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Asegurando la Estabilidad Financiera con Grandes Depositantes

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Ensuring Financial Stability with Large Depositors

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Abstract

Using a version of the model of Diamond-Dybvig in which a block of depositors move together stochastically, I look for the type of contracts that a bank can always fulfill. I consider economies with liquidity and capital requirements placed on large deposits where the banks can offer positive net interest rates to their depositors. The results suggest that carefully chosen capital requirements on large deposits result in higher utility than liquidity requirements with approximately the same first period interest rate.

1. Introduction

Bank regulators have become concerned about the effects that the sudden withdrawal of very large deposits can have on a bank or a banking system. Many banks may not hold sufficient liquidity to meet instantly the demands placed upon it by the decision of its largest depositors to remove their funds from that bank or from a national banking system. While liquidity normally can be obtained by selling assets on the interbank funds market, such assistance is limited and often expensive. Central banks can offer short term liquidity assistance (through repurchase agreements, for example) but might be reluctant or unable to do so on a large scale. There exists a suspicion among some central bank officers that very large depositors are more of the nature of investors in the bank than of what are traditionally considered depositors and may have much more influence over the bank's operating decision than would be customary. It is feared that very large depositors are using their position as depositor to gain a more favorable treatment in case the bank fails while the size of their deposit and the threat of removal gives them some influence over bank actions.

In spite of such concerns, banks accept very large deposits and central banks continue to permit them, usually without any liquidity or capital requirements beyond those met by any other deposits. That being the case, it is worth attempting to understand better the nature of large deposits and of the effects that some of the traditional regulations might have on a system where these are possible.

To study this problem, I use as my starting point the liquidity model of Diamond-Dybvig (1983). In the traditional D-D model, there is a continuum of agents all of whom have independent probabilities of needing to withdraw their funds early from a bank. In order to mimic the behavior of a large depositor, I have a block of these agents behave together, as if they were one individual. This depositor has the same probabilities of withdrawing funds early as the other agents, but, by being of finite dimension, introduces an uncertainty in the bank's operations that doesn't exist in the standard model.

I look for the kinds of contracts that banks can offer to its clients in an environment with large depositors and which the bank can always fulfill. I consider systems 1) where longer term projects can be liquidated to cover withdrawals, 2) where such liquidations is prohibited, 3) where special partial liquidity requirements are placed on large deposits, and 4) where special capital requirements are placed on large deposits. In cases 3) and 4) I am interested in the contracts that the bank can offer that look like standard bank deposit contracts: those that have net interest rates that are positive between every period.

Nash equilibria in the standard Diamond-Dybvig model either have a bank run (and bank failures) or they do not. There is no dynamics for transitions between situations without a bank run to one with one. Such Nash equilibria with bank runs continue to exist in this version of the model, but are ignored.

The results suggest that a carefully chosen capital requirement on large deposits is a more efficient (in terms of utility) method of responding to large deposits when compared to liquidity requirements that generate approximately the same first period interest rate. However, if these capital requirements are set too high, they can close down the banking system. Capital demands a normal expected return, and setting the capital requirement too high makes it impossible to achieve that necessary return.

In the next section, I outline the basic model. Section 3 develops the analytics an economy without capital or liquidity requirements in which some of the long term investment can be liquidated. Section 4 solves an example economy. Section 5 considers the same economy with a prohibition on liquidation of the long term asset. Section 6 examines liquidity requirements and Section 7 capital requirements. Section 8 concludes.

2. The basic model

There are three time periods, which are called periods zero, one, and two. In period zero, individuals make a decision about how much to invest independently and how much to invest in a bank. There are two types of investment projects: storage which gives one unit return in either period one or two, and long term investment which gives a liquidation return in period one of $L < 1$ and a completed project return of $R > 1$ in period two. Long term investments must be made in period zero. Individuals will turn out to be either impatient (and need to consume in period one) or patient (when they are willing to wait until period two to consume), but they do not know which type they will be until the beginning of period 1. We call the impatient type ones because they get utility only from consumption in period one and the patient type twos because they get utility only from consumption in period two.

Consider a version of this economy with a continuum of consumers from $[0, 1]$, where each agent in the set $[0, x)$ is independently of type one (with probability π_1) or type two (with probability $\pi_2 = (1 - \pi_1)$) and where the agents in the $[x, 1]$ set are either all type one (with probability π_1) or are all type two (with probability $\pi_2 = (1 - \pi_1)$). Type ones only get utility from consumption in period one and type twos from consumption in period two. There is a 1 to 1 storage technology so that anyone can store goods from one period to the next without any loss. The proportion of the agents who are type ones or type twos can be seen from this chart:

	number of type one	number of type two
with probability π_1	$\pi_1 \cdot x + (1 - x)$	$\pi_2 \cdot x$
with probability π_2	$\pi_1 \cdot x$	$\pi_2 \cdot x + (1 - x)$

These consumers can deposit funds in a bank at time zero and receive consumption C_1 if they turn out to be type ones in period one or consumption C_2 if they turn out to be type twos in period two. Individuals are either type one or type two and do not know their type until period one.

