Strategic Behavior in Capital Markets and Asset Prices

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Abstract

In this paper we study the impact of the degree of concentration of a financial system on the aggregate demand for housing as well as the feedback effect of the size of the mortgage loan market on lenders' profits, internal capital accumulation, loan losses and potential bailouts. In a general equilibrium framework with endogenous borrowing constraints, we show that, contrary to the traditional view, competitive lenders can generate larger profits and accumulate more internal capital than monopolistic lenders. Furthermore, in the event of a severe economic downturn, a competitive financial system can withstand a financial crisis just as well as a concentrated financial system. We provide empirical evidence consistent with the main predictions of our model.

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1 Introduction

"The genius of American banking is competition. And the more competition the better. You look at every other major country and they only have a handful of banks that account for most of the business" (William Proxmire, late Chairman of the U.S. Senate Banking Committee).[1]

Banking system plays a vital role in any well functioning economy by intermediating the optimal allocation of capital across different economic agents. The size of the economic rents extracted by the lenders in this process depends on the structure of the lending sector. At the heart of the banking structure is the degree of concentration among lenders. Historically, both concentrated and competitive banking structures have coexisted simultaneously (in different countries). From an economic perspective this fact raises an important question, namely what are the trade-offs between a competitive banking system and a concentrated banking system?

The traditional view is that competition in the lending sector is beneficial for the same reasons competition in any industry is beneficial. Namely, competition promotes efficient allocation of resources in the economy by minimize the costs and prices of banking services and by allowing economic agents to make undistorted investment decisions (e.g., Alhadeff (1954), Fischer (1968), Rhoades (1982), Gilbert (1984), Freixas and Rochet (1997)). However, Allen and Gale (2000) argue that lenders in competitive banking structures also generate lower profits and have an incentive to invest in riskier assets (e.g., loans). Consequently, more concentrated banking structures seem more efficient in this regard. Their result follows from a standard wealth transfer argument between shareholders and creditors. Keeley (1990) provides some evidence in support of this argument, by showing that the Savings and Loan Crises of late 1980s was the result of heavy deregulation of the banking industry in the 1970's and 1980's as well as excessive real estate lending. Thus, the distorted incentive argument of Allan and Gale (2000) collaborated with the empirical evidence of Keeley (1990) seem to suggest that there is a link between competition and financial instability. In particular, a more concentrated banking structure allows lenders to make more profits and build a "buffer" against a potential financial crisis.

In spite of the Allan-Gale argument and the evidence in Keeley, it is not necessarily clear

[1]Quoted by Allen, Gersbach, Krahnen, and Santomero (2001), from 'Naylor, Proxmire to seek Bank Size Limits', *American Banker* December 10, 1986, p.1.

whether a less concentrated banking structure should always be expected to generated less ex-post profits. For instance, when lenders' assets consist mostly of mortgage loans, a less concentrated banking system encourages larger demand for housing, and therefore larger loans to finance a unit of housing. Thus, while lenders in less concentrated banking systems earn less (ex-post) profits per dollar lent, they could earn larger total (ex-post) profits due to the larger size of the loans.

In this paper we investigate theoretically and explore empirically the relationship between the degree of concentration of the lending sector and the lenders' ability to accumulate internal capital.

Our model studies the impact of the degree of concentration of the lending sector on the demand for mortgage loans, and the feedback response of the size of the mortgage loan market on the lenders' profits, internal capital accumulation, loan losses and potential bailouts.

Aggregate demand for housing is modeled endogenously in a general equilibrium framework in which households decide how to split their income between consumption and housing services. Households can borrow to finance the purchase of their homes as long as they have enough income for a set down payment on the home. Lenders can be either competitive or monopolistic, and they use the value of the home as potential collateral on the mortgage loan. Household can default on their loans and are not penalized for doing so.

In equilibrium, aggregate housing demand is larger in less concentrated lending systems because lenders extract no rents from household and because households use the capital gains in housing prices to supplement their income and buy more housing. In contrast, in monopolistic lending systems, aggregate demand for housing is small because lenders extract maximum rents from households and the latter are left with just their regular income to finance both consumption and housing. There is endogenous default in the model as households' income is both uncertain and dependent on an aggregate state of the economy.

On the feedback effect, the size of the mortgage market affects directly lenders' profits and internal capital accumulations. To determine the later, we assume that lenders receive an exogenous supply of deposits every period and that they can only supplement this income with new equity. Under these conditions, we show that competitive lenders can generate more profits and accumulate more internal capital than monopolistic lenders, provided that the economy has not experience a severe downturn in a while. Furthermore, competitive lenders are also subject to larger loan losses then monopolistic lenders, in the event of an economic downturn, because mortgage loans are larger in size in an economy with a less concentrated lending sector.

Last but not least, we show that when lenders' capital ratios are sufficiently small, both competitive and monopolistic lenders need a bailout in a severe economic downturn. Interestingly, the size of the bailout is the same for both types of lenders. This follows from the result that the value of lenders' equity is same regardless of the degree of concentration of the lending sector.

We test empirically the main implications of the model by using cross-country banking data. Our sample contains two banking crises, namely the Savings and Loans Crisis of late 1980s and the Financial Crisis of 2007. We show that lenders in countries with more concentrated lending sectors generate more profits right after the first banking crisis, but less profits for the rest of the period between the two banking crises. Furthermore, lenders in countries with less concentrated lending sectors accumulate more internal capital. During the two banking crises competitive lenders have incurred larger loans losses and have set aside larger provisions for future loan losses. These empirical results seem to support the main implications of our theory.

To summarize, our theory seems to suggest that less concentrated financial systems do not necessarily require larger bailouts in the event of an economic downturn. In fact, lenders in less concentrated financial systems can generate larger profits and accumulate more capital than lenders in more concentrated financial systems. This goes against the Alan-Gale argument, suggesting that more competitive financial systems can withstand a financial crisis just as well as more concentrated financial systems.

Our study is related to the literature on financial frictions and the macroeconomy. Some recent studies in this literature include Mandelman (2006), Stebunovs (2008), and Andres and Arce (2008). Except for Andres and Arce (2008), the only financial friction in these studies is imperfect banking competition. While these studies investigate the entry/exit dynamics of firms or depositors behavior in the presence of imperfect competition, lending is not linked explicitly to the demand for an asset (e.g., housing).

The closest model to ours is the one in Andres and Arce (2008), where households make endogenous consumption and housing purchasing decisions, facing endogenous borrowing constraints in the spirit of Kiyotaki and Moore (1997). Just as in our model, the interaction between the households' borrowing constraints and the degree of concentration in the banking sector plays a crucial role. However, while the model in Andres and Arce (2008) is richer as it allows for endogenous deposits, the equilibrium analysis of the effect of imperfect competition on demand for housing is only studied in the steady state. In our model, housing price dynamics are not always stationary, and full knowledge of these dynamics is crucial to understanding the link between the degree of concentration in the lending sector and the demand for housing.

The rest of the paper is organized as follows. Section 2 introduces the model and describes the theoretical results. Section 3 calibrates the model and provides a thorough numerical analysis. Section 4 tests empirically the main implications of the model. Finally, Section 5 concludes.

2 Model

2.1 Economic Environment

Consider an economy with a large number of agents (with the mass normalized to 1) who earn wages and derive utility from consumption and housing services.

All the available housing is denominated in units of housing. The supply of units of housing is assumed fixed.

In order to purchase housing, agents can supplement their wages by borrowing against the value of their new homes. Lenders demand that agents finance themselves a fraction of the value of their home (similar to a down payment) and that agents pledge the entire value of their home as collateral. A typical mortgage loan has a maturity of one period. In the event of default, borrowers are not ousted from the credit market, but they lose their homes. We preclude Ponzi schemes by assuming that the borrowed money can only finance house purchases and that income can be costlessly verified.

The structure of the lending sector determines how lenders will set their loan interest rates. We consider two extreme case, namely a concentrated financial system (monopolistic lenders) and a competitive financial system (competitive lenders). Monopolistic lenders set their loan interest rates so that to maximize their profits, while competitive lenders set their rates so that their expected profits are zero. To understand lenders' profit functions, we have to say something about how lenders finance their assets.

We assume that lenders are financed with only two types of capital, namely insured deposits and equity. Insured deposits are guaranteed a rate of return of r_0, which is assumed exogenous in or model. When lenders cannot pay depositors this interest rate, the value of their equity falls below zero and lenders default. Since deposits are insured, we assume that, in the event of default, lenders are taken over by the government and reorganized. In particular, the government provides bailout funds to finance the claim of the depositors in the failed lenders less the value of the lenders post reorganization.

In order to keep the analysis as parsimonious as possible, we assume that the wages of the agents (borrowers) are drawn from an i.i.d. distribution which depends on the state of the economy. Thus, while wages depend on the state of the economy, wages are also completely unpredictable. From lenders' perspective this means that lenders cannot increase their revenues by "screening" borrowers, as all borrowers are equally likely to lose their jobs next period, when loans are due. In particular, the only way for monopolistic lenders to increase revenues is to extract more from each borrower.

2.2 Agents

Agents are infinitely lived and derive utility from consumption (c) and housing services (k) according to the following utility function:

$$\sum_{s\geq t} E_t[\beta^s u(c_s, k_s)] \tag{1}$$

where $u(c,k) = \alpha c + (1-\alpha)k$. The parameter $0 < \beta < 1$ captures the agents patience while the parameter $0 < \alpha < 1$ captures the intra-temporal substitution between consumption and housing services.

Every period agents earn random income e_t distributed as follows:

$$e_t = C_0 + \bar{e}\tilde{y} \tag{2}$$

where $C_0 > 0$ is a constant, $\tilde{y}$ is uniformly distributed over the interval $[0, \tilde{x}]$ and $\tilde{x}$ is the state of the economy. For simplicity we assume that the state of the economy $\tilde{x}$ is distributed as an iid binomial variable which can take the values x^H or x^L with probabilities q^H and q^L, respectively. Clearly, $q^H + q^L = 1$.

To satisfy the need for housing services at time t the agent buys $k_t - k_{t-1}$ units of housing, at the price per housing unit of p_t. She can finance a fraction $0 < 1 - \phi < 1$ of the purchase with one period debt but she has to finance the rest from her own pocket (similar to a down payment).

Then, if the interest charged by the bank between t and $t+1$ is r_t, an agents budget constraint becomes:

$$c_t + [k_t - k_{t-1}]p_t + [1 + r_{t-1}]b_{t-1} \leq e_t + b_t \tag{3}$$

subject to the additional constraints:

$$\begin{aligned} c_t &\geq C_0 \\ b_t &\leq [1-\phi]p_t k_t \\ k_{-1} = r_{-1} &= b_{-1} = 0 \end{aligned} \tag{4}$$

The first condition ensures that the demand for housing cannot be excessively large (taking prices as given). The second condition ensures that borrowers use the borrowed amount to purchase houses rather than finance consumption. Finally, the last condition states the initial values at time $t = 0$.

