the banks they acquire. If the parent bank can fully apply its management and technology after the merger, so that the target bank's lesser techniques do not influence costs at all, then the resulting distribution of markups is exactly the same as under the loan liberalization scenario (without any cross-border takeovers) discussed above. However, suppose that the foreign bank in niche j is more efficient than the lowest cost home bank, $C_1^*(j) < C_1(j)$, but the unit cost of the merged bank after a foreign takeover is some average of the two technologies. For instance, let the unit cost following the buyout, where a low-cost bank from niche j in the foreign country buys the low-cost bank from niche j in the home country, be given by

$$C_1^M(j) = (C_1^*(j))^{\frac{1}{\delta_{fdi}}} (C_1(j))^{1-\frac{1}{\delta_{fdi}}},$$

with $\delta_{fdi} \geq 1$.[18]

Because the lowest-cost foreign bank will be able to run a more efficient home branch after a merger, it can charge lower lending rates, lend out more money, and reap more

[18] The assumption is in the spirit of Nocke and Yeaple's (2007) modeling of foreign direct investment given mobile versus immobile technologies–the technology here is partially mobile, as the foreign parent must rely on the acquired firm for some know-how to help navigate the local market. In a more elaborate framework with asymmetric information, the acquired bank might have important information about the creditworthiness of local borrowers.

profits from the venture than the second-lowest-cost foreign bank could possibly do, given its inferior technology. Thus, it is immediately obvious that the most efficient foreign bank will be able to outbid the second-most efficient foreign bank for any potential target in the host country. The parent bank buys out the target by paying a dividend equal to the maximum of either (i) whatever profits the target would have made if it had been bought out by the second-highest foreign bidder in exchange for all operating profits, or (ii) whatever profits the target would make if it does not sell out and prices its loans according to the threat that its next-best domestic competitor might be bought out. The pricing of the takeover is specified in detail in Appendix B. The cherry-picking of the most efficient local bank in the niche is a result, rather than an assumption– taking all other banks' behavior as given, a merged bank is most profitable when it employs the most efficient technology available.

What is the impact of the mergers on markups? Given that the most efficient foreign bank buys out the most efficient home bank, if the second-lowest cost foreign bank in niche j wanted to enter the home market, it would then have to purchase the second-lowest cost home bank in niche j, giving it a cost of

$$C_2^M(j) = \left(C_2^*(j)\right)^{\frac{1}{\delta_{fdi}}} \left(C_2(j)\right)^{1-\frac{1}{\delta_{fdi}}}.$$

This matching process generates a distribution of markups under direct investment liberalization that may or may not first-order stochastically dominate the distribution of the markup under either autarky or loan liberalization. For the case where $C_1^*(j) < C_1(j)$ and $C_2^*(j) < C_2(j)$, one might expect an increase in the markup (a widening of the spread). However, under special circumstances the markup may fall in some niches. Suppose that $C_1(j) < C_1^*(j) < C_2(j)$. Then, although the low-cost home bank will not choose to merge, the threat of entry by the low-cost foreign competitor merging with the second-lowest cost home competitor will compel the low-cost home bank to lower its markup. Thus, direct investment liberalization can increase or decrease the average markup–the result is ambiguous, depending entirely on parameterization and the set of productivity draws in the two countries.[19]

To show this, we use the same data from the simulation above. FDI liberalization–

[19] It is only certain that the markup will never increase for local banks that are not bought out by foreigners. Therefore, merged banks in any sample will display a higher propensity to increase markups, even though only some of them actually do so, while others may have a markup that is reduced or unchanged from its pre-liberalization level.

opening the home country banking sector to FDI while prohibiting any direct borrowing from foreign banks located abroad–results in a reduced average markup in only 16 percent of cases for the arithmetic average and 34 percent of cases for the market-share-weighted average. That is to say, the distribution of markups under FDI liberalization is not stochastically dominated by the distribution under autarky (Figure 9). The cdf for markups under FDI liberalization crosses the cdf under autarky, meaning FDI can increase markups in some niches and reduce them in others, with no certainty as to the impact on the average markup.

In contrast, the cdf for loan liberalization will not generally fall below the cdf under autarky when the home and foreign country have the same level of technology, T. Loan liberalization will increase the markup in a particular niche only when three conditions hold: $C_1^*(j) < C_1(j)$, $C_2^*(j) < C_2(j)$, and $\frac{C_2^*(j)}{C_1^*(j)} > \frac{C_2(j)}{C_1(j)}$. Put another way, these three conditions imply that inflows of foreign loans will only increase the spread in the home country's niche j if both low-cost foreign banks have superior efficiency to the low-cost home banks *and* there is already a larger spread in the foreign country's niche j, so that the home country effectively imports a higher markup from the foreign country in that particular niche. In the absence of any one of these conditions, loan liberalization will reduce or have no effect the markup. Only one of the three conditions is always necessary to generate an increased markup in niche j following FDI liberalization: $C_1^*(j) < C_1(j)$. The second condition, $C_2^*(j) < C_2(j)$, is never necessary and the third, $\frac{C_2^*(j)}{C_1^*(j)} > \frac{C_2(j)}{C_1(j)}$, is only necessary if $C_2^*(j) < C_2(j)$. The matching process involved in foreign takeovers thus makes an increased spread much more likely than loan liberalization.

In the majority of cases, the duopolistic competition combined with imperfect transferability of bank efficiency results in an increased average markup as compared with autarky. Nonetheless, the average interest rate charged falls in all 1000 cases: the mergers increase banking sector efficiency to a degree that supercedes the impact of increased market power arising within a few sectors. Frictions impeding the full transfer of parent bank efficiency could very plausibly be higher in developing than industrialized countries and diminish with age. Thus, our model offers one explanation for why Claessens, Demirgüç-Kunt, and Huizinga (2001) find that markups are higher after foreign entry in developing countries, but not in industrialized ones. It also explains why Martinez-Peria and Mody (2004) find that the increased markup after foreign takeovers disappears when conditioning on the age of the merger. Increasing age may dissipate the technological transfer frictions, bringing the banks closer to the loan liberalization result.

