On the Stability of Different Financial Systems

Falko Fecht

Discussion paper 10/03
Economic Research Centre
of the Deutsche Bundesbank

March 2003

Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-1
Telex within Germany 41227, telex from abroad 414431, fax +49 69 5601071

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax No. +49 69 9566-3077

ISBN 3–935821–53–0

Abstract

An economy in which deposit-taking banks of a Diamond/ Dybvig style and an asset market coexist is modelled.

Firstly, within this framework we characterize distinct financial systems depending on the fraction of households with direct investment opportunities that are less efficient than those available to banks. With this fraction comparatively low, the evolving financial system can be interpreted as *market-oriented*. In this system, banks only provide efficient investment opportunities to households with inferior investment alternatives. Banks are not active in the secondary financial market nor do they provide any liquidity insurance to their depositors. Households participate to a large extent in the primary as well as in the secondary financial markets. In the other case of a relatively high fraction of households with inefficient direct investment opportunities, a *bank-dominated* financial system arises, in which banks provide liquidity transformation, are active in secondary financial markets and are the only player in primary markets, while households only participate in secondary financial markets.

Secondly, we analyze the effect a run on a single bank has on the entire financial system. Interestingly, we can show that a bank run on a single bank causes contagion via the financial market neither in market-oriented nor in extremely bank-dominated financial systems. But in only moderately bank-dominated (or hybrid) financial systems fire sales of long-term financial claims by a distressed bank cause a sudden drop in asset prices that precipitates other banks into crisis.

Zusammenfassung

Im vorliegenden Papier wird eine Ökonomie modelliert, in der Diamond/ Dybvig-Banken neben einem Finanzmarkt koexistieren.

Innerhalb dieses Ansatzes lässt sich zunächst zeigen, dass zwei sehr unterschiedliche Finanzsysteme entstehen, je nach dem wie hoch der Anteil von solchen Haushalten in der Ökonomie ist, die im Vergleich zu Banken weniger effiziente Anlagemöglichkeiten am Finanzmarkt haben. Ist der Anteil dieser Haushalte vergleichsweise gering, so entsteht ein Finanzsystem, das sich als *markt-orientiertes* auffassen lässt. In diesem System beschränkt sich die Funktion von Banken darauf, auch den Haushalten mit weniger rentablen Direktanlagemöglichkeiten eine effiziente Investitionsalternative zu bieten. Während hier Banken nicht am sekundären Finanzmarkt partizipieren, handeln private Haushalte sowohl am Primär- als auch am Sekundärmarkt. Einlageverträge von Banken bieten in diesem Finanzsystem keine Liquiditätsversicherung. Ist hingegen der Anteil der Haushalte mit wenig effizienten Direktanlagemöglichkeiten vergleichsweise hoch, so bildet sich eine *bank-dominiertes* Finanzsystem heraus, in dem Bankeinlagen sehr wohl eine Liquiditätsversicherung darstellen. In diesem Finanzsystem sind *nur* die Banken am Primärmarkt aktiv und partizipieren darüber hinaus auch am Sekundärmarkt. Sämtliche private Haushalte handeln hingegen nur am Sekundärmarkt.

In einem zweiten Schritt wird der Effekt untersucht, der vom Zusammenbruch einer Bank auf das gesamte Finanzsystem ausgeht. Interessanterweise zeigt sich hier, dass ein Run auf eine Bank weder in einem markt-orientierten noch in einem stark bank-dominierten Finanzsystem zu Ansteckungseffekten über den Finanzmarkt führt. Nur in schwach bank-dominierten (oder hybriden) Finanzsystemen verursachen die Notverkäufe von langfristigen Finanztiteln durch eine illiquide Bank einen Preisverfall dieser Anlagen, der weitere Banken zusammenbrechen lässt.

Contents

On the Stability of Different Financial Systems*

1 Introduction

1.1 Motivation

The financial systems of the major industrialized economies differ to a large extent. In general, the German financial system and the financial system of the Anglo-Saxon type are perceived as the two polar extremes between which all other developed countries can be classified.[1]

One of the main respects in which the German and Anglo-Saxon financial systems differ is the relative importance of banks and markets in channelling funds saved by households to investing firms. While in the US the ratio of bank assets to GDP in 1993 was only about a third of the respective German ratio, the reverse holds for the relation of equity market capitalization to GDP: Here the ratio in Germany was about a third of the US figure.[2] Correspondingly, households' direct holdings (and indirect holdings via pension funds, insurance companies, and mutual funds) of financial claims against the non-financial private sector are much higher in the US than in Germany, where households still invest a larger proportion of their portfolio in cash and cash equivalents (i.e. demand deposits).[3] But not only the size of the banking sector differs in the two contrasting financial systems, the structure of the banking sector is also quite distinct. In the US the Glass-Steagall Act of 1933 decreed a separation of commercial banking activities and investment banking that - although gradually relaxed in recent decades - continues to have an effect. Deposit-taking and loan-granting banks still rarely underwrite securities and do not generally invest in equity holdings. In contrast, German banks are mainly universal banks that take deposits and grant loans, while at the same time underwriting securities and holding large stakes in equity and other securities of private corporations.[4]

As pointed out in Allen and Gale (1995) these particular differences in the institutional structure enable the two distinct financial systems to deal more or less efficiently with different types of risks. While the market-based financial system provides households with a richer menu of financial instruments to hedge against cross-sectional risks, bank-

*I would like to thank Christian Pfeil and Marcel Tyrell for fruitful discussions and very useful suggestions. I am also indebted to Patrick Bolton, Jürgen Eichberger and Elu von Thadden for very helpful comments.

[1]See Allen and Gale (2000a), chapter 1.

[2]See Allen and Gale (2000a), table 3.1, p.48.

[3]See Allen and Gale (2000a), table 3.4, p.51.

[4]Allen and Gale (2000a), p. 52-59 and p. 71-74.

dominated financial systems are more efficient in smoothing non-diversifiable aggregate shocks over time and in providing insurance against idiosyncratic risks if markets are incomplete due to problems of asymmetric information.

It was not only the introduction of the euro, in particular, but also the global stock market boom at the end of the nineties as well as the privatization of large public enterprises that seem to have initiated a change in the German financial system towards a stronger market orientation.[5] The integration of the financial markets within the euro area has increased financial markets' depth and liquidity, making market-based financing more attractive for borrowers and investors alike.[6] In other euro-area countries, such as France, these recent developments speeded up a general tendency towards a stronger market-orientation that was already being observed since the deregulation and liberalization of the late eighties.

One eminent question that is attached to these observations is whether the fragility of the financial system in the euro area, and particularly in Germany, has been increased by these most recent developments.[7] Or, to put the question more generally: is the stability of a financial system in a phase of transition from a bank-dominated towards a market-oriented financial system more endangered than either a bank-based or a market-based system? Are the risks of financial contagion higher in hybrid financial systems, which have neither very liquid financial markets nor an extremely powerful banking industry?

In the first part of this paper, we model a simple economy in which a financial market and deposit-taking banks coexist since a certain fraction of households cannot invest as efficiently as the bank at the financial market. Households are subject to idiosyncratic intertemporal preference shocks, which cannot be verified by the public. Therefore, only banks can provide an efficient liquidity insurance against these shocks. Within this framework, depending on the proportion of households with inferior direct investment opportunities, two distinct financial systems emerge displaying rudimentarily most of the above-mentioned features: With this fraction comparatively low, the evolving financial system can be interpreted as *market-oriented*. In this system, banks only enable those households that cannot efficiently invest directly themselves to benefit from investments in the corporate sector. Banks are not active in the secondary financial market nor do they provide any liquidity insurance to their depositors. Households, by contrast, participate to a large extent in the primary as well as in the secondary financial markets. In the other case of a higher fraction of households without efficient direct investment opportunities, a *bank-dominated* financial system arises, in which banks provide liquidity transformation,

[5]See European Central Bank (2002c) and Deutsche Bundesbank (2000)

[6]See Galati and Tsatsaronis (2001)

[7]A conjecture particularly emphasized in Rajan and Zingales (2002), also raised in Danthine, Giavazzi, Vives, and von Thadden (1999) as well as in Schmidt, Hackethal, and Tyrell (1999) and dealt with in European Central Bank (2002a,b).

are active in secondary financial markets and are the only player in primary markets, while households only participate in secondary financial markets.

The second part of the paper uses this model to analyze how a changing structure of a financial system affects its stability. With regard to this framework, the degree of financial stability is given by the ability of the financial system to cope with a run on a single bank. Therefore, at the heart of this analysis is a certain channel of financial contagion that runs through the capital market by taking the following steps:

- Because of concerns about the stability of an individual bank its depositors withdraw on a large scale.
- The bank has to raise additional liquidity to meet the withdrawals. In order to do so, the bank has to sell-off its long-term assets.
- Since some of the former depositors prefer to hoard money instead of investing it at the financial market, these fire sales cause significant asset price deteriorations.
- In general, banks partially rely on liquidity which they raise by selling long-term assets. Thus, if the asset prices drop owing to fire sales of an individual bank this worsens the liquidity position of other banks, driving them into crisis as well.

Though the model cannot account for the formation of an asset price bubble often observed as preceding a financial crisis, it reasonably captures the self-enforcing process between asset price deteriorations and the escalating collapse of the banking system which is often observed during financial crises.[8]

But, interestingly, this vicious circle only occurs in weakly bank-dominated (or hybrid) financial systems. Neither in market-oriented nor in extremely bank-dominated financial systems do fire sales of long-term financial claims by a distressed bank cause a sudden drop in asset prices that is large enough to precipitate other banks into crisis. The reasoning is rather straightforward: In market-oriented financial systems banks do not trade in the secondary financial market. They do not depend on liquidity raised by selling assets. However, besides the fact that there is no direct effect on the banks' liquidity position, the incentive of depositors to withdraw their deposits to buy assets cheaply is limited since markets are deep and the initial price effect of the fire sales is therefore limited. On the contrary, in strongly bank-dominated financial systems, markets tend to be illiquid and the price effects of fire sales are therefore extreme. However, in these financial systems the trading volume of banks in relation to banks' total assets is low enough. So banks can compensate for losses due to price deteriorations. In hybrid financial systems, in contrast, this ratio is so high that banks cannot buffer the losses and collapse.

[8]See, for instance, the collection of stylized facts in Lai (2002), p.3-5, and the outline of the major crises of the last two decades in Allen and Gale (2001a), p.43/44.

1.2 Relationship to the literature

The role of banks as an efficient risk-sharing mechanism in an environment in which households face unobservable liquidity shocks and in which the yield curve of real investments has a positive slope is obviously borrowed from the seminal work of Diamond and Dybvig (1983). In their model they show that, in contrast to financial markets, demandable debt contracts provide an incentive compatible insurance mechanism that allows for some consumption smoothing between households which turn out to have immediate consumption needs and those that are willing to wait: Demand deposits of a monopolistic bank implement an efficient redistribution from patient households - i.e. long-run depositors - to households with early consumption wishes.

But as we try to model an economy in which deposit-taking banks exist simultaneously with financial markets, the paper takes up the extensive discussion on the possibility of such a coexistence, which started with Jacklin (1987). He showed that, in the standard framework of Diamond and Dybvig (1983), the liquidity insurance of deposit contracts supplied by banks is not incentive compatible for households that turn out to be patient if a financial market coexists. If there is an exit option of switching to an investment at the financial market, depositors who turn out not to have an immediate need for liquidity will expost not be willing to bear the cross-subsidies to impatient depositors implied by the optimal deposit contract. See von Thadden (1999) for a survey of the literature which analyzes the additional frictions, that have to be incorporated into the framework in order to allow for a bank that provides liquidity insurance in the presence of existing financial markets .

Amongst these approaches my model is closest in spirit to Diamond (1997). By assuming that expost - after liquidity shocks have been realized - only a fraction of the patient depositors can really access the financial market, Diamond (1997) shows that the bank can at least implement a liquidity insurance which is more efficient than the intertemporal return structure provided by the financial market. Therefore, by assuming a constraint in the participation of households at the financial markets, Diamond (1997) models an economy in which banks and markets can coexist. As the fraction of households without access to the financial market increases, the degree of liquidity insurance increases and converges to the optimal risk-sharing scheme.

My model differs from Diamond (1997) in three respects. Firstly, in the present model, households know exante (when signing a deposit contract) whether they will have access to the financial markets or not. But the bank does not have that information concerning every single household. It only knows the overall fraction of households that will be able to participate in the financial market. This seemingly small difference in the framework allows the endogenous generation of the two distinct financial systems by simply varying the fraction of households with financial market access. Secondly, we additionally assume that the economy is divided into two regions. In both regions, one bank is the monopolistic supplier of deposit contracts. This additional assumption allows an analysis of the interplay among banks at the financial market. In particular, the effect of fire sales by an individual distressed bank on the financial market and, ultimately, on the other bank can be analyzed. Thirdly, in contrast to Diamond (1997), no household faces infinitely high transaction costs when participating in the financial market in the present model. Owing to informational disadvantages, some households cannot reap the entire return of direct investments. Even though the expected shortfall in return on direct investments is prohibitively high during normal times, if fire sales caused by a bank run depress asset prices severely it may become beneficial, even for these households, to hold financial claims against the corporate sector directly.

There are several papers that also model regional monopolistic banks in an approach based on Diamond and Dybvig (1983) and analyze contagion between these banks through financial markets.[9] But most of this literature deals with propagation mechanisms which run through the interbank market. Aghion, Bolton, and Dewatripont (2000), for instance, show that, if banks are linked by the interbank market and aggregate liquidity shocks are sequentially correlated, a run on a single bank serves as a signal for depositors of other banks to withdraw, triggering off the collapse of the entire banking system. In contrast to these informational spill-overs, Freixas, Parigi, and Rochet (2000) and Allen and Gale (2000b) put forward a contagion mechanism that draws on the credit exposure between banks. While interbank loans are motivated very differently in these two approaches, their main findings tend to be similar. The unexpected default of an interbank loan or the unexpected refusal to roll over such a credit because of a crisis at one bank can push the related banks into a liquidity crisis as well. What is particularly interesting in both models is the observation that the propagation of this crisis to larger parts of the financial system depends on the structure of the interbank market. On the one hand, the smaller the number of other banks with which one institution is (directly and indirectly) interlinked, the larger is the part of the banking sector whose stability is irrelevant to the particular institute's soundness. On the other hand, the more complete the interconnection between the banks is, the more diversified they are and the more likely it is that they can withstand a default of an individual institution.

