

# Banks, Markets, and Efficiency\*

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## Abstract

Following Diamond (1997) and Fecht (2004) we use a model in which financial market access of households restrains the efficiency of the liquidity insurance that banks' deposit contracts provide to households that are subject to idiosyncratic liquidity shocks. But in contrast to these approaches we assume spacial monopolistic competition among banks. Since monopoly rents are assumed to bring about inefficiencies, improved financial market access that limits monopoly rents also entails a positive effect. But this beneficial effect is only relevant if competition among banks does not sufficiently restrain monopoly rents already.

Thus our results suggest that in the bank-dominated financial system of Germany, in which banks intensely compete for households' deposits, improved financial market access might reduce welfare because it only reduces risk sharing. In contrast, in the banking system of the U.S., with less competition for households' deposits, a high level of households' financial market participation might be beneficial.

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\*The views expressed here are those of the authors and not necessarily those of the Deutsche Bundesbank, the Federal Reserve Bank of Kansas City, or the Federal Reserve System.

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# 1 Introduction

In the discussion about differences between financial systems Germany is usually viewed as the most prominent example of a system in which banks play the central role in channelling funds from households to investing firms. Banks typically collect funds issuing sight, time, and saving deposits and provide these funds as loans to the corporate sector. In contrast to more market-oriented financial systems, direct investments in the corporate sector play a minor role in households' portfolios. At the same time only a few corporations issue tradable bonds to raise funds directly over the capital market.

However, in recent years the German financial system has undergone many remarkable changes. The most remarkable one has probably been in the refinancing of German banks. While in 1991 a fraction of around 46% of German households' portfolio was invested in bank deposits (including currency), this portfolio fraction dropped to 36% in 2003 which is, however, still far larger than the 15% that U.S. households hold in currency and bank deposits. Due to technological progress and innovation in the financial service industry, households' access to financial markets became more efficient. The privatization of large public enterprises also created a large supply of corporate claims in the financial market. Finally the introduction of the euro created a more liquid financial market for corporate stocks and corporate bonds making these financial assets more attractive to households.<sup>1</sup> Thus banks compete for households' funds with direct investments and more financial market-related intermediaries, such as money market funds, to a much larger extent today than they had to at the beginning of the nineties.

At the same time the competition among banks for households' deposits has always been more intense in the German bank-dominated financial system than in more market-oriented financial systems like those of the U.S. and UK. This is reflected, for instance, in the number of banking institutions which in 2003 amounted to 2,225 in Germany compared with 426 in the UK. More importantly, the Herfindahl index for total assets as a measure of concentration in the national banking industry only reached 173 in Germany in 2003 — the lowest in the European Union where

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<sup>1</sup>See Deutsche Bundesbank (2000) for a detailed discussion of the interaction between bank lending and the bond market in Germany.

the average Herfindahl index amounted to 541.<sup>2</sup>

Due to the more return-oriented investment behavior of households the competition among banks for households' funds has still intensified in recent years. The market share of direct banks that mainly offer sight deposit that pay an interest rate closely linked to the money market rates has increased from about 4% in 1999 to more than 12% in 2004. This high and still intensifying degree of competition among banks and the increased competition between banks on the one side and financial markets and market-related financial intermediaries on the other has eroded the profitability of the German banking sector significantly in recent years.<sup>3</sup>

This paper analyzes in a theoretical model the welfare implications of these developments. We address the question of whether an increasing financial market access of private households improves welfare in a financial system in which banks compete intensely for private households' funds. We compare these implications with the welfare effects of an improved financial market access of households in a financial system with less intense competition among banks for households' deposits. In our model, regional monopolistic banks offer deposit contracts to local households. As in Diamond and Dybvig (1983) these deposit contracts provide liquidity insurance to households that face uncertain intertemporal consumption preferences. But similar to Diamond (1997) and Fecht (2004) the degree of liquidity insurance that deposit contracts can offer is restrained by households' financial market access. Liquidity insurance implies an ex post redistribution of resources from patient depositors to impatient depositors. Financial market access provides patient depositors with an ex post option to withdraw from this insurance scheme. Thus an improvement of households' financial market access limits the degree of risk sharing that banks' deposit contracts can provide. However, in contrast to previous approaches, in our model banks have local monopoly power that allows them to earn a monopoly rent.<sup>4</sup> We assume that these rents are associated with welfare losses. This might be viewed, for instance, as a shortcut for the managerial moral hazard that arises in the

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<sup>2</sup>Data taken from European Central Bank (2004). For a more detailed analysis of measures of the degree of competition in the German banking industry see Fischer and Pfeil (2004).

<sup>3</sup>See Deutsche Bundesbank (2004) and International Monetary Fund (2003) for a more detailed discussion.

<sup>4</sup>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.

relationship between the equity owners of the bank and the bank management. The higher the monopoly rents of banks (and the lower therefore the debt-equity ratio) the more severe becomes this moral hazard problem and the higher the associated inefficiencies.<sup>5</sup> Since an improved financial market access of households reduces the monopoly rent it also limits managerial moral hazard at banks. Consequently, a trade-off emerges: households' improved financial market access reduces risk-sharing in the economy but at the same time limits the efficiency losses resulting from banks' monopoly rents. We derive the optimal degree of financial market access that optimizes this trade-off.

However, the results change if the monopoly power of regional banks is also limited by households' option to deposit their funds at a cost with a bank from another region. As soon as the monopoly rent of local banks is sufficiently restrained by the competition between banks, the welfare improving effect of increased financial market access becomes obsolete. In that case improved financial market access only limits the degree of risk-sharing offered by banks' deposit contracts.

