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Banks, Taxes, and Nonbank Competition[*]

by

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Abstract

This paper models banks' choice of capital structure and interest rates on loans and deposits when financial services markets are characterized by economies of scope, corporate taxes, and competition from nonbanks (shadow banks). In markets with rich retail lending opportunities but limited retail savings, banks may choose high equity capital (low leverage) when they are not subject to corporate income taxes. When banks are taxed, capital declines and retail borrowers bear the tax burden. In the opposite case of markets with few lending opportunities but plentiful retail savings, the tax burden falls on depositors and banks minimize capital. When banks face greater nonbank competition for retail savings, equilibrium loan rates increase, encouraging entry from nonbank lenders. The model's predictions are consistent with U.S. banks over the last two centuries. Recent empirical research on how taxes affect bank behavior also supports the model.

Banks, Taxes, and Nonbank Competition

I. Introduction

In many countries, a variety of intermediaries compete to provide similar financial services. This paper takes an industrial organization approach to analyze competition between banking and nonbanking institutions for retail lending and savings/transactions services. It focuses on how differences in government support, regulation, economies of scope, and corporate income taxes determine the market shares of these different institutions.

Banks, defined as intermediaries that primarily make loans and fund them mainly with deposits, have experienced changes in regulation, taxation, and nonbank competition over the last two centuries. A cost of funding-based model is presented that explains how banks and nonbanks evolved during this period. The analysis highlights the role that taxes play in determining banks' equilibrium interest rates on retail loans and deposits, their capital structures, and the incentives for nonbanks to enter the market for financial services. Depending on regulation and the market structure where a bank operates, taxes can affect either the equilibrium retail loan rates charged by the bank or the equilibrium retail deposit rates paid by the bank. Thus, the model derives conditions under which retail borrowers or retail depositors bear the burden of a bank's corporate taxes. The model also predicts when, in the absence of taxes, banks will choose high equity capital versus low equity capital.

The paper is related to DeAngelo and Stulz (2015) who examine banks' optimal capital structure when loans and deposits can be priced differently from competitively-priced debt. They argue that when banks are able to provide liquidity (savings/transaction) services to individuals who lack access to capital markets, high leverage is optimal for banks. Like them, the current paper assumes banks serve retail loan and deposit customers. However, while their analysis assumes retail loan and deposit rates have exogenously-fixed spreads relative to similar

competitively-priced securities, the current paper's model derives the equilibrium level of these spreads from the structure of loan and deposit markets.

When spreads are endogenous, the model shows that, contrary to DeAngelo and Stulz (2015), banks may choose low leverage (high equity capital) if they are not taxed and retail loan demand exceeds retail savings. If banks are subject to corporate taxes, borrowers bear some of the burden of corporate taxes and, at the margin, loans are funded with competitively priced debt and equity. In contrast, if retail savings is larger than loan demand, retail deposits fund a bank's security purchases at the margin. The effect of higher corporate taxes is to reduce security purchases with no effect on equilibrium retail loan rates. Rather, retail depositors bear the brunt of corporate taxes.

The paper then introduces the possibility of competition from nonbanks, also known as "shadow banks." In this respect, the paper relates to Hanson et al. (2015) who present a model where deposit insurance differentiates banks from nonbanks. While the current paper also considers how the introduction of a government lender of last resort and deposit insurance changed bank behavior, it focuses on two different features that distinguish banks from nonbanks. First, unlike banks, nonbanks do not simultaneously make loans and issue retail deposits. Rather loans are funded with competitively-priced debt and equity by one set of nonbank institutions that can be interpreted as securitization vehicles that pool loans and issue asset-backed securities or, alternatively, mutual funds that invest in corporate loans. Another set of nonbank intermediaries issue savings/transactions accounts and invest the proceeds in marketable, competitively-priced debt securities rather than retail loans. The main example of nonbank savings/transactions providers are money market mutual funds. Consequently, nonbanks do not benefit from an information-related economy of scope in the joint provision of loans and deposits.

The second main difference between these nonbanks and banks is that the nonbanks, such as loan securitization vehicles, loan mutual funds, and money market funds, are almost always structured to be exempt from corporate income taxes. This tax exemption can give nonbanks a

cost of funding advantage that, in some circumstances, may overcome their economy of scope disadvantage.

Extending the model to consider nonbank competition shows that in markets where retail savings dominate retail lending, depositors bear the burden of corporate income taxes which creates an incentive for money market funds to enter. But as money funds reduce banks' retail deposits relative to their retail loans, at the margin bank loans are funded with equity and competitively-priced debt and the corporate tax burden is shifted to retail borrowers. Consequently, an incentive for entry by nonbank loan investors is created, and subsequently securitization reduces banks' share of retail loans. Han, Park, and Pennacchi (2015) derive related results, but their model is of a single bank. They take the bank's demand for retail loans and supply of retail deposits as exogenous. The current paper derives these demands and supplies based on a market equilibrium that explicitly models competition with other banks and nonbanks.

The plan of the paper is as follows. Section II outlines the basic model assumptions and solves for equilibrium loan and deposit rates when only banks populate a market. The model is used to understand the evolution of U.S. banking from the early 1800's to around 1970. Section III introduces nonbank competition and shows how, in equilibrium, loan rates and deposit rates differ between nonbanks and banks, as well as across banks. This section also outlines the conditions under which nonbanks would find it profitable to enter and explains the rise of nonbank competition from the 1970s to the present. Section IV surveys recent empirical research related to the model's predictions. Section V concludes.

II. A Model with Only Banks

The foundation of the paper's retail financial services market is the Salop (1979) circular city model. Chiappori, Perez-Castrillo, and Verdier (1995) and, in particular, Park and Pennacchi (2009) are notable applications of this type of model. The current paper begins by solving for equilibrium interest rates and market shares when only banks operate. What defines the relevant

market for retail financial services can vary across countries. For example, in the United States different metropolitan statistical areas (MSAs) or rural counties tend to constitute individual retail markets. In other countries, the entire nation might correspond to a single retail market.

II.A Assumptions

The basic model assumes a single period during which funds are intermediated. Banks operate in a market that has two types of retail customers: savers and borrowers. There is a continuum of these customers uniformly located around a circle of unit circumference. Let D equal the total volume of retail savers' funds to be invested, which is the product of the market's density of savers and each saver's investible funds, which is assumed fixed. Also let L be the total volume of potential retail loans, which is equal to the product of the market's density of borrowers and each borrower's fixed loan amount.

As a starting point, let there be n different banks located equidistantly around the market of unit circumference, so that the distance between each bank is $1/n$. Banks are assumed to have identical production functions for financial services at marginal operating costs of c_D per unit of savings account balance and c_L per unit of loans, where c_D includes account administrative costs and c_L combines the costs of screening a borrower's credit and monitoring the borrower along with expected default losses. It is assumed that there is an economy of scope in that issuing retail deposits reduces a bank's cost of screening and monitoring a retail borrower. Specifically, if a particular bank, say bank i, issues retail deposits in amount D_i, then its per unit loan cost satisfies $\partial c_L(D_i)/\partial D_i \leq 0$. This assumption is based on Black (1975) and Fama (1985) who argue that information obtained from deposit transactions reduces the cost of monitoring borrowers. Empirical evidence in Mester et al. (2007) supports this view that banks are "special" because issuing deposits reduces their costs of making loans by reducing default losses.

The source of an individual bank's market power is modeled by retail customers incurring linear costs of traveling to a particular bank, equal to t_D for savers and t_L for borrowers. Retail customers are assumed to obtain sufficient gross surplus from consuming financial services

such that they are always willing to incur these transportation costs.[1] These costs give a comparative advantage to the bank located closest to a given customer, and therefore each bank directly competes with the two neighboring banks that are closest to it. What determines a customer's closeness to a given bank need not be limited to physical or geographic distance, but could include the distance between the particular attributes of an individual bank's financial services and an individual's product preferences.

Denote the retail loan rate offered by bank i as $r_{L,i}$, so that $r_{L,i-1}$ and $r_{L,i+1}$ are the loan rates offered by its two neighboring banks. If a borrower is a distance $x_- \in [0, 1/n]$ from bank i and a distance $(1/n - x_-)$ from bank i-1, this borrow will be indifferent between obtaining the loan from these banks if

$$r_{L,i} + t_L x_- = r_{L,i-1} + t_L \left(\frac{1}{n} - x_- \right) \tag{1}$$

Another borrower located between bank i and bank i+1 and who is a distance $x_+ \in [0, 1/n]$ from bank i is indifferent between obtaining the loan from bank i and bank i+1 if

$$r_{L,i} + t_L x_+ = r_{L,i+1} + t_L \left(\frac{1}{n} - x_+ \right) \tag{2}$$

For the distances satisfying (1) and (2), bank i's total loan demand is $(x_- + x_+)L \equiv L_i$ or

$$L_i = \left(x_- + x_+ \right) L = \left(\frac{r_{L,i-1} + r_{L,i+1}}{2} - r_{L,i} \right) \frac{L}{t_L} + \frac{L}{n} \tag{3}$$

Recall that c_L combines the per unit of loan costs of screening a borrower's credit, of monitoring the borrower, and expected default losses. While screening and monitoring the borrower is efficient in reducing expected default losses, for simplicity it is assumed that these activities do not affect the lowest (minimum) end-of-period rate of return on any bank's portfolio

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[1] Thus, in equilibrium all customers are served: the total volume of loans made by financial services firms equals L and the total volume of savings accounts issued equals D.

of loans, equal to a proportional loss of ρ_{low} per unit of loan.[2] Besides making loans to retail

borrowers, banks may invest in default-free money market securities that earn the interest rate r_M.

Assume, for now, that retail savers face no default risk when investing their savings in

the banks' deposit accounts. Later, the conditions for which deposits are riskless will be given.

Denote the interest rate paid by bank i on a deposit account as $r_{D,i}$. Then if y_- and $y_+ \in [0, 1/n]$ are

distances where savers are just indifferent to supplying funds to bank i, this bank faces the

savings supply curve, defined as D_i, of the form:

$$D_i = \left(y_- + y_+ \right) D = \left(r_{D,i} - \frac{r_{D,i-1} + r_{D,i+1}}{2} \right) \frac{D}{t_D} + \frac{D}{n} \tag{4}$$

Besides retail deposits, banks can also obtain funds in a wholesale deposit market which

is perfectly competitive and where the bank is a price taker. Denote by W_i the amount of

wholesale funds borrowed by bank i. If there is no risk of default on wholesale deposits, the bank

must pay interest equal to the default-free money market interest rate, r_M. If $W_i < 0$, then this

denotes a situation where the bank chooses to invest (lend), rather than borrow, funds in the

wholesale market at the money market interest rate.

In addition to retail and wholesale deposits, bank i can fund its assets by issuing

shareholders' equity in the amount E_i. Besides providing a source of funding, bank equity can

prevent runs by retail and wholesale depositors and may also make these deposits default-free.

Bank runs are assumed to be costly because they force the bank to liquidate borrower's

projects/loans *prior* to the end of the period at a proportional loss of $\rho_{run} > \rho_{low}$. Thus, as in

Diamond and Dybvig (1983), runs are assumed to be especially disruptive in that loans liquidated

prior to maturity have a value less than their minimum end-of-period value.

Note that at the start of the period, bank i's balance sheet equation is

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[2] For example, for each unit loan made to a retail borrower, $1-\rho_{low}$ is the end-of-period value of the borrower's project if it fails. Credit screening and monitoring decrease, but do not completely eliminate, the probability of project failure, thereby reducing expected default losses but not the minimum project return.

$$L_i = D_i + W_i + E_i \tag{5}$$

Initially, assume that deposits are uninsured and, if savers withdraw their deposit funds prior to the end of the period, they are serviced sequentially and entitled to receive their initial contribution but no interest. In this case, a bank run equilibrium exists whenever[3]

$$L_i\left(1 - \rho_{run}\right) < D_i + W_i \tag{6}$$

Consequently, comparing (5) and (6), the bank run equilibrium can be ruled out whenever

$$E_i \geq L_i \rho_{run} \tag{7}$$

which requires sufficient equity to cover the losses on loans due to early liquidation from runs.[4] For simplicity, it is assumed that this cost of runs is sufficiently high that bank owners choose adequate equity to eliminate the incentive to run so that inequality (7) holds for bank i. In addition, since $\rho_{run} > \rho_{low}$, it is also assumed that

$$E_i + L_i\left(1 - \rho_{low}\right) \geq D_i\left(1 + r_{D,i}\right) + W_i\left(1 + r_M\right) \tag{8}$$

In other words, sufficient equity to rule out a bank run is enough to ensure there is no default on the end-of-period promised payments to depositors. If condition (7) holds, then condition (8) holds when

$$\left(\rho_{run} - \rho_{low}\right)L_i > D_i r_{D,i} + W_i r_M \tag{9}$$

The interpretation of condition (9) is that the relatively greater loss on loans from runs exceeds the interest paid on retail and wholesale deposits. If $W_i < 0$, then the greater loss on loans from runs plus security interest income exceeds the interest paid on retail deposits. Of course L_i, D_i, and the retail deposit interest rate, $r_{D,i}$, are determined in equilibrium based on other parameters of the model. Once this is done, parameter restrictions for which condition (9) holds can be stated

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[3] If $W_i < 0$, so that the bank invests in money market securities, it is assumed that these securities can be liquidated at their initial values. In other words, money market securities are not costly to liquidate.
[4] Note that inequality (7) accounts for the possibility that the bank may hold liquid securities ($W_i < 0$) to reduce liquidation costs.

precisely. In the interim, this restricted parameter space is assumed, so that bank i's equity is sufficient to both rule out runs and make its deposits default-free.

