Bank Size and Economic Growth

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November 13, 2020

Abstract

This paper studies how bank size affects economic growth. The growth model with a finite number Cournot banks from Cetorelli and Peretto (2012) is simplified into that with two big and small banks. Big bank with larger equity tends to borrow less, lend more credit, and provide less relationship service than the small one. Nonetheless, we find that the size difference holding the total credit constant does not deteriorate the growth prospect but rather encourage big bank to lend and contribute more to economic growth due to its efficiency in providing relationship loan.

1 Introduction

The banking industry has become more and more concentrated. Federal Deposit Insurance Corporation (FDIC) reports that there were over 10,000 commercial banks in 1984, but fell to under 5,000 in 2016. After the 2008 economic crisis, McCord and Prescott (2014) found that the biggest slump of the number of banks is due to the smallest size class, which is those with less than $100 million in assets and that two-thirds of such drop are attributed to the lack of entry. Incidentally, the US economy expands at a lower rate compared with pre-crisis trend. Many inquiries are conducted to investigate the relationship between banking market structure and economic growth.

The relationship between banking competition and economic growth is theoretically and empirically ambiguous. Many studies support the view that the more perfectly competitive the banking market is, the better the credit market functions since the loan rate will be kept

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at a competitive rate and support growth (Black and Strahan 2002, Smith 1998, Guzman 2000). On the other hand, many literature argues that banks with market power have more incentive to screen and monitor their clients, and issue more loans, fostering economic growth (Petersen and Rajan 1995, Cetorelli and Gambera 2001, Zarutskie 2006). Nonetheless, some researches suggest that such a relationship is not straightforward and depends on the characteristics of the economy (Deidda and Fattouh 2005, Cetorelli and Peretto 2012).

Given how concentrated the banking market has become, bank size is another prospect we could model banking competition. Berger and Dick (2007) found that there is an early-mover advantage in the service industry of banking, using data between 1972 to 2002. Banks that enter markets early enjoy larger market shares. Large banks often secure innovation before fringe banks, for example, in credit scoring (Akhavein et al. 2005), securitization (Minton et al. 2004), and internet banking (Furst et al. 2002). With better technology, empirical evidence suggests that bigger banks have lower average cost. Corbae and D'Erasmo (2014) also modeled dominant and fringe banks' interaction and investigates how a change in capital requirement contributes to a change in the banking market structure.

The strategic advantage or disadvantage between large and small banks is not new in the banking industry. Davila and Walther (2017) discussed how bank size affects bailout policy. In their model, large banks influence how much taxpayer's fund is spent since the government will concern about its size due to a too-big-too-fail story that might create systemic risks.

In Cetorelli and Peretto (2012), Cournot banks provide two types of loans for entrepreneurs: relationship and standard loans. The relationship services guarantee that the credits are successfully transformed into capital for production, while the standard loans are lent to investment projects with some degree of failure. They found that when the economy has intrinsic market uncertainty, less competition leads to more capital accumulation because banks with market power will have more incentive to provide relationship loans and facilitate entrepreneurs' investment projects.

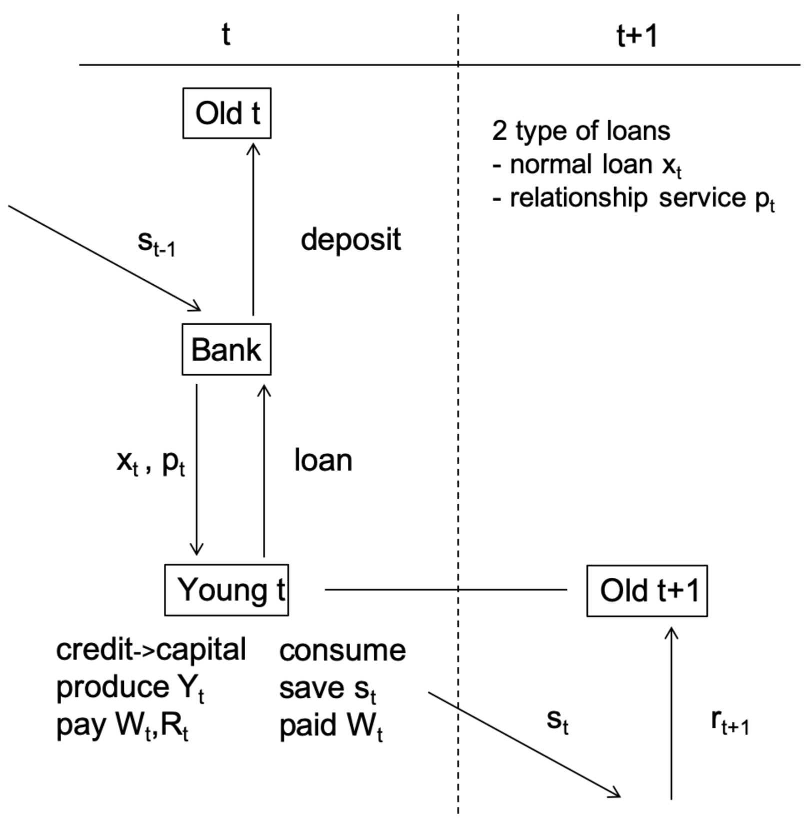
Nonetheless, there are different sizes of banks out there in the real economy. The size differences might have some implication on economic growth. Thus, Cetorelli and Peretto's model could be extended to incorporate banks' type. This paper aims to study how the banking market structure with big and small banks affects capital accumulation. We find that the differences in size foster growth. When the efficient banks becomes larger, they can afford to lend more of both standard and relationship loans and contribute to higher level of total output.

The paper organizes as following. The next section outlines the model, how households, entrepreneurs, and banks behave, and how credit is transformed into capital. Section 3 characterizes the equilibrium, while section 4 talks about aggregate capital accumulation. Section 5 concludes.

2 The model

We study the economy with an infinite horizon. Overlapping generation household and firm's setups follows Cetorelli and Peretto (2012), but two banks of banks: big and small. Young household works, consumes and saves s_t for their consumption when old, while firms pay young household W_t as wage and produce output Y_t.