The propagation mechanism put forward in my model is most closely related to the channel of financial contagion described in Allen and Gale (2001b). In their approach, banks - instead of granting each other credit as in Allen and Gale (2000b) and Freixas, Parigi, and Rochet (2000) - trade long-term assets to reallocate liquidity within the banking sector. In equilibrium there are always banks that try to sell these financial claims because they are in need of liquidity and others that have excess liquidity and prefer to invest it.

[9] See Lai (2002) for a broader survey of different channels of financial contagion and also for a more general overview on contagion in the banking sector.

But if asset prices deteriorate owing to unexpected fire sales of one institution, some other banks that rely on a certain liquidity inflow from asset sales may collapse.

However, contrary to Allen and Gale (2001b), in the present model the asset market is not an interbank market. Instead, as already discussed, we follow Diamond (1997) and assume that households participate in this financial market, too. Besides the fact that this seems to be a more realistic picture of the asset market, it brings about an entirely different motive for banks to sell assets. Here rather than trading assets to reallocate liquidity after negatively correlated aggregate liquidity shocks have occurred in the different regions, banks hold some of their long-term claims in order to sell them to households that turn out to be patient. But more importantly by varying the fraction of those households that can efficiently invest directly at the financial market this approach allows to analyze the strength of the described contagion mechanism in different financial systems. A growing market participation of households increases market depth, reduces liquidity transformation at banks and extends the expected volume of assets traded. The present paper examines the question of how these effects interact with respect to the risk of contagion caused by the depressing effect of asset price deteriorations after fire sales by a collapsing institution.

2 The framework

Agents, preferences, and technologies: The economy is assumed to last two periods and to consist of a linear city of measure 2 with a continuum of households living along the city. All households have exante (in $t = 0$) identical preferences over future consumption, given by

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

The uncertainty concerning the preferred date of consumption is resolved in $t = 1$: At this point in time it becomes clear to every single household whether it is patient - i.e. wants to consume in $t = 2$ - or whether it is impatient and only appreciates consumption goods in $t = 1$. Owing to the law of large numbers, the aggregate amount of patient and impatient consumers is given by $2 \cdot (1-q)$ and $2 \cdot q$, respectively. To simplify notation, we assume a utility function with constant relative risk-aversion:

$$u'(c_t) = c_t^{-a} \qquad a > 1$$

There are two production technologies available in the economy: First, there is a publicly available storage technology which does not pay any interest but enables investors to transfer resources between any two successive points in time. Second, there is a continuum of entrepreneurs in the economy without any initial endowment, but owning a production technology. Entrepreneurs can decide in $t = 1$ either to “behave” or to “shirk”. If they behave they spend full effort on their long-term production project generating a return of R in $t = 2$ for every unit invested in $t = 0$. If they shirk, they spend less effort on the project increasing their private utility but reducing the production of the project to $\gamma \cdot R$, with $R > 1 > \gamma \cdot R > 0$. If liquidated in $t = 1$ the return of a project is always $\epsilon \to 0$. The maximum amount invested per entrepreneur is 1.

	t=0	t=1	t=2
Storage			
	-1	$+1$	0
	0	-1	$+1$
Production			
finished			
behave	-1	0	R
shirk	-1	0	$\gamma \cdot R$
liquidated	-1	$\epsilon \to 0$	0

Financial institutions: There exists a financial market which is located in the centre of the linear city at measure 1. To invest in the long-term and productive technology, households have to use the financial market, whereas to store their initial endowment they can directly invest in the short-term technology. In $t = 0$ households can invest at the primary financial market in the long-term technology by buying financial claims from an entrepreneur. Since an excess demand for funds is assumed, funds are scarce and competition among entrepreneurs will result in an equilibrium promised repayment of R in $t = 2$ for every unit invested in $t = 0$. At the secondary financial market in $t = 1$ households can trade financial claims on the long-term investment against $t = 1$ consumption goods with other agents. In $t = 2$ entrepreneurs pay out the actual return of the project to the current holder of a financial claim.

Households are divided into two groups. Type A households - located within a distance of $(1 - i)$ to the left and to the right of the financial market - can monitor entrepreneurs perfectly. In addition, when investing in a project, type A households immediately learn how to replace a misbehaving entrepreneur without forgoing any of the expected return of the project. Thus type A households can assert the entrepreneurial effort level necessary to realize the return R for every unit invested. In contrast, type B households - farther away from the market - cannot monitor entrepreneurs. Therefore, entrepreneurs financed by those households will always shirk and type B households can only realize a return of $\gamma \cdot R$ even if the financial claim on that firm promises a return of R in $t = 2$.

Besides direct investment opportunities households can deposit money with a bank. A bank is a financial institute that can offer a deposit contract against the initial endowment of households and invest the collected goods in the storage technology and in financial claims on long-term investments bought at the $t = 0$ financial market. Banks can also trade in the secondary financial market at $t = 1$. There is a bank located at both endpoints of the city. A bank is the monopolistic supplier of deposit contracts to the households next to it. But each local banking market is a contestable market.

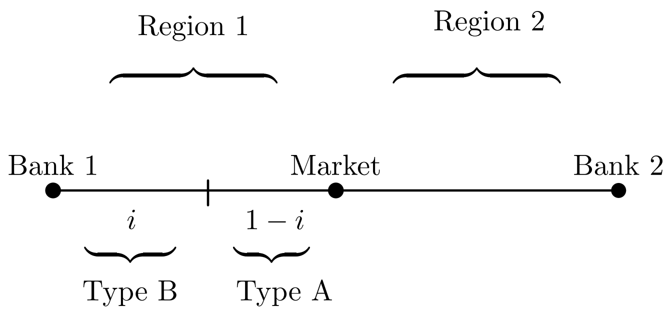

Figure 1

Banks just like type A households can monitor and assert the efficient effort level of entrepreneurs perfectly. But in contrast to type A households banks can - as put forward in Diamond and Rajan (2001) - by setting up deposit contracts avert the moral hazard problem: Type A households could, in general, also collect funds from type B households and invest them into long-term projects. Since they can efficiently monitor the entrepreneurs they could promise the type B households a repayment of up to R. But type B households cannot achieve that repayment. If the type A household would renege on the repayment and offer to pay just $\gamma \cdot R$ the type B households could not do better by forcing the type A household to deliver the financial claim against the entrepreneur. So any promised repayment of type A households that exceeds $\gamma \cdot R$ would not be credible. In contrast, the liquidity transformation of deposit financed banks makes them vulnerable to runs. But precisely because of the threat to run and to withdraw all deposits if the bank attempts to renegotiate on the promised repayment depositors can enforce the promised repayment. So the collective action problem that is inherent in deposit contracts and that brings about the fragility of individual banks enables them to credibly commit to pass on the returns on the long-term project.[10]

For simplicity we assume that both regions are symmetric with respect to the set of parameters.

[10] For a broader exposition of that argument see also Diamond and Rajan (2000).

3 The Financial System at Work

3.1 Some basic effects

To gain an intuition of the mechanics of the model it is useful to start the analysis with the equilibrium on one side of the market (one region) and gradually aggravate informational asymmetries. We thus first assume that all the characteristics of an individual household are observable: The realization of the intertemporal preference shock, i.e. its individual liquidity needs, and whether it is of type A or B is both public information. The only friction in the economy is the inability of type B households to collect the entire promised repayment of a financial contract other than a deposit contract. Therefore, these households cannot benefit from the efficient long-term production technology with a direct investment.

Since liquidity needs are publicly observable and type A households can collect the entire return from the long-term production technology, those households can set up an efficient risk-sharing mechanism. One possible way could be by issuing two types of Arrow-Debreu securities. The first promises a payment of 1 in $t = 1$ to the buyer of the contract if he turns out to be impatient and nothing if he is patient; the second delivers in $t = 1$ the holder - if he is patient - a financial claim against an entrepreneur that promises to pay 1 in $t = 2$. The cost of supplying an additional unit of the first contract in $t = 0$ is q.[11] For providing an additional unit of the other contract paying 1 to patient consumers in $t = 2$, the resources needed in t=0 are $\frac{(1-q)}{R}$.[12] In order to get households to supply both types of contracts, the relative price has to be equal to the relation of the costs.

Since households will adjust their demand for these insurance contracts up to the point where the relation of expected marginal utility if patient to expected marginal utility if impatient is equal to the relative price of the insurance contracts, the equilibrium condition describing the efficient risk sharing scheme is given by

$$\frac{q \cdot u'(c_1^A)}{(1-q) \cdot u'(c_2^A)} = \frac{p_{0;1}}{p_{0,2}} = \frac{q}{(1-q)} \cdot R$$

Inserting the assumed utility function, the optimal risk sharing condition can be simplified to:

$$\frac{c_2^A}{c_1^A} = (R)^{\frac{1}{\alpha}} \tag{2}$$

with

$$\{c_1^A; c_2^A\} = \left\{ \frac{R}{R - (R - R^{\frac{1}{\alpha}}) \cdot (1-q)}; \frac{R \cdot R^{\frac{1}{\alpha}}}{R - (R - R^{\frac{1}{\alpha}}) \cdot (1-q)} \right\} \tag{3}$$

[11] In order to perfectly diversify, an equal fraction of this additional unit is supplied to all other households. A fraction q of these other households will become impatient and therefore has to be paid 1, which is efficiently provided by investing in the storage technology.

[12] To a fraction $(1-q)$ the claim has to be delivered in $t = 1$. A claim paying R in $t = 2$ is offered at a price of 1 in $t = 0$. A claim paying 1 therefore costs $\frac{1}{R}$.

In contrast to type A households, households of type B have to use a deposit contract in order to benefit from the higher productivity of the long-term production technology. Since the local banking market is a contestable market, banks are not able to make any profit from these efficiency gains. Quite the reverse: they have to offer type B households the utility maximizing deposit contract $\{d_1^B; d_2^B\}$, given the expected budget constraint per depositor (BC).

$$(P_B1) \begin{cases} \max\limits_{d_1^B; d_2^B} & q \cdot u\left(d_1^B\right) + (1-q) \cdot u\left(d_2^B\right) \\ \text{s.t.} & q \cdot d_1^B + (1-q) \cdot \frac{d_2^B}{R} \leq 1 \qquad (BC) \end{cases}$$

Solving the Lagrangian implied by (P_B1) shows that the optimal deposit contract provides type B households with the same efficient risk-sharing scheme that type A household realize by financial market transactions. Therefore, taking the assumed utility function into account, the relation of payments to patient depositors to payments to impatient depositors also follows

$$\frac{d_2^B}{d_1^B} = (R)^{\frac{1}{\alpha}} \quad \text{and} \quad \{d_1^B; d_2^B\} = \{c_1^A; c_2^A\} \tag{4}$$

Thus, in this setting where no informational asymmetries concerning the households are assumed, the only function of a bank is to provide an efficient mechanism for type B households to benefit from the efficient production technology and implement the efficient investment portfolio in the economy.[13]

This changes dramatically if we now assume that individual liquidity needs are private information. Information concerning the type of a particular household we continue to take as publicly available for the moment. As Diamond and Dybvig (1983) already put forward in this framework, banks but not markets can provide efficient liquidity insurance. The reason for this is that, if the preference shock is not publicly observable, any contract has to be expost incentive compatible: in $t = 1$, neither patient nor impatient households must have an incentive to pretend to be of the other type.

However, the insurance contracts which provided type A households with the efficient risk-sharing in the previous setting are no longer incentive compatible. To show this, note that given that all type A households continue to hold insurance contracts against each other, an individual type A household could benefit from investing only into long-term financial claims: if he turns out to be patient he can consume $R > c_2^A$, whereas if he is impatient he can offer his financial claims at the $t = 1$ financial market. Some of the patient type A households - holding insurance contracts with all other type A households - will pretend to be impatient, obtain liquidity from the insurance contract and use the liquidity to buy these long-term claims. They will have an incentive to do so until they have bid up the price $p_{1;2}$ of a long-term claim paying R in $t = 2$ expressed in

[13] Note that if banks were not available type B household would only invest in the storage technology.

$t = 1$ consumption goods to $(R)^{\frac{\alpha-1}{\alpha}}$.[14] Thus, the impatient type A household, which has invested its entire endowment in long-term assets and sells them in $t = 1$ at the financial market, obtains $t = 1$ consumption goods which amount to $(R)^{\frac{\alpha-1}{\alpha}} > c_1^A$. Therefore, the expected utility of a type A household which directly invests into the corporate sector is higher than the expected utility a type A household realizes if it only holds insurance contracts. Thus all type A households have an incentive to invest directly. However, if all type A households invest only in the long-run project there are no patient type A households to which financial claims could be sold if the holder turns out to be impatient. Thus, the price of financial claims would fall to zero. Therefore, in equilibrium there must be some patient type A households who have $t = 1$ consumption goods to offer. They can either provide this liquidity by investing exante into the storage technology or by holding insurance contracts and pretending to be impatient. In equilibrium, however, if all patient type A households holding an insurance contract claim to be impatient, the expected cost of this insurance contract is 1. Thus, the insurance contract can only offer the same return structure as the storage technology - the insurance contract is therefore redundant.

Moreover, to have in equilibrium both households which hold liquidity and households which invest in long-term claims, the equilibrium price at the $t = 1$ financial market must ensure that households are exante indifferent between these two alternatives. The expected utility of investing directly $(q \cdot u(p_{1;2}) + (1 - q) \cdot u(R))$ is obviously only equal to the expected utility of holding liquidity $(q \cdot u(1) + (1 - q) \cdot u(\frac{R}{p_{1;2}}))$ if $p_{1;2} = 1$.

But if patient type A households pretend to be impatient in order to obtains the liquidity in $t = 1$, the underlying insurance contracts can no longer be an equilibrium.