Bank equity is risky due to possible loan defaults, but let r_E be the *certainty-equivalent* rate of return required by equity investors. Like the rate of return on money market instruments (wholesale debt), r_M, it is assumed that r_E is a fixed competitive rate of return set in national or global financial markets. Banks (and later nonbanks) take these competitive rates as given. Moreover, r_E and r_M are assumed to be rates of return after personal income taxes paid by the marginal equity and debt investors. Hence, r_E and r_M may be unequal if the marginal equity investor is more or less heavily taxed at the personal level than the marginal debt investor.[5]

Banks are assumed to be subject to corporate income taxes at the constant marginal tax rate of τ. As in most countries, it is assumed that a bank's interest expense on debt is deductible prior to calculating taxable income. Moreover, it is assumed that $r_M(1-\tau) < r_E$, a condition which implies that the total personal and corporate tax burden on equity exceeds that of debt. Much empirical evidence, such as Graham (2000), supports this assumption.

Lastly, banks are assumed to choose retail loan and deposit rates, shareholders' equity, and wholesale deposits/investments to maximize the after tax, certainty-equivalent return on equity. Han, Park, and Pennacchi (2015) show how this objective function can be derived when loans are default risky but markets are complete.[6]

II.B Model Derivation

Given the previous assumptions, bank i's maximization problem is

$$\underset{r_{L,i}, r_{D,i}, E_i, W_i}{\text{Max}} \left[L_i \left(r_{L,i} - c_L \left(D_i \right) \right) - D_i \left(r_{D,i} + c_D \right) - W_i r_M \right] (1-\tau) - E_i r_E \tag{10}$$

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[5] For example, if all investors were identical and had marginal personal income tax rates for debt and equity equal to τ_D and τ_E, respectively, then in equilibrium $r_M = r_E(1-\tau_E)/(1-\tau_D)$.

[6] They show that objective function (10) holds if deposits have default risk but are paid a fair risk premium (credit spread) or deposits are insured but the bank pays fairly-priced deposit insurance.

subject to the balance sheet equality (5) and the capital constraint (7). Let λ be the Lagrange multiplier associated with the capital constraint. The Appendix shows that the first order conditions are

$$\frac{r_{L,i-1}+r_{L,i+1}}{2}-2r_{L,i}+c_L\left(D_i\right)+\frac{r_E}{1-\tau}+\frac{t_L}{n}-\lambda\left(1-\rho_{run}\right)=0 \tag{11}$$

$$2r_{D,i}-\frac{r_{D,i-1}+r_{D,i+1}}{2}+\frac{t_D}{n}+c_D+L_i\frac{\partial c_L\left(D_i\right)}{\partial D_i}-\frac{r_E}{1-\tau}+\lambda=0 \tag{12}$$

$$-r_M+r_E/\left(1-\tau\right)-\lambda=0 \tag{13}$$

Substituting for λ in (11) and (12), one finds

$$r_{L,i}=\frac{1}{2}\left[\frac{r_{L,i-1}+r_{L,i+1}}{2}+c_L\left(D_i\right)+\frac{r_E}{1-\tau}+\frac{t_L}{n}-\left(\frac{r_E}{1-\tau}-r_M\right)\left(1-\rho_{run}\right)\right] \tag{14}$$

$$r_{D,i}=\frac{1}{2}\left[\frac{r_{D,i-1}+r_{D,i+1}}{2}-\frac{t_D}{n}-c_D-L_i\frac{\partial c_L\left(D_i\right)}{\partial D_i}+r_M\right] \tag{15}$$

In a symmetric Bertrand-Nash equilibrium where $r_{L,i}=r_{L,i-1}=r_{L,i+1}$, $r_{D,i}=r_{D,i-1}=r_{D,i+1}$, $D_i=D/n$, and $L_i=L/n$, the equilibrium loan and deposit rates are

$$\begin{aligned}r_{L,i}&=\frac{r_E}{1-\tau}-\left(\frac{r_E}{1-\tau}-r_M\right)\left(1-\rho_{run}\right)+c_L\left(D_i\right)+\frac{t_L}{n}\\&=r_M\left(1-\rho_{run}\right)+\rho_{run}\frac{r_E}{1-\tau}+c_L\left(D_i\right)+\frac{t_L}{n}\end{aligned} \tag{16}$$

$$r_{D,i}=r_M-c_D-\frac{t_D}{n}-\frac{L}{n}\frac{\partial c_L\left(D_i\right)}{\partial D_i} \tag{17}$$

Equation (16) shows that the profit maximizing loan rate reflects a weighted average of the marginal cost of wholesale funding, r_M, and the tax-adjusted cost of equity funding, $r_E/(1-\tau)$, with the weight on equity, ρ_{run}, equaling the minimum amount required to avoid runs. In addition, the equilibrium loan rate is higher the greater is the direct costs of monitoring, screening, and loan losses, c_L, and loan market power, t_L/n. Equation (17) indicates that the bank optimally raises the

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retail deposit rate until it equals the wholesale rate less operating costs, the marginal loss of market power, plus the marginal benefit from lower loan costs from greater retail deposits. Since $\partial c_L / \partial D_i \leq 0$, economies of scope in deposit-taking and loan-making result in a higher equilibrium deposit rate.

Two types of equilibria can be categorized based on the sign of W_i. Since in equilibrium $E_i = L_i \rho_{run} = (L/n) \, \rho_{run}$, the balance sheet identity (5) implies $(L/n)(1-\rho_{run}) = D_i + W_i = D/n + W_i$. The implication is that $W_i > 0$ when $D < L(1-\rho_{run})$. In other words, when the market's equilibrium amount of deposits is less than the proportion of loans not funded with equity, the bank uses wholesale deposits to fund the remainder. This type of equilibrium where $W_i = (L/n)(1-\rho_{run}) - D/n > 0$, $i = 1, \ldots, n$ characterizes a "loan rich, deposit poor" retail market. In contrast, when $W_i < 0$ which occurs when $D > L(1-\rho_{run})$, the retail market can be characterized as "loan poor, deposit rich." In this case, banks invest the excess of retail deposits over loans into money market securities earning the wholesale return r_M.

Note that even if $\tau = 0$ and $r_E = r_M$, so that competitively priced equity and debt are taxed the same, the "loan poor, deposit rich" equilibrium where $W_i < 0$ and the bank invests the excess of deposits into securities continues to hold. The equity capital constraint $E_i = L_i \rho_{run} = (L/n)\rho_{run}$ continues to bind. However, in the absence of taxes the "loan rich, deposit poor" equilibrium is no longer be characterized by a binding equity capital constraint. In this situation, a bank would be indifferent between issuing additional equity or issuing wholesale deposits in order to fund its profitable loans in excess of retail deposits. This case is a counterexample to the general conclusion of DeAngelo and Stulz (2015) that banks' specialness in providing retail deposits implies that they will choose high leverage.

The intuition is that even though retail depositors lack access to securities paying a competitive return, with high retail loan demand each bank's equilibrium marginal cost of issuing retail deposits is bid up to the competitive return on wholesale deposits and equity. At that point

the bank stops issuing more retail deposits and becomes indifferent between funding the excess of loans over retail deposits with wholesale debt or equity since they both have the same certainty-equivalent required rate of return. Consequently, each bank's equity capital constraint does not bind.

Such a "loan rich, deposit poor" environment may have described the general situation of U.S. banks prior to the start of corporate income taxation in 1909. Figure 1 Panel A shows U.S. commercial banks' proportions of total assets held as cash, securities, and loans over the period 1834 to 1909. At least until the time of the National Banking Acts of 1863 and 1864, cash and securities holdings of banks were not a large proportion of total assets, rather, the average loan to total asset ratio was over 69 percent. Also, as shown in Figure 1 Panel B, prior to these Acts deposits and privately-issued bank notes were relatively small proportions of banks' total funding needs. Instead, equity capital averaged over 44 percent of assets.

The National Banking Acts that were passed during the U.S. Civil War taxed privately-issued bank notes out of existence and required that if national bank issued national bank notes that the notes be over-collateralized by federal government bonds. As seen in Figure 1, this collateral requirement raised the demand for government securities, reducing loans as a proportion of bank assets. Since fully-collateralized national banknotes were now default-free, the need for equity capital to deter runs by noteholders was less important compared to when banks issued uncollateralized private notes. However, since banknotes were no longer a source of funding for loans, deposits came to be a more important liability. While equity capital was still needed to prevent depositor runs, it appears that the net effect of note collateralization and deposit expansion led to relative decline in equity capital.

After banks began paying corporate income taxes in 1909, the tax-adjusted cost of equity capital became relatively more expensive than wholesale and retail deposits. The model predicts that even with a "loan rich, deposit poor" market environment, banks' equity capital constraint (7) would bind, resulting in $E_i = L_i \rho_{run}$. Shortly thereafter, the early establishment of a government

lender of last resort, whose mission is to provide funds to a solvent bank experiencing a run, would likely decrease ρ_{run} and further reduce banks' funding with equity. Figure 2 Panel A is consistent with this model prediction. When the Federal Reserve Act of 1913 established a lender of last resort to provide "an elastic currency," average equity capital ratios of banks declined from 18.7 % in 1913 to 11.8% in 1920.

However, the Federal Reserve's lender of last resort function was unable to prevent widespread depositor runs at the start of the Great Depression of the early 1930s, arguably because the Federal Reserve did not lend freely enough (Friedman and Schwartz (1963)) and because bank opacity prevented depositors from gauging the solvency of individual banks. In response, the Banking Act of 1933 established the Federal Deposit Insurance Corporation (FDIC). Federal deposit insurance was successful in stopping runs and, as shown in Figure 2 Panel A, banks' capital ratios also fell considerably following its implementation. In addition, the figure shows that with the start of FDIC insurance, there was a "flight to quality" as retail deposits flowed into banks.[7]

Also as shown in Figure 2 Panel B, bank lending declined substantially during the Great Depression of the 1930s, both in absolute terms and as a proportion of total bank assets.[8] The inflow of deposits and reduction in loans is reflected in the substantial buildup of cash and securities in bank portfolios, leading to a "loan poor, deposit rich" type of equilibrium.

The 1930s banking regulation did not establish minimum numerical capital ratio requirements but relied on bank supervisors' subjective assessments of whether capital was "adequate."[9] This policy of regulatory discretion was increasingly questioned during the late 1970s. As shown in Figure 2 Panel A, average equity capital to assets ratios had been falling since the early 1960s and stayed below 6% from 1977 through 1982. At the same time, Figure 2

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[7] Total deposits of all U.S. banks rose by 70.0% from 1933 to 1940.
[8] Total loans of all U.S. banks fell by 46% from 1929 to 1940.
[9] See Burhouse, Feid, French, and Ligon (2003) for a summary of capital regulation and regulatory developments during this period.

Panel B indicates that banks' asset portfolios were shifting out of cash and securities into loans. Together with increasing loan losses and banking industry weakness, formal numerical capital requirements were implemented by federal banking regulators beginning in 1981. Over the next decade, (primary) equity capital to asset ratio requirements between 5% and 6%, depending on the type of bank, were established. In 1991, the U.S. implemented the 1988 Basel Accord which created more detailed capital requirements.

While recognizing that implicit or explicit regulatory capital requirements varied since FDIC insurance was established, eventually banks were subject to some form of capital constraint. One can model a "leverage" -type equity capital requirement as:

$$E_i \geq \frac{\rho_{reg}}{1 - \rho_{reg}} \left[D_i + \max\left(W_i, 0\right) \right] \tag{18}$$

where ρ_{reg} is the minimum required equity capital to asset ratio, so that $\rho_{reg}/(1-\rho_{reg})$ is the minimum equity-to-debt ratio.