2.3 The Housing Market

We assume that the supply of housing per period is fixed at $\mathbf{K}$ units of housing. The price p_t per housing unit is determined so that the market for housing units clears.

Notice that due to the fact that banks lend to all borrowers and that we have a continuum of borrowers, the aggregate demand for housing will only depend on the state of the economy and the time-varying distribution of eligible borrowers. The later reflects only aggregate risk associated with the state of the economy. Since the supply of housing units is fixed, prices will vary over time but will only reflect aggregate risk. Thus, depending on the state of the economy the price can take one of the (deterministic) values p_t^H or p_t^L. These will be determined in equilibrium.

2.4 Monopolistic Markets for Capital

2.4.1 Monopolistic Lending Rates

Banks behave monopolistically and for a given face value b_t they charge the borrowers interest r_t so that the following objective function is maximized:

$$\max_r \{E[(1+r)b_t\chi_{t+1}] + E[\min\{k_t p_{t+1}, (1+r)b_t\}[1-\chi_{t+1}]] - [1+r_0]b_t\} \tag{5}$$

where r_0 is the rate at which the bank borrows (r_0 is like the LIBOR rate) and χ_{t+1} is an indicator variable for the default event:

$$\begin{aligned} \chi_{t+1} &= 1, \text{ if } [1+r_t]b_t \leq [e_{t+1} - C_0] + k_t p_{t+1} \\ \chi_{t+1} &= 0, \text{ otherwise} \end{aligned} \tag{6}$$

Suppose the following parameter restrictions are satisfied:

$$\begin{aligned} q^H &> 1/2 \\ \frac{x^H}{x^L} &> \frac{1}{1-\frac{1}{2q^H}} \end{aligned} \tag{7}$$

Then for a given face value b_t financing k_t units of housing, a monopolistic lender maximizes her profits when charging interest given by:

$$r_t^* = -1 + \frac{1}{b_t}\left[\frac{1}{2}\bar{e}x^H + k_t p_{t+1}^H\right] \tag{8}$$

2.4.2 Optimal Demand for Housing

First notice that since the agent's utility function increases in consumption, the budget constraint is binding so that consumption can be computed as the residual:

$$c_t = e_t + b_t - [k_t - k_{t-1}]p_t - [1+r_{t-1}]b_{t-1}. \tag{9}$$

Substitute this into the utility function as well as the minimal consumption constraint and let $\lambda_t = \lambda(y_t)$ denote the Lagrange multiplier associated with this constraint.

At time t if $k_{t-1} > 0$, an agent owes the bank $(1 + r_{t-1})b_{t-1} = \frac{1}{2}\bar{e}x^H + k_{t-1}p_t^H$.

If the state of the economy is x^L, the agent will never be able to afford to pay the loan because the maximum resources she can generate that period are $C_0 + \bar{e}x^L + k_{t-1}p_t^L$ and these are not enough to ensure minimum consumption level and cover the loan payment (under the parameter restrictions at the beginning of the previous section).

If the state of the economy is x^H, the agent will be able to afford to pay the loan if her income is large enough:

$$e_t \geq C_0 + \frac{1}{2}\bar{e}x^H \tag{10}$$

Recall that we work under the assumption that the lender can verify borrower's income at no cost and so the borrower can not shirk and declare default when she can afford to pay back the loan.

Thus, the agent's problem simplifies substantially since the decision to default on the loan does not depend on the agent's demand for housing or on any of the endogenous variables in the model. Thus:

$$\begin{aligned} \chi_{t+1} &= 1, \text{ if } e_t \geq C_0 + \frac{1}{2}\bar{e}x^H \\ \chi_{t+1} &= 0, \text{ otherwise} \end{aligned} \tag{11}$$

$$\begin{aligned} J(e_t, d_t, x_t) = \max_{k_t, b_t} \Big\{ &\alpha\{e_t + b_t - k_t p_t + d_t\} + (1-\alpha)k_t + \\ &\beta E_t J(e_{t+1}, d_{t+1}, x_{t+1}) \Big\} \end{aligned} \tag{12}$$

subject to the constraints:

$$\begin{aligned} b_t &\leq \frac{1-\phi}{\phi}[e_t - C_0 + d_t] \\ \frac{1}{1-\phi} b_t &\leq k_t p_t \leq e_t - C_0 + b_t + d_t \end{aligned} \tag{13}$$

where $d_{t+1} = [k_t p_{t+1} - (1 + r_t) b_t]\chi_{t+1}$ and r_t is defined in (21). Note that:

$$\begin{aligned} d_t &= -\frac{1}{2}\bar{e}x^H, \text{ if } e_t \geq C_0 + \frac{1}{2}\bar{e}x^H, \ x_t = x^H \text{ and } t \geq 1 \\ &= 0, \text{ if } e_t < C_0 + \frac{1}{2}\bar{e}x^H \text{ or } t = 0 \end{aligned} \tag{14}$$

Disregarding for the moment the constraints (13), the first order condition wrt k_t in the program (12) becomes:

$$\begin{aligned} FOC(k_t) =& -\alpha p_t + (1 - \alpha) + \beta E_t[J_2(e_{t+1}, d_{t+1}, x_{t+1})\frac{\partial d_{t+1}}{\partial k_t}] \\ =& -\alpha p_t + (1 - \alpha) \end{aligned} \tag{15}$$

We now state the main result of this section.

Proposition 1 For $\alpha > 0$ sufficiently small and for x^H, x^L, q^H satisfying the constraints in (7), the exists a unique equilibrium $(c_t, k_t, b_t, p_t)_t$ such that (c_t, k_t, b_t) solve the household's problem given prices p_t and the housing market clears. The equilibrium prices have the following dynamics:

$$\begin{aligned} p_t^L &= \frac{1}{2\phi\mathbf{K}}\bar{e}x^L, \text{ for any } t \geq 0 \\ p_t^H &= \frac{1}{4\phi\mathbf{K}}\bar{e}x^H, \text{ for any } t \geq 1 \\ p_0^H &= \frac{1}{2\phi\mathbf{K}}\bar{e}x^H \end{aligned} \tag{16}$$

where $\mathbf{K}$ is the fixed supply of units of housing. The decision functions are given by:

$$\begin{aligned} c_t &= C_0, \text{ for any } t \geq 0 \\ k_t &= \frac{e_t - C_0 - \frac{1}{2}\bar{e}x^H}{\phi p_t^H}, \text{ if } x_t = x^H \text{ and } e_t \geq C_0 + \frac{1}{2}\bar{e}x^H \\ k_t &= \frac{e_t - C_0}{\phi p_t^H}, \text{ if } x_t = x^H \text{ and } e_t < C_0 + \frac{1}{2}\bar{e}x^H \end{aligned} \tag{17}$$

$$k_t = \frac{e_t - C_0}{\phi p_t^L}, \text{ if } x_t = x^L$$

and $b_t = (1-\phi)p_t k_t$.

In particular, households never default whenever $x_t = x^H$ and $e_t \geq C_0 + \frac{1}{2}\bar{e}x^H$, and they default in all the other cases.

The following result characterizes the conditions under which the expected profits of the lenders are positive.

Proposition 2 Under the parameter constraints in (7) and the following additional constraints:

$$\begin{aligned} \frac{1}{4\phi}\bar{e}x^H \frac{\alpha}{1-\alpha} &\leq \mathbf{K} \\ \frac{1+r_0-\left[q^H + 2\frac{x^L}{x^H}q^L\right]}{1+r_0+\frac{1}{2}q^H} &< \phi \end{aligned} \tag{18}$$

the ex-ante economic rents extracted by the monopolistic lenders from each borrower are strictly positive.

2.5 Competitive Markets for Capital

In this section we study a version of the previous model in which the lending sector is populated with competitive rather than monopolistic banks.

2.5.1 Competitive Lending Rates

When lenders behave competitively, they set the lending rates so that their expected profits are zero. That is for a given face value b_t, the competitive lending rate, r_t, solves:

$$E[(1+r_t)b_t\chi_{t+1}] + E\left[\min\{k_t p_{t+1}, (1+r_t)b_t\}[1-\chi_{t+1}]\right] = [1+r_0]b_t \tag{19}$$

where the indicator variable χ_{t+1} is defined as in Section 1.2.

If the following conditions are satisfied:

$$\begin{aligned} p_t^H &> p_t^L, \text{ for all } t \geq 0, \\ b_t &\leq \frac{1}{1+r_0}k_t E_t \tilde{p}_{t+1}, \text{ for all } t \geq 0, \end{aligned} \tag{20}$$

the above equation admits a unique solution, given by:

$$
\begin{aligned}
(1+r_t)b_t &= (1+r_0)b_t, \text{ if } b_t \leq \frac{k_t p^L_{t+1}}{1+r_0} \\
&= k_t p^L_{t+1} + \frac{\bar{e}x^L}{2q^L}[1-\sqrt{\Delta}], \text{ if } \frac{k_t p^L_{t+1}}{1+r_0} < b_t \leq \frac{k_t p^L_{t+1} + \bar{e}x^L q^H}{1+r_0} \\
&= \frac{(1+r_0)b_t - k_t p^L_{t+1} q^L}{q^H}, \text{ if } \frac{k_t p^L_{t+1} + \bar{e}x^L q^H}{1+r_0} < b_t \leq \frac{k_t E_t \tilde{p}_{t+1}}{1+r_0}
\end{aligned}
\tag{21}
$$

where $\Delta = 1 + \frac{4q^L}{\bar{e}x^L}[k_t p^L_{t+1} - (1+r_0)b_t]$.

2.5.2 Optimal Demand for Housing when $x^L = 0$

The competitive rates charged by the banks can depend nonlinearly on the borrowed principal and the value of collateral. In this section we consider a simpler case when $x^L = 0$ and therefore rates depend only linearly on principal and collateral values.

Households take home prices as given and use the above menu of rates to determine the optimal amount of housing that they can afford. At time t the problem of determining k_t and b_t reduces to:

$$
\begin{aligned}
J(e_t, d_t, x_t) = \max_{k_t, b_t} \Big\{ & \alpha\{e_t + b_t - k_t p_t + d_t\} + (1-\alpha)k_t + \\
& \beta E_t J(e_{t+1}, d_{t+1}, x_{t+1}) \Big\}
\end{aligned}
\tag{22}
$$

subject to the constraints:

$$
\begin{aligned}
b_t &\leq \frac{e_t - C_0 + d_t}{\max\left\{(1+r_0)\frac{p_t}{E_t \tilde{p}_{t+1}}, \frac{1}{1-\phi}\right\} - 1} \\
\max\left\{(1+r_0)\frac{p_t}{E_t \tilde{p}_{t+1}}, \frac{1}{1-\phi}\right\} b_t &\leq k_t p_t \leq e_t - C_0 + b_t + d_t
\end{aligned}
\tag{23}
$$

where $d_{t+1} = [k_t p_{t+1} - (1+r_t)b_t]\chi_{t+1}$ and r_t is defined in (21). Note that:

$$\begin{aligned} d_{t+1} &= k_t p_{t+1} - (1+r_0)b_t, \text{ if } (1+r_0)b_t \leq k_t p^L_{t+1} \\ &= k_t p^H_{t+1} - \frac{1+r_0}{q^H} b_t, \text{ if } k_t p^L_{t+1} \leq (1+r_0)b_t \leq k_t E_t \tilde{p}_{t+1} \text{ and } x_{t+1} = x^H \\ &= 0, \text{ if } k_t p^L_{t+1} \leq (1+r_0)b_t \leq k_t E_t \tilde{p}_{t+1} \text{ and } x_{t+1} = x^L \end{aligned} \tag{24}$$

Let $\lambda_1 \geq 0$, $\lambda_2 \geq 0$, and $\lambda_3 \geq 0$ be the Lagrange multipliers for each of the three constraints in (23), respectively.