The equilibrium insurance contracts which take into account the asymmetry of information concerning the liquidity preferences of the individual households can only provide impatient households with a consumption of 1 in $t = 1$ and patient ones with a $t = 1$ delivery of a financial claim paying R in $t = 2$. The corresponding equilibrium price in the financial market is $p_{1;2} = 1$. It is only under these conditions that neither a patient nor an impatient type A household has an incentive to pretend to have other than its true liquidity preference and households are indifferent between buying insurance contracts and investing directly. This is because type A households can realize the same consumption plan by directly investing in either the storage or the long-term production technology and selling long-term claims against liquidity in $t = 1$ at $p_{1;2} = 1$ if becoming impatient or buying them with held liquidity if they turn out to be patient. Thus, at the equilibrium price, incentive compatible insurance contracts are redundant and the financial markets

[14] To see this note that patient type A households will be indifferent between getting the payment specified in the insurance contract for patient households and claiming to be impatient and use the liquidity to buy long-term financial claims, if $\frac{R}{p_{1;2}} \cdot c_1^A = c_2^A$ with $R^{\frac{1}{\alpha}} \cdot c_1^A = c_2^A$.

provide type A households with a risk-sharing scheme that is characterized by

$$\frac{c_2^A}{c_1^A} = R \quad \text{and} \quad \{c_2^A; c_2^A\} = \{1; R\} \tag{5}$$

The question that now arises is what deposit contracts the banks will offer and how banks and their deposit contracts interact with the equilibrium in the $t = 1$ financial market.

Since the type of a particular household has so far been assumed to be observable, banks can offer different deposit contracts to type A and type B households. The contract $\left\{d_1^T; d_2^T\right\}$ offered to type $T \in \{A, B\}$ households solves the program $(P_T 2)$. Thus it maximizes the particular expected utility subject to the per capita budget constraint (BC) and a type specific incentive compatibility constraint (IC). This incentive compatibility constraint is the only thing that distinguishes contracts designed for type A from those for type B households. In general, it states that returns to long-term depositors must not be smaller than the maximum returns a patient depositor can realize, if he withdraws in $t = 1$ and either invests the money at the financial market or stores it until $t = 2$. While $\Gamma_T R$ with $\Gamma_A = 1$ and $\Gamma_B = \gamma$ describes the type specific enforceable repayment on one unit of a financial asset, $p_{1;2}$ stands for the price of a financial claim expressed in $t = 1$ consumption goods, sold at the $t = 1$ financial market and promising a repayment of R in $t = 2$. Therefore $\frac{\Gamma_T \cdot R}{p_{1;2}}$ are the type specific enforceable returns of a unit of $t = 1$ consumption goods invested at the financial market.

$$(P_T 2) \begin{cases} \max\limits_{d_1^T; d_2^T} & q \cdot u\left(d_1^T\right) + (1-q) \cdot u\left(d_2^T\right) \\ \text{s.t.} & q \cdot d_1^T + (1-q) \cdot \frac{d_2^T}{R} \leq 1 \qquad (BC) \\ & \max\left\{1; \frac{\Gamma_T \cdot R}{p_{1;2}}\right\} \cdot d_1^T \leq d_2^T \qquad (IC) \end{cases}$$

As the solution to this problem shows (see appendix A) the optimal contract implies a proportion between the long-term and the short-term payments to type T depositors given by

$$\frac{d_2^T}{d_1^T} = \max\left\{(R)^{\frac{1}{\alpha}}; \frac{\Gamma_T \cdot R}{p_{1;2}}; 1\right\}$$

with $T \in \{A, B\}$, $\Gamma_A = 1$ and $\Gamma_B = \gamma$.

In order to entirely describe the optimal deposit contract one finally has to show that the equilibrium price on the financial market is still $p_{1;2} = 1$. The easiest way to do so works by contradiction:

Assume that $p_{1;2} > 1$

- and $\frac{R}{p_{1;2}} < R^{\frac{1}{\alpha}}$. In that case, the incentive compatibility constraint would be redundant for both types of households and the bank could offer type A and type B households a contract that implements the optimal risk sharing. Thus, all households would prefer to hold their wealth with the bank and the only agents potentially trading in the financial markets would be banks. However, if $p_{1;2} > 1$, banks would only invest in long-term claims, planning to provide the liquidity needed for the payment to short-term depositors by selling parts of these claims. This would increase the resources available to the bank.

- and $\frac{R}{p_{1;2}} \geq R^{\frac{1}{\alpha}} > \frac{\gamma \cdot R}{p_{1;2}}$. In this situation, the incentive compatibility constraint of type A households is binding. Therefore, in comparison with the financial market, the bank could not provide any additional liquidity insurance to this type of household. Consequently, only type B households would deposit their wealth with the bank, which would still invest their total resources in long-term claims. Type A households, just like the bank, would also prefer to invest their entire wealth directly in firms, expecting to sell these stakes off if they turn out to be impatient.

Thus, if agents in the economy in $t = 0$ expect the price in the financial market in $t = 1$ to be $p_{1;2} > 1$, nobody in the entire economy would invest exante in the storage technology, although in $t = 1$ there is a strong demand for liquidity. This obviously cannot be an equilibrium.

Similarly, if one assumes $p_{1;2} < 1$ all resources of the economy would be stored, since agents would gain if they meet their requirements of long-term assets at the $t = 1$ financial market. Although there is a demand for financial claims in $t = 1$, no one in the economy will invest in any firm in $t = 0$. If $p_{1;2} < 1$ is such that $\frac{R}{p_{1;2}} \geq R^{\frac{1}{\alpha}} > \frac{\gamma R}{p_{1;2}}$ holds, type B households again only hold deposits with the bank. But, since holding liquidity to buy long-term assets in the financial market in $t = 1$ dominates an investment in a firm in $t = 0$, both the banks and the type A households will only store goods from $t = 0$ to $t = 1$. If, on the other hand, $p_{1;2}$ is so small that even $\frac{\gamma R}{p_{1;2}} > R^{\frac{1}{\alpha}}$, nobody holds deposits with the bank but both type A and type B households will store their total resources from $t = 0$ to $t = 1$. Thus $p_{1;2} < 1$ cannot be an equilibrium either.

Only at $p_{1;2} = 1$ banks and agents are indifferent between investing and storing resources and a positive amount of financial claims *and* liquidity will be held.

Inserting the equilibrium price $p_{1;2} = 1$ into the type specific optimal deposit contract shows that the contract offered to type B households provides them with the optimal risk sharing. In contrast, the binding incentive compatibility constraint of type A households prevents the bank from offering to these households a deposit contract that efficiently insures them against individual liquidity shocks. Moreover, because of the binding incentive compatibility constraint, the deposit contract offered to type A households only resembles the return structure those households can realize by investing directly at the financial market. Given a weak preference for investing directly at the financial market, type A households will not hold deposits with their bank.

Figure 2 shows the optimal contracts. The optimal contracts maximize the strictly concave utility function subject to two linear constraints - the budget constraint and the respective incentive compatibility constraint. The graphical representation of the budget constraint is derived by solving (BC) for d_2^T. We obtain a downward sloped line with a negative slope of $q/(1-q)\cdot R$. The incentive constraint is represented by the upward sloping line $d_2^T = d_1^T \cdot \frac{\Gamma_T \cdot R}{p_{1,2}}$ - this condition being different for the two types A and B. Therefore, the two contracts also vary. While the optimal contract offered to type B households is given by the point of tangency between the budget constraint and the indifference curve, the contract offered to type A households is given by the point where the budget line and the incentive compatibility constraint intersect. The dotted lines in the two figures represent the optimal risk-sharing condition. Note that only the contract of type B provides them with optimal risk sharing.

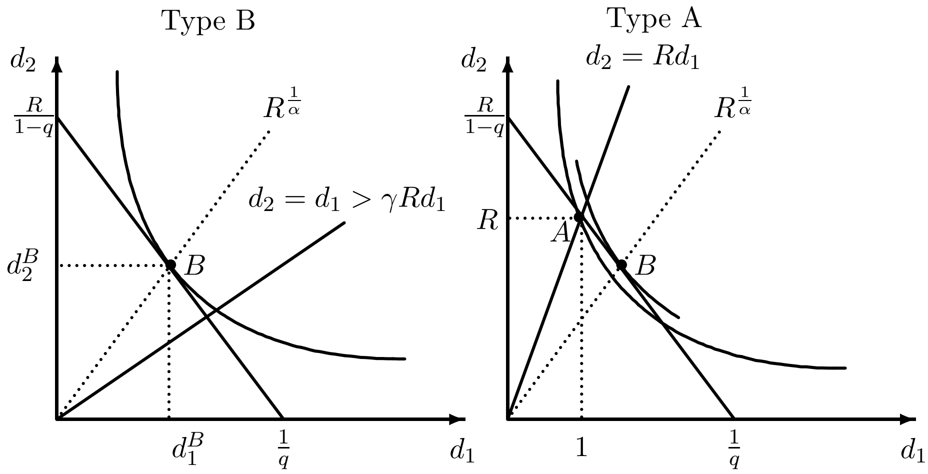

Figure 2

3.2 The bank-based financial system

In reality, the return a household can realize by holding financial claims cannot be observed directly by a bank. Thus, in fact, not only the intertemporal preference shock of a household is its private information, the effective return of its investment opportunities are also subject to an asymmetric information distribution. Therefore, a more realistic framework should assume that - besides the individual liquidity needs - the particular type (A or B) of a household is also not publicly observable. However, if the type of an individual household is no longer assumed to be public information, a bank can only continue to offer type-specific contracts if these contracts are self-revealing: Type A households must have an incentive to choose the contract designed for these households, while type B households must pick the contracts designated for them.

Showing that the optimal deposit contracts calculated in the previous setting are not self-revealing is straightforward. Obviously, type A households do not have an incentive to choose the contracts designated for them. By pretending to be of type B, a type A household is strictly better off. If it becomes impatient it can consume $d_1^B > 1$, while it can withdraw and invest at the financial market earning $R \cdot d_1^B > R$ if it turns out to be patient.

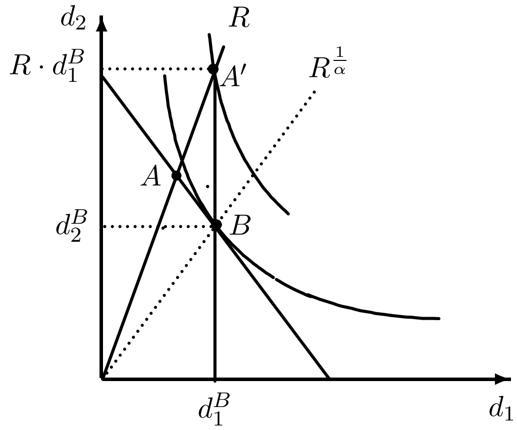

Figure 3

Figure 3 illustrates the argument that the optimal contracts derived in the previous section are no longer incentive compatible. As can easily be seen, type A households can achieve a higher indifference curve by pretending to be of type B. The expected utility level attached to this situation of misrepresentation is given by the indifference curve passing through point A'.

However, the bank is not only unable to implement these type-specific contracts, any pair of separating contracts cannot be an equilibrium. To show this, note first that as long as the contracts do not provide less liquidity insurance than the market ($\frac{d_2^{T\prime}}{d_1^{T\prime}} \leq \frac{R}{p_{1;2}}$), patient type A households will always prefer to withdraw and invest at the financial market. Since they will withdraw in $t = 1$ anyway, they will choose in $t = 0$ whatever contract promises the higher $t = 1$ repayment. Therefore, in order to make the contract designed for type A households preferable for them, the bank would have to increase d_1^A - while reducing d_1^B - so that $d_1^{A\prime} \geq d_1^{B\prime}$. Nevertheless, because all type A households withdraw in $t = 1$, the funds provided by these households cannot be invested in the productive long-term technology. A payment to type A households in $t = 1$ exceeding 1 is therefore only possible if the bank uses returns on funds provided by type B households.[15] Contracts for type B households have to be used to cross-subsidize contracts for type A households. However, since the local banking market is a contestable market, this situation cannot be an equilibrium. Another potentially competing bank could always offer a preferable contract to type B

[15]Since $t = 2$ payment to type A households can be reduced to zero while the contract for type B households promises d_2^B, type B households will favor their type specific contract as long as $q \cdot u(d_1^{B\prime}) + (1-q) \cdot u(d_2^{B\prime}) > u(d_1^A) > u(1)$ holds.

households attracting all households of this type, making the necessary cross-subsidies for a pair of separating contracts infeasible. Thus, in equilibrium *only pooling contracts are feasible.*

The equilibrium deposit contract the bank offers solves problem ($P3$). The objective function is given by the expected utility of type B households. Since the optimal deposit contract can be expected to provide more liquidity insurance than the market, patient type A households will withdraw early. Remember, if the deposit contract incorporates some liquidity insurance compared to the payment structure realizable by a direct market investment, $d_2 < \frac{R}{p_{1;2}} \cdot d_1$. However, if type A households always withdraw early irrespective of their intertemporal consumption preferences, they are only interested in a very high short-term repayment on deposits. Thus also taking into account the expected utility of type A households when deriving the optimal deposit contract would imply a higher weight on short-term payments than is optimal for type B households. The deposit contract offered would provide type B households with a suboptimally high liquidity insurance. (The detailed contract is derived in appendix B.) Therefore, a competitor could again offer a preferable contract to type B households, attracting all type B households and making any liquidity insurance by the first bank impossible. Thus, in order to keep type B households, the bank must optimize its deposit contract according to the needs of these households.

The optimal deposit contract is restricted by a per capita budget constraint (BC), which averages over type A and type B households taking into account the fact that type A households withdraw in $t = 1$ anyway, whereas type B households leave their deposits with the bank until $t = 2$ if they turn out to be patient and only withdraw in $t = 1$ if they become impatient.

$$
(P3) \begin{cases} \max\limits_{d_1;d_2} & q \cdot i \cdot u(d_1) + (1-q) \cdot i \cdot u(d_2) \\ \text{s.t.} & [q \cdot i + (1-i)] \cdot d_1 + (1-q) \cdot i \cdot \frac{d_2}{R} \leq 1 \quad (BC) \\ & \max\left\{1; \frac{R}{p_{1;2}}\right\} \cdot d_1 \geq d_2 \quad (IC_A) \\ & \max\left\{1; \frac{\gamma R}{p_{1;2}}\right\} \cdot d_1 \leq d_2 \quad (IC_B) \end{cases}
$$

The type-specific incentive compatibility constraints (IC_A) and (IC_B) guarantee that patient type A households really have an incentive to withdraw early and patient type B households are really better off if they leave their money with the bank. These restrictions ensure that the assumptions concerning the type-specific behavior of patient households reflected in the budget constraint will indeed be observed in equilibrium.

