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RESEARCH ARTICLE

Banks, markets, and efficiency

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Abstract A competitive financial system can help reduce banks' monopoly power and the associated inefficiencies. However, according to Diamond (J Polit Econ 105: 928–956, 1997) and Fecht (J Eur Econ Assoc 6(2), 2004) competition with the financial sector may also constrain the amount of liquidity insurance that banks can provide to households affected by unobservable idiosyncratic liquidity shocks. To study this trade-off, we model competition between banks and between banks and financial markets. Our analysis shows that competition between banks and financial markets can constrain the risk-sharing offered by deposit contracts. This effect is the same if competition between banks mainly affects the reallocation of deposits. However, if banking competition primarily affects new deposits, then such competition only limits inefficient monopoly rents without restraining risk-sharing.

Keywords Banks · Financial markets · Risk-sharing · Competition

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1 Introduction

This paper analyzes a model in which banks compete for depositors against each other and against a financial sector. We address the question of whether better access to financial markets by households improves welfare. Our study considers a financial system in which banks compete with each other for private households' funds as well as a financial system in which there is little competition between banks.

In our model, regional monopolistic banks offer deposit contracts to local households. As in Diamond and Dybvig (1983), these contracts provide liquidity insurance to households that face uncertain intertemporal consumption preferences. As in Diamond (1997) and Fecht (2004), the degree of liquidity insurance that deposit contracts can offer is constrained by households' financial market access. Liquidity insurance implies an ex post redistribution of resources from patient to impatient depositors. Access to financial markets provides patient depositors with an ex post option to withdraw from this insurance scheme. Thus, the larger the costs of accessing the financial market, the greater the scope of banks for providing liquidity insurance.

Our model considers the possibility that competition between banks may also constrain the liquidity insurance that a deposit contract can provide. We show that if depositors can move their funds from one bank to another after they observe their preference shock, competition between banks will impose the same constraint as competition with the financial market. Hence, we generalize a result by Diamond (1997) and Fecht (2004), based on Jacklin (1987), and show that competition between banks can also limit risk-sharing.

In contrast to previous approaches, we assume that banks have local monopoly power that allows them to earn rents.[1] These rents are associated with welfare losses. This association might be viewed, for instance, as a shortcut for the managerial moral hazard that arises in the relationship between the equity owners of a bank and the bank's management. The higher the monopoly rents of banks (and therefore the lower the debt-equity ratio) the more severe this moral hazard problem becomes and the higher the associated inefficiencies become.[2] Improved access to the financial market by depositors as well as more intense competition between banks can reduce monopoly rents, thus reducing managerial moral hazard at banks. Consequently, competition in the financial sector leads to a trade-off: It can reduce risk-sharing but can also limit inefficient monopoly rents. We derive the degree of competition in the financial sector that optimizes this trade-off.

However, this trade-off is found to depend on the nature of competition between banks. Empirical studies report that depositors face obstacles to changing banks and

[1] See von Thadden (1999) for a detailed survey of the various approaches that allow for a coexistence of a financial market and a deposit-taking bank that provides liquidity insurance.

[2] See Harris and Raviv (1990) and Aghion and Bolton (1992), who model the disciplining role of debt.

rarely do so.[3] Thus, competition between banks for new deposits seems to be particularly intense. But, as our model shows, such competition reduces monopoly rents without limiting risk-sharing. Consequently, if competition between banks is intense enough, banks' monopoly rents are contained, and improved access to financial markets always reduces welfare because it only limits risk-sharing without any beneficial reduction of monopoly rents.

Thus, our results suggest that better access to financial markets may improve welfare in a financial system characterized by insufficient competition for new deposits between banks. In contrast, in a financial system with strong competition, better access to financial markets reduces welfare by restraining the available risk-sharing in the economy.

Related Literature Apart from Diamond (1997), few papers analyze the interplay between competition in the financial sector for households' funds and the liquidity insurance provided by banks' deposit contracts. von Thadden (1997) introduces to the Diamond and Dybvig (1983) framework an additional long-term asset that has a different term structure—i.e., a different maturity risk. He shows that if banks' deposit contracts can provide households with more insurance against maturity risk than direct investments can, then deposit contracts can also offer some degree of liquidity insurance even if households have perfectly efficient access to financial markets. Extending the model to continuous time von Thadden (1998), shows that if households are sufficiently risk-averse, then the demand for maturity risk insurance enables banks to offer incentive-compatible deposit contracts that provide the optimal degree of liquidity insurance even if households can efficiently invest directly in financial markets. Although they provide a very detailed focus on the effect of competition between banks and direct financial market investments on liquidity provision, all of these approaches assume perfect competition for new depositors but infinitely large costs of switching between banks. Carletti et al. (2007) analyze the effect of bank mergers on liquidity provision. They show that a bank merger (owing to the economies of scale in liquidity provision) will increase aggregate liquidity if ex post refinancing in the interbank market is expensive relative to ex ante financing through deposits. However, in their paper, changes in competition are associated only with intensifying competition in the loan market. The authors neither analyze the aggregate liquidity effect of increasing competition among banks for deposits nor study the impact of intensifying competition between banks and financial market investments on the provision of liquidity. Thus, in contrast to previous studies, our paper considers competition between banks and financial markets as well as competition within the banking sector for deposits and analyzes the impact on liquidity provision and ultimately welfare.

[3] For the US, Kiser (2002), for instance, reports that switching costs have a significant impact on a household's decision to change its bank, in particular, households of certain income classes. Kiser (2002) also shows that these costs substantially reduce the price sensitivity of switching decisions such that households ultimately only switch when they migrate. See also Sharpe (1997), who shows that switching costs are an important determinant of the pricing of consumer deposits. Gondat-Larralde and Nier (2004) and Rhoades (2000) also point out the significance of switching costs in the retail deposit market.

The remainder of our paper is organized as follows. Section 2 describes the basic model. In Sect. 3, we derive the optimal financial market access given that banks are local monopolists. In Sect. 4, we allow for competition among banks from different regions. Section 5 derives the optimal financial structure for a given degree of competition from the market and from other banks. Section 6 concludes.

2 The model

The economy consists of $N + 1$ regions and takes place at three dates, denoted by $t = 0$, 1, and 2. The first N regions contain one bank and a continuum of mass 1 of households. The last region contains a bank, but no depositors. This bank, which we call the non-local bank, can only have depositors if it attracts them from other regions. There are also a large number of entrepreneurs and an infinite number of crooks in the economy.

Households are endowed with one unit of the only consumption good in the economy at date 0. At this date, households do not know whether they want to consume at date 1 or 2. They only know that at date $t = 1$ they will learn whether they are patient or impatient. A household will turn out to be impatient with probability q, in which case it only derives utility from consumption at date 1. With probability $(1-q)$, the household will turn out to be patient, in which case it only derives utility from consumption at date 2. The expected utility of a household from consuming c_t with $t = 1, 2$ can be written as

$$U\left(c_1, c_2\right) = \begin{cases} u\left(c_1\right) & \text{with probability } q, \\ u\left(c_2\right) & \text{with probability } 1 - q. \end{cases} \tag{1}$$

As is standard, we assume that the fraction of impatient households in each region is given by q as well. The intratemporal utility function is assumed to display constant relative risk-aversion: $u(c_t) = \frac{1}{1-\alpha} c_t^{1-\alpha}$, with $\alpha > 1$.

There are two technologies in this economy. The storage technology returns 1 unit of goods at date t; for each unit invested at $t - 1$, $t = 1, 2$. The long-term technology is operated by the entrepreneurs. It returns R units of goods at date 2 for each unit invested at date 0. Entrepreneurs sell claims on their future returns in the date 0 financial market. Since funds are scarce, competition ensures that entrepreneurs receive 1 unit of funds at date 0 for claims promising a return R at date 2. The long-term technology can also be liquidated at date 1, in which case it returns $r < 1$. Crooks have no investment technology available but can pretend to be entrepreneurs, write fake claims promising a repayment of R at date 2, and consume any provided funds. Unsophisticated households cannot distinguish crooks from real entrepreneurs. When making a long-term investment, they finance a crook with probability $p \approx 1$ and do not receive any return. Sophisticated households are able to effectively screen their counterparties. Thus, they will only finance entrepreneurs who can repay R at $t = 2$. The table below summarizes these investment alternatives.

	$t=0$	$t=1$	$t=2$
Storage			
	-1	$+1$	0
	0	-1	$+1$
Long-term investment			
If finished			
screened	-1	0	R
unscreened	-1	0	0
If liquidated	-1	r	0

At date 1, long-term claims can be traded against consumption goods in a centralized asset market. Crooks also try to sell fake claims in this secondary market, and unsophisticated households are not able to identify these claims. Thus, only sophisticated households have an incentive to buy assets in the secondary market.

Households choose whether or not to become sophisticated at date 0 before they invest. In order to become sophisticated, a household must pay a cost $(1-m)$ for each unit of wealth. In addition to investing directly in the financial market, households can deposit their funds with banks. Banks are able to screen investments at no cost, so they always realize a return R when investing in long-term assets.[4]

Banks offer households a deposit contract. The contract specifies an amount, d_1, that depositors receive if they withdraw at $t = 1$, and an amount, d_2, that they receive if they keep their deposits until $t = 2$, for each unit deposited at $t = 0$.[5] Because becoming sophisticated allows households to invest directly in the financial market, rather than through banks, we say that the competition between banks and the financial market is more intense when the cost of becoming sophisticated is low.