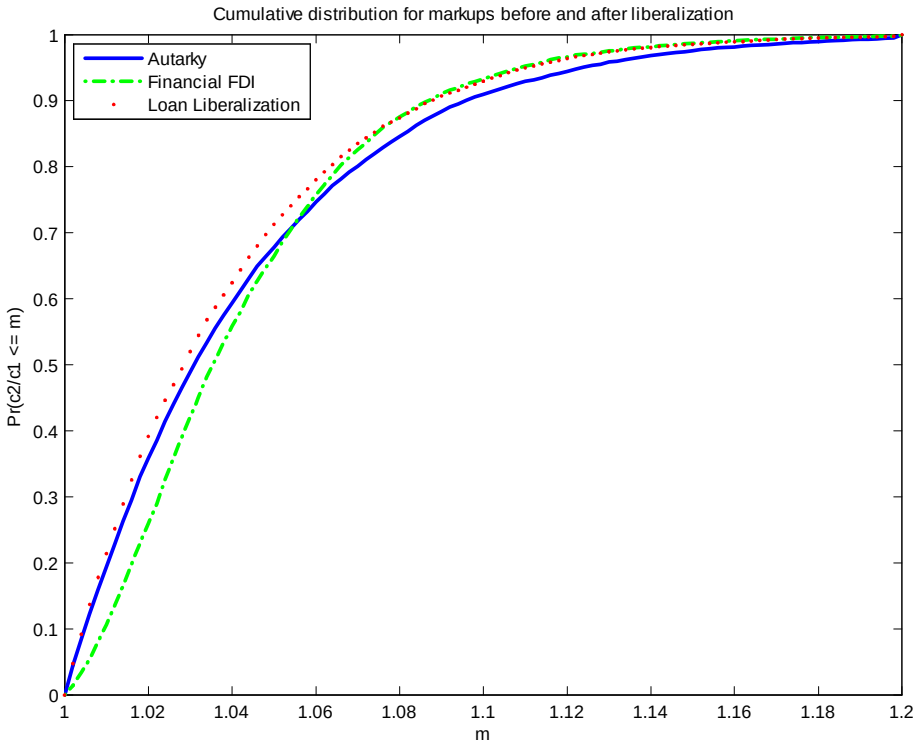

Figure 9: Loan liberalization vs. FDI in the financial sector

6.2 Bank efficiency and interest rates

What do increased markups mean for firms? Efficiency gains prevent these increased average markups from translating into higher borrowing costs. The distributions of costs and interest rates under autarky stochastically dominate the distributions for either loan or FDI liberalization (Figures 10 and 11). Thus, we can say unequivocally that either type of liberalization increases average bank efficiency and reduces the average lending rate. Numerical computations confirm that this is true in 100 percent of the simulated cases.

Theoretically, we can show why. Although the markup may increase, the actual spread always falls after a merger. Recall that the acquiring bank is always more efficient than

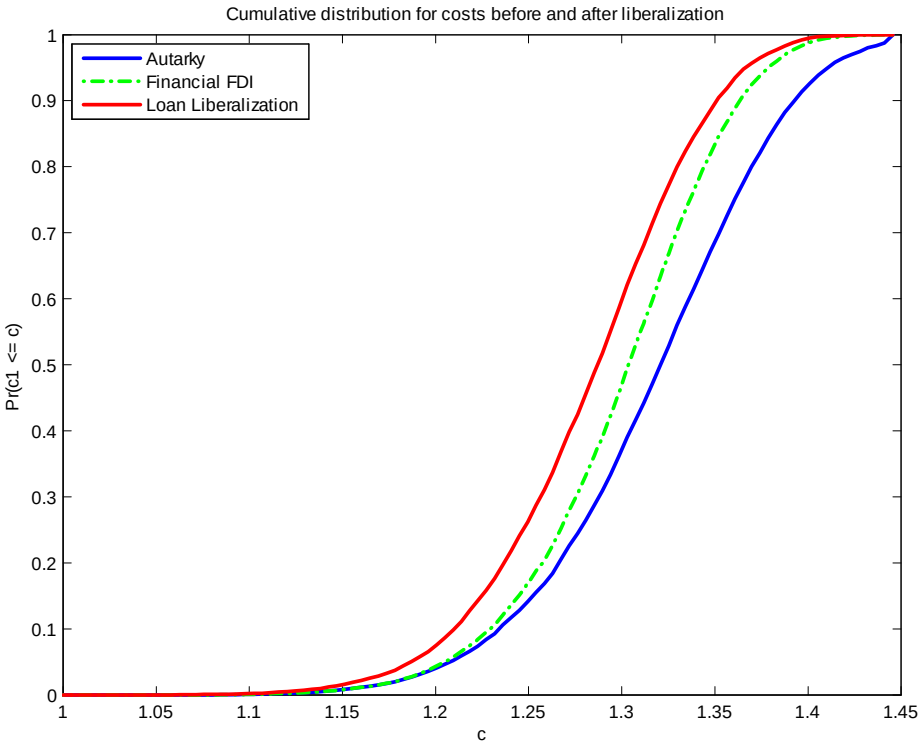

Figure 10: Loan liberalization and FDI in the financial sector reduce average costs

the target, or $C_1^M(j) < C_1(j)$. Then, the interest rate for the merged bank will be

$$\begin{aligned} r^M(j) &= \min\left\{\frac{\min\{C_2(j), C_2^M(j)\}}{C_1^M(j)} * C_1^M(j)\bar{r}, \bar{m}C_1^M(j)\right\} \\ &= \min\{\min\{C_2(j), C_2^M(j)\}\bar{r}, \bar{m}C_1^M(j)\}. \end{aligned}$$

The cost parameter of the second-best supplier of credit to niche j in the domestic market will either stay the same or fall after FDI liberalization, meaning the interest rate in niche j will never increase due to a takeover or the threat of a takeover. With a constant deposit rate, $\bar{r}$, that means that the actual spread ($r(j) - \bar{r}$, before the merger) can decrease even while the markup increases or stays the same due to the increased efficiency of the merged bank and possibly its potential rivals.