Figure 1: Timeline



Banks are born with an endowment e^i: $e^b = e_0 + \delta$ for big bank and $e^s = e_0 - \delta$ for small bank where $e_0 > \delta$. Banks obtain deposits S_t from young households and lend firms $X_t + 2e_0$ amount of credit. Apart from a standard credit issuance, they lend a portion of credit p^i as relationship loan. We can think of such a loan as a liquidity insurance against any mishap which can happen in an investment project. By extending relationship loans, banks incur a cost β, and the provision of this particular type of loan can raise the likelihood of success of the project. A special characteristic of this loan is that it can be free ridden and will be discussed more in the later subsection. Both households and firms have no preference for any particular type of bank.

Timing. Figure 1 sums up the timeline of the model. At date t, the young work in firms, save wages in banks and consumes. Firms receive credit X_t from banks. If they succeed in transforming credit into capital, capital stock K_t and labor L_t are used to produce final goods Y_t, which will be bought by the old and paid back, not only the interest to banks but also wages to young households. Banks return the deposit plus interest to savers at date t+1.

2.1 Household

Consider a unit mass of household who lives for two periods and has no population growth. The young have no capital endowed, but only one unit of labor, while the old use only the saving left after work in the period before. Assume that young household supplies labor inelastically $L_t = 1$. Household optimizes:

$$\max_{c_t, c_{t+1}, s_t} U(c_t, c_{t+1}) = c_t^{\alpha} + c_{t+1}^{\alpha}, \text{ where } \alpha < 1 \tag{2.1}$$

subject to

$$c_t = W_t - s_t$$
$$c_{t+1} = s_t r_{t+1}$$

Let c_t and c_{t+1} be consumption in young and old, respectively. Household decides to save s_t at date t and obtain wage W_t from work. They receive saving plus interest back when old at a rate, r_{t+1}. Solving the above problem yields equation 2.2, which is the upward-sloping supply for saving for banks.

$$r_{t+1}(S_t; W_t) = \left(\frac{S_t}{W_t - S_t}\right)^{\frac{1-\alpha}{\alpha}} \tag{2.2}$$

2.2 Firm

There exists a representative firm producing homogenous final goods for the economy. Suppose its technology satisfies a standard neoclassical production function and Inada conditions.

$$Y_t = F(K_t, L_t) = AK_t^{\gamma} L_t^{1-\gamma}, \text{ where } 0 < \gamma < 1 \tag{2.3}$$

Producer optimizes according to the following demand for capital and labor equations:

$$R_t = f'(K_t) = \gamma A K_t^{\gamma-1} \tag{2.4}$$

$$W_t = f(K_t) + K_t f'(K_t) = (1-\gamma) A K_t^{\gamma} \tag{2.5}$$

Prices of both capital and labor depend on their respective marginal products. Firms will hire young labor with wage W_t and obtain credit with loan rate R_t before transforming it into capital. We talk about such technology in the next section.

2.3 Capital and Credit

Capital. Entrepreneurs have no endowment and need to borrow from banks in order to invest it into capital. That is, a unit mass of entrepreneur $i \in [0, 1]$ borrows credit from bank and converts it into capital with linear transformation technology:

$$K_{it} = \vartheta_i X_{it} \tag{2.6}$$

where ϑ_i is a random variable, i.i.d. across time and across entrepreneurs, which takes value one with probability θ and zero with probability $1-\theta$ and X_{it} is the total credit obtained by an individual entrepreneur i at time t. Each entrepreneur succeeds with probability less than one, and if he fails, the expected liquidation value is zero. Assume that ϑ_i is size invariant for simplicity.

Credit. Banks can engage with all borrowers at any optimal scale since they can collect more savings from the working young if they are short of credit to lend. There are two types of services banks can provide. The first one is the standard loan that a firm will face uncertainty around their investment project. The second type of loan is relationship services that is assumed to facilitate entrepreneurs to succeed in their investment activities.

The relationship loan can be thought of as a contingent liquidity line for entrepreneurs to borrow in case of an emergency. A mismatch of inflows and outflows of firms' financial obligation could potentially disrupt a successful project. By providing such services, it costs banks β unit of output, but it helps dissipate the uncertainty according to the random variable ϑ_i. Therefore, firms with a relationship loan from a bank will successfully invest credit into capital with probability one. There are some literatures discussing about bank liquidity services and better firms' performances (James 1987, James and Wier 1987, Lummer and McConnell 1989, Hoshi et al. 1991, Gatev and Strahan 2006, Shockley and Thakor 1997, and more recently Li and Ongena 2015)

Free riding issue. An essential feature of the model is the spillover of relationship service that might incentivize other banks to free ride. If at least one bank offers a relationship loan, all uncertainty for that entrepreneurs disappears. Other banks will want to issue standard loan to that particular entrepreneur without incurring relationship costs. There are literature in favor of this setup. Ongena et al. (2014) found that bank loan announcement affects bond spread issued by that particular firm, which is an evidence to support our claim that credit commitment provides less risky investment perceived by others.

One might argue that banks will want to offer an exclusive relationship contract and hinder a firm from other banks. But there is no incentive for entrepreneurs to stick with the contract since there is also another bank out there to borrow, and they can keep borrowing up to their expected profit without relationship loan. Although banks can threaten firm to withdraw a relationship contract, firms will find it hard to believe because relationship loans raise the likelihood of success and the expected profit. Walking away from the contract only hurts banks' revenue. Evidences in Detragiache et al. (2000), Ongena and Smith (2000), Gopalan et al. (2011), and Presbitero and Zazzaro (2011) suggest that firms borrow from more than one banks to diversify their sources of fund and/or reduce liquidity risks.

In our model, a bank decides how much they lend to firms either with or without additional services to accommodate the success of an investment project, taking into account that the other financial intermediary acts simultaneously on the same population of borrowers. We study how the interaction between big and small banks about their loan and relationship services affects the capital accumulation process and thus economic growth.