We also consider competition between banks. Such competition could occur at date 0, in which case it affects new deposits, or at date 1, in which case it affects old deposits that are moved from one bank to another. To deposit in a bank from another region at date 0, households must pay a cost $(1-k)$ for each unit of wealth. Besides physical transportation costs, $(1-k)$ can be thought of as the cost of ensuring the legitimacy of the bank in the other region.

To withdraw at date 1 and redeposit in a bank from another region, households must pay a cost $(1-b)$ for each unit of wealth. For tractability, the cost $(1-b)$ must be proportional to wealth. This assumption also simplifies the comparison between the different costs. The cost of redepositing at date 1 has a similar interpretation as the cost of investing in the financial market: a cost of becoming sophisticated or planning ahead so that redepositing is not too disruptive. In addition, $(1-b)$ may include

[4] We assume that banks can screen at no cost to simplify the notation. The assumption that banks also have to invest in their ability to screen does not change our results as long as their screening costs are lower than households' screening costs and are offset by banks' monopoly rents.

[5] We assume that a bank can only offer one deposit contract to all of its depositors; it cannot offer deposit contracts contingent on the depositor's wealth. This means that a bank cannot offer sophisticated and unsophisticated depositors a different repayment. This assumption reflects the fact that in reality households' initial endowments vary for many reasons and cannot serve as a good signal of whether or not a household has invested in becoming sophisticated.

switching costs in the sense that planning ahead for the possibility of redepositing enables households to make switching costs negligible. In contrast, households that did not plan ahead face prohibitively high switching costs. Switching costs could be high for “behavioral” reasons.

Before banks determine deposit contracts, the right to run the different regional banks has to be allocated. There are B potential bank managers with $B > N$. They compete for the licenses to run regional banks. The bank managers can only promise to distribute a certain profit to households, they cannot commit to offering a certain deposit contract when competing for a license. Thus, licenses will be allocated to those bank managers who promise to distribute the highest profits to households. But bank managers can only realize the maximum feasible profit Π if they expend some effort. Without effort, the monopoly rent will only amount to $\delta\Pi$ with $\delta < 1$. The actual effort expended by the bank manager is not verifiable and therefore cannot be required in a contract. Bank managers' disutility from effort is assumed to always be higher than the utility from keeping a fraction $(1 - \delta)$ of the profits. Consequently, the maximum profit of local banks that can be credibly promised to households and that will actually be realized is $\delta\Pi$.[6] We assume that banks profits are distributed to households. However, households need not deposit in a given bank to claim their share of profits.

3 No bank competition at date 0

In this section, we study the problem of a bank that does not face a competitive threat from other banks at date 0; i.e., $k = 0$. The local bank's monopoly position at date 0 is challenged only by the ability of households to invest directly in the centralized financial market. However, the bank must take into account the fact that its depositors can withdraw at date 1 and either invest in the financial market or redeposit in another bank.

3.1 Date 1 competition: an equivalence result

We show that, at date 1, competition between banks and competition between the financial market and banks have the same effect. This will allow us to consider competition at date 1 without specifying whether it arises from banks or the market.

First, we show that the price of claims on the productive technology in the secondary market at date 1 is determined by arbitrage.

[6] There are several other explanations for why monopoly rents might lead to inefficiencies and why the profits cannot be distributed entirely to households. For instance, we could relate this managerial moral hazard problem to the return on the long-term investment technology and assume that only a certain fraction of R would be realized if bank managers did not exert full effort. This would probably be more convincing but would complicate the analysis without qualitatively changing the result. Moreover, there are several other explanations for the inefficiencies that we assume to be associated with the monopoly rent of banks and the debt-equity relationship. See, for instance, Harris and Raviv (1990) and Aghion and Bolton (1992). As usual in principal-agent problems, we assume that it is impossible to punish bank managers who do not realize a promised profit.

Lemma 1 *The price of claims on the productive technology in the date 1 financial market is 1.*

Proof We show that assuming a price different than 1 must lead to a contradiction.

Suppose the price of claims is $p < 1$, and compare the return to investing one unit in the storage and the productive technology. One unit invested in the storage technology at date 0 returns one unit of goods at date 1, or it can be exchanged for $1/p$ claims on the productive technology for a return of $R/p > R$ at date 2. One unit invested in the productive technology at date 0 can be exchanged for $p < 1$ units of goods at date 1, or it can be held to maturity for a return of R. Hence, the return to investing in storage at date 0 is higher both at date 1 and at date 2, and all agents that trade on the financial market prefer to invest in storage. However, if there is no investment in the productive technology, $p < 1$ cannot be an equilibrium price. A symmetric argument shows that $p > 1$ cannot be an equilibrium price. □

The next proposition shows that the effect of competition with the financial market is the same as the effect of competition between banks at date 1. Let $\{d_1; d_2\}$ denote the contract offered by the bank and M denote the wealth of a household at date 0, which is given by the household's endowment as well as the value of its share of the bank's profits: $M = 1 + \delta\Pi$.

Proposition 2 *If $b = m$, the effect of competition between banks at date 1 is the same as the effect of competition between a bank and the financial market at date 1.*

Proof We prove the proposition by showing that the constraints imposed by both types of competitions are the same. First, consider the case where $d_1 \geq 1$. Here, all agents deposit their wealth in the local bank at date 0. Patient depositors can withdraw from their banks at date 1 and invest in the financial market. Since claims on the productive technology have a return of R at date 2, sophisticated depositors can obtain consumption Rd_1 at date 2 if they withdraw their deposits and invest in the financial market. We show below that $Rd_1 > d_2$ whenever banks offer some liquidity insurance. Hence, depositors choose to become sophisticated if

$$qu\left(d_1 mM\right) + (1-q)\,u\left(Rd_1 mM\right) \geq qu\left(d_1 M\right) + (1-q)\,u\left(d_2 M\right). \tag{2}$$

Given the assumed intratemporal utility function, this can be simplified to

$$\chi_m\left[qu\left(d_1 M\right) + (1-q)\,u\left(Rd_1 M\right)\right] \geq qu\left(d_1 M\right) + (1-q)\,u\left(d_2 M\right), \tag{3}$$

with $\chi_m = m^{1-\alpha}$.

Patient depositors can also withdraw from their bank at date 1 and redeposit at another bank. Since the non-local bank does not have any depositors, it will offer a contract that maximizes potential depositors' utility. At date 1, the non-local bank can promise depositors at most Rd_1 for a deposit of d_1. Indeed, since $k = 0$, the non-local bank has no other resources and can only invest the deposit it receives at date 1 in the financial market. Depositors choose to bear the switching costs if

$$qu\left(d_1 bM\right) + (1-q)\,u\left(Rd_1 bM\right) \geq qu\left(d_1 M\right) + (1-q)\,u\left(d_2 M\right). \tag{4}$$

Again, this can be simplified to

$$\chi_b \left[qu\left(d_1 M\right) + (1-q)\, u\left(Rd_1 M\right)\right] \geq qu\left(d_1 M\right) + (1-q)\, u\left(d_2 M\right), \tag{5}$$

with $\chi_b = b^{1-\alpha}$ due to the specific intratemporal utility function assumed here. Thus, in the case where $d_1 \geq 1$, if $\chi_b = \chi_m$ then both constraints are the same.

Now consider the case where $d_1 < 1$. Agents that become sophisticated can invest directly in a portfolio of storage and long-term assets. Their expected utility is $qu\,(mM) + (1-q)\,u\,(RmM)$. It is incentive-compatible to become sophisticated if

$$\chi_m \left[qu\left(M\right) + (1-q)\, u\left(RM\right)\right] \geq qu\left(d_1 M\right) + (1-q)\, u\left(d_2 M\right). \tag{6}$$

Agents also have the option to pay a cost allowing them to deposit in a bank from another region at date 1. Since $d_1 < M$, agents that choose to pay that cost will hold liquidity at date 0, and invest the proceeds in the non-local bank if they turn out to be patient. The resulting expected utility is $qu\,(bM) + (1-q)\,u\,(RbM)$. It is incentive-compatible to pay that cost if

$$\chi_b \left[qu\left(M\right) + (1-q)\, u\left(RM\right)\right] \geq qu\left(d_1 M\right) + (1-q)\, u\left(d_2 M\right). \tag{7}$$

Thus, in the case where $d_1 < 1$ as well, if $\chi_b = \chi_m$, both constraints are the same. □

Hence, if the costs associated with redepositing are smaller than the costs of direct market access, $(1-b) < (1-m)$, so that $\chi_m > \chi_b$, depositors prefer changing banks at date 1, rather than investing in the centralized financial market. Otherwise, depositors prefer to invest in the financial market rather than redeposit in another bank. Competition at date 1 will thus depend on $\chi \equiv \min\{\chi_b, \chi_m\}$.

Empirical evidence suggests that households rarely change banks (see, for example, Gondat-Larralde and Nier 2004; Rhoades 2000; Kiser 2002). This result could be attributable to high resource costs of switching or for other, "behavioral," reasons. Based on this evidence, for the remainder of our paper we prefer to interpret χ as the cost of direct access to the market. However, nothing about the theory requires this interpretation.

Note also that the results in our paper would be consistent with a model in which a cost of redepositing is borne only by patient depositors, provided that this cost is high enough for households to choose not to redeposit. Again, this appears to be consistent with available empirical evidence.