Claessens, Demirgüç-Kunt, and Huizinga (2001) offer evidence that domestic banks

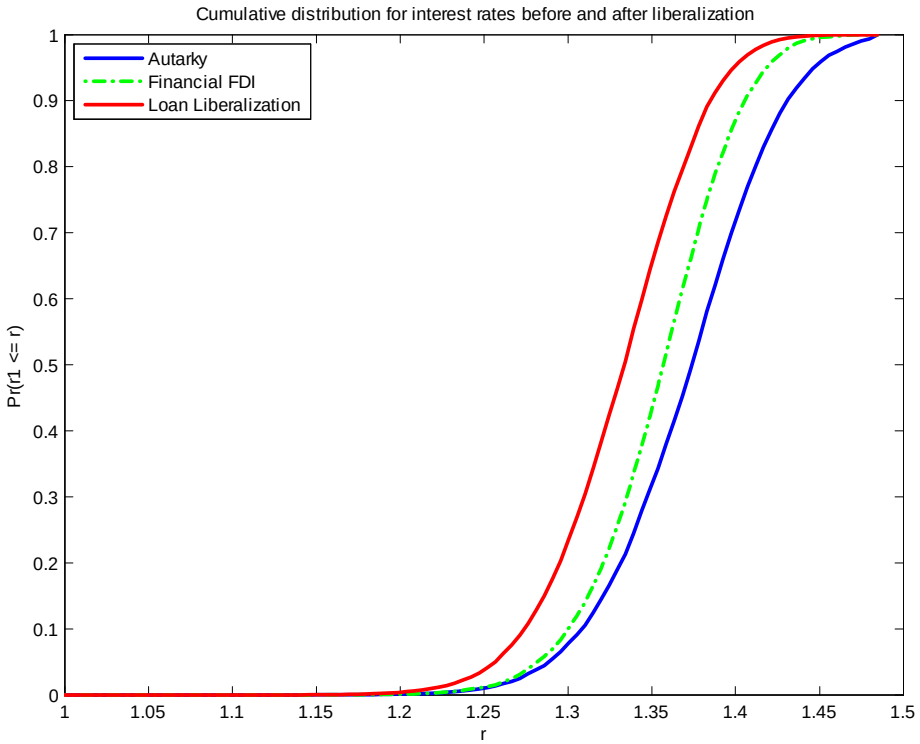

Figure 11: Loan liberalization and FDI in the financial sector reduce the average interest rate

appear to increase their efficiency following entry by foreign banks. In our model, we could observe what looks like increased efficiency in the domestic banking sector simply because the domestic banks that still supply loans after liberalization are some of the most efficient banks in the domestic market. The appearance of increased efficiency may also simply be evidence of unmerged local banks having to lower their markups. However, as suggested by Goldberg (2007), increased efficiency among unmerged local banks could also occur due to technological spillover from foreign entrants to these locally owned competitors, or induced cost-cutting behavior. In the case of technological spillover or cost-cutting, the technology parameter, T, would presumably be higher for the foreign-owned banking industry than for the indigenous banks, or $T_f > T_h$, at the time of liberalization. One should then observe a rightward shift in the distribution of cost parameters for surviving indigenous banks over and above the selection effect involved in liberalization, an empirically testable implication

we leave for future research.

6.3 Technology vs. contestability

The impact of either type of liberalization on the distribution of markups and lending rates in the home country is similar whether the home market opens up to a country with higher mean technology (T_f) or higher contestability (n_f). However, entry by foreign banks with superior technology through M&As has little effect on the size of the "spike" at the far end of the markup distribution when the country opening up has high levels of contestability, while the new entrants do shift the markup distribution to the right, as in Figure 12 (compared to Figure 5). Recall that, as in Figure 6, countries with low contestability have a flat pdf with a large "spike" at the upper end of the probability density for markups. When foreign banks enter a market with low contestability, the spike falls dramatically and the distribution becomes more hump-shaped (Figure 13), similar to the change observed for China in Figure 2. Fewer banks now charge the maximum markup. Measuring changes in the relative flatness (via second-order stochastic dominance) and size of the spike at the upper end of the markup distribution before and after liberalization, could help disentangle whether it is technological spillovers or increased competition that generates the reduced profitability among domestic banks following foreign entry noted in the empirical literature.

When we estimate the parameters of the Weibull distribution employed in this paper to match the behavior of costs across countries, we find that there is little variation of technology whereas the number of competitors (our measure of contestability) does vary considerably. That is, bank competition within niches is more important to shape the distribution of markups than the available technology, which is consistent with the findings in Claesens and Laeven (2004). The detailed results are reported in Appendix E.

6.4 Welfare effects

Since the impact of financial openness on the aggregate interest rate is computable using only data from the simulated cost parameters, it is possible to solve for all variables in terms of the aggregate interest rate using the open economy version of the steady state equations in Table 2. We transform the consumer's budget constraint (3) and the goods

