A banking panic occurs when depositors at all banks seek a large reduction in their deposit holdings. Suspension of convertibility of demand deposits into currency was the banking system's response to a banking panic. When depositors are incompletely informed about the state of bank investments, a panic can occur when depositors expect capital losses, conditional on having observed noisy indicators of the state of bank investments. Banks, with superior information about the investments, can signal to depositors, by suspending convertibility, that continuation of the long-term investments is mutually beneficial.

1. Introduction

During the nineteenth and early twentieth centuries the American banking system suspended convertibility eight times.\textsuperscript{1} That is, during these episodes banks refused to exchange currency for demand deposits upon demand.\textsuperscript{2} In each case, suspension was the response to a banking panic which was coincident (or nearly so) with a business cycle downturn [see Cagan (1965) and Gorton (1984)]. A curious aspect of suspension is that despite its explicit illegality, neither banks, depositors, nor the courts opposed it at any time. This paper argues that such accommodating behavior arose because suspension was part of a mutually beneficial arrangement.

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\textsuperscript{1}Those eight times were: August 1814, Fall 1819, May 1837, October 1839, October 1857, September 1873, July 1893, October 1907. Major panics occurred in all these cases, though during this period suspension also happened without a banking panic (in the 1860's). Also panics happened without suspension. There were also some minor cases of suspension. Friedman and Schwartz (1963) distinguish between the terms 'restriction' and 'suspension', reserving the latter for the Great Depression during which the government closed banks. Previous episodes were marked by banks 'restricting' convertibility between deposits and cash, but unlike the 1933 episode, they carried on all other activities. The analysis here does not involve a government, and no distinction is made between the two terms, though the older usage of 'suspension' is maintained throughout, as in Hammond (1957).

\textsuperscript{2}This refusal was usually qualified in various ways. Banks sometimes limited the amounts of the exchange, or only paid out currency needed for wage bills. For details see Sprague (1910).
The strategy of analysis is to first examine the relations between banks and depositors under full information so that decision rules and outcomes have a useful basis for comparison when an incomplete information setting is subsequently examined. The focus is on the conditions under which suspension of convertibility would be a Pareto-improving part of an assumed demand deposit contract.3

With full information there is no role for suspension of convertibility. In the full information setting a banking panic occurs when depositors decide to withdraw all their deposits from banks because of expected capital losses. The expectation of future capital losses is rational and depositors would never agree to suspension because it would prevent them from achieving their optimal portfolio allocations.

Under incomplete information there is a role for suspension. Incomplete information means that depositors do not know the state of banks' investments, but use a noisy indicator to form rational expectations of deposit return rates. A banking panic can be triggered by a movement of the indicator, causing depositors to withdraw all their deposits because of fears of capital losses. By suspending convertibility, banks can signal to depositors that continuation of the investments is mutually beneficial. Suspension, however, only occurs when depositors panic because of expectations formed conditional on observing the noisy indicator, but would not panic if they had full information. Thus, the full information world can be approximated by including suspension as part of the demand deposit contract.

2. The banking system

The model economy lasts for three periods. Depositors maximize the utility of consumption the first two periods and end of world wealth during the third period. Depositors are retired during the third period and live off their savings. Each depositor begins the world with an inherited endowment of wealth, \( M_0 \). Currency and demand deposits are the only available stores of value. The banking system has two essential, exogenously imposed, features. First, individual banks, in a competitive banking system, finance two-period investments (at the beginning of the world) with debt (deposits) and equity. Debt is the senior claimant on a bank's returns. The return on debt may include capital losses, but deposits cannot incur capital gains. Second, depositors may withdraw their deposits at the end of the first period. These two features create the possibility of depositors ending the investment process after the first period.

There are two sources of uncertainty in the model. The rate of return to holding currency is random, and the rate of return on banks' investments is

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3 Santomero (1983, sec. I) surveys the literature on why banks exist. Also, see Haubrich and King (1983).
random. It is assumed that currency consists of gold coins, and its rate of return is its rate of appreciation or depreciation against goods.\textsuperscript{4} At the beginning of the world, the rate of return on currency for period 1 is known, but it is not known what the rate of return on currency will be during period 2. That random variable is realized at the end of period 1.

The rate of return on bank investments is random because of underlying real shocks to produced output upon which banks hold claims. Since the physical realization of the technology that banks have invested in is random, the value of bank investments, referred to as 'the state of bank investments', reflects these underlying shocks. Thus, the state of bank investments is a random variable, realized at the ends of periods 1 and 2. Realizations of the state of bank investments determines whether a capital loss is imposed on depositors at the end of each period.