Thus our results suggest that a more efficient financial market access of households might improve welfare in a financial system that is characterized by an insufficient competition for deposits among banks. In contrast, in a financial system with a strong competition for households' deposits among banks, more efficient financial market access only reduces welfare by restraining the available risk-sharing in the economy. Consequently, while in the U.S. and the UK, which are characterized by a less competitive banking sectors, a high level of households participation in the financial market may be beneficial, households' improved financial market access in Germany, which is characterized by a strong competition for deposits among banks, might be welfare reducing.

Apart from Diamond (1997) there are only very few papers that 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 in 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 matu-

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<sup>5</sup>See Harris and Raviv (1990) and Aghion and Bolton (1992) who model the disciplining role of debt.

rity risk than direct investments, then deposit contracts can also offer some degree of liquidity insurance even if households have a 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 persisting 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 the financial market. While providing a very detailed focus on the effect of competition between banks and direct financial market investments on liquidity provision all these approaches assume a perfectly competitive banking sector. In contrast, Carletti, Hartmann, and Spagnolo (2003) analyze the effect of bank mergers on liquidity provision. They show that a bank merger (due 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 only relate to an intensifying competition in the loan market. They neither analyze the aggregate liquidity effect of an increasing competition among banks for deposits nor do they study the impact of an intensifying competition between banks and financial market investments on the liquidity provision. Thus in contrast to previous studies our paper takes both the competition between banks and financial markets as well as the competition within the banking sector for deposits into account and analyzes its impact on liquidity provision and ultimately welfare.

The remainder of the paper is organized as follows. Section 2 describes the basic set up. In section 3 we first derive the optimal financial market access given that banks are local monopolists. In section 4 we also allow for competition among bank from different region. In section 5 we derive 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  $N$  regions and takes place at three dates, denoted by  $t = 0, 1,$  and  $2$ . Each region contains one bank and a continuum of mass 1 of households. There is also a large number of entrepreneurs. Households are endowed with one

unit of the only consumption good in the economy at date 0. They can deposit their endowment with the local bank or with a bank from another region. Households can also invest directly at a centralized financial market. Each bank offers a deposit contract and maximizes its profits. Entrepreneurs operate a long-term technology as described below.

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 has a high potential return but is subject to moral hazard. The long-term technology returns  $R$  units of goods at date 2 for each unit invested at date 0, provided the entrepreneur operating the technology is monitored at date 1. If the entrepreneur is not monitored, the return is only  $\gamma R$  at date 2, with  $\gamma R < 1$ . The long-term technology can also be liquidated at date 1, in which case it returns  $r < 1$ . This is summarized in the table below.

	t=0	t=1	t=2
<b>Storage</b>			
	-1	+1	0
	0	-1	+1
<b>Long-term technology</b>			
If finished			
<i>monitored</i>	-1	0	$R$
<i>unmonitored</i>	-1	0	$\gamma \cdot R$
If liquidated	-1	$r$	0

Banks are able to costlessly monitor entrepreneurs at date 1. Households can also monitor entrepreneurs, but only if they become sophisticated. In order to become sophisticated, a household must pay a proportional utility cost denoted by  $\chi$ .<sup>6</sup> Households choose whether or not to become sophisticated at date 0, after observing the deposit contracts offered by banks.

At date 1, households learn whether they are patient or impatient. Patient households only derive utility from consuming at date 1, while impatient households only derive utility from consuming at date 2. The probability of being impatient is

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<sup>6</sup>While assuming a proportional cost simplifies the exposition, we conjecture that modelling the cost differently would yield qualitatively similar results. Assuming a resource cost instead of a utility cost yields similar results as shown in Fecht, Huang, and Martin (2004).

denoted by  $q$ . We assume a law of large number holds so that  $q$  also denotes the fraction of impatient households in the economy. The expected utility of a household from consuming  $c_t$  with  $t = 1, 2$  can thus be written as

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

if it remains unsophisticated. The expected utility of a sophisticated household is given by

$$U(c_1, c_2) = \begin{cases} \chi \cdot u(c_1) & \text{with probability } q \\ \chi \cdot u(c_2) & \text{with probability } 1 - q \end{cases} \quad (2)$$

where  $\chi$  denotes the disutility from the effort required to become sophisticated. Similarly, if a household prefers to deposit the endowment with a bank from another region its expected utility is discounted by  $\mu$ , reflecting the disutility due to the additional effort that has to be spent in that case. The intratemporal utility function is assumed to display constant relative risk aversion:  $u(c_t) = \frac{1}{1-\alpha} c_t^{1-\alpha}$ , with  $\alpha > 1$ .<sup>7</sup>

Banks offer households a deposit contract. A deposit contract specifies the repayment  $d_1$  that depositors receive if they withdraw their funds in  $t = 1$  and the repayment  $d_2$  that those depositors receive that keep their deposits until date 2.

Before banks decide about the 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 licences to run a regional bank. The bank managers that can credibly promise to distribute the highest profit to the households in the economy receive a licence. Bank managers can only realize the maximum feasible profit  $\Pi$  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 be always 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  $\delta\Pi$ .<sup>8</sup>

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<sup>7</sup>Note that because the utility function is a negative function  $\mu, \chi > 1$ . A higher number means more disutility.

<sup>8</sup>There are several other explanations why monopoly rents might lead to inefficiencies and why the profits cannot be distributed entirely to household. For instance, we could relate this managerial moral hazard problem to the return on the long-term investment technology and assume that only a

### 3 Monopolistic banking system

In this section we study the problem of a monopolistic bank. We assume that the local bank does not compete with other banks for depositors; i.e.,  $\mu = \infty$ . The local bank's monopoly position is only challenged by the ability of households to invest directly in the centralized financial market.