Suppose, $(1+r_0)b_t \leq k_t p^L_{t+1}$. Disregarding for the moment the constraints (23), the first order condition wrt k_t in the program (22) becomes:

$$\begin{aligned} FOC(k_t) =& -\alpha p_t + (1-\alpha) + \beta E_t[J_2(e_{t+1}, d_{t+1}, x_{t+1})\frac{\partial d_{t+1}}{\partial k_t}] \\ =& -\alpha p_t + (1-\alpha) + \beta[\alpha + \lambda_1 \frac{1-\phi}{\phi} + \lambda_3]E_t[\tilde{p}_{t+1}] \end{aligned} \tag{25}$$

where for the second equality we used the Envelope condition:

$$J_2(e_t, d_t, x_t) = \alpha + \frac{1-\phi}{\phi}\lambda_1 + \lambda_3 \tag{26}$$

Note also that $FOC(k_t)$ does not depend on k_t. In particular, if $FOC(k_t) > 0$ we would expect that the double constraint in (23), binds to the right. In particular, the demand for housing is given by:

$$k_t = \frac{e_t - C_0 + b_t + d_t}{p_t} \tag{27}$$

Suppose, now that $k_t p^L_{t+1} \leq (1+r_0)b_t \leq k_t E_t \tilde{p}_{t+1}$. Disregarding for the moment the constraints (23), the first order condition wrt k_t in the program (22) becomes:

$$\begin{aligned} FOC(k_t) =& -\alpha p_t + (1-\alpha) + \beta E_t[J_2(e_{t+1}, d_{t+1}, x_{t+1})\frac{\partial d_{t+1}}{\partial k_t}] \\ =& -\alpha p_t + (1-\alpha) + \beta q^H[\alpha + \lambda_1 \frac{1-\phi}{\phi} + \lambda_3]p^H_{t+1} \end{aligned} \tag{28}$$

As before, note that $FOC(k_t)$ does not depend on k_t. In particular, if $FOC(k_t) > 0$ we must have that:

$$k_t = \min\Big\{\frac{1+r_0}{p^L_{t+1}}b_t, \frac{e_t - C_0 + b_t + d_t}{p_t}\Big\} \tag{29}$$

We now argue that there exists a price process p_t satisfying the constraints (20) and clearing the housing market for every t.

Proposition 3 For $\alpha > 0$ sufficiently small and for r_0, ϕ, q^H such that:

$$(1+r_0)(1-\phi) \geq q^H$$

the exists a unique equilibrium $(c_t, k_t, b_t, p_t)_t$ satisfying the constraints (20) such that (c_t, k_t, b_t) solve the household's problem given prices p_t and the housing market clears. The equilibrium prices have the following dynamics:

$$\begin{aligned} p^L_t &= 0, \text{ for any } t \geq 0 \\ p^H_t &= \frac{1+r_0}{q^H}p^H_{t-1} - \frac{\phi}{1-\phi}p^H_0, \text{ for any } t \geq 1 \\ p^H_0 &= \frac{1}{2\phi\mathbf{K}}\bar{e}x^H \end{aligned} \tag{30}$$

where $\mathbf{K}$ is the fixed supply of units of housing. The decision functions are given by:

$$\begin{aligned} c_t &= C_0, \text{ for any } t \geq 0 \\ k_t &= \frac{e_t - C_0}{\phi p^H_t} + \frac{1}{\phi}[k_{t-1} - \frac{(1+r_0)(1-\phi)}{q^H}k_{t-1}\frac{p^H_{t-1}}{p^H_t}], \text{ if } x_t = x^H \text{ and } x_{t-1} = x^H \\ k_t &= \frac{e_t - C_0}{\phi p^H_t}, \text{ if } x_t = x^H \text{ and } x_{t-1} = x^L \\ k_t &= 0, \text{ if } x_t = x^L \\ b_t &= (1-\phi)p^H_t k_t, \text{ if } x_t = x^H \\ b_t &= 0, \text{ if } x_t = x^L \end{aligned} \tag{31}$$

In particular, households always default when $x_t = x^L$, and they never default when $x_t = x^H$.

2.6 Internal Capital, Loan Losses, and Bailouts

We now focus on lenders' profits and internal capital. Both these quantities are sensitive to how lenders access external capital markets. Lenders are owned by risk-neutral shareholders and can raise equity costlessly whenever necessary.[2] In return, shareholders are compensated with distributions in the form of dividends or share repurchases (we do not distinguish between these two forms of compensation). These distributions equal the residual cash after investment (mortgage loans) and interest expenses are netted out of lenders' revenues.

We assume further that the only form of debt that lenders can carry is in the form of deposits.[3] Furthermore, lenders have no control over the supply of deposits or the interest rate on deposits, r_0. The later is exogenous in our model. While outside the scope of our study here, a constant interest rate on deposits could be the result of deposit insurance.[4]

Finally, we assume that the supply of deposits is exogenous and is modeled by a persistent stochastic process, D_t.

Suppose lenders extend aggregate credit $\int b_{t-1}^{n,i}\mu(di)$ at $t-1$, where $n = M$ for monopolistic lender or $n = C$ for competitive lender. Then the lenders' earnings at time t become:

$$\begin{aligned}\pi_t^n = &\int \Big\{(1+r_t^{n,i})b_{t-1}^{n,i}\chi_t^{n,i} + \min\{k_{t-1}^{n,i}p_t^n, (1+r_t^{n,i})b_{t-1}^{n,i}\}[1-\chi_t^{n,i}]\Big\}\mu(di) + \\ &D_t - (1+r_0)D_{t-1}\end{aligned} \tag{32}$$

where $n = M, C$. To economize on notation we only use the subscript n when we need to make a distinction between the monopolistic case and the competitive case.

We can now express the going concern value of a monopolistic lender as

$$V_t^M = \pi_t^M - \int b_t^{M,i}\mu(di) + \beta E_t\left[\xi_{t+1}^M V_{t+1}^M\right] \tag{33}$$

where $b_s^{M,i}$ is defined as in Proposition 1, the monopolistic lending rates are described as in

[2]Shareholders should be though of as large institutional investors. They are risk neutral and make no household decisions.

[3]In our model households do not make savings decisions and, therefore, cannot be the ones supplying deposits to lenders. Instead the supply of deposits is exogenous. One can think of the potential suppliers of these deposits as being lenders themselves, firms or large investors (such as lenders' shareholders).

[4]There is an extensive literature on the role of deposit insurance on lenders' investment behavior.

section 2.4.1, and $\xi_t^M = 1$ when $V_t^M > 0$ and $\xi_t^M = 0$, otherwise.

Similarly, the going concern value of a competitive lender is

$$V_t^C = \pi_t^C - \int b_t^{C,i}\mu(di) + \beta E_t\left[\xi_{t+1}^X V_{t+1}^C\right] \tag{34}$$

where $b_s^{C,i}$ is defined as in Proposition 3, the competitive lending rates are described in section 2.5.1, and $\xi_t^C = 1$ when $V_t^C > 0$ and $\xi_t^C = 0$, otherwise.

Shareholders default when lenders' going concern values fall below 0. Since deposits are guaranteed, lenders will have to be bailed out by government. The amount of the bailout is $\max\{0, D_t - V_t^M\}$ for monopolistic lenders and $\max\{0, D_t - V_t^C\}$ for competitive lenders.

The lenders' assets consist of mortgage loans only. At time t, the competitive or monopolistic lenders' assets are simply $\int b_t^i\mu(di)$. Lenders finance these assets with both deposits and equity capital. Therefore, since deposits at time t are D_t, the equity capital of the lenders is the residual $\max\{0, \int b_t^i\mu(di) - D_t\}$. The internal capital of the lenders is $\min\left\{\pi_t, \int b_t^i\mu(di)\right\}$.

Loan losses could trigger lenders' default. In the event of default, loan losses amount to $\min\left\{0, -\int b_{t-1}^i\mu(di) + \int \min\{k_{t-1}^i p_t, (1+r_t^i)b_{t-1}^i\}[1-\chi_t^i]\mu(di)\right\}$ for both competitive and monopolistic lenders.

Proposition 4 The going concern value of a monopolistic lender equals the going concern value of a competitive lender. In particular, the bailout amount is the same across lending sectors:

$$\max\{0, D_t - V_t^M\} = \max\{0, D_t - V_t^C\} \tag{35}$$

Proof: We show that $\pi_t^C - \int b_t^{C,i}\mu(di) = \pi_t^M - \int b_t^{M,i}\mu(di)$ for any t. We first notice that

$$\pi_t^M - \int b_t^{M,i}\mu(di) = \frac{1}{4}\bar{e}x^H + \mathbf{K}p_t^{M,H} - (1-\phi)\mathbf{K}p_t^{M,H} = \frac{1}{2}\bar{e}x^H$$

Similarly,

$$\pi_t^C - \int b_t^{C,i}\mu(di) = (1-\phi)\left[\frac{1+r_0}{q^H}p_{t-1}^{C,H} - p_t^H\right]\mathbf{K} = \frac{1}{2}\bar{e}x^H$$

where the next to last equality follows from the dynamics of housing prices in Proposition 3.

3 Numerical Results

The previous sections establish theoretical links between the degree of concentration of the lending sector and either the households' demand for housing or the lenders' internal capital, loan losses, and size of the bailouts. In this section, we investigate these links numerically.

To calibrate the model, we assume that deposits are constant $D_t = D$, for some positive constant D. We normalize $x^H = 1$, $\bar{e} = 1$, and $\mathbf{K} = 1$. Given our iid assumption on the state of the economy, we choose q^H to maximize the likelihood of a recession ($x_t = x^L$) over the business cycle (I assume that the business cycle is 7-years long). We obtain $q^H = 0.8$.

Next we assume values for the parameters of the model that can be matched directly to some observable quantity in the data. We assume that the average real interest rate on deposits is $r_0 = 3\%$, and that the down payment is $\phi = 20\%$. The rest of the parameters are calibrated so we can match certain quantities in the data which are also relevant for our model. We choose D to match the capital adequacy ratio for banks, according to the Basel Accords, namely 8%. In the model, the capital ratio of a lender can be computed as $\frac{V_t^n}{V_t^n + D_t}$. We obtain $D = 12.7$.