\textsuperscript{4}In general, $C$ can be thought of as an alternative investment which earns $\lambda_1$ over the first period, and $\lambda_2$ over the second period.
The notation adopted is presented in Table 1. The rate of return on demand deposits at the end of period 1, the repurchase price, is \((1 + r_{d1})(1 - \pi_1(\theta_1))\), i.e., the predetermined rate of return on demand deposits \(r_{d1}\) discounted by the capital loss on demand deposits \(\pi_1(\theta_1)\). The capital loss is determined from the bank's balance sheet, so it follows that

\[(1 + r_{d1})[1 - \pi_1(\theta_1)] = \min[(1 + r_{d1}), \theta_1 L/\Delta_1]. \tag{1}\]

Whether the depositors incur a capital loss or not depends on the state of bank loans, \(\theta_1\), and on the amount that senior claimants can claim, \((1 + r_{d1})\Delta_1\). If a bank cannot repay depositors at the initially agreed upon specie price of deposits, then the deposit price depreciates to reflect the value of the bank's assets. The required depreciation is

\[1 - \pi_1(\theta_1) = 1 \quad \text{if} \quad \theta_1^* \leq \theta_1 \leq \theta_1, \]
\[= \frac{\theta_1 L}{(1 + r_{d1})\Delta_1} \quad \text{if} \quad \theta_1 \leq \theta_1 \leq \theta_1^*, \tag{2}\]

where the critical value,

\[\theta_1^* = \frac{(1 + r_{d1})\Delta_1}{L},\]

just permits satisfaction of the claims against the bank at the fixed price.

Similarly, if depositors hold deposits until the end of the world, then the two-period rate of return on deposits is

\[(1 + r_{d1})(1 + r_{d2})(1 - \pi_2(\theta_2)) = \min\left[(1 + r_{d1})(1 + r_{d2}), \frac{(1 + r)\theta_2 L}{\Delta_2}\right]. \tag{3}\]

There is again a critical value, \(\theta_2^*\), above which capital losses do not occur, i.e., \(\pi_2(\theta_2^*) = 0\). From (3), this is

\[\theta_2^* = \frac{(1 + r_{d1})(1 + r_{d2})\Delta_2}{(1 + r)L}.\]
The required depreciation is

\[ 1 - \pi_2(\theta_2) = 1 \quad \text{if } \theta_2^* \leq \theta_2 \leq \bar{\theta}_2, \]

\[ = \frac{(1 + r)\theta_2 L}{(1 + r_d)(1 + r_{d2})\Delta_2} \quad \text{if } \theta_2 \leq \theta_2 \leq \theta_2^*. \quad (4) \]

Faced with these return distributions depositors must choose an initial portfolio at the beginning of period 1 and decide whether to withdraw deposits at the beginning of period 2. These decisions will be based on comparing the prospective returns associated with different portfolios, and will utilize all available information. The information structure of the problem is shown in table 2. The information available to depositors at the times described by the first row of table 2 is the case of full information (FI). Under full information depositors know the state of bank investments, \( \theta_1 \), at the beginning of period 2. Expectations are formed rationally, so depositors use \( \bar{\theta}_x \) to compute \( \pi_1(\theta_1) \) at the time they are making the decision to withdraw or deposit.

Previously, the states of the bank investments were explained as reflecting real shocks to an underlying production process. If it is assumed that this underlying process exhibits persistence, then the state of bank investments each period is serially correlated. So an observation on the state of bank investments at the end of period 1 allows an inference about what final outcome will be realized at the end of period 2. A specification which incorporates this is

\[ \theta_2 - \bar{\theta}_2 = \gamma(\theta_1 - \bar{\theta}_1) + \mu, \quad (5) \]

where \( \gamma > 0, E(\theta_1) = \bar{\theta}_1, E(\theta_2) = \bar{\theta}_2, \bar{\theta}_2 \gg \bar{\theta}_1, \) and \( \mu \) is white noise with density function \( Z(u) \). ‘E’ indicates the expectation operator.
Banks and depositors are assumed to know the process (5). At the beginning of period 2, having observed \( \theta_1 \), depositors' expectation of \( \theta_2 \) is

\[
E_1(\theta_2) = E(\theta_2|\theta_1) = \bar{\theta}_2 + \gamma(\theta_1 - \bar{\theta}_1).
\]

