Liquidity Creation through Banks and Markets: Multiple Insurance and Limited Market Access

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Abstract

The paper surveys theories of the intertemporal allocation of funds through demand deposits and anonymous markets, …rst separately and then in an integrated model. It reviews some work on the role of market frictions and asset characteristics, and suggests that the interplay between these two is crucial in explaining the observed coexistence of demand deposits and anonymous markets.

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1 Introduction

The question of the role and merits of "banks" and "markets" for the functioning of an economy is as topical as it is ill-de…ned. Accordingly, the answers to this question vary widely with to the position and the perspective adopted, and often appear contradictory. One reason for this confusion is that in modern economies, banks of di¤erent types serve several functions in di¤erent institutional frameworks. Hence, any debate about their role can only be productive if the context is spelled out clearly. This context is, in particular, the market environment in which banks operate, which immediately poses the next problem, namely that "banks are useless in the Arrow-Debreu world" of perfect markets (Freixas-Rochet, 1997, p. xix). This is no surprise, of course: if, by assumption, all goods and services are allocated freely and optimally by the omnipotent auctioneer, then there is no need for institutions which help to channel …nancial ‡ows through the economy. It is therefore indispensable for any discussion of the role of banks and markets to be explicit not only about the role of banks but also about the notion of markets.

In this paper, I will study a small part of the grand question, try to de…ne precisely the type and function of banking under consideration, and review one particular answer, which relies on a speci…c notion of market friction. The paper considers commercial banks - institutions that take in funds from the public in the form of demand deposits and provide …nance on their own account in the form of loans - and focusses on one particular economic function they perform, namely the provision of liquidity.

Liquidity provision is usually listed as one of the main macroeconomic functions of the banking system. Yet, already the de…nition of liquidity is elusive and would be a worthy subject of a …nancial Sokratian dialogue. The core of the di¤erent notions of liquidity used in …nance is similar: liquidity helps agents to realize a …nancial undertaking when they most want it. Yet, the de…nitions advanced in di¤erent contexts di¤er substantially. Here are three prominent examples:

1. "An asset is liquid if it can be bought or sold quickly at low transaction costs and a reasonable price" (Biais-Foucault-Hillion, p. 13).

2. "Liquidity refers to the availability of instruments (market and nonmarket) that can be used to transfer wealth across periods" (Holmström-Tirole, p. 2).

3. An asset is liquid if it allows agents to consume intertemporally as they would like to.

The analysis in this paper is mainly based on the third definition, introduced by Diamong and Dybvig (1983), not because the other definitions are unnatural, but because it has yielded some interesting and empirically appealing implications for the theory of banking. I will come back to the other two definitions later on in the paper.

To narrow the scope of the analysis even further, I consider only one aspect of commercial banking, namely deposit taking. As has been argued convincingly by Diamond and Dybvig (1983), a lot can be learned about liquidity provision through banks by abstracting from their lending role and focussing on the liability side of their balance sheets. In fact, this ignores some interesting aspects of liquidity related to banks' lending activities, but these are outside the scope of the present paper.[1]

Due to space constraints, this paper focusses excessively on my own contribution to the subject. Important other work which has paralleled or influenced the ideas presented here but which I cannot discuss, includes Waldo (1985), Bhattacharya and Gale (1987), Haubrich and King (1990), Mitusch (1991), Qi (1994), Hellwig (1994), and Hellwig (1998).

2 The Starting Point

2.1 Modelling liquidity demand:

We use as our starting point a slight generalisation of the model of liquidity demand introduced by Bryant (1980) and Diamond and Dybvig (1983) which is now standard in the banking and corporate finance literature. The model assumes an economy with three dates, $t = 0; 1; 2$, one (physical) good, and a continuum of agents $a \in [0; 1]$ who each have identical endowments of 1 at date 0, nothing thereafter, and identical preferences over future consumption at date 0, given by

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

The individual consumption shocks of different agents are realised at date 1, are identically distributed and satisfy the Law of Large Numbers. Hence, there is no uncertainty about aggregate consumption needs. This utility is

[1] On lending and liquidity see, in particular, Holmström and Tirole (1998a, 1998b) and Diamond and Rajan (1998).

extreme in the sense that agents only consume once in their lives (they are either extremely "impatient" or "patient"), but the analysis can be extended to more general preferences.[2] For simplicity, we assume that the elasticity of instantaneous marginal utility with respect to consumption be constant ("constant intertemporal relative risk aversion"):

$$u'(c) = c^{-a}, \quad a > 0. \tag{2}$$

Individual consumption needs are private information. Therefore, if agents interact, type-dependent consumption allocations must be incentive-compatible.