Finally, parameter α does not play a direct role in our numerical analysis, but it is constrained by the parameter restrictions of the model. We choose it to be below 1%.

Figure 1 shows housing prices for an economy with competitive lending sector as well as one with a concentrated lending sector. We notice that the price per unit of housing in an economy with a competitive lending sector is increasing as long as the economy is not experiencing an economic downturn. In contrast, in an economy with a concentrated lending sector, housing prices decrease and are substantially below the housing prices in the economy with competitive lenders.

To understand why housing prices behave so differently across the two economies, we now look at what drives the demand for housing. Figure 2 shows the aggregate demand curves for housing across the two economies. Notice that the aggregate demand curve in the economy with competitive lenders always dominates the aggregate demand curve in the economy with monopolistic lenders. Interestingly, the demand curve in the economy with competitive lenders increases after housing prices reach a certain threshold. This threshold corresponds to the level of prices for which households are indifferent between defaulting or not. For prices above this threshold, households earn additional income from house prices capital gains. As Figure 3 shows the fraction of household income contributed by capital gains can be significant. The surplus housing demand generated by these capital gains increases in housing prices and dominates the housing demand from wages alone. The result is a positive-sloping demand curve (post threshold).

A direct consequence of the discrepancy in prices across lending systems is the stark difference in the demand for capital. Figure 5 shows that while the aggregate capital is decreasing in the economy with a concentrated lending sector, the aggregate capital in the economy with competitive lenders is increasing and substantially larger than the one in the other economy. This result is due mainly to the difference in housing prices trends across the two economies. To buy the same number of units of housing, a household would have to borrow more (because of higher prices) in the economy with competitive lenders than in the one with monopolistic lenders.

In the previous section we showed that lenders finance part of their assets with internal capital. Figure 5 shows lenders' internal capital across the two economies. In particular, we notice that, initially, monopolistic lenders are more successful in accumulating internal capital than competitive lenders. However, as normal times persist, the situation reverses, and lenders accumulate internal capital at a faster pace in the economy with competitive lenders than in the other one. This trend in lenders' capital across economies is a direct result of how profitable lenders are. Figure 4 shows that monopolistic lenders are more profitable, initially, but less profitable as the normal times persist. This result should come as no surprise as lenders' profits are tied to housing prices.

Figure 5 also shows an important difference across economies. Monopolistic lenders generate enough profits to cover all their investment outlays with internal capital. In contrast, competitive lenders can never accumulate internal capital to cover all their investment outlays.

In the event of an economic downturn, lenders incur substantial loan losses. Figure 6 shows that loan losses are substantially smaller in the economy with concentrated lenders than in the economy with competitive lenders. This result is again a consequence of the aggregate demand for capital across the two economies. When lenders' capital ratios are small (around 3%), both monopolistic and competitive lenders default. In this case, financial systems in both economies need a government bailout to cover the losses to the lenders' creditors (i.e., depositors). As

Proposition 4 shows, the amount of the bailout across the two economies is the same. When capital ratios are around 3%, the fraction of deposits that require a governmental bailout is close to 97%.

To summarize, the numerical results of this section show several important differences between an economy with a concentrated financial system and an economy with a competitive financial system. First, in normal times, a competitive financial system encourages demand for housing, and, as a consequence, housing prices increase as the period of normal times grows larger. In contrast, a concentrated financial system discourages demand for housing and housing prices never increase. Second, competitive lenders generate larger profits and accumulate more internal capital than monopolistic lenders provided that the period of normal times is not too short. Third, and final, while competitive lenders suffer far larger loan losses than monopolistic lenders, in the event of an economic downturn, a concentrated financial system needs just as much bailout as a competitive financial system, when lenders' default.

4 Some Empirical Evidence

Our model has several testable implications:

H1: Demand for mortgage loans is larger in economies with less concentrated financial systems.

H2: Lenders make more profits and accumulate more internal capital in economies with less concentrated financial systems.

H3: Lenders suffer more loan losses in economies with less concentrated financial systems.

In this section we attempt to test these hypothesis using cross-country data on banks. We use Compustat to obtain annual accounting data on banks across countries between 1982 and 2009. We eliminate the countries with less than three banks, and we end up with a sample of 12 countries. In this sample, the U.S. has 1133 banks, followed by Canada with 7 banks. The rest of the countries have between 3 and 6 banks. Table 1 presents summary statistics for several accounting variables. In particular, we notice that the U.S. is the most competitive of all countries with an annual average Herfindahl-Hirschman (HH) concentration index for the banking sector of 3.68% with respect to deposits and 4.19% with respect to assets. The rest of countries have concentrated banking sectors, with HH index ranging from 24.88% for

Canada to 76.43% for Japan. We also notice that deposits finance a large fraction of banks' assets and that total loans make up a large fraction of the banks' assets. Where available, loans secured by real estate are typically at least 25% of the total loans. Retained earnings as a fraction of total assets are almost 3 times larger in countries such as the U.S. and Argentina than countries such as Germany and Japan. Actual loan losses seem to be largest for the U.S. with 1.11% of total loans and smallest for Australia with only 0.47% of total loans. Provisions for loan losses as a fraction of total loans are larger for countries such as the US, Brazil, Chile and Argentina, and smaller for countries such as Canada, Australia, and Germany.

Over this sample period the U.S. has seen two major banking crisis, namely the Savings and Loans Crisis of late 1980s and the Financial Crisis of 2007. Both these crisis were preceded by a tremendous increase in the real estate market. Since the predictions of our model work best for the period between two banking (and real estate) crisis, the two events set the ground for a natural experiment. In particular, if our model is right, we would expect not to reject hypothesis H1-H3 on the period between crisis, namely 1990-2007.

To test hypothesis H1-H3, we construct an equally weighted portfolio of all the countries with a HH concentration index above 20%. This portfolio includes all the countries other than the U.S. and it contains all the countries with concentrated lending sectors. The U.S. is the only country with a competitive lending sector. We then test the three hypothesis by inspecting visually the behavior of the competitive and concentrated lending sectors along relevant dimensions. Figure 7 shows the range for the HH concentration index of the portfolios of countries with concentrated lending sectors as well as the U.S..

To test H1 we check whether the amount of loans secured by real estate, as a fraction of total assets, is larger in the US than in the portfolio of countries with concentrated lending sectors. Figure 8 shows the results. We notice that the U.S. has consistently dominated the portfolio of countries for the period covering late 80' to 2009, suggesting that hypotheses H1 is unlikely to be rejected. The time-series pattern for the U.S. is particularly interesting, especially around the two banking crisis. Real estate loans as a fraction of assets have increase substantially both before the Savings and Loans Crises of late 1980s (from 16% to 20%) and the Financial Crises of 2007 (from 16.5% to 22%). In the U.S. both crisis were followed by a sharp decrease in the real estate loans as a fraction of the assets. For the portfolios of countries with a concentrated lending sector, real estate loans as a fraction of assets has grown steadily for the entire duration of our sample. Real estate loans decrease somewhat after the Financial Crises of 2007 but has rebounded strongly ever since.

We next test hypotheses H2. To capture lenders' profits we use two measures of profitability. Our first measure of profitability is net income to total assets. As Figure 9 shows banks in the portfolio of countries with more concentrated lending sectors have lower and less volatile profits (as a fraction of assets) than banks in the U.S., for most of the period between 1990 and 2007. However, U.S. banks' profits drop sharply right after the two banking crisis. This is consistent with our model, as the profits of the competitive lenders are larger prior to a crisis, but drop down to same negative value as the profits of the monopolistic lenders during a crisis. Interestingly, we also notice that right after the Savings and Loans crisis, the profits of the banks in the portfolio of countries with concentrated lending sectors dominated for a short while the profits of the banks in the US. This is consistent with hypotheses H2 as well, as competitive lenders become more profitable only if the period of normal times is not too short.

We also use an alternative measure of profitability, namely net income plus provisions for loan losses as a fraction of total assets. Typically, banks charge provisions to loan losses against net income. Since these provisions reflect expectations of potential loan losses rather than actual loan losses, we added it back in to obtain a better picture of the banks' profits. Figure 10 shows the results. Just as before, this measure of profitability capture the fact that banks' profits are larger in countries with more concentrated lending sectors for the years following the Savings and Loans crisis, but lower for the period between early 1990s and 2007.

To test the second part of hypotheses H2 regarding internal capital accumulation we investigate the banks' retained earnings plus provisions for loan losses as a fraction of total assets. Figure 11 shows the results. We notice almost opposite patterns in this variable between the U.S. and the portfolio of countries with concentrated lending sectors. Banks in the U.S. accumulate substantially more internal capital than banks in the portfolios of countries, over the period between the two banking crisis. Interestingly, the internal capital of banks in the U.S. sees a downtrend even before the Financial Crises of 2007. This trend has reversed quickly after the crisis.

To summarize, the three pieces of evidence on banks' profits and internal capital seem to suggest that hypotheses H2 is not likely to be rejected.

Finally, to test the last of the three hypothesis, namely H3, we inspect both banks' actual loan write downs (charged against the banks' credit reserves) as well as banks' provisions for loan losses. As explained above, the latter is reflects banks' expectations about the size of aggregate potential loan losses. Figure 12 and Figure 13 show the results. Actual loan losses for the U.S. banks far exceeded those for the banks in the portfolio of countries with concentrated lending sectors. This pattern is particularly pronounced during the two banking crisis in our sample. Also quite noticeable is the large discrepancy in actual loan losses between the competitive and concentrated lending systems during the Financial Crises of 2007. The piece of evidence regarding actual loan losses seems to suggest that hypotheses H3 is not likely to be rejected. This conclusion is also supported by the evidence on the provisions for loan losses presented in Figure 13. Banks in competitive lending sectors seem to put aside larger provisions for loan losses than banks in concentrated lending sectors, especially during the two banking crisis.

In summary, the empirical evidence of this section seems to support overwhelmingly the three main testable implications of our model. In particular, competitive lenders, such as the ones in the U.S., are more profitable and accumulate more internal capital during normal times, and they incur or expect to incur more loan losses during crisis, than lenders in concentrated lending sectors. Furthermore, demand for loans secured by real estate is substantially lower in countries with more concentrated lending sectors.

5 Conclusion

In this paper we study the impact of the degree of concentration of the lending sector on the demand for mortgage loans, and the feedback response of the size of the mortgage loan market on the lenders' profits, internal capital accumulation, loan losses and potential bailouts.

Aggregate demand for housing is modeled endogenously in a general equilibrium framework in which households decide how to split their income between consumption and housing services. Households can borrow to finance the purchase of their homes as long as they have enough income for a set down payment on the home. Lenders can be either competitive or monopolistic, and they use the value of the home as potential collateral on the mortgage loan. Household can default on their loans and are not penalized for doing so.