3.2 The profit-maximizing deposit contract

The deposit contract $\{d_1; d_2\}$ offered by the bank maximizes profits subject to a number of constraints.[7] First, the deposit contract must ensure that households prefer to deposit

[7] As usual in this kind of model, there are multiple equilibria. Our paper focuses on the good equilibrium and leaves the study of bank panics in this context to future research. Skeie (2008) argues that bank runs cannot arise in modern banking systems. Also, Martin (2006) shows that the appropriate lender-of-last-resort policy can prevent bank runs.

their funds with the bank rather than invest in the storage technology if they decide to remain unsophisticated. This participation constraint, denoted by (PC_N), is given by

$$qu(d_1 M) + (1-q)u(d_2 M) \geq u(M). \tag{8}$$

In addition, the optimal deposit contract must also provide an incentive for households not to become sophisticated and invest directly in the financial markets. As noted above, the price in the centralized financial market in $t = 1$ of a claim against the corporate sector that pays R in $t = 2$ is always 1. Consequently, the constraint that households remain unsophisticated, denoted by (PC_S), can be written as

$$qu(d_1 M) + (1-q)u(d_2 M) \geq \chi[qu(M) + (1-q)u(RM)]. \tag{9}$$

Note that, in principle, sophisticated households could also deposit their wealth in the bank at date 0, withdraw at date 1, and invest d_1 in the financial market if they turn out to be patient. Sophisticated households would choose this option if

$$\chi[qu(M) + (1-q)u(RM)] < \chi[qu(d_1 M) + (1-q)u(Rd_1 M)], \tag{10}$$

which obviously only holds if $d_1 > 1$. As shown in the appendix, the monopolistic deposit contract always satisfies $d_1 \leq 1$, so (PC_S) is the relevant constraint.[8]

For the sake of completeness, we include the incentive-compatibility constraint $d_1 \leq 1$ in the problem below and denote it by (IC_S).

The profit-maximizing deposit contract is also subject to another incentive-compatibility constraint, denoted by (IC_N), which ensures that unsophisticated households will not withdraw if they turn out to be patient. This is the case if $d_2 \geq d_1$. This constraint never binds.

The deposit contract offered by a monopolistic bank thus solves

$$(P1)\begin{cases} \max\limits_{d_1;d_2} M - qd_1 M - (1-q)\frac{d_2}{R}M, \\ \text{s.t.} \quad (PC_N), (PC_S), (IC_N), (IC_S). \end{cases}$$

We denote by $\{d_1^m; d_2^m\}$ the deposit contract that solves $(P1)$.

We can now completely characterize the deposit contract offered by a regional bank. Comparing (PC_S) and (PC_N) shows that if the cost χ of becoming sophisticated is above the threshold level

$$\bar{\chi} = \frac{1}{q + (1-q) \cdot R^{1-\alpha}}, \tag{11}$$

[8] In this paper, sophisticated households never withdraw their deposits to buy claims against the corporate sector in the financial market because banks offer their deposit contracts before households decide whether to become sophisticated. This allows banks to offer households contracts that make them indifferent between becoming sophisticated or not. We assume that households remain unsophisticated when they are indifferent. Nevertheless, the cost of access to the financial markets does constrain the deposit contract offered by the banks. In contrast, Fecht et al. (2008) assume that competitive banks must choose a deposit contract at the same time that households decide to become sophisticated. Under this assumption, some households choose to become sophisticated and invest in the financial market at date 1.

households remain unsophisticated even if they do not plan to deposit in the bank (see the appendix for the derivation of $\bar{\chi}$). In that case, (PC_N) is the only binding constraint. If $\chi \leq \bar{\chi}$, households become sophisticated if they do not plan to deposit their funds with the regional bank. In that case, (PC_N) is never binding. If $\chi \in \left[\underline{\chi}, \bar{\chi}\right)$, where $\underline{\chi}$ is given by

$$\underline{\chi} = \frac{q + (1-q) \cdot R^{(1-\alpha)/\alpha}}{q + (1-q) \cdot R^{1-\alpha}}, \tag{12}$$

then $d_1 < 1$ and the optimal deposit contract maximizes profits subject to (PC_S) only (details of the derivation of $\underline{\chi}$ are provided in the appendix). If the cost of becoming sophisticated is even lower, so that $\chi \in \left[1, \underline{\chi}\right)$, then $d_1 = 1$ and (IC_S) holds with equality.

We derive the deposit contract offered by the bank for each case in turn. If $\chi \in [\bar{\chi}, \infty)$, the deposit contract offered by the monopolistic bank is given by

$$\left\{d_1^m; d_2^m\right\} = \left\{\left(\frac{1}{q + (1-q)R^{(1-\alpha)/\alpha}}\right)^{\frac{1}{1-\alpha}}; \left(\frac{R^{(1-\alpha)/\alpha}}{q + (1-q)R^{(1-\alpha)/\alpha}}\right)^{\frac{1}{1-\alpha}}\right\}. \tag{13}$$

The degree of risk-sharing provided by this contract is $d_2^m = R^{1/\alpha} d_1^m$. It can be shown that this is the optimal degree of risk-sharing that would also be provided by a social planner. This degree of risk-sharing optimally trades off the return difference of the long- and short-term investment technology against the difference in the marginal utility of patient and impatient depositors. Since this contract is independent of χ, the monopolist deposit contract is the same for all $\chi \in [\bar{\chi}, \infty]$.

If $\chi \in \left[\bar{\chi}, \underline{\chi}\right)$, the equilibrium deposit contract is given by

$$\left\{d_1^m; d_2^m\right\} = \left\{\left(\frac{q + (1-q)R^{1-\alpha}}{q + (1-q)R^{(1-\alpha)/\alpha}}\chi\right)^{\frac{1}{1-\alpha}}; \left(\frac{q + (1-q)R^{1-\alpha}}{q + (1-q)R^{(1-\alpha)/\alpha}}\chi\right)^{\frac{1}{1-\alpha}} R^{1/\alpha}\right\}. \tag{14}$$

The degree of risk-sharing provided by this contract is also $d_2^m = R^{1/\alpha} d_1^m$. The degree of risk-sharing remains the same for all $\chi \in \left[\bar{\chi}, \underline{\chi}\right)$. However, the level of repayment on deposit contracts offered by the monopolistic bank changes with χ in that interval.

Finally, if $\chi \in \left[1, \underline{\chi}\right)$, the optimal deposit contract is given by

$$\left\{d_1^m; d_2^m\right\} = \left\{1; \left[\frac{\chi[q + (1-q) \cdot R^{1-\alpha}] - q}{(1-q)}\right]^{1/(1-\alpha)}\right\}. \tag{15}$$

Indeed, the contract is determined by $d_1 = 1$ and

$$q \cdot u(M) + (1-q) \cdot u(d_2 \cdot M) = \chi \left[q \cdot u(M) + (1-q) \cdot u(R \cdot M)\right].$$

The degree of risk-sharing offered by this contract is

$$\Theta = \left[\frac{\chi[q + (1-q)\cdot R^{1-\alpha}] - q}{(1-q)}\right]^{1/(1-\alpha)}. \tag{16}$$

Thus, when $\chi \in \left[1, \underline{\chi}\right]$, a decrease in χ not only increases the average repayments to households, and therefore their expected utility, but also changes the degree of liquidity insurance, Θ, provided by the deposit contract. The threat of becoming sophisticated and investing directly in the market not only forces banks to repay more. Since a higher short-term repayment on deposits makes it particularly attractive for households to become sophisticated, the lower costs of becoming a sophisticated investor also distort the liquidity insurance that banks provide in that case.

Proposition 3 *If $\chi < \bar{\chi}$, a reduction in the cost of becoming a sophisticated investor improves the outside option of households. Therefore, the bank increases the repayment level on deposits. However, if $\chi < \underline{\chi}$, a reduction in the cost of becoming sophisticated constrains the degree of risk-sharing that is provided by the deposit contract.*

Proof If $\chi < \bar{\chi}$, then Eqs. (14) and (15) show that d_1 is weakly decreasing in χ and d_2 is strictly decreasing in χ. If $\chi < \underline{\chi}$, then Eq. (15) shows that risk-sharing decreases as χ decreases. □

3.3 Equilibrium monopoly rent and households' wealth

The monopoly rent a bank could realize with the full effort of the bank manager is given by

$$\Pi = M - qd_1M - (1-q)\frac{d_2}{R}M. \tag{17}$$

For different values of χ, we can substitute the relevant value of d_1 and d_2 in this equation to obtain an expression for the maximum realizable profits.

Once again, we consider each case in turn. If $\chi \in [\bar{\chi}, \infty)$, the monopoly rent is

$$\Pi = M - qAM - (1-q)AMR^{(1-\alpha)/\alpha}, \tag{18}$$

where

$$A = \left(\frac{1}{q + (1-q)R^{(1-\alpha)/\alpha}}\right)^{\frac{1}{1-\alpha}}.$$

Rearranging yields

$$\Pi = \left(1 - \left(q + (1-q)R^{(1-\alpha)/\alpha}\right)^{\alpha/(\alpha-1)}\right)M. \tag{19}$$

Details are provided in the appendix. In this interval, the monopoly rent is independent of χ.

If $\chi \in \left[\underline{\chi}, \bar{\chi}\right)$, the monopoly rent is given by

$$\Pi = (1 - A^{\alpha} \cdot B \cdot \chi^{\frac{1}{1-\alpha}})M, \tag{20}$$

where $B = \left(q + (1-q)R^{1-\alpha}\right)^{\frac{1}{1-\alpha}}$. Details are provided in the appendix. In this interval, a reduction in χ leads to a higher level of repayments on the deposit contract, which brings about a lower monopoly rent.