Let us re-derive the bank's profit maximization problem in (10) but with the constraint (18) replacing the previous "no-run" equity capital constraint. It is straightforward to show that for a "loan rich, deposit poor" market where $D < L(1-\rho_{reg})$ so that $W_i \geq 0$, the equilibrium loan and deposit rates satisfy:

$$r_{L,i} = \left(1 - \rho_{reg}\right) r_M + \rho_{reg} \frac{r_E}{1 - \tau} + c_L\left(D_i\right) + \frac{t_L}{n} \tag{19}$$

$$r_{D,i} = r_M - c_D - \frac{t_D}{n} - \frac{L}{n} \frac{\partial c_L\left(D_i\right)}{\partial D_i} \tag{20}$$

which is the same as (16) and (17) but with ρ_{reg} replacing ρ_{run}. Similarly, for a "loan poor, deposit rich" market where $D > L(1-\rho_{reg})$ so that $W_i < 0$, the equilibrium loan and deposit rates satisfy:

$$r_{L,i} = r_M + c_L\left(D_i\right) + \frac{t_L}{n} \tag{21}$$

$$r_{D,i} = r_M - c_D - \left[\frac{t_D}{n} + \frac{\rho_{reg}}{1-\rho_{reg}} \left(\frac{r_E}{1-\tau} - r_M \right) + L_i \frac{\partial c_L(D_i)}{\partial D_i} \right] \quad (22)$$

Here, the loan rich, deposit poor case of (19) and (20) is very similar to the prior case where equity was constrained to equal a level that would prevent bank runs. The effect of corporate income taxes is passed on to borrowers but not depositors. However, with $\rho_{reg} < \rho_{run}$, equilibrium loan rates are lower since they reflect a weighted cost of debt and equity finance but with a lower weight on the relatively expensive tax-adjusted cost of equity. The equilibrium retail deposit rate is unchanged. As mentioned earlier, in the absence of a corporate income tax and where $r_E = r_D$, the regulatory capital constraint would not be binding.

The case of a loan poor, deposit rich market differs because previously it was assumed that equity was held to cushion possible losses from loan liquidations due to runs. Now, a minimum required equity capital to total asset ratio means that capital must also be issued to fund security investments, not only loans. Since banks hold securities in a loan poor, deposit rich market, equity funding is based on total assets, not just loans. The corporate tax wedge implies that depositors are affected because, at the margin, banks do not bid as aggressively for retail deposits to fund security investments. If, instead, the required capital ratio was based on risk-weighted assets and securities had a zero risk weight, then the loan and deposit rates in (19) and (20) would also characterize the loan poor, deposit rich market. These results are summarized in the following proposition.

Proposition I: Under a leverage constraint where ρ_{reg} is the minimum required equity capital to asset ratio, retail borrowers bear the burden of higher corporate income taxes and higher capital requirements when market loan demand is relatively high, $L(1-\rho_{reg}) > D$. Conversely, under this leverage constraint but when market deposit supply is relatively high, $D > L(1-\rho_{reg})$, retail depositors bear the burden of higher corporate taxes and capital requirements. Under a risk-based

capital requirement where securities have a zero risk weight, retail borrowers always bear the burden of higher corporate taxes.

For a given number of banks in the market, our results show that either retail borrowers (in the loan rich, deposit poor case) or retail depositors (in the loan poor, deposit rich case) bear the burden of corporate taxes. Effectively, either retail borrowers or retail depositors bear the higher cost of funding assets with required outside equity capital. However, bank owners (inside equity) also bear some of the tax burden. Similar to other Salop (1979)-type models, the Appendix shows that each bank owner's profit is

$$\left[\frac{L}{n}\left(\frac{t_L}{n}\right) + \frac{D}{n}\left(\frac{t_D}{n} + \frac{L}{n}\frac{\partial c_L(D_i)}{\partial D_i}\right)\right](1-\tau) \tag{23}$$

where in equilibrium $D_i = D/n$. The after tax profits in (23) hold for both the loan rich, deposit poor case and the loan poor, deposit rich case. Profits are lower in proportion to the tax rate compared to what they would be in the absence of taxes.

In a more general longer-run equilibrium where the number of banks in the market, n, is endogenous and each bank must pay a fixed cost to enter, then a zero profit entry condition where (23) equals this fixed entry cost would determine n. Obviously, the higher the tax rate, τ, the lower is the equilibrium n. In this long run case, one sees that from the equilibrium retail loan and deposit rates (19), (20), (21), and (22) that higher taxes, by reducing n, are borne by both retail borrowers and retail depositors. Higher corporate taxes increase market concentration which raises the monopoly rent needed to compensate banks for operating in the market.

III. Banks and Nonbank Competition

This section introduces nonbank savings account providers and nonbank lenders operating in the same market as banks. Nonbank savings account providers are modeled as money market mutual funds (MMFs) which invest purely in money market securities (wholesale

debt) that pay the default-free interest rate r_M. They issue retail saving account shares that have a marginal operating cost of c_D per unit of savings account balance, which is assumed to be the same constant marginal operating cost as a bank deposit. However, because nonbank savings providers have a mutual fund structure, they have little leeway in setting the rate of return paid to retail savers. They must pass through the returns on their assets less operating expenses to their shareholders.[10] Denote the return paid by nonbank savings provider i as $r_{S,i}$. Since its mutual fund structure exempts it from corporate income taxes, it must pay the return $r_{S,i} = r_M - c_D$.

Nonbank lenders are modeled as loan brokers or banks that follow an "originate-to-distribute" model of lending. These intermediaries originate loans and immediately sell them to special purpose vehicle (SPV) securitizations or loan-holding mutual funds. They differ from traditional banks because they do not access deposit funding. Rather, all of their funding is off-balance sheet at wholesale rates, having a cost of funding equal to r_M for debt and r_E for equity. They also differ from banks because the off-balance sheet vehicles that provide funding are exempt from paying corporate income taxes. Examples of such corporate tax-exempt funding vehicles are SPVs whose assets are mortgages, consumer loans, or corporate loans and whose liabilities are debt and equity tranches, variously referred to as mortgage-backed securities (MBS), asset-backed securities (ABS), or collateralized loan obligations (CLOs). Another example is mutual funds known as "prime rate" funds that specialize in holding corporate syndicated loans.[11] These mutual funds are corporate tax-exempt and typically issue only equity shares. A final example is a particular type of closed-end mutual fund, called a business development company (BDC). It invests in small and medium-sized enterprises (SMEs), can issue debt up to 50% of its assets, and yet is corporate tax exempt.[12]

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[10] On this point, see Gorton and Pennacchi (1993) who note that MMF advisors are limited to charging reasonable fees, and there have been several instances where advisors have been sued by MMF shareholders when fees were alleged to be excessive.

[11] These funds can be both open-end and closed-end mutual funds. Standard & Poor's (2014) reports that total assets in these prime rate funds exceeded $170 billion in March 2014.

[12] Beltratti, Bock, Jewsikow, and Nelson (2014) review BDCs and their stock return performance.

As in Han, Park, and Pennacchi (2015), this paper models nonbank lenders as having a corporate tax advantage relative to banks. However, they have a disadvantage from not issuing deposits, so that nonbank lender i's marginal cost of per unit of loans is $c_L(D_i) = c_L(0) \equiv c_L^*$. For simplicity, let us take a special case of the previous section's assumption and assume that for traditional banks which issue any positive amount of retail deposits, they have a constant marginal loan cost of $c_L < c_L^*$. In other words, it is assumed that once bank i has established a retail branch network, any addition issuance of deposits does not further reduce marginal loan operating costs. Hence, at the margin, $\partial c_L / \partial D_i = 0$ and any further marginal decline in loan costs from issuing additional retail deposits can be ignored.

Suppose that there are a total of n financial service providers in the market, and index these individual financial service providers by $i = 1,\dots,n$. Initially, let us assume that in both the retail loan market and in the retail deposit market there are k nonbank financial service providers, so that $n - k$ are banks. Later, it will be straightforward to show that the model can be modified to allow a different number of nonbank providers in the loan market versus the number of nonbank providers in the deposit market.

Consider, first, the case of $k = 1$, and assume this nonbank is financial service provider $i = 1$, so that the banks are indexed by $i = 2,\dots,n$. This situation is depicted in Figure 3 for the case of $n = 8$ financial service providers, with $k = 1$ nonbank and $n - k = 7$ banks. A symmetric equilibrium is assumed such that banks that are equidistant from the nonbank set the same loan and deposit rates. However, banks that differ in their distance from the nonbank will not, in general, set equivalent loan and deposit rates.

To solve for the market's equilibrium loan and savings account rates, consider the profit maximization problems of the nonbank and each bank. As was just mentioned, nonbank providers of savings accounts are assumed to have no discretion in setting the rates they pay customers.

They simply pass through their investment returns less expenses so that $r_{D,1} = r_{S,i} = r_M - c_D$ is fixed.

Nonbank lenders have more discretion. For example, a nonbank loan broker chooses its retail loan rate based on the rates of its neighboring banks and then immediately sell the resulting loans to an off-balance sheet vehicle. The vehicle funds the loans by issuing some combination of wholesale debt and equity securities. This loan broker pays corporate taxes on its profit or "gain-on-sale" from selling the loans. But the off-balance sheet vehicle that funds the loans is exempt from corporate taxes. Specifically, nonbank lender $i = 1$ will chose loan rate $r_{L,1}$ which leads to total loans of L_1 satisfying equation (3). It then securitizes these loans in an off-balance sheet vehicle that issues an amount W_1 in wholesale debt and $E_1 = L_1 - W_1$ in equity. Thus, the nonbank lender's problem is to maximize the following after-tax profit:[13]

$$\underset{r_{L,1}, W_1}{\text{Max}} \ \left[L_1 \left(r_{L,1} - c_L^* \right) - W_1 r_M - E_1 r_E \right] (1 - \tau) \tag{24}$$

subject to the no-run constraint (7) and the balance sheet constraint $L_1 = E_1 + W_1$. The profit function (24) differs in several ways from the traditional bank's profit function in (10). First, the nonbank does not fund loans on-balance sheet with retail deposits. Second, because it does not issue retail deposits but funding occurs in an off-balance sheet vehicle, $c_L^* > c_L$ due to inefficient credit screening and monitoring which raises expected default losses. Third, unlike the traditional bank, equity is not tax-disadvantaged relative to wholesale debt due to the off-balance sheet vehicle's corporate tax exemption.

The Appendix shows that when nonbank lender 1's neighboring banks set loan rates equal to $r_{L,2} = r_{L,n}$, the nonbank lender 1's optimal loan rate, $r_{L,1}$, satisfies

$$r_{L,1} = \frac{1}{2} \left[r_{L,2} + c_L^* + r_E \rho_{run} + \text{Min} \left(r_E, r_M \right) \left(1 - \rho_{run} \right) + \frac{t_L}{n} \right] \tag{25}$$

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[13] The term in square brackets can be interpreted as the end-of-period gain-on-sale that is subject to corporate tax. It equals the difference between the end-of-period value of net loan revenue minus the end-of-period costs of wholesale debt and equity financing.

The nonbank lender chooses an off-balance sheet vehicle that finances its loans with all equity when $r_E < r_M$ and finances its loans with a proportion ρ_{run} of equity and $(1- \rho_{run})$ of wholesale debt when $r_E > r_M$.

The optimization problem for banks in the market is similar to our earlier solution. Consider the case of a "loan rich, deposit poor" market where retail lending opportunities significantly exceed retail savings, $L \gg D$. The Appendix shows that the profit maximizing loan rate and savings rates for bank i are

$$r_{L,i} = \left(1-\delta_{i,n/k}\right)\left(\left(1-\rho_{reg}\right)r_M + \rho_{reg}\frac{r_E}{1-\tau}+c_L +\frac{t_L}{n}\right)+\delta_{i,n/k}r_{L,1} \qquad (26)$$

$$r_{D,i} = \left(1-\delta_{i,n/k}\right)\left(r_M -c_D -\frac{t_D}{n}\right)+\delta_{i,n/k}\left(r_M -c_D\right)$$
$$= r_M -c_D -\frac{t_D}{n}\left(1-\delta_{i,n/k}\right) \qquad (27)$$

where for the case that n is an even number[14]

$$\delta_{i,n/k} \equiv \frac{\left(2+\sqrt{3}\right)^{\frac{n}{2k}+1-i} +\left(2-\sqrt{3}\right)^{\frac{n}{2k}+1-i}}{\left(2+\sqrt{3}\right)^{\frac{n}{2k}} +\left(2-\sqrt{3}\right)^{\frac{n}{2k}}} \qquad (28)$$

Equations (26) and (27) show that banks' loan and deposit rates are a weighted average of the equilibrium rates they would have set in the absence of a nonbank and the rates set by the nonbank. The variable $\delta_{i,n/k} < 1$, $i = 2, \ldots, n$, is the weight on the nonbank's rate and reflects the impact of nonbank competition. Banks closer to the nonbank are more affected by its rates: $\delta_{i,n/k}$ is a declining function of i over the range from $i = 2$ to $i = n/2 + 1$, the mid-point of the circle, and it satisfies the symmetry conditions: $\delta_{2,n/k}=\delta_{n,n/k}$, $\delta_{3,n/k}=\delta_{n-1,n/k}$,…, $\delta_{n/2,n/k}=\delta_{n/2+2,n/k}$. Moreover, for a given number of bank intervals i, $i= 1,\ldots, n$ away from the nonbank, a bank's rates are less

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[14] The Appendix discusses the case of n being an odd number.

sensitive to the nonbank's rate the greater is the total number of financial service providers in the market; that is, $\partial \delta_{i,n/k}/\partial(n/k) < 0$.