Suppose the banks are only allowed to offer non-contingent, (C_1^*, C_2^*), contracts that they will be able to complete independent of the type of the block group. Since these contracts can be fulfilled, as long as $C_2^* > C_1^*$, there is a Nash equilibria where no type twos pretend that they are type ones (there is also the bank run Nash equilibria). Of course, if $C_1^* > C_2^*$, then all the type twos will pretend to be type ones and will store the good until period two. If $C_1^* = C_2^*$, a condition encountered in some equilibria here, the situation is more complex. Although I don't model it here, the existence of any investment between period one and two with a gross return greater than one will cause all type twos to withdraw their deposits and invest in this asset. Without such an asset, type twos will be indifferent between leaving the deposits in the bank and withdrawing the deposits and storing them. There is a very tenuous Nash equilibria without runs.

3. Liquidation of investment permitted

The bank chooses a quantity, I, to invest in the long term project that maximizes

$$U = \pi_1 \cdot u(C_1^*) + \rho \cdot \pi_2 \cdot u(C_2^*), \tag{1}$$

subject to the budget constraints

$$1 - I + k \cdot L = [\pi_1 \cdot x + (1 - x)] \cdot C_1^*,$$

and

$$R \cdot (I - k) = \pi_2 \cdot x \cdot C_2^*,$$

when the $[x, 1]$ block is a type one and

$$1 - I \geq \pi_1 \cdot x \cdot C_1^*, \tag{2}$$

and

$$R \cdot I + [1 - I - \pi_1 \cdot x \cdot C_1^*] = [\pi_2 \cdot x + (1 - x)] \cdot C_2^* \tag{3}$$

when they are type two. In these budget constraints, R is the return on a two period investment, L is the return on the investment if it is liquidated in the first period, and k is the quantity of investment liquidated. The expected utility function reflects the certain division of consumption among the continuum of small depositors in the set $[0, x)$ and the expected utility of the block depositors in the set $[x, 1]$.

The first budget constraint says that if the block depositor is type one, the bank will pay off it and the other type one depositors from the reserves and (possibly) by liquidating a portion of its investment portfolio. This constraint holds with equality if $R > 1$, since the return on the long term project dominates other alternatives. In one sense, this restriction implies that the bank is carrying enough reserves to meet the worse case. With the reserves it carries plus the liquidation of some of its assets it will be able to meet the largest withdrawal demands it can face and still meet its obligations with the type twos in period two.

Budget constraint two indicates that what is left in the investment portfolio is exactly sufficient to pay off all the continuum of type two depositors. Budget constraint three shows that if the block depositor is type two, the reserves must be enough to pay off the other type ones. This is so because the size of this group is perfectly predictable and the return on liquidation is less than one, so the bank will never choose to liquidate investment to pay off this group. This can hold with inequality if the bank chooses to hold reserves to cover all or part of the required payouts if the block depositors are type one. The final budget constraint indicates that the return on the full investment plus any reserves not used to pay off the type ones just covers the contract with the predictable type twos plus the block depositor.

Two other restrictions apply: $1 \geq I \geq 0$, and $I \geq k \geq 0$. One can not invest more than the initial endowment of one unit of the good and investment cannot be negative. Likewise, one cannot liquidate more than all of the investment and negative liquidations has no meaning.

If the reserves, $1 - I$, are more than enough to cover consumptions when the large depositor is of type two, when equation (2) is a strict inequality, the solution is found from the first order conditions of the utility function after using the other three budget constraint equations to find C_2^* as a function of C_1^*, $C_2^* = g(C_1^*)$. This function is

$$\begin{aligned} C_2^* &= g(C_1^*) \qquad (4) \\ &= a - bC_1^* \qquad (5) \\ &= \frac{R(R-L)}{(R-L)\pi_2 x + R(1-L)(1-x)} - \frac{R(R-L)\pi_1 x + R(R-1)(1-x)}{(R-L)\pi_2 x + R(1-L)(1-x)} \cdot C_1^* \end{aligned}$$

and its derivative is simply

$$g'(C_1^*) = -b = -\frac{R(R-L)\pi_1 x + R(R-1)(1-x)}{(R-L)\pi_2 x + R(1-L)(1-x)} < 0.$$

These first order conditions are

$$\pi_1 \cdot u'(C_1^*) + \rho \cdot \pi_2 \cdot u'(g(C_1^*))g'(C_1^*) = 0.$$

One can find C_1^* using this first order condition and the rest of the variables (C_2^*, I, k) from the budget constraints:

$$\begin{aligned} 1 - I + k \cdot L &= [\pi_1 \cdot x + (1-x)] \cdot C_1^*, \\ R \cdot (I - k) &= \pi_2 \cdot x \cdot C_2^*, \\ R \cdot I + [1 - I - \pi_1 \cdot x \cdot C_1^*] &= [\pi_2 \cdot x + (1-x)] \cdot C_2^*. \end{aligned}$$

When the equation (2) is a strict equality, the equilibrium is a corner solution so the marginal conditions for the utility function do not hold. The solution is found by solving the four budget constraints: defining I equal to

$$I = 1 - \pi_1 \cdot x \cdot C_1^*,$$

substituting this into budget equation (3) to get

$$R \cdot (1 - \pi_1 \cdot x \cdot C_1^*) = [\pi_2 \cdot x + (1 - x)] \cdot C_2^*.$$

Replace C_2^* with $g(C_1^*)$ to get

$$C_1^* = \frac{a\,[\pi_2 \cdot x + (1 - x)] - R}{b\,[\pi_2 \cdot x + (1 - x)] - R\pi_1 \cdot x},$$

where a and b are defined in equation (4). This simplifies to

$$C_1^* = \frac{L}{1 - (1 - L) \cdot \pi_1 \cdot x}.$$

Notice that as long as there exists a positive probability of being type ones, $C_1^* > L$.