2.4 Bank

Suppose that there are two banks: big and small ones. Both banks collect deposits from the young and issue standard and relationship loans to entrepreneurs. Big and small bank will obtain endowment $e^b = e_0 + \delta$ and $e^s = e_0 - \delta$, respectively[1]. They both have market power and compete in Cournot type of setting.

2.4.1 Big Bank

Ignoring the time subscript without loss of generality, for Big bank, its expected profit from issuing to an entrepreneur i a loan of size $x_i^b + e_i^b$ is[2]

$$\pi_i^b = \underbrace{p^b\Big(R(x_i^b + e_i^b) - \beta\Big)}_{\text{issues relationship}} + \underbrace{(1-p^b)(1-p^s)\theta R(x_i^b + e_i^b)}_{\text{not issue relationship and neither does other}} + \underbrace{(1-p^b)(p^s)R(x_i^b + e_i^b)}_{\text{not issue but the other issues rel}} - r x_i^s$$

Define p^b and p^s as the probability that big and small banks offer relationship loans, respectively, since they move simultaneously and employ mixed strategy. β is the cost of a relationship loan. R is the loan rate from producer optimization problem, whereas r is the deposit rate from households' optimization problem.

The above equation indicates the profit of a small bank from both issuing or not issuing relationship loan to entrepreneur i. The first term tells the net profit from providing the relationship services. The second term gives the expected profit if none of the relationship loans are given by any other banks, which is why there is a probability θ attached. The third term is the free-riding profit if at least one bank relates to entrepreneur i. The fourth is the interest paid back to the old.

We can then aggregate over the mass of applicants $i \in [0,1]$. Define $x_i^b = \int_0^1 x_i^b di$, $e^b = \int_0^1 e_i^b di$. Rearrange the equation:

$$\begin{aligned}
\pi^b =& \int_0^1 p^b\Big(R(x_i^b + e_i^b) - \beta\Big)di + \int_0^1 (1-p^b)(1-p^s)\theta R(x_i^b + e_i^b)di \\
&+ \int_0^1 (1-p^b)(p^s)R(x_i^b + e_i^b)di - \int_0^1 r x_i^b di \\
=& \Big\{1 - (1-\theta)(1-p^b)(1-p^s)\Big\} R(x^b + e^b) - r x^b - p^b \beta
\end{aligned}$$

Given how banks give standard and relationship loans to entrepreneurs, we can derive the total capital from the summation of relationship credit and the expected amount of standard

[1] We have e_0 to make sure that a change in δ affects only the size difference δ not the total capital of the economy.

[2] Assume that banks need to issue credits to all entrepreneurs. We rule out a possible profitable deviation in which a bank decides to double the amount of credits x and lower relationship p twice to keep the same level of revenue and reduce its cost.

credit.

$$K = \left(x^{b,rel} + \theta x^{b,nor}\right) + \left(x^{s,rel} + \theta x^{s,nor}\right)$$

We can sum successfully transformed credit by both big and small banks and the expected value of standard credits by both banks as:

$$\begin{aligned} K &= \left\{1 - (1-\theta)(1-p^b)(1-p^s)\right\}x^b + \left\{1 - (1-\theta)(1-p^b)(1-p^s)\right\}x^s \\ &= \left[1 - (1-\theta)(1-p^b)(1-p^s)\right]X \\ &= mX \end{aligned}$$

where

$$m = 1 - (1-\theta)(1-p^b)(1-p^s) \tag{2.7}$$

Denote X and m as total credit and credit efficiency. This credit efficiency demonstrates how successfully the economy can transform credit to capital. If either type of banks decides to lend out more relationship loan, the credit efficiency of the whole economy will increase and so does the total amount of capital. We can rewrite big bank's optimization problem as in equation 2.8. They choose the amount of credit and relationship services to maximize their profit.

$$\max_{x^b,p^b} \pi^b = \left[m \cdot R(mX) - r(X)\right]x^b - p^b\beta \tag{2.8}$$

2.4.2 Small Bank

Apart from being endowed with a smaller amount of endowment, the small bank has a similar objective function. Its expected profit is

$$\max_{x^s,p^s} \pi^s = \left[m \cdot R(mX) - r(X)\right]x^s - p^s\beta \tag{2.9}$$

The equation 2.9 gives us the optimization problem of small banks where the first term gives the net profit of return from both relationship and standard loans. The second is the cost for relationship services. We will next discuss their decisions on credit issued and relationship services provided.

2.4.3 Banks' optimal choices

To find an optimal choice of banks in credit issuing, we differentiate equation 2.8 with respect to x^b, we obtain equation 2.10, which implies that the marginal benefit from borrowing including how much it can influence the demand for loans is equal to the marginal cost from paying back its source of fund.

$$mR + (x^b + e_0 + \delta)m\frac{\partial R}{\partial x^b} = r + x^b\frac{\partial r}{\partial x^b} \tag{2.10}$$

The equation 2.10 can be rewritten as 2.11 and indicates that the spread between loan and deposit rate depends on the inverse of credit efficiency m. As the economy becomes more and more efficient in transforming credit into capital, firms will have more productive capital at hand, and their marginal product in capital will fall, leading to a decrease in loan rate. The second term in equation 2.11 tells us about the market power of big bank: the nominator is for deposits, while the denominator is for loans.

$$\frac{R}{r} = \frac{1}{m}\left[\frac{1 + \frac{x^b}{X}\frac{1}{\epsilon_r}}{1 + \frac{x^b+e_0+\delta}{X+2e_0}\frac{1}{\epsilon_R}}\right] \tag{2.11}$$

where the interest elasticities of deposit and loan are expressed as following

$$\epsilon_r = \frac{\partial X}{\partial r}\frac{r}{X} = \frac{\alpha}{1-\alpha}\frac{W-X}{W}$$
$$\epsilon_R = \frac{\partial X + 2e_0}{\partial R}\frac{R}{X+2e_0} = -\frac{1}{1-\gamma}$$