Using eqs. (4) and (5), the expected capital loss at the end of period 2, conditional on having observed \( \theta_1 \) at the end of period 1, is

\[
E_1[\pi_2(\theta_2)] = \int_{\mu^*}^{\mu} \left\{ 1 - \frac{(1 + r)L[\bar{\theta}_2 + \gamma(\theta_1 - \bar{\theta}_1) + \mu]}{(1 + r_{d1})(1 + r_{d2})} \right\} Z(\mu) \, d\mu,
\]

where

\[
\mu^* = \theta_2^* - \bar{\theta}_2 - \gamma(\theta_1 - \bar{\theta}_1).
\]

3. The depositors' full information problem

At the beginning of the world, depositors choose a portfolio to get a consumption path. The representative depositor faces the following problem:

\[
\max V_0 = E_0 \{ U(X_1) + \beta U(X_2) + \beta^2 \Lambda(W) \},
\]

subject to

(i) \( X_1 + C_1 + D_1 \leq M_0 \),

(ii) \( X_2 + C_2 \leq (1 + \lambda_1)C_1 + (1 + r_{d1})[1 - \pi_1(\theta_1)](D_1 - D_2) \),

(iii) \( W = (1 + \lambda_2)C_2 + (1 + r_{d1})(1 + r_{d2})[1 - \pi_2(\theta_2)]D_2 \).

Constraint (ii) requires second-period consumption \( (X_2) \) and second-period currency holdings \( (C_2) \) to be financed by the value of the depositor's portfolio realized at the end of period 1. Constraint (ii) applies the capital loss on deposits only to the amount of deposits withdrawn at the end of the first period, i.e., \( (D_1 - D_2) \). We assume returns are bounded such that \( D_2 \leq D_1 \), i.e., the representative depositor never deposits more at the end of period 1. Constraint (iii) determines the representative depositor's end of world wealth as a function of returns realized at the end of period 2.

Working backwards in typical dynamic programming fashion, we start by analyzing the problem faced by agents at the end of the first period. That problem is

\[
\max V_1 = E_1 \{ U(X_2) + \beta \Lambda(W) \},
\]

subject to (ii), (iii).
Assume that depositors are risk-averse with respect to lotteries on consumption during periods 1 and 2, but are risk-neutral with respect to retirement wealth. This assumption simplifies the analysis and focuses attention on the problem of interest. The assumption causes depositors to choose portfolios which are corner solutions; depositors hold either currency or deposits, but not both. Consequently, if depositors hold deposits at the beginning of the world, then all their wealth is in this form. If depositors withdraw their deposits at the end of period 1, they withdraw all their deposits, switching completely to currency. Under this assumption,

\[ \Lambda(W) = A + BW, \quad A, B > 0, \]

and using

\[ E_1(W) = (1 + \lambda_2)C_2 + (1 + r_{d1})(1 + r_{d2})[1 - E_1(\pi_2(\theta_2))] D_2, \]

we find that if depositors start the world holding deposits, then they will withdraw all their deposits if

\[ (1 + \lambda_2)[1 - \pi_1(\theta_1)] > (1 + r_{d2})[1 - E_1(\pi_2(\theta_2))]. \quad (7) \]

According to (7), depositors withdraw their deposits if the known rate of return to currency over period 2 is greater than the expected rate of return to holding deposits over period 2, accounting for the capital loss associated with withdrawing. \((\lambda_2\text{ and } \theta_1\text{ are independent.})\) This decision rule for withdrawing, which compares a known return to an expected return, is the result of depositors' risk neutrality toward end of world wealth, and the fact that, knowing \(\theta_1\), second-period utility is not uncertain.

For each realized \(\theta_1\), there exists a critical value of the rate of return on currency, \(\lambda^*_2(\theta_1)\), such that depositors are just indifferent between withdrawing and not withdrawing,

\[ [1 + \lambda^*_2(\theta_1)] = \frac{(1 + r_{d2})[1 - E_1(\pi_2(\theta_2))]}{[1 - \pi_1(\theta_1)]}. \quad (8) \]

That is, the decision rule is to withdraw if \(\lambda_2 > \lambda^*_2(\theta_1)\), which divides the area of possible \((\lambda_2, \theta_1)\) realizations into a region over which depositors will withdraw their deposits and the remainder over which they will not withdraw (see fig. 1).
The slope of rule (8) depends on the implications of the $\theta_1$ realization for the prospective return on deposits at the end of period 2,

$$\frac{\partial \lambda_2^*(\theta_1)}{\partial \theta_1} = \frac{(1 + r_{d_2})\gamma \Gamma}{\theta_2^*} \quad \text{if} \quad \theta_1^* \leq \theta_1 \leq \bar{\theta},$$

$$= \frac{(1 + r)\gamma \Gamma}{\theta_2^*} - \frac{(1 + r_{d_2})(1 - E_1(\pi_2(\theta_2)))}{[1 - \pi_1(\theta_1)]^2 \theta_1^*} \quad \text{if} \quad \theta_1 \leq \theta_1 < \theta_1^*,$$

where

$$\Gamma = 1 - \int_{\mu}^{\mu^*} Z(\mu) \, d\mu,$$

which is the probability of the banking system not failing at the end of period 2.

