

Liquidity Provision and Optimal Bank Regulation

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Abstract

We extend the set of regulatory instruments for banks' liquidity provision by adding a policy instrument for controlling the fraction of perfectly-liquid accounts. We demonstrate how this instrument induces self-selection on behalf of depositors who are differentiated according to their probability of facing a liquidity shock. This self-selection leads to a market segmentation, which can break the bundling of deposits with risk and thereby enhance social welfare. The optimal regulatory policy is explicitly characterized as a function of banks' investment return, and of depositors' gain from early withdrawals to fund a realized investment opportunity.

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1. Introduction

In recent years we have witnessed a rapid worldwide consolidation process of the banking industry. The securitization of markets has broken the traditional link between taking deposits and making loans. Nowadays, large corporations have direct access to international capital markets at terms, which might often outperform those of intermediated bank funding. Thus, banks have to operate in a world where the markets for financial services - banking, brokerage as well as insurance - have become increasingly competitive. This development has serious consequences from the point of view of traditional banking, since, as Kay (1998) wrote, "The rationale for the traditional association of functions that we call a bank has simply disappeared, and most of these specific functions - retail marketing of financial services, financial advice to companies, monitoring the creditworthiness of large companies - are better done by some specialist institution that is not necessarily a bank." Also, with the vast development of money market funds, insurance investment, and investment via brokerage firms in the US, Europe and Asia, and with the fast globalization of investment opportunities, consumers do not suffer from any lack of investment opportunities. Similarly, startup firms can raise capital in a wide variety of markets without approaching banks. In fact, given the large number of money market funds and financial instruments existing today, consumers can always pick such a ratio of risk and return that exactly match their degree of risk aversion.

Faced with intensified competition from other types of financial markets banks presently make use of their retail deposit base as a collateral for risky investment activities in securities markets such as trading, market making and placing as well as for traditional lending to illiquid long-term investment projects. In this way the banks effectively bundle their deposit base with their risky investment activities. This bundling of deposits with risk generates a market failure, which is supported, and not corrected, by the regulatory environment where the banks' risks are effectively underwritten by the governments, and ultimately by the taxpayers. This applies in particular with respect to the banks which are large enough to enjoy full protection under the prevailing "too-big-to-fail"-doctrine [see, for example, Feldman and Rolnick (1998)].

Basically, the banks' bundling of deposits with illiquid and risky investment activities generates a welfare distortion, because those depositors who wish to utilize bank services associated with deposit accounts may be willing to pay an extra fee to the bank in return for perfectly liquid and risk-free accounts. This market failure cannot be corrected within a regulatory framework with reserve requirements as the only instrument for restricting the banks' risk exposure.

In the present article we extend the set of instruments for the regulation of banks by adding a policy instrument for controlling the fraction of perfectly-liquid accounts. By adding this instrument within the framework of a model with depositors differentiated according to their probability of facing a liquidity shock, the market failure generated by the bundling of deposits with risk can be reduced or eliminated. Based on depositor-specific private information, each depositor has to decide at which bank to make a deposit, and then whether to open an illiquid interest-bearing account, or to open a costly risk free perfectly-liquid account. Thus, self-selection on behalf of the depositors will induce a market segmentation, which can break the bundling of deposits with risk.

Our analysis will delineate those circumstances under which the addition of perfectly-liquid deposit accounts will generate a socially superior allocation relative to a world where risky accounts represent the only channel whereby consumers can enjoy the deposit services offered by the banking industry. Intuitively, the social gains from the presence of perfectly-liquid deposit accounts arise, because the costs of regulated liquidity provision in the form of reserves ratios is restricted to those deposits with a sufficiently high probability of facing a liquidity need. Thus, the instruments of mandating a certain fraction of perfectly-liquid accounts and the reserve requirement applied to all deposits are not equivalent, since the reserve requirements cover all depositors independently of the probability of facing liquidity needs. In this study, we characterize the optimal regulatory policy when the set of policy instruments includes the fraction of perfectly-liquid accounts in addition to the traditional reserve requirements applied on partially-liquid accounts. In particular, we outline the conditions under which the currently applied policy of applying only reserve requirements is socially optimal.