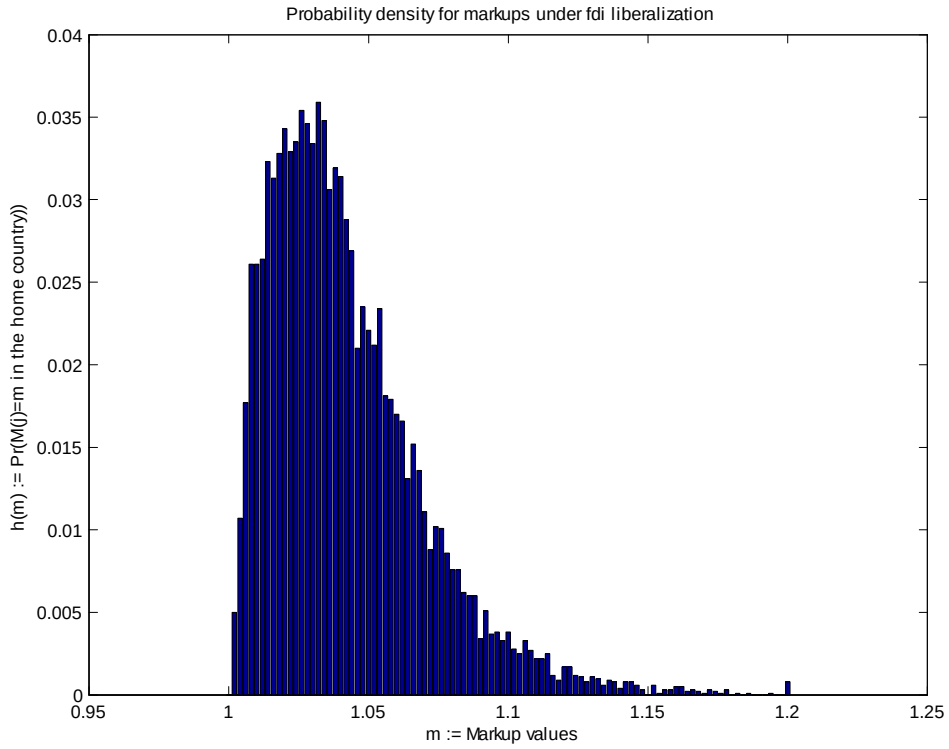

Figure 12: Foreign country has superior technology ($T_f > T_h$) and both countries have high contestability ($n_f = n_h = 100$).

clearing condition (11) into two new equations,

$$\begin{aligned} q &= q_h + q_f \\ q &= wh + \pi_h^F + \pi_h^B + d\bar{r} + \pi_h^{B*} + V - V^* \qquad ((3')) \\ y &= q + nx, \qquad ((11')) \end{aligned}$$

where q_h and q_f denote the quantity of the manufactured good that is produced in the home and foreign country, respectively, and consumed in the home country. V is the total of all takeover fees paid to owners of native home-country banks acquired by foreign-owned banks. Profits earned by home and foreign banks, respectively, in the home country are represented by π_h^B and π_f^B. Variables representing consumption, production, or payments taking place in the foreign country are denoted by asterices. That is, π_h^{B*} represents profits

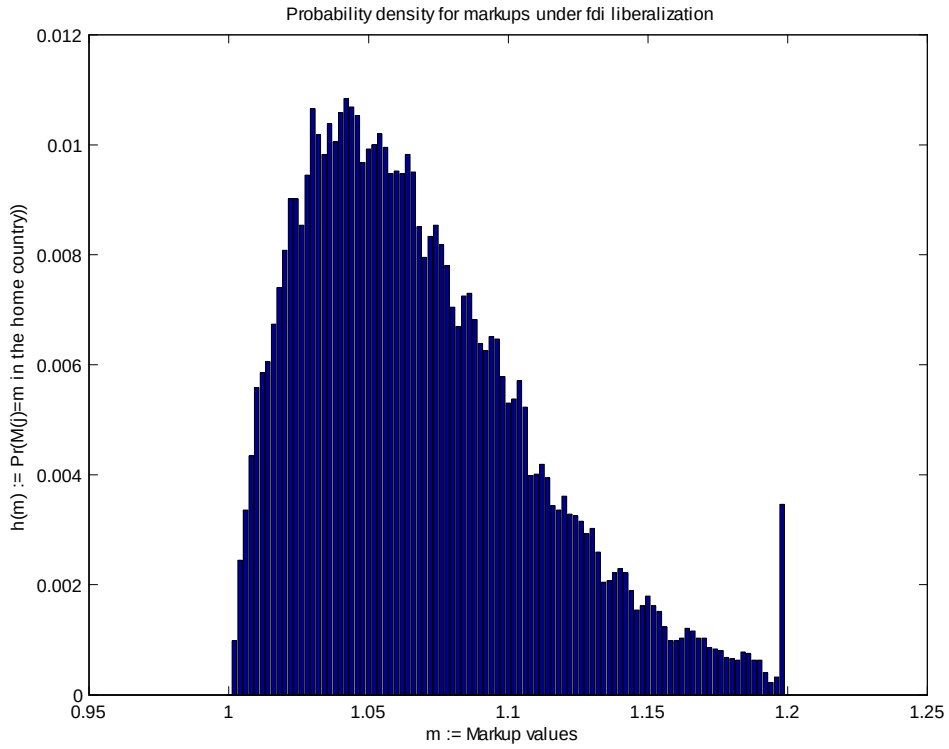

Figure 13: Host and foreign country have equal technology ($T_f = T_h$), but host country has low contestability ($n_f = 100, n_h = 2$)

earned by home-owned banks in the foreign country, and V^* is the total of all takeover fees paid by home acquirors to the owners of targeted foreign banks. The balance of payments equation is given by

$$nx = q_h^* - q_f \equiv (\pi_f^B - V^*) - (\pi_h^{B*} - V) \tag{13}$$

where q_h^* is consumption of goods produced by home firms in the foreign country. That is, a home export surplus must be financed by the positive net profits of foreign banks operating in the home country. Analogous equations apply to the foreign country in equilibrium. The open economy differs from autarky because bank profits now include activity from making loans abroad, be it at arms-length under loan liberalization or in local branches with FDI. Trade does not have to be balanced if bank profits, net of takeover fees, are greater for one country than another. With the interest rates already known

from computations above, we reduce the model into two equations (the aggregate budget constraints) and two unknowns, w and w^*, then solve using a nonlinear equation solver.

The overall effect of liberalization is to reduce the average interest rate, which increases consumption and utility. Computations using data from the simulations above[20] show an increase in utility of just over 50 percent moving from autarky to liberalization. Whether FDI or loan liberalization improves welfare more depends on the relative size of δ and δ_{fdi}. Interestingly, liberalization increases the welfare in both countries even when their respective T or n parameters are not identical. However, a country with a more efficient banking sector will have a persistent trade deficit unless the distance parameters are equal to zero. Under FDI, for instance, a country with lower overall available technology (lower T) will run a persistent trade surplus, paid for by the net profits of resident foreign banks. When both countries are identical, either country can run a trade surplus or deficit, depending on the particular draws of cost parameters by individual banks.