Maximizing the objective function taking only the budget constraint into account yields a risk sharing provided by the pooling deposit contract which is characterized by (see appendix C for the detailed solution)

$$\frac{d_2^{BD}}{d_1^{BD}} = \underbrace{\left(\frac{1-(1-q)\cdot i}{q\cdot i}\cdot R\right)^{\frac{1}{\alpha}}}_{\Theta} \tag{6}$$

The optimal risk sharing program is also feasible according to the incentive compatibility constraints (IC_A) and (IC_B) if

$$\Theta \leq \max\left\{1; \frac{R}{p_{1,2}}\right\} \tag{7}$$

$$\Theta \geq \max\left\{1; \frac{\gamma\cdot R}{p_{1,2}}\right\} \tag{8}$$

Obviously, for the optimal pooling contract to be incentive compatible the equilibrium price $p_{1;2}$ in the $t = 1$ financial market is crucial. But, as can easily be shown, because of the no-arbitrage restriction the equilibrium price is again $p_{1;2} = 1$:

If equation (7) and (8) hold, both type A and type B households deposit their total funds with the bank in $t = 0$. Consequently, the entire issue of financial claims from the corporate sector goes to the bank in the first place. Households are not active in the primary financial market. Therefore, the existence of a secondary market at which type A households can invest in $t = 1$ depends on the readiness of the bank to sell the long-term assets. At first sight, one might think that by not selling any financial claims the bank could prevent patient type A households from withdrawing early. But the competition in the secondary financial market by the bank from the other region obstructs such an (efficiency-enhancing) behavior.

As soon as the bank in the other region expects bank 1 not to offer financial claims, bank 2 will invest additional funds in firms in $t = 0$ in order to sell these financial claims to patient type A depositors of bank 1 in $t = 1$. As long as $p_{1;2} \geq 1$, this provides bank 2 with the needed $t = 1$ consumption goods more efficiently than does storing. After all, bank 1 will not be able to prevent patient type A households from withdrawing and investing at the secondary market.

Therefore, rationing does not make any sense at all. It only causes an outflow of liquidity from region 1 to region 2, increasing the welfare in region 2 to the detriment of region 1. In order to benefit likewise from this efficient way of providing liquidity, it is profitable for bank 1 to compete with bank 2 for the liquidity of patient type A depositors in the secondary financial market.

Competition among banks in the secondary financial market will reduce the equilibrium price of financial claims to $p_{1;2} = 1$. Only at that price are banks indifferent between providing $t = 1$ consumption goods by storing or by selling long-term assets to patient type A households in the financial market.

Since the equilibrium price is given by $p_{1;2} = 1$, the feasibility conditions for the optimal deposit contract (7 and 8) can be reduced to $R \geq \Theta \geq 1$ which is true for all

$$i \geq \bar{i} = \frac{1}{q \cdot R^{\alpha-1} + (1-q)} \tag{9}$$

In an economy characterized by a fraction of type B households which is larger than $\bar{i}$, banks offer a pooling deposit contract BD given by

$$\left\{d_1^{BD}; d_2^{BD}\right\} = \left\{\frac{R}{R - (R-\Theta) \cdot (1-q) \cdot i}; \frac{R \cdot \Theta}{R - (R-\Theta) \cdot (1-q) \cdot i}\right\} \tag{10}$$

As $i > \bar{i}$ and therefore $\Theta \in \left[R^{\frac{1}{\alpha}}; R\right[$, the deposit contract offered incorporates at least some degree of liquidity insurance compared to the return structure of direct investments. For an economy without any type A households ($i = 1$), this contract provides the optimal risk sharing. But as the fraction of type A households increases and finally approaches $(1 - \bar{i})$, the optimal feasible deposit contract converges to the inefficient market solution.

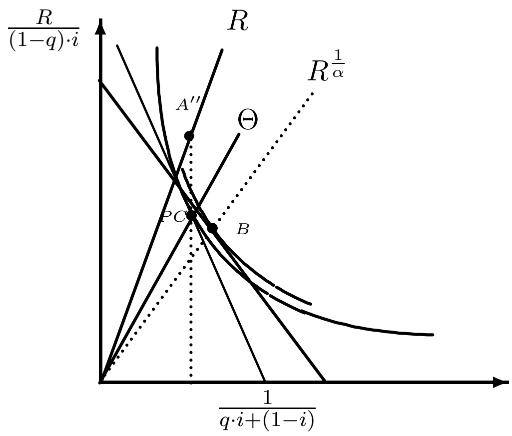

Figure 4

Figure 4 illustrates the optimal deposit contract in this setting. Compared to the optimal contract offered to type B households when types are publicly observable (see figure 2), the budget constraint is turned clockwise around point $\{1; R\}$. The budget constraint is all the steeper, the higher is the fraction $(1 - i)$ of type A households - those households that always withdraw in $t = 1$. The point of tangency between the budget constraint and the indifference curve characterizing the optimal contract moves to the upper left, the higher $(1 - i)$ and the steeper the budget constraint is. Therefore, the risk sharing implied by the deposit contract converges from optimal risk sharing ($R^{\frac{1}{\alpha}}$) to the risk sharing scheme provided by market investments as $(1 - i)$ increases.

As was already assumed in the per capita budget constraint (BC), the bank provides the funds needed for the promised repayment in $t = 1$ and $t = 2$ *efficiently*. This means that the $t = 2$ consumption goods needed for the payments to long-term depositors are produced by investing in the production technology and not by storing the funds for two periods. Similarly, the $t = 1$ consumption goods for the payments to impatient consumers are assumed to be provided by stored funds (and not by liquidating long-term projects). However, since there exists a financial market in $t = 1$, at which financial claims are traded against $t = 1$ this does not necessarily mean that the bank has to invest the funds in $t = 0$ accordingly. Moreover, as the equilibrium price in the financial market will be $p_{1;2} = 1$, any portfolio is the same for an individual bank.

The only thing that matters is the aggregate portfolio in the economy. Since the $t = 1$ financial market can only reallocate existing liquidity and financial claims, for the economy as a whole already in $t = 0$ the aggregate liquidity held by banks ($l_1^{BD} + l_2^{BD}$) has to be equal to the funds needed for the contracted payment to impatient consumers in both regions:

$$l_1^{BD} + l_2^{BD} = 2 \cdot q \cdot d_1^{BD} \tag{11}$$

The long-term financial claims bought in $t = 0$ by the banking sector of the economy serve two purposes. One fraction is supposed to earn the aggregate $t = 2$ consumption goods for the patient type B households of both regions: $2 \cdot (1-q) \cdot i \cdot \frac{d_2^{BD}}{R}$. The other fraction is held in order to be sold in the $t = 1$ financial market to patient type A households. Since patient type A households pay the price $p_{1;2} = 1$ for a financial claim at the financial market with the short-run return on deposits,[16] this fraction of held capital is given by $2 \cdot (1 - q) \cdot (1 - i) \cdot d_1^{BD}$. Thus aggregate capital ($k_1^{BD} + k_2^{BD}$) in the portfolio adds up to

$$k_1^{BD} + k_2^{BD} = 2 \cdot (1 - q) \cdot i \cdot \frac{d_2^{BD}}{R} + 2 \cdot (1 - q) \cdot (1 - i) \cdot d_1^{BD} \tag{12}$$

In general, the way in which the shares of liquidity and of long-term financial claims in the aggregate portfolio are initially split among the banks is undetermined. For the sake of simplicity, we concentrate on the symmetric equilibrium,[17] in which each bank $j \in \{1; 2\}$ holds the same portfolio - half of the aggregate long-term claims and half of the aggregate liquidity

$$\begin{aligned} l_j^{BD} &= q \cdot d_1^{BD} \\ k_j^{BD} &= (1 - q) \cdot i \cdot \frac{d_2^{BD}}{R} + (1 - q) \cdot (1 - i) \cdot d_1^{BD} \end{aligned} \tag{13}$$

[16] It is interesting to note that this fraction of short-term deposits could be interpreted as inside money within this model.

[17] This could be justified, for instance, by assuming infinitesimal trading costs of banks.

In this case, both regions are self-sufficient. No liquidity is exchanged against long-term claims between regions. Each bank pays $(1-q) \cdot (1-i) \cdot d_1^{BD}$ to its patient type A households which use these funds to demand long-term assets from their bank at $p_{1;2}$. Therefore, the financial market is in equilibrium since the capital supply k_j^s of each bank meets the capital demand k_j^d of its patient type A households at the same price for all banks.

$$k_j^s = (1-q) \cdot (1-i) \cdot d_1^{BD} \tag{14}$$

$$k_j^d = (1-q) \cdot (1-i) \cdot \frac{d_1^{BD}}{p_{1;2}} \tag{15}$$

To sum up, if the fraction of households that can efficiently invest directly in a firm is comparatively low ($i > \bar{i}$), our model economy shows basic features of a bank-based financial system:

1. Banks not only economize on transaction costs, i.e. provide access to efficient investment opportunities for all households, they also provide liquidity insurance to their depositors.
2. Banks are active in the secondary financial market.
   They are the dominant (or only) player in the primary financial market.
3. Households are not engaged in the primary market.
   They only demand long-term claims at the secondary financial market.

3.3 The market-oriented financial system

Now we turn to the case in which the share of type A households exceeds the critical threshold level $(1-\bar{i})$. To see why the optimal deposit contract offered by the banks in the previous setting is no longer an equilibrium if $i < \bar{i}$ we turn to the graphical representation of the optimization problem.

As shown in figure 5, an increase in the fraction of type A households beyond $(1-\bar{i})$ would further increase the steepness of the budget constraint so that the point of tangency (D') between the budget constraint and the indifference curve moves to the upper left of $A = (1; R)$. However, this is inconsistent with the assumption underlying the budget constraint that all type A households withdraw their deposits in $t = 1$ irrespective of their liquidity needs. By withdrawing and investing the funds at the financial market, type A households can only realize the consumption bundle given by point D''. This obviously provides them with less utility than point D', which they could reach by behaving just like type B households, withdrawing only when having immediate consumption needs. Thus, given a deposit contract D', patient type A households would not withdraw, which contradicts the assumption of the budget constraint.

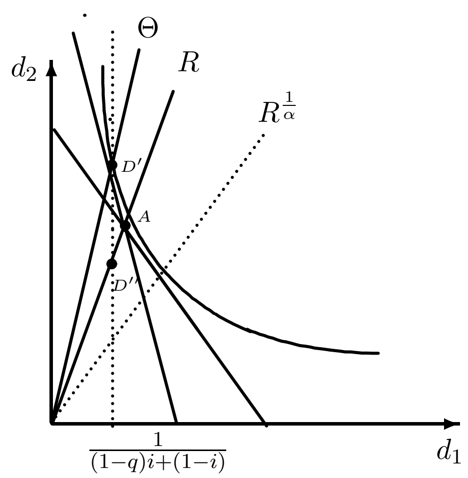

Figure 5

On the other hand, the bank cannot simply optimize the deposit contract subject to the budget constraint (BC) in ($P4$), assuming patient type A households keep their deposits until $t = 2$. This would induce the bank to offer a deposit contract with the optimal risk sharing $\Theta = R^{\frac{1}{\alpha}}$. But given this contract, patient type A households would again prefer to withdraw early.

Thus, the optimal deposit contract that can be offered by the bank in this setting has to take into account that type A households must not have an incentive to withdraw their money in $t = 1$. In the optimization problem ($P4$), this restriction is captured by the changed incentive compatibility constraint of patient type A households (IC_A). Note, that in ($P4$), since arbitrage conditions for the equilibrium price in the $t = 1$ financial market remained the same, $p_{1;2}$ is already set to 1.[18]

$$(P4)\begin{cases} \max\limits_{d_1;d_2} & q \cdot i \cdot u(d_1) + (1-q) \cdot i \cdot u(d_2) & \\ \text{s.t.} & q \cdot d_1 + (1-q) \cdot \frac{d_2}{R} \leq 1 & (BC) \\ & \max\{1; R\} \cdot d_1 \leq d_2 & (IC_A) \\ & \max\{1; \gamma R\} \cdot d_1 \leq d_2 & (IC_B) \end{cases}$$

As can easily be seen, the maximum risk sharing the bank can provide with its deposit contract in this setting is determined by the incentive compatibility constraint of type A households. Any deposit contract that would provide a smoother consumption profile than the returns realizable at the financial market is not incentive compatible. Thus, banks cannot provide liquidity insurance in an economy where the fraction of type A households exceeds $(1 - \bar{i})$. Inserting the binding incentive compatibility constraint of patient type A

[18] It is only at this equilibrium price that market participants will not invest their entire resources into the long-term technology (which would be the case if $p_{1;2} > 1$) nor hold all their funds in liquid reserves until $t = 1$ (which they would do if in equilibrium $p_{1;2} < 1$).

households into the budget constraint gives the optimal deposit contract a bank can offer in such an economy:

$$\left\{d_1^{MO}; d_2^{MO}\right\} = \{1; R\} \tag{16}$$

As we assume an exante weak preference of households for investing directly at the financial market if both investments have the same payoffs,[19] in equilibrium the two types of households will follow a very different investment strategy. While type A households will hold a portfolio of liquidity and direct financial claims against the corporate sector, type B households will invest their entire wealth in deposits.

Given the returns on the deposit contract, the only function of banks in this regime is obviously to enable type B households to benefit from the efficient long-term production technology. Thus, banks do not provide any liquidity insurance in this setting; they only offer a mechanism to commit credibly to pass efficiency gains in investments owing to a more efficient monitoring to patient type B households.