The rest of the variables (C_2^*, I, k) are found from the same three budget constraint equations with

$$\begin{aligned} C_2^* &= \frac{R}{L} C_1^*, \\ I &= 1 - \pi_1 \cdot x \cdot C_1^*, \end{aligned}$$

and

$$k \cdot L = (1 - x) \cdot C_1^*.$$

This last equation tells us what happens when equation (2) holds with equality. If the block is type one, then k units of the investment must be liquidated to pay for their consumption. These same k units of investment pay for their consumption if they turn out to be type twos:

$$(1 - x) \cdot C_2^* = \frac{R}{L} \cdot (1 - x) \cdot C_1^* = \frac{R}{L} \cdot k \cdot L = k \cdot R.$$

Since $C_1^* > L$, the fraction of the investment liquidated, k, must be larger than $(1 - x)$, the proportion of the large depositor in the economy.

4. Results for example economies

Equilibria for a version of this economy with subutility functions[1] of the form:

$$u(C) = -\frac{1}{C}$$

were calculated over a range of values of x (where $1 - x$ is the size of the block depositors) and of π_1 (the probability of needing to withdraw funds in period one). In the version shown, $R = 1.3$, $L = .8$, and $\rho = .95$. Figures 1 to 4 show consumption of type ones and type twos (C_1^* and C_2^*), investment (I), and the fraction of the investment liquidated if the block is of type one (k). The lower flat surface of Figure 1 is where the $I \leq 1$ constraint binds. Along this surface, all of the consumption of the block group is paid for by liquidation if they turn out to be type ones. This same quantity of asset pays for their consumption if they turn out to be type twos. Notice in Figure 4 that the flat surface rises in a linear fashion as the size of the block depositor increases. The view point has been rotated for Figures 2, 3,

[1] The subutility function chosen meets the condition from Diamond and Dybvig that $\frac{-Cu''(C)}{u'(C)} > 1$.

and 4, so special attention need be paid to the labeling of the axes.

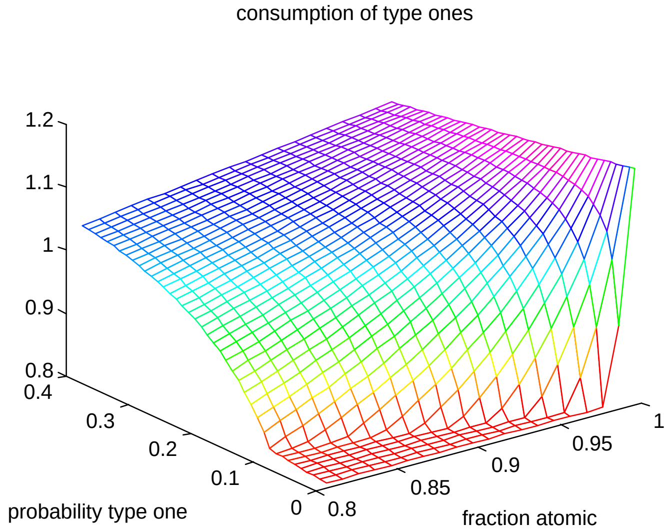


Figure 1

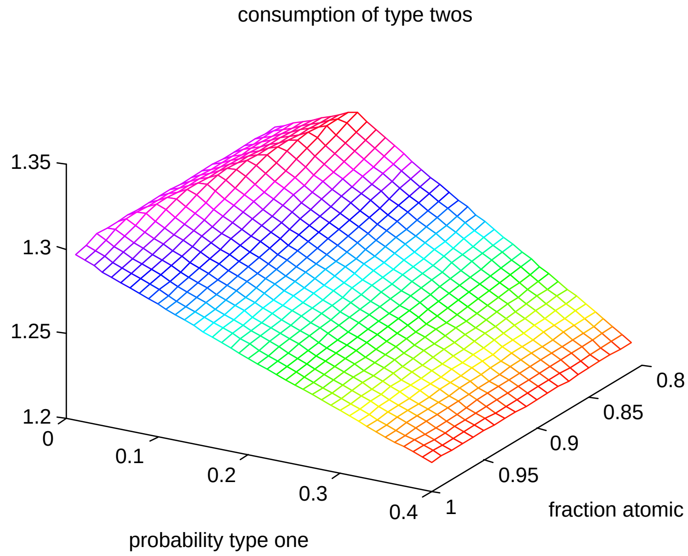


Figure 2

Figure 1 indicates that, when the block depositor is large relative to the rest of the depositors who will be needing to withdraw in period 1, the contract that the bank will offer is one in which the large depositor (and the rest of the depositors who withdraw in period one), if it turns out to want to withdraw in period one, receives less than one unit for each unit of good deposited. This is the contract that the bank can fulfill but it is inconsistent with the concept of liquid bank deposits. In the portions of the graph where the consumption of a type one is less than one ($C_1^* < 1$), while the contracts the banks are offering are better than autarchy, banks are not offering contracts that are providing what is commonly considered liquidity.