Finally, there is one (real) investment opportunity, which has constant returns to scale, is arbitrarily divisible, is available to everybody, and yields a gross return per unit invested at date t of either R_1 in $t + 1$ or R_2 in $t + 2$, where $R_1^2 \leq R_2$ and $R_2 > 1$. Hence, if investment takes place at time 0 it can either be "left in place to mature", or it can be "liquidated early".

The assumption that $R_2 > 1$ means that the economy is not shrinking and is made for notational convenience. The assumption that $R_1^2 \leq R_2$ simply means that the option of leaving the asset in place is meaningful, i.e. not dominated by liquidating early and reinvesting. If $R_1^2 < R_2$, the investment has an "irreversibility, or goods-in-process, feature" (Wallace, 1988): leaving the investment in place for two periods yields strictly higher returns than a sequence of short-term investments.[3]

2.2 Optimal liquidity:

The model describes a situation in which agents are facing a liquidity problem, in the sense that they may be forced to consume their investments when these have not yet matured. This will be the case under autarky, where the consumption path of each agent is given by $(c_1, c_2) = (R_1, R_2)$ (note that an agent consumes either c_1 or c_2). By definition, an allocation is said to provide liquidity if it insures the agent against such an outcome. Optimal liquidity is then defined as first-best intertemporal insurance, i.e. as the allocation agents would like best at date 0 if there were no informational constraints ex post. Formally, this amounts to maximising expected utility subject only to the constraint that consumption is feasible in the aggregate:

$$\max \quad qu(c_1) + (1 - q)u(c_2)$$

[2] See Jacklin (1987) or Jacklin and Bhattacharya (1988).

[3] In their original paper, Diamond and Dybvig (1983) assume $R_1 = 1$.

$$\text{subject to} \quad \begin{cases} (R_1 - q c_1)\dfrac{R_2}{R_1} = (1 - q)c_2 \\ \Leftrightarrow \quad q\dfrac{c_1}{R_1} + (1 - q)\dfrac{c_2}{R_2} = 1 \end{cases} \tag{3}$$

The second version of the resource constraint shows that $1/R_t$ can be interpreted as the state-price density in a standard dynamic consumption problem. The solution to this problem will then depend on the relative magnitude of the intertemporal income and substitution effects for the utility function (1). Formally, it is given by the following first-order condition, which equates state-price weighted marginal utilities:

$$R_1 u'(c_1) = R_2 u'(c_2).$$

Together with the resource constraint, this yields for the case of CRRA utility, (2), assumed above

$$c_1^* = \left(\frac{R_1}{R_2}\right)^{1/a} c_2^*. \tag{4}$$

This solution has the following qualitative features. If $a = 1$, then $c_t^* = R_t$. In this case, the income effect compensates exactly the substitution effect and autarky is optimal. If $a < 1$, then $c_1^* < R_1 < R_2 < c_2^*$ (the substitution effect dominates), if $a > 1$, then $R_1 < c_1^* < c_2^* < R_2$ (the income effect dominates), and if $a \to \infty$, then $c_1^* - c_2^* \to 0$, the consumption path becomes constant over time. For liquidity to play a role, we assume from now on, as in all of the literature, that $a > 1$. In this case, agents want to consume more in the short run than they have under autarky, hence need "liquidity".

It is worth emphasising that this notion of liquidity, which corresponds to definition 3 in the Introduction, is different from other equally plausible notions of liquidity. In particular, in the spirit of definition 2 above, the "liquidity of an investment opportunity" often denotes how easy it is reversible. Taking the example of a being large and $R_2 = R_1^2$ shows that these two notions of liquidity are very different. In this case, the investment is fully reversible (long-term investment yields the same intertemporal return stream as a sequence of short-term investments), but "optimal liquidity" as defined here demands a considerable transformation of investment returns.

2.3 The market outcome:

Suppose there exist competitive markets for intertemporal trade in $t = 0$ and $t = 1$, in which agents can take market clearing prices as given (without asking how they are determined). Obviously, in $t = 0$ there is no trade because everybody is identical, and everybody invests 1 unit into the (real) asset.