At the $t = 1$ equilibrium price of $p_{1;2} = 1$ - just like in the case of the bank-based financial system - only the aggregate portfolio of the economy, i.e. liquidity and long-term financial claims, respectively, held in sum by banks and type A households in the two regions, is determined by the equilibrium conditions (but not the portfolio of the individual banks). From the fact that all impatient households (type A as well as type B) will consume 1 in $t = 1$, it follows that aggregate liquidity is simply given by

$$L^{MO} = 2 \cdot q \tag{17}$$

Similarly, since patient type A households as well as patient type B ones will be provided with a $t = 2$ consumption of R, aggregate long-term investment in the economy has to be

$$K^{MO} = 2 \cdot (1 - q) \tag{18}$$

Imposing again the additional assumption of infinitesimal trading costs, it becomes optimal for both banks to hold exactly the amount of liquidity needed for repayments to impatient type B households of the respective region and invest the rest that finances the payment to the patient depositors in the long-term technology:

$$l_1^{MO} = l_2^{MO} = q \cdot i \quad \text{and} \quad k_1^{MO} = k_2^{MO} = (1 - q) \cdot i \tag{19}$$

The remaining liquidity and long-term investments,

$$l_A^{MO} = 2 \cdot q \cdot (1 - i) \quad \text{and} \quad k_A^{MO} = 2 \cdot (1 - q) \cdot (1 - i) \quad , \tag{20}$$

[19] This weak preference can be interpreted as a shortcut for the costs of running a bank, which are shifted to depositors.

are held by type A households and reallocated at the $t = 1$ financial market according to the patience of the individual households. The fraction q of type A households turns out to be impatient and will therefore offer their long-term financial claims at $p_{1;2}$, while the patient type A households demand long-term assets paying with their stored liquidity. Therefore, the market equilibrium condition:

$$q \cdot p_{1;2} \cdot k_A^{MO} = (1 - q) \cdot l_A^{MO} \tag{21}$$

determines $p_{1;2} = 1$.

To sum up, in the parameter setting where the fraction of type A households is relatively large ($i < \bar{i}$), a financial system emerges, which can be interpreted as a sketch of a market-oriented financial system:

1. Banks only economize on transaction costs, i.e. by providing an efficient monitoring mechanism they improve investment profitability for disadvantaged households. But they do not provide any liquidity insurance to their depositors.

2. Banks are (in the extreme case) inactive in the secondary financial market.

3. Households invest to a large extent directly at the financial market. They are actively trading in the primary (or IPO market) as well as in the secondary financial market. Thus, their trading volume is much larger than in the bank-based financial system.

4 Financial Crises

In this section we want to study the fragility of the two different types of financial systems described above. More specifically, we want to analyze whether the impact of a single bank's breakdown on the stability of the financial sector differs in the two distinct financial systems.

To keep the setting as simple as possible, we assume that coordination failures are the reason for a bank run. Extending the model to a stochastic framework in which bank panics are caused, for instance, by extremely low returns on long-term projects would not change the results substantially, but would only complicate the analysis.

Let us assume that a coordination failure triggers a bank run on one particular bank, say, the bank 1 in region 1. In order to raise the liquidity needed to pay out the promised short-term repayment d_1 to *all* (patient and impatient) depositors the bank is forced to sell off its long-term financial claims.[20] In equilibrium these fire sales reduce the asset price dramatically, which might have an impact on bank 2 in the other region.

[20] Note that, as long as $p_{1;2} > \epsilon$, selling the assets at the financial market is preferable to liquidating the firm.

4.1 Financial crises in market-oriented financial systems

In order to assume coordination failures as the trigger of a bank run in the further analysis, we first have to show that a bank run is indeed an equilibrium in a market-oriented financial system. At first glance, one might think that since banks do not provide any liquidity insurance in market-oriented financial systems they would not be vulnerable to bank runs. But this reasoning only holds if asset markets were perfectly liquid in the sense that any amount of long-term assets could be sold at $p_{1;2} = 1$. However, as soon as the asset price weakens only slightly, if the bank sells off large stakes of its long-term claims, bank runs can also occur in our market based financial system.

To see this, remember that the portfolio of bank 1 in the market-oriented financial system is given by $l_1^{MO} = q \cdot i$ and $k_1^{MO} = (1-q) \cdot i$. As soon as patient depositors expect a fraction $i \cdot q^e$ to be withdrawn in $t = 1$, with $q^e > q$, patient depositors will assume that the bank sells long-term assets given by

$$k_1^s = \frac{i \cdot (q^e - q)}{p_{1,2}^e}$$

Thus, the repayment a patient depositor anticipates if he leaves his deposits with the bank until $t = 2$ is

$$d_2^e = \left(k_1^{MO} - k_1^s\right) \cdot \frac{R}{i \cdot (1 - q^e)} \tag{22}$$

If this expected repayment is smaller that the promised short-term repayment of 1 ($d_2^e < 1$), it is rational for a patient depositor to withdraw in $t = 1$.

Inserting the expected sales of long-term claims k^s and the $t = 0$ investment in these assets k_1^{MO} into (22) gives us the combinations of expected prices for long-term financial assets ($p_{1;2}^e$) and expected fractions of early withdrawers (q^e) for which this argument holds

$$p_{1;2}^e < \frac{(q^e - q) \cdot R}{(1-q) \cdot R - (1 - q^e)} \tag{23}$$

As can easily be seen, if q^e approaches 1, it is sufficient that the expected asset price is smaller than 1. Thus, a bank run is a rational equilibrium in our framework if the asset market is not perfectly liquid and asset prices fall in the event of fire sales. As we will see below, this is always true in the present setting.

In describing the financial market equilibrium that will prevail in the event of a run on a particular bank, we have to distinguish two cases.

First, assume that the equilibrium price will exceed $\gamma \cdot R$. In that case, after withdrawing their deposits, because they expect a run on their bank, patient depositors of bank 1 will hoard the liquidity. Buying long-term assets at $p_{1;2}^{BR} > \gamma \cdot R$ that pay them only $\gamma \cdot R < 1$ in $t = 2$ is less preferable than storing liquidity. Moreover, given that the equilibrium price is larger than $\gamma \cdot R$, the incentive of patient depositors of bank 2 in the second region to keep their deposits until $t = 2$ is not influenced:

$$\frac{\gamma \cdot R}{p_{1,2}} \cdot d_1^{MO} \leq d_2^{MO} \quad \text{with} \quad \left\{d_1^{MO}; d_2^{MO}\right\} = \{1; R\} \tag{24}$$

Thus type B households of the second region leave their deposits with their bank and do not show up at the financial market.

In addition to type A households which would also trade in a non-crisis situation, only bank 1 sells off financial assets during a crisis in this particular case. Since the bank will sell all its long-term assets k_1^{MO}, the equilibrium condition (21) changes during a financial crisis to

$$q \cdot p_{1;2}^{BR} \cdot k_A^{MO} + p_{1;2}^{BR} \cdot k_1^{MO} = (1-q) \cdot l_A^{MO} \tag{25}$$

As can easily be seen by inserting the respective values of k_A^{MO}, k_1^{MO} and l_A^{MO} into the equilibrium condition, the price for a long-term claim in the event of a bank run is

$$p_{1;2}^{BR} = \frac{2 \cdot q \cdot (1-i)}{2 \cdot q \cdot (1-i) + i} \tag{26}$$

Obviously, the equilibrium price in the event of a crisis is smaller than 1 as long as there are any households of type B ($i > 0$). Thus a bank run is indeed an equilibrium.

The drop in asset prices due to a run on one bank is all the larger, the more depositors hoard liquidity during a run. The difference between the price prevalent in normal times (when no run occurs) and the one observable during a financial turmoil is all the larger, the higher is the proportion of households of type B (i is comparatively high) and the smaller the probability of being patient (q is large).

Remember the assumption that patient type B households from neither of the two regions trade in the financial market in $t = 1$ when formulating the underlying equilibrium condition. Thus, $p_{1;2}^{BR}$ is only an equilibrium if additionally

$$\gamma \cdot R < \frac{2 \cdot q \cdot (1-i)}{2 \cdot q \cdot (1-i) + i} \tag{27}$$

However, what happens if (27) does not hold? In that case, the equilibrium price will always be exactly $p_{1;2}^{BR} = \gamma \cdot R$. To see this, remember that, at this price, patient depositors who withdrew their money from bank 1 are indifferent between buying long-term assets and storing liquidity for one period. Thus, in equilibrium any fraction μ of the patient type B households from region 1 will be willing to use the repayment d_1^{BR} to buy long-term claims at the financial market

$$q \cdot p_{1;2}^{BR} \cdot k_A^{MO} + p_{1;2}^{BR} \cdot k_1^{MO} = (1-q) \cdot l_A^{MO} + \mu \cdot (1-q) \cdot d_1^{BR} \tag{28}$$

The amount bank 1 can repay on deposits (d_1^{BR}) is given by the liquid reserves plus the revenue from the sold financial assets

$$d_1^{BR} = p_{1;2}^{BR} \cdot k_1^{MO} + l_1^{MO} \tag{29}$$

Inserting (29), (19), (20) and $p_{1;2}^{BR} = \gamma \cdot R$ into (28) yields

$$\mu = \frac{\gamma \cdot R \cdot i - 2 \cdot q \cdot (1-i) \cdot (1-\gamma) \cdot R}{\gamma \cdot R \cdot (1-q) \cdot i + q \cdot i} \tag{30}$$

As is shown in appendix D for the given parameter setting, μ never exceeds 1 and therefore $p_{1;2}^{BR} = \gamma \cdot R$ is the lower bound for the asset price during crises in market-oriented financial systems.

Since the incentive compatibility constraint (24) of patient depositors at bank 2 is not violated at $p_{1;2}^{BR} = \gamma \cdot R$, a run on bank 1 in a market-oriented financial system and the resulting drop in asset prices does not endanger the stability of any other bank. The threshold level ($p_{1;2}^{CT}$) below which patient type B households at bank 2 would withdraw to invest directly at the financial market can be derived by inserting the repayments from the deposit contract $\left\{d_1^{MO}; d_2^{MO}\right\} = \{1; R\}$ into (24). Thus, contagion would occur in market-oriented financial systems only if asset prices could fall below $p_{1;2}^{CT} = \gamma$.

Altogether, in market-oriented financial systems

1. bank runs are an equilibrium phenomenon
2. but financial markets are liquid enough to prevent contagion
3. the lower the fraction of type B households - the deeper financial markets are - and the fewer households turn out to be patient, the smaller is the effect of a bank run on financial market equilibrium.

4.2 Financial crises in bank-based financial systems

Turning to financial crises in bank-based financial systems, it is important to note, first, that in this financial system a bank subject to a run could only raise additional liquidity by selling financial assets to patient depositors of the other region. Remember that the entire liquidity available in region 1 is already held by the bank; long-term financial claims sold by the bank to patient type A households of region 1 can only be paid by the latter with claims against the bank and not with $t = 1$ consumption goods. But, if bank 1 sells assets to patient depositors of region 2, those households will pay with liquidity raised by withdrawing deposits from bank 2. However, looking at the portfolio of bank 2 in the symmetric equilibrium (13) shows that all the available liquidity $l_2^{BD} = q \cdot d_1^{BD}$ is needed to repay the impatient depositor. Given that bank 2 also planned to sell to their patient type A households long-term assets at the financial market against their deposits, these claims of patient type A households are not backed by liquid reserves. Therefore, whenever bank 1 offers financial assets at a discount in order to raise liquidity from depositors of region 2, bank 2 also runs out of liquidity and has to sell off assets to meet its liquidity needs. In equilibrium, bank 2 must try to meet the demand of its patient households at the given price. If the bank is not able to do so, the patient type A households will demand liquidity in order to invest it at the financial market by buying assets supplied by the other bank. But, since bank 2 has just sufficient liquidity to meet the payment obligations to impatient depositors, any liquidity outflow to patient type A households of this kind would mean that the bank would be unable to meet the promised $t = 1$ repayment of d_1^{BD} and cause an immediate collapse of the bank.

Therefore, with respect to the equilibrium asset price, two cases can emerge. Either bank 2 can meet the demand for long-term assets of its patient type A depositors at the equilibrium price or bank 2 also collapses. If bank 2 can cope with the drop in asset prices due to the run on bank 1, all liquidity of bank 2 goes to its impatient depositors and is immediately consumed. If the asset prices fall so severely that bank 2 cannot meet the demand of its patient type A depositors, bank 2 will be subject to a run as well. In that case, region 2 is just a reflection of region 1, and bank 2 suffers from the same lack of liquidity. In any case, the equilibrium asset price can be calculated by the equilibrium between the supply of assets by bank 1 and the demand by depositors of region 1.[21]

In general, the fire sales of bank 1 in the event of a run only cause a drop in asset prices that may destabilize the other bank. However, these fire sales do not increase the liquidity available to bank 1.

Before calculating the equilibrium after a run on one bank, we should check whether a run is indeed an equilibrium phenomenon in this setting, too. Just like in the market-oriented financial system, a run will occur if patient type B households expect that the bank has to sell off too much of its long-term assets, so that the long-term payment on deposits falls below the short-term repayments. While the expression for the expected long-run return on deposits can be expressed in this setting by (22), too, the expected asset sales are now given by the sum of those sold to the patient type A households and those sold to raise liquidity in order to meet withdrawals of patient type B households:

$$k_1^s = (1-q)\cdot(1-i)\cdot\frac{d_1}{p_{1;2}^e} + \frac{i\cdot(q^e-q)\cdot d_1}{p_{1;2}^e} \tag{31}$$

Inserting (31) and (13) into (22) yields expression (32), which gives the combinations of expected fractions of early withdrawals (q^e) and expected prices at the financial market ($p_{1;2}^e$) that cause a run

$$p_{1;2}^e < \frac{R\cdot i\cdot(q^e-q) + R\cdot(1-q)\cdot(1-i)}{i\cdot[(1-q)\cdot\Theta-(1-q^e)] + R\cdot(1-q)\cdot(1-i)} \tag{32}$$

Besides the fact that (32) shows the existence of a self-fulfilling run equilibrium for $q^e \to 1$ even if $p_{1;2}^e = 1$, it is interesting to note that, in the bank-based financial system,

[21] In the case of both banks being subject to a run, supply and demand for assets should actually be multiplied by 2. If bank 2 can withstand the drop in asset prices, it will successfully have neutralized the asset demand of its patient type A depositors. Thus, dropping these two terms in the first place does not change the result.

the pure expectation of a drop in asset prices can cause a run. Even if a patient type B household expects the other patient type B households not to withdraw early ($q^e = q$) but anticipates an asset price drop to

$$p^e_{1;2} < \frac{R \cdot (1-q) \cdot (1-i)}{i \cdot (1-q) \cdot (\Theta - 1) + R \cdot (1-q) \cdot (1-i)} \tag{33}$$

it is preferable for it to withdraw in $t = 1$. Given these price expectations for many patient type B households, a run will occur that might bring about the expected asset price deterioration.