For relationship services, consider big bank's optimal decision. We differentiate equation 2.8 with respect to p^b yields equation 2.12

$$p^b = \begin{cases} 0 & \text{if } x^b\left[R + m\frac{\partial R}{\partial K}X\right]\frac{\partial m}{\partial p^b} < \beta \\ (0,1) & \text{if } x^b\left[R + m\frac{\partial R}{\partial K}X\right]\frac{\partial m}{\partial p^b} = \beta \\ 1 & \text{if } x^b\left[R + m\frac{\partial R}{\partial K}X\right]\frac{\partial m}{\partial p^b} > \beta \end{cases} \tag{2.12}$$

For $p^b \in (0,1)$,

$$\beta = \underbrace{(x^b + e_o + \delta)}_{\substack{\text{credit}\\ \text{issued}}} \cdot \underbrace{R}_{\substack{\text{interest rate}\\ \text{on relationship}\\ \text{loan}}} \cdot \underbrace{(1 + \frac{1}{\epsilon_R})}_{\substack{\text{contribution to}\\ \text{capital via}\\ \text{contribution to}\\ \text{credit efficiency}}} \underbrace{\left[(1-\theta)(1-p^s)\right]}_{\substack{\text{contribution to}\\ \text{aggregate probability}\\ \text{of relationship loan}}} \tag{2.13}$$

Equation 2.12 narrates the big bank's decision on relationship loan. If the marginal cost of relationship β is higher than its marginal benefit, there is no incentive for big bank to engage in relationship services, and vice versa. Banks are indifferent and will choose any portion of credits for relationship loans when the marginal cost and benefit are equal, following equation 2.13. More relationship services will increase the aggregate probability of success in credit transformation and raise the amount of total capital. Those capital returns will come back to big bank as an interest payment in a proportion of credit issued.

For small bank's optimal choice, we have the following:

$$\frac{R}{r} = \frac{1}{m}\left[\frac{1+\frac{x^s}{X}\frac{1}{\epsilon_r}}{1+\frac{x^s+e_o-\delta}{X+2e_o}\frac{1}{\epsilon_R}}\right] \tag{2.14}$$

$$\beta = (x^s + e_o - \delta)\cdot R \cdot (1+\frac{1}{\epsilon_R})\Big[(1-\theta)(1-p^b)\Big] \tag{2.15}$$

3 The banking sector's equilibrium

Big and small banks obtain a different amount of endowment. We can think of the big bank as having larger equity than the small one. This difference in size will have an impact on how they choose their optimal actions against the counterparty. We have the following equations to characterize the equilibrium for capital and credit efficiency.

$$1-(1-\theta)(1-p^b)(1-p^s) = \left\{\frac{X^{1-\gamma}\left(\frac{W}{W-X}\right)^{\frac{1-\alpha}{\alpha}}\left(1+\frac{(1-\alpha)W}{\alpha(W-X)}\frac{x^b}{X}\right)}{A\gamma(1-(1-\gamma)\frac{x^b+e_o+\delta}{X+2e_o})}\right\}^{\frac{1}{\gamma}} \tag{3.1}$$

$$1-(1-\theta)(1-p^b)(1-p^s) = \left\{\frac{X^{1-\gamma}\left(\frac{W}{W-X}\right)^{\frac{1-\alpha}{\alpha}}\left(1+\frac{(1-\alpha)W}{\alpha(W-X)}\frac{x^s}{X}\right)}{A\gamma(1-(1-\gamma)\frac{x^s+e_o-\delta}{X+2e_o})}\right\}^{\frac{1}{\gamma}} \tag{3.2}$$

$$\frac{x^b+e_o+\delta}{(X+2e_o)^{1-\gamma}} = \frac{\beta}{\gamma^2 A}\frac{\Big\{1-(1-\theta)(1-p^b)(1-p^s)\Big\}^{1-\gamma}}{(1-\theta)(1-p^s)} \tag{3.3}$$

$$\frac{x^s+e_o-\delta}{(X+2e_o)^{1-\gamma}} = \frac{\beta}{\gamma^2 A}\frac{\Big\{1-(1-\theta)(1-p^b)(1-p^s)\Big\}^{1-\gamma}}{(1-\theta)(1-p^b)} \tag{3.4}$$

Equations 3.1 and 3.2 are derived from big and small banks' optimization problem with respect to credit called lending curves, while equations 3.3 and 3.4 are rearranged from big and small banks' decisions on relationship services, called relationship curves. The first two equations indicate the optimal credit each bank will provide given the level of relationship services, while the other two point out the optimal relationship loan each bank will serve given the amount of credit issued. Proposition 1 dicusses how big and small banks interact each other.

Proposition 1. *In equilibrium, big and small banks behave as following:*

1. big bank borrows less than small bank: $x^{b^*} < x^{s^*}$

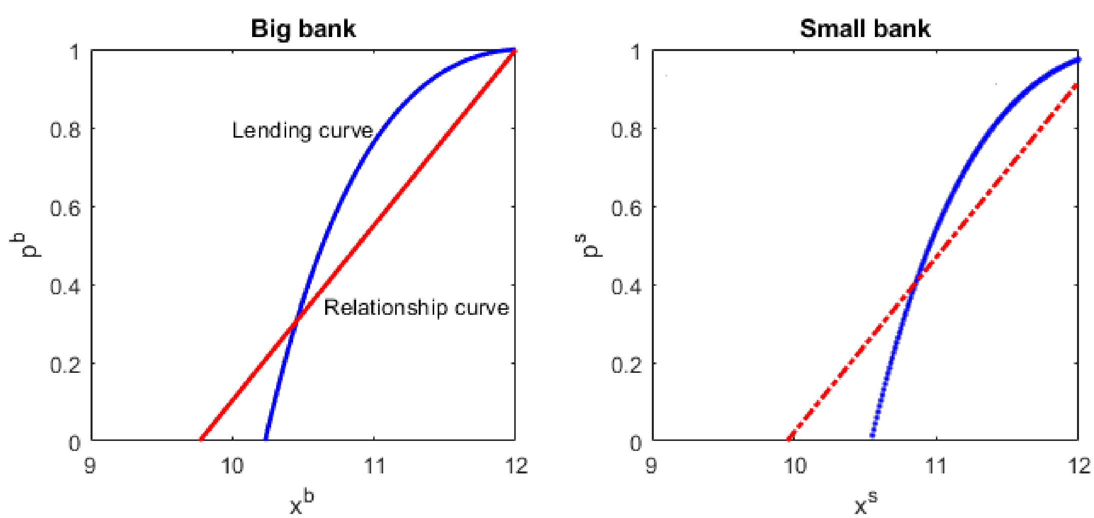
2. big bank lends more than small bank: $x^{b^*} + e_0 + \delta > x^{s^*} + e_0 - \delta$