7 Conclusions

This study presents a stylized model for analyzing the implications of financial sector openness for consumption, welfare, and the components of the balance of payments. It abstracts from issues such as currency and maturity mismatches that are discussed in depth in the international finance literature, but focuses on the interaction of imperfect competition and bank heterogeneity–the first to do so in a general equilibrium environment. We find that opening the financial sector to mergers and acquisitions by foreign acquirors can increase average net interest margins (markups), an ubiquitous proxy for lending-to-deposit rate spreads, while still generating efficiency gains that reduce the cost of borrowing overall. Differences in the efficiency or competitive environment across countries can lead to persistent trade imbalances, while still generating large welfare gains for both countries when allowing foreign participation in the form of loans or FDI. It is the first model to explain how widening measures of interest rate spreads under liberalization can be compatible with lower lending costs, increased efficiency, and lower actual spreads. It further demonstrates that increases in net interest margins are less likely to occur when opening to foreign loans as opposed to FDI in the banking sector. Finally, the analysis

[20] We report results for calibration with standard values $\alpha = 0.7$, $\rho = 1$ (logarithmic utility), and $\gamma = 1$ (unit elasticity of labor supply), and choose $\delta_{loan} = 0$ and $\delta_{fdi} = 2$. Results are robust for $\alpha \geq .2$, $1 \leq \rho < 6$, and $\gamma \geq 0.01$.

provides an argument for liberalizing a country's banking sector to foreign entry even if its banking sector is already technically efficient relative to the rest of the world, since only competitors that are superior in a particular niche buy out local banks.

Existing studies and several simple stylized facts presented here motivate the our model's predictions, though there are several caveats involved in relying on these observations as motivations for the model. First, it is not possible to identify fees associated with loans, which may increase the effective interest rate that a borrower pays and such fees are entirely omitted from the model. An increase in market competitiveness or the introduction of sophisticated foreign credit instruments may lead banks to hide the full costs of a loan by attaching fees to a contract with a low lending rate. In this case, we would still expect local banks taken over by foreign financial institutions to charge higher markups after the merger whenever possible, leaving the theoretical prediction regarding markups unchanged. Second, there is an endogeneity problem inherent in trying to identify a causal relationship between cross-border mergers and increasing measures of spreads. Do spreads increase as a result of the takeover, as in the model, or are foreign banks good at choosing targets for whom market conditions are about to cause spreads to increase? The model here does not resolve this problem, which permeates the entire literature on spreads and foreign takeovers, but simply offers an explanation whereby one might observe increased measures of spreads following foreign entry but still see improvements in lending rates and welfare. Third, we do not model default or problems associated with asymmetric information, which naturally can also increase spreads. However, to the degree that local banks have information about local borrowers, the main engines driving the results– the cherry-picking of the best targets in the model and the inability of foreign banks to seemlessly transfer their own technology– are even more plausible.

The omission most likely to alter the results is the potential consolidation or elimination of branches that might arise due to economies of scope. This effect could occur due to foreign and domestic merger activity, which we do not explore here. The Ricardian framework in the model above leaves the number of credit niches fixed (though the number of banks is not necessarily fixed if we assume that banks can take draws of cost parameters in any niche without economies of scope.) There is some evidence in recent literature that consolidation occurring after liberalization may cause reductions in the availability of credit to small firms, an important credit niche for innovation and growth in an economy. This might occur if the profit margins of some local banks who do not sell out are squeezed so that they are less likely to take on riskier loans, or if the superior efficiency of foreign

acquirors involves being less willing to take on risk than their targets. Empirical studies are already addressing these questions, but theory has lagged behind. The interaction of an endogenous number of heterogeneous borrowers (or niches) and heterogeneous banks with economies of scope could further enrich our understanding of changes in market power that occur due to foreign entry and their implications for actual and proxied interest rate spreads.

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A Summary Statistics

We use the model to analyze data from a number of developing countries which experienced an influx of foreign direct investment into their financial sector after 1999. We do this using measures of net interest rate margins and two measures of costs for individual banks reporting consolidated balance sheets in 2000 and 2006 from the Bankscope databases. Since a number of studies have already documented the fact that foreign-owned banks tend to have higher net interest margins and lower costs using regression analysis, this study focuses on whether the distributions shift in the way the model would predict following cross-border merger waves in the financial sector. We find that the behavior of observed distributions in countries experiencing surges in cross-border mergers in the financial sector is quite similar to the simulated distributions. Since the analysis focuses on country-specific distributions for the variables of interest, rather than the behavior of individual banks, the sample is narrowed to the 80 countries for which there were at least five observations for net interest margins in 2000 (or 2001, for India and Pakistan) and 2006.

A.1 Identifying surges in financial FDI

Liberalization with respect to the entry of foreign banks can take place legally without being followed by actual entry. Thus, we use a *de facto* indicator for liberalization, identifying countries which have experienced a surge in foreign takeovers of domestic banks within the sample period (2000-2006). For this task, we use data on cross border M&As from the Thomson SDC Platinum database involving lending or depository institutions as acquirors or targets from 1984-2005. There are many ways to identify a surge. A very simple rule would be to select countries for whom the annual number of cross-border M&As is twice as high for any year within the sample period as it had been in any year preceding the sample period. Using this method, we identify four countries: China, Indonesia, Taiwan, and Turkey.

A more sophisticated method involves testing for structural breaks in the series, counting those countries for which a break to a *higher* mean (for any length of time) occurs between the beginning of 2000 and the end of 2005 as having a surge during the sample period. Using code from Bai and Perron (2003),[21] one can try to pinpoint such breaks using four different methods. The Bai-Perron method provides alternative ways of testing for the absence of a structural break (the null hypothesis) against the existence of a particular number of strucutral breaks (sup-F) or against an unknown number of breaks (UDmax and WDmax). Once the null has been rejected, the method tests for the number of structural breaks sequentially up to a maximum of 5 possible breaks (1 versus 2, 2 versus 3 ...), and also uses information criteria for the choice of structural breaks. To be conservative, we use the UDmax and WDmax and sup-F tests to determine whether the series shows structural breaks, and then the Bayesian Information Criterion (BIC) to test for the number of break points. This is what we refer to as "all tests." When there is disagreement between the tests (mainly because the sup-F sometimes fails to reject the null of no structural break when the UDmax, WDmax, and BIC tests do reject it), we follow the indications given by the BIC. The Bai-Perron code conveniently estimates the mean of a series before and after each break point. We consider that a surge has occurred only if the mean increases after a break identified using the BIC.