#### 3.1 The profit maximizing deposit contract

The deposit contract  $\{d_1; d_2\}$  offered by the bank maximizes profits subject to a number of constraints.<sup>9</sup> First, the deposit contract must ensure that households prefer to deposit their funds with the bank rather than investing in the storage technology if they decide to stay naïve. Let  $M$  denote 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:  $M = 1 + \delta\Pi$ . Thus this participation constraint, denoted by  $(PC_N)$ , is given by

$$qu(d_1) + (1 - q)u(d_2) \geq u(M). \quad (3)$$

In addition, the optimal deposit contract must also provide an incentive for households not to become sophisticated and invest directly at the financial market. The arbitrage-free 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.<sup>10</sup> Consequently, the constraint that households remain naïve, denoted by  $(PC_S)$ , can be written as

$$qu(d_1) + (1 - q)u(d_2) \geq \chi qu(M) + \chi(1 - q)u(RM). \quad (4)$$

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

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certain fraction of  $R$  would be realized if bank managers did not spend their 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 relation. See, for instance, Harris and Raviv (1990) and Aghion and Bolton (1992).

<sup>9</sup>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.

<sup>10</sup>See Fecht (2004) for a detailed explanation.

turn out to be patient. Sophisticated households would choose this option if

$$\chi qu(M) + \chi(1-q)u(RM) < \chi qu(d_1) + \chi(1-q)u(Rd_1), \quad (5)$$

which obviously only holds if  $d_1 > M$ . As shown in the Appendix, the monopolistic deposit contract always satisfies  $d_1 \leq M$ , so  $(PC_S)$  is the relevant constraint.<sup>11</sup>

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

The profit maximizing deposit contract is also subject to another incentive compatibility constraints, denoted by  $(IC_N)$ , which ensures that naïve 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

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

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

Comparing  $(PC_S)$  and  $(PC_N)$  shows that if the cost  $\chi$  of becoming sophisticated is above the threshold level

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

households stay naïve even if they plan to invest directly in either technology (see Appendix for the derivation of  $\bar{\chi}$ ). In that case,  $(PC_N)$  is the only binding constraint. If  $\chi \leq \bar{\chi}$ , naïve households do not invest in the centralized financial market and  $(PC_N)$  is never binding. If  $\chi \in [\underline{\chi}, \bar{\chi})$ , where  $\underline{\chi}$  is given by

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

then  $d_1 < M$  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

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<sup>11</sup>So in the present paper sophisticated households never invest in deposits that they withdraw to buy claims against the corporate sector in the financial market if they turn out to be patient. This contrast to the equilibrium in Fecht, Huang, and Martin (2004) results from the assumptions in the present paper that banks are regional monopolists and offer their deposit contract before households decide whether to become sophisticated or not.

becoming sophisticated is even lower, so that  $\chi \in [1, \underline{\chi})$ , then  $d_1 = M$  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

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

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. Since this contract is independent of  $\chi$ , the monopolist deposit contract is the same for all  $\chi \in [\bar{\chi}, \infty]$ .

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

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

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

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

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

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

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

The degree of risk-sharing offered by this contract is

$$\Theta = \left[ \frac{\chi[q + (1-q) \cdot R^{1-\alpha}] - q}{(1-q)} \right]^{1/(1-\alpha)} \quad (6)$$

Thus when  $\chi \in [1, \underline{\chi}]$  a decrease in  $\chi$  not only increases the average repayments to households, and therefore their expected utility, but also changes the degree of liquidity insurance,  $\Theta$ , provided by the deposit contract.

We can summarize the effect of a change in the cost of becoming a sophisticated investor in the following proposition.

**Proposition 1** *For  $\chi < \bar{\chi}$  a reduction in the cost of becoming a sophisticated investor improves the outside option of households vis-à-vis the monopolistic bank. 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.*

### 3.2 Equilibrium monopoly rent and households' wealth

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

$$\Pi = M - qd_1 - (1 - q)\frac{d_2}{R}. \quad (7)$$

For different values of  $\chi$ , 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

$$\Pi = M - qAM - (1 - q)AMR^{(1-\alpha)/\alpha}, \quad (8)$$

where

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

Rearranging yields

$$\Pi = \left( 1 - (q + (1 - q)R^{(1-\alpha)/\alpha})^{\alpha/(\alpha-1)} \right) M, \quad (9)$$

with details provided in the Appendix. Not surprisingly, in this interval the monopoly rent is independent of  $\chi$ .

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

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

where

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

with details provided in the Appendix. In this interval a reduction in  $\chi$  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

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

with details are provided in the Appendix. In this interval also, a decrease in  $\chi$  increased the outside option of households, forcing the bank to increase the level of repayment on the deposit contract. It is thus not surprising that a decrease in  $\chi$  reduces the monopoly rent in this case as well.

We can state the following proposition.

**Proposition 2** *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  $\chi$  reduces the monopoly rent of banks.*

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,

$$M = 1 + \delta\Pi. \quad (10)$$

For different values of  $\chi$ , inserting the relevant value of  $\Pi$  into the above equation yields the households' equilibrium wealth.

If  $\chi > \bar{\chi}$  the monopoly profits are given by (9). Substituting this expression into equation (10) yields

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

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

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

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

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

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

We can now state the following proposition.

**Proposition 3** *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  $\chi$  reduces the initial wealth of households.*

### 3.3 Households' welfare and the optimal $\chi$

In this section, we find the value of  $\chi$ , denoted by  $\chi^*$ , that maximizes the expected utility received by households that invest in a monopolist bank. First we show that that  $\chi^* \in [1, \underline{\chi})$ .