In equilibrium, aggregate housing demand is larger in less concentrated lending systems because lenders extract no rents from household and because households use the capital gains in housing prices to supplement their income and buy more housing. In contrast, in monopolistic lending systems, aggregate demand for housing is small because lenders extract maximum rents from households and the latter are left with just their regular income to finance both consumption and housing. There is endogenous default in the model as households' income is both uncertain and dependent on an aggregate state of the economy.

On the feedback effect, the size of the mortgage market affects directly lenders' profits and internal capital accumulations. To determine the later, we assume that lenders receive an exogenous supply of deposits every period and that they can only supplement this income with new equity. Under these conditions, competitive lenders make more profits, accumulate more internal capital, and incur more losses (in an adverse economic downturn) then monopolistic lenders. If the capital ratios are sufficiently small, both competitive and monopolistic lenders need a bailout in a severe economic downturn. Interestingly, the size of the bailout is the same for both types of lenders.

We test empirically the main implications of the model by using cross-country banking data. We find strong support for our theory in the data.

Our results go against Allan-Gale intuition that banks in less concentrated financial systems accumulate less internal capital and require a larger bailout amount than monopolistic banks. Instead, we find that in the presence of endogenous borrowing constraints more competitive financial systems can withstand a financial crisis just as well as more concentrated financial systems.

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6 Appendix

Proof of Proposition 1: When α is sufficiently small the first order condition (15) is positive. In particular, the optimal demand will be given by:

$$k_t = \frac{e_t - C_0 + b_t + d_t}{p_t} \tag{36}$$

Accounting for the optimal demand in the objective function and disregarding for the moment the constraints for b_t in (13), we obtain the first order condition for b_t:

$$\begin{aligned} FOC(b_t) =& \frac{1-\alpha}{p_t} + \beta E_t[J_2(e_{t+1}, d_{t+1}, x_{t+1})\frac{\partial d_{t+1}}{\partial b_t}] \\ =& \frac{1-\alpha}{p_t} \end{aligned} \tag{37}$$

Clearly, this first order condition is positive and thus the optimal borrowing is given by:

$$b_t = \frac{1-\phi}{\phi}[e_t - C_0 + d_t] = (1-\phi)k_t p_t \tag{38}$$

The optimal demand becomes:

$$k_t = \frac{e_t - C_0 + d_t}{\phi p_t} \tag{39}$$

We are now ready to compute the equilibrium prices. If $x_t = x^L$, we know that all agents default. Consequently, $d_t = 0$ and the optimal demand for everybody is:

$$k_t = \frac{e_t - C_0}{\phi p_t^L} \tag{40}$$

Aggregating, we obtain the equilibrium prices:

$$p_t^L = \frac{1}{2\phi\mathbf{K}}\bar{e}x^L \tag{41}$$

Similarly, when if $x_t = x^H$, only the agents earning $e_t \geq C_0 + \frac{1}{2}\bar{e}x^H$ do not default. Their optimal demand for housing is:

$$k_t = \frac{e_t - C_0 - \frac{1}{2}\bar{e}x^H}{\phi p_t^H} \tag{42}$$

All the other agents end up defaulting. Their optimal demand becomes:

$$k_t = \frac{e_t - C_0}{\phi p_t^H} \tag{43}$$

Aggregating, and imposing the market clearing condition, we obtain:

$$\begin{aligned}\mathbf{K} &= E_t\left[\frac{e_t - C_0 - \frac{1}{2}\bar{e}x^H}{\phi p_t^H} 1_{\{e_t \geq C_0 + \frac{1}{2}\bar{e}x^H\}}\right] + E_t\left[\frac{e_t - C_0}{\phi p_t^H} 1_{\{e_t < C_0 + \frac{1}{2}\bar{e}x^H\}}\right] \\ &= \frac{1}{4}\frac{\bar{e}x^H}{\phi p_t^H}\end{aligned} \tag{44}$$

Therefore, the equilibrium prices become:

$$p_t^H = \frac{1}{4\phi \mathbf{K}}\bar{e}x^H \tag{45}$$

Q.E.D.

Proof of Proposition 2: The expected profit of the lender from each borrower is:

$$\begin{aligned}\pi(e_t, x_t) &= [1 + r_t]b_t + E_t\left\{\min\{k_t\tilde{p}_{t+1} - (1 + r_t)b_t, 0\}[1 - \chi_{t+1}]\right\} - [1 + r_0]b_t \\ &= \frac{1}{4}\bar{e}x^H q^H + k_t p_t\left\{\frac{E_t\tilde{p}_{t+1}}{p_t} - [1 + r_0][1 - \phi]\right\}\end{aligned} \tag{46}$$

Using the optimal demand and the equilibrium prices we obtain:

$$\pi(e_t, x_t) = \frac{1}{4}\bar{e}x^H q^H + \frac{e_t - C_0 - \frac{1}{2}\bar{e}x^H\chi_t}{\phi}\left\{\frac{q^H x^H + 2q^L x^L}{x^H} - (1 + r_0)(1 - \phi)\right\} \tag{47}$$

if $x_t = x^H$, and

$$\pi(e_t, x_t) = \frac{1}{4}\bar{e}x^H q^H + \frac{e_t - C_0}{\phi}\left\{\frac{q^H x^H + 2q^L x^L}{2x^L} - (1 + r_0)(1 - \phi)\right\} \tag{48}$$

if $x_t = x^L$. Note now that $0 \leq e_t - C_0 - \frac{1}{2}\bar{e}x^H\chi_t \leq \frac{1}{2}\bar{e}x^H$, and consequently, the expected profits of the lender from each borrower is strictly positive if:

$$\begin{aligned}(1+r_0)(1-\phi) &< \min\left\{\frac{q^H x^H(1+\frac{1}{2}\phi)+2q^L x^L}{x^H}, \frac{q^H x^H(1+\phi\frac{x^L}{x^H})+2q^L x^L}{2x^L}\right\} \\ &= \frac{q^H x^H(1+\frac{1}{2}\phi)+2q^L x^L}{x^H}\end{aligned} \tag{49}$$

Solving for ϕ obtains:

$$\frac{1+r_0-\left[q^H+2\frac{x^L}{x^H}q^L\right]}{1+r_0+\frac{1}{2}q^H} < \phi$$

This concludes the proof.

Q.E.D.

Proof of Proposition 3: Notice that for $\alpha > 0$ sufficiently small, the first order conditions $FOC(k_t)$ are always positive (e.g. one can use a continuation argument together with the fact that $FOC(k_t) > 0$ when $\alpha = 0$). Then, the demand for housing is given by (27), whenever $k_t p^L_{t+1} \geq (1+r_0)b_t$, and by (29), whenever $k_t p^L_{t+1} \leq (1+r_0)b_t \leq k_t E_t \tilde{p}_{t+1}$.

Suppose $p^L_t > 0$ for some t. Then, it has to be the case that some households have non trivial demand for housing. However, recall that when $x_t = x^L = 0$, households earn exactly C_0. This implies that their budget constraint at time t is:

$$c_t = C_0 + b_t - k_t p^L_t + d_t$$

The constraints (23) imply:

$$k_t \leq \frac{1}{p^L_t}\frac{\max\left\{(1+r_0)\frac{p_t}{E_t\tilde{p}_{t+1}}, \frac{1}{1-\phi}\right\}}{\max\left\{(1+r_0)\frac{p_t}{E_t\tilde{p}_{t+1}}, \frac{1}{1-\phi}\right\}-1}d_t$$

Since $k_t > 0$, it has to be the case that $d_t > 0$. This means that the only way a household can generate positive demand for housing when $x_t = x^L = 0$, is if the price p^L_t is sufficiently large to induce $d_t > 0$. In particular, this means that $r_{t-1} = r_0$, and $d_t = k_{t-1}p^L_t - (1+r_0)b_{t-1}$. But in this case, the demand is given by equation (27):

$$k_t = \frac{b_t + d_t}{p_t^L} \leq \frac{1}{p_t^L} \frac{\max\left\{(1+r_0)\frac{p_t}{E_t\tilde{p}_{t+1}}, \frac{1}{1-\phi}\right\}}{\max\left\{(1+r_0)\frac{p_t}{E_t\tilde{p}_{t+1}}, \frac{1}{1-\phi}\right\} - 1} d_t$$

With this expression for demand, we can now go back to (22) and solve for the optimal borrowed principal b_t.

Notice first that the first constraint of (23) can be rewritten as follows:

$$b_t \leq \min\left\{k_t \frac{E_t\tilde{p}_{t+1}}{1+r_0}, \frac{1-\phi}{\phi}[e_t - C_0 + d_t]\right\} \tag{50}$$

Suppose $k_t p_{t+1}^L \geq (1+r_0)b_t$. Disregarding the first constraint in (23), the first order condition wrt b_t becomes:

$$\begin{aligned} FOC(b_t) =& \frac{1-\alpha}{p_t^L} + \beta E_t[J_2(e_{t+1}, d_{t+1}, x_{t+1})\frac{\partial d_{t+1}}{\partial b_t}] \\ =& \frac{1-\alpha}{p_t^L} + \beta[\alpha + \lambda_1 \frac{1-\phi}{\phi} + \lambda_3][\frac{E_t\tilde{p}_{t+1}}{p_t^L} - (1+r_0)] \end{aligned} \tag{51}$$

Similarly, suppose $k_t p_{t+1}^L \leq (1+r_0)b_t \leq k_t E_t\tilde{p}_{t+1}$. Disregarding the first constraint in (23), the first order condition wrt b_t becomes:

$$\begin{aligned} FOC(b_t) =& \frac{1-\alpha}{p_t^L} + \beta E_t[J_2(e_{t+1}, d_{t+1}, x_{t+1})\frac{\partial d_{t+1}}{\partial b_t}] \\ =& \frac{1-\alpha}{p_t^L} + \beta[\alpha + \lambda_1 \frac{1-\phi}{\phi} + \lambda_3][q^H \frac{p_{t+1}^H}{p_t^L} - (1+r_0)] \end{aligned} \tag{52}$$

We now consider the possibility that $p_{t+1}^L > 0$ or $p_{t+1}^L = 0$.

Suppose $p_{t+1}^L > 0$. An argument similar to the one before shows that it can only be the case that $(1+r_0)b_t \leq k_t p_{t+1}^L$. We consider two cases depending on whether (51) is positive or negative.

Suppose the first order condition (51) is positive. Then we must have that:

$$b_t = \min\left\{\frac{k_t p_{t+1}^L}{1+r_0}, \frac{1-\phi}{\phi} d_t\right\}$$

Suppose first that $b_t = \frac{k_t p_{t+1}^L}{1+r_0}$. Then if at $t+1$, $x_{t+1} = x^L$, we have that $d_{t+1} = 0$. The budge constraint at time $t+1$ becomes: $C_0 \leq c_{t+1} = C_0 + b_{t+1} - k_{t+1}p_{t+1}^L$. Using the constraints in (23), this yields $k_{t+1} = 0$, meaning $p_{t+1}^L = 0$. This contradicts our assumption about p_{t+1}^L.