We collapse the Thomson data into quarterly series and identify seven countries as having a surge during the sample period according to all tests– China, Indonesia, Lithuania, Pakistan, the Russian Federation, the Slovak Republic, and Turkey. We further identify five more surges using only the BIC which are not indicated by any other test results. These are the Cayman Islands, Croatia, Estonia, Japan, Lithuania, and Taiwan. Another group appears to have a surge that began before and ended after 2000 according to the BIC minimization. These are Argentina, Brazil, Chile, France, Greece, Hong Kong, Hungary, India, Norway, Peru, Poland, Singapore, South Korea, Thailand, and Venezuela.[22] Table A.1 contains the complete results for the break testing.[23] Table A.2 lists countries experiencing surges. In the analysis below, we focus only on countries experiencing a surge during the sample period and ignore the countries in mid-surge at the beginning of 2000 except when specified. We use the 12 countries with surges during the sample identified

[21] Available on Pierre Perron's website in a very user-friendly format.

[22] Within this group of countries that were "mid-surge" in 2000, at the time our bank data sample begins, the results described below hold only for countries with surges beginning in 1999.

[23] The M&A series have at most 87 observations and in many cases less than half that number. In this Appendix we report results for countries experiencing surges that begin before and end after 2000.

using the BIC as our baseline list of “surge countries."

A.2 The distribution of net interest margins and costs

Table 1 in the text shows summary statistics for net interest margins, the ratio of overhead expenses to total interest earning assets, and the ratio of personnel expenses to total interest earning assets for the entire panel of 80 countries, split by whether there is at least one test indicating that there was a surge in foreign takeovers in the financial sector between 2000 and 2005 for any length of time.

We formalize the analysis of distributional shifts between 2000 and 2006 using the test for first-order stochastic dominance discussed by Barrett and Donald (2003). The tests are based on a null hypothesis of "reject stochastic dominance." Thus, following their methodology, we test for stochastic dominance of a particular variables distribution in a particular country in 2000 over the corresponding distribution for 2006. If we fail to reject stochastic dominance of the 2000 over the 2006 distribution but reject stochastic dominance of the 2006 over the 2000 distribution, then we consider the 2000 distribution to be stochastically dominant. Table A.3 contains a tabulation of the outcomes for net interest margin using the sample of all 12 countries identified as having a surge in 2000 or afterward by the BIC minimization described above. A majority (7 of 12) surge countries experienced a significant change in the distribution of net interest margins, while the majority of non-surge countries (47 of 68) did not. Surge countries were about 17 percentage points more likely to have the 2000 distribution of net interest margins be stochastically dominant (a reduction in the average margin) and 10 percentage points more likely to have 2006 stochastically dominate (an increase in the average margin). Note that these results describe the overall distribution of net interest margins. For any given bank, the spread could have increased or decreased. The results are even stronger if we restrict surge countries to be only the 7 identified by all break tests as having a positive break (an increasing mean number of M&As) during the sample.

Table A.4 contains the tabulation for average overhead costs. In this case, the 2000 distribution of overhead costs stochastically dominates for exactly half (6 of 12) of surge countries, while this is the case for only a quarter of non-surge countries (17 of 68). It is remarkable that for almost three-quarters of non-surge countries, there is no statistically significant shift in the distribution of average overhead costs. For one surge country, the 2006 distribution is stochastically dominant, revealing a general increase in average over-

head costs that conflicts with the predictions of the theory. This country is Indonesia. A similar but somewhat weaker pattern emerges from the analysis of distributions of average personnel costs in Table A.5. Here again, the 2006 distribution of costs in Indonesia stochastically dominates that from 2000, conflicting with the theory above. Nonetheless, consistent with the theory, surge countries are 16 percentage points more likely than non-surge countries to have an overall drop in average personnel costs demonstrated by the stochastic dominance of the distribution from 2000. Again, results are strongest if we restrict the surge sample to the 7 countries most likely to have a break.

A.3 Bank-level data in detail

The variables used for the empirical analysis are obtained from Bankscope database for the period 2000-2006 at an annual frequency. In particular, the variables employed are:

- Net interest margin: This ratio is the net interest income expressed as a percentage of earning assets. The higher this figure the cheaper the funding or the higher the margin the bank is commanding. Higher margins and profitability are desirable as long as the asset quality is being maintained.

- Ratio of overhead expenses to total interest earning assets: Non interest expenses or overheads plus provisions give a measure of the cost side of the banks performance relative to the assets invested.

- Ratio of personnel expenses to total interest earning assets

Following previous studies, we eliminate the 1st and 99th percentile for each variable within each country's observations in each year.

B The Merger Market

Suppose for a moment that $C_1^*(j) < C_2^*(j) < C_1(j)$. The second-lowest-cost foreign bank will bid for a target home bank, increasing its bid until it offers all potential profits from the takeover. If successful, the second-lowest-cost foreign bank could charge a markup of

$$m_2^M(j) = \min \left\{ \frac{(C_1^*(j))^{\frac{1}{\delta}} (C_2(j))^{1-\frac{1}{\delta}}}{(C_2^*(j))^{\frac{1}{\delta}} (C_1(j))^{1-\frac{1}{\delta}}}, \bar{m} \right\},$$

assuming that the lowest-cost foreign bank would threaten to enter by buying out the next-best home bank if it did not purchase the best one. The hypothetical merged bank

would then charge the interest rate

$$r_2^M(j) = \min\left\{\frac{(C_1^*(j))^{\frac{1}{\delta}}(C_2(j))^{1-\frac{1}{\delta}}}{(C_2^*(j))^{\frac{1}{\delta}}(C_1(j))^{1-\frac{1}{\delta}}}, \bar{m}\right\}(C_2^*(j))^{\frac{1}{\delta}}(C_1(j))^{1-\frac{1}{\delta}}\bar{r}$$