The existing literature views depository institutions as "pools of liquidity" providing households

with insurance against idiosyncratic shocks that affect their consumption needs. In an influential model by Diamond and Dybvig (1983) banks provide liquidity to depositors who are ex ante uncertain about their intertemporal preferences over consumption sequences [see also Bryant (1980) and Villamill (1991)]. In the Diamond-Dybvig model demand deposits are needed because liquidity shocks are not publicly observed and therefore cannot be insured. They demonstrate how deposit contracts offer insurance to households and how such contracts can potentially induce a Pareto efficient allocation of risk. Subsequently, Diamond and Rajan (2001) have designed a model in which they defend the bundling of banks' deposits with illiquid and risky investment activities. The argument of Diamond and Rajan builds on the view that banks have specific collection skills with respect to the illiquid projects in their outstanding loan portfolio. Demand deposits represent a commitment mechanism making sure that the banks have incentives to create liquidity when a sufficiently large fraction of the depositors face liquidity needs. Kashyap, Rajan and Stein (2002) develop a theoretical as well as empirical case for the presence of synergies between deposit-taking and lending. In their model these synergies arise from the presence of loan commitments and from the consideration that bundling of deposits and loan commitments may make it possible to economize on the liquid assets needed to support these activities.

It is well known that the interaction between pessimistic depositor expectations might generate bank runs as an inefficient Nash equilibrium within the framework of the Diamond and Dybvig (1983) model. As Diamond and Dybvig originally pointed out, deposit insurance systems can eliminate such inefficient Nash equilibria. Despite the indisputable insurance benefits, empirical observations as well as theoretical research convincingly demonstrate how federal deposit insurance will encourage banks to engage in excessive risk taking [see, for example, Cooper and Ross (1998)]. For that reason researchers have systematically investigated mechanisms other than deposit insurance as instruments for reducing the instability of the banking system. In line with Freixas and Rochet (1997), the adoption of partial narrow banking seems to be the most natural mechanism to eliminate this instability.¹

¹Narrow banking refers to regulatory systems where the banks are required to back demand deposits entirely by safe and liquid short-term assets.

The research contributions evaluating the consequences of narrow banking have typically conducted comparisons between the polar cases of complete narrow banking and risky banking operating with reserve requirements determining the boundary conditions of the banking activities.² In the present analysis we contribute to this fundamental debate by introducing the possibility of designing banking systems where one fraction of the banking activities are required to obey the principles of narrow banking, whereas the complementary fraction operates as risky banking equipped with a reserve requirement determined in an optimal way. We ask the following question: What is the socially optimal combination of narrow banking and risky banking supported by reserve requirements?

Our study is organized as follows. Section 2 presents the model. In section 3 we calculate the equilibrium interest rates and fees. Section 4 characterizes the optimal regulatory policy for supporting a socially optimal system of liquidity provision by banks. Finally, Section 5 offers some concluding comments.

2. The Model

Consider an imperfectly-competitive banking industry with two banks labeled bank A and B . There are three periods. In period 1, banks determine their fees and interest rates, based on which depositors determine which bank to make a deposit with, and whether to open a liquid or a illiquid account subjected to a reserve requirement. In period 2 some depositors realize a liquidity need and attempt to withdraw their entire deposit. In period 3 banks collect the return on their investments, liquidate all accounts, and pay interest on interest-bearing accounts.

2.1 The regulator

The regulator of the banking industry imposes two restrictions on banks. The first, denoted by ρ ($0 \leq \rho \leq 1$), is the commonly practiced reserve requirement. That is, ρ is the fraction of risky deposits which the bank must keep liquid, whereas $(1 - \rho)$ is the fraction of risky deposits that

²See, for example, Friedman (1960, Ch.3) or Wallace (1996).

banks use for lending activities for funding of credit worthy projects, which are illiquid in the short run.

The second policy instrument, denoted by δ ($0 \leq \delta \leq 1$) is the maximal fraction of accounts on which banks can maintain the minimal reserve requirement. Thus, $(1 - \delta)$ is the fraction of accounts that must be kept 100% liquid. Accordingly, we will make use of the following terminology.

DEFINITION 1

We say that the regulator allows/mandates

- *Risky banking if $\delta = 1$;*
- *Narrow banking if $\delta = 0$, and*
- *Mixed banking if $0 < \delta < 1$.*

Partially-liquid accounts, subjected to a minimum reserve requirement $\rho < 1$, constitute what is widely observed in today's private banking. The fraction δ is not a policy instrument within the framework of current banking regulation. The academic literature on banking regulation has to a large extent focused on comparisons of narrow banking systems with banking systems operating with a minimal reserve requirement as the only policy instrument. In this respect our analysis represents a more ambitious research task insofar as our goal is to characterize the socially optimal combination of the policy instruments ρ and δ as the basis for the design of banking regulation. In particular, we will specify circumstances under which mixed banking socially dominates risky banking for all possible levels of mandated minimum reserve requirements.