In particular, since a nonbank savings account provider is assumed to pay a competitive rate less account operating costs, $r_M - c_D$, one sees from (27) that bank deposit rates are always greater than what would occur in the absence of the nonbank, with banks closest to the nonbank paying relatively greater rates.

To fully solve for the nonbank and banks' equilibrium loan rates, first substitute (26) for the case if $i = 2$ into (25) and rearrange to obtain:

$$r_{L,1} = \left(1 - \rho_{reg}\right) r_M + \rho_{reg} \frac{r_E}{1-\tau} + c_L + \frac{t_L}{n} - \frac{\Lambda}{2 - \delta_{2,n/k}} \tag{29}$$

where $\Lambda \equiv \left[\left(1 - \rho_{reg}\right) r_M + \rho_{reg} \frac{r_E}{1-\tau} + c_L\right] - \left[\rho_{run} r_E + \left(1 - \rho_{run}\right) \mathrm{Min}\left(r_E, r_M\right) + c_L^*\right]$ is the

nonbank's net funding and operating cost advantage. Thus, if $\Lambda > 0$ because regulatory capital requirements and corporate taxes are sufficiently high to offset the nonbank's operating cost disadvantage, the nonbank loan rate will be less than what banks would have charged in its absence.

Substituting (29) into (26), bank i's equilibrium loan rate is

$$r_{L,i} = \left(1 - \rho_{reg}\right) r_M + \rho_{reg} \frac{r_E}{1-\tau} + c_L + \frac{t_L}{n} - \frac{\delta_{i,n/k}\Lambda}{2 - \delta_{2,n/k}} \tag{30}$$

Consequently, if $\Lambda > 0$, a bank's equilibrium loan rate is lower the closer it is to the nonbank.

The equilibrium rates on deposits and loans for this case of a single nonbank and several banks extends to the case of $k > 1$ nonbanks when these nonbanks are symmetrically located around the deposit and loan markets. Figure 4 shows an example of a market with $k = 2$ nonbanks with a total of $n = 8$ total financial service providers and, therefore, 6 banks. The Appendix outlines why formulas (27) and (30) for equilibrium bank deposit and loan rates and formula (29) for the nonbanks' equilibrium loan rate continue to hold for the case of $k > 1$. The

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logic is that in this more general case, each "cluster" of one nonbank separated by n/k - 1 banks face the identical profit maximization problem previously encountered in a market with one nonbank and n-1 banks.

Until now, competition between nonbanks and banks have assumed a "loan rich, deposit poor" market where $L \gg D$. Let us now consider the case of a retail "loan poor, deposit rich" market where $L \ll D$. Recall that when such a market has no nonbanks, equations (21) and (22) obtain for bank's equilibrium loan and deposit rates in the absence of nonbanks. Using a similar derivation, it is straightforward to show that for a loan poor, deposit rich market, the nonbank's equilibrium loan rate is:[15]

$$r_{L,1} = r_M + c_L + \frac{t_L}{n} - \frac{\Lambda^*}{2 - \delta_{2,n/k}} \tag{31}$$

where $\Lambda^* \equiv [r_M + c_L] - \left[\rho_{run} r_E + (1 - \rho_{run}) \text{Min}(r_E, r_M) + c_L^* \right]$ is the difference between the nonbank and banks' cost of funding. The Appendix also shows that bank i's equilibrium loan and deposit rates are

$$r_{L,i} = r_M + c_L + \frac{t_L}{n} - \frac{\delta_{i,n/k} \Lambda^*}{2 - \delta_{2,n/k}} \tag{32}$$

$$r_{D,i} = r_M - c_D - (1 - \delta_{i,n/k}) \left[\frac{t_D}{n} + \frac{\rho_{reg}}{1 - \rho_{reg}} \left(\frac{r_E}{1 - \tau} - r_M \right) \right] \tag{33}$$

Since if $r_M \approx r_E$, because $c_L^* > c_L$, it is likely that $\Lambda^* < 0$. The implication is that in this loan poor, deposit rich market, banks will charge lower rates on retail loans compared to nonbanks. Hence, one would not expect entry by nonbank lenders due to their higher net operating costs. In equation (33), banks' retail deposit rates reflect their corporate tax disadvantage so that depositors bear the tax burden. However, banks' retail deposit rates are higher than in a "loan poor, deposit

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[15] As before, the analysis is simplified by assuming that banks have a fixed marginal loan operating cost advantage, $c_L < c_L^*$ when they issue any positive amount of retail deposits. This allows us to assume the term $L_i \partial c_L / \partial D_i$ in equation (22) equals zero.

rich" market with no nonbanks, equation (22). The competitive effects of nonbank savings account providers' higher rates forces banks to increase their deposit rates.

As a consequence of the generality of the derived loan and deposit rates to the case of $k > 1$ nonbanks, a comparative statics exercise can determine the effects on competition from holding the total number of financial service providers fixed but increasing the relative proportion of nonbanks. Doing so leads to the following proposition:

Proposition 2: For a market with a fixed number of financial service providers, increasing the proportion of nonbank providers raises banks' deposit interest rates. When $L \gg D$ and $r_E = r_D$ so that $\Lambda > 0$, a greater proportion of nonbank lenders lowers banks' retail loan rates. When $L \ll D$ and $r_E = r_D$ so that $\Lambda^* < 0$, a greater proportion of nonbank lenders raises banks' retail loan rates.

To emphasize some implications our results, note that in a "loan poor, deposit rich" environment ($L \ll D$ and $\Lambda^* < 0$) banks' retail deposits are an inexpensive source of funding, and nonbank lenders' competitive wholesale funding puts them at a disadvantage. Consequently, nonbanks would lack an incentive to enter this market. Rather, when retail deposit rates are low, nonbank savings providers are most advantaged and their entry would capture high market share.

The implications are reversed when the environment is "loan rich, deposit poor" ($L \gg D$ and $\Lambda^* > 0$). Here, retail deposits are an expensive source of funding since banks are issuing wholesale deposits at the margin. Since banks are also required to fund a portion of loans with tax-disadvantaged equity capital, nonbank lenders now have a relative advantage and would desire to enter.

The above derivation of bank and nonbank competition assumes equal proportions of nonbanks in both retail loan and retail deposit markets. Yet, since nonbank lenders' maximization problem is separable from that of nonbank savings account providers, the model results generalize to different numbers of nonbanks in the two markets.

Consider the case where $k = 0$ in the retail loan market but $k \geq 1$ in the retail deposit market. For a "loan poor, deposit rich" environment, equation (32) continues to characterize banks' equilibrium loan rate but with $\delta_{i,n/k} = 0$, $i = 1,\ldots, n$. This is the same "loan poor, deposit rich" equilibrium loan rate set by banks in the absence of nonbanks, equation (21). In a significantly "rich" retail deposit market with $k \geq 1$ of the n savings account providers being nonbanks, bank deposit rates are given by equation (33) and, since $0 < \delta_{i,n/k} < 1$, strictly higher than for the case of no nonbanks. Note that this "loan poor, deposit rich" equilibrium continues to hold as long as $D_i > L_i(1-\rho_{reg})$ for every bank so that it is optimal for each bank to invest in securities rather than issue wholesale deposits.

However, if only nonbank savings providers enter without nonbank lenders, L_i would remain at L/n for banks but D_i for banks would be strictly less than $D/(n-k)$ as nonbank savings account providers pay higher savings account rates and capture proportionally more market share. As a result, banks' effective market equilibrium would tend to switch from being "loan poor, deposit rich" to "loan rich, deposit poor." Such a situation would describe the U.S. starting in the 1970s and lasting until 2001 as MMF competition led to "disintermediation."

Figure 5 shows the MMF share of total savings/transaction accounts, defined as the ratio of total MMF assets to the sum of total bank deposits plus MMF assets. It also shows the Retail MMF share, defined as the ratio of retail MMF assets to the sum of insured bank deposits plus retail MMF assets.[16] Furthermore, the figure graphs the ratio of banks' holdings of cash plus securities assets to total bank assets.

Clearly from the late 1970s until around 2001, the MMF share of total savings/transactions accounts was rising as banks' investments in cash and securities were declining. This is consistent with the hypothesis that greater competition by MMFs reduced banks' retail deposits, turning from what was previously a "loan poor, deposit rich" market equilibrium

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[16] Money market funds are classified as retail funds or institutional funds, with the latter catering to wholesale investors.

to a "loan rich, deposit poor" equilibrium. Under this scenario, the model predicts that the corporate tax burden shifts from banks' retail depositors to their retail borrowers. If, initially, there were no nonbank lenders, banks' equilibrium retail loan rates would rise from the level given in equation (21) to the higher value in equation (19).

Importantly, the higher bank retail loan rates satisfying equation (19) now create incentives for nonbank lenders to enter. That is because in this situation, equilibrium nonbank lender loan rates are less than those of banks. Consequently, with k of n lenders being nonbanks, nonbank and bank retail loan rates satisfy equations (29) and (30), respectively. In particular, one now expects that in this "loan rich, deposit poor" market that banks' corporate taxation creates a lending disadvantage that makes securitization via special purpose vehicles relatively more profitable.

Evidence consistent with this shift is given in Figure 6. It shows the MBS and ABS share, defined as the ratio, in percent, of outstanding MBS and ABS securities to the sum of outstanding MBS and ABS securities plus outstanding bank loans.[17] Of course, there may be additional reasons outside the scope of our model for nonbanks to hold loans previously held by banks. Banks may have been discouraged from holding particular types of loans for risk management reasons.[18]

In addition, not every type of loan experienced the same degree of securitization. Banks tend to specialize in relationship loans made to opaque borrowers that require monitoring of the borrower's cashflow, rather than monitoring of a borrower's asset value (collateral). An example of such loans is an unsecured line of credit. Relative to nonbanks, banks have an advantage in making such loans due to their ability to have a network of branches that simultaneously benefit

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[17] The measure of outstanding bank loans include real estate-related loans, agriculture loans, commercial and industrial loans, loans to individuals, and leases. Excluded are loans to depository institutions and "other" loans.

[18] For example, during the 1970s high and volatile interest rates caused losses on the long duration mortgages held by many banks, precipitating the savings and loan institution crisis. Bank regulators encouraged mortgage securitization, in part via government sponsored enterprises such as Fannie Mae and Freddie Mac.

retail deposit collection and retail loan monitoring. Both retail borrowers and retail depositors tend to choose banks that are physically close.[19]

Unsecured loans, particularly those made to opaque small businesses, may typically be harder to securitize. In contrast, collateralized loans with well-established underwriting standards, such as mortgages and automobile loans rated by credit scores, may be easier. In terms of our model, the difference between nonbanks' and banks' operating and credit loss costs, $c_L^* - c_L$, are smaller for these loans relative to relationship loans.

IV. Survey of Prior Evidence Relating to the Model

Our model has analyzed two main dimensions of corporate taxes. How they affect banks' choice of equity capital ratios and how corporate taxes may encourage nonbank entry, particularly in the form of tax-exempt securitization vehicles. This section examines empirical evidence on these two issues.

IV.A Corporate Taxes and Banks Choice of Equity Capital

The paper's model assumes that banks must meet a minimum equity capital to asset ratio. In practice, regulators often require multiple minimum capital ratios, such as Tier 1 and Tier 2 risk-weighted capital ratios and a leverage ratio (equity capital to total unweighted asset ratio). In some instances, banks can meet a particular capital requirement using either subordinated debt or equity capital. Ashcraft (2008) focuses on how the mix of subordinated debt to shareholders' equity capital in meeting a capital constraint affects risk-taking by U.S. banks. As an instrument for banks' non-risk-related incentive to use subordinated debt, he uses the corporate income tax rate paid by commercial banks. A bank's total income tax rate depends on where it operates in the

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[19] Park and Pennacchi (2009) report that the Federal Reserve's 2004 Survey of Consumer Finance indicates that the median distance between a household and its bank is 2 miles for checking accounts and 3 miles for savings accounts and Certificates of Deposit. Based on the 2003 Federal Reserve Survey of Small Business Finances, for bank loans made in the 1970s, 1980s, 1990s, and 2000-2003, the median distances were 2, 2, 4, and 9 miles, respectively. One might conclude that distances from their banks are becoming less important for small businesses but not for depositors.

United States because individual states may add state-level corporate income taxes on to the federal corporate income tax.

If a bank can meet its capital requirement by issuing competitively-priced subordinated debt, rather than equity, the current paper's model would predict it should do so because interest on subordinated debt is tax-deductible. A bank's incentive to substitute subordinated debt for equity is greater the higher is the corporate income tax rate it faces. Indeed, Ashcraft's (2008) empirical evidence supports this prediction. He finds a statistically and economically significant positive relationship between a commercial bank's proportion of subordinated debt to equity and the effective state corporate income tax rate that it pays.