Suppose now that $b_t = \frac{1-\phi}{\phi} d_t$. Then:

$$k_t p_t^L = \frac{1}{\phi} d_t$$

Wlog, we can assume that $t = 1$ and that $x_{t-1} = x^H$. Since we know that $p_t^L > 0$, it has to be the case that $(1+r_0)b_{t-1} \leq k_{t-1}p_t^L$.

Suppose the equivalent of (51) for $t = 0$ is positive. Then, since we know that $d_t > 0$, we have that $b_{t-1} = \frac{1-\phi}{\phi}[e_{t-1} - C_0]$. In particular, $k_{t-1} = \frac{e_{t-1}-C_0}{\phi p_{t-1}^H}$, $p_{t-1}^H = \frac{\bar{e}x^H}{2\phi \mathbf{K}}$ and $d_t = \frac{e_{t-1}-C_0}{\phi}[\frac{p_t^L}{p_{t-1}^H} - (1+r_0)(1-\phi)]$.

Similarly, if the equivalent of (51) for $t = 0$ is negative, we must have that $b_{t-1} = 0$. This leads to $k_{t-1} = \frac{e_{t-1}-C_0}{p_{t-1}^H}$, $p_{t-1}^H = \frac{\bar{e}x^H}{2\mathbf{K}}$, and $d_t = \frac{e_{t-1}-C_0}{p_{t-1}^H} p_t^L$

We now notice that the later case cannot happen because it would lead to:

$$k_t p_t^L = \frac{1}{\phi} d_t = \frac{1}{\phi} \frac{e_{t-1} - C_0}{p_{t-1}^H} p_t^L$$

This implies that $k_t = \frac{1}{\phi} k_{t-1}$. But this cannot hold because it will imply that $\mathbf{K} = 0$.

Thus it must be the case that $k_{t-1} = \frac{e_{t-1}-C_0}{\phi p_{t-1}^H}$, $p_{t-1}^H = \frac{\bar{e}x^H}{2\phi \mathbf{K}}$ and $d_t = \frac{e_{t-1}-C_0}{\phi}[\frac{p_t^L}{p_{t-1}^H} - (1+r_0)(1-\phi)]$. Going back to the expression for demand we obtain:

$$k_t p_t^L = \frac{1}{\phi} d_t = \frac{1}{\phi} \frac{e_{t-1} - C_0}{\phi} [\frac{p_t^L}{p_{t-1}^H} - (1+r_0)(1-\phi)]$$

Solving for p_t^L, we obtain:

$$p_t^L = (1+r_0)p_{t-1}^H$$

Suppose that instead at time t, $x_t = x^H$. Then $b_t = \frac{1-\phi}{\phi}[e_t - C_0 + d_t]$, while the demand for housing is given by:

$$k_t p_t^H = \frac{e_t - C_0}{\phi} + \frac{1}{\phi} d_t = \frac{e_t - C_0}{\phi} + \frac{1}{\phi} \frac{e_{t-1} - C_0}{\phi} [\frac{p_t^H}{p_{t-1}^H} - (1 + r_0)(1 - \phi)]$$

Solving for p_t^H yields:

$$p_t^H = p_t^L - \frac{\bar{e} x^H}{2(1 - \phi)\mathbf{K}} < p_t^L$$

This contradicts the first constraint in (20).

Suppose now that the first order condition (51) is negative. Then we must have that $b_t = 0$. In this case the demand for housing at time t, assuming $x_t = x^L$, is given by:

$$k_t p_t^L = d_t = k_{t-1} p_t^L - (1 + r_0) \frac{1 - \phi}{\phi} [e_{t-1} - C_0]$$

Aggregating this equation leads:

$$\mathbf{K} p_t^L = \mathbf{K} p_t^L - (1 + r_0) \frac{1 - \phi}{2\phi} \bar{e} x^H$$

Clearly this equation has no solution for $\phi < 1$.

To summarize, we showed that we cannot have $p_{t+1}^L > 0$ when $p_t^L > 0$. We now investigate whether the case $p_t^L > 0$ and $p_{t+1}^L = 0$ is possible.

Suppose $p_t^L > 0$ and $p_{t+1}^L = 0$. We distinguish again two cases depending on whether the first order condition in (52) is positive or negative.

Suppose the first order condition in (52) is positive. Then we must have that:

$$b_t = \min \left\{ \frac{k_t E_t \tilde{p}_{t+1}}{1 + r_0}, \frac{1 - \phi}{\phi} d_t \right\}$$

Suppose that $b_t = \frac{k_t E_t \tilde{p}_{t+1}}{1 + r_0}$. Then

$$k_t p_t^L = \frac{k_t E_t \tilde{p}_{t+1}}{1 + r_0} + \frac{e_{t-1} - C_0}{\phi} [\frac{p_t^L}{p_{t-1}^H} - (1 + r_0)(1 - \phi)]$$

Aggregating gives,

$$\mathbf{K} p_t^L = \mathbf{K} \frac{E_t \tilde{p}_{t+1}}{1 + r_0} + \mathbf{K} p_t^L - \frac{\bar{e} x^H}{2\phi} (1 + r_0)(1 - \phi)$$

which implies that p_t^L is undeterminated and that

$$\mathbf{K}q^H \frac{p_{t+1}^H}{1+r_0} = \frac{\bar{e}x^H}{2\phi}(1+r_0)(1-\phi)$$

But $d_{t+1} = 0$ and thus $p_{t+1}^H \leq \frac{\bar{e}x^H}{2\phi\mathbf{K}}$. Combinig this with the previous equation leads to:

$$q^H \geq (1+r_0)^2(1-\phi) > (1+r_0)(1-\phi)$$

This last inequality contradicts the assumed parameter restriction in the hypothesis.

Therefore, it must be the case that $b_t = \frac{1-\phi}{\phi}d_t$, which leads further to:

$$k_t p_t^L = \frac{1}{\phi}d_t = \frac{e_{t-1} - C_0}{\phi^2}[\frac{p_t^L}{p_{t-1}^H} - (1+r_0)(1-\phi)]$$

Solving for the price obtains: $p_t^L = (1+r_0)p_{t-1}^H$.

Suppose that instead at time t, $x_t = x^H$. Then, just as before we can show that $b_t = \frac{1-\phi}{\phi}[e_t - C_0 + d_t]$. The demand for housing is given by:

$$k_t p_t^H = \frac{1}{\phi}[e_t - C_0] + \frac{e_{t-1} - C_0}{\phi^2}[\frac{p_t^H}{p_{t-1}^H} - (1+r_0)(1-\phi)]$$

Solving for p_t^H yields:

$$p_t^H = p_t^L - \frac{\bar{e}x^H}{2(1-\phi)\mathbf{K}} < p_t^L$$

This contradicts the first constraint in (20).

Suppose now that the first order condition (52) is negative. Then we must have $b_t = 0$. The demand is now given by:

$$k_t p_t^L = d_t = \frac{e_{t-1} - C_0}{\phi}[\frac{p_t^L}{p_{t-1}^H} - \frac{(1+r_0)(1-\phi)}{q^H}]$$

Aggregating gives:

$$\mathbf{K}p_t^L = \mathbf{K}p_t^L - \frac{(1+r_0)(1-\phi)}{q^H\phi}\bar{e}x^H$$

which has no solution in p_t^L for $\phi < 1$.

Thus, we showed that $p_t^L = 0$, for any t.

We now focus on characterizing the prices whenever $x_t = x^H$. First, notice that the optimal demand is given by:

$$k_t = \frac{e_t - C_0 + b_t + d_t}{p_t^H}$$

while the first order condition for the optimal borrowed principal is:

$$FOC(b_t) = \frac{1-\alpha}{p_t^H} + \beta[\alpha + \lambda_1 \frac{1-\phi}{\phi} + \lambda_3][q^H \frac{p_{t+1}^H}{p_t^H} - (1+r_0)] \tag{53}$$

for all borrowed principals in the interval:

$$0 \leq b_t \leq \min\left\{\frac{k_t}{1+r_0} E_t \tilde{p}_{t+1}, \frac{1-\phi}{\phi}[e_t - C_0 + d_t]\right\} \tag{54}$$

Suppose $t = 0$ and $x_t = x^H$. By definition, $d_t = 0$. If (53) is positive, then $b_t = \frac{1-\phi}{\phi}[e_t - C_0]$, $k_t = \frac{e_t - C_0}{\phi p_t^H}$, and $p_t^H = \frac{\bar{e}x^H}{2\phi\mathbf{K}}$. If (53) is negative, then $b_t = 0$, $k_t = \frac{e_t - C_0}{p_t^H}$, and $p_t^H = \frac{\bar{e}x^H}{2\mathbf{K}}$.

Suppose now $t = 1$ and $x_t = x^H$. Then $d_t = k_{t-1}p_t^H - \frac{1+r_0}{q^H}b_{t-1}$ is either $d_t = \frac{e_{t-1} - C_0}{\phi}[\frac{p_t^H}{p_{t-1}^H} - \frac{(1+r_0)(1-\phi)}{q^H}]$ or $d_t = [e_{t-1} - C_0]\frac{p_t^H}{p_{t-1}^H}$.