2.2 Depositors

There is a continuum of uniformly distributed depositors indexed by the pair (λ, x) on the unit square $[0, 1] \times [0, 1]$. This captures depositors who are differentiated along two dimensions. The banks are horizontally differentiated. Bank A is located at $x = 0$, whereas bank B is located at $x = 1$. Each depositor deposits \$1 either in bank A or bank B . The characteristic of horizontal

differentiation, x , measures the disutility (transportation cost) associated with making a deposit with bank A , whereas $(1 - x)$ measures the disutility associated with banking at B . The index λ measures depositors' probability of realizing a liquidity need in period 2. The idiosyncratic depositor characteristics (x, λ) are private information of depositors and cannot be observed by the banks. Thus, the bank cannot make its fees and interest rates contingent on λ .

Let β denote a depositor's basic utility derived from the services obtained by opening a bank account and making the \$1 deposit. The variables i_A and i_B denote the deposit rates paid on risky accounts, whereas f_A and f_B denote the fees applied on liquid accounts, for banks A and B , respectively. Let θ_A and θ_B , where $0 \leq \theta_i \leq 1$, denote the per-depositor amount of money available for withdrawal in period 2 from partially-liquid accounts upon realizing a liquidity need. The parameters θ_A and θ_B are endogenously determined within our model in a way consistent with rational expectations on behalf of depositors. Finally, let v denote the value of the opportunity faced by a depositor realizing a liquidity need in period 2.³ That is, a higher value of v makes an earlier withdrawal more beneficial to depositors. Altogether, the expected utility of a depositor indexed by (λ, x) is given by

$$U_{\lambda,x} \stackrel{\text{def}}{=} \begin{cases} \beta - \tau x + \lambda \theta_A v + (1 - \lambda) i_A & \text{Deposits in a risky account with bank } A \\ \beta - \tau x + \lambda v - f_A & \text{Deposits in a liquid account with bank } A \\ \beta - \tau(1 - x) + \lambda \theta_B v + (1 - \lambda) i_B & \text{Deposits in a risky account with bank } B \\ \beta - \tau(1 - x) + \lambda v - f_B & \text{Deposits in a liquid account with bank } B. \end{cases} \quad (1)$$

Thus, if banks maintain 100% reserves on all accounts then $\theta_i = 1$. In this case depositors who realize a liquidity need (probability λ) can fully reach the full return potential, captured by the indirect utility v , by making an early withdrawal of their \$1 investment. In contrast, if banks lend out some or all of the amount deposited, depositors who face liquidity needs can withdraw only the proportion $\theta_i < 1$ and thus gain a utility of $\theta_i v$ from early withdrawal. The parameter $\tau > 0$ is the standard Hotelling's differentiation (transportation cost) parameter. Thus, low values of τ capture situations with intense competition between the banks. Finally, notice that interest on

³This could capture the deposit-specific opportunity of buying an urgent durable consumption good, of making an investment at favorable terms or of exploiting a good business opportunity. Models characterizing optimal bank regulation frequently do not take this feature into account. As we will see later on, the presence of this feature has important consequences for the optimal design of bank regulation.

partially-liquid accounts is not paid to depositors who withdraw money in period 2.

2.3 Banks

Banks A and B set their interest rates, i_A and i_B paid on risky interest-bearing accounts, and the fees, f_A and f_B on perfectly-liquid accounts, subject to the regulator's imposition of the fraction of risky accounts, δ , and the minimum reserve requirement, ρ , applied to risky accounts. Let r denote a bank's return on an outside investment project. Let $q_j^R(\lambda)$ and $q_j^L(\lambda)$ denote the number of risky and liquid accounts opened with bank j by depositors of type λ . Then, each bank j , $j = A, B$, chooses interest paid on risky and fee levied on liquid accounts to solve

$$\max_{i_j, f_j} \pi_j = \int_{\{\lambda | q_j^R(\lambda) > 0\}} [(1 - \rho)r - (1 - \lambda)i_j] q_j^R(\lambda) d\lambda + \int_{\{\lambda | q_j^L(\lambda) > 0\}} f_j q_j^L(\lambda) d\lambda. \quad (2)$$

The first term measures the profit bank j earns from risky accounts. On each risky account the bank's return is determined by the difference $(1 - \rho)r - (1 - \lambda)i_j$, which reflects that the fraction ρ of the deposits into risky accounts has to be held as liquid reserves. Notice again that the banks pay interest only if depositors do not realize liquidity needs. The second term in (2) measures the revenue collected from the fees on perfectly-liquid accounts.