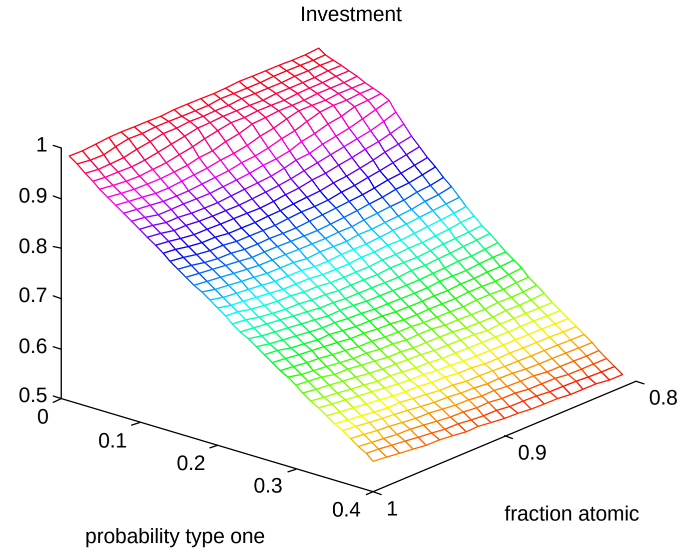


Figure 3

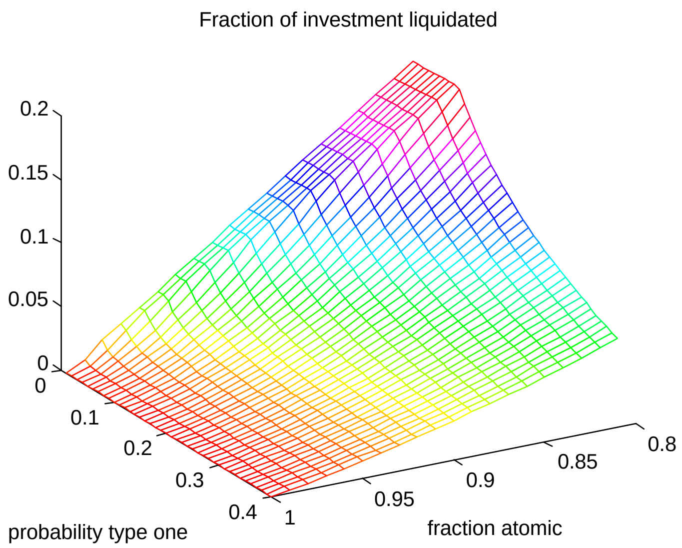


Figure 4

5. Liquidation is prohibited (100% liquidity reserves)

One possible rule is to prohibit liquidation of the invested good and force the banks to hold sufficient reserves to cover all normal withdrawal eventualities (but not runs by type twos). If liquidation of the invested good is prohibited, then the part of initial deposits that are not invested must cover the sure consumption of the $\pi_1 \cdot x$ fraction of the population who will turn out to be type ones and the consumption of the $(1-x)$ fraction who could become type ones. This is equivalent to a 100% liquidity requirement on the maximum amount that can be withdrawn in period one. The expected utility function (equation 1) is maximized subject to

$$\begin{aligned} 1 - I &\geq [\pi_1 \cdot x + 1 - x] \cdot C_1^*, \\ R \cdot I + [1 - I - [\pi_1 \cdot x + 1 - x] \cdot C_1^*] &= \pi_2 \cdot x \cdot C_2^*, \\ R \cdot I + [1 - I - \pi_1 \cdot x \cdot C_1^*] &= [\pi_2 \cdot x + (1-x)] \cdot C_2^*. \end{aligned}$$

The last two equations imply that

$$C_1^* = C_2^*.$$

If the first budget constraint holds with equality (which it will when $R > 1$) then we find that the budget constraints imply that

$$C_1^* = \frac{R}{R \cdot (\pi_1 \cdot x + 1 - x) + \pi_2 \cdot x}.$$

It is then simple to calculate I from the first budget constraint and

$$I = 1 - [\pi_1 \cdot x + 1 - x] \cdot C_1^*.$$

It is simple to show that when liquidation is prohibited, consumption increases with x and decreases with π_1. From derivation of the above equation for consumption we get that

$$\frac{dC_1^*}{dx} = -R \cdot [R - (R-1) \cdot (1 - \pi_1) \cdot x]^{-2} \cdot (R-1) \cdot (1 - \pi_1) < 0$$

and

$$\frac{dC_1^*}{d\pi_1} = R \cdot [R - (R-1) \cdot (1 - \pi_1) \cdot x]^{-2} \cdot (R-1) \cdot x > 0.$$

Note that in a world in which there is a risk free asset that offers some small return between period one and period two, the solution indicated above is not feasible. Since the contracts offers $C_1^* = C_2^*$, everyone will want to withdraw in period one and deposit in the risk free asset. All type twos will run the bank and purchase the risk free asset. Under these conditions, the equilibria found above are not feasible. In this version of the Diamond–Dybvig model, liquidation must be allowed to occur in the first period if the block of agents turns out to be type one. Prohibiting liquidation (100% liquidity requirement on large depositors) results in a equilibrium without banks.