3. big bank lends less relationship loan than small bank: $p^{b^*} < p^{s^*}$

Proof See appendix A.1.

Proposition 1 gives us three results. First, the big bank with larger endowment borrows less than the small one because it can use an endowment without incurring cost of paying deposit back to households[3]. Second, the big bank still lends more than the small one even if they borrow less since it uses the advantages of its size from endowment to lend more. The third implication is that the big bank with larger equity can afford in more risk-taking behavior by reducing the number of relationship services and paying fewer costs.

Figure 2: Banks' optimal choices



Note: The figure shows the optimal choice of each bank fixing the other bank's choice. Parameters used for numerical computation are: $e_0 = 0.5, \delta = 0.1, w = 10, A = 20, \beta = 3.7, \theta = 0.5, \gamma = 0.5, \alpha = 0.5$. LHS fixes $x^s = 4.8, p^s = 0.5$, while RHS fixes $x^b = 5.2, p^b = 0.5$.

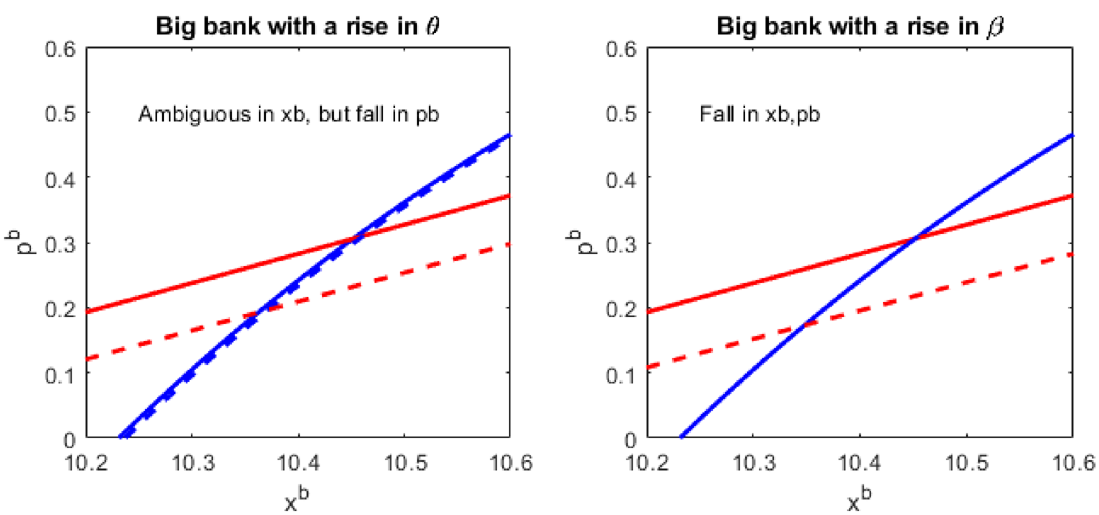
Figure 2 illustrates how big and small banks decide their optimal choices in credit and relationship service. The big bank's lending curve comes from equation 3.1. Its positive relationship implies the higher the relationship service, the more borrowing big bank should

[3]During 2015-2019, even if Bank of America has lower level of total equity capital than JP Morgan Chase, the former accumulates more deposit than the latter. Such relationship (larger equity, lower deposit) breaks down when we compare the top-5 banks and the smaller ones.

engage in lending more and enjoying more profit. The relationship curve from equation 3.3 indicates that the more borrowing, the more relationship service provided to make sure that their lending are successful. Big bank ends up with a lower level of deposit x^b compared with the smaller one.

This paper conducts comparative statics of each bank's optimal choices. Figure 3 shows how a bank responds to the change in the probability of success of the investment project (θ) and the cost of relationship service. A higher θ incentivizes bank to lend more as its tendency to obtain the fund back is higher, shifting the lending curve to the right. Still, its marginal benefit of relationship service is lower so its share of this type of loan falls, shifting the relationship curve to the right. The right-hand side of figure 3 has a rise in β. A bank decides to lower its relationship service due to its higher cost.

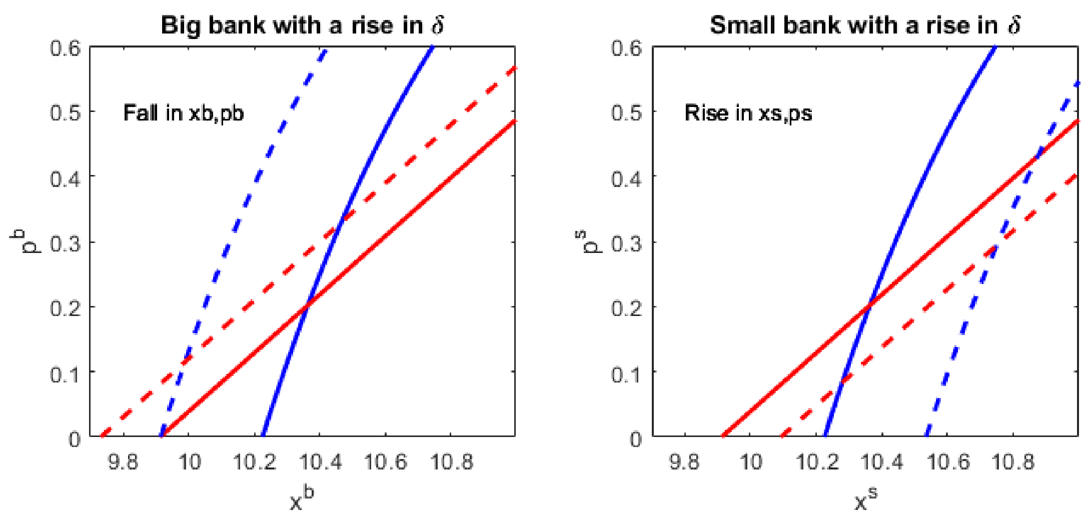
Figure 3: Bank's optimal choices after changes in θ and β