3. Equilibrium Interest Rates and Fees

Figure 1 describes an arbitrary allocation of depositors between the banks and it illustrates depositors' choices of whether to open a risky account or a liquid account. As we demonstrate below, Figure 1 delineates an out-of-equilibrium allocation in the sense that interest rates are not equal.

In view of Figure 1 and the utility function (1), depositors who choose to open a risky account and are indifferent between banks A and B are indexed by

$$x^R = \frac{1}{2} + \frac{\lambda v (\theta_A - \theta_B) + (1 - \lambda)(i_A - i_B)}{2\tau}. \quad (3)$$

In Figure 1, x^R is drawn as a function of the depositors' probability of facing liquidity shocks for an out-of-equilibrium case where $i_A > i_B$ and $\theta_A < \theta_B$, just for the sake of illustration. Clearly,

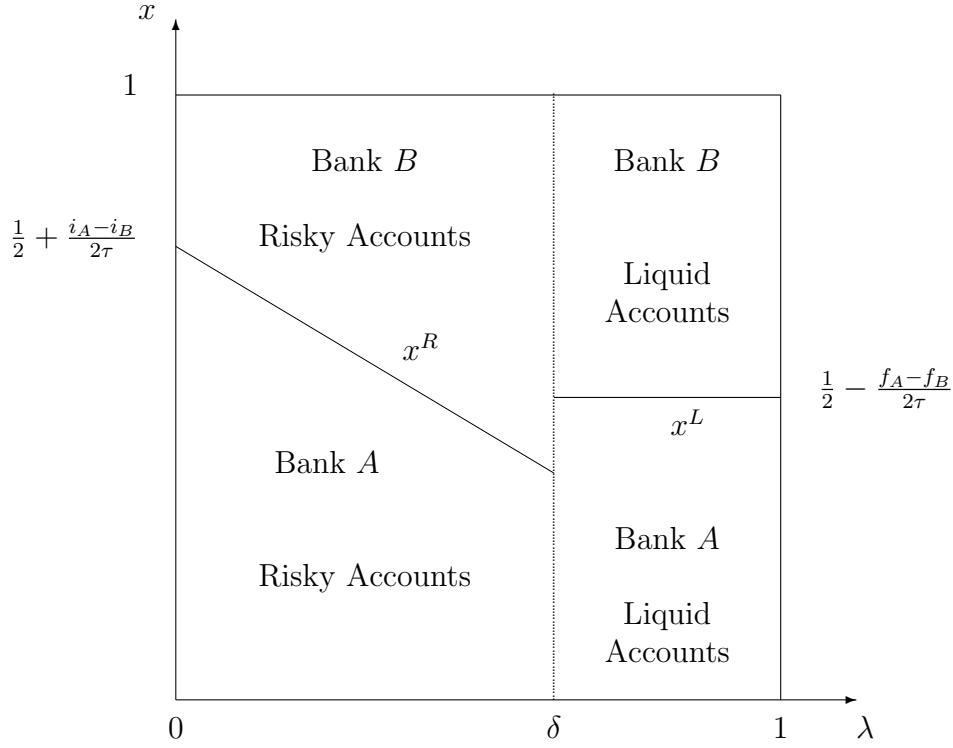


Figure 1: Possible (out-of-equilibrium) allocation of depositors among banks and account types.

depositors indexed close to $\lambda = 0$ have a very low probability of realizing liquidity needs and therefore compare mainly the interest rates, i_A and i_B , paid by the banks. In the limit, when $\lambda = 0$, more depositors will choose bank A than B if and only if $i_A > i_B$.

However, as λ increases towards δ , depositors also compare the available funds for withdrawal upon realizing liquidity needs as given by θ_A and θ_B . Figure 1 assumes that $\theta_A < \theta_B$ so depositors with high probability of realizing a liquidity need find bank A less attractive, hence, x^R is declining with λ .