6. Partial liquidity reserves

Since 100% reserves are not successful in providing for a stable banking environment, we search for a partial reserve requirement that might. We are looking for a partial liquidity rule that would cover contracts (except runs) in which payments to the type ones is at least one and the payments to the type twos are greater than the payments to the type ones. Under such a feasible contract, the type twos do not have incentives to run the bank (although the standard D-D run equilibrium still exists).

Suppose that a government or central bank imposes a rule on the banks that, given the $[C_1^*, C_2^*]$ contracts they are offering, they must hold sufficient liquid reserves to cover the expected withdrawals of the π_1 fraction of the small depositors who will withdraw early (as before) plus a fraction $\delta \in [0, 1)$ of the deposits of the block depositor in case it withdraws in the first period. We insert this change into the model and see what level of δ will generate contracts of the form desired.

The only change this makes in the model is that budget equation 2 becomes

$$1 - I \geq [\pi_1 \cdot x + \delta \cdot (1 - x)] \cdot C_1^*,$$

where δ is the fractional liquidity requirement on the large depositor.

When this constraint is not binding, the results are identical as for the unbinding sections of the general model. When δ is greater than zero, this constraint binds over a larger portion of the $[\pi_1, x]$ space than does budget equation 2. Over the set of $[\pi_1, x]$ where it binds, the consumptions, investment, and liquidation are given by:

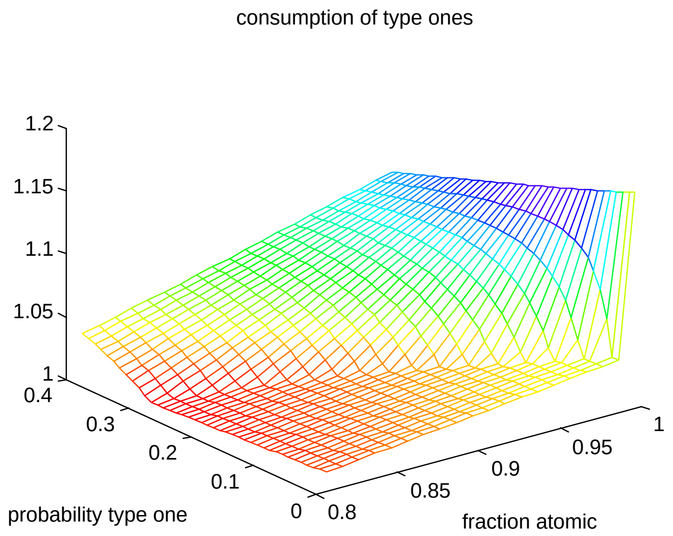
$$C_1 = \frac{L}{1 - (1 - L) \cdot \pi_1 \cdot x - \delta[\pi_2 \cdot x \cdot (1 - \frac{L}{R}) + (1 - x) \cdot (1 - L)]}, \tag{6}$$

$$\begin{aligned} C_2 &= a - bC_1, \\ I &= 1 - [\pi_1 \cdot x + \delta \cdot (1 - x)] \cdot C_1, \\ k &= \frac{(1 - \delta) \cdot (1 - x)] \cdot C_1}{L}, \end{aligned}$$

where a and b are defined as in Equation 3.

Since the coefficient of δ, $[\pi_2 \cdot x \cdot (1 - \frac{L}{R}) + (1 - x) \cdot (1 - L)]$, in Equation 6 is strictly positive (except when $x = 1$ and $\pi_1 = 1$, or $L = R = 1$, when the coefficient is zero), increases in δ will increase consumption of the type ones. A partial liquidity requirement increases consumption of the type ones and, given that b is greater than zero, will decrease consumption of type twos.

Figure 5 shows consumption for type ones in the example economy when δ is equal to .6. Note that at this level of reserves, the bank is able to offer a contract which pays off more than one unit to type ones over the full set of $[\pi_1, x]$ considered. Notice in Figure 6 that the consumption of the type twos is unambiguously greater than that of type ones.



Fugure 5

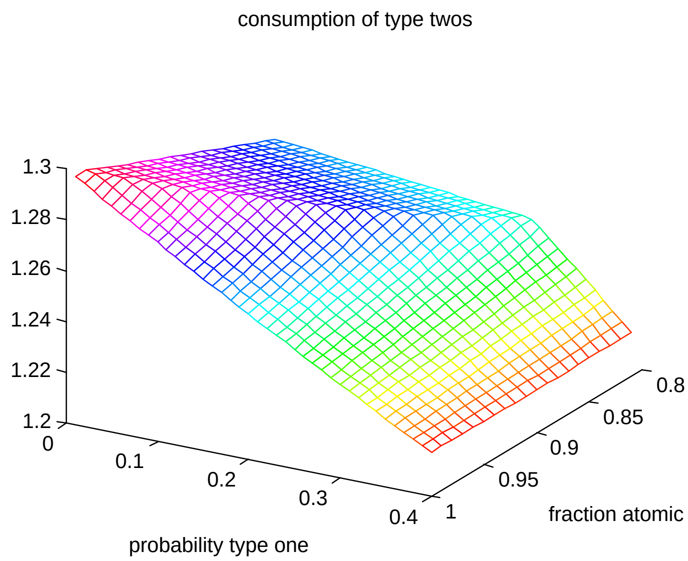


Figure 6

Equation 6 can be solved for $C_1^* = 1$ to find the values of δ which are needed to give exactly a zero interest on deposits taken out early. This is the lower bound for the liquidity requirement that meets our objectives. Figure 7 shows these values for the part of the $[\pi_1, x]$

set over which a liquidity requirement is necessary.