Clearly,  $\chi^*$  does not belong to  $[\bar{\chi}, \infty)$ , since this interval provides the lowest expected utility for households. In this case,  $\chi$  is so large that becoming sophisticated in order to invest directly in the financial market is not a relevant alternative for households. Indeed, for such high values of  $\chi$  a household invests only in the storage technology. Changes in the value of  $\chi$  in this interval affect neither the deposit contract, nor the monopoly rent, nor the households' wealth.

Whenever  $\chi \in [\underline{\chi}, \bar{\chi})$  a reduction in  $\chi$  improves the outside option of households by increasing the expected utility received from direct investments in the financial market. Therefore, 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 so that a decrease in  $\chi$  increases households' expected utility. To see that, note in this case the expected utility of a household is given by

$$E[U(d_1, d_2)] = (q + (1 - q)R^{1-\alpha}) \frac{M^{1-\alpha}}{1 - \alpha} \chi. \quad (11)$$

Recall  $M$  is a function of  $\chi$ . Differentiating with respect to  $\chi$  yields

$$\frac{\partial E[U]}{\partial \chi} = - (q + (1 - q)R^{1-\alpha}) \frac{M^{2-\alpha}}{\alpha - 1} (1 - \delta) < 0, \quad (12)$$

with details provided in the Appendix. Consequently, reducing the costs of becoming an efficient investor is always welfare improving in that interval because it reduces the monopoly rent of banks and thereby limits the inefficiencies associated with these rents.

The most interesting case is when  $\chi \in [1, \underline{\chi})$ . In that case a second effect goes against the efficiency gains arising from reducing the monopoly rent. Indeed, for

such low levels of  $\chi$  the liquidity insurance provided by the deposit contract worsens as  $\chi$  decreases, reducing the households' welfare. Consequently a trade-off emerges between these two effects and the optimal value of  $\chi$  must balance both costs. To see this, note that the expected utility of households in this case is

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

To solve for the optimal value of  $\chi$ , we first find the value of  $\Theta$  which maximizes households' expected utility and then back out the corresponding value of  $\chi$ . The optimal  $\Theta$  is a solution to

$$\frac{\partial E[U]}{\partial \Theta} = (1 - q)\Theta^{-\alpha}M^{1-\alpha} + [q + (1 - q)\Theta^{1-\alpha}]M^{-\alpha}\frac{\partial M}{\partial \Theta} = 0. \quad (13)$$

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

$$M = \frac{1}{1 - \delta(1 - q)(1 - R^{-1}\Theta)},$$

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

Substituting for these in equation (13) and rearranging yields

$$\Theta^* = \left( \frac{1 - \delta + \delta \cdot q}{\delta \cdot q} \cdot R \right)^{1/\alpha}, \quad (14)$$

with details provided in the Appendix. Using equation (6) it is easy to see that the optimal  $\chi$  is

$$\chi^* = \frac{(1 - q) \left( \frac{\delta \cdot q}{1 - \delta + \delta \cdot q} \right)^{(\alpha-1)/\alpha} R^{(1-\alpha)/\alpha} + q}{(1 - q)R^{(1-\alpha)} + q}. \quad (15)$$

Now we can state the following proposition.

**Proposition 4** *Improving financial market access of households is not necessarily welfare enhancing. If  $\chi \in [\bar{\chi}, \infty]$  changing  $\chi$  does not affect welfare. If  $\chi \in [1, \chi^*]$  a reduction in  $\chi$  strictly decreases welfare. Only in the case  $\chi \in [\chi^*, \bar{\chi}]$  does a decrease in  $\chi$  increase welfare. In that case, reducing the inefficiencies due to the monopoly rents dominates the cost of reducing the risk-sharing provided by the equilibrium deposit contract.*

Figure 1: Households' utility in a monopolistic banking system

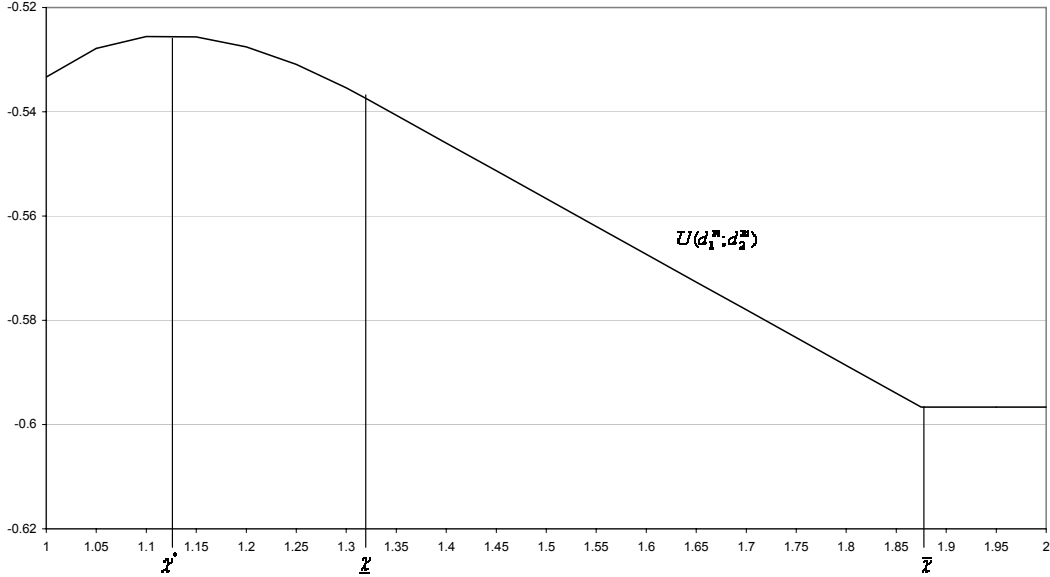


Figure 1 depicts the expected utility received by a household under the monopolist deposit contract (the figure assumes  $R = 3$ ,  $q = 0.3$ ,  $\alpha = 2$ , and  $\delta = 0.8$ ).