The slope of the withdraw rule is positive with respect to increases in $\theta_1$. To see this recall that above we assumed that a low $\theta_1$ realization currently implies a lower $\theta_2$ realization next period since $\gamma > 0$ in (5). Now consider the range of
\( \theta_1 \) realizations over which there is no capital loss on deposits at the end of period 1, i.e., \( \theta_1^* \leq \theta_1 < \tilde{\theta}_1 \). Over this range, as \( \theta_1 \) increases, \( E_1(\pi_2(\theta_1)) \) decreases, increasing \( \lambda_2^*(\theta_1) \) since the prospective return to deposits at the end of the second period is more favorable.

Over the range where there is currently a capital loss on deposits, \( \theta_1 \leq \theta_1 < \theta_1^* \), two forces pull \( \lambda_2^*(\theta_1) \) in opposite directions. As \( \theta_1 \) increases over this range, both the current and prospective capital losses decline. If \( \gamma \) is large enough, then, as \( \theta_1 \) increases, \( \lambda_2^*(\theta_1) \) increases because \( E_1(\pi_2(\theta_2)) \) declines by more than \( \pi_1(\theta_1) \). Though it is not necessary for what follows, diagrams which follow assume that \( \gamma \) is large enough that the slope over this range is positive.

4. Deposit market equilibrium under full information

Banks are risk-neutral and there are no bankruptcy costs. The investment process is assumed to be such that a positive return on equity can only be earned if depositors do not withdraw their deposits at the end of period 1. Banks are required to earn an expected return on equity no greater than an exogenously given number, \( r_Q \). Once chosen, the level of equity cannot be changed by the bank at the end of the first period. Given the depositors' rule for withdrawing, any initial level of debt, \( \Delta \), and depositors' choice of \( r_d \), a bank then chooses a full information equity level, \( Q^F \), by equating expected profits with the return on equity, \( Q(1 + r_Q) \). This yields a decision rule for equity (see appendix).

At the beginning of the world each bank announces its rule for choosing an amount of equity. Depositors choose a portfolio at the beginning of the world to maximize expected utility (assuming \( r_{d1} = r_{d2} = r_d \)) knowing the relations between the expected capital loss, the promised rate of return on deposits \( (r_d) \), the total level of deposits at the bank (\( \Delta \)), and the banks' rules for equity. Since depositors have identical attitudes toward risk and can choose any amount of risk, they distribute themselves across banks so that, in equilibrium, all banks have identical debt–equity ratios \( (Q/\Delta) \) and deposit rates \( (r_d) \).

At the end of the first period, banks and depositors observe \( \lambda_2 \) and \( \theta_1 \). Depositors re-evaluate their portfolios and decide whether to withdraw their deposits or not. The information in \( \theta_1 \) about the likely realization of capital losses at the end of period 2 is rationally used by depositors in making the decision to withdraw or not. If depositors withdraw their deposits, then they

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5. Second-period consumption is implicitly determined by the first-order conditions for (II). Using that function and the withdraw rule, eq. (8), the depositors' first-period problem may be solved. Appendix A of Gorton (1982) solves the depositors' first-period problem. At the beginning of the world depositors choose an initial portfolio, \( (C_1, D_1) \), and \( r_d \). Gorton (1982) also considers indexing \( r_{d2} \) by \( \theta_1 \).
6. This is a result of constraining depositors to each have only one bank, i.e., an underlying assumption about returns to scale in the transaction technology. The results do not depend on identical debt–equity ratios in equilibrium.
end the investment process. The decision to withdraw deposits at the end of period 1 is an optimal decision in the presence of full information.  

5. The incomplete information equilibrium

There is no role for suspension to play under full information conditions. Under full information, depositors know the stochastic process of shocks to bank investments, eq. (5), and observe the $\theta_1$ realization at the end of period one. Conditional on the observed $\theta_1$, and knowing $\lambda_2$, depositors withdraw all their deposits at the end of period 1 when they expect large enough capital losses on deposits at the end of period 2 as determined by the withdraw rule. In this case it is optimal for depositors to withdraw their deposits, and suspension would be a constraint preventing the realization of that decision.