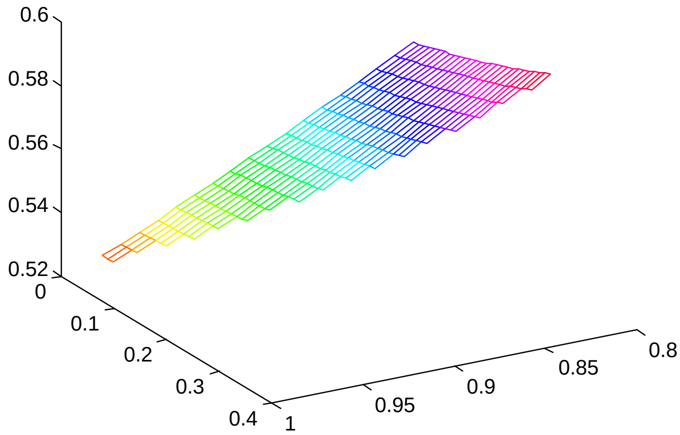


Figure 7

As might be expected, the imposition of partial reserve requirements is not without utility costs. These costs are highest where the probability of early withdrawal is small and where the size of the block deposit is large. Figure 7A shows the difference between the utility in the sample economy with liquidity requirements and the same economy without.

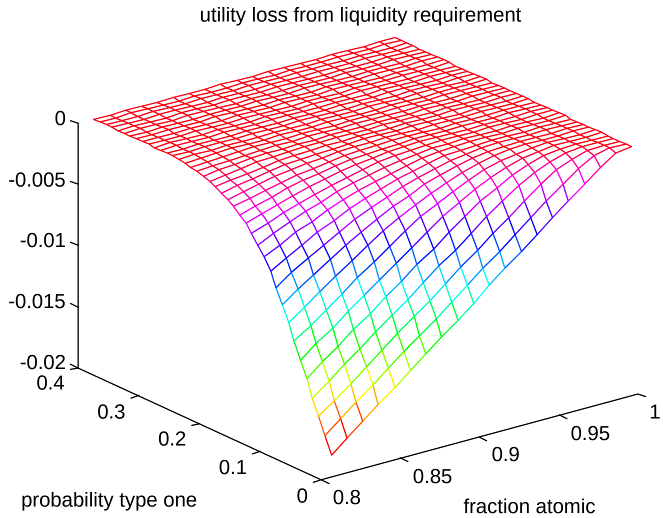


Figure 7A

7. Capital Requirements

One might consider the requirement that if the banks accept very large deposits, these deposits must be matched by an increase in the capital of the bank by some fraction, δ, of these deposits. This capital would be held the entire period of the investment if the large deposits stay in the bank and would be liquidated if the large deposits are withdrawn early, in which case the investors would get a zero gross return. Assume that the investors who provide this capital are risk neutral and demand an expected return equal to the sure return, R, they would get by investing in the long term project themselves under no threat of needing funds early. Since the large depositor will withdrawn with probability π_1, capital used to meet the requirement must get a return of R/π_2 in the state of the world where the withdrawn does not occur.

Under these considerations, the budget constraints become

$$\begin{aligned}
1+\delta\cdot(1-x)-I+k\cdot L &= [\pi_1\cdot x+(1-x)]\cdot C_1^*,\\
R\cdot(I-k) &= \pi_2\cdot x\cdot C_2^*,\\
1+\delta\cdot(1-x)-I &\geq \pi_1\cdot x\cdot C_1^*\\
R\cdot I+[1+\delta\cdot(1-x)-I-\pi_1\cdot x\cdot C_1^*] &= [\pi_2\cdot x+(1-x)]\cdot C_2^*+\delta(1-x)\frac{R}{\pi_2}
\end{aligned}$$

The function $C_2^*=g(C_1^*)$ that we get from the first, second, and fourth equations of the budget constraint is

$$\begin{aligned}
C_2^* &= g(C_1^*)=a-bC_1^*=\frac{R(R-L)[1+\delta\cdot(1-x)]-R(1-L)\frac{\delta\cdot R}{\pi_2}(1-x)}{(R-L)\pi_2 x+R(1-L)(1-x)} \\
&\quad -\frac{R(R-L)\pi_1 x+R(R-1)(1-x)}{(R-L)\pi_2 x+R(1-L)(1-x)}C_1^*.
\end{aligned} \tag{7}$$

Notice that the new part of a is equal to

$$\frac{R\cdot\delta\cdot(1-x)\left[(R-L)-\frac{R(1-L)}{\pi_2}\right]}{(R-L)\pi_2 x+R(1-L)(1-x)},$$

which is positive when $R(1-L)/(R-L)<\pi_2$. (For the sample economies we are using here, with $R=1.3$ and $L=.8$, π_2 must be bigger than .52 for this condition to hold.) If this condition holds, the budget constraint shifts out as δ increases. Given the assumptions on the utility function, both C_1^* and C_2^* increase as δ increases. When a capital requirement it not too high, it allows the bank to offer contracts with $[C_1^*, C_2^*]$ pairs that dominate the situation without capital requirements.