Now we arrive at the calculation of the equilibrium asset price in the event of a run. In doing so we can again distinguish two cases. As long as $p^{BR}_{1;2} > \gamma \cdot R$, it is never efficient for type B households to buy any long-term asset. They will instead prefer to hoard liquidity. Therefore, in this case, even during a bank run only patient type A households demand assets and the equilibrium condition is given by

$$k^{BD}_1 = (1-q) \cdot (1-i) \frac{d^{BR}_1}{p^{BR}_{1;2}} \tag{34}$$

As all depositors want to withdraw, the bank will sell off all long-term assets. But now since patient type B households also withdraw, available liquidity has to be split between impatient depositors and patient type B depositors. The effective equilibrium short-term repayment in the crisis situation d^{BR}_1 is therefore given by

$$l^{BD}_1 = q \cdot d^{BR}_1 + (1-q) \cdot i \cdot d^{BR}_1 \tag{35}$$

Solving (34) and (35) for the equilibrium price and the equilibrium repayment yields

$$d^{BR}_1 = \frac{l^{BD}_1}{q + (1-q) \cdot i} \tag{36}$$

$$p^{BR}_{1;2} = \frac{(1-q) \cdot (1-i)}{1 - (1-q) \cdot (1-i)} \cdot \frac{l^{BD}_1}{k^{BD}_1} \tag{37}$$

Obviously, in the event of a run, a bank cannot repay the promised amount. Inserting the optimal exante holding of liquidity $l^{BD}_1 = q \cdot d^{BD}_1$, shows that only the fraction

$$\frac{d^{BR}_1}{d^{BD}_1} = \frac{q}{q + (1-q) \cdot i} \tag{38}$$

will be repayed.

As can be seen from the expression for the equilibrium asset price during a banking crisis, the fire sales cause a drop of asset value compared to those in normal situations.[22]

[22]From $p^{BR}_{1;2} = \frac{(1-q)\cdot(1-i)}{1-(1-q)\cdot(1-i)} \cdot \frac{l^{BD}_1}{k^{BD}_1} < 1$ follows $(1-q) \cdot (1-i) \cdot \frac{l^{BD}_1}{k^{BD}_1} < 1 - (1-q) \cdot (1-i)$ and $(1-q) \cdot (1-i) \cdot \left(\frac{l^{BD}_1}{k^{BD}_1} + 1 \right) < 1$. Since, by definition, $l^{BR}_1 + k^{BR}_1 = 1$, $(1-q) \cdot (1-i) < k^{BD}_1$, which always holds given the exante optimal value of k^{BD}_1 and the fact that $d^{BD}_1 > 1$.

Apparently, the extent of the drop caused by the banking crisis is determined by two effects. On the one hand, the effect of fire sales on the equilibrium price is influenced by the depth of the financial market. This effect is captured by the first term on the right-hand side of (37). It is the relation of patient type A depositors to the rest of the households. As this fraction increases, the relative depth of the market increases, in the sense that more households in the economy are participating in the financial market and are willing to buy long-term assets during a crisis. Thus the deviation of the asset price from its normal level becomes smaller.

The second term captures the opposite effect. It is a measure of the liquidity of the bank. Since all funds of the region are held by the bank, it also captures the liquidity of the region. As the liquidity ratio in the bank's portfolio decreases as the fraction of type A households increases, this effect enlarges the disruption of the asset price caused by fire sales if $1 - i$ becomes bigger.

Since there are two opposed effects of an increase in the fraction of type A households, the comparative statics of $p_{1;2}^{BR}$ with respect to i are not trivial. However, guessing that the overall effect of an increase in i on the equilibrium asset price is negative tends to be intuitive. As can be seen from expression (37) for the critical value $\bar{i}$, the asset price in the event of a banking crisis is positive. But, as the fraction of type A households vanishes ($i \rightarrow 1$), the depth of the financial market approaches zero while the liquidity to capital ratio of bank 1 approaches $\frac{q}{(1-q)} \cdot R^{\frac{\alpha-1}{\alpha}}$.[23] Thus, overall the asset price converges to 0.[24]

One of the assumptions made when formulating the equilibrium condition in a crisis situation was that patient type B households do not have an incentive to buy long-term assets. Instead, they were assumed to hoard liquidity since $p_{1;2}^{BR} > \gamma \cdot R$. But as stated in the previous paragraph for $i \rightarrow 1$, $p_{1;2}^{BR} \rightarrow 0$. Therefore, for $p_{1;2}^{BR}(\bar{i}) > \gamma \cdot R$ there always exists a threshold value $\hat{i} > \bar{i}$ for which

$$\frac{(1-q) \cdot (1-\hat{i})}{1-(1-q) \cdot (1-\hat{i})} \cdot \frac{l_1^{BD}(\hat{i})}{k_1^{BD}(\hat{i})} = \gamma \cdot R$$

Analyzing the crisis equilibrium for economies with $i \geq \hat{i}$, we start by assuming $p_{1;2}^{BR} = \gamma \cdot R$. Therefore, patient type B households are indifferent as to whether to buy long-term assets or store the withdrawn liquidity for one period. Given this assumption, the equilibrium conditions for the financial market changes to

$$k_1^{BD} = (1-q) \cdot (\mu \cdot i + (1-i)) \frac{d_1^{BR}}{\gamma \cdot R} \tag{39}$$

[23] Note, for $i = 1$ the optimal risk sharing $\Theta = R^{\frac{1}{\alpha}}$ can be realized. Replacing this in the optimal deposit contract (10) and inserting the results into the optimal portfolio of the bank given by (13) yields $l_1^{BD} = q \cdot \frac{R}{q \cdot R + (1-q) \cdot R^{\frac{1}{\alpha}}}$ and $k_1^{BD} = (1-q) \cdot \frac{R^{\frac{1}{\alpha}}}{q \cdot R + (1-q) \cdot R^{\frac{1}{\alpha}}}$. Therefore, the liquidity to capital ratio is given by $\frac{l_1^{BD}}{k_1^{BD}} = \frac{q}{(1-q)} \cdot R^{\frac{\alpha-1}{\alpha}}$.

[24] A formal proof that $p_{1;2}^{BR}$ falls monotonically within the interval $1 \geq i \geq \bar{i}$ is given in appendix E.

where μ is again the fraction of indifferent patient type B households that just ensures the clearing of the financial market. Similarly, the equilibrium condition for the effective repayment on deposits is now given by

$$l_1^{BD} = q \cdot d_1^{BR} + (1-q) \cdot (1-\mu) \cdot i \cdot d_1^{BR} \tag{40}$$

Solving (39) and (40), one obtains the market clearing fraction of the indifferent patient type B households that have to buy long-term assets:

$$\mu^* = 1 - \frac{l_1^{BD} \cdot (1-q) - \gamma \cdot R \cdot k_1^{BD} \cdot q}{i \cdot \left(l_1^{BD} + \gamma \cdot R \cdot k_1^{BD}\right) \cdot (1-q)} \tag{41}$$

Thus, whenever the fraction of type B households is larger than the threshold value $\hat{i}$, the equilibrium arising during a banking crisis is characterized by an asset price $p_{1;2}^{BR} = \gamma \cdot R$ and a fraction μ^* of patient type B households demanding long-term financial assets.[25]

Having calculated the equilibrium asset price in the event of a run on the bank in region 1, we can turn to the most interesting question: Under which circumstances will bank 2 be able to cope with this given asset price drop and under which parameter setting will financial contagion through the asset market occur in that economy?

Remember, the long-term assets in the portfolio of bank 2 are given by

$$k_2^{BD} = (1-q) \cdot i \cdot \frac{d_2^{BD}}{R} + (1-q) \cdot (1-i) \cdot d_1^{BD} \tag{42}$$

in which the first term was the amount of assets held to finance the long-term payment on deposits, while the second term was the planned supply of financial claims to its patient type A depositors.

In order to calculate the threshold value of the asset price below which the second bank will also collapse, we have to keep in mind the fact that the bank will need

$$(1-q) \cdot (1-i) \cdot \frac{d_1^{BD}}{p_{1;2}^{BR}} \tag{43}$$

long-term assets to meet the demand of its patient type A depositors to prevent them from withdrawing liquidity in order to demand financial claims from bank 1.

Whenever the asset price falls below 1, the only way for the bank to meet the increased demand of its patient type A depositors is by reducing the long-term repayment

[25] To show that, in fact, the equilibrium asset price can never fall below that critical level, it is sufficient to prove that at least if all patient type B households demand assets there is no excess supply of assets at $p_{1;2} = \gamma \cdot R$ and markets are cleared at that price, or more formally, we have to show for $p_{1;2} = \gamma \cdot R$ that $\mu^* \leq 1$ always holds. Since the denominator in (41) is always positive, in order to demonstrate that $\mu^* \leq 1$ it is sufficient to verify that $l_1^{BD} \cdot (1-q) - \gamma \cdot R \cdot k_1^{BD} \cdot q$ is also always non-negative. By inserting the equilibrium level of the banks portfolio given by (13) this expression can be simplified to $\gamma \cdot R \cdot [i \cdot \frac{\Theta}{R} + (1-i)] \leq 1$. This is obviously always true, since on the one hand by assumption $\gamma \cdot R < 1$ and since, on the other hand, $\frac{\Theta}{R} < 1$ and therefore $i \cdot \frac{\Theta}{R} + (1-i) < 1$.

on deposits. These repayments go to patient type B households. Given $p_{1;2} \geq \gamma \cdot R$, the best alternative to keeping their money with the bank is for these depositors to withdraw and store the consumption goods for one period yielding no additional return. Therefore, these repayments can at maximum be reduced to d_1^{BD} without inducing these depositors to withdraw early and the minimal amount of assets needed to finance these payouts is given by $(1-q) \cdot i \cdot \frac{d_1^{BD}}{R}$. Consequently, if the amount of assets that can be saved by reducing the repayment to patient type B depositors is not enough to meet the increase in demand of patient type A households to $(1-q) \cdot (1-i) \cdot \frac{d_1^{BD}}{p_{1;2}^{BR}}$, bank 2 will also collapse. Thus, the threshold level for the asset price below which contagion occurs ($p_{1;2}^{CT}$) is defined by

$$(1-q) \cdot i \cdot \frac{d_2^{BD} - d_1^{BD}}{R} = (1-q) \cdot (1-i) \cdot \left(\frac{d_1^{BD}}{p_{1;2}^{CT}} - d_1^{BD} \right) \tag{44}$$

Taking the optimal deposit contract given by (10) into account, the rearranging of (44) yields

$$p_{1;2}^{CT} = \frac{R \cdot (1-i)}{R \cdot (1-i) + i \cdot (\Theta - 1)} \tag{45}$$

As shown in appendix F for $i \leq \hat{i}$, this threshold level is always above the equilibrium asset price during a banking crisis. The drop in asset prices caused by fire sales of a bank subject to a run will be so large that the other bank will not be able to meet the asset demand of its patient type A households. Patient type A households will therefore withdraw liquidity to demand assets from the other bank. But since bank 2 needs all liquidity to repay impatient households, this withdrawal of liquidity by patient type A households will precipitate bank 2 into a collapse as well.

However, it is easy to see from expression (45) that if the fraction of type A households becomes smaller than $(1-\hat{i})$ and converges to 0, the asset price the bank is able to hold out, approaches 0. Therefore, there exists a level $i^* > \hat{i}$ at which $p_{1;2}^{CT}$ falls below $p^{BR} = \gamma \cdot R$. For $i > i^*$, the asset price deterioration due to a run on a single bank is not so large that the price actually falls below the respective $p_{1;2}^{CT}$ and destabilizes the other bank.

Thus, while in rather moderately bank-dominated financial systems ($\bar{i} < i < i^*$) the asset price drop due to a run on one bank cannot be buffered by the second bank and financial contagion occurs, in more strictly bank-dominated financial systems, in which only a small fraction of households has an equally efficient access to investment opportunities like banks ($i > i^*$), the asset price deterioration caused by a bank run does not destabilize other institutions.

Altogether, in bank-based financial systems

1. just like in a market-oriented financial system, the lower the fraction of type B households is, or, the deeper financial markets are, the smaller is the effect of a bank run on the asset price

2. the drop in asset prices due to the fire sales of an illiquid institute can cause contagion of another bank if the financial system is only moderately bank-dominated, i.e. if there is still a rather large fraction of type A households ($\bar{i} < i < i^*$).

3. banks may be able to buffer even extremely large drops in asset prices if a fairly large fraction of households ($i > i^*$) cannot invest as efficiently as the bank at the financial market.

Figure 6 summarizes graphically the relationship between $p_{1;2}^{BR}$ and $p_{1;2}^{CT}$ with respect to i.

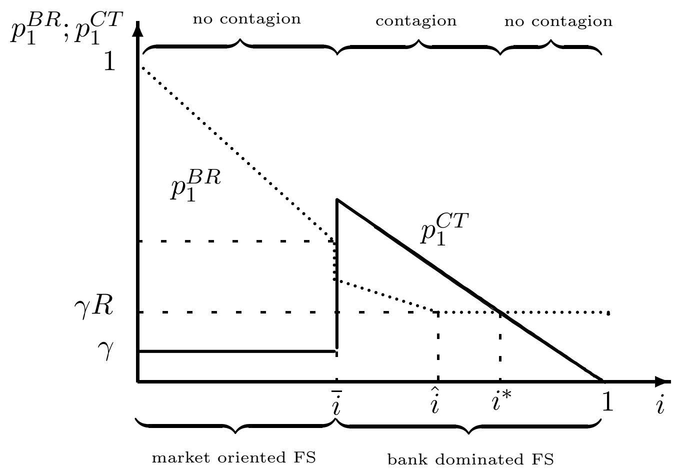

Figure 6

Whenever $p_{1;2}^{CT}$ exceeds $p_{1;2}^{BR}$ at a given level of i, a bank run on an individual bank causes asset price drops which induce a collapse of the other bank. As can be seen from the graph, this happens neither in market-oriented nor in strictly bank-dominated financial systems.