In $t = 1$, agents differ and can trade the asset (or equivalently, date 2 consumption). Let p denote the price (at date 1) of 1 unit of the asset (i.e. of R_2 units of date 2 consumption). In principle, each agent now has five possibilities: (i) liquidate the asset and consume the proceeds, (ii) liquidate the asset and use the proceeds to buy the asset in the market, (iii) sell the asset in the market and consume the proceeds, (iv) sell the asset in the market and invest the proceeds in new units of the asset, and (v) hold on to the asset.[4] Note that impatient agents will choose between (i) and (iii) and patient agents between (ii), (iv), and (v).

Comparing the returns from (i) and (iii) yields the following asset excess demand by impatient agents:

$$D^I(p) = \begin{cases} -q & \text{if } p > R_1 \\ [-q; 0] & \text{if } p = R_1 \\ 0 & \text{if } p < R_1 \end{cases}$$

Similarly, patient agents' excess demand correspondence is:

$$D^P(p) = \begin{cases} -(1-q) & \text{if } p > \frac{R_2}{R_1} \\ [-(1-q); 0] & \text{if } p = \frac{R_2}{R_1} \\ 0 & \text{if } R_1 < p < \frac{R_2}{R_1} \\ [0; (1-q)\frac{R_1}{p}] & \text{if } p = R_1 \\ (1-q)\frac{R_1}{p} & \text{if } p < R_1 \end{cases}$$

Not surprisingly, patient agents sell when the price is high, hold when it is intermediate, and buy when it is low. Setting aggregate excess demand equal to zero shows that in equilibrium patient agents must be indifferent between holding and buying. More precisely, we have:

[4] Note the difference between "liquidating" and "selling" (and similarly between "investing" and "buying"). Think of the asset as a potato field: each agent can either undig the potatoes and use them ("liquidation") or sell the field (for potatoes, in this one-good economy).

Proposition 1 (Diamond-Dybvig, 1983): In a competitive market for intertemporal trade, the unique equilibrium price is $p = R_1$, and the resulting consumption path is the autarkic one, $(c_1; c_2) = (R_1; R_2)$.

Note that there may be trivial trades in equilibrium, of patient agents who liquidate their asset holdings with impatient ones who do not. But the resulting allocation is no improvement over autarky. This proposition also shows that the definition of liquidity used here is very different from the first notion of liquidity introduced in the Introduction: Because of the price-taking assumption, the competitive market is perfectly "liquid" (according to the market-microstructure definition), but it does not provide "liquidity" as defined here.

2.4 Banking:

I consider the case of a single bank ("the banking system"), which offers to take in the agents' funds at date 0, invest them, and pay back a prespecified amount at either time 1 or 2.[5]

Definition: A demand deposit outcome is a list $(d_1; d_2, \alpha; A_1; A_2)$, where A_1 and A_2 are a partition of the set of all agents, such that

1. each agent invests the fraction α of her funds in the real asset and deposits $1 - \alpha$ with the bank in $t = 0$,
2. depositors $a \in A_1$ withdraw $(1 - \alpha)d_1$ at date 1 and nothing at date 2,
3. depositors $a \in A_2$ withdraw $(1 - \alpha)d_2$ at date 2 and nothing at date 1,
4. each depositor prefers her withdrawal date over the alternative one,
5. the repayments satisfy $\lambda \frac{d_1}{R_1} + (1 - \lambda)\frac{d_2}{R_2} \le 1$, where λ is the size (measure) of A_1.

In this definition, d_1 and d_2 are the gross interest rates paid on deposits over one, resp. two periods, and $1 - \alpha$ can be interpreted as the size of the banking system. Note that we have imposed symmetry ex ante (which is reasonable because all agents are identical ex ante).

[5] In the basic model of this section, the case of competing banks is not different from the single-bank case. In some of the later sections, this assumptions is not without loss of generality.

Proposition 2 (Diamond-Dybvig, 1983): Suppose that $R_1 = 1$ and that no markets for intertemporal trade exist. Then the first-best consumption path can be implemented as a demand deposit outcome $(d_1; d_2, \alpha; A_1; A_2) = (c_1^*; c_2^*; 0; \{\text{impatients}\}; \{\text{patients}\})$. The implementation is unique if the deposit contract suspends convertibility in case of excess withdrawal.