If (53) is positive, for $t = 1$, then the demand k_t is given by:

$$k_t = \frac{e_t - C_0}{\phi p_t^H} + \frac{1}{\phi p_t^H} d_t \tag{55}$$

Aggregating we obtain the price constraints:

$$\begin{aligned} \mathbf{K}p_t^H &= \frac{1}{\phi}\mathbf{K}p_t^H + [1 - \frac{(1+r_0)(1-\phi)}{\phi q^H}]\mathbf{K}p_0^H, \text{ if } p_0^H = \frac{\bar{e}x^H}{2\phi\mathbf{K}}, \text{ or} \\ \mathbf{K}p_t^H &= \frac{1}{\phi}\mathbf{K}p_t^H + \frac{1}{\phi}\mathbf{K}p_0^H, \text{ if } p_0^H = \frac{\bar{e}x^H}{2\mathbf{K}} \end{aligned} \tag{56}$$

Notice that the second equation yields no solution for $\phi < 1$. We obtain that when $p_0^H = \frac{\bar{e}x^H}{2\phi\mathbf{K}}$, the price p_t^H is given by:

$$p_t^H = \frac{(1+r_0)(1-\phi) - \phi q^H}{(1-\phi)q^H} p_0^H \tag{57}$$

Similarly, when (53) is negative, for $t = 1$, then the demand k_t is given by:

$$k_t = \frac{e_t - C_0}{p_t^H} + \frac{1}{p_t^H} d_t \tag{58}$$

The price constraints become:

$$\begin{aligned} \mathbf{K} p_t^H &= \mathbf{K} p_t^H + [\phi - \frac{(1+r_0)(1-\phi)}{q^H}] \mathbf{K} p_0^H, \text{ if } p_0^H = \frac{\bar{e} x^H}{2\phi \mathbf{K}}, \text{ or} \\ \mathbf{K} p_t^H &= \mathbf{K} p_t^H + \mathbf{K} p_0^H, \text{ if } p_0^H = \frac{\bar{e} x^H}{2\mathbf{K}} \end{aligned} \tag{59}$$

Clearly, in general, neither of the above equation leads to a deterministic solution in p_t^H. Thus, p_t^H is given by the formula in (57). Notice now that:

$$q^H p_t^H \geq (1+r_0)(1-\phi) p_0^H, \text{ iff } (1+r_0)(1-\phi) > q^H$$

More generally, given p_{t-1}^H and k_{t-1}, we can determine the optimal demand for housing at time $t \geq 1$ with the following formula:

$$k_t = \frac{e_t - C_0}{\phi p_t^H} + \frac{1}{\phi}[k_{t-1} - \frac{(1+r_0)(1-\phi)}{q^H} k_{t-1} \frac{p_{t-1}^H}{p_t^H}] \tag{60}$$

The price p_t^H is determined by the following formula:

$$\begin{aligned} p_t^H &= \frac{1+r_0}{q^H} p_{t-1}^H - \frac{\phi}{1-\phi} p_0^H, \text{ if } x_{t-1} = x^H, \text{ or} \\ p_t^H &= p_0^H, \text{ if } x_{t-1} = x^L \end{aligned} \tag{61}$$

Notice that, whenever $x_{t-1} = x^H$, we have:

$$q^H p_t^H \geq (1+r_0)(1-\phi) p_{t-1}^H, \text{ iff } (1+r_0)(1-\phi) > q^H$$

Thus the price constraints (20) are satisfied whenever the following parameter constraint is satisfied:

$$(1+r_0)(1-\phi) > q^H \tag{62}$$

We now need to check that the first order condition (53) is positive at all $t \geq 0$. Using the optimal policies for c_t, k_t, and b_t, as well as the price dynamics, we have:

$$J(e_t, d_t, x_t^H) = d_t + \alpha \frac{C_0}{1-\beta} + (1-\alpha) \sum_{s \geq 0} [\beta q^H]^s [a_s + b_s(e_t - C_0 + d_t)] \qquad (63)$$

where d_t, a_s and b_s, do not depend on d_t, for any $s \geq 0$. More importantly,$b_s \geq 0$, for any $s \geq 0$, and thus the coefficient of d_t is always positive. This ensures that $J_2 \geq 0$, and the proof is complete.

Q.E.D.

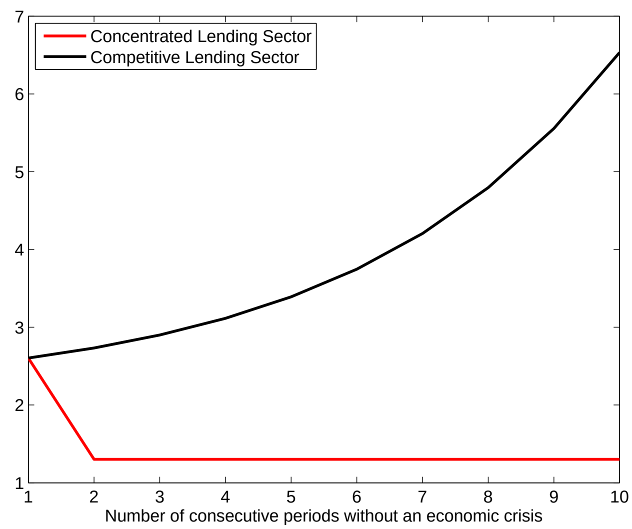

Figure 1: Housing Prices across systems

Country	No.	HHI1	HHI2	CR	De/TA	TLo/TA	RLo/TLo	RE/TA	LoL/TLo	LoP/TLo
US	1133	0.0368	0.0419	0.0793	0.7891	0.5341	0.3490	0.0413	0.0111	0.0117
CAN	7	0.2488	0.2493	0.0510	0.6591	0.4693	0.3957	0.0282	0.0057	0.0052
CHL	6	0.4708	0.4734	0.0792	0.5867	0.7172	NaN	0.0180	NaN	0.0117
ARG	5	0.4319	0.4303	0.0982	0.5538	0.5310	NaN	0.0473	NaN	0.0271
GBR	5	0.4394	0.4305	0.0477	0.6372	0.5018	0.2596	0.0293	0.0086	0.0097
BRA	4	0.5340	0.5354	0.1038	0.3580	0.3648	NaN	0.0280	NaN	0.0559
ESP	4	0.5049	0.5083	0.0596	0.6689	0.5480	0.1363	0.0226	0.0093	0.0088
JPN	4	0.7645	0.7643	0.0370	0.6785	0.5031	0.1171	0.0166	0.0078	0.0063
KOR	4	0.4335	0.4306	0.0557	0.6423	0.6901	NaN	0.0228	NaN	0.0113
AUS	3	0.4235	0.4190	0.0627	0.5685	0.6417	0.4121	0.0288	0.0047	0.0051
DEU	3	0.5815	0.5893	0.0332	0.5057	0.3178	NaN	0.0151	NaN	0.0059
IND	3	0.6306	0.6942	0.0741	0.6100	0.5319	NaN	0.0326	NaN	0.0124

Table 1: Summary statistics: This table reports the averages across banks/years within country for several variables of interest. “No”. stands for the number of banks, “HHI1” stands for the HH concentration index for the banking sector with respect to bank deposits, “HHI2” stands for the HH concentration index for the banking sector with respect to bank assets, “CR” stands for bank capital ratio, “De/TA” stands for deposits as a fraction of total assets, “TLo/TA” stands for total loans as a fraction of total assets, “RLo/TA” stands for loans secured by real estate as a fraction of total assets, “RE/TA” stands for retained earnings as a fraction of total assets, “LoL/TLo” stands for actual loan losses as a fraction of total loans, “LoL/TLo” stands for bank provisions for loan losses as a fraction of total loans

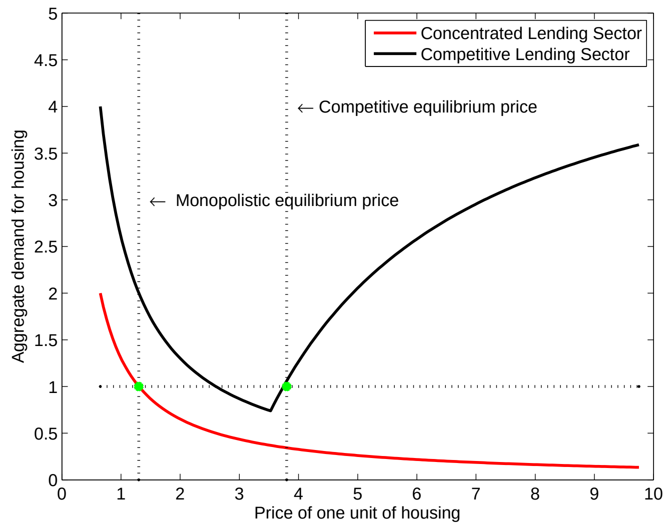

Figure 2: Aggregate demand for housing

Figure 3: Households income decomposition

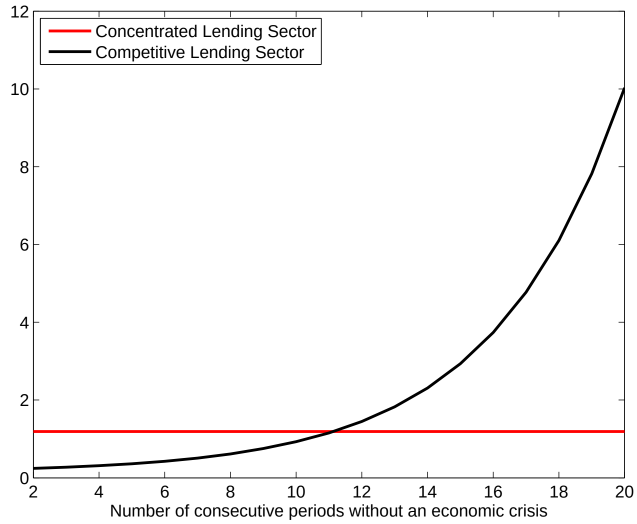

Figure 4: Lenders' profit

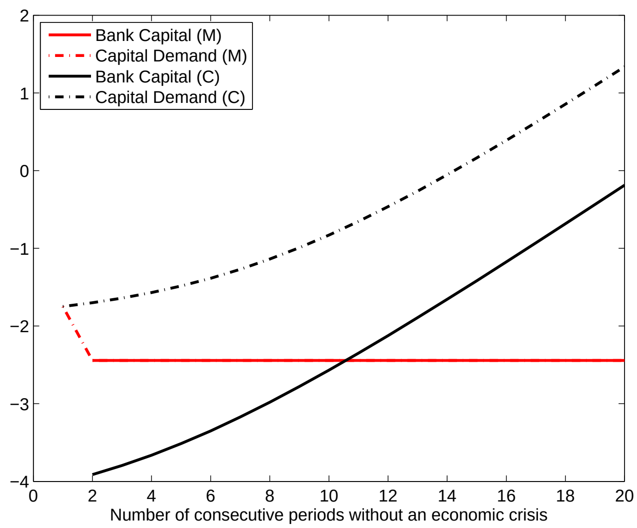

Figure 5: Lenders' internal capital

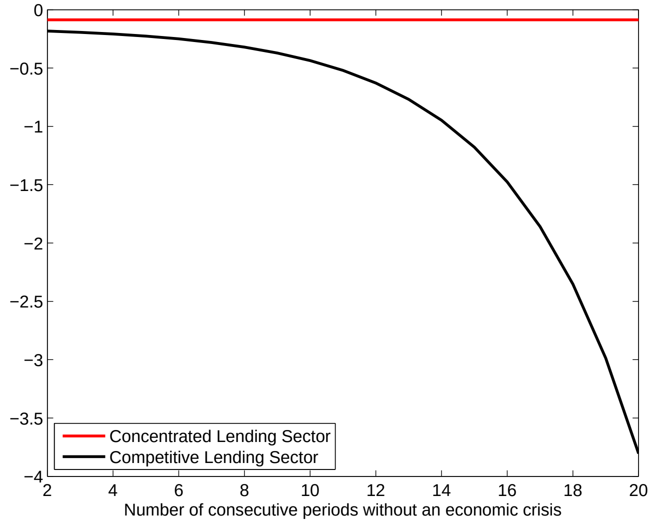

Figure 6: Lenders' loan losses in the event of large negative economic shocks

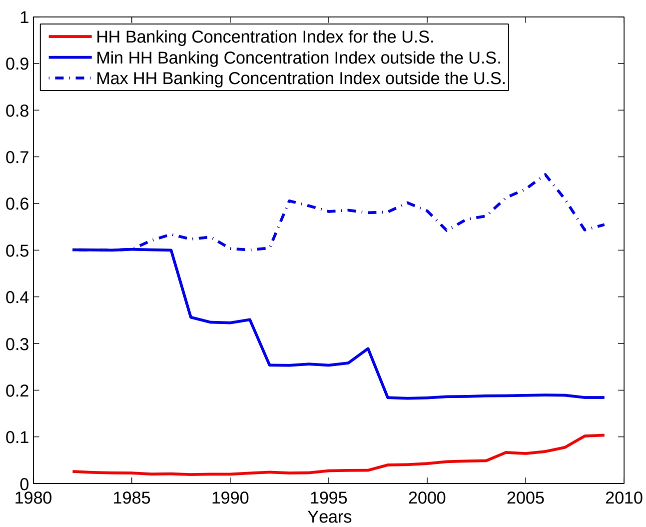

Figure 7: The HH Concentration Index for banking sector in the U.S. and outside the U.S. The targeted market is consumer bank deposits.