This is true as long as the capital requirement is not so high that the other budget constraint,

$$1+\delta\cdot(1-x)-I\geq\pi_1\cdot x\cdot C_1^*,$$

binds. When this constraint does bind, the $[C_1^*, C_2^*]$ pair is found by the intersection of equation 7 and

$$R\cdot[1+\delta\cdot(1-x)-\pi_1\cdot x\cdot C_1^*]=[\pi_2\cdot x+(1-x)]\cdot C_2^*+\delta(1-x)\frac{R}{\pi_2}.$$

This second constraint is declining in δ if $\pi_1 > 0$. One can see this by rewriting the equation as

$$C_2^* = c - d \cdot C_1^* = \frac{R + \delta \cdot (1-x)R\left[1 - \frac{1}{\pi_2}\right]}{\pi_2 \cdot x + (1-x)} - \frac{\pi_1 \cdot x}{\pi_2 \cdot x + (1-x)} \cdot C_1^*$$

For $\pi_1 > 0$, $1 - \frac{1}{\pi_2} < 0$, so the constant of this equation, c, declines as δ increases.

The two constraints (written simply as $C_2^* = a - bC_1^*$ and $C_2^* = c - d \cdot C_1^*$) have the characteristics that $a > c$ and, if $R + L > 2$, that $b > d$. In addition, a increases in δ and c declines. Neither b nor d change as δ changes. In situations in which both these constraints are binding,

$$C_1^* = \frac{a-c}{b-d}$$

and C_1^* is increasing in δ. Using the second constraint, we see that

$$C_2^* = c - d \cdot C_1^* = c - d \cdot \frac{a-c}{b-d},$$

so C_2^* is decreasing in δ. These changes in C_1^* and C_2^* provide us with an unfortunate result. If capital requirements on the large deposits are very high, banks become inviable since the contracts they offer (the $[C_1^*, C_2^*]$ pairs) are such that $C_1^* > C_2^*$. All deposits would be withdrawn in period 1 in a rational bank run.

However, one can find examples of capital requirements where the two budget constraints bind over a part of the $[\pi_1, x]$ set considered and where $C_2^* > C_1^* > 1$. Figure 8 shows consumption of the type ones when the capital requirement is $\delta = .25$. The upper surface of Figure 9 shows the consumption of the type twos (the consumptions of the type ones is included, as the lower surface, for comparison).

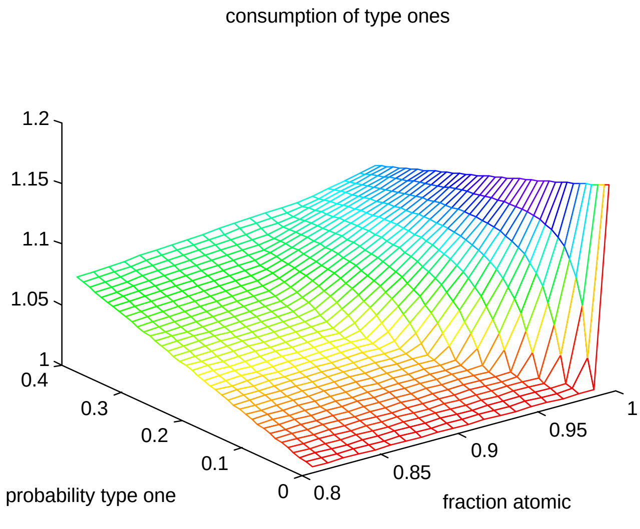


Figure 8

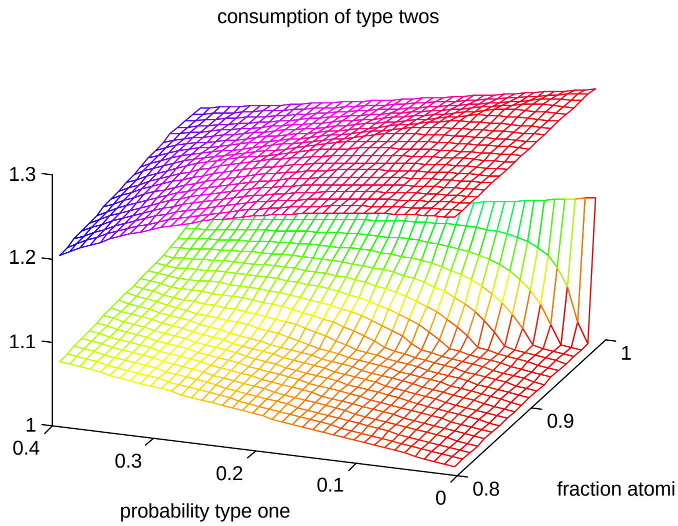


Figure 9

Of particular interest is that the utility of depositors improves in capital requirements are instituted. Figure 10 shows the difference in utility between the example economy when banks have a 25% capital requirement on large deposits and when they do not. Utility differences are all positive (except when there are no large depositors and 'fraction atomic' equals one) over the $[\pi_1, x]$ set considered.