The rivalry forces the lowest-cost foreign bank to offer at least the amount of profits that could be earned under the second-best merger scenario to secure the takeover in the merger market. Any acquiror also must offer at least as much as the target bank would earn independently in the new liberalized environment. To calculate these amounts, both the acquiror and the target take as given that all potential buyouts in other niches will occur. Thus, the price offered for the takeover is

$$V(j) = wh\max\left\{\begin{array}{c} r_2^M(j)\left(\frac{r_2^M(j)}{r_{fdi}}\right)^{-\sigma} - \bar{r}(C_2^*(j))^{\frac{1}{\delta}}(C_1(j))^{1-\frac{1}{\delta}}\left(\frac{r_2^M(j)}{r_{fdi}}\right)^{-\sigma}, \\ r^A(j)\left(\frac{r^A(j)}{r_{fdi}}\right)^{-\sigma} - \bar{r}C_1(j)\left(\frac{r^A(j)}{r_{fdi}}\right)^{-\sigma}, 0 \end{array}\right\},$$

where $r^A(j) = \min\left\{\frac{\min\left\{(C_1^*(j))^{\frac{1}{\delta}}(C_2(j))^{1-\frac{1}{\delta}}, C_2(j)\right\}}{C_1(j)}, \bar{m}\right\}C_1(j)\bar{r}$ is the interest rate that the lowest cost home bank would charge in the absence of any takeover. The merger market participants calculate r_{fdi} as the aggregate interest rate that would emerge if all possible takeovers occurred (anywhere where $C_1^*(j) < C_1(j)$).

C Consumer First-Order Conditions

Given the following utility function:

$$u(q_t, \mathtt{h}_t) = \frac{q_t^{1-\rho}}{1-\rho} - \frac{\mathtt{h}_t^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}},$$

the FOC are given by

$$q_t^{\rho} = w_t \mathtt{h}_t^{-\frac{1}{\gamma}},$$

$$q_t^{-\rho} = \beta(1+\bar{r}_t)q_{t+1}^{-\rho},$$

$$d_t(1+\bar{r}_t) + w_t\mathtt{h}_t + \pi_t^F + \pi_t^B = d_{t+1} + q_t.$$

D Equilibrium

The set of equations governing the steady state open economy equilibrium is given in the table below. It is similar to the closed economy version in Table 1, plus four new equations, which include an augmented budget constraint (3') and market-clearing equation (11'). In the table below, $C_{k,lib}(j)$ represents the k^{th} lowest-cost bank supplying niche j in the home country. Under loan liberalization, this could be either a home or foreign bank. If it is a foreign bank, then $C_{k,lib}(j)$ would be calculated including the distance friction. With FDI, this could be either a fully domestically owned home bank or a merged bank.

E Estimation procedure

In order to understand to what extend our results depend on the parameters used for the underlying Weibull distribution function, in particular, those measuring technology and competition among banks, we proceed to estimate $\{T, T_r\}$. These parameters are related to the scale parameter in the Weibull function, which becomes $\alpha n^{-\frac{1}{\beta}}$ in the case of order statistics; and the number of potential bank competitors. The parameter θ corresponds to the shape parameter in the Weibull function, which is a very important parameter. Eaton and Kortum (1999) find estimates of θ between 3.6 and 8.32. In our case, we set θ equal to the maximum likelihood estimator obtain for the sample data. Our findings show values for $\widehat{\theta}$ between 0.435 and 28.6, somewhat lower than those reported by Eaton and Kortum (1999), but positive as required by the Weibull distribution. We do not use maximum likelihood estimation for all the parameters given that this method may not be appropriate for small data sets, such as ours.[24]

We use data for the 80 countries we have over the period 2000-2006, and fit a Weibull distribution for costs to match a set of representative moments, in particular, the mean, standard deviation, kurtosis, and skewness of the distribution of overhead costs observed for each country. We use a SMM method that minimizes the square of the distance between sample and simulated moments, weighted by the inverse of the variance-covariance matrix of the moments in the data

$$J(\Theta) = \left[\mu\left(T_n, \Theta\right) - \mu_{sample}\right]' \otimes \Omega \otimes \left[\mu\left(T_n, \Theta\right) - \mu_{sample}\right],$$

[24] For a detailed discussion on estimation methods for Weibull distributions, see Pham (2006).

where $\mu(T_n, \Theta)$ denotes the simulated moments for a given set of parameters Θ and T_n simulations; μ_{sample} refers to the moments in the data; and Ω is weighting matrix of variance-covariance of the moments in the data. Given the two parameters to estimate and the four moments to match, we have that $J(\Theta)$ follows a χ^2 distribution with two degrees of freedom. This minimization is performed individually for each country in the sample.

As initial conditions, we set θ equal to each country's MLE estimator and $T_0 = 5$ (our benchmark calibration). Regarding the number of potential competitors we use three alternatives. First, we use as initial condition the number of banks we have in the data. Then, to control for country size effects we also consider the number of banks over the total population in the country in two different ways, first

$$n_0 = \frac{\text{number of banks in the data}}{\text{number of inhabitants}} \times \text{constant}$$

where the constant is such that it assures $n_0 > 2$ or it is set equal to $10e{+}8$ for all countries. In all cases, the initial condition must be $n_0 > 2$ so that it is consistent with our model. The results shown below are for those estimates where n_0 is set according to the second case, which gave us the best fit.

The next step is to test which of the two estimated parameters shows larger dispersion, that is, where do the differences in mark-ups come from: differences in technologies or in the number of competitors. To test this on $\widehat{T}$ and $\widehat{n}$ we need a method that does not require normality of the sample data, given that we do not know the distribution of these estimates. Such a method is provided by the Ansari-Bradley test of dispersion. This method tests the null hypothesis that two independent samples come from the same distribution, against the alternative that they come from distributions with the same median but different dispersions. In order to apply this test, we first need to test for independence of the two samples of estimates. We do this by using the χ^2 test, and find that in fact, both series are independent. The second assumption is that both samples must have the same median. Of course, this is not the case for the estimates we have, but the Ansari-Bradley test suggests substracting the median of each sample before applying the test, although this means that the distribution of the results under the null is no longer independent of the common distribution of the samples. We do this and find that the test rejects the null hypothesis of same distributions, and when tested which sample has a larger dispersion we find that the sample of estimates for n, the number of potential competitors in the banking

industry, shows higher dispersion than the sample for T, as previous studies have shown (e.g. Claessens and Laeven, 2004). The Ansari-Bradley test can be run in two-tails or one, and we check for robustness on all the combinations and obtain the same results.