In market-dominated financial systems ($i < \bar{i}$), asset price deteriorations after the run on one bank are rather moderate (p_1^{BR}) because financial markets are comparatively deep. Moreover, since banks do not trade in the secondary financial market, the threshold level for asset prices below which contagion would occur is considerably lower. The asset price drop would destabilize other banks only if those patient households without efficient access to direct investments suddenly preferred to hold financial claims directly because of their low price ($p_1^{CT} = \gamma$).[26]

[26] Note the saltus of p_1^{BR} at the transition from a market-based financial system to a bank-based financial system ($i = \bar{i}$). This results from the fact that the amount of financial claims held by banks and sold off in a crisis jumps upward at the change from a market-based financial system to a bank-based financial system. Formally, this can be shown by inserting $k_1^{BR}(\bar{i}) = (1-q)$ and $l_1^{BR}(\bar{i}) = q$ into $\frac{2 \cdot q \cdot (1-i)}{2 \cdot q \cdot (1-i)+i} > \frac{(1-q)\cdot(1-i)}{1-(1-q)\cdot(1-i)} \cdot \frac{l_1^{BR}(\bar{i})}{k_1^{BR}(\bar{i})}$. This yields $\frac{2}{2 \cdot q \cdot (1-i)+i} > \frac{1}{q \cdot (1-i)+i}$, which is obviously always true.

In contrast, financial markets in strictly bank-dominated financial systems ($i > i^*$) tend to be illiquid and fire sales cause severe asset price deteriorations ($p_1^{BR} = \gamma R$). But, since the trading volume of banks in the secondary financial market is quite small in relation to their total assets, they are able to buffer trading losses by reducing long-run repayments without inducing long-run depositors to withdraw (p_1^{CT}).

It is only in rather hybrid or weakly bank-dominated financial systems ($\bar{i} > i > i^*$) that the trading volume of banks in the secondary financial market - i.e. the expected liquidity inflow from trading - is so large (relative to their balance sheet total) that a drop of asset prices due to fire sales of one bank will cause the collapse of other banks. Thus, only those financial systems are so fragile that the breakdown of a single bank has a contagious effect on the other financial institution.

5 Summary and Conclusion

The first part of the paper derived endogenously two very distinct financial systems covering some basic features of the two contrasting financial systems of Germany, on the one hand, and UK and the US, on the other.

For a relatively high fraction of households with investment opportunities which are as efficient as those available to banks, the model depicts some elementary characteristics of the US and UK-type financial system. For instance, in this setting, banks do not provide any additional liquidity insurance compared to the market. They simply provide households lacking access to efficient direct investment opportunities with efficient indirect alternatives. Thus, banks' main function is to economize on transaction costs for its depositors. Compared with the bank-based financial system, the trading volume of households at the financial markets is large, although banks do not play a major (in the extreme case, any) role in the secondary financial market. A large fraction of households holds claims against the corporate sector directly. Households are actively trading in the primary as well as in the secondary financial market.

Quite the opposite holds if the fraction of households with access to efficient direct investment opportunities is comparatively small. In that case, the emerging financial system displays basic characteristics of the German bank-dominated financial system. The role of banks is not restricted to enabling all households to benefit from efficient investment opportunities; they provide liquidity insurance as well. Banks trade actively in the secondary financial market and are the dominant (or only) player in the primary market. Households are not engaged in the primary market and only some participate in the secondary financial market.

The second part of the paper analyzed the effect of a bank run on the economy. In doing so, the model proved for the different types of financial systems the assessment of Allen and Gale (2000a), p. 13:

Troubled intermediaries, seeking to find liquidity by selling their assets on the market, simply reduce the value of their assets, thereby making their problems worse. The mere existence of a market does not provide liquidity to the system as a whole, nor does it ensure that liquidity will be available to the banking sector on reasonable terms.

With respect to the implications for 'lender of last resort' policies, it is interesting to note that it is only in market-oriented financial systems that a stabilization of asset prices at the pre-crisis (or *normal*) level can prevent inefficient bank runs. In bank-based financial systems, by contrast, a lender of last resort that provides emergency liquidity assistance at the *normal* price $p_{1;2} = 1$ cannot avert self-fulfilling banking collapses. Thus, in these financial systems there is an additional role for a deposit insurance.

But, most interestingly, the paper shows that, in some economies, fire sales of troubled banks not only worsen their own problems but also trigger crises at other banks if the lender of last resort does not stabilize asset prices. Banks in market-oriented systems face a financial market that is always deep enough to buffer the effect of fire sales, with the result that contagion of other institutions is prevented. Moreover, since banks in market-oriented financial systems do not trade in the secondary financial market, they are less dependent on asset price developments. Banks in strictly bank-dominated financial systems face very severe asset price deteriorations during a crisis. However, they are able to compensate for these large drops, since the ratio of banks' trading volume to their total assets tend to be low. But banks in hybrid or weakly bank-dominated financial systems face rather large asset price drops due to fire sales of other institutions and have a comparatively high trading volume. Thus, they cannot buffer the shortfall in liquidity inflow during a crisis by a reduction of long-term deposit repayments.

Hence, the paper points out that

- economies without one of the polar financial systems are more fragile; in other words, hybrid financial systems bear the risk of financial contagion
- a gradual transformation of a bank-based financial system towards a market-oriented financial system may be accompanied by a transitory increase in financial fragility and in risks of financial contagion.

Thus, in a hybrid financial system as well as in an economy with a financial system under transition, there is a need for a lender of last resort to provide liquidity to the financial market during crisis periods, thereby stabilizing asset prices.

One possible criticism of the model presented here could be that there is no reason for a financial market to exist. The introduction of a financial market not only restraints the utility-enhancing liquidity transformation of banks, it also entails the risk of financial contagion. However this is obviously a drawback that results from necessary simplifications.

Introducing perfectly negatively correlated region-specific fluctuations of the fraction of impatient households, for instance, would generate an efficiency-enhancing effect of financial markets[27] without changing the basic features of the presented model.

Another caveat is certainly that banks have no reason to hold excess liquidity in the model, since there is no aggregate risk against which they could insure by keeping more liquidity than needed for the expected repayment to short-term depositors. If the model incorporated, for instance, aggregate risk concerning the fraction of impatient households, banks would have an incentive to hold additional liquidity in order to prevent a collapse in situations with a rather high proportion of impatient households. However, if this fraction is coincidentally low, banks can use these additional liquide reserves to buy assets from a bank that is hit by a run, limiting the price effect of fire sales and thereby reducing the scope of contagion. But even if this effect were large enough to prevent severe asset price deteriorations and financial contagion in cases with a low aggregate fraction of impatient households, the results of the paper would still hold in instances with a rather high fraction of impatient depositors.

[27] One recent paper in which the emergence of interbank markets is explained in this way is Allen and Gale (2001b).

Appendix

A Solution to Problem 2

Solving

$$(P_T2)\begin{cases} \max\limits_{d_1^T;d_2^T} & q\cdot u\left(d_1^T\right)+(1-q)\cdot u\left(d_2^T\right) \\ \text{s.t.} & q\cdot d_1^T+(1-q)\cdot\frac{d_2^T}{R}\leq 1 \qquad (BC) \\ & \frac{\Gamma_T\cdot R}{p_{1;2}}\cdot d_1^T\leq d_2^T \qquad (IC) \end{cases}$$

only with respect to the first constraint yields again

$$\frac{d_2^T}{d_1^T}=(R)^{\frac{1}{\alpha}} \tag{46}$$

The repayment scheme of the deposit contract will only deviate from that optimal risk sharing ratio if it violates the incentive compatibility constraint. This is the case if the incentive compatibility constraint is steeper than the optimal risk sharing ratio. In that case, the ratio of the optimal constraint deposit contract will be given by the incentive compatibility constraint, because the expected utility of the representative depositor monotonically decreases if $\frac{d_2^T}{d_1^T}$ increases along the budget constraint.

B Pooling contract for maximizing expected utility of type A ***and*** type B households

$$
(P3') \begin{cases} \max\limits_{d_1;d_2} & q \cdot u(d_1) + (1-q) \cdot i \cdot u(d_2) + (1-q) \cdot (1-i) \cdot u\left(\frac{R}{p_{1;2}} \cdot d_1\right) \\ \text{s.t.} & [q \cdot i + (1-i)] \cdot d_1 + (1-q) \cdot i \cdot \frac{d_2}{R} \leq 1 & (BC) \\ & \max\{1; \frac{R}{p_{1;2}}\} \cdot d_1 \geq d_2 & (IC_A) \\ & \max\{1; \frac{\gamma R}{p_{1;2}}\} \cdot d_1 \leq d_2 & (IC_B) \end{cases}
$$

FOC:

$$
\begin{aligned}
q \cdot u'(d_1) + (1-q) \cdot (1-i) \cdot u'\left(\frac{R}{p_{1;2}} \cdot d_1\right) \cdot \frac{R}{p_{1;2}} &= [q \cdot i + (1-i)] \cdot \lambda \\
(1-q) \cdot i \cdot u'(d_2) &= \left[\frac{(1-q) \cdot i}{R}\right] \cdot \lambda \\
\Rightarrow \frac{q \cdot u'(d_1) + (1-q) \cdot (1-i) \cdot u'\left(\frac{R}{p_{1;2}} \cdot d_1\right) \cdot \frac{R}{p_{1;2}}}{(1-q) \cdot i \cdot u'(d_2)} &= \frac{q \cdot i + (1-i)}{(1-q) \cdot i} \cdot R \\
\Leftrightarrow q \cdot u'(d_1) + (1-q) \cdot (1-i) \cdot u'\left(\frac{R}{p_{1;2}} \cdot d_1\right) \cdot \frac{R}{p_{1;2}} &= q \cdot i + (1-i) \cdot R \cdot u'(d_2)
\end{aligned}
$$

By inserting the specific assumed utility function, this can be simplified to

$$
\begin{aligned}
\left(q + (1-q) \cdot (1-i) \left(\frac{R}{p_{1;2}}\right)^{1-\alpha}\right) \cdot d_1^{-\alpha} &= (q \cdot i + (1-i)) \cdot R \cdot d_2^{-\alpha} \\
\Leftrightarrow \left(\frac{d_2}{d_1}\right)^{\alpha} &= \frac{q \cdot i + (1-i)}{q + (1-q) \cdot (1-i) \left(\frac{R}{p_{1;2}}\right)^{1-\alpha}} R \\
\Leftrightarrow \frac{d_2}{d_1} &= \underbrace{\left(\frac{q \cdot i + (1-i)}{q + (1-q) \cdot (1-i) \left(\frac{R}{p_{1;2}}\right)^{1-\alpha}} R\right)^{\frac{1}{\alpha}}}_{X}
\end{aligned}
$$

The liquidity insurance provided by this contract is suboptimally high if $\Theta > X$. Since $\Theta = \left(\frac{1-(1-q) \cdot i}{q \cdot i} \cdot R\right)^{\frac{1}{\alpha}}$, $\Theta > X$ if $q \cdot i < q + (1-q) \cdot (1-i) \left(\frac{R}{p_{1;2}}\right)^{1-\alpha}$. This is always true because

$$
\underbrace{q \cdot (i-1)}_{<0} < \underbrace{(1-q) \cdot (1-i) \left(\frac{R}{p_{1;2}}\right)^{1-\alpha}}_{>0}. \tag{47}
$$

C Solution to Problem 3

$$(P3)\begin{cases} \max\limits_{d_1;d_2} & q \cdot i \cdot u\left(d_1\right) + (1-q) \cdot i \cdot u\left(d_2\right) \\ \text{s.t.} & [q \cdot i + (1-i)] \cdot d_1 + (1-q) \cdot i \cdot \frac{d_2}{R} \leq 1 \quad (BC) \\ & \max\{1; \frac{R}{p_{1;2}}\} \cdot d_1 \geq d_2 \quad (IC_A) \\ & \max\{1; \frac{\gamma R}{p_{1;2}}\} \cdot d_1 \leq d_2 \quad (IC_B) \end{cases}$$

Taking only BC into account yields the first order conditions

$$q \cdot i \cdot u'(d_1) = \lambda \cdot [q \cdot i + (1-i)] \tag{48}$$

$$(1-q) \cdot i \cdot u'(d_2) = \lambda \cdot \frac{(1-q) \cdot i}{R} \tag{49}$$

From (48) divided by (49) follows

$$\frac{q \cdot i \cdot u'(d_1)}{(1-q) \cdot i \cdot u'(d_2)} = \frac{q \cdot i + (1-i)}{(1-q) \cdot i} \cdot R$$

$$\frac{q \cdot u'(d_1)}{(1-q) \cdot u'(d_2)} = \frac{q + \frac{(1-i)}{i}}{(1-q)} \cdot R$$

Inserting the assumed utility function

$$\frac{(d_1)^{-\alpha}}{(d_2)^{-\alpha}} = \frac{1-(1-q) \cdot i}{q \cdot i} \cdot R$$

$$d_2 = \underbrace{\left(\frac{1-(1-q) \cdot i}{q \cdot i} \cdot R\right)^{\frac{1}{\alpha}}}_{\Theta} \cdot d_1 \tag{50}$$

(50) into (BC) yields

$$[q \cdot i + (1-i)] \cdot d_1 + (1-q) \cdot i \cdot \frac{\Theta \cdot d_1}{R} = 1$$

$$\frac{1}{R-(R-\Theta) \cdot (1-q) \cdot i} = d_1^{BD} \tag{51}$$

Reinserting (51) into (50)

$$\frac{\Theta}{R-(R-\Theta) \cdot (1-q) \cdot i} = d_2^{BD} \tag{52}$$

D Proof that $p_{1;2}^{BR}$ has a lower bound at $\gamma \cdot R$ in market-oriented financial systems

The fraction of patient type A households that has to buy long-term claims in order to ensure the financial market equilibrium is given by (30). If $\mu \leq 1$ holds for all parameter settings, the equilibrium price $p_{1;2}^{BR}$ will never fall below $\gamma \cdot R$. This always holds because

$$\begin{aligned}
1 &\geq \frac{\gamma \cdot R \cdot i - 2 \cdot q \cdot (1-i) \cdot (1 - \gamma \cdot R)}{\gamma \cdot R \cdot (1-q) \cdot i + q \cdot i} \\
\gamma \cdot R \cdot (1-q) \cdot i + q \cdot i &\geq \gamma \cdot R \cdot i - 2 \cdot q \cdot (1-i) \cdot (1 - \gamma \cdot R) \\
-\gamma \cdot R \cdot q \cdot i + q \cdot i &\geq -2 \cdot q \cdot (1-i) \cdot (1 - \gamma \cdot R) \\
\underbrace{(1 - \gamma \cdot R) \cdot q \cdot i}_{\geq 0} &\geq \underbrace{-2 \cdot q \cdot (1-i) \cdot (1 - \gamma \cdot R)}_{\leq 0}
\end{aligned}$$