Finally, if $\chi \in [1, \underline{\chi})$, the monopoly rent is given by

$$\Pi = \left(1 - R^{-1}\left(\frac{\chi[q + (1-q)R^{(1-\alpha)}] - q}{(1-q)}\right)^{1/(1-\alpha)}\right)(1-q)M. \tag{21}$$

Details are provided in the appendix. In this interval as well, a decrease in χ increases the outside option of households, forcing the bank to increase the level of repayment on the deposit contract. Thus, a decrease in χ reduces the monopoly rent in this case too.

Proposition 4 *If $\chi < \bar{\chi}$, in which case becoming sophisticated and investing directly in the financial market is the relevant alternative for households, a decrease in χ reduces the monopoly rent of banks.*

Proof The proof follows from Eqs. (20) and (21). □

As noted above, the wealth of each household is given by its endowment, normalized to 1, and the payout of the actual profits $\delta\Pi$ the bank manager realizes without expending effort. Hence,

$$M = 1 + \delta\Pi. \tag{22}$$

For different values of χ, inserting the relevant value of Π into the above equation yields the households' equilibrium wealth.

If $\chi > \bar{\chi}$, the monopoly profits are given by Eq. (19). Substituting this expression into Eq. (22) yields

$$M = \frac{1}{1 - \delta \cdot (1 - \left(q + (1-q) \cdot R^{(1-\alpha)/\alpha}\right)^{\alpha/(\alpha-1)})}. \tag{23}$$

If $\chi \in \left[\underline{\chi}, \bar{\chi}\right)$, households' initial wealth is given by

$$M = \frac{1}{1 - \delta(1 - A^{\alpha} \cdot B \cdot \chi^{-1/(\alpha-1)})}. \tag{24}$$

Obviously, given the participation of households in banks' profits, lower profits attributable to lower costs of becoming sophisticated reduce the initial wealth of households.

Similarly, in the case where $\chi \in [1, \underline{\chi})$, a reduction in monopoly rents lowers households' initial wealth, which is given by

$$M = \frac{1}{1 - \delta \left(1 - R^{-1} \left(\frac{\chi[q+(1-q)R^{(1-\alpha)}]-q}{(1-q)}\right)^{-1/(\alpha-1)}\right)(1-q)}. \tag{25}$$

Proposition 5 *If $\chi < \bar{\chi}$, in which case becoming sophisticated and investing directly in the financial market is the relevant alternative for households, a decrease in χ reduces the initial wealth of households.*

Proof The proof follows from Proposition 4 and Eq. (22). □

3.4 Households' welfare and the optimal χ

This section considers how χ affects welfare. In particular, we show that welfare is not monotone in χ and there is an optimal value of χ denoted by χ^*. First, we show that if χ is high enough, then a change in the value of χ does not affect welfare.

Proposition 6 *If $\chi \in [\bar{\chi}, \infty]$, changing χ does not affect welfare.*

Proof From Eqs. (13), (19), and (23), we know that if $\chi \in [\bar{\chi}, \infty]$, then a change in χ does not affect the deposit contract offered by the bank, the monopoly rent of banks, or the wealth of households. Hence, welfare is unaffected. □

The expected utility for households is lowest when $\chi \in [\bar{\chi}, \infty]$. In this case, χ is so large that households never choose to become sophisticated. Instead, households would prefer to invest only in the storage technology. Next, we consider the case where $\chi \in \left[\underline{\chi}, \bar{\chi}\right)$.

Proposition 7 *If $\chi \in \left[\underline{\chi}, \bar{\chi}\right)$, a reduction in χ increases welfare.*

Proof In this interval, the expected utility of a household is given by

$$E\left[U\left(d_{1;}d_2\right)\right] = \left(q + (1-q)R^{1-\alpha}\right)\frac{M^{1-\alpha}}{1-\alpha}\chi. \tag{26}$$

Recall that M is a function of χ. Differentiating with respect to χ yields

$$\frac{\partial E\left[U\right]}{\partial \chi} = -\left(q + (1-q)R^{1-\alpha}\right)\frac{M^{2-\alpha}}{\alpha - 1}(1-\delta) < 0, \tag{27}$$

with details provided in the appendix. □

Reducing the cost of access to the financial market is always welfare-improving in that interval because it only reduces the monopoly rent of banks and thereby limits the inefficiencies associated with these rents. Two effects are in play: On the one hand, the monopolistic bank has to increase the repayment on the deposit contract, improving households' expected utility. On the other hand, a higher repayment on deposits squeezes the monopoly rent of banks and thereby reduces households' wealth. The first effect always dominates, however.

The most interesting case is when $\chi \in \left[1, \underline{\chi}\right)$. here, the amount of the liquidity insurance provided by the deposit contract is reduced when χ decreases, reducing household welfare. Consequently, decreasing χ generates a trade-off between the reduction in monopoly rent and the reduction in risk-sharing. The optimal value χ^* balances both costs.

Proposition 8 $\chi^* \in \left[1, \underline{\chi}\right)$. *If* $\chi \in \left[1, \chi^*\right]$, *a reduction in* χ *strictly decreases welfare.*

Proof If $\chi \in \left[1, \underline{\chi}\right)$, then the expected utility of households is

$$E\left[U\right] = \left[q + (1-q)\,\Theta^{1-\alpha}\right]\frac{M^{1-\alpha}}{1-\alpha}.$$

To solve for the optimal value of χ, we first find the value of Θ that maximizes households' expected utility and then back out the corresponding value of χ. The optimal Θ is a solution to

$$\frac{\partial E\left[U\right]}{\partial \Theta} = (1-q)\,\Theta^{-\alpha}M^{1-\alpha} + \left[q + (1-q)\,\Theta^{1-\alpha}\right]M^{-\alpha}\frac{\partial M}{\partial \Theta} = 0. \tag{28}$$

The expressions for the initial wealth of households and its derivative are given by

$$M = \frac{1}{1-\delta(1-q)\left(1-R^{-1}\Theta\right)},$$
$$\frac{\partial M}{\partial \Theta} = -\frac{\delta(1-q)R^{-1}}{\left[1-\delta(1-q)\left(1-R^{-1}\Theta\right)\right]^2}.$$

Substituting for these in Eq. (28) and rearranging yields

$$\Theta^* = \left(\frac{1-\delta+\delta\cdot q}{\delta\cdot q}\cdot R\right)^{1/\alpha}, \tag{29}$$

with details provided in the appendix. According to Eq. (16), it follows that the optimal χ is

$$\chi^* = \frac{(1-q)\left(\frac{\delta\cdot q}{1-\delta+\delta\cdot q}\right)^{(\alpha-1)/\alpha}R^{(1-\alpha)/\alpha} + q}{(1-q)R^{(1-\alpha)} + q}. \tag{30}$$

□

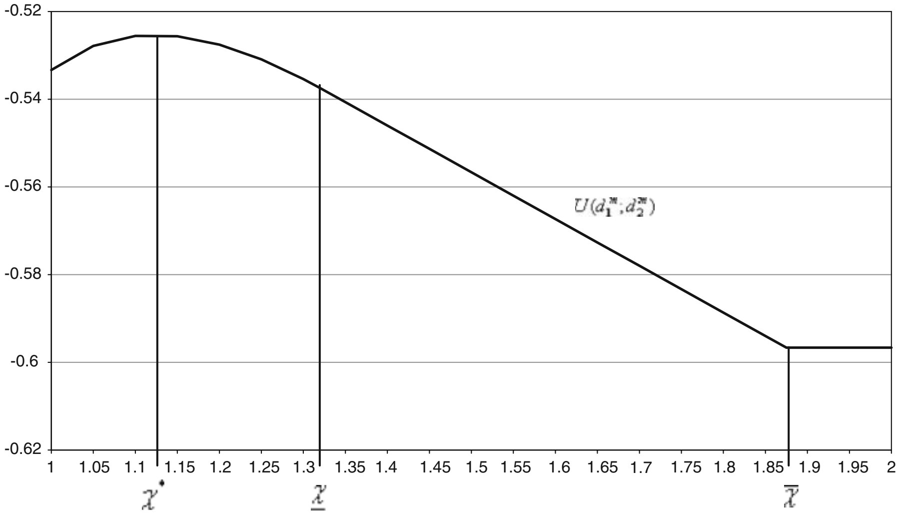

Fig. 1 Households' utility in a monopolistic banking system

Figure 1 depicts the expected utility received by a household under the monopolist deposit contract (the figure assumes $R = 3$, $q = 0.3$, $\alpha = 2$, and $\delta = 0.8$).

In the remainder of this section, we provide conditions under which χ^* is an interior solution; i.e., $\underline{\chi} > \chi^* > 1$. Inserting the equilibrium expression for $\underline{\chi}$ and χ^*, respectively, and rearranging yields

$$1 > \delta > \frac{1}{qR^{1/(\alpha-1)} + (1-q)}. \tag{31}$$

Details are provided in the appendix.

Whenever there are some inefficiencies associated with the monopoly power of banks ($\delta < 1$), χ^* should be smaller than $\underline{\chi}$ because limiting the monopoly power at the expense of some liquidity insurance is welfare-improving. It can be seen from Eq. (30) that whenever Eq. (31) holds,

$$\frac{\partial \chi^*}{\partial \delta} > 0.$$

Hence, the optimal value of χ decreases as the inefficiencies attributable to the monopoly rent increase. However, if these inefficiencies become too severe, χ^* will attain the lower bound $\chi^* = 1$. This constraint binds whenever $\delta > \frac{1}{qR^{1/(\alpha-1)}+(1-q)}$.

4 Monopolistically competitive banking system

In this section, we relax the assumption that $k = 0$. If $(1-k)$ is sufficiently small, each regional bank must be concerned that local households might deposit their wealth in the bank of another region. Note that we allow for k to change independently from

b or, equivalently, χ_b. We continue to assume that $\chi = \chi_m$ but note that the analysis would remain essentially the same if $\chi = \chi_b$.