Schandlbauer (2014) also uses variation in U.S. states' corporate income tax rates to test whether higher rates affect leverage. Using a difference-in-difference approach that compares similar banks in geographically close states, he finds that, on average, banks increase their non-deposit debt by 5.9% in the year before a corporate tax increase is enacted in the state where the bank operates. Thus, banks appear to raise their leverage ratios in anticipation of a higher tax rate. The increase in debt is the greatest for better-capitalized banks. Banks facing a tax increase also reduce loan growth by 2.3%, consistent with the current paper's prediction that higher taxes lead banks to lose market share to nonbanks. This slowing of loan growth occurs primarily with worse-capitalized banks.

In 2006, Belgium initiated a notional interest deduction that applied to a corporation's shareholders' equity. The notional interest equaled the 10-year government bond rate. This tax policy change, to a close approximation, equalized the corporate income tax treatment for debt and equity. Schepens (2014) analyzes whether this reduction in the tax disadvantage of equity changed the equity capital ratios of Belgian banks. His test matches 35 Belgian banks to other European banks based on a "nearest neighbor" propensity score. He finds that implementation of this tax policy increased Belgium banks' equity ratios by an average of 14% relative to the control group of banks. Moreover, this rise in the equity capital ratio occurred via an increase in

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banks' absolute amount of equity, not by a reduction of debt and bank assets. Hence, this policy's effective decrease in the tax rate on equity supports the current paper's model prediction that banks should expand their market share.

IV.B Corporate Taxes and the Incentive to Securitize Loans

Recall that the model predicts that higher corporate tax rates, by making a bank's on-balance sheet equity financing more expensive, increases the likelihood that loans will be securitized. In other words, off-balance sheet financing where a corporate tax-exempt special purpose vehicle holds loans funded by debt and equity, becomes more profitable. The incentive for SPV funding is greatest when a bank operates in a "loan rich, deposit poor" market. Han, Park, and Pennacchi (2015) test this model prediction by examining U.S. banks' decision to retain or sell the mortgages they originate. They use Home Mortgage Disclosure Act (HMDA) data on banks operating in different U.S. Metropolitan Statistical Areas (MSA) over the period 2001 to 2008. An MSA is characterized as "loan rich, deposit poor" if it has relatively large numbers of young people compared to those over age 65. In contrast, an MSA is characterized as "loan poor, deposit rich" if there is a relatively large number of people over age 65.[20]

As the model predicts, they find that banks that operate in higher tax states tend to sell relatively more of their mortgages, but only when these banks also operate in an MSA with relatively young people (loan rich, deposit poor). For banks in relatively young MSAs, a one-standard deviation increase in the state corporate income tax rate raises mortgage sales by 24.6%.

Gong and Ligthart (2014) analyze the same issue but in a multi-country setting. They examine the securitization activities of 4,423 banks headquartered in 19 OECD countries over the period 1999 to 2006. Based on ABS Alert data, 265 of these banks had sponsored at least one MBS or ABS deal. They classify a bank as operating in a "loan rich, deposit poor" environment if

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[20] Categorizing markets by age is based on the idea that younger people are more likely to take out loans while older people are more likely to be savers. In particular, after age 65 many people invest heavily in bank certificates of deposit. This concept of associating older (*younger*) MSAs with more (*less*) savings originates with Becker (2007).

it has a relatively high loan to deposit ratio. Based on the effective marginal corporate income tax rate of the country in which the bank is headquartered, they find that banks in high tax countries were more likely to securitize loans, but only if they had a relatively high ratio of loans to deposits. For these "loan rich, deposit poor" banks, a one standard deviation rise in the corporate tax rate increased securitization intensity by 1.12 percent.

In closing this section, it should be acknowledged that corporate taxes can distort banks' decisions in other ways that are beyond the scope of this paper's model. For example, in many countries a bank's taxable income is recorded only when capital gains on its securities holdings are realized. The ability to defer corporate income taxes on unrealized capital gains creates incentives for banks to maintain their holdings of appreciated securities. Von Beschwitz and Foos (2014) document that, due to a 50% capital gains tax, German banks maintained their ownership of appreciated stocks of corporations to which they also lent. After this tax was repealed in 2000, banks divested 86% of their equity stakes in the following six years but also increased their lending to these same corporations by 60%. This behavior is consistent with capital gains taxes creating excess exposure to corporate risk that inhibits banks' desire to make corporate loans.

V. Concluding Remarks

This paper developed a model of financial services markets to study the determinants of banks' equilibrium retail loan and retail deposit rates. The model considered the effect of corporate income taxes on equilibrium interest rates. When banks are subject to a minimum ratio of equity capital to total assets, retail depositors bear a corporate tax burden in the form of lower deposit rates if the market structure is one of limited lending opportunities but rich amounts of retail deposits. In this situation, banks use excess retail deposits to invest in securities. In contrast, retail borrowers bear a corporate tax into burden in the form of higher loan rates if the market structure is one of rich lending opportunities but limited retail deposits. In this setting, banks use competitively-priced wholesale debt to help fund the high demand for loans. In the absence of

corporate income taxes, equity capital requirements may not be binding in this latter case, a situation that appears to characterize U.S. banks during some periods prior to the enactment of corporate income taxes in 1909.

The model was extended to consider nonbank financial service firms. If a nonbank savings/transactions account provider in the form of a corporate tax-exempt MMF now competes, banks are forced to raise their retail deposit interest rates and will tend to lose market share. Consequently, there would be a tendency for banks to switch from a situation of rich deposits to poor deposits so that loans would need to be funded, at the margin, with competitively priced bank debt. The model predicts that such a situation would increase retail loan rates so that a corporate tax burden is shifted from retail depositors to retail borrowers. In turn, these higher bank loan rates create profitable opportunities for nonbank lending in vehicles holding securitized loans. Such a rise in MMF competition coincident with rapid growth in securitization characterizes the U.S. situation during the past 40 years.

An empirical literature examining the effects of corporate income taxes on bank and nonbank behavior has recently emerged. Several studies support the theoretical predictions that higher corporate taxes give banks an incentive to reduce equity capital and, in loan rich - deposit poor environments, to increase nonbank lending activity. What policy reforms might remedy these tax-induced distortions?

Clearly, repealing the corporate income tax is an obvious remedy, though implementing such a reform is likely to be politically difficult. A more indirect channel for reducing the tax disadvantage of bank equity might permit a Belgium-like tax deduction for a notional return on equity. Another alternative is to allow issuance of appropriately-designed contingent convertible (CoCo) securities.[21] Such CoCos take the form of tax-deductible debt when a bank is financially healthy but convert to stabilizing equity capital at the onset of bank distress.

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[21] Calomiris and Herring (2013) and Pennacchi, Vermaelen, and Wolff (2014) propose particular designs for "going-concern" CoCos.

Appendix

A. Equilibrium with Only Banks

Substituting in for E_i in the maximization problem (10) using the balance sheet equality $E_i = L_i - D_i - W_i$, it can be written

$$\underset{r_{L,i},r_{D,i},W_i}{\text{Max}} \left[L_i \left(r_{L,i} - c_L(D_i) - \frac{r_E}{1-\tau} \right) - D_i \left(r_{D,i} + c_D - \frac{r_E}{1-\tau} \right) - W_i \left(r_M - \frac{r_E}{1-\tau} \right) \right] (1-\tau) \quad \text{(A.1)}$$

which is equivalent to maximizing

$$\underset{r_{L,i},r_{D,i},W_i}{\text{Max}} \; L_i \left(r_{L,i} - c_L(D_i) - \frac{r_E}{1-\tau} \right) - D_i \left(r_{D,i} + c_D - \frac{r_E}{1-\tau} \right) - W_i \left(r_M - \frac{r_E}{1-\tau} \right) \quad \text{(A.2)}$$

subject to the no-run constraint:

$$L_i(1-\rho_{run}) \geq D_i + W_i \quad \text{(A.3)}$$

Let λ be the Lagrange multiplier for constraint (A.3) and then substitute equations (3) and (4) for L_i and D_i into (A.2) and (A.3). The first order condition for $r_{L,i}$ is

$$-\frac{L}{t_L}\left(r_{L,i} - c_L(D_i) - \frac{r_E}{1-\tau} \right) + \left(\frac{r_{L,i-1} + r_{L,i+1}}{2} - r_{L,i} \right)\frac{L}{t_L} + \frac{L}{n} - \lambda\frac{L}{t_L}(1-\rho_{run}) = 0 \quad \text{(A.4)}$$

which simplifies to equation (11). The first order condition for $r_{D,i}$ is

$$-L_i\frac{\partial c_L(D_i)}{\partial D_i}\frac{D}{t_D} - \frac{D}{t_D}\left(r_{D,i} + c_D - \frac{r_E}{1-\tau} \right) - \left(r_{D,i} - \frac{r_{D,i-1} + r_{D,i+1}}{2} \right)\frac{D}{t_D} - \frac{D}{n} - \lambda\frac{D}{t_D} = 0 \quad \text{(A.5)}$$

which simplifies to equation (12). The first order condition for W_i is equation (13).

B. Equilibrium with a Regulatory Capital Leverage Requirement

The problem is to maximize (A.2) subject to constraint (18) which can be rewritten as

$$L_i \geq \begin{cases} \dfrac{D_i + W_i}{1 - \rho_{reg}} & \text{if } W_i \geq 0 \\[2ex] \dfrac{D_i}{1 - \rho_{reg}} + W_i & \text{if } W_i < 0 \end{cases} \quad \text{(A.6)}$$

Let λ be the Lagrange multiplier for constraint (A.6) and then substitute equations (3) and (4) for L_i and D_i into (A.2) and (A.6). The first order condition for $r_{L,i}$ simplifies to

$$\frac{r_{L,i-1} + r_{L,i+1}}{2} - 2r_{L,i} + c_L(D_i) + \frac{r_E}{1-\tau} + \frac{t_L}{n} - \lambda = 0 \quad \text{(A.7)}$$

The first order condition for $r_{D,I}$ simplifies to

$$2r_{D,i} - \frac{r_{D,i-1} + r_{D,i+1}}{2} + \frac{t_D}{n} + c_D + L_i\frac{\partial c_L(D_i)}{\partial D_i} - \frac{r_E}{1-\tau} + \frac{\lambda}{1 - \rho_{reg}} = 0 \quad \text{(A.8)}$$

The first order condition for W_i is

$$-r_M + r_E / (1-\tau) - \frac{\lambda}{1-\rho_{reg}} = 0 \quad \text{if } W_i \geq 0$$

$$-r_M + r_E / (1-\tau) - \lambda = 0 \qquad \text{if } W_i < 0$$

(A.9)

If $W_i \geq 0$, substituting in for $\lambda = \left[r_E / (1-\tau) - r_M \right](1-\rho_{reg})$ in (A.7) and (A.8) gives

$$r_{L,i} = \frac{1}{2}\left[\frac{r_{L,i-1} + r_{L,i+1}}{2} + c_L(D_i) + \frac{r_E}{1-\tau} + \frac{t_L}{n} - \left(\frac{r_E}{1-\tau} - r_M \right)(1-\rho_{reg}) \right]$$

(A.10)

$$r_{D,i} = \frac{1}{2}\left[\frac{r_{D,i-1} + r_{D,i+1}}{2} - \frac{t_D}{n} - c_D - L_i \frac{\partial c_L(D_i)}{\partial D_i} + r_M \right]$$

(A.11)

In a symmetric Bertrand-Nash equilibrium where $r_{L,i} = r_{L,i-1} = r_{L,i+1}$, $r_{D,i} = r_{D,i-1} = r_{D,i+1}$, $D_i = D/n$, and $L_i = L/n$, the equilibrium loan and deposit rates in (A.10) and (A.11) become equations (19) and (20). If $W < 0$, substituting in for $\lambda = \left[r_E / (1-\tau) - r_M \right]$ in (A.7) and (A.8) gives

$$\frac{r_{L,i-1} + r_{L,i+1}}{2} - 2r_{L,i} + c_L(D_i) + \frac{t_L}{n} + r_M = 0$$

(A.12)

$$2r_{D,i} - \frac{r_{D,i-1} + r_{D,i+1}}{2} + \frac{t_D}{n} + c_D + L_i \frac{\partial c_L(D_i)}{\partial D_i} + \rho_{reg} \frac{r_E}{1-\tau} - r_M / (1-\rho_{reg}) = 0 \quad \text{(A.13)}$$

In a symmetric Bertrand-Nash equilibrium where $r_{L,i} = r_{L,i-1} = r_{L,i+1}$, $r_{D,i} = r_{D,i-1} = r_{D,i+1}$, $D_i = D/n$, and $L_i = L/n$, the loan and deposit rates in (A.12) and (A.13) become equations (21) and (22).