Substituting $\theta_A = \theta_B = 1$ into the utility function (1) implies that depositors who choose to open a liquid account and are indifferent between banks A and B are indexed by

$$x^L = \frac{1}{2} + \frac{f_B - f_A}{2\tau}. \quad (4)$$

x^L is drawn in Figure 1 as a constant which is affected only by the difference in fees, $f_B - f_A$. x^L is independent of λ since depositors can always withdraw the full amounts, that is, $\theta_A = \theta_B = 1$

on liquid accounts.

3.1 Banks' optimization

In view of Figure 1, for each type of λ with $0 \leq \lambda \leq \delta$, the number of depositors opening risky accounts with each bank are $q_A^R(\lambda) = x^R(\lambda)$ and $q_B^R(\lambda) = 1 - x^R(\lambda)$. Similarly, the total number of liquid accounts are $q_A^L \stackrel{\text{def}}{=} (1 - \delta)q_A^L(\lambda) = (1 - \delta)x^L$ and $q_B^L \stackrel{\text{def}}{=} (1 - \delta)q_B^L(\lambda) = (1 - \delta)(1 - x^L)$, as these liquid accounts are chosen by all λ types with $\delta \leq \lambda \leq 1$. In the above, x^R and x^L are given in (3) and (4), respectively.

Now, in view of Figure 1, the imposed regulation that no more than the fraction δ of the accounts can be risky, implies that depositors indexed by $\lambda = \delta$ must be indifferent between opening risky and liquid accounts. Therefore, substituting $\lambda = \delta$ into the utility function (1), we have $\beta - \tau x + (1 - \lambda)i_A + v\theta_A\delta = \beta - \tau x - f_A + v\delta$ for bank A , and analogously for bank B . Hence, the fee levied on liquid accounts in bank i can be expressed as

$$f_j = \delta v(1 - \theta_j) - (1 - \delta)i_j, \quad j = A, B. \quad (5)$$

Substituting (5) into (4), we obtain

$$x^L = \frac{1}{2} + \frac{\delta v(\theta_A - \theta_B) + (1 - \delta)(i_A - i_B)}{2\tau}. \quad (6)$$

Substituting (3), (5), and (6) into (2), the optimization problem facing each bank j is reduced into the problem of choosing the interest rate applied to risky accounts according to

$$\begin{aligned} \max_{i_j} \pi_j = & \int_0^\delta [(1 - \rho)r - (1 - \lambda)i_j] \left[\frac{1}{2} + \frac{\lambda v(\theta_j - \theta_k) + (1 - \lambda)(i_j - i_k)}{2\tau} \right] d\lambda \\ & + [\delta v(1 - \theta_j) - (1 - \delta)i_j] (1 - \delta) \left[\frac{1}{2} + \frac{\delta v(\theta_j - \theta_k) + (1 - \delta)(i_j - i_k)}{2\tau} \right], \end{aligned} \quad (7)$$

where $j, k = A, B$ and $j \neq k$. The profit function (7) is strictly concave in i_j since $\partial^2 \pi_j / \partial (i_j)^2 = (\delta - 1)^3 / \tau < 0$. The first-order condition associated with (7) yields the interest rate best-response function of bank j as a function of the interest rate set by its rival bank k . These best-response functions are given by

$$i_j(i_k) = \frac{(1 - \delta)i_k + v\delta(1 - 2\theta_i + \theta_k) - \tau}{2(1 - \delta)} \quad j, k = A, B, \quad j \neq k. \quad (8)$$

Consequently, we can conclude that the interest rates are strategic complements.

3.2 Equilibrium liquid funds under rational expectations

In order to calculate the equilibrium interest rates, i_A and i_B , we must first compute θ_A and θ_B . Therefore, we make the following assumption.

ASSUMPTION 1

Depositors have perfect foresight for θ_A and θ_B . That is, each depositor is able to compute the equilibrium amount of money available for withdrawal from a risky account upon realizing a liquidity need.

Clearly, Assumption 1 imposes behavior based on rational expectations on behalf of depositors. Figure 2 illustrates the allocation of depositors among banks and accounts in a symmetric equilibrium.