Suspension of convertibility, however, can play a role if depositors are incompletely informed about the state of bank investments. The incomplete information setting is assumed here, but has recently been rationalized by several researchers [e.g., Boyd and Prescott (1984)]. Without full information depositors make mistakes relative to full information. It is the existence of these potential mistakes which creates the possibility of a signalling role for suspension, that is, suspension by banks can signal to depositors that they have made a suboptimal decision relative to full information.

Suppose that depositors do not know $\theta_1$ at the end of period 1, but banks observe $\theta_1$. Without knowledge of $\theta_1$, depositors cannot compute $\pi_1(\theta_1)$ exactly. Nor can depositors revise their expectation of $\pi_2(\theta_2)$. Depositors, however, will be assumed to have a noisy indicator of $\theta_1$. For purposes of the model it is convenient to let $\lambda_2$ serve as the indicator of the value of banks’ portfolios. Suppose that $\lambda_2$ is negatively correlated with $\theta_1$ and that depositors observe $\lambda_2$ at the end of period 1. The assumed correlation means that gold coins appreciate during ‘bad’ times, i.e., when $\theta_1$ is low.

Again working backwards, at the end of period 1, depositors, with incomplete information, maximize expected second-period utility conditional on having observed $\lambda_2$,

$$\max V_2 = \mathbb{E}[U(X_2)|\lambda_2] + \beta \mathbb{E}[\Lambda(W)|\lambda_2],$$

subject to (ii) and (iii).

(Expectations conditional on having observed $\lambda_2$ are indicated by ‘$|\lambda_2$’.) As before, depositors will behave as ‘plungers’ and hold either all currency or all

\[\text{At the end of the first period, if depositors decide to withdraw and } \pi_1(\theta_1) > 0, \text{ then there is the possibility of renegotiation of the contract. This possibility is considered in section VI of Gorton (1982). The initial contract could also incorporate this possibility by indexing } r_{22} \text{ by } \theta_1 \text{ and } \lambda_2. \text{ This would change the area over which the bank would be declared bankrupt, but under incomplete information, does not eliminate suspension as a Pareto-improving part of the contract.}\]
deposits over period 2. Under incomplete information, depositors decide to withdraw if $\lambda_2 > \lambda_2^{**}$, where $\lambda_2$ is observed and $\lambda_2^{**}$ is given by

$$
(1 + \lambda_2^{**})E\{[1 - \pi_1(\theta_1)]U'_{x_2}\} = (1 + r_{d2})[1 - E[\pi_2(\theta_2)]]E[U'_{x_2}].
$$

The expectations in (9) are conditional on having observed $\lambda_2$.

Under full information, $\lambda_2^*(\theta_1)$ was chosen to equate the marginal utility of withdrawing with the marginal utility of not withdrawing. Now, $\lambda_2^{**}$ is chosen to equate the expected marginal utilities of withdrawing and not withdrawing. Since $\theta_1$ is not known, under incomplete information, second-period utility is uncertain, so expected marginal utilities (conditional on having observed $\lambda_2$) enter the decision rule for withdrawing.

Given depositors’ decision rule for withdrawing, banks choose a different rule for their choice of equity (see appendix). Then given the rule for withdrawing and the bank’s rule for choosing equity, depositors, at the beginning of the world, choose a level of deposits and an initial $r_d$. In general, under incomplete information, $Q$, $\Delta$, and $r_d$ will be chosen differently, so that all the variables depending on these, $\theta_1^*, \theta_2^*, \pi_1(\theta_1), \pi_2(\theta_2)$, will have different values under incomplete information.

![Diagram](https://via.placeholder.com/150)

Fig. 2. Full and incomplete information rules.
The full and incomplete information rules for depositor withdrawal are shown in fig. 2. The incomplete information rule cannot replicate the full information decisions, so depositors are worse off. In particular, a realization of \((\lambda_2, \theta_1)\) in area A or area C results in an incorrect decision by depositors under incomplete information. In area A depositors withdraw all their deposits under incomplete information, when they would not if they had full information. In area C, depositors do not withdraw deposits when they would if they had full information. These mistakes result from the fact that the indicator, \(\lambda_2\), does not reveal the exact state of bank investments.