4.1 The non-local deposit contract

First, we derive the deposit contract offered by the non-local bank. That contract is the outside option against which local banks—those that do have depositors in their region—must compete.[9]

Competition between banks implies that the non-local bank can only attract depositors if it offers a deposit contract that maximizes the utility of these depositors, subject to some constraints. Since it has no depositors in its region, the non-local bank makes zero profits. Hence, this bank's budget constraint, denoted (BC), is given by

$$qd_1M + (1-q)\frac{d_2}{R}M = M. \tag{32}$$

Also, it can be verified that the constraints (PC_N) and (IC_N) never bind.

If $\chi > 1$, the deposit contract offered by the non-local bank will provide some risk-sharing. This implies $d_1 > M$. In that case, as noted in the previous section, sophisticated households deposit their wealth in the bank and withdraw at date 1 whether or not they turn out to be impatient. Hence, the relevant constraint providing incentives for depositors to remain unsophisticated is (PC'_S), or

$$qu(d_1M) + (1-q)u(d_2M) \geq \chi qu(d_1M) + \chi(1-q)u(Rd_1M). \tag{33}$$

The equilibrium deposit contract offered by the non-local bank thus solves the following problem:

$$(P2)\begin{cases} \max\limits_{d_1;d_2} qu(d_1M) + (1-q)u(d_2M) \\ \text{s.t.} \quad (BC), (PC'_S). \end{cases}$$

Hence, the non-local bank offers the deposit contract

$$\{d_1^*; d_2^*\} = \left\{\frac{1}{q+(1-q)\Gamma\cdot R^{-1}}; \frac{\Gamma}{q+(1-q)\Gamma\cdot R^{-1}}\right\}.$$

The degree of risk-sharing provided by this contract is

$$\frac{d_2^*}{d_1^*} = \Gamma = \max\left\{R^{1/\alpha}; \Theta\right\}, \tag{34}$$

where Θ is defined in Eq. (16).

[9] Alternatively, we could assume that banks can distinguish between depositors from their region and depositors from other regions. The deposit contract offered to depositors from other regions would be the same as the deposit contract derived in this section.

Proposition 9 *The equilibrium deposit contract offered by the non-local bank is not affected by changes in* χ *if* $\chi \in \left[\underline{\chi}, \infty\right]$. *If* $\chi \in \left[1, \underline{\chi}\right]$, *then the risk-sharing provided by the equilibrium deposit contract decreases as* χ *decreases.*

Proof If $\chi > \underline{\chi}$, then (PC'_S) is not binding. In that case, the contract offered by the non-local bank is the same as the contract a planner would offer since it maximizes depositors' utility subject to (BC), which in this case is equivalent to a resource constraint. Changes in χ affect neither the objective function nor the constraint of the bank.

If $\chi < \underline{\chi}$, then the deposit contract is given by the intersection of (PC'_S) and (BC). Because (PC'_S) is binding, the contract cannot implement the socially optimal risk-sharing in this case. Thus, whenever $\chi < \underline{\chi}$, the option of households to become sophisticated, withdraw their deposits at $t = 1$, and invest them in the secondary financial market prevents the non-local bank from offering a deposit contract that implements the efficient degree of risk-sharing. Further, as immediately follows from the definition of Θ, a lower cost of becoming sophisticated reduces risk-sharing (i.e., increases Θ). □

4.2 The local deposit contract

If $(1 - k)$ is sufficiently high, the cost of investing in the non-local bank is so high that the local bank can offer the contract derived in Sect. 3. In contrast, if $(1 - k)$ is small, competition from the non-local bank can become a constraint on the contract offered by the local bank. In this case, the local bank must offer a contract that provides incentives for depositors not to invest in the non-local bank. This constraint, which we denote (PC_C), can be written as

$$qu\left(d_1 M\right) + (1-q)\, u\left(d_2 M\right) \geq qu\left(d_1^* kM\right) + (1-q)\, u\left(d_2^* kM\right). \qquad (35)$$

Taking our specific intratemporal utility function into account, we note that (PC_C) becomes

$$qu\left(d_1 M\right) + (1-q)\, u\left(d_2 M\right) \geq \mu qu\left(d_1^* M\right) + \mu\,(1-q)\, u\left(d_2^* M\right), \qquad (36)$$

with $\mu = k^{1-\alpha}$.

It can be shown that if μ is sufficiently small, $d_1 > 1$. Hence, the local bank also faces the constraint (PC'_S). The local bank thus solves the following problem:

$$(P3)\begin{cases} \max\limits_{d_1;d_2} \; M - q \cdot d_1 \cdot M - (1-q) \cdot \frac{d_2}{R} \cdot M \\ \text{s.t.} \quad (PC_C), (PC'_S). \end{cases}$$

The deposit contract solving $(P3)$ is given by

$$\left\{d_1^c; d_2^c\right\} = \left\{\mu^{1/(1-\alpha)} d_1^*; \mu^{1/(1-\alpha)} d_2^*\right\}.$$

If both (PC_C) and (PC'_S) bind, then the deposit contract is given by the intersection of these two constraints holding at equality. A decrease in μ leads to an increase in the repayment offered by the local bank.

For a given χ, there exists a threshold value for μ, denoted by $\bar{\mu}$, such that if $\mu > \bar{\mu}$, then the local bank offers the deposit contract derived in Sect. 3, $\{d_1^m; d_2^m\}$. If $\mu < \bar{\mu}$, then the local bank offers the contract $\{d_1^c; d_2^c\}$ derived in this section. If $\mu = \bar{\mu}$, depositors are indifferent between the two contracts. Next, we derive the expression for $\bar{\mu}$ given χ.

If $\chi \in [1, \underline{\chi})$, then $d_1^m = 1$ and $d_2^m = \Theta$. Also,

$$d_1^c = \frac{\mu^{\frac{1}{1-\alpha}}}{q + (1-q)\Theta R^{-1}}$$

and $d_2^c = \Theta d_1^c$. It follows that $U\left(d_1^m, d_2^m\right) = U\left(d_1^c, d_2^c\right)$ if and only if $d_1^m = d_1^c$. This is the case if

$$\bar{\mu} = \left[q + (1-q)\Theta R^{-1}\right]^{1-\alpha}. \tag{37}$$

Using the same logic one can verify that for any value of χ, $U\left(d_1^m, d_2^m\right) = U\left(d_1^c, d_2^c\right)$ if and only if $d_1^m = d_1^c$. If $\chi \in \left[\underline{\chi}, \bar{\chi}\right]$, this condition implies

$$\bar{\mu} = \chi \frac{q + (1-q)R^{1-\alpha}}{\left[q + (1-q)R^{\frac{1-\alpha}{\alpha}}\right]^{\alpha}}. \tag{38}$$

If $\chi > \bar{\chi}$, this same condition implies

$$\bar{\mu} = \left[q + (1-q)R^{\frac{1-\alpha}{\alpha}}\right]^{-\alpha}. \tag{39}$$

Lemma 10 *$\bar{\mu}$ is weakly increasing in χ.*

Proof Whenever $\chi > \bar{\chi}$, the threshold value of μ is independent of χ since neither $\{d_1^m; d_2^m\}$ nor $\{d_1^c; d_2^c\}$ depends on χ. If $\chi \leq \bar{\chi}$, then $\bar{\mu}$ increases as χ increases. □

The next lemma shows that when the local bank is constrained by competition with the non-local bank, χ affects the deposit contract offered by the local bank only if it distorts the deposit contract offered by the non-local bank.

Lemma 11 *Let $\mu < \bar{\mu}$ for a given χ. If $\chi \in [\underline{\chi}, \infty]$, then small changes in χ have no effect on the deposit contract offered by the local bank. If $\chi \in [1, \underline{\chi}]$, small changes in χ affect the risk-sharing of the deposit contract offered by the local bank.*

Proof Since $\mu < \bar{\mu}$, the local bank offers the contract $\left\{d_1^c; d_2^c\right\}$. If $\chi \in [\underline{\chi}, \infty]$, then a change in χ has no effect on the risk-sharing offered by the non-local bank, and thus no effect on $\left\{d_1^c; d_2^c\right\}$. If $\chi \in [1, \underline{\chi}]$, then changes in χ affect the risk-sharing offered by the non-local bank and thus affect $\left\{d_1^c; d_2^c\right\}$. □

Proposition 12 *If $\mu < \bar{\mu}$ for a given χ, then household wealth, M, is independent of χ.*

Proof To derive M, we first need to find the local bank's profits when $\mu < \bar{\mu}$. To do this, we substitute d_1^c and d_2^c into the general profit function given by Eq. (17) and obtain

$$\Pi = \left[1 - \mu^{-1/(\alpha-1)}\right] M.$$

Substituting this expression into the general equation of households' wealth given by Eq. (22) yields

$$M = \frac{1}{1 - \delta\left(1 - \mu^{-1/(\alpha-1)}\right)}. \tag{40}$$

The proof follows. □

Changes in χ do not affect the inefficiencies associated with the monopoly rent of banks.