C. A Bank's Profit in a Market with Only Banks

From (A.1), the profits of a bank's inside owner (equityholder) equal

$$\left[\frac{L}{n}\left(r_{L,i} - c_L(D_i) - \frac{r_E}{1-\tau} \right) - \frac{D}{n}\left(r_{D,i} + c_D - \frac{r_E}{1-\tau} \right) - W_i\left(r_M - \frac{r_E}{1-\tau} \right) \right](1-\tau)$$

(A.13)

Since the regulatory capital constraint is binding, when $W_i \geq 0$ one can substitute $W_i = (L/n)(1-\rho_{reg}) - D/n$ to obtain

$$\left[\frac{L}{n}\left(r_{L,i} - c_L(D_i) - \frac{r_E}{1-\tau} - (1-\rho_{reg})\left(r_M - \frac{r_E}{1-\tau} \right) \right) - \frac{D}{n}\left(r_{D,i} + c_D - \frac{r_E}{1-\tau} - \left(r_M - \frac{r_E}{1-\tau} \right) \right) \right](1-\tau) \quad \text{(A.14)}$$

Then substituting in for $r_{L,i}$ and $r_{D,i}$ from (19) and (20) into (A.14) leads to profits of

$$\left[\frac{L}{n}\left(\frac{t_L}{n} \right) + \frac{D}{n}\left(\frac{t_D}{n} + \frac{L}{n} \frac{\partial c_L(D_i)}{\partial D_i} \right) \right](1-\tau)$$

(A.15)

When $W_i < 0$, one can substitute into (A.13) the binding constraint $W_i = (L/n) - (D/n)/(1-\rho_{reg})$ and $r_{L,i}$ and $r_{D,i}$ from (21) and (22). Doing so also leads to (A.15).

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D. Nonbank Lender's Maximization Problem

Note that since the nonbank lender's after-tax profit in (24) is proportional to the exogenous term $(1-\tau)$, maximizing after-tax profit is the same as maximizing before-tax profit. Therefore, without loss of generality the term $(1-\tau)$ can be ignored. Do so and substituting in the funding constraint $E_1 = L_1 - W_1$, the objective function (24) becomes

$$\underset{r_{L,1},W_1}{\text{Max}} \ L_1\left(r_{L,1}-c_L^*\right)-W_1 r_M -\left(L_1-W_1\right)r_E \tag{A.16}$$

subject to $L_1\left(1-\delta_{run}\right)\geq W_1$. Note that $L_1 = \left(\dfrac{r_{L,n}+r_{L,2}}{2}-r_{L,1}\right)\dfrac{L}{t_L}+\dfrac{L}{n}$ and from the symmetry

assumption that $r_{L,2}=r_{L,n}$ .Thus (A.16) becomes

$$\underset{r_{L,i},W_1}{\text{Max}} \ \left[\left(r_{L,2}-r_{L,1}\right)\frac{L}{t_L}+\frac{L}{n}\right]\left(r_{L,1}-c_L^*-r_E\right)-W_1\left(r_M-r_E\right) \tag{A.17}$$

subject to $\left[\left(r_{L,2}-r_{L,1}\right)\dfrac{L}{t_L}+\dfrac{L}{n}\right]\left(1-\delta_{run}\right)\geq W_1$. Let λ be the Lagrange multiplier on this constraint.

Then the first order condition with respect to $r_{L,1}$ simplifies to

$$r_{L,2}-2r_{L,1}+c_L^*+r_E+\frac{t_L}{n}-\lambda\left(1-\delta_{run}\right)=0 \tag{A.18}$$

The first order condition with respect to W_1 is

$$\left[-\left(r_M-r_E\right)-\lambda\right]W_1=0 \tag{A.19}$$

Thus, if $W_1 > 0$, $\lambda = r_E - r_M$. Therefore when $r_E > r_M$, the capital constraint is binding. If $r_E \leq r_M$, it is not and $\lambda = 0$. Consequently from (A.18) one see that equation (25) holds.

E. Banks' Maximization Problem

The derivation is almost exactly the same as Park and Pennacchi (2009). The optimization problem for banks in a market containing nonbanks is similar to our earlier solution. For the case of a "loan rich, deposit poor" market, the profit maximizing loan rate and deposit rates for bank i satisfy equations similar to (14) and (15):

$$r_{L,i}=\frac{1}{2}\left[\frac{r_{L,i-1}+r_{L,i+1}}{2}+\left(1-\rho_{reg}\right)r_M+\rho_{reg}\frac{r_E}{1-\tau}+c_L+\frac{t_L}{n}\right] \tag{A.20}$$

$$r_{D,i}=\frac{1}{2}\left[\frac{r_{D,i-1}+r_{D,i+1}}{2}+r_M-c_D-\frac{t_D}{n}\right] \tag{A.21}$$

First, consider (A.20). It can be rewritten in the form of the second-order difference equation

$$r_{L,i+1} - 4r_{L,i} + r_{L,i-1} + 2\left[\left(1-\rho_{reg}\right)r_M + \rho_{reg}r_E / \left(1-\tau\right) + c_L + t_L / n\right] = 0 \tag{A.22}$$

For shorthand, define $\overline{r}_L = \left(1-\rho_{reg}\right)r_M + \rho_{reg}r_E / \left(1-\tau\right) + c_L + t_L / n$, which would be the

equilibrium loan rate in the market if there were only banks. Equation (A.22) can be re-written

using the backward operator as

$$\left(1 - 4B + B^2\right)r_{L,i} + 2\overline{r}_L = 0 \tag{A.23}$$

for $i = 3, \ldots, n$. The roots to the quadratic equation for the backward operator are $B = 2 \pm \sqrt{3}$.

Also, note that a particular solution to equation (A.23) is $r_{L,i} = \overline{r}_L$. Therefore, the general solution

to (A.23) takes the form

$$r_{L,i} = \alpha_1\left(2+\sqrt{3}\right)^i + \alpha_2\left(2-\sqrt{3}\right)^i + \overline{r}_L \tag{A.24}$$

where the constants α_1 and α_2 are determined subject to two boundary conditions. One boundary

condition results from the rate set by the nonbank $i=1$, which, initially, we take as exogenous:

$$r_{L,1} = \alpha_1\left(2+\sqrt{3}\right) + \alpha_2\left(2-\sqrt{3}\right) + \overline{r}_L \tag{A.25}$$

The second boundary condition is the symmetry property for the one or two banks that are most

distant from the nonbank. When n is even, the one farthest bank is $i = n/2 + 1$, and symmetry

implies that the loan rates of its two neighbors, $r_{L\,i-1}$ and $r_{L,i+1}$, are the same. Hence, equation

(A.22) is

$$r_{L,\frac{n}{2}+1} = \tfrac{1}{2}r_{L,\frac{n}{2}} + \tfrac{1}{2}\overline{r}_L, \qquad n \text{ even.} \tag{A.26}$$

When n is an odd number, there are two banks farthest away from the nonbank, banks $i = (n+1)/2$

and $i = (n+1)/2 + 1$. If equation (A.22) is written down for each of these two banks, and the

symmetry condition $r_{L,\frac{n+1}{2}+2} = r_{L,\frac{n+1}{2}-1}$ is imposed, then solving these two equations for $r_{L,\frac{n+1}{2}}$ results

in

$$r_{L,\frac{n+1}{2}} = \tfrac{1}{3}r_{L,\frac{n+1}{2}-1} + \tfrac{2}{3}\overline{r}_L, \qquad n \text{ odd.} \tag{A.27}$$

It what follows, we derive the solution assuming that n is even.[22] Therefore, in addition to (A.25),

the second boundary condition is based on (A.26). Substituting (A.24) into (A.26), simplifying,

and noting that $\left(2-\sqrt{3}\right) = \left(2+\sqrt{3}\right)^{-1}$, leads to a proportional relationship between α_1 and α_2:

$$\alpha_2 = \alpha_1\left(2+\sqrt{3}\right)^{n+2} \tag{A.28}$$

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[22] The case of n odd is similar but uses condition (A.14) rather than (A.13).

Using (A.28) to substitute for α_2 in boundary condition (A.25), one finds the solution for α_1 to be

$$\alpha_1 = \frac{r_{L,1} - \left(r_E + c_L + t_L/n\right)}{\left(2+\sqrt{3}\right)\left[1+\left(2+\sqrt{3}\right)^n\right]} \tag{A.29}$$

Using (A.28) and (A.29) to substitute for α_1 and α_2 in (A.25), we obtain the solution

$$r_{L,i} = \left(1-\delta_{i,n}\right)\overline{r}_L + \delta_{i,n}r_{L,1} , \quad i=1,...,n \tag{A.30}$$

which shows that $r_{L,i}$ is a weighted average of rates with the weight on nonbank 1's rate being

$$\delta_{i,n} \equiv \frac{\left(2+\sqrt{3}\right)^{\frac{n}{2}+1-i} + \left(2-\sqrt{3}\right)^{\frac{n}{2}+1-i}}{\left(2+\sqrt{3}\right)^{\frac{n}{2}} + \left(2-\sqrt{3}\right)^{\frac{n}{2}}} \tag{A.31}$$

Note that (A.31) satisfies the symmetry conditions: $\delta_{2,n}=\delta_{n,n}$, $\delta_{3,n}=\delta_{n-1,n}$,..., $\delta_{n/2,n}=\delta_{n/2+2,n}$. Its derivative with respect to i is

$$\frac{\partial \delta_{i,n}}{\partial i} = \frac{\ln\left(2+\sqrt{3}\right)}{\left(2+\sqrt{3}\right)^{\frac{n}{2}} + \left(2-\sqrt{3}\right)^{\frac{n}{2}}}\left[\left(2-\sqrt{3}\right)^{\frac{n}{2}+1-i} - \left(2+\sqrt{3}\right)^{\frac{n}{2}+1-i}\right] \tag{A.32}$$

Since $0 < \left(2-\sqrt{3}\right) < 1 < \left(2+\sqrt{3}\right)$, $\partial\delta_{i,n}/\partial i < 0$ over the range from $i = 2$ to $i = n/2 + 1$, the midpoint of the circle. This implies that a bank rate's weight on nonbank 1's rate declines the further is its distance from nonbank 1. The derivative of (A.31) with respect to n is

$$\frac{\partial \delta_{i,n}}{\partial n} = \frac{\ln\left(2+\sqrt{3}\right)}{\left[\left(2+\sqrt{3}\right)^{\frac{n}{2}} + \left(2-\sqrt{3}\right)^{\frac{n}{2}}\right]^2}\left[\left(2-\sqrt{3}\right)^{i-1} - \left(2+\sqrt{3}\right)^{i-1}\right] \tag{A.32}$$

Since $i = 2,...,n$ for the banks, $\partial\delta_{i,n}/\partial n < 0$. This means that the rate charged by a bank of a given distance $i - 1$ from nonbank 1 will have a smaller weight on nonbank 1's rate the less concentrated is the market. In other words, keeping distance constant, nonbank 1's rate has less impact on a bank's rate the greater is the number of banks in the market.

For the general case of a market with n total financial service providers having $k \geq 1$ nonbanks located symmetrically around the circle, let the number of banks between any two nonbanks, $(n/k) - 1$, be an odd integer. Then the same derivation as above applies to each $(n/k) -$ 1 group of banks bordered by two nonbanks.[23] A bank's rate is given by equation (A.30) except that $\delta_{i,n}$ is replaced with $\delta_{i,n/k}$, where $\delta_{i,n/k}$ is given by equation (A.31) but with (n/k) replacing n.

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[23] Note that since nonbanks are identical and are assumed to set rates symmetrically, (A.25) continues to be a boundary condition because the two nonbanks bordering a group of banks set the same rates.

This is exactly equations (26) and (28). Since $\partial \delta_{i,n/k}/\partial(n/k) = \partial \delta_{i,n}/\partial n < 0$, one obtains $\partial \delta_{i,n/k}/\partial k = -(n/k^2)\,[\partial \delta_{i,n/k}/\partial(n/k)] > 0$. This implies that given n, banks' rates place greater weight on the rate of the nonbanks the greater is the number of nonbanks in the market. Each nonbank's rate setting problem is the same as in the $k = 1$ case, such that its equilibrium loan rate equals (25) and, inserting this back into its neighboring bank's loan rate one obtains equation (30). The same derivation is used to find banks' deposit rates.

References

Ashcraft, A. 2008. Does the Market Discipline Banks? New Evidence from Regulatory Capital Mix. *Journal of Financial Intermediation* 17, 543-561.

Becker, B. 2007. Geographical Segmentation of U.S. Capital Markets. *Journal of Financial Economics* 85, 151-178.

Beltratti, A., J. Bock, R. Jewsikow, and G. Nelson. 2014. BDCs - The Most Important Commercial Lenders You've Never Heard About. Mimeo, Bocconi University and Wells Fargo Securities.

Black, F. 1975. Bank Funds Management in an Efficient Market. *Journal of Financial Economics* 2, 323-339.

Burhouse, S., J. Feid, G. French, and K. Ligon. 2003. Basel and the Evolution of Capital Regulation: Moving Forward, Looking Back. *An Update on Emerging Issues in Banking*. Federal Deposit Insurance Corporation. Available at https://www.fdic.gov/bank/analytical/fyi/2003/011403fyi.html .