6. The suspension contract

Both banks and depositors would prefer to avoid the banking panic occurring in area A. Depositors prefer to avoid the area A mistake because withdrawing in area A reduces expected end of world wealth. Banks prefer that the investment process not be ended so that a (positive expected) return on equity can be earned. The situation, however, is asymmetric because only depositors have an incentive to avoid area C. A mistake by depositors in area C is to the advantage of banks since depositors do not end the investment process (which they would if they had full information). A prestate agreement which avoided the effects of the area A banking panic would be mutually beneficial to both banks and depositors. But this would not be the case for area C.

Since banks and depositors are asymmetrically informed we modify the model to allow information about the state of banks, \(\theta_1\), to be transmitted to depositors at a cost. Any realization of \(\theta_1\) is known only by banks unless a verification cost is borne. [See Townsend (1979).] In this setting we will consider a prestate agreement which states when verification is to take place.

Comparing the banks' decision rules under full and incomplete information (see appendix) it is apparent that if depositors choose \(\lambda_{2*}\) such that areas A and C are equal (see fig. 2), then \(\Delta, Q, \) and \(r_d\) would be the same under either information assumption. This, however, cannot be the solution under incomplete information. Under incomplete information depositors will choose some combination of a lower level of deposits and a lower \(r_d\). In that case the expected marginal value of the withdraw option [see appendix A of Gorton (1982)] under full information would be higher than it would be under incomplete information by exactly the marginal utility over areas A and C, which, moreover, would be equal (i.e., \(A = C\)). In this case, however, depositors' beginning of the world first-order condition, eq. (A9) of appendix A of Gorton (1982), cannot possibly be satisfied. Satisfying it requires lowering \(D\) and \(r_d\), which would lower \(\lambda_{2*}\), so that area C would be less than area A.

Since closed form solutions for the beginning of the world problems cannot be obtained [see appendix A of Gorton (1982)], it cannot be proven that areas A and C, in the figure, exist. In what follows it is assumed that, under incomplete information, \(\lambda_{2*}\) is chosen such that areas A and C exist.

Since depositors do not observe \(\theta_1\), but observe \(\lambda_2\) and form a conditional expectation of \(\theta_1\) using \(\lambda_2\), fig. 2 has only one relevant dimension under incomplete information. It is drawn in two dimensions for illustrative purposes.
and what the outcome of exchange is to be, contingent on the state revealed. If banks signal when verification is to take place, submit to verification, and abide by the prestate specified outcome, then the contract is said to be incentive compatible.

The only difficulty is the asymmetry between areas A and C. Both banks and depositors have incentives to avoid area A, but only depositors want to avoid area C. However, if the prestate agreement refers only to area A, allowing this mistake to be avoided, then depositors will be compensated for the area C mistake. Since the expected rate of return on equity cannot exceed \( \bar{r}_Q \), the gain to banks from avoiding area A will accrue to depositors.

Consider the following arrangement between a bank and its depositors. If depositors, under incomplete information, withdraw their deposits at the end of period 1 because \( \lambda_2 > \lambda_2^* \), then the bank is allowed to suspend convertibility if it chooses. Suspension, however, requires the equity holders of the bank to pay a verification cost proportional to its debt, \( v_\Delta \). If the verification cost is paid, then the true realization of \( \theta_1 \) is determined and revealed to depositors.

There is no incentive for a bank to suspend outside area A. After verification, depositors will demand the return of their deposits anyway and the verification cost would be unnecessarily lost to equity holders. If depositors withdraw and there is no capital loss, i.e., \( \hat{\theta}_1^* \leq \theta_1 \leq \bar{\theta}_1 \), then the bank can pay off the claims of depositors without inflicting capital losses. But the bank has an incentive to suspend and leave the investments undisturbed. However, suspension would require verification, so that depositors would receive \( (1 + r_{d1}) \Delta \) and equity holders would be liable for \( v_\Delta \). This strategy cannot be optimal. The situation is similar if depositors withdraw and there is a positive capital loss, i.e., \( \hat{\theta}_1 \leq \theta_1 < \hat{\theta}_1^* \). While the bank has an incentive to suspend, verification would show that, unless the realization was in area A, depositors would demand their deposits and equity holders would have to pay the verification cost \( (v_\Delta) \). The bank, therefore, only suspends in area A. Therefore, this agreement is incentive compatible.