E Proof that $p_{1;2}^{BR}$ is monotonically falling for $i > \bar{i}$

$$p_{1;2}^{BR}(i) = \underbrace{\frac{(1-q)\cdot(1-i)}{1-(1-q)\cdot(1-i)}}_{g(i)} \cdot \underbrace{\frac{l_1^{BD}}{k_1^{BD}}}_{h(i)}$$

Thus

$$\frac{\partial p_{1;2}^{BR}}{\partial i} = g'(i)\cdot h(i) + g(i)\cdot h'(i) < 0$$

if

$$-\frac{g'(i)}{g(i)} > \frac{h'(i)}{h(i)} \tag{53}$$

Obviously,

$$\frac{g'(i)}{g(i)} = -\frac{1}{(1-i)\cdot(q+i\cdot(1-q))}$$

Taking account of $k_1^{BD} = (1-q)\cdot i\cdot \frac{d_2^{BD}}{R} + (1-q)\cdot(1-i)\cdot d_1^{BD}$, $l_1^{BD} = q\cdot d_1^{BD}$ and $d_2^{BD} = \Theta(i)\cdot d_1^{BD}$

$$h(i) = \frac{q\cdot R}{(1-q)\cdot i\cdot\Theta(i) + (1-q)\cdot(1-i)\cdot R}$$

and

$$\frac{h'(i)}{h(i)} = \frac{R-\Theta-i\cdot\Theta'(i)}{R-i\cdot R+i\cdot\Theta}$$

Thus $p_{1;2}^{BR}$ is monotonically falling if

$$\frac{1}{(1-i)\cdot(q+i\cdot(1-q))} > \frac{R-\Theta-i\cdot\Theta'(i)}{R-i\cdot R+i\cdot\Theta}$$

$$\Leftrightarrow (1-i)\cdot R + i\cdot\Theta > [R-\Theta-i\cdot\Theta'(i)]\cdot(1-i)\cdot(q+i\cdot(1-q))$$

$$\Leftrightarrow (1-i)\cdot R+i\cdot\Theta-[R-\Theta-i\cdot\Theta'(i)]\cdot(1-i) > [R-\Theta-i\cdot\Theta'(i)]\cdot(1-i)\cdot(q-1+i\cdot(1-q))$$

$$\Leftrightarrow \underbrace{\Theta+\Theta'(i)\cdot i\cdot(1-i)}_{Y} > -\underbrace{[R-\Theta-i\cdot\Theta'(i)]}_{Z}\cdot(1-i)^2\cdot(1-q)$$

This is always true if $Z > 0$ and $Y > 0$. From

$$\Theta = \left(\frac{1-(1-q)\cdot i}{q\cdot i}\cdot R\right)^{\frac{1}{\alpha}}$$

follows that

$$\Theta'(i) = -\frac{R}{\alpha\cdot q\cdot i^2}\cdot\left(\frac{1-(1-q)\cdot i}{q\cdot i}\cdot R\right)^{\frac{1}{\alpha}-1} < 1$$

Therefore, since $R-\Theta > 0$, also $Z > 0$.

Moreover, Y can be simplified to

$$Y = \left(1-\frac{i\cdot(1-i)\cdot R}{\alpha\cdot q\cdot i^2}\cdot\left(\frac{1-(1-q)\cdot i}{q\cdot i}\cdot R\right)^{-1}\right)\cdot\Theta$$

$$= \left(1-\frac{i\cdot(1-i)\cdot R\cdot q\cdot i}{\alpha\cdot q\cdot i^2\cdot(1-(1-q)\cdot i)}\right)\cdot\Theta$$

$$= \underbrace{\left(\frac{(\alpha - 1) \cdot (1 - i) + \alpha \cdot q \cdot i}{\alpha \cdot (1 - (1 - q) \cdot i)}\right)}_{W} \cdot \Theta$$

Since $W > 0$ also $Y > 0$ which finally proves that p_1^{BR} is monotonically falling in i.

F Proof that $p_{1;2}^{BR} > p_{1;2}^{CT}$ for $i > \bar{i}$

Taking account of $l_1^{BD} = q \cdot d_1^{BD}$, $d_2^{BD} = \Theta \cdot d_1^{BD}$ and $k_1^{BD} = (1-q) \cdot i \cdot \frac{d_2^{BD}}{R} + (1-q) \cdot (1-i) \cdot d_1^{BD}$, $p_{1,2}^{BR} > p_{1,2}^{CT}$ can be rearranged yielding

$$\frac{R \cdot (1-i)}{R \cdot (1-i) + i \cdot (\Theta - 1)} > \frac{(1-q) \cdot (1-i)}{1 - (1-q) \cdot (1-i)} \cdot \frac{q \cdot d_1^{BD}}{(1-q) \cdot i \cdot \frac{\Theta}{R} \cdot d_1^{BD} + (1-q) \cdot (1-i) \cdot d_1^{BD}}$$

$$\Leftrightarrow \frac{1}{R \cdot (1-i) + i \cdot (\Theta - 1)} > \frac{q}{[1 - (1-q) \cdot (1-i)][i \cdot \Theta + (1-i) \cdot R]}$$

$$\Leftrightarrow \underbrace{\frac{1}{R \cdot (1-i) + i \cdot (\Theta - 1)}}_{A} > \underbrace{\frac{1}{R \cdot (1-i) + i \cdot \Theta}}_{B} \cdot \underbrace{\frac{q}{1 - (1-q) \cdot (1-i)}}_{C}$$

Note that $A > B$ since $\Theta - 1 < \Theta$ and $C < 1$ since $\frac{q}{q + i \cdot (1-q)} < 1$.
Therefore, $A > B \cdot C$ always holds.

References

Aghion, P., P. Bolton, and M. Dewatripont, 2000, "Contagious bank failures in a free banking system," *European Economic Review*, 44, 713–718.

Allen, F., and D. Gale, 1995, "A welfare comparison of intermediaries and financial markets in Germany and the US," *European Economic Review*, 39, 179–209.

Allen, F., and D. Gale, 2000a, *Comparing Financial Systems*, MIT Press, Cambridge, Massachusetts.

Allen, F., and D. Gale, 2000b, "Financial Contagion," *Journal of Political Economy*, 108, 1–33.

Allen, F., and D. Gale, 2001a, "Comparative Financial Systems: A Survey," Wharton Financial Institutions Center, Working Paper 01-15.

Allen, F., and D. Gale, 2001b, "Financial Fragility," Wharton Financial Institutions Center, Working Paper 01-37.

Danthine, J.-P., F. Giavazzi, X. Vives, and E.-L. von Thadden, 1999, *The Future of European Banking* . Monitoring Eurpean Integration 9, Centre for Economic Policy Research.

Deutsche Bundesbank, 2000, "The relationship between banklending and the bond market in Germany," *Monthly Report*, January, 33–47.

Diamond, D., 1997, "Liquidity, Banks, and Markets," *Journal of Political Economy*, 105, 928–956.

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

Diamond, D., and R. Rajan, 2000, "A Theory of Bank Capital," *Journal of Finance*, 55, 2431–2465.

Diamond, D., and R. Rajan, 2001, "Liquidity Risk, Liquidity Creation and Financial Fragility: A Theory of Banking," *Journal of Political Economy*, 109, 287–327.

European Central Bank, 2002a, "Developments in Banks's Liquidity Profile and Management," May.

European Central Bank, 2002b, "Recent developments and risks in the euro area banking sector," *Monthly Bulletin*, August, 51–63.

European Central Bank, 2002c, *Report on financial structures*.

Freixas, X., B. Parigi, and J.-C. Rochet, 2000, "Systemic Risk, Interbank Relations, and Liquidity Provision by the Central Bank," *Journal of Money, Credit, And Banking*, 32, 611–638.

Galati, G., and K. Tsatsaronis, 2001, "The impact of the Euro on Europe's financial markets," BIS Working Paper 100.

Jacklin, C. J., 1987, "Demand deposits, trading restrictions, and risk sharing," in *Prescott, E.C. and N. Wallace: Contractual Arrangements for Intertemporal Trade*, pp. 26–47.

Lai, A., 2002, "Modelling Financial Instability: A Survey of the Literature," Bank of Canada Working Paper 2002-12.

Rajan, R. G., and L. Zingales, 2002, "Banks and Markets: The Changing Charakter of European Finance," Paper presented at the Second ECB Central Banking Conference.

Schmidt, R. H., A. Hackethal, and M. Tyrell, 1999, "Disintermediation and the Role of Banks in Europe: An international comparison," *Journal of Financial Intermediation*, 8, 36–67.

von Thadden, E.-L., 1999, "Liquidity Creation through Banks and Markets: Multiple Insurance and Limited Market Access," *European Economic Review*, 43, 991–1006.

The following papers have been published since 2002:

January	2002	Rent indices for housing in West Germany 1985 to 1998	Johannes Hoffmann Claudia Kurz
January	2002	Short-Term Capital, Economic Transform-ation, and EU Accession	Claudia M. Buch Lusine Lusinyan
January	2002	Fiscal Foundation of Convergence to European Union inLászló Halpern Pre-Accession Transition Countries	Judit Neményi
January	2002	Testing for Competition Among German Banks	Hannah S. Hempell
January	2002	The stable long-run CAPM and the cross-section of expected returns	Jeong-Ryeol Kim
February	2002	Pitfalls in the European Enlargement Process – Financial Instability and Real Divergence	Helmut Wagner
February	2002	The Empirical Performance of Option Based Densities of Foreign Exchange	Ben R. Craig Joachim G. Keller
February	2002	Evaluating Density Forecasts with an Application to Stock Market Returns	Gabriela de Raaij Burkhard Raunig
February	2002	Estimating Bilateral Exposures in the German Interbank Market: Is there a Danger of Contagion?	Christian Upper Andreas Worms
February	2002	The long-term sustainability of public finance in Germany – an analysis based on generational accounting	Bernhard Manzke

March	2002	The pass-through from market interest rates to bank lending rates in Germany	Mark A. Weth
April	2002	Dependencies between European stock markets when price changes are unusually large	Sebastian T. Schich
May	2002	Analysing Divisia Aggregates for the Euro Area	Hans-Eggert Reimers
May	2002	Price rigidity, the mark-up and the dynamics of the current account	Giovanni Lombardo
June	2002	An Examination of the Relationship Between Firm Size, Growth, and Liquidity in the Neuer Markt	Julie Ann Elston
June	2002	Monetary Transmission in the New Economy: Accelerated Depreciation, Transmission Channels and the Speed of Adjustment	Ulf von Kalckreuth Jürgen Schröder
June	2002	Central Bank Intervention and Exchange Rate Expectations – Evidence from the Daily DM/US-Dollar Exchange Rate	Stefan Reitz
June	2002	Monetary indicators and policy rules in the P-star model	Karl-Heinz Tödter
July	2002	Real currency appreciation in accession countries: Balassa-Samuelson and investment demand	Christoph Fischer
August	2002	The Eurosystem's Standing Facilities in a General Equilibrium Model of the European Interbank Market	Jens Tapking

August	2002	Imperfect Competition, Monetary Policy and Welfare in a Currency Area	Giovanni Lombardo
August	2002	Monetary and fiscal policy rules in a model with capital accumulation and potentially non-superneutral money	Leopold von Thadden
September	2002	Dynamic Q-investment functions for Germany using panel balance sheet data and a new algorithm for the capital stock at replacement values	Andreas Behr Egon Bellgardt
October	2002	Tail Wags Dog? Time-Varying Information Shares in the Bund Market	Christian Upper Thomas Werner
October	2002	Time Variation in the Tail Behaviour of Bund Futures Returns	Thomas Werner Christian Upper
November	2002	Bootstrapping Autoregressions with Conditional Heteroskedasticity of Unknown Form	Sílvia Gonçalves Lutz Kilian
November	2002	Cost-Push Shocks and Monetary Policy in Open Economies	Alan Sutherland
November	2002	Further Evidence On The Relationship Between Firm Investment And Financial Status	Robert S. Chirinko Ulf von Kalckreuth
November	2002	Genetic Learning as an Explanation of Stylized Facts of Foreign Exchange Markets	Thomas Lux Sascha Schornstein
December	2002	Wechselkurszielzonen, wirtschaftlicher Aufholprozess und endogene Realignmentrisiken *	Karin Radeck

***** Available in German only.

December	2002	Optimal factor taxation under wage bargaining – a dynamic perspective	Erkki Koskela Leopold von Thadden
January	2003	Testing mean-variance efficiency in CAPM with possibly non-gaussian errors: an exact simulation-based approach	Marie-Claude Beaul Jean-Marie Dufour Lynda Khalaf
January	2003	Finite-sample distributions of self-normalized sums	Jeong-Ryeol Kim
January	2003	The stock return-inflation puzzle and the asymmetric causality in stock returns, inflation and real activity	Jeong-Ryeol Kim
February	2003	Multiple equilibrium overnight rates in a dynamic interbank market game	Jens Tapking
February	2003	A comparison of dynamic panel data estimators: Monte Carlo evidence and an application to the investment function	Andreas Behr
March	2003	A Vectorautoregressive Investment Model (VIM) And Monetary Policy Transmission: Panel Evidence From German Firms	Joerg Breitung Robert S. Chirinko Ulf von Kalckreuth
March	2003	The international integration of money markets in the central and east European accession countries: deviations from covered interest parity, capital controls and inefficien-Cies in the financial sector	Sabine Herrmann Axel Jochem
March	2003	The international integration of foreign exchange markets in the central and east European accession countries: speculative efficiency, transaction costs and exchange rate premiums	Sabine Herrmann Axel Jochem

March	2003	Determinants of German FDI: New Evidence from Micro-Data	Claudia Buch Jörn Kleinert Farid Toubal
March	2003	On the Stability of Different Financial Systems	Falko Fecht

Visiting researcher at the Deutsche Bundesbank

The Deutsche Bundesbank in Frankfurt is looking for a visiting researcher. Visitors should prepare a research project during their stay at the Bundesbank. Candidates must hold a Ph D and be engaged in the field of either macroeconomics and monetary economics, financial markets or international economics. Proposed research projects should be from these fields. The visiting term will be from 3 to 6 months. Salary is commensurate with experience.

Applicants are requested to send a CV, copies of recent papers, letters of reference and a proposal for a research project to:

Deutsche Bundesbank
Personalabteilung
Wilhelm-Epstein-Str. 14

D - 60431 Frankfurt
GERMANY