Suspension of convertibility is a mechanism which has historically been used as a "circuit breaker" in banking panics. In the present model it states that the bank pays out significantly less than d_1 to at least some depositors at date 1 if more than λ depositors demand their money back.[6] The proposition then simply states that, in the absence of markets, banks can provide optimal liquidity, and that they do so unambiguously if suspension of convertibility is imposed.

3 A First Critique

In important papers, Jacklin (1987) and Haubrich and King (1990) asked the following question, which in hindsight is obvious: what is the role of deposit contracts if a market for intertemporal trade exists in the model introduced above?[7] To clarify this question, one first must integrate the concept of (Walrasian) market equilibrium used earlier with that of demand deposits. Again, we assume that all agents behave identically at date 0, which is plausible and standard, given that they are identical. Hence, market activity only takes place at date 1.

Definition: A market equilibrium with banking consists of a demand deposit outcome $(d_1; d_2; \alpha; A_1; A_2)$ with $\alpha < 1$ and an asset price p, together

[6] A demand deposit outcome as defined above includes the notion of a Nash equilibrium in an appropriately defined withdrawal game between depositors. Without suspension of convertibility, a "panic outcome" is possible, too, in which all depositors withdraw at date 1.

[7] In his paper, Jacklin made in fact three important contributions, which should be kept apart. First, he showed that other institutional arrangements than deposit contracts (market based ones) can provide liquidity in the Diamond-Dybvig model. Second, he generalised the model to less extreme, smooth preferences. His third contribution, the "Jacklin critique" discussed here, however, was less convincing as it stood, because it considered individual deviations from the banking contract at date 0, without modelling trading at date 1 (if every agent but one invests in the bank, there is no market!). The argument given here corrects this lacuna.

All these three points can also be found in Haubrich and King (1990).

with net trades for each agent at date 1, such that all agents maximise their utility from trading and the asset market clears.

In market equilibria with banking, the trading possibilities at date 1 become more complicated. Consider first asset demand by the impatients at date 1. For given $d_1; d_2; \alpha$, they have four options. In all of them they withdraw their deposits. Furthermore, they can (i) sell their asset holdings and consume the proceeds and the deposit, (ii) sell their asset holdings, use the deposit to buy the asset on the market, liquidate it, and consume the proceeds, (iii) liquidate their asset holdings and consume the proceeds and the deposit, or (iv) liquidate their asset holdings, use the deposit to buy the asset on the market, liquidate it, and consume the proceeds.

One easily checks that options (ii) and (iii) are always dominated if $p \neq R_1$. Comparing the associated payoffs, the following impatient asset excess demand obtains:

$$D^I(p) = \begin{cases} -q\alpha & \text{if } p > R_1 \\ [-q\alpha; q(1-\alpha)\frac{d_1}{p}] & \text{if } p = R_1 \\ q(1-\alpha)\frac{d_1}{p} & \text{if } p < R_1 \end{cases}$$

Asset demand by patient agents is more complicated, because they now have seven non-trivial possibilities for behaviour at date 1. Yet, it is not difficult (though somewhat lengthy) to derive the following proposition.

Proposition 3: Suppose the bank offers a deposit contract $(d_1; d_2)$ at date 0 and a perfect asset market exists at date 1. At a market equilibrium with banking one either has

- $\frac{(1-q)R_1^2}{R_1^2+q(R_2-R_1^2)} \quad \alpha < 1-q$, $d_1 = R_1$, $d_2 \quad \frac{q\alpha}{(1-q)(1-\alpha)}R_2$ indeterminate, $p = \frac{(1-q)(1-\alpha)}{q\alpha}R_1 (> R_1)$, all agents withdraw their deposit at date 1, and the patients buy the impatients' asset holdings with the proceeds from the withdrawal, or

- $d_1 = R_1$, $d_2 = R_2$, $p = R_1$, α indeterminate, all impatients withdraw their deposits at date 1, patients are indifferent between withdrawing and not, and withdraw just enough to buy the impatients' asset holdings.

Both of these two types of equilibria yield the autarkic consumption path $(R_1; R_2)$ to each agent, and in both banking is degenerate. In each type of equilibrium, the return path from banking is identical to the one from investing directly into the asset (taking into account trading in the first type of equilibrium), and hence, agents are indifferent ex ante between investing in the asset or the bank. Not surprisingly, therefore, the proposition amounts to a new version of the irrelevance result of banking in general equilibrium theory stated in the Introduction.