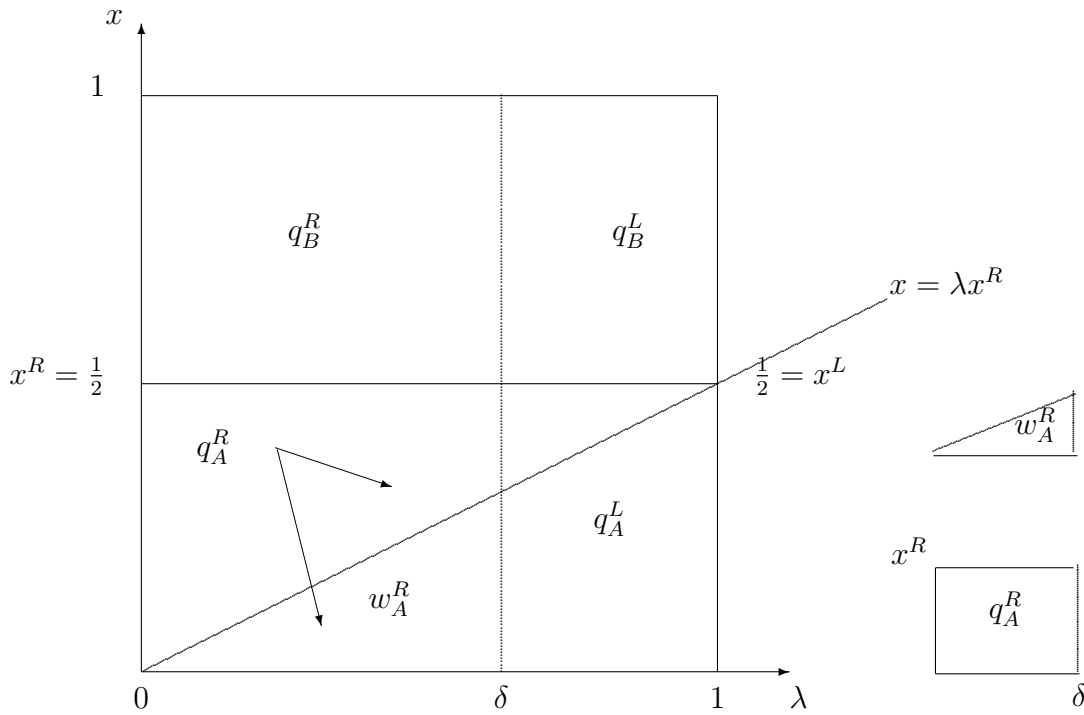


Figure 2: Equilibrium allocation of depositors, and expected withdrawals from risky accounts.

Denote by w_j^R the expected number of those depositors with bank j 's risky accounts who realize a liquidity need in period 2. Formally, in a symmetric equilibrium we have

$$w_A^R = \int_0^\delta \lambda x^R d\lambda, \quad w_B^R = \int_0^\delta \lambda(1 - x^R) d\lambda, \quad \text{hence} \quad w_A^R = w_B^R = \int_0^\delta \frac{\lambda}{2} d\lambda = \frac{\delta^2}{4}. \quad (9)$$

We start by investigating bank A . The expected number of withdrawals from bank A 's risky accounts, w_A^R , is drawn in Figure 2 as the area (triangle) restricted by $x = \lambda x^R$ and $\lambda = \delta$. Next, the number of risky accounts (also equals to the amount of money deposited into risky accounts) is $q_A^R = 0.5\delta$. However, since the banks maintain only a fraction ρ of the funds deposited into risky accounts, only $\rho q_A^R = \rho 0.5\delta$ dollars are available for withdrawal from risky accounts. Therefore, the expected amount of money that can be withdrawn by each depositor who deposits \$1 in bank A 's risky account (similarly bank B) is

$$\theta_A = \theta_B = \begin{cases} \frac{\rho q_A^R}{w_A^R} = \frac{\rho 0.5\delta}{0.25\delta^2} = \frac{2\rho}{\delta} & \text{for } \rho \leq \frac{\delta}{2} \\ 1 & \text{for } \rho > \frac{\delta}{2}. \end{cases} \quad (10)$$

Equation (10) and the utility function (1) imply that there is no benefit from establishing a reserve requirement $\rho > \delta/2$. This means that the regulator's choice of socially optimal reserve ratio, analyzed in Section 4, can be restricted to the interval $[0, \delta/2]$, instead of $[0, 1]$. In particular, the requirement $\rho \leq \delta/2$ means that there is no gain from imposing a reserve requirement in a world with narrow banking (with $\delta = 0$), because under narrow banking all accounts are 100% liquid.