4.3 Household welfare

We can obtain an expression for the welfare of households by inserting equilibrium wealth and the optimal deposit contract into the expected utility function. If $\chi \in [\underline{\chi}, \infty]$, this yields

$$U\left(d_1^c; d_2^c\right) = \frac{1}{1-\alpha}\left(\mu^{1/(1-\alpha)}(1-\delta) + \mu^{2/(1-\alpha)}\right)^{1-\alpha}\left(q + (1-q)\,R^{(1-\alpha)/\alpha}\right)^{\alpha}. \tag{41}$$

If $\chi \in [1, \underline{\chi}]$, we obtain

$$U\left(d_1^c; d_2^c\right) = -\frac{1}{\alpha-1}\left(\mu^{1/(1-\alpha)}(1-\delta) + \mu^{2/(1-\alpha)}\right)^{1-\alpha}\left(q + (1-q)\,\Theta R^{-1}\right)^{\alpha}. \tag{42}$$

Details are provided in the appendix.

We can now describe the effect of a change in χ on the welfare of households when the local bank is constrained by competition with the non-local bank.

Proposition 13 *If $\mu < \bar{\mu}$ for a given χ, household welfare is weakly increasing in χ.*

Proof If $\chi \in [\underline{\chi}, \infty]$, a change in χ has no welfare effect, as shown in Eq. (41).

If $\chi \in [1, \underline{\chi}]$, Eq. (42) shows that a decrease in χ will lower welfare, since $\dfrac{\partial\Theta}{\partial\chi} > 0$. This effect comes from the reduction in risk-sharing that arises from the decrease in χ. □

When $\mu < \bar{\mu}$, changes in χ do not affect the monopoly rent of the local bank. Hence, the only possible effect of lowering the cost of gaining access to financial markets is

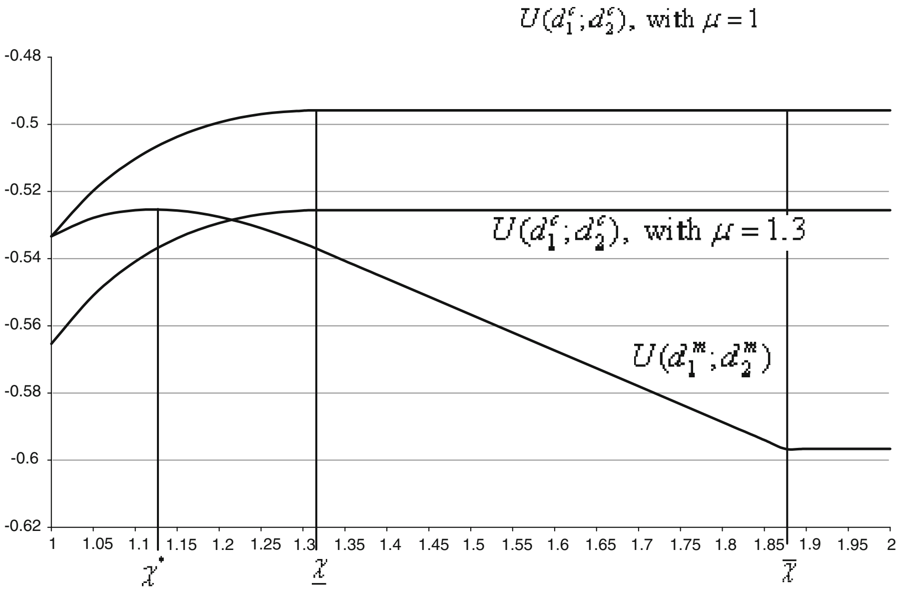

Fig. 2 Households' utility in competitive banking systems

to reduce risk-sharing, which must reduce welfare. A decrease in μ, however, reduces the monopoly power of local banks and thereby limits the monopoly rents and the inefficiencies associated with these rents. The higher these inefficiencies (the lower δ), the more beneficial the reduction in local banks' monopoly power.

Figure 2 depicts the expected utility received by a household under the monopolist deposit contract, as well as the competitive deposit contract for two different values of μ (the figure assumes $R = 3$, $q = 0.3$, $\alpha = 2$, and $\delta = 0.8$). Graphically, an increase in μ simply lowers the curve showing the expected utility provided by the competitive deposit contract.

5 Globally optimal financial market access

In Sect. 3, we demonstrated that when banks do not compete with each other, the optimal cost of access to the financial market is positive. That cost trades off the reduction of banks' monopoly rent, which improves welfare, with the inefficiencies attributable to suboptimal risk-sharing, which decrease welfare. In Sect. 4, we showed that if the competition between banks is strong enough, then welfare is maximized if households do not have access to financial markets. When banks compete with each other, access to the financial market only reduces risk-sharing.

In this section, we determine how intense the competition between banks must be in a system where households do not have access to the financial market for such a system to be preferred to a monopolistic banking sector with the optimal degree of access to financial markets.

The highest expected utility households can obtain from a monopolistic bank is achieved for $\chi = \chi^*$. The expected utility offered by this contract is given by

$$U\left(d_1^m, d_2^m \left|\chi = \chi^*\right.\right) = \left[q + (1-q)\left(\Theta^*\right)^{1-\alpha}\right]\frac{M_m^{1-\alpha}}{1-\alpha}, \tag{43}$$

where

$$M_m = \frac{1}{1-\delta(1-q)\left(1-\frac{\Theta^*}{R}\right)}$$

and

$$\Theta^* = \left(\frac{1-\delta+\delta q}{\delta q}R\right)^{1/\alpha}.$$

When banks are competing with each other, the highest expected utility households can obtain from their local bank, given μ, is achieved for $\chi \geq \underline{\chi}$. The expected utility offered by this contract is

$$U\left(d_1^c; d_2^c \left|\chi = \underline{\chi}\right.\right) = \frac{1}{1-\alpha}\left(\mu^{1/(\alpha-1)}(1-\delta)+\delta\right)^{\alpha-1}\left(q+(1-q)R^{(1-\alpha)/\alpha}\right)^{\alpha}. \tag{44}$$

The threshold $\underline{\mu}$, below which households are better off in a competitive banking system without financial market access than they are in a system with monopolistic banks and an optimal degree of financial market access, therefore follows from

$$U\left(d_1^c; d_2^c \left|\chi = \underline{\chi}\right.\right) = U\left(d_1^m, d_2^m \left|\chi = \chi^*\right.\right)$$

and is given by

$$\underline{\mu} = \left(\frac{\left(q+(1-q)(\Theta^*)^{1-\alpha}\right)^{1/(\alpha-1)}}{(1-\delta)M_m\left(q+(1-q)R^{(1-\alpha)/\alpha}\right)^{\alpha/(\alpha-1)}} - \frac{\delta}{(1-\delta)}\right)^{\alpha-1}.$$

Proposition 14 *If μ is sufficiently small, then a competitive banking system without access to financial markets provides higher welfare than a monopolistic banking system with the optimal costs of accessing financial markets ($\chi = \chi^*$).*

Proof The proof follows directly from Eqs. (43) and (44). □

6 Conclusion

This paper studies the deposit contracts offered by banks when they face competition from financial markets and from other banks. When competition from other banks is weak, promoting competition from the financial market can be welfare-improving. Such competition reduces the monopoly rents that banks can extract and limits the inefficiencies associated with these rents. However, competition from the financial market also constrains the amount of risk-sharing offered by banks. Hence, there is a point after which greater competition from the market will decrease depositors' welfare.

When competition between banks is strong enough, competition with the financial market is no longer necessary to reduce monopoly rents. In that case, the only effect of increased competition between banks and the financial market is reduced risk-sharing. Thus, our results suggest that whether competition between the financial market and banks improves welfare may depend on the intensity of competition between banks.

In addition, we show that if competition among banks is sufficiently high, then a financial system with little household access to financial markets is preferable to a financial system with weak competition between banks but efficient household access to financial markets. Indeed, competition among banks reduces the banks' monopoly rents without distorting the deposit contracts. In contrast, competition with financial markets may reduce banks' monopoly rents at the cost of reducing the liquidity insurance provided by banks.

An interesting dimension in which to extend this framework is to analyze the implications to the stability of the financial system of changes in competition between banks and between banks and markets. Following Fecht (2004), it would be interesting to study the effect of a collapse of one bank on the overall financial system and the likelihood of contagion of other institutions in the economy. Improved household access to the financial markets would, on the one hand, reduce the negative effect of "fire-sales" of troubled banks. On the other hand, banks would be more sensitive to changes in the price of claims against the corporate sector if households became more efficient at investing directly in the financial markets. Our framework adds an additional dimension by considering the monopoly rents of banks, which serve as a buffer in periods of crisis.

Appendix A

A.1 Proof that the monopolistic contract always satisfies $d_1 \leq M$

Here we show that it is never optimal for a bank to offer a deposit contract with $d_1 > M$. Note that in such a case, households will—if they made the effort to become sophisticated—deposit their funds initially with the bank and withdraw at date 1. Impatient sophisticated depositors consume d_1 while patient sophisticated depositors buy claims on the long-term technology in the financial market. Hence, patient sophisticated depositors can buy d_1 claims on the long-term technology that provide them with a consumption of $Rd_1 > d_2$ at date 2. Thus, (PC_S) is no longer the relevant constraint. The optimal deposit contract solves $\left(P1'\right)$

$$\left(P1'\right)\begin{cases} \max\limits_{d_1^B;d_2^B} & M - q\cdot d_1\cdot M-(1-q)\cdot\frac{d_2}{R}\cdot M \\ \text{s.t.} & q\cdot u\left(d_1\cdot M\right)+(1-q)\cdot u\left(d_2\cdot M\right)\geq \\ & \chi\cdot q\cdot u\left(d_1\cdot M\right)+\chi\cdot(1-q)\cdot u\left(R\cdot d_1\cdot M\right), \quad \left(PC_S'\right) \\ & d_2\geq d_1, \quad \left(IC_N\right) \\ & d_1 > M, \quad \left(IC_S'\right) \\ & q\cdot u\left(d_1\cdot M\right)+(1-q)\cdot u\left(d_2\cdot M\right)\geq \frac{1}{1-\alpha}M^{1-\alpha}. \quad \left(PC_N\right) \end{cases}$$

It is obvious that for any contract satisfying (IC_N) and (IC_S'), (PC_N) will hold. From $\left(PC_S'\right)$, it follows that the risk-sharing of the contract solving $(P1')$ must satisfy

$$d_2\geq\Theta\cdot d_1. \tag{45}$$

Hence, the degrees of risk-sharing implied by the contracts solving $(P1)$ and $\left(P1'\right)$ are identical for $\chi\in[0,\underline{\chi}]$. However, given that $d_1>1$, the deposit contract solving $\left(P1'\right)$ will always provide lower profits to the bank than the optimal contract solving $\left(P1'\right)$ with $d_1\leq 1$.