Calomiris, C., and R. Herring. 2013. How to Design a Contingent Convertible Debt Requirement that Helps Solve Our Too-big-to-fail Problem. *Journal of Applied Corporate Finance* 25(2), 39-62.

Chiappori, P.-A., D. Perez-Castrillo, and T. Verdier. 1995. Spatial Competition in the Banking System: Localization, Cross Subsides and the Regulation of Deposit Rates. *European Economic Review* 39: 889-918.

DeAngelo, H., and R. Stulz. 2015. Liquid-claim Production, Risk Management, and Bank Capital Structure: Why High Leverage is Optimal for Banks. *Journal of Financial Economics* 116: 219-236.

Diamond, D. 1984. Financial Intermediation and Delegated Monitoring. *Review of Economic Studies* 51: 393-414.

Diamond, D., and P. Dybvig. 1983. Bank Runs, Deposit Insurance, and Liquidity. *Journal of Political Economy* 91: 401-419.

Fama, E. 1985. What's Different About Banks? *Journal of Monetary Economics* 15, 29-40.

Friedman, M., and A. Schwartz. 1963. *A Monetary History of the United States: 1867-1960*. Princeton University Press, Princeton, NJ.

Gong, D., and J. Ligthart. 2014. Does Corporate Income Taxation Affect Securitization? *Journal of Financial Services Research* (forthcoming).

Gorton, G., and G. Pennacchi. 1993. Money Market Funds and Finance Companies: Are They the Banks of the Future? in M. Klausner and L. White, eds. *Structural Change in Banking*. Business One Irwin, Homewood, Illinois.

Graham, J. 2000. How Big Are the Tax Benefits of Debt? *Journal of Finance* 55, 1901-1941.

Han, J., K. Park, and G. Pennacchi. 2015. Corporate Taxes and Securitization. *Journal of Finance* 70, 1287-1321.

Hanson, S., A. Shleifer, J. Stein, and R. Vishny. 2015. Banks as Patient Fixed-Income Investors. *Journal of Financial Economics* (forthcoming).

Mester, L., L. Nakamura, and M. Renault. 2007. Transactions Accounts and Loan Monitoring. *Review of Financial Studies* 20, 529-556.

Park, K., and G. Pennacchi. 2009. Harming Depositors and Helping Borrowers: The Disparate Impact of Bank Consolidation. *Review of Financial Studies* 22, 1-40.

Pennacchi, G., T. Vermaelen, and C. Wolff. 2014. Contingent Capital: The Case of COERCs. *Journal of Financial and Quantitative Analysis* 49, 541-574.

Salop, S. 1979. Monopolistic Competition with Outside Goods. *Bell Journal of Economics* 10: 141-56.

Schepens, G. 2014. Taxes and Bank Capital Structure. Working paper, National Bank of Belgium and Department of Financial Economics, Ghent University.

Shandlbauer, A. 2014. How Do Financial Institutions React to a Tax Increase? Working paper, Vienna Graduate School of Finance.

Standard & Poor's. 2014. Leveraged Loan Primer. Available at http://www.leveragedloan.com/primer/ .

Von Beschwitz, B., and D. Foos. 2014. Banks' Equity Stakes and Lending: Evidence from a Tax Reform. Working paper, Federal Reserve Board of Governors and Deutsche Bundesbank.

Figure 1

Panel A: Cash, Securities, and Loans as Percentages of Assets for All U.S. Commercial Banks, 1834 to 1909
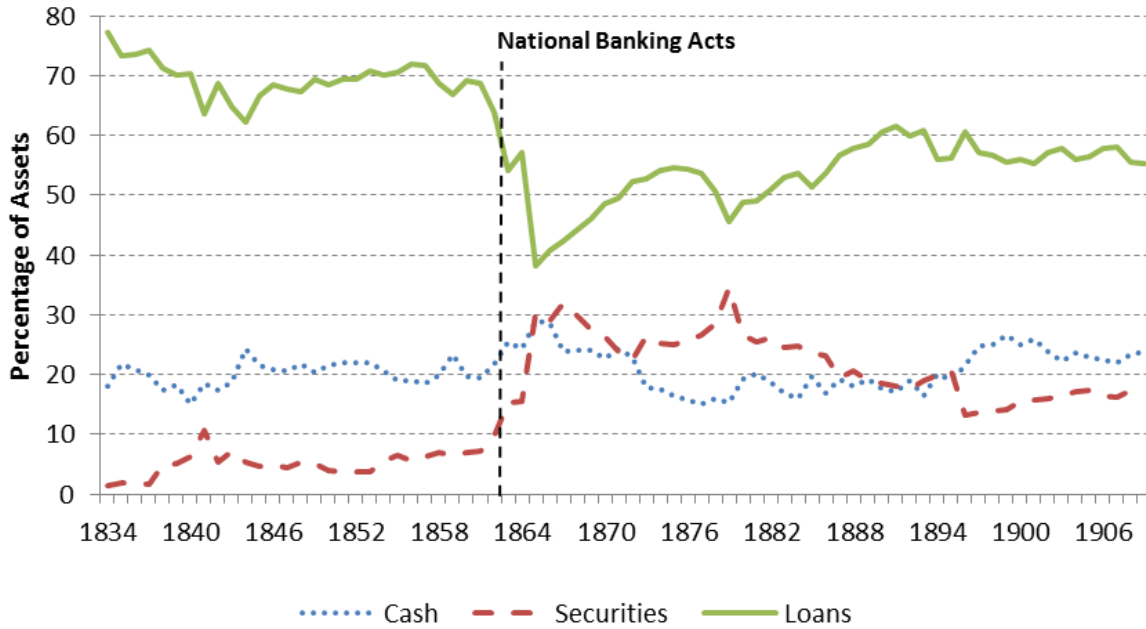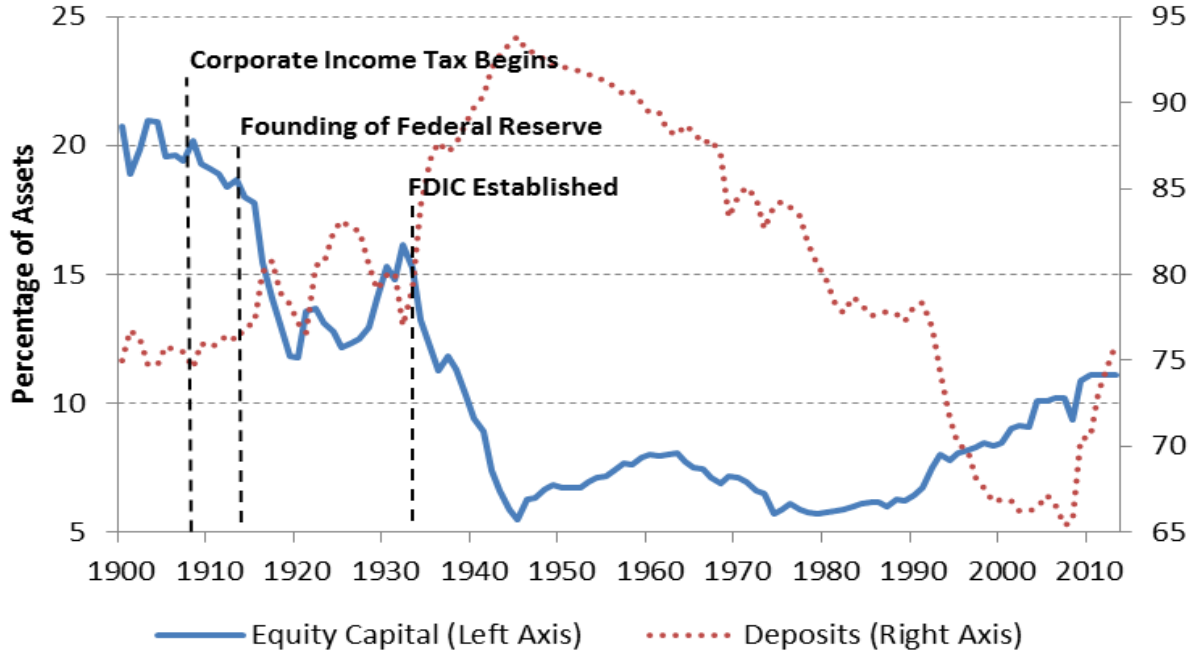

Panel B: Banknotes, Deposits, and Equity Capital as Percentages of Assets for All U.S. Commercial Banks, 1834 to 1909
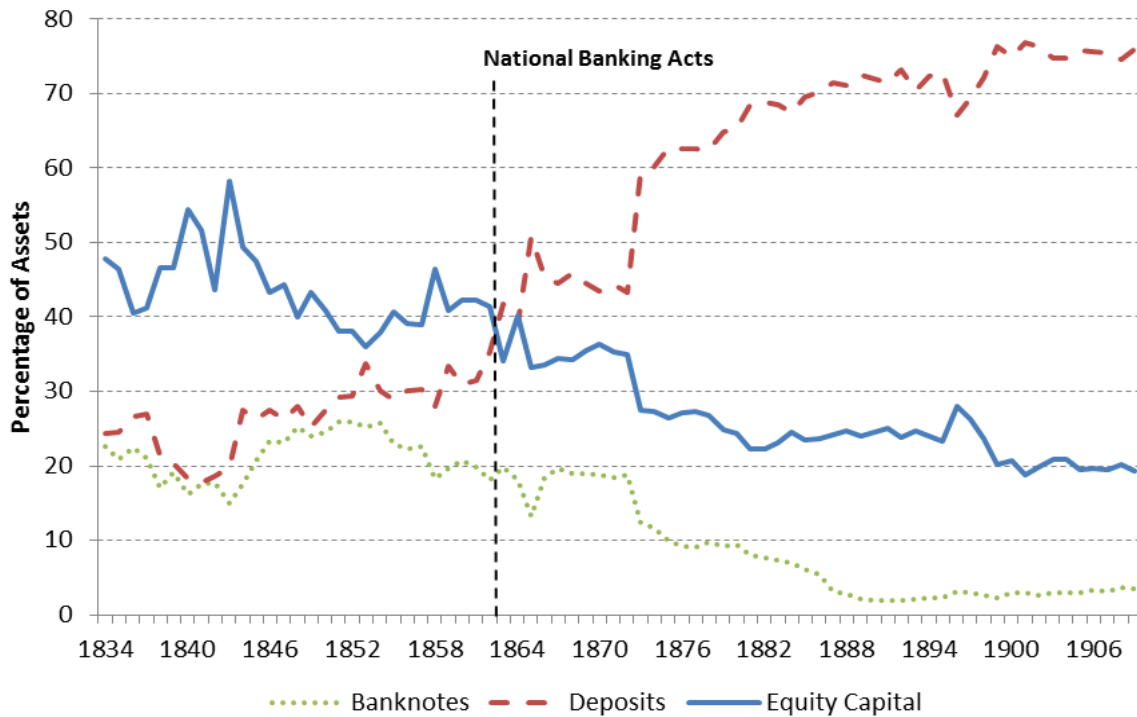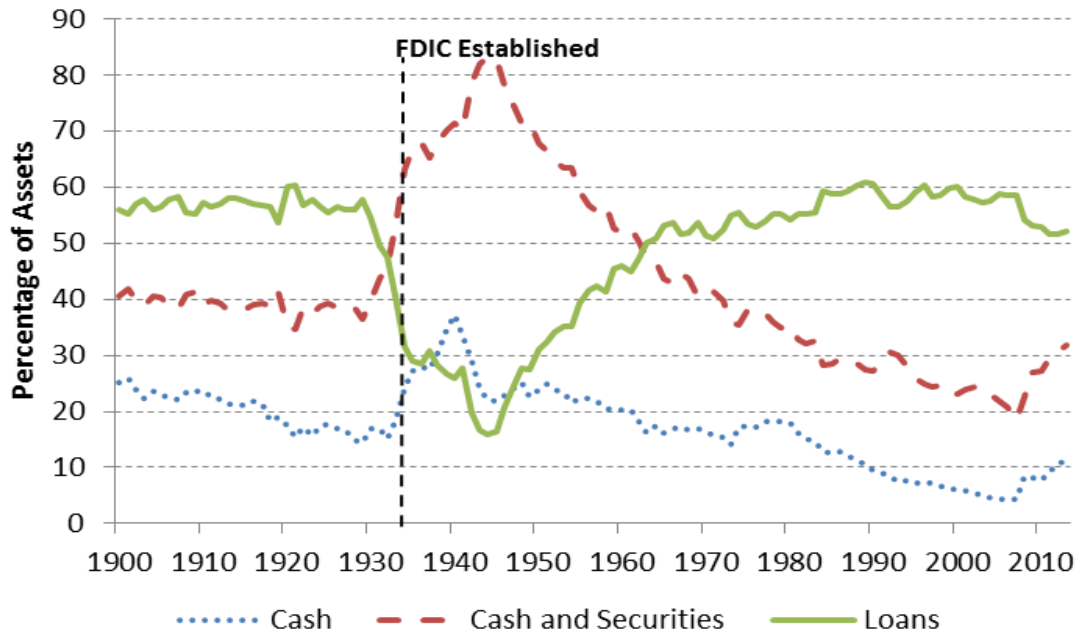