3.3 Equilibrium interest rates and fees

Substituting (10) into (8), the equilibrium interest rates paid on risky accounts are

$$i_A = i_B = \frac{v(\delta - 2\rho) - \tau}{1 - \delta}. \quad (11)$$

Next, substituting (11) into (5) yields the banks' fee levied on each liquid account

$$f_A = f_B = \tau. \quad (12)$$

The equilibrium fees (12) depend only on the location parameter τ since perfectly-liquid accounts are homogenous products on the risk dimension indexed by λ .

The following proposition demonstrates how the equilibrium interest rates and fees given in (11) and (12) are affected by the regulatory instruments and the parameters of the model.

Proposition 1

In a duopoly banking industry where banks compete on interest rates paid on risky accounts, and fees levied on liquid accounts, for every bank $j = A, B$,

- (a) An increase in the degree of competition increases equilibrium interest rates, and reduces equilibrium fees. Formally, $di_j/d\tau < 0$ and $df_j/d\tau = 1 > 0$.*
- (b) An increase in the mandated reserve requirement of risky accounts reduces the equilibrium interest rates paid on risky accounts. Formally, $di_j/d\rho < 0$.*
- (c) Interest rates and fees are invariant with respect to the return on banks' investment, r .*

Proposition 1(a) is rather intuitive, since competition is reduced when τ increases. Thus, equilibrium fees are raised and interest rates lowered in response to an increase in τ . Part (b) demonstrates that those who deposit into a risky account are willing to trade higher reserves for lower interest. In this respect, higher reserves operate in a way which is equivalent to relaxed competition between the banks. Part (c) captures the idea that banks do not transfer any gains from an increase in their investment return r to depositors in the form of higher interest on deposits or lower fees on liquid accounts. This follows from the specified nature of deposit contracts.

4. Regulation and Social Welfare

In this section we approach the climax of our analysis. We characterize the socially optimal combination of the two regulatory instruments: (a) The reserve requirement on risky accounts, ρ^* ; and (b) the mandated maximum fraction of risky accounts, δ^* . In particular, we characterize

the conditions under which it is socially optimal to require that banks maintain a certain fraction of accounts one-hundred percent liquid, meaning that $\delta^* < 1$.

Since the interest rates (i_A and i_B) as well as the fees (f_A and f_B) are transfers between the depositors and the banks, they do not impact on social welfare measured as the sum of depositors' surplus and profit of the banking industry. These transfers are therefore omitted in the calculations below. We define aggregate depositor surplus as the sum of depositors' equilibrium utility levels. From (1), again omitting interest and fees, we have

$$DS \stackrel{\text{def}}{=} 2 \int_0^\delta \int_0^{0.5} [\beta - \tau x + v\theta\lambda] dx d\lambda + 2 \int_\delta^1 \int_0^{0.5} [\beta - \tau x + v\lambda] dx d\lambda, \quad (13)$$

where $\theta = 2\rho/\delta$ by (10). The first term in (13) is the aggregate surplus of depositors with risky accounts (we multiply by "2" to add the utility of depositors with bank B). The second term is the aggregate surplus from liquid accounts (where $\theta_A = \theta_B = 1$ since all deposits are available for withdrawal).

Next, aggregate industry profit (again, net of interest paid to depositors, and fees received from depositors) is $\delta(1 - \rho)r$, which captures the return on the $(1 - \rho)\delta$ dollars deposited by the mass of δ depositors in to risky accounts in all banks combined. Evaluating (13), the regulator chooses ρ and δ to maximize the social welfare

$$\max_{\rho, \delta} W = \frac{4\beta + 2v(1 - \delta^2 + 2\delta\rho) - \tau}{4} + \delta(1 - \rho)r. \quad (14)$$

Differentiating (14) yields

$$\frac{\partial W}{\partial \rho} = \delta(v - r), \quad \text{and} \quad \frac{\partial W}{\partial \delta} = (1 - \rho)r + v(\rho - \delta) = 0. \quad (15)$$

Therefore, for a given δ , the reserve requirement maximizing social welfare is

$$\rho^* = \begin{cases} \frac{\delta}{2} & \text{if } v > r \\ 0 & \text{if } v < r, \end{cases} \quad (16)$$

where the value for the maximal ρ is taken from (10). Substituting (16) into (15) yields

$$\delta^* = \begin{cases} \frac{2r}{r+v} & \text{if } v > r \\ \max\left\{\frac{r}{v}, 1\right\} = 1 & \text{if } v < r \end{cases} \quad \text{hence} \quad \rho^* = \begin{cases} \frac{r}{r+v} & \text{if } v > r \\ 0 & \text{if } v < r. \end{cases} \quad (17)$$

Now, we are ready to state our main proposition.