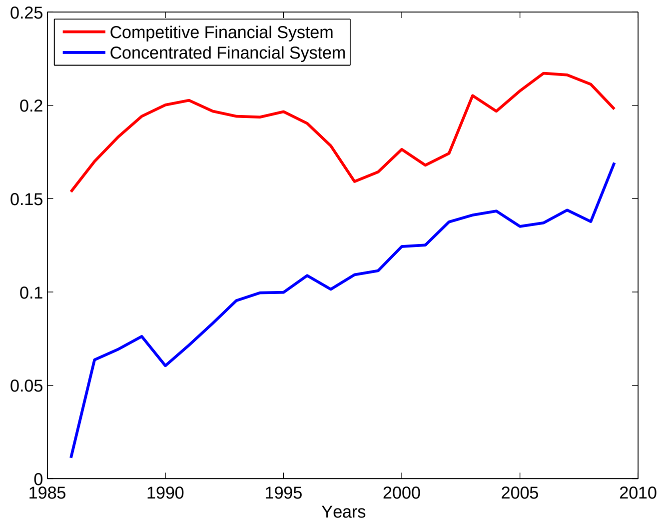

Figure 8: Demand for mortgage loans: Total mortgage loans as a fraction of total assets. Total mortgage loans is the aggregate sum of loans, claims and advances secured by real estate (Compustat item LCAM) across banks in a country. Total assets is the aggregate sum of a bank's total assets (Compustat item AT) across banks in a country. Competitive Financial System plots the variable for the U.S. only (the only country with a HH Index below 0.1). Concentrated Financial System plots the cross-sectional median across the countries with an HH Index above 0.1.

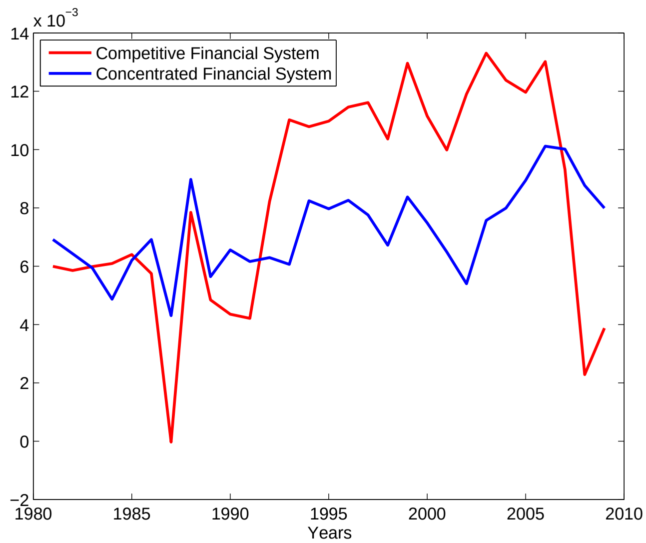

Figure 9: Bank profits (take 1): Total net income as a fraction of total assets. Total net income is the aggregate sum of a bank's net income (Compustat item NI) across banks in a country. Total assets is the aggregate sum of a bank's total assets (Compustat item AT) across banks in a country. Competitive Financial System plots the variable for the U.S. only (the only country with a HH Index below 0.1). Concentrated Financial System plots the cross-sectional median across the countries with an HH Index above 0.1.

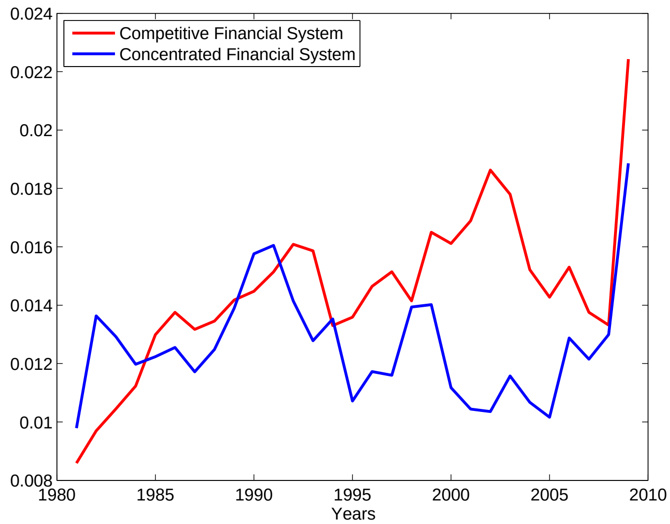

Figure 10: Bank profits (take 2): Total net income plus provision for loan losses as a fraction of total assets. Total net income plus provision for loan losses is the aggregate sum of a bank's net income (Compustat item NI) and a bank's provision for loan losses, charged against net income, (Compustat item PLL) across banks in a country. Total assets is the aggregate sum of a bank's total assets (Compustat item AT) across banks in a country. Competitive Financial System plots the variable for the U.S. only (the only country with a HH Index below 0.1). Concentrated Financial System plots the cross-sectional median across the countries with an HH Index above 0.1.

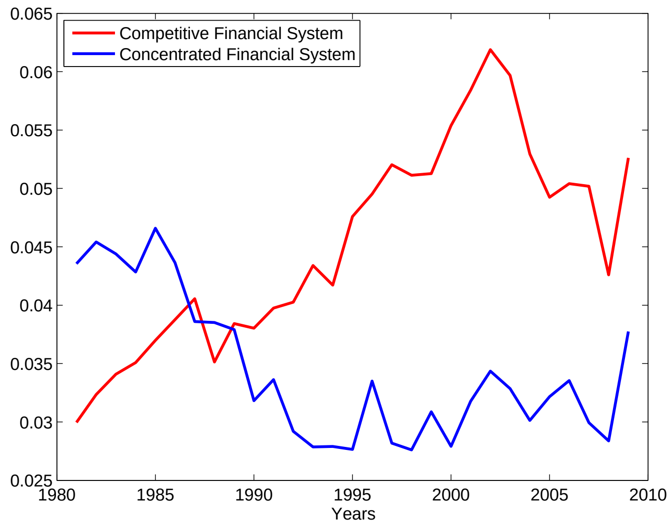

Figure 11: Bank profits (take 3): Total cumulative retained earnings plus provision for loan losses as a fraction of total assets. Total cumulative retained earnings plus provision for loan losses is the aggregate sum of a bank's cumulative retained earnings (Compustat item RE) and a bank's provision for loan losses, charged against net income, (Compustat item PLL) across banks in a country. Total assets is the aggregate sum of a bank's total assets (Compustat item AT) across banks in a country. Competitive Financial System plots the variable for the U.S. only (the only country with a HH Index below 0.1). Concentrated Financial System plots the cross-sectional median across the countries with an HH Index above 0.1.

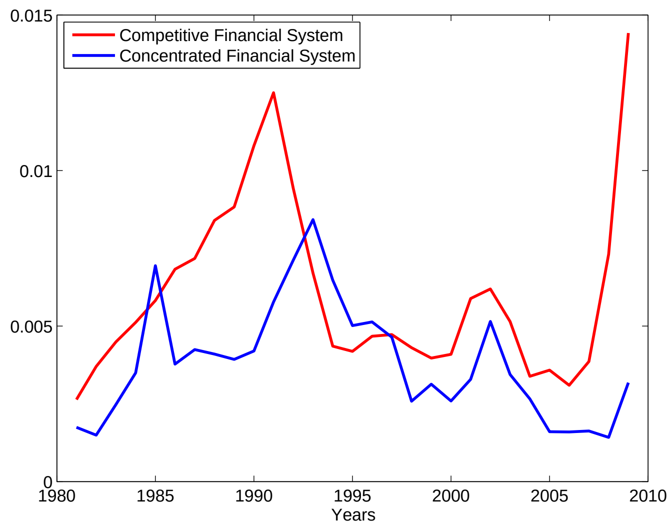

Figure 12: Bank actual losses: Total loan write-offs as a fraction of total assets. Total loan write-offs is the aggregate sum of a bank's actual loan losses written off (Compustat item LLWOCR) and charged against a bank's credit loss reserve across banks in a country. Total assets is the aggregate sum of a bank's total assets (Compustat item AT) across banks in a country. Competitive Financial System plots the variable for the U.S. only (the only country with a HH Index below 0.1). Concentrated Financial System plots the cross-sectional median across the countries with an HH Index above 0.1.

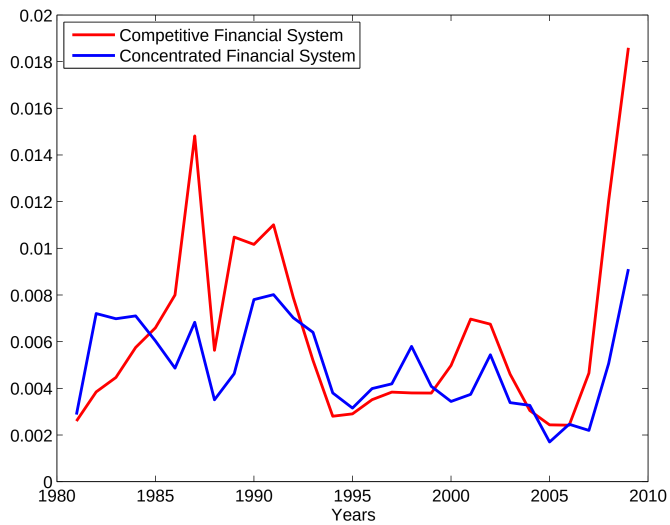

Figure 13: Bank expected losses: Total loan loss provision as a fraction of total assets. Total loan loss provision is the aggregate sum of a bank's provision for loan losses (Compustat item PLL) across banks in a country. Total assets is the aggregate sum of a bank's total assets (Compustat item AT) across banks in a country. Competitive Financial System plots the variable for the U.S. only (the only country with a HH Index below 0.1). Concentrated Financial System plots the cross-sectional median across the countries with an HH Index above 0.1.