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

$$1 > \delta > \frac{1}{qR^{1/(\alpha-1)} + (1-q)} \quad (16)$$

(details are provided in the Appendix).

Whenever there are some inefficiencies associated with the monopoly power of banks ( $\delta < 1$ ),  $\chi^*$  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 expression (15) that, whenever (16) holds,

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

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

We can summarize these findings in the following proposition.

**Proposition 5** *If there are some inefficiencies associated with monopoly power, the cost to become sophisticated should be reduced to  $\chi^* < \underline{\chi}$  to limit these inefficiencies even though this reduces risk-sharing. The optimal cost of becoming sophisticated decreases as the inefficiencies due to the monopoly power increase.*

## 4 Monopolistically competitive banking system

In this section, we relax the assumption that  $\mu = \infty$ . If  $\mu$  is sufficiently low, each regional bank must be concerned that local households might deposit their wealth in the bank of another region. We assume that households can only deposit money in either bank at  $t = 0$ . In  $t = 1$  households can only invest over the centralized financial market. Thus if banks want to raise funds in  $t = 1$  they have to issue bank bonds. Just like in the case of bonds issued by the non-financial corporate sector — households can only efficiently invest in these bank bonds if they spend the utility cost  $\chi$  to become sophisticated.<sup>12</sup>

### 4.1 The non-local deposit contract

We assume that there is at least one bank, called the non-local bank, which does not have any depositors in its region. This bank will have depositors only if it can attract them from other regions. The contract offered by the non-local bank is the

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<sup>12</sup>This assumption reflects the argument put forward in Diamond and Rajan (2001) that a deposit contract only provides a credible disciplining device of the borrower because of the threat that lenders withdraw on an unexpectedly large scale if the borrower misbehaves. If a deposit contract incorporates no such option—because it is due after one period anyway—it is subject to the same inefficiencies as other financial claims against the corporate sector.

Note that if we would assume that banks could also raise one-period deposits in  $t = 1$ , non-local banks could offer one-period deposits in  $t = 1$  promising for each unit deposited a repayment smaller but close to  $R$  in  $t = 2$ . This would be beneficial for non-local banks because it provides them with liquidity at a lower cost than investing in the storage technology in  $t = 0$ . If households utility costs of switching to a non-local bank in  $t = 1$  is sufficiently low then they will indeed withdraw their funds from their regional bank and deposit them at the non-local bank. In order to prevent this, regional banks have to limit the degree of risk-sharing provided by their initial deposit contract. Thus allowing to switch deposits from the local to a non-local bank in  $t = 1$  at a cost has the same effect as the secondary financial market access of households described in the previous section.

outside option against which local banks—those that do have depositors in their region—must compete.<sup>13</sup>

Because of competition between banks, the non-local bank offers a deposit contract which maximizes the utility of depositors, subject to some constraints. First, since it has no depositors in its region, the non-local bank makes zero profits. Hence this bank's budget constraint, denoted by  $(BC)$ , is given by

$$qd_1 + (1 - q) \frac{d_2}{R} = M. \quad (17)$$

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 naïve is  $(PC'_S)$ , or

$$qu(d_1) + (1 - q)u(d_2) \geq \chi qu(d_1) + \chi(1 - q)u(Rd_1). \quad (18)$$

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

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

Hence, the non-local bank offers the deposit contract

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

The degree of risk-sharing provided by this contract is

$$\frac{d_2^*}{d_1^*} = \Gamma = \max \{ R^{1/\alpha}; \Theta \}, \quad (19)$$

where  $\Theta$  is defined in equation (6).

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

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<sup>13</sup>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.

depositors' utility subject to  $(BC)$ , which in this case is equivalent to a resource constraint. 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 in  $t = 1$ , 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  $\Theta$ , a lower cost of becoming sophisticated reduces risk-sharing (i.e., increases  $\Theta$ ).

As will be shown in the next section, if  $\mu$  is sufficiently small, so that the deposit contract offered by the non-local bank constrains the contract offered by local banks, then the agent's wealth,  $M$ , is independent of  $\chi$ . Hence, a decrease in risk-sharing will imply a lower utility for depositors. We can now state the following proposition.

**Proposition 6** *The equilibrium deposit contract offered by the non-local bank is not affected by changes of  $\chi$  if  $\chi \in [\underline{\chi}, \infty]$ . If  $\chi \in [1, \underline{\chi}]$  then the risk-sharing provided by the equilibrium deposit contract decreases as  $\chi$  decreases.*

## 4.2 The local deposit contract

When  $\mu$  is finite, local banks must potentially take into account the competition from the non-local bank. If  $\mu$  is sufficiently high, the local bank will still be able to offer the contract derived in section 3. However, if  $\mu$  is low then the local bank must offer a contract which provides incentives for depositors in its region not to invest in the non-local bank. This constraint, which we denote  $(PC_C)$ , can be written as

$$qu(d_1) + (1 - q)u(d_2) \geq \mu qu(d_1^*) + \mu(1 - q)u(d_2^*). \quad (20)$$

It is easy to see that if  $(PC_C)$  binds then  $d_1 > M$ . Hence the local bank also faces the constraint  $(PC'_S)$ . The local bank thus solves the following problem.

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

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

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

Note that if both  $(PC_C)$  and  $(PC'_S)$  bind, then the deposit contract is given by the intersection of these two constraints holding at equality.