4 A First Answer

In a pragmatic response to this result, Wallace (1988) simply proposed to interpret the Diamond-Dybvig model differently. In his interpretation, the three dates of the model are periods during which the agents live without interacting with each other. Banking then is a substitute for market activity in a world where agents are isolated. More specifically, therefore, demand deposits either concern only those financial activities for which markets do not form, such as minor transactions services, or are used only by agents who do not have access to existing markets, such as unsophisticated savers.[8]

5 A Second Critique

Even if one adopts Wallace's (1988) perspective and assumes that agents in the Diamond-Dybvig model are isolated, a basic incentive constraint must be taken into account in the liquidity model of Section 2: agents can withdraw and re-invest deposits privately (von Thadden, 1998). This point does not concern the original model of Diamond and Dybvig (1983), where $R_1 = 1$. It only becomes relevant in the more general model above when $R_1 > 1$.

There are two interpretations of such a model of limited interaction. The first is in terms of a fully specified one-good economy with separated agents in Wallace's (1988) sense, in which each agent has access to the given physical production process. Alternatively, one can see it as a partial equilibrium model of banking with individual selling and buying, where $(R_1; R_2)$ represents each agent's market investment opportunity ("the market portfolio"), without trade being explicitly modelled. The latter interpretation also assumes a limited market access of agents: they have access to the market return, but are not able to directly exchange the underlying assets. Agents

[8] In fact, Wallace (1988) is concerned with another issue (aggregate risk) and notes this interpretation only in passing. Probably he was not surprised.

who invest, at any given date, "in the market" (defined by the return stream $(R_1; R_2)$) or another asset, can liquidate such investments later and invest anew, but they cannot trade them.

5.1 The basic model:

In its simplest form, the model is just the one presented in Section 2.1, with $R_1 > 1$. The optimal deposit contract solves the same problem as (3), with an incentive constraint added that restricts second-period consumption to be at least as high as what a patient agent would obtain from withdrawing early and reinvesting:

$$\begin{aligned} \max \quad & \theta u(c_1) + (1 - \theta)u(c_2) \\ \text{subject to} \quad & \theta \frac{c_1}{R_1} + (1 - \theta)\frac{c_2}{R_2} = 1 \\ \text{and} \quad & c_2 \geq R_1 c_1 . \end{aligned} \tag{5}$$

One easily checks that the first-best, (4), is incentive compatible if and only if

$$R_1^{\alpha+1} \leq R_2 .$$

This is a simple condition relating the investment opportunity (given by $(R_1; R_2)$) to utility (given by α). In particular, if the market investment opportunity is completely reversible ($R_1^2 = R_2$), the first-best is never incentive compatible (remember that $\alpha > 1$). More generally, the higher the degree of irreversibility,[9] the larger the range of α for which the first-best is incentive compatible. If $R_1^{\alpha+1} > R_2$, the solution to program (5) is determined by the incentive constraint, which forces the consumption path to be steeper than first-best optimal. One easily calculates that

$$c_1 = \frac{R_1}{\theta + (1 - \theta)\frac{R_1^2}{R_2}}$$

In particular, if $R_1^2 = R_2$, then $c_1 = R_1$ and only autarky is incentive compatible. The following proposition summarises these findings non-formally.

[9] A degree of irreversibility can be defined naturally as the number $\gamma \geq 2$ such that $R_1^{\gamma} = R_2$.

Proposition 4: In the three-period banking model with $R_1 > 1$ and isolated agents, the scope for liquidity provision through demand deposits depends on the degree of irreversibility of the market investment opportunity. If the latter is fully reversible, no liquidity provision is possible at all. The less it is reversible, the more liquidity can be provided through demand deposits.

5.2 The extended model:

The basic model discussed above suffers from an important shortcoming as a model of dynamic insurance in that it only has three dates. This feature implies that an agent who considers deviating from a deposit contract at date 1 faces no more uncertainty about future consumption, which makes sticking to the deposit contract less attractive. In reality, of course, life goes on and deposit contracts provide ongoing insurance against liquidity risks. One would, therefore, expect that in a model with an infinite number of dates the incentive constraint introduced above has little bite: deviating from a deposit contract at any point in time means giving up the future intertemporal insurance the agent has found desirable to start with. Interestingly, in a straightforward generalisation of the above three-period model to continuous time, von Thadden (1998) finds that this is not the case.