Sources: U.S. Statistical Abstract and FDIC Call Reports

Figure 2

Panel A: Equity Capital and Deposits as Percentages of Assets for All U.S. Commercial Banks, 1900 to 2013

Panel B: Cash, Securities, and Loans as Percentages of Assets for All U.S. Commercial Banks, 1900 to 2013

Sources: U.S. Statistical Abstract and FDIC Call Reports
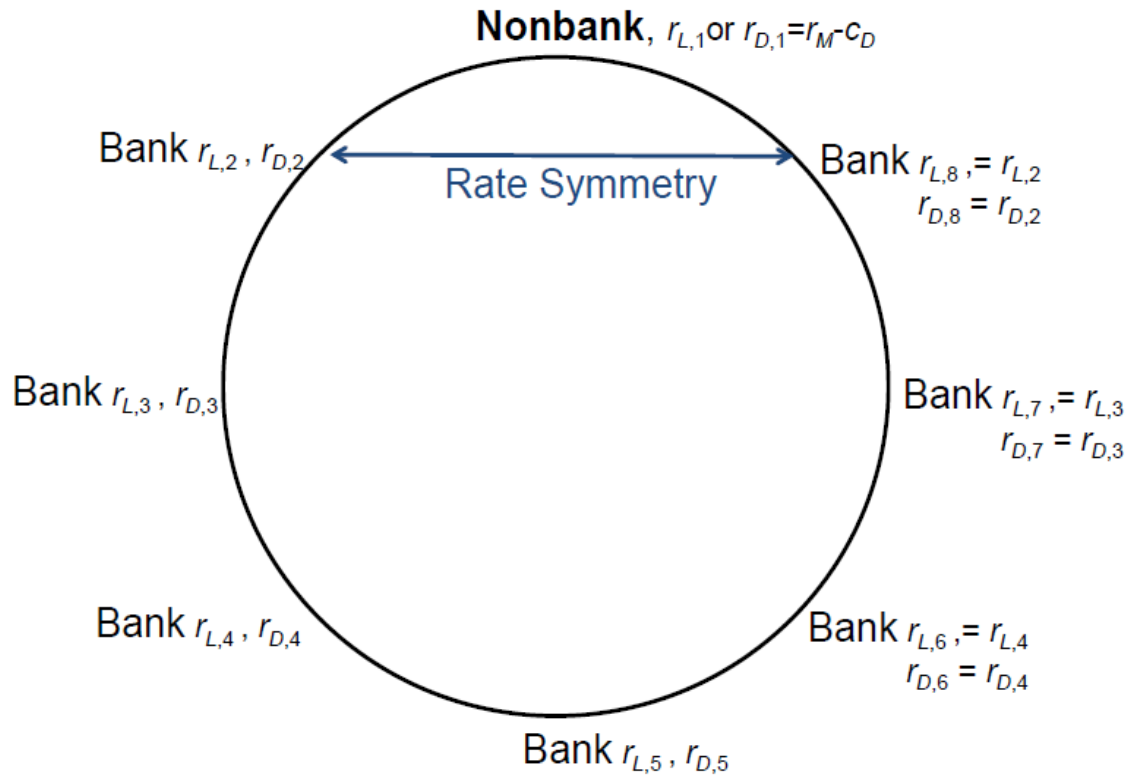
Figure 3

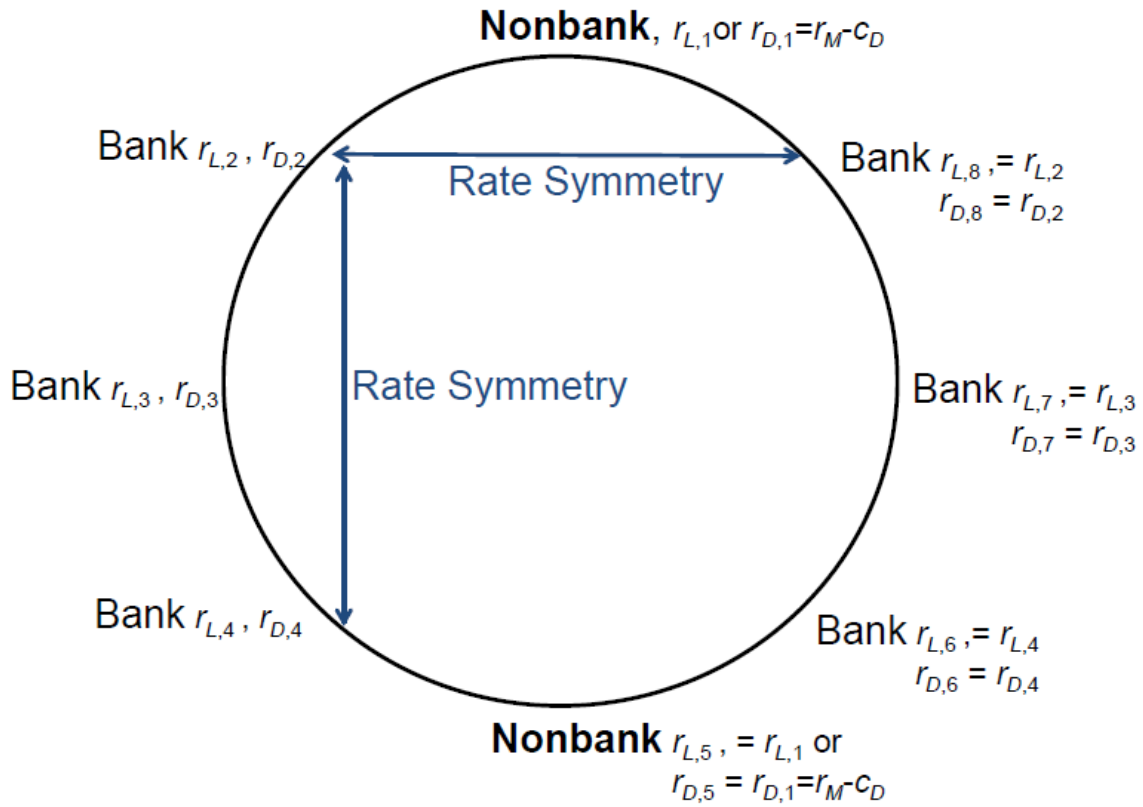**Market with One Nonbank**

Figure 4

Market with Two Nonbanks

Nonbank, $r_{L,1}$ or $r_{D,1} = r_M - c_D$

Bank $r_{L,2}$, $r_{D,2}$

Rate Symmetry

Bank $r_{L,8}$, $= r_{L,2}$
$r_{D,8} = r_{D,2}$

Bank $r_{L,3}$, $r_{D,3}$

Rate Symmetry

Bank $r_{L,7}$, $= r_{L,3}$
$r_{D,7} = r_{D,3}$

Bank $r_{L,4}$, $r_{D,4}$

Bank $r_{L,6}$, $= r_{L,4}$
$r_{D,6} = r_{D,4}$

Nonbank $r_{L,5}$, $= r_{L,1}$ or
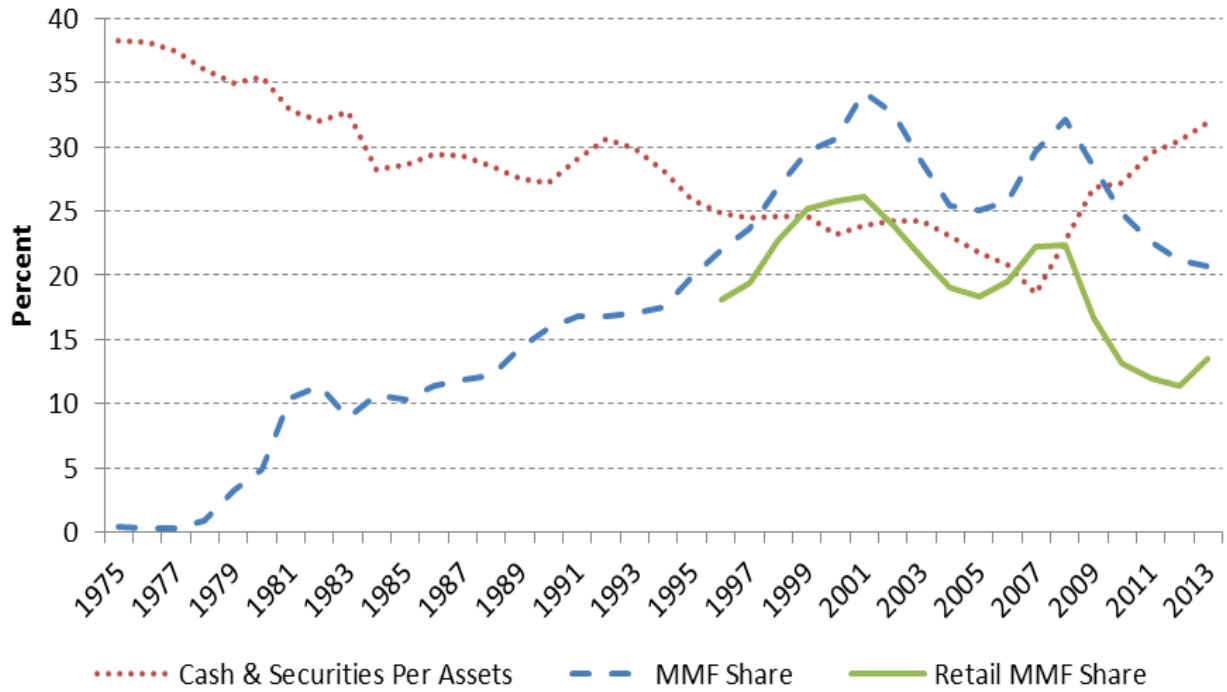$r_{D,5} = r_{D,1} = r_M - c_D$
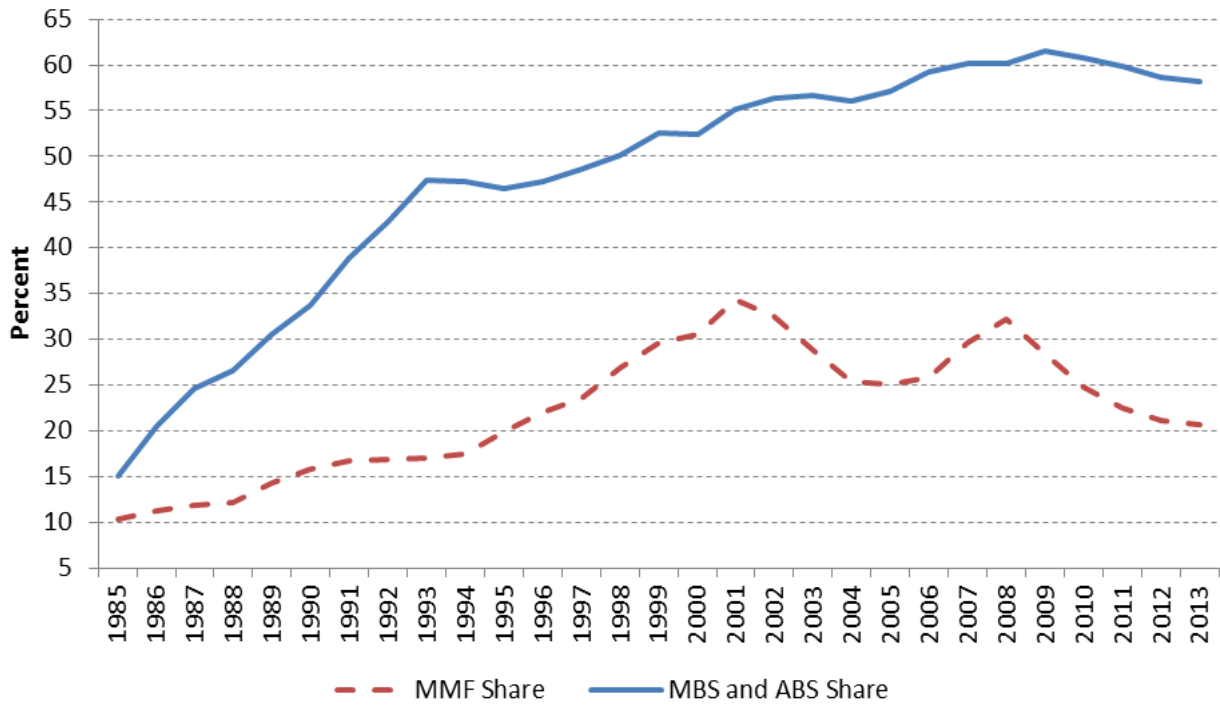
Figure 5

Money Market Mutual Fund Share of Savings/Transactions Account Balances

Sources: Investment Company Institute and FDIC

Figure 6

MBS and ABS Share of All Loans

Sources: Securities Industry and Financial Markets Association, FDIC, and Investment Company
    Institute