Note: Same set of parameters used in figure 2, and $\theta' = 0.505$, $\beta' = 3.75$

Figure 4 illustrates how big and small banks react when there is a change in their size difference δ. The small bank will borrow more to compensate for a loss in endowment and lend less relationship loan because its stake in investment project or its marginal benefit of relationship loan is lower. Nonetheless, the small bank choices on x^s and p^s are ambiguous, depending on which curve dominates. It borrows less since it has more endowment but lend more relationship loan since its marginal benefit is higher. The ambiguous implication in big bank's optimal choices similar to the small bank is drawn.

Figure 4: Bank's optimal choices after a change in δ



Note: Same set of parameters used in figure 2, and $\delta' = 0.2$

4 The equilibrium in capital and output

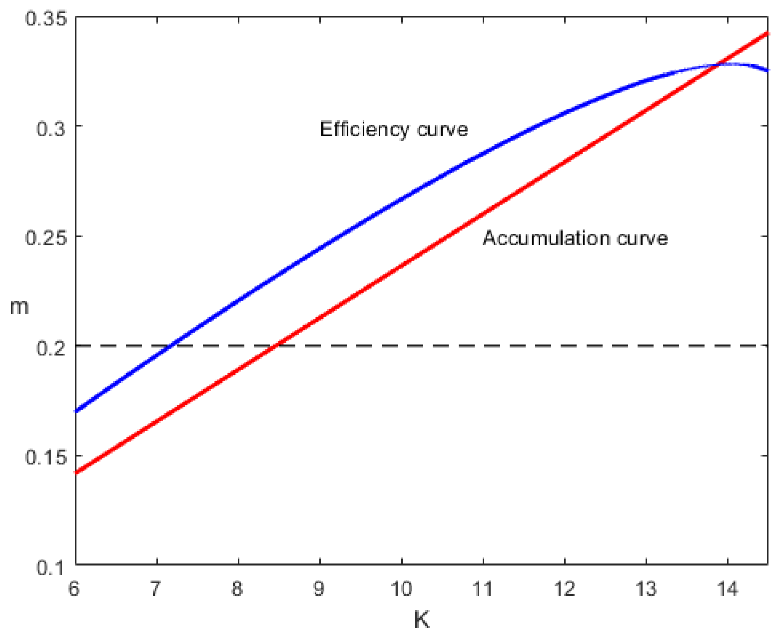
In this section, we study the general equilibrium of aggregate capital (K) and credit efficiency (m), and conduct comparative statics on how a change in size difference (δ) affects the total output. As we observe in the real world, big banks become larger and larger. Observing how higher δ leads to a change in output helps us understand what happens in the economy.

Figure 5 shows the equilibrium in capital and credit efficiency. The efficiency curve is solved numerically from the lending equations 3.1 and 3.2, pinning down the optimal level of credit efficiency given capital. A higher level of capital leads to higher credit efficiency. As the economy has more capital, the marginal product of capital will be lower and thus the interest rate on loan will fall. To compensate such loss in revenue, banks need to raise relationship loans to make investment project more successful.

The accumulation curve, on the other hand, is obtained from the relationship equations 3.3 and 3.4, expressing the optimal capital given credit efficiency. Capital and credit efficiency are also positively related. As credit efficiency is higher, banks find themselves profitable by lending more, and as a result, more capital is accumulated. The dashed line in the figure discloses the minimum value of credit efficiency when both banks decide to lend none of relationship services.

We can study the effect of a change in δ to the equilibrium capital, credit efficiency, and total output. First, consider how a change in δ affects the efficiency curve. Since the efficiency curve reveals the optimal m given capital K, a change in δ does not affect the amount of accumulated capital. In our setup, a rise in endowment of big bank means a fall in endowment of small bank. The total capital is transformed without depending on the change in the size difference: $K = m(x^b + x^s + 2e_0)$. Therefore, there is no change in the efficiency curve after a change in δ.

Figure 5: Equilibrium in K and m

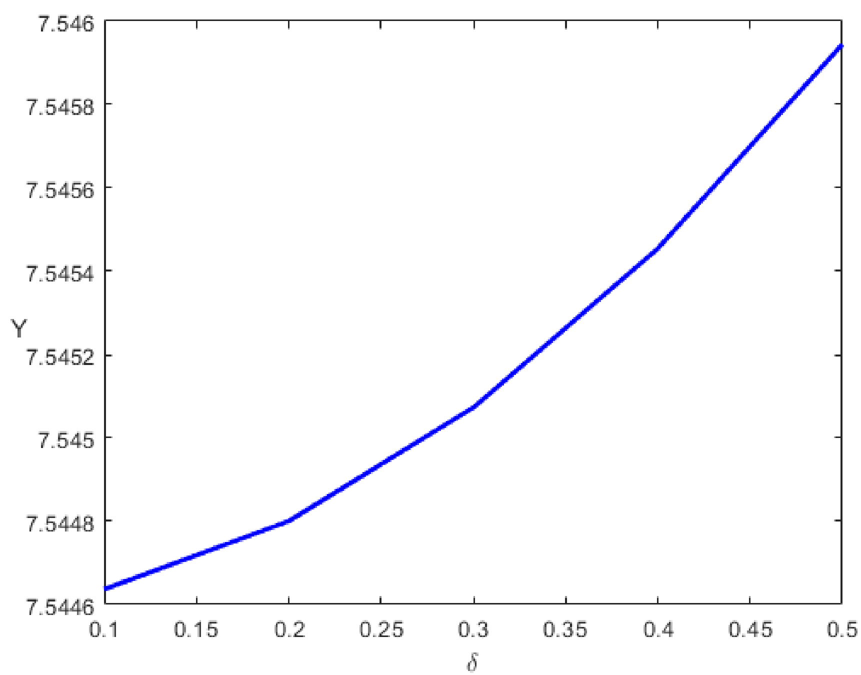


Note: Parameters used for numerical computation are: $e_0 = 5, \delta = 0, w = 15, A = 13, \beta = 10, \theta = 0.2, \gamma = 0.5, \alpha = 0.5$.