The model developed in von Thadden (1998) has a continuum of agents who live during $t \in [0,1]$ and experience random consumption shocks which are identically distributed and satisfy the Law of Large Numbers. The real investment opportunity delivers continuous gross returns $R(\tau - t)$ at date τ for investment at date t, where $R(0) = 1$ and R'/R is non-decreasing.[10]

In this model, the first-best again involves a flattening of the consumption path with respect to the autarky path $R(t)$, and deposit contracts must respect the incentive for withdrawal and private reinvestment at every date. Yet, although deviating from a deposit contract now carries the downside of loosing future insurance, this incentive constraint turns out to be remarkably strong. In fact, despite some technical complexities, Proposition 4 continues to hold in the continuous-time model without any qualifications. In particular, if the market investment is reversible, deposit contracts can provide no liquidity even in the absence of trading opportunities.

[10] This last assumption is the exact analogue to the assumption $R_1^2 \geq R_2$ made in the three-period case.

6 A Second Answer

Building on earlier contributions by Bhattacharya and Gale (1986), Jacklin and Bhattacharya (1988), and Haubrich and King (1990), von Thadden (1997) has extended the model of Section 2.1 by introducing a second investment opportunity. This creates a second insurance role for deposit contracts and alleviates the depositors' moral hazard problem described in the last section in a remarkable way.

6.1 The basic model:

Consider the model introduced in Section 2.1 and assume that there is one additional real investment opportunity $(S_1; S_2)$ such that $S_1 < R_1$ and $S_2 > R_2$ ("$(S_1; S_2)$ is less reversible than $(R_1; R_2)$").

Now each agent has a non-trivial, though simple, portfolio problem even under autarky, namely the choice of how much to invest in each asset. However, even the optimal autarkic portfolio has the downside that whenever an agent consumes, she consumes one asset whose yield is not optimal at the time of consumption. Hence, in addition to the "liquidity risk" discussed until now, there is a further "maturity risk".

At the first-best, both these risks are fully insured away. In particular, since the proportion of agents who consume early is known in advance, the optimal aggregate portfolio choice can reflect this. Hence, the first-best problem is

$$\begin{array}{rll} \max_{\alpha; c_1; c_2} & qu(c_1) + (1 - q)u(c_2) & \\ \text{subject to} & qc_1 = \alpha R_1 & \quad (6) \\ \text{and} & (1 - q)c_2 = (1 - \alpha)S_2; & \end{array}$$

where α denotes the fraction of initial funds invested in the R-asset. The solution to this problem is similar to that of Section 2.2. In particular, the first-order-condition equates weighed marginal utilities across time:

$$R_1 u'(c_1) = S_2 u'(c_2);$$

where the weights now correspond to the optimal rates of transformation in each period. Just as in (4) we therefore obtain

$$c_1 = \left(\frac{R_1}{S_2}\right)^{1/a} c_2 \tag{7}$$

for the first-best consumption pattern. Hence, the first-best flattens the consumption path through the $1/a$ - term and eliminates maturity risk by using the aggregate production pattern $(R_1; S_2)$, which dominates each of the individually available assets.

The construction of incentive-compatible demand deposit contracts then is exactly as in the one-asset case of Section 5, with R_2 being replaced by S_2. In particular, the introduction of the new S - asset does not change the incentive constraint of depositors, because if depositors deviate, they deviate by investing in the R - asset. However, the availability of higher long-term returns (S_2) allows to shift more income towards the short-run, without violating the incentive constraint. Formally, this yields the following second-best consumption:

$$c_1 = \begin{cases} \left(\frac{R_1}{S_2}\right)^{1/a} c_2 & \text{if } R_1^{a+1} \geq S_2 \\ \frac{R_1}{q+(1-q)\frac{R_1^2}{S_2}} & \text{if not} \end{cases}$$

Comparing this result with the one of Section 5.1, we can summarise it informally as follows:

Proposition 5: In the three-period banking model with two assets, demand deposit contracts can fully eliminate maturity risk and provide partial insurance against liquidity risk. Liquidity insurance is higher than in the one-asset case.