For $\chi\in[\bar{\chi},\infty]$, $\Theta<1$ and therefore (PC_S') is always implied if (IC_N) holds. Thus, the profit-maximizing deposit contract in $(P1')$ is constrained by (IC_N), (IC_S'), and (PC_N), which implies $\{d_1;d_2\}=\{M;M\}$. Clearly, such a contract leaves less profits to the bank than the point of tangency between (PC_N) and the profit function that is the optimal deposit contract in $(P1)$ for this case.

Finally, it remains to be shown that for $\chi\in[\underline{\chi},\bar{\chi}]$ the contract solving $(P1)$ provides higher profits than the one that is given by $(P1')$. But comparing (PC_S) and (PC_S') shows that any contract solving $(P1')$ is on a higher indifference curve than a contract solving $(P1)$. Given that the latter contract maximizes profits along that indifference curve, profits provided by this contract must always be higher.

A.2 Derivation of $\bar{\chi}$

Since the LHS of (PC_S) and (PC_N) is identical, (PC_S) cannot be a binding constraint if

$$\bar{\chi}\left[q+(1-q)R^{1-\alpha}\right]u(M)\leq[q+(1-q)]\,u(M).$$

Since $u(M)<0$, this condition is equivalent to

$$\bar{\chi}\cdot\left[q+(1-q)R^{1-\alpha}\right]\geq[q+(1-q)]\,,$$

so we can write

$$\bar{\chi}\geq\frac{1}{q+(1-q)R^{1-\alpha}}.$$

A.3 Derivation of $\underline{\chi}$

The expression for $\underline{\chi}$ comes from Eq. (9) at equality and substituting $1 = d_1$ and $d_2 = R^{\frac{1}{\alpha}}$. This yields

$$qu(d_1 \cdot M) + (1-q)R^{\frac{1-\alpha}{\alpha}} u(d_1 \cdot M) = \chi \left[qu(d_1 \cdot M) + (1-q)R^{1-\alpha} u(d_1 \cdot M) \right].$$

Eliminating $u(d_1)$ gives the result.

A.4 Calculation of the equilibrium rent of a monopolistic bank

Recall,

$$A = \left(\frac{1}{q + (1-q)R^{(1-\alpha)/\alpha}} \right)^{\frac{1}{1-\alpha}},$$

$$B = \left(q + (1-q)R^{1-\alpha} \right)^{\frac{1}{1-\alpha}}.$$

If $\chi \in [\bar{\chi}, \infty]$**:**
Rearranging Eq. (18) yields

$$\Pi = M - (q + (1-q) \cdot R^{(1-\alpha)/\alpha}) \cdot A \cdot M.$$

Substitute for A to obtain

$$\Pi = M - (q + (1-q) \cdot R^{(1-\alpha)/\alpha}) \cdot \left(\frac{1}{q + (1-q) \cdot R^{(1-\alpha)/\alpha}} \right)^{\frac{1}{1-\alpha}} \cdot M.$$

Simple algebra implies

$$\Pi = M - (q + (1-q) \cdot R^{(1-\alpha)/\alpha}) \cdot \left(q - (1-q) \cdot R^{(1-\alpha)/\alpha} \right)^{-1/(1-\alpha)} \cdot M,$$

$$\Pi = M - \left(q + (1-q) \cdot R^{(1-\alpha)/\alpha} \right)^{-\alpha/(1-\alpha)} \cdot M,$$

$$\Pi = (1 - \left(q + (1-q) \cdot R^{(1-\alpha)/\alpha} \right)^{\alpha/(\alpha-1)}) \cdot M.$$

If $\chi \in \left[\underline{\chi}, \bar{\chi} \right)$**:**
Substitute for d_1 and d_2 in Eq. (17) to obtain

$$\Pi = M - q \cdot A \cdot B \cdot \chi^{1/(1-\alpha)} \cdot M - (1-q) \cdot A \cdot B \cdot \chi^{1/(1-\alpha)} \cdot M \cdot R^{(1-\alpha)/\alpha}. \quad (46)$$

Rearranging (46) yields

$$\Pi = M - (q + (1-q) \cdot R^{(1-\alpha)/\alpha}) \cdot A \cdot B \cdot \chi^{1/(1-\alpha)} \cdot M,$$
$$\Pi = M - (q + (1-q) \cdot R^{(1-\alpha)/\alpha}) \cdot \left(\frac{q + (1-q) \cdot R^{(1-\alpha)}}{q + (1-q) \cdot R^{(1-\alpha)/\alpha}} \right)^{\frac{1}{1-\alpha}} \cdot \chi^{1/(1-\alpha)} \cdot M,$$
$$\Pi = M - \left(q + (1-q) \cdot R^{(1-\alpha)/\alpha}\right)^{-\alpha/(1-\alpha)} \cdot \left(q + (1-q) \cdot R^{(1-\alpha)}\right)^{\frac{1}{1-\alpha}} \cdot \chi^{1/(1-\alpha)} \cdot M,$$
$$\Pi = (1 - \left(q + (1-q) \cdot R^{(1-\alpha)/\alpha}\right)^{\alpha/(\alpha-1)} \cdot \left(q + (1-q) \cdot R^{(1-\alpha)}\right)^{-1/(\alpha-1)} \cdot \chi^{1/(1-\alpha)} \cdot M,$$
$$\Pi = (1 - A^{\alpha} \cdot B \cdot \chi^{\frac{1}{1-\alpha}}) M.$$

If $\chi \in \left[1, \underline{\chi}\right)$**:**
Substitute for d_1 and d_2 in Eq. (17) to obtain

$$\Pi = M - q \cdot M - (1-q) \cdot \Theta \cdot M \cdot R^{-1}. \tag{47}$$

Rearranging Eq. (47) yields

$$\Pi = M - (q + (1-q) \cdot R^{-1} \cdot \Theta) \cdot M,$$
$$\Pi = M - \left(q + (1-q) \cdot R^{-1} \cdot \left(\frac{\chi[q + (1-q) \cdot R^{(1-\alpha)}] - q}{(1-q)} \right)^{1/(1-\alpha)} \right) \cdot M,$$
$$\Pi = \left(1 - R^{-1} \cdot \left(\frac{\chi[q + (1-q) \cdot R^{(1-\alpha)}] - q}{(1-q)} \right)^{1/(1-\alpha)} \right) \cdot (1-q) \cdot M.$$

A.5 Derivation of the welfare optimum in the monopoly case

If $\chi \in \left[\underline{\chi}, \bar{\chi}\right)$**:**
We can show that $\partial E\left[U\right]/\partial \chi < 0$.
To simplify notation, we can write the deposit contract and households' wealth as

$$\{d_1; d_2\} = \left\{ A \cdot B \cdot \chi^{1/(1-\alpha)} \cdot M;\ A \cdot B \cdot \chi^{1/(1-\alpha)} \cdot R^{1/\alpha} \cdot M \right\}$$
$$M = \frac{1}{1 - \delta\left(1 - A^{\alpha} \cdot B \cdot \chi^{1/(1-\alpha)}\right)}.$$

A depositor's expected utility is thus given by

$$\begin{aligned} E\left[U\left(d_{1;}d_2\right)\right] &= q\frac{1}{1-\alpha}\chi\left(A\cdot B\cdot M\right)^{1-\alpha} + (1-q)\frac{1}{1-\alpha}\chi\left(A\cdot B\cdot M\right)^{1-\alpha}R^{\frac{1-\alpha}{\alpha}} \\ &= \frac{1}{1-\alpha}\left(q+(1-q)R^{\frac{1-\alpha}{\alpha}}\right)\chi\left(A\cdot B\cdot M\right)^{(1-\alpha)} \\ &= \frac{1}{1-\alpha}\chi\left(B\cdot M\right)^{(1-\alpha)}. \end{aligned}$$

Take the derivative of the expected utility with respect to χ, keeping in mind that M is a function of χ.

$$\begin{aligned} \frac{\partial E[U]}{\partial\chi} &= \frac{1}{1-\alpha}B^{1-\alpha}\left(M^{(1-\alpha)} + \chi(1-\alpha)\frac{\partial M}{\partial\chi}M^{-\alpha}\right). \\ \frac{\partial M}{\partial\chi} &= \frac{1}{\alpha-1}A^{\alpha}\cdot B\cdot\delta\cdot\chi^{\frac{\alpha}{1-\alpha}}M^2. \end{aligned}$$