If  $\mu$  decreases, the repayment to households from the contract offered by their local bank obviously increases. A reduction in  $\chi$  does not affect the repayment on the deposit contract of local banks if  $\chi \in [\underline{\chi}, \infty)$  because in that case  $(PC'_S)$  is not binding. However, if  $\chi \in [1, \underline{\chi})$  a decrease in  $\chi$  leads to a decrease in the degree of risk-sharing, a decrease in  $d_1$ , and an increase in  $d_2$ .

For a given  $\chi$ , there exists a threshold value for  $\mu$  such that if  $\mu$  is above that threshold then the regional bank offers the monopolist deposit contract derived in section 3 and denoted by  $\{d_1^m; d_2^m\}$ . However, if  $\mu$  is below the threshold value, then the local bank offers the contract  $\{d_1^c; d_2^c\}$  derived in this section. The threshold value of  $\mu$ , denoted by  $\bar{\mu}$  is the one that makes depositors indifferent between the two contracts.

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

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

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

$$\bar{\mu} = [q + (1-q)\Theta R^{-1}]^{1-\alpha}. \quad (21)$$

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

$$\bar{\mu} = \chi \frac{q + (1-q)R^{1-\alpha}}{\left[q + (1-q)R^{\frac{1-\alpha}{\alpha}}\right]^\alpha}. \quad (22)$$

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

$$\bar{\mu} = \left[q + (1-q)R^{\frac{1-\alpha}{\alpha}}\right]^{-\alpha}. \quad (23)$$

Whenever  $\chi > \bar{\chi}$ , the threshold value of  $\mu$  is independent of  $\chi$ . This is not surprising since neither the deposit contract  $\{d_1^m; d_2^m\}$  nor  $\{d_1^c; d_2^c\}$  depend on  $\chi$ . When  $\chi \leq \bar{\chi}$ ,  $\bar{\mu}$  increases as  $\chi$  increases.

Thus  $\bar{\mu}$  is a weakly increasing function of the costs  $\chi$  of becoming a sophisticated investor. If the costs of investing efficiently in the financial markets are high then the

non-local banks can offer a more efficient deposit contract. Consequently, the costs of depositing at a non-local bank  $\mu$  must be higher to leave the deposit contract of a monopolistic local bank unconstrained by the competition of non-local banks.

We can summarize our findings in the following proposition:

**Proposition 7** *Whenever  $\mu < \bar{\mu}$ , for a given  $\chi$ , the deposit contract offered by local banks is constrained by the competition with the non-local bank. In that case changes of  $\chi$  have either no effect on the deposit contract offered by the local bank (for  $\chi \in [\underline{\chi}, \infty]$ ) or only affect the risk-sharing offered by that contract (for  $\chi \in [1, \underline{\chi}]$ ). The cutoff  $\bar{\mu}$  increases (weakly) with  $\chi$ .*

### 4.3 Equilibrium monopoly rent and households' wealth

To find banks' profits when competition between local and non-local banks is a binding constraint, we can substitute  $d_1^c$  and  $d_2^c$  into the general profit function given by equation (7) and get

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

Then, substituting this expression into the general equation of households' wealth given by (10) yields

$$M = \frac{1}{1 - \delta (1 - \mu^{-1/(\alpha-1)})}. \quad (24)$$

From (24) we can immediately derive the following proposition.

**Proposition 8** *Whenever competition among banks is binding ( $\mu < \bar{\mu}$ , for a given  $\chi$ )  $M$  is independent of  $\chi$ . Changes in  $\chi$  do not affect the inefficiencies related to the monopoly rent of banks.*

### 4.4 Households' welfare and the effect of $\chi$

Inserting the households' equilibrium wealth and the optimal deposit contract offered if  $\chi \in [\underline{\chi}, \infty]$  in the expected utility function yields (see Appendix for details)

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

This is the households' welfare in the case where competition between banks limits local banks' monopoly power, but direct financial market access does not restrain

the risk-sharing provided by the equilibrium deposit contract. It is easy to see that in this case a change in  $\chi$  does not have any welfare effect. A decrease in  $\mu$ , 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  $\delta$ ) the more beneficial is a reduction in local banks' monopoly power.

If  $\chi \in [1, \underline{\chi}]$  then the local banks' equilibrium deposit contract is not only constrained by competition with non-local banks. The financial market access of households also restrains the equilibrium contract in that it limits the degree of risk-sharing the contract can provide. In that case households' expected utility is given by (see Appendix for details)

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

Since  $\frac{\partial \Theta}{\partial \chi} > 0$ , it is easy to see that households' expected utility decreases strictly when the cost of becoming sophisticated decreases. As long as the monopoly rent is determined by the competition between the local and non-local banks, rather than by the competition between banks and markets, a more efficient financial market access of households only limits the risk-sharing that the deposit contract provides.