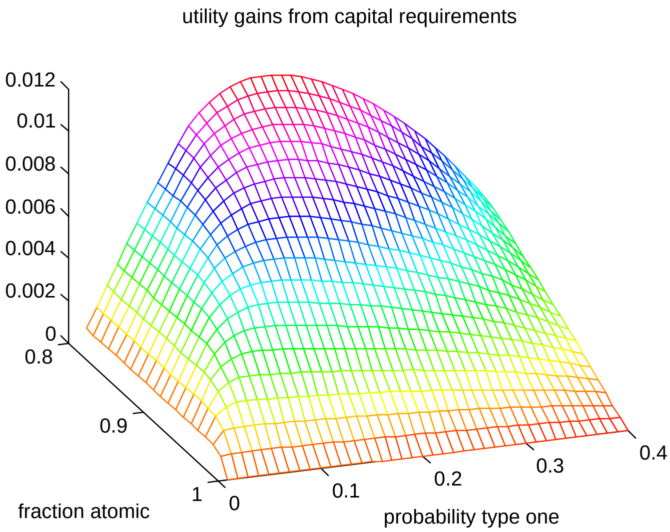


Figure 10

If capital requirements are much high than 25% the banks shut down if the probability of being a type one is relatively high. Figure 11 shows the consumption of they type ones (the plane that rises as probablity type one increases) and the consumption of the type twos for an version of the sample economy where the capital requirement is 45%. Notice that the consumption of the type twos is declining as the probability of type ones increases. This is because one needs to offer a higher return in in the case the block is type two for the required capital to make up for the higher probability of loss. The payout for the type twos declines enough so that if the probability of being a type one is more than 23%, payouts to the type twos are less than those to the type ones. Banks can't exist under those conditions since no one will wait until period two to withdraw deposits.

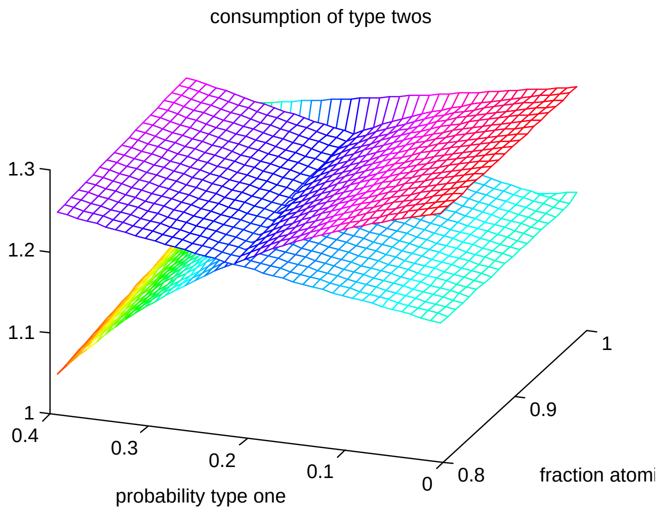


Figure 11

8. Conclusions

In general, the introduction of block (large) deposits to a banking system of the type studied by Diamond-Dybvig changes the contracts that banks can offer. When the block deposits are small relative to the fraction of the deposits that are normally withdrawn early, the change is relatively small, and banks will offer (and meet) deposit contracts with positive net returns over each period. When the block deposits are large relative to the fraction of deposits normally withdrawn early, the change is substantial and can result in contracts little different from the consumptions that would occur if banks did not exist.

If liquidation of the long term asset is not permitted (if banks must hold 100% reserves for possible withdrawals of the large deposits) then the contracts the bank can offer will pay out the same amount in period one as in period two: there are no benefits from holding deposits in the bank until the second period. This implies that if any alternative asset exists or even if any of the type twos who are indifferent between keeping their deposits in the bank or holding the deposits themselves decide to withdraw, the banks are in a liquidity crisis and close. To prevent this the banks can not invest anything in the long term asset and the net return on bank deposits must be zero. Banks do not exist.

Partial liquidity requirements on the large deposits (along with permitted liquidation of some of the long term asset) can produce payouts that resemble bank deposits: positive net interest rates each period. However, this solution involves a utility loss since more liquidity reserves are held than would be without the requirement. In the example, the liquidity requirement on the large deposits that was needed to generate positive net interest rates was quite high, in the neighborhood of 60%. It is not clear that the coefficients chosen for the example economy mimic actual economies well, so that care should be taken in interpreting this result.

Carefully chosen partial capital requirements on large deposits can result in equilibria with positive net interest rates on deposits each period and with utility improvements over equilibria without the requirement. The capital requirements that achieved this result for the example economy were significantly less than liquidity requirements (25% capital requirements). However, increasing capital requirements much above this amount has the effect of closing banks, since the capital cannot earn expected returns equal to that of alternative assets.

Both the liquidity requirements and the capital requirements have the biggest impact in environments in which the block deposits is large relative to the cohort of small depositors who are expected to withdrawn early. When the cohort of small depositors expected to withdraw early is large, neither liquidity requirements nor capital requirements are necessary to have perfectly reliable deposit contracts with positive net interest over each period.

9. References

Diamond, Douglas, and Phil Dybvig. “Bank Runs, Deposit Insurance, and Liquidity.” *Journal of Political Economy* 91 (1983), 401-19.