Combining these two expressions yields

$$\begin{aligned} \frac{\partial E[U]}{\partial\chi} &= \frac{1}{1-\alpha}\left(B\cdot M\right)^{1-\alpha}\left[1-\chi\left(1-\alpha\right)\frac{1}{1-\alpha}A^{\alpha}\cdot B\cdot\chi^{\frac{1}{\alpha}}\cdot M^{2-\alpha}\right] \\ &= \frac{1}{1-\alpha}\left(B\cdot M\right)^{1-\alpha}\left[1-\delta A^{\alpha}\cdot B\cdot\chi^{1/(1-\alpha)}\cdot M^{2-\alpha}\right] \\ &= \frac{1}{1-\alpha}\left(B\cdot M\right)^{1-\alpha}\left[(1-\delta)\,M\right] \\ &= -\frac{1}{\alpha-1}\cdot B^{1-\alpha}\cdot M^{2-\alpha}\left(1-\delta\right) < 0. \end{aligned}$$

If $\chi\in\left[1,\underline{\chi}\right)$:
Recall,

$$\begin{aligned} M &= \frac{1}{1-\delta\cdot(1-q)\cdot\left(1-R^{-1}\cdot\Theta\right)}, \\ \frac{\partial M}{\partial\Theta} &= -\delta\cdot(1-q)\cdot R^{-1}\cdot M^2, \end{aligned}$$

and

$$E\left[U\right] = q\cdot u\left(d_1\right) + (1-q)\cdot u\left(d_2\right) = \left[q+(1-q)\,\Theta^{1-\alpha}\right]\frac{M^{1-\alpha}}{1-\alpha}.$$

Take the derivative of $E[U]$ with respect to Θ and set it equal to zero to obtain

$$\frac{\partial E[U]}{\partial \Theta} = (1-q)\,\Theta^{-\alpha}\frac{M^{1-\alpha}}{(1-\alpha)^2} + \left[q + (1-q)\,\Theta^{1-\alpha}\right]\frac{M^{-\alpha}}{(1-\alpha)^2}\frac{\partial M}{\partial \Theta} = 0$$
$$\iff (1-q)\,\Theta^{-\alpha}M + \left[q + (1-q)\,\Theta^{1-\alpha}\right]\frac{\partial M}{\partial \Theta} = 0.$$

Substituting for $\frac{\partial M}{\partial \Theta}$ yields

$$\Theta^{-\alpha} = \left[q + (1-q)\,\Theta^{1-\alpha}\right]\cdot \delta \cdot R^{-1}M.$$

Now substitute for M and multiply both sides by Θ^{α} to obtain

$$1 = \frac{[q\cdot\Theta^{\alpha} + (1-q)\cdot\Theta]\cdot\delta\cdot R^{-1}}{1-\delta\cdot(1-q)\cdot\left(1-R^{-1}\cdot\Theta\right)}.$$

The remaining steps follow from simple algebra

$$\begin{aligned}
&R-\delta\cdot(1-q)\cdot(R-\Theta) = \delta\cdot q\cdot\Theta^{\alpha} + \delta\cdot(1-q)\cdot\Theta,\\
&R-\delta\cdot(1-q)\cdot R = \delta\cdot q\cdot\Theta^{\alpha},\\
&\frac{1-\delta\cdot(1-q)}{\delta\cdot q}\cdot R = \Theta^{\alpha},\\
&\left(\frac{1-\delta+\delta\cdot q}{\delta\cdot q}\cdot R\right)^{1/\alpha} = \Theta.
\end{aligned}$$

We also know from Eq. (16) that

$$\Theta = \left(\frac{\chi[q+(1-q)\cdot R^{(1-\alpha)}]-q}{(1-q)}\right)^{1/(1-\alpha)}.$$

Thus,

$$\begin{aligned}
&\left(\frac{1-\delta+\delta\cdot q}{\delta\cdot q}\cdot R\right)^{(1-\alpha)/\alpha} = \frac{\chi[q+(1-q)\cdot R^{(1-\alpha)}]-q}{(1-q)},\\
&(1-q)\left(\frac{1-\delta+\delta\cdot q}{\delta\cdot q}\cdot R\right)^{(1-\alpha)/\alpha} + q = \chi[q+(1-q)\cdot R^{(1-\alpha)}],\\
&\frac{(1-q)\left(\frac{\delta\cdot q}{1-\delta+\delta\cdot q}\right)^{(\alpha-1)/\alpha}R^{(1-\alpha)/\alpha}+q}{(1-q)R^{(1-\alpha)}+q} = \chi.
\end{aligned}$$

A.6 Derivation of condition (31)

We start with the condition

$$\chi^* > 1,$$

where χ^* is given by Eq. (30). Rearranging yields

$$\begin{aligned}
&(1-q)\left(\frac{\delta\cdot q}{1-\delta+\delta\cdot q}\right)^{(\alpha-1)/\alpha} R^{(1-\alpha)/\alpha}+q > (1-q)R^{(1-\alpha)}+q,\\
&\left(\frac{\delta\cdot q}{1-\delta+\delta\cdot q}\right)^{(\alpha-1)/\alpha} R^{1/\alpha} > 1,\\
&\left(\frac{\delta\cdot q}{1-\delta+\delta\cdot q}\right) > R^{-1/(\alpha-1)},\\
&\delta\cdot q > (1-(1-q)\delta)\, R^{-1/(\alpha-1)},\\
&\delta\left(q+(1-q)R^{-1/(\alpha-1)}\right) > R^{-1/(\alpha-1)},\\
&\delta > \frac{R^{-1/(\alpha-1)}}{q+(1-q)R^{-1/(\alpha-1)}},
\end{aligned}$$

and finally

$$\delta > \frac{1}{qR^{1/(\alpha-1)}+(1-q)}.$$

Similarly, starting with the condition

$$\underline{\chi} > \chi^*,$$

we obtain

$$\begin{aligned}
&\frac{q+(1-q)R^{(1-\alpha)/\alpha}}{q+(1-q)R^{(1-\alpha)}} = \underline{\chi},\\
&\frac{q+(1-q)R^{(1-\alpha)/\alpha}}{q+(1-q)R^{(1-\alpha)}} > \frac{(1-q)\left(\frac{\delta\cdot q}{1-\delta+\delta\cdot q}\right)^{(\alpha-1)/\alpha} R^{(1-\alpha)/\alpha}+q}{(1-q)R^{(1-\alpha)}+q},\\
&q+(1-q)R^{(1-\alpha)/\alpha} > (1-q)\left(\frac{\delta\cdot q}{1-\delta+\delta\cdot q}\right)^{(\alpha-1)/\alpha} R^{(1-\alpha)/\alpha}+q,\\
&1 > \left(\frac{\delta\cdot q}{1-\delta+\delta\cdot q}\right)^{(\alpha-1)/\alpha},\\
&1 > \frac{\delta\cdot q}{1-\delta+\delta\cdot q},
\end{aligned}$$

which is equivalent to

$$1 > \delta.$$

To summarize, there is an interior solution if

$$1 > \delta > \frac{1}{qR^{1/(\alpha-1)} + (1-q)}.$$

A.7 Derivation of households' expected welfare in the competition case

For $\chi > \underline{\chi}$, the deposit offered by the local bank is

$$\left\{d_1^c; d_2^c\right\} = \left\{\frac{\mu^{1/(1-\alpha)}}{q + (1-q)R^{(1-\alpha)/\alpha}}; \frac{\mu R^{1/\alpha}}{q + (1-q)\Gamma R^{(1-\alpha)/\alpha}}\right\},$$

and households' wealth is given by

$$M = \frac{1}{1 - \delta\left(1 - \mu^{-1/(\alpha-1)}\right)}.$$

The expected utility of a household can thus be written

$$U\left(d_1^c; d_2^c\right) = \frac{1}{1-\alpha}\mu\left(\frac{M}{q + (1-q)R^{(1-\alpha)/\alpha}}\right)^{1-\alpha}\left(q + (1-q)\,R^{(1-\alpha)/\alpha}\right),$$

$$U\left(d_1^c; d_2^c\right) = \frac{1}{1-\alpha}\mu\left(1 - \delta\left(1 - \mu^{-1/(\alpha-1)}\right)\right)^{1-\alpha}$$

$$\times\left(\frac{1}{q + (1-q)R^{(1-\alpha)/\alpha}}\right)^{1-\alpha}\left(q + (1-q)\,R^{(1-\alpha)/\alpha}\right),$$

$$U\left(d_1^c; d_2^c\right) = \frac{1}{1-\alpha}\left(\mu^{1/(1-\alpha)}\,(1-\delta) + \mu^{2/(1-\alpha)}\right)^{1-\alpha}\left(q + (1-q)\,R^{(1-\alpha)/\alpha}\right)^{\alpha}.$$

For $\chi < \underline{\chi}$, the deposit contract offered by the local bank is

$$\left\{d_1^c; d_2^c\right\} = \left\{\frac{\mu^{1/(1-\alpha)}}{q + (1-q)\Theta R^{-1}}; \frac{\mu^{1/(1-\alpha)}\Theta}{q + (1-q)\Gamma\Theta R^{-1}}\right\},$$

where M is the same as above and Θ is defined in Eq. (16). Thus, households' expected utility in that case is

$$U\left(d_1^c; d_2^c\right) = \frac{1}{1-\alpha}\mu\left(\frac{M}{q + (1-q)\Theta R^{-1}}\right)^{1-\alpha}\left(q + (1-q)\,\Theta R^{-1}\right).$$

Substitute for M to obtain

$$U\left(d_1^c; d_2^c\right) = -\frac{1}{\alpha - 1}\left(\mu^{1/(1-\alpha)}\left(1-\delta\right) + \mu^{2/(1-\alpha)}\right)^{1-\alpha}\left(q + (1-q)\,\Theta R^{-1}\right)^{\alpha}.$$

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