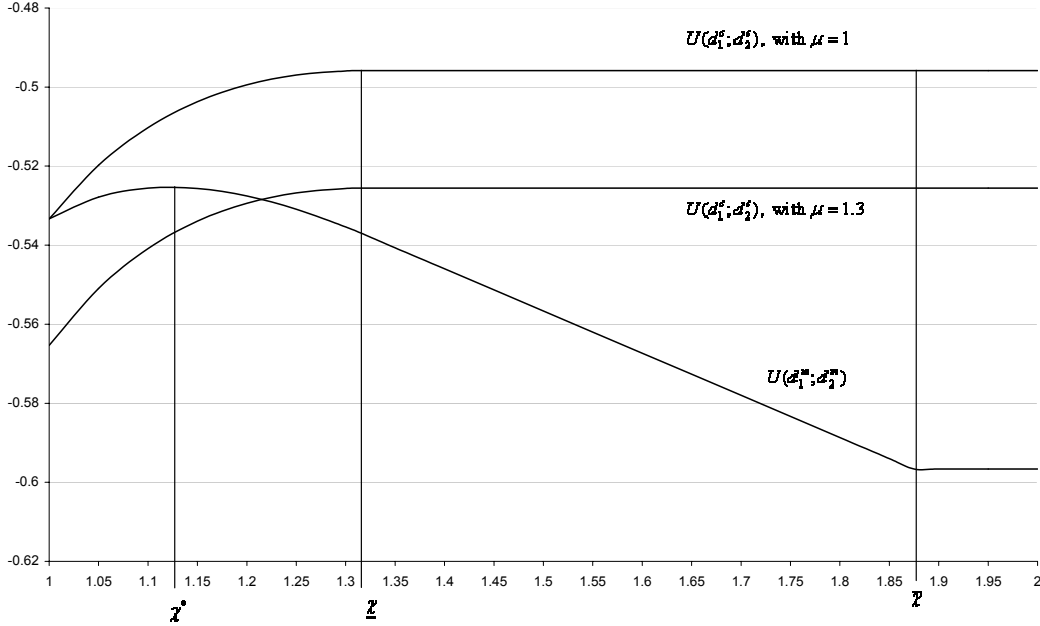
**Proposition 9** *Whenever for a given  $\chi$ ,  $\mu > \bar{\mu}$  improving financial market access of households (lowering  $\chi$ ) is not welfare improving. In that case competition among banks efficiently restrains banks' monopoly rents. Lower costs of becoming sophisticated have either no effect (for  $\chi \in [\underline{\chi}, \infty)$ ) or decrease welfare (for  $\chi \in [1, \underline{\chi}]$ ), because they reduce the available risk-sharing in the economy.*

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  $\mu$  (the figure assumes  $R = 3$ ,  $q = 0.3$ ,  $\alpha = 2$ , and  $\delta = 0.8$ ). Graphically, an increase in  $\mu$  simply lowers the curve showing the expected utility provided by the competitive deposit contract.

## 5 The globally optimal financial market access

In the two previous sections we have shown that in an economy in which the banking system is not sufficiently competitive there is an optimal cost of financial mar-

Figure 2: Households' utility in competitive banking systems



ket access for households that trades off the welfare improving reduction of banks' monopoly rent versus the inefficiencies due to suboptimal risk-sharing. If the banking system is sufficiently competitive, welfare is maximized if households have no efficient access to financial market, because in these economies the option of households to invest in the financial market only limits the risk-sharing the deposit contract offers. Inefficiencies due to banks' monopoly rents are limited by the competition among banks and not by the financial market access of households. Consequently, in these economies increasing households' costs of accessing the financial market always improved welfare. In this section we address the question of how intense competition between banks has to be for a competitive banking sector without efficient financial market access of households to be preferable to a monopolistic banking sector with the optimal degree of financial market access of households.

As shown above, 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

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

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  $\mu$ , is achieved for  $\chi \geq \underline{\chi}$ . The expected utility offered by this contract is

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

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

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

and is given by

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

Thus we can state the following proposition.

**Proposition 10** *If the costs of switching to non-local banks are sufficiently small ( $\mu < \underline{\mu}, \bar{\mu}$ ) in the competitive banking system, then the competitive banking system without efficient financial market access ( $\chi \geq \underline{\chi}$ ) of households is more efficient than a monopolistic banking system ( $\mu > \bar{\mu}$ ) with the optimal costs of accessing the financial market ( $\chi = \chi^*$ ).*

## 6 Conclusion

In the paper we study the deposit contract offered by banks when they face competition from a financial market and from other banks. When competition from other banks is too weak, promoting competition from the financial market can be welfare improving. Competition reduces the monopoly rents that banks can extract

and limits the inefficiencies associated with these rents. However, competition from the financial market at the same time restrains the risk-sharing offered by banks. Hence, there is a point after which more competition from the market will decrease depositors' welfare. When competition from other banks is strong enough, competition from the financial market is no longer necessary to reduce monopoly rents. In that case, the competition among banks limits banks' monopoly rents. The only effect of increased competition between banks and the financial market is to reduce risk-sharing. Thus our results suggest that even though greater access to financial markets might be preferable if competition between banks is not sufficiently strong, if banks compete with each other intensely enough, increased competition from a financial market might be welfare reducing.

We can also show that if in a particular financial system the competition among banks is higher than a threshold level (and the banks' monopoly rents are therefore sufficiently reduced) but households cannot efficiently invest at the financial market then this financial system is preferable to a financial system with weak competition among banks but an efficient access of households to the financial market.

We conclude that while in the U.S. and the UK financial systems with a less competitive banking sector the increased participation of private households in financial markets might have been preferable, these developments are likely to be welfare reducing in Germany where competition between banks seems to be more intense. The still increasing level of competition within the German banking industry makes this conclusion even more relevant.

One limitation of our model is that, by assumption, competition among banks does not affect the ability of banks to attract depositors from other banks in the interim period. This is why changes to the degree of competition between banks do not restrain the risk-sharing provided by the banks. However, allowing for such an effect of competition between banks does not change the results for reasonable parameter settings. It would only provide a reason why, in this context, the maximum degree of competition between banks is not necessarily optimal. We leave the study of this effect in our framework for further research.

Obviously, another interesting dimension to extend this framework is to analyze the implications of changes in competition between banks and between banks and markets on the stability of the financial system. 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. Similar to Fecht (2004) an improved access of households to financial markets would, on the one hand, reduce the negative impact of fire-sales of troubled banks. On the other hand, banks are more sensitive to changes in the price of claims against the corporate sector if households become more efficient in investing directly at the financial market. But in addition to Fecht (2004) in our framework the effect of changes in competition between banks and financial markets on banks' monopoly rents is taken into account. Since banks' monopoly rents serve as a buffer in crisis periods this effect would add an interesting additional dimension.