For the accumulation curve, it gives us an optimal value of capital given credit efficiency. A rise in δ affects the marginal benefit of relationship service (from equations 2.13 and 2.15). The big bank will then lend more of relationship loan. Higher relationship services mean the project has a higher tendency to succeed. Lending more of standard loans will guarantee a better return. Small bank will react the opposite because its marginal benefit in relationship service falls. The shift in accumulation curve will depend on which side dominates.

We then compute how a change in δ affects the total output. Figure 6 plots the change in δ on the horizontal axis and the total output on the vertical axis. Output ends up increasing after an increase in bank size because big bank dominates by lending more in both standard and relationship credits. The fixed cost in providing relationship loans plays a major role[4]. With such cost, a bigger bank can afford to provide more relationship loans to entrepreneurs without incurring additional cost per unit of credit. Therefore, a bank with efficient technology can give out more credit line and liquidity insurance to entrepreneurs and thus help foster economic growth.

Figure 6: Output after changes in δ



Note: Same set of parameters used in figure 5

5 Conclusion

Banks are heterogeneous in their size. This paper studies how big and small banks interact and how their size differences affects economic growth. We find that big bank with larger equity borrows less from households, lends more loan, and provide less relationship service

[4]However, consider another scenario when the cost of relationship services is linear for example. Its cost is higher and the bank might not be able to afford it. The result from a change in size to output will be different.

to entrepreneurs than the small one.

When a big bank gets larger and a small bank gets smaller, the former lends more in both standard and relationship loans while the latter lends less. Fixed cost in relationship services is the main reason why big bank engages in more financial activities. Bigger bank lend more credit using endowment and its marginal benefit of relationship loan is higher, encouraging itself to provide more relationship services. The credit efficiency is improved and generates more capital, which implies higher economic growth. If banks are efficient enough, it is willing to lend more and provide better services for their own profit. The economy benefits from its efficiency.

References

Akhavein, J., Frame, W. S., and White, L. J. (2005). The diffusion of financial innovations: An examination of the adoption of small business credit scoring by large banking organizations. *The Journal of Business*, 78(2):577–596.

Berger, A. N. and Dick, A. A. (2007). Entry into banking markets and the early-mover advantage. *Journal of Money, Credit and Banking*, 39(4):775–807.

Black, S. and Strahan, P. E. (2002). Entrepreneurship and bank credit availability. *Journal of Finance*, 57(6):2807–2833.

Cetorelli, N. and Gambera, M. (2001). Banking market structure, financial dependence and growth: International evidence from industry data. *The Journal of Finance*, 56(2):617–648.

Cetorelli, N. and Peretto, P. F. (2012). Credit quantity and credit quality: Bank competition and capital accumulation. *Journal of Economic Theory*, 147(3):967 – 998.

Corbae, D. and D'Erasmo, P. (2014). Capital requirements in a quantitative model of banking industry dynamics.

Davila, E. and Walther, A. (2017). Does size matter? bailouts with large and small banks. Technical report, National Bureau of Economic Research.

Deidda, L. and Fattouh, B. (2005). Concentration in the banking industry and economic growth. *Macroeconomic Dynamics*, 9(02).

Detragiache, E., Garella, P., and Guiso, L. (2000). Multiple versus single banking relationships: Theory and evidence. *The Journal of Finance*, 55(3):1133–1161.

Furst, K., Lang, W. W., and Nolle, D. E. (2002). Internet banking. *Journal of Financial Services Research*, 22(1-2):95–117.

Gatev, E. and Strahan, P. E. (2006). Banks' advantage in hedging liquidity risk: Theory and evidence from the commercial paper market. *The Journal of Finance*, 61(2):867–892.

Gopalan, R., Udell, G. F., and Yerramilli, V. (2011). Why do firms form new banking relationships? *Journal of Financial and Quantitative Analysis*, 46(5):1335–1365.

Guzman, M. G. (2000). Bank structure, capital accumulation and growth: a simple macroeconomic model. *Economic Theory*, 16(2):421–455.

Hoshi, T., Kashyap, A., and Scharfstein, D. (1991). Corporate structure, liquidity, and investment: Evidence from japanese industrial groups. *The Quarterly Journal of Economics*, 106(1):33–60.

James, C. (1987). Some evidence on the uniqueness of bank loans. *Journal of financial economics*, 19(2):217–235.

James, C. M. and Wier, P. (1987). Returns to acquirers and competition in the acquisition market: The case of banking. *Journal of Political Economy*, 95(2):355–370.

Li, C. and Ongena, S. (2015). Bank loan announcements and borrower stock returns before and during the recent financial crisis. *Journal of Financial Stability*, 21:1–12.

Lummer, S. L. and McConnell, J. J. (1989). Further evidence on the bank lending process and the capital-market response to bank loan agreements. *Journal of Financial Economics*, 25(1):99–122.

McCord, R. and Prescott, E. (2014). The financial crisis, the collapse of bank entry, and changes in the size distribution of banks. *Economic Quarterly*, (1Q):23–50.

Minton, B., Sanders, A., and Strahan, P. E. (2004). Securitization by banks and finance companies: Efficient financial contracting or regulatory arbitrage?