Proposition 2

(a) If the return on depositors' early withdrawal exceeds banks' investment return, formally if $v > r$, then the socially-optimal reserve requirement and the fraction of risky accounts are given by

$$\rho^* = \frac{r}{r+v} \quad \text{and} \quad \delta^* = \frac{2r}{r+v}.$$

(b) In contrast, if $v < r$ then $\rho^* = 0$ and $\delta^* = 1$.

Proposition 2(b) can be seen as characterizing the circumstances under which the commonly observed risky banking system is socially optimal. In light of Proposition 2(b) the current system with very low reserve requirements seems justified if it holds true that the returns of the investment projects funded by banks exceed those of depositors realizing a liquidity need. This could be the case if the banks offer value-adding inputs, for example, valuable expertise, to the funded projects, and if the credit market frictions are low.

The particular novelty of this paper is the characterization of the opposite case given in Proposition 2(a), which holds for $v > r$. Namely, if the returns of the investment projects funded by banks fall short of depositors' opportunity associated with the realizations of the liquidity needs, the socially optimal policy is for the regulator to require that banks maintain some 100% liquid accounts *in addition* to the imposition of a reserve requirement on risky accounts. This seems to be a natural case, since the return on banks' portfolios are derived from the returns on projects pursued by individuals.

Proposition 2(a) states the condition under which the current banking system where banks do not offer any perfectly-liquid accounts to depositors is *inefficient*. Under this condition, social welfare is maximized when commercial banks *segment* depositors according to their privately known probability of realizing liquidity needs. Under this regulation, Figure 2 illustrates that depositors with high probabilities ($\lambda > \delta^*$) of realizing liquidity needs will choose to pay higher fees and have their banks maintain 100% reserves on their funds. In addition, depositors with low probabilities of realizing liquidity needs ($\lambda \leq \delta^*$) will choose to open the now commonly observed risky accounts subjected to a ρ^* reserve requirement.

Clearly, the mechanism analyzed in this paper can be extended to cover banking industries offering a spectrum of deposit contracts offering different degrees of liquidity. No matter how complete this spectrum is, the basic mechanism highlighted in this paper holds true. Namely, the introduction of perfectly liquid accounts will improve welfare as the implied liquidity segmentation makes it possible to sustain price discrimination, whereby the costs of liquidity-providing regulation are carried only by the depositors with a sufficiently high probability of facing a liquidity need.

5. Conclusion

Our paper points out the social inefficiency implied by the feature that the present regulatory design of the banking system rules out perfectly liquid and safe banking as a financial product. In the absence of this financial product banks have an incentive to bundle the deposit activities with their risk taking.

In this article we have extended the set of instruments for regulating banks' liquidity provision by adding the fraction of perfectly-liquid accounts as an additional regulatory instrument. We have demonstrated how the presence of this added instrument will induce self-selection on behalf of the depositors, who are differentiated according to their probability of facing a liquidity shock. This self-selection will lead to a market segmentation, which can break the bundling of deposits with risk and thereby enhance welfare. In this respect our analysis characterized those circumstances under which the addition of perfectly-liquid deposit accounts could represent a Pareto improvement relative to a banking industry where risky accounts represent the only channel whereby consumers can enjoy the financial services offered by the banks.

We derived the socially optimal regulatory policy when the set of policy instruments includes the fraction of perfectly-liquid accounts in addition to the traditional reserve requirements applied on risky accounts. The optimal policy was explicitly characterized as a function of banks' investment return and the return of depositors realizing a liquidity shock. In particular, we outlined the conditions under which the currently applied policy of applying only reserve requirements or under which a system with extreme narrow banking would be optimal.

Our analysis has ignored the widely observed system of deposit insurance for the simple reason that the benchmark for optimal regulation should always be characterized without any additional distortions of banks' incentives for maintaining liquidity to meet the potential needs of depositors. Once deposit insurance is introduced, banks have no incentives to compete with respect to liquidity provision, since liquidity is then guaranteed within the framework of this insurance system. The present model can, with fairly minor and straightforward modifications, be extended to so as to make possible to compare deposit insurance systems with systems incorporating a mandated fraction of perfectly liquid deposit accounts.

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