## Appendix

**Proof that the monopolistic contract always satisfies  $d_1 \leq M$ :**

To 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 spent 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 which 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  $(P1')$

$$(P1') \left\{ \begin{array}{ll} \max_{d_1^B; d_2^B} & M - q \cdot d_1 - (1 - q) \cdot \frac{d_2}{R} \\ \text{s.t.} & q \cdot u(d_1) + (1 - q) \cdot u(d_2) \geq \\ & \chi \cdot q \cdot u(d_1) + \chi \cdot (1 - q) \cdot u(R \cdot d_1) \quad (PC'_S) \\ & d_2 \geq d_1 \quad (IC_N) \\ & d_1 > M \quad (IC'_S) \\ & q \cdot u(d_1) + (1 - q) \cdot u(d_2) \geq \frac{1}{1-\alpha} M^{1-\alpha} \quad (PC_N) \end{array} \right.$$

It is obvious that for any contract satisfying  $(IC_N)$  and  $(IC'_S)$ ,  $(PC_N)$  will hold. From  $(PC'_S)$  it follows that the risk-sharing of the contract solving  $(P1')$  must satisfy

$$d_2 \geq \Theta \cdot d_1. \quad (25)$$

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

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.

**Derivation of  $\bar{\chi}$ :**

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

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

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

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

so we can write

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

**Derivation of  $\underline{\chi}$ :**

The expression for  $\underline{\chi}$  comes from equation (4) at equality and substituting  $M = d_1$  and  $d_2 = R^{\frac{1}{\alpha}}d_1$ . This yields

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

Eliminating  $u(d_1)$  gives the result.

**Calculation of the equilibrium rent of a monopolistic bank**

Recall,

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

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

**If  $\chi \in [\bar{\chi}, \infty]$ :**

Rearranging (8) yields

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

Substitute for  $A$  to get

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

Simple algebra implies

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

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

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

**If  $\chi \in [\underline{\chi}, \bar{\chi}]$ :**

Substitute for  $d_1$  and  $d_2$  in equation (7) to get

$$\Pi = M - q \cdot A \cdot B \cdot \chi^{1/(1-\alpha)} \cdot M - (1 - q) \cdot A \cdot B \cdot \chi^{1/(1-\alpha)} \cdot M \cdot R^{(1-\alpha)/\alpha} \quad (26)$$

Rearranging (26) yields

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

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

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

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

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

**If  $\chi \in [1, \underline{\chi}]$ :**

Substitute for  $d_1$  and  $d_2$  in equation (7) to get

$$\Pi = M - q \cdot M - (1 - q) \cdot \Theta \cdot M \cdot R^{-1}. \quad (27)$$

Rearranging (27) yields

$$\Pi = M - (q + (1 - q) \cdot R^{-1} \cdot \Theta) \cdot M,$$

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

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

### Derivation of the welfare optimum in the monopoly case

**If  $\chi \in [\underline{\chi}, \bar{\chi}]$ :**

We can show that  $\partial E[U] / \partial \chi < 0$ .

To simplify notation the deposit contract and households' wealth can be written as

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

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

A depositor's expected utility is thus given by

$$\begin{aligned} E[U(d_1, d_2)] &= q \frac{1}{1-\alpha} \chi (A \cdot B \cdot M)^{1-\alpha} + (1-q) \frac{1}{1-\alpha} \chi (A \cdot B \cdot M)^{1-\alpha} R^{\frac{1-\alpha}{\alpha}} \\ &= \frac{1}{1-\alpha} \left( q + (1-q) R^{\frac{1-\alpha}{\alpha}} \right) \chi (A \cdot B \cdot M)^{(1-\alpha)} \\ &= \frac{1}{1-\alpha} \chi (B \cdot M)^{(1-\alpha)}. \end{aligned}$$

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

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

Combining these two expressions yields

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

**If  $\chi \in [1, \underline{\chi}]$ :**

Recall,

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

and

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

Take the derivative of  $E[U]$  with respect to  $\Theta$  and set it equal to zero to get

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

$$\iff (1 - q) \Theta^{-\alpha} M + [q + (1 - q) \Theta^{1-\alpha}] \frac{\partial M}{\partial \Theta} = 0.$$

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

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

Now substitute for  $M$  and multiply both sides by  $\Theta^\alpha$  to get

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

The remaining steps follow from simple algebra

$$R - \delta \cdot (1 - q) \cdot (R - \Theta) = \delta \cdot q \cdot \Theta^\alpha + \delta \cdot (1 - q) \cdot \Theta,$$

$$R - \delta \cdot (1 - q) \cdot R = \delta \cdot q \cdot \Theta^\alpha,$$

$$\frac{1 - \delta \cdot (1 - q)}{\delta \cdot q} \cdot R = \Theta^\alpha,$$

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

We also know from equation (6) that

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

Thus

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

### Derivation of condition (16):

We start with the condition

$$\chi^* > 1,$$

where  $\chi^*$  is given by equation (15). Rearranging yields

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

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

and finally

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

Similarly, starting with the condition

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

we get

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

which is equivalent to

$$1 > \delta.$$

To summarize, there is an interior solution if

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

**Derivation of households' expected welfare in the competition case:**

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

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

and households' wealth is given by

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

The expected utility of a household can thus be written

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

$$U(d_1^c; d_2^c) =$$

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

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

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

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

where  $M$  is the same as above and  $\Theta$  is defined in equation (6). Thus the households' expected utility in that case is

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

Substitute for  $M$  to get

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

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