Ongena, S., Roşcovan, V., Song, W.-L., and Werker, B. J. (2014). Banks and bonds: The impact of bank loan announcements on bond and equity prices. *Journal of Financial Management, Markets and Institutions*, 2(2):131–156.

Ongena, S. and Smith, D. C. (2000). What determines the number of bank relationships? cross-country evidence. *Journal of Financial intermediation*, 9(1):26–56.

Petersen, M. A. and Rajan, R. G. (1995). The effect of credit market competition on lending relationships. *The Quarterly Journal of Economics*, 110(2):407–443.

Presbitero, A. F. and Zazzaro, A. (2011). Competition and relationship lending: Friends or foes? *Journal of Financial Intermediation*, 20(3):387–413.

Shockley, R. L. and Thakor, A. V. (1997). Bank loan commitment contracts: Data, theory, and tests. *Journal of Money, Credit, and Banking*, pages 517–534.

Smith, R. T. (1998). Banking competition and macroeconomic performance. *Journal of Money, Credit and Banking*, 30(4):793–815.

Zarutskie, R. (2006). Evidence on the effects of bank competition on firm borrowing and investment. *Journal of Financial Economics*, 81(3):503 – 537.

A Proof

A.1 Proof of Proposition 1

1. From equations 2.10, we have

$$mR + (x^b + e_0 + \delta)m\frac{\partial R}{\partial x^b} = r + x^b\frac{\partial r}{\partial x^b}$$
$$mR - r = \left(\frac{x^b}{x}\right)\frac{r}{\epsilon_r} - \left(\frac{x^b + e_0 + \delta}{X + 2e_0}\right)\frac{mR}{\epsilon_R}$$

Same for small bank: $mR - r = \left(\frac{x^s}{x}\right)\frac{r}{\epsilon_r} - \left(\frac{x^s + e_0 - \delta}{X + 2e_0}\right)\frac{mR}{\epsilon_R}$. We subtract between two equations and obtain:

$$\frac{x^b - x^s}{x} \cdot \frac{r}{\epsilon_r} = \frac{x^b - x^s + 2\delta}{X + 2e_0}\frac{mR}{\epsilon_R}$$
$$\Leftrightarrow x^b - x^s = \frac{2\delta}{X + 2e_0}\frac{mR}{\epsilon_R}\left(\frac{1}{\frac{r}{X\epsilon_r} - \frac{mR}{(X+2e_0)\epsilon_R}}\right) < 0$$

The RHS is negative because the interest elasticity of loan ϵ_R. Therefore, $x^b - x^s < 0$. That is, big bank borrows less than small bank.

2. We can write big and small bank's FONCs as following:

$$1-(1-\theta)(1-p^b)(1-p^s)=\left\{\frac{X^{1-\gamma}\left(\frac{W}{W-X}\right)^{\frac{1-\alpha}{\alpha}}}{A\gamma}\frac{\left(1+\frac{1-\alpha}{\alpha}\frac{W}{W-X}\frac{x^b}{X}\right)}{(1-(1-\gamma)\frac{x^b+e_o+\delta}{X+2e_o})}\right\}^{\frac{1}{\gamma}}$$

$$1-(1-\theta)(1-p^b)(1-p^s)=\left\{\frac{X^{1-\gamma}\left(\frac{W}{W-X}\right)^{\frac{1-\alpha}{\alpha}}}{A\gamma}\frac{\left(1+\frac{1-\alpha}{\alpha}\frac{W}{W-X}\frac{x^s}{X}\right)}{(1-(1-\gamma)\frac{x^s+e_o-\delta}{X+2e_o})}\right\}^{\frac{1}{\gamma}}$$

Use this property $\frac{A}{B}=\frac{C}{D}=\frac{A+C}{B+D}=\frac{A-C}{B-D}\Rightarrow$.

$$\frac{2+\frac{1-\alpha}{\alpha}\frac{W}{W-X}}{1+\gamma}=\frac{\frac{x^b-x^s}{X}\frac{1-\alpha}{\alpha}\frac{W}{W-X}}{-A\gamma(1-\gamma)\frac{(x^b-x^s+2\delta)}{X+2e_0}}$$

$$\underbrace{\frac{2+\frac{1-\alpha}{\alpha}\frac{W}{W-X}}{1+\gamma}}_{+}=\frac{\overbrace{\left(\frac{x^b-x^s}{X}\right)}^{-}\overbrace{\left(\frac{1-\alpha}{\alpha}\frac{W}{W-X}\right)}^{+}}{\underbrace{\left(\frac{-(1-\gamma)A\gamma}{X+2e_0}\right)}_{-}\underbrace{(x^b-x^s+2\delta)}_{\text{must be }+}}$$

We know from proposition 1 that $x^b-x^s<0$. Then, $x^b-x^s+2\delta$ must be positive so that the LHS is positive. Therefore, $(x^b+e_0+\delta)-(x^s+e_0-\delta)$ is positive. Big bank lends more credit.

3. From equation 2.13 and 2.15, we can write

$$\frac{x^b+e_o+\delta}{(X+2e_o)^{1-\gamma}}=\frac{\beta}{\gamma^2A}\frac{\left\{1-(1-\theta)(1-p^b)(1-p^s)\right\}^{1-\gamma}}{(1-\theta)(1-p^s)}$$

$$\frac{x^s+e_o-\delta}{(X+2e_o)^{1-\gamma}}=\frac{\beta}{\gamma^2A}\frac{\left\{1-(1-\theta)(1-p^b)(1-p^s)\right\}^{1-\gamma}}{(1-\theta)(1-p^b)}$$

$$\Rightarrow p^s-p^b=\underbrace{(1-p^b)(1-p^s)\frac{(1-\theta)\gamma^2A}{\beta m^{1-\gamma}}}_{+}\left[\frac{x^b-x^s+2\delta}{(X+2e_0)^{1-\gamma}}\right]$$

We know from 1 that $x^b-x^s+2\delta>0$ and total credit $X+2e_0>0$. Therefore, $p^s-p^b>0$. Big bank lend less relationship loan than small bank.