The contract is pictured in fig. 3. Since depositors now withdraw over a smaller area of the space of possible first-period realizations, the expected rate of return on an equity share, \( E(r_Q) \), will exceed \( \bar{r}_Q \) when \( E(r_Q) \) is computed using the banks' decision rule for equity under incomplete information (see appendix). Under the suspension contract the amount of equity chosen will exceed the amount chosen without suspension in the contract (see appendix). In other words, to satisfy the constraint banks are forced to return the increase in expected profits to depositors. Banks raise their equity–debt ratios, making deposits 'safer' by reducing expected capital losses. This is the source of the welfare gain to depositors. But as long as \( \sigma > 0 \), depositors cannot achieve the level of expected utility attainable under full information. (See appendix.)

During a banking panic suspension signals that the realization is in area A. The verification process accompanying suspension allows depositors to determine the state of bank investments, information not fully revealed by \( \lambda_2 \). In
effect, depositors only monitor (or monitor more intensely) when they have reason to expect that high capital losses on deposits are more probable, i.e., 'high' realizations of $\lambda_2$. The Pareto-improvement captured by the suspension contract originates in avoiding the results of the panic which would occur without suspension.

7. Conclusion

The view of panic and suspension presented here may best be described as an information-based explanation. Without full information about the state of bank investments, a panic can be rationally triggered by movements in a noisy indicator of the state of bank investments. The panic is 'rational' because the indicator contains useful information; it is, in fact, correlated with the state of bank investments. The indicator is not an intrinsically irrelevant variable. If a panic occurs, banks, with superior information, can signal to depositors that continuation of the investment process is mutually beneficial. Suspension circumvents the realization of suboptimal depositor withdrawals which are based on (rational) fears of capital losses.
The information-based explanation of panic and suspension implies that these events are predictable on the basis of prior information. That is, panic and suspension are not random events, but are related to changes in expected returns caused by movements in the indicator. While the indicator used in the model, $\lambda_2$, should not be interpreted literally (as the rate of return on currency), the model makes fairly strong predictions about when panics and suspensions should occur. In a study of the National Banking Era (1865–1914), Gorton (1984) uses the liabilities of failed non-financial businesses as the indicator and shows that every time this variable reached a defined critical level there was a panic. Other researchers have cited, as indicators, the failure of particular large, non-financial corporations [e.g., Friedman and Schwartz (1963)], or ‘seasonal stringency’ [e.g., Kemmerer (1910)].

The information-based explanation of panic and suspension contrasts sharply with what may be described as bubble explanations. Recent examples of this latter view include Diamond and Dybvig (1983) and Waldo (1982). In these models the occurrence of an intrinsically irrelevant event can cause a panic because of the exogenous imposition of a first come, first serve rule for bank payouts to depositors. Hence, individual depositors have an incentive to ‘beat’ runs and anything which happens causing them to anticipate a panic causes the panic. Unfortunately, bubble explanations appear to place no testable restrictions on the data.

Appendix

Under full information, given $r_d$, a level of debt, $\Delta$, and the depositors’ rule for withdrawing [eq. (7) in the text], each bank, at the beginning of the world, chooses an amount of equity, $Q^F$, by equating expected profits with $(1 + \bar{r}_Q)Q$, where $\bar{r}_Q$ is the maximum rate of return on equity. The solution to the banks’ problem is

$$\frac{Q^F}{\Delta} = \frac{E_0[(1 + r) | NW] - E_0[(1 + r_d)^2 | NW]}{1 + \bar{r}_Q - E_0[(1 + r) | NW]},$$

(A.1)

where

$$E_0[(1 + r) | NW] = G(1 + r) \int_{\mu^*}^{\bar{\mu}} [\bar{\theta}_2 + \mu] Z(\mu) \, d\mu,$$

$$E_0[(1 + r_d)^2 | NW] = G(1 + r_d)^2 \bar{\theta}_1 \int_{\mu^*}^{\bar{\mu}} Z(\mu) \, d\mu,$$

$$G = \int_{\bar{\theta}_1}^{\bar{\theta}_2} \int_{\lambda_2}^{\lambda^*_2} g(\lambda_2) f(\theta_1) \, d\lambda_2 \, d\theta_1.$$
at the beginning of the world. Under incomplete information, each bank chooses an amount of equity, $Q^1$, in the same way except that the depositors' rule for withdrawing is different [eq. (9) in the text]. The form of the banks' solution is the same as (A.1), except, under incomplete information,

$$G = \int_{\theta_1}^{\delta_1} \int_{\lambda_2}^{\lambda_2^*} g(\lambda_2) f(\theta_1) \, d\lambda_2 \, d\theta_1.$$ 