6.2 The extended model:

The basic model of before has an important drawback which again stems from its limitation to three periods. If we had started the analysis with the S - asset and added the R - asset, we would, as before, have created the opportunity for maturity insurance (which favours the viability of deposit contracts), but we would at the same time have tightened the incentive constraint by introducing a more attractive deviation for depositors (which reduces the viability of deposit contracts).

This is due to the artefact that when considering a deviation at date 1, agents only have a one-period horizon, for which one asset (the R - asset) is unambiguously preferred (no more maturity risk). The infinite-horizon model of Section 5.2 is a natural way to eliminate this bias, because there is an ongoing insurance need in the infinite-horizon case. Surprisingly, as shown in von Thadden (1997), the ongoing double demand for insurance is even strong enough for deposit contracts to implement the first-best if intertemporal risk aversion (a) is large.

Proposition 6: In the continuous-time banking model with two assets, demand deposit contracts can provide first-best insurance if intertemporal risk aversion is sufficiently large.

Comparing Propositions 5 and 6 shows an interesting interplay between the two insurance functions of demand deposits. To make the point, consider the extreme case of full reversibility of the R - asset. If there is only liquidity insurance possible (the case of Proposition 5), even the ongoing need for insurance in the infinite-horizon framework is not sufficient to make any liquidity provision incentive compatible at all. However, if a bank can offer both types of insurance (the case of Proposition 6), it can always provide full maturity insurance and some liquidity insurance, and can even provide full liquidity insurance if intertemporal risk aversion is large, i.e. if the demand for it is strongest. Insurance against maturity risk therefore stabilises insurance against liquidity risk in the sense that the latter becomes incentive compatible if the former is provided with it.

7 Conclusion

The model of Section 6 presumably overestimates the potential for liquidity provision through demand deposits, because it assumes the extreme separation of agents à la Wallace (1988). In reality, agents do interact, although this interaction is usually imperfect. In the extreme case of perfect Walrasian markets of Section 3, Propositions 5 and 6 would unravel as the Diamond-Dybvig result in Proposition 3; in the more realistic case of imperfect market interaction the results would be partially preserved. However, this reasoning assumes that deposit contracts and asset markets exist independently of each other and agents interact directly in the market. In reality, of course, this interaction is mostly indirect, and it is often intermediated by the very institutions that offer demand deposits.

Diamond (1997) has used this observation as the basis for an interesting extension of the model presented in Section 6.1 above (with R_1 1; $R_2 = R_1^2$; and $S_1 = 0$), which shows that demand deposits can provide liquidity even if agents are not fully separated. He assumes that at date 1 there exists a

Walrasian market as in Section 3, but that a certain fraction of all agents learns at time 1 that they will not have access to the market. The size of this group is known at date 0, but not its composition, so agents are exposed to the risk of individual exclusion, but can provide for it collectively. Banks now do exactly that: Diamond (1997) shows that all short-term asset holding is optimally done through banks (agents at date 0 only hold deposits and the S - asset), and that banks typically trade at date 1 in order to reallocate deposits among patient and impatient agents. The …rst feature is exactly that of maturity insurance of Section 6 adapted to the partial participation setting, the second feature shows how markets can actually be complements rather than substitutes for banks in the creation of liquidity.

Another line of research, proposed by Gorton and Pennacchi (1990), also points to the complementarity of banks and markets. They explicitly start from the insight that trading can impose costs on market participants stemming from informational asymmetries, and argue that demand deposits are an institutional reaction to this de…ciency of markets. If the value of the asset $(R_1; R_2)$ in the model of Section 2 is uncertain and agents di¤er with respect to their expected liquidity preference q, then there is room for institutions to o¤er deposit or debt-like contracts, precisely to help avoid the costs of market trading. Some individuals will prefer to hold deposits, which are less information sensitive and, therefore, have low individual risk, others will hold tradeable assets and incur the informational risk related to the lemons problem in this market. Again, "banks" and "markets" naturally coexist, but for reasons very di¤erent from those in Diamond (1997).

In sum, the examples considered in this paper show how in a speci…c institutional framework - banks de…ned as demand deposit providers, markets as anonymous, automatic exchange mechanisms, and with liquidity provision as the economic function under consideration - banks do have a role to play, but that this role depends on the characteristics of assets and the interaction between banks and markets. The challenge is to extend such considerations to more comprehensive de…nitions of banking and to more realistic notions of markets.

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