Once the distribution has been estimated, we simulate costs series and compute the implied markup to compare with the reported net interest rate margins in each country. The results are displayed in Table A.6. For ease of exhibition, we present the estimates for selected countries. Technology are expressed as ratios of USA levels. Table A.6 reports estimates of the Weibull parameters when fixing θ to 6 (our benchmark), and two alternative values $3.6, 8.32$, close to those employed in Eaton and Kortum (2002).

Table A.6. Estimation results for the Weibull parameters

	$\theta = 3.6$		$\theta = 6$		$\theta = 8.32$	
Country	T	n	T	n	T	n
Argentina	0.0294	7.1	2.04E-06	7.1	0.391	7.1
Austria	0.835	9.47	0.978	9.47	0.503	9.47
Belgium	0.0241	6.84	2.04E-06	6.84	0.391	6.84
Brazil	2.15E+03	5.67	1.02	5.67	1.95E+05	5.67
Croatia	2.72	270	0.00201	270	832	270
Czech Republic	7.06	13.7	0.00154	13.7	148	13.7
China	54.7	23.3	0.0681	23.3	3.45E+04	23.3
France	0.198	5.94	2.04E-06	5.94	0.391	5.94
Germany	0.446	18.1	1.77E-05	18.1	0.391	18.1
Hong Kong	2.09	13.5	0.000184	13.5	7.12	13.5
Iceland	373	8.59	2.28	8.59	7.26E+06	8.59
India	2.15E+03	26.3	1.02	26.3	1.95E+05	26.3
Ireland	0.00429	13.2	2.04E-06	13.2	0.391	13.2
Israel	318	25.4	1.41	25.4	2.42E+6	25.4
Italy	67.3	3.31	0.0293	3.31	5.46E+03	3.31
Japan	0.00429	18.4	2.04E-06	18.4	0.391	18.4
Jordan	7.54	17.4	0.00209	17.4	272	17.4
Lebanon	0.806	5.87	2.04E-05	5.87	0.391	5.87
Luxembourg	0.205	6.66	2.42E-06	6.66	0.391	6.66
Netherlands	0.376	6.3	6.13E-06	6.3	0.391	6.3
Norway	1.14E+08	14	2.65E+05	14	1.29E+11	14
Russia	1.16	8.79	5.81E-05	8.79	1.31	8.79
Slovakia	6.24	16.7	0.0016	16.7	181	16.7
South Africa	7.77	18.6	0.00225	18.6	276	18.6
Spain	0.0179	4.59	2.04E-06	4.59	0.391	4.59
Switzerland	0.00429	16.1	2.04E-06	16.1	0.391	16.1
Turkey	6.45	11.1	0.00158	11.1	176	11.1
United Kingdom	0.00975	6.22	2.04E-06	6.22	0.391	6.22
United States	1	10.7	1	10.7	1	10.7

Consumers		
Labor supply	$q^{\rho} = w\mathtt{h}^{-\frac{1}{\gamma}}$	(1)
	$q^{*\rho} = w^* \left(\mathtt{h}^*\right)^{-\frac{1}{\gamma}}$	
Euler condition	$\bar{r} = \bar{r}^* = \frac{1-\beta}{\beta}$	(2)
Budget constraint	$q = w\mathtt{h} + \pi_h^F + \pi_h^B + d\bar{r} + \pi_h^{B*} + V - V^*$	(3')
	$q^* = w^*\mathtt{h}^* + \pi_f^{F*} + \pi_f^{B*} + d^*\bar{r}^* + \pi_f^B + V^* - V$	
Aggregate consumption	$q = q_h + q_f$	
	$q^* = q_h^* + q_f^*$	
Firms		
Technology	$y = Ah^{1-\alpha}$	(4)
	$y^* = A^* \left(h^*\right)^{1-\alpha}$	
Optimal labor demand	$h = \left(\frac{(1-\alpha)A}{(1+r)w}\right)^{\frac{1}{\alpha}}$	(5)
	$h^* = \left(\frac{(1-\alpha)A^*}{(1+r^*)w^*}\right)^{\frac{1}{\alpha}}$	
Demand for loans	$l(j) = \left(\frac{r(j)}{r}\right)^{-\sigma} wh$	(6)
	$l^*(j) = \left(\frac{r^*(j)}{r^*}\right)^{-\sigma} w^*h^*$	
Banks		
Lending rate	$r(j) = \min\left\{\bar{r}C_{2,lib}(j), \bar{m}\left[\bar{r}C_{1,lib}(j)\right]\right\}$	(7')
	$r^*(j) = \min\left\{\bar{r}C_{2,lib}^*(j), \bar{m}\left[\bar{r}C_{1,lib}^*(j)\right]\right\}$	
Loan market clearing (I)	$l(j) = \frac{d(j)}{C_{1,lib}(j)}$	(8)
	$l^*(j) = \frac{d^*(j)}{C_{1,lib}^*(j)}$	
Market Clearing and Aggregation		
Loan market clearing (II)	$l = \sum_1^J l(j), \;\; l^* = \sum_1^J l^*(j)$	(9)
Deposit market clearing	$d = \sum_1^J d(j), \;\; d^* = \sum_1^J d^*(j)$	(10)
Goods market clearing	$y = q + nx = q_h + q_h^*,\; y^* = q^* + nx^* = q_h^* + q_f$	(11')
Aggregate interest rate	$r = \left[\frac{1}{J}\sum_1^J r(j)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}, \;\; r^* = \left[\frac{1}{J}\sum_1^J r^*(j)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$	(12)
Balance of Payments	$nx = \pi_f^B - \pi_h^{B*} - V + V^*$	(13)
	$nx^* = -\left(\pi_f^B - \pi_h^{B*} - V + V^*\right)$	
Labor market clearing	$\mathtt{h} = h,\; \mathtt{h}^* = h^*$	(14)