Under the suspension contract, the banks' decision rule is given by

$$\frac{Q^s}{\Delta} = \frac{E_0[(1 + r) | NW, II, S] - E_0[(1 + r_d)^2 | NW, II, S] + E_0[(1 + r) | S]}{1 + r_Q - E_0[(1 + r) | NW, II, S] - E_0[(1 + r) | S]}
- \frac{E_0[(1 + r_d)^2 + r | S]}{1 + r_Q - E_0[(1 + r) | NW, II, S] - E_0[(1 + r) | S]},$$

(A.2)

where

$$E_0[(1 + r)^2 | NW, II, S] = G(1 + r) \int_{\mu^*}^{\tilde{\theta}_2 + \mu} Z(\mu) \, d\mu,$$

$$E_0[(1 + r_d)^2 | NW, II, S] = G(1 + r_d)^2 \tilde{\theta}_1 \int_{\mu^*}^{\tilde{\mu}} Z(\mu) \, d\mu,$$

$$E_0[(1 + r) | S] = A(1 + r) \int_{\mu^*}^{\tilde{\theta}_2 + \mu} Z(\mu) \, d\mu,$$

$$E_0[(1 + r_d)^2 + v | S] = A[(1 + r_d)^2 + v] \int_{\mu^*}^{\tilde{\mu}} Z(\mu) \, d\mu,$$

$$G = \int_{\theta_1}^{\delta_1} \int_{\lambda_2}^{\lambda_2^*} g(\lambda_2) f(\theta_1) \, d\lambda_2 \, d\theta_1,$$

$$A = \int_{\theta_1}^{\delta_1} \int_{\lambda_2}^{\lambda_2^*} g(\lambda_2) f(\theta_1) \, d\lambda_2 \, d\theta_1.$$ 

'S' indicates that the solution is conditional on suspension being part of the contract; 'II' indicates incomplete information. To compare this decision rule for equity to the incomplete information decision rule for equity, suppose depositors chose the same $\Delta$ and $r_d$ as under incomplete information. Then eq. (A.2) can be written as

$$\frac{Q^s}{\Delta} = \frac{Q^1}{\Delta} + \frac{E_0[(1 + r) | S](1 + \Delta/Q) - E_0[(1 + r_d)^2 + v | S]}{1 + r_Q - E_0[(1 + r) | NW, II]}.$$
Therefore, if depositors chose the same $\Delta$ and $r_d$, $Q^S > Q^I$.

Under the suspension contract depositors withdraw with suspension allowed if $\lambda^*_2 > \lambda^*_2^{**}$, where $\lambda^*_2^{**}$ is given by eq. (9) of the text, but $\lambda^*_2^{**}$ is computed given the banks' decision rule (A.2). Solving eq. (10) for the equity–debt ratio, get:

$$[1 + Q^S/\Delta] = \frac{(1 + r_d)^2 \int_{\theta_1}^{\mu} f(\theta_1 | \lambda_2) Z(\mu) \, d\mu \cdot \int_{\theta_1}^{\bar{\theta}_1} U_{x_1} f(\theta_1 | \lambda_2) \, d\theta_1}{(1 + \lambda^*_2^{**}) \int_{\theta_1}^{\bar{\theta}_1} \theta_1 U_{x_1} f(\theta_1 | \lambda_2) \, d\theta_1} + \frac{(1 + r)}{(1 + r_d)} \int_{\mu}^{\bar{\theta}_1} \int_{\theta_1}^{\bar{\theta}_1} [\bar{\theta}_2 + \mu] f(\theta_1 | \lambda_2) \, d\theta_1 \cdot \int_{\theta_1}^{\bar{\theta}_1} U_{x_1} f(\theta_1 | \lambda_2) \, d\theta_1$$

If depositors chose the same $\Delta$ and $r_d$ under the suspension contract as under incomplete information, then the right side of (A.4) would be the same in both cases. Then since $Q^S > Q^I$, $\lambda^*_2^{**}$ would have to be lower everywhere. Call this choice of $\lambda^*_2^{**}$, $\lambda^*_2^{***}$. Since deposits are now safer, under the assumption that depositors choose the same $\Delta$ and $r_d$ as under incomplete information, $\lambda^*_2^{***} < \lambda^*_2^{**}$, increasing the area of suspension, since capital losses decline, and minimizing the error associated with area $C$. Depositors, however, cannot completely eliminate area $C$ because $\nu > 0$. Depending on depositors beginning of the world first-order conditions, however, the compensation to depositors can be absorbed by depositing more and raising $r_d$, which raises $\lambda^*_2^{***}$. The gain to depositors remains, but the form changes.

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