

BANKING PANICS AND BUSINESS CYCLES*

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I. Introduction

THE nearly universal experience of banking panics has led many governments to regulate the banking industry. Economists, too, have increasingly focused on panics as evidence of bank uniqueness. Yet, competing theories to explain banking panics have never been tested. Are banking panics caused by the same relations governing consumer behavior during nonpanic times? Are panics random events, or are panics associated with movements in expected returns, in particular, with movements in perceived risk which are predictable on the basis of prior information? If so, what is the relevant information? Using newly constructed data this study addresses these questions by examination of the seven panics during the U.S. National Banking Era (1863–1914). Depositor behavior under subsequent monetary regimes is also examined. In all, one hundred years of depositor behavior are examined.

A common view of panics is that they are random events, perhaps self-confirming equilibria in settings with multiple equilibria, caused by shifts in the beliefs of agents which are unrelated to the real economy. An alternative view makes panics less mysterious. Agents cannot discriminate between the riskiness of various banks because they lack bank-specific information. Aggregate information may then be used to assess risk, in which case it can occur that all banks may be perceived to be riskier. Consumers then withdraw enough to cause a panic. While the former hypothesis is not testable, it suggests that panics are special events and implies that banks are inherently flawed. The latter hypothesis is testable; it suggests that movements in variables predicting deposit riskiness cause panics just as such movements would be used to price such risk at all other times. This hypothesis links panics to occurrences of a threshold value of some variable predicting the riskiness of bank deposits.

* The comments and assistance of Andy Abel, Robert Barro, Phillip Cagan, Bob DeFina, Mike Dotsey, Mark Edwards, Stanley Engerman, Lauren Feinstone, Claudia Goldin, Jack Guttentag, Robert King, Erv Miller, Jeremy Siegel, Alan Stockman, John Taylor, Steve Zeldes, two anonymous referees, and the University of Pennsylvania Macro Lunch Group, were helpful and greatly appreciated. They are not responsible for errors. The research assistance of Earl Pearsall, Elaine Ross, and Wendy Tann was invaluable for this work, as was the programming assistance of Steve Franklin, and Wells Vinton. Thanks to Robert Avery for help with the Tobit program, CRAWTRAN. This study was initiated while the author was at the Federal Reserve Bank of Philadelphia. The study was completed using the Philadelphia Fed's computers, thanks to Richard Lang. The views expressed in this paper are not necessarily those of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

The thrust of this paper is to differentiate between these two hypotheses. Since the former hypothesis imposes no restrictions on the data, this will, needless to say, be difficult. I, therefore, focus attention on the second hypothesis. The analysis is conducted along two lines. A reduced-form equation describing the behavior of the deposit-currency ratio is studied, and correlations in the data using only the panic dates are studied.

The results suggest that banking panics can be explained by the economic theory explaining consumer behavior during nonpanic times. Banking panics during the U.S. National Banking Era were systematic responses by depositors to changing perceptions of risk, based on the arrival of new information rather than random events. In fact, I show below that every time a variable predicting a recession reached a threshold level, a panic occurred. All the large movements in this variable exactly correspond to large movements in a consumption-beta-type measure of deposit riskiness. The risk measure also reaches a threshold or critical level at panic dates. Panics did not occur at other times. The interpretation is intuitive. Consumers know that during recessions they will want to dissave, drawing down bank accounts. But, banks, like other firms, tend to fail during recessions. When consumers forecast a coming recession they withdraw deposits in advance to avoid losses due to bank failure.

Thus, the analysis confirms that there is something special about panics, but not in the way suggested by theories of self-fulfilling panics or random shifts of depositor beliefs. Rather, depositor behavior during panics is accurately described by a model which characterizes their behavior at other times. But, the information arriving about a coming recession (while noisy) reaches a critical level; this is "special."

The panics of the 1930s, however, cannot be ascribed to the same pattern of consumer behavior. An estimated counterfactual shows that had the downturn of the thirties come during the National Banking Era, losses to depositors would have been four to five times lower; the number of banks that failed during the thirties was roughly twenty-five times what it would have been had the pre-Federal Reserve System institutions been in place. The banking panics during the Great Depression were, thus, special events. Those panics occurred without the private deposit insurance supplied by private bank clearinghouses or the deposit insurance supplied publicly afterwards.

II. Banking panics: description and theories

A bank panic occurs when depositors demand such a large-scale transformation of deposits into currency that, at the contracted for exchange rate (of a currency dollar for a deposit dollar), the banking system can only respond by suspending convertibility of deposits into currency, issuing

clearinghouse loan certificates, or both.¹ Table 1 lists the recessions and panics during the National Banking Era, the declines in output as measured by pig iron production, and the increases in the currency-deposit ratio. Also shown are the losses to depositors and the numbers of banks failing. Notice that the banking panics tended to occur just after business cycle peaks. Also, losses on deposits and the number of failures seem small considering that the panics were generalized events which literally involved all banks and depositors.

TABLE 1
National Banking Era Panics

<i>NBER Cycle Peak-Trough</i>	<i>Panic Date</i>	$\% \Delta \left(\frac{C}{D} \right)^*$	$\% \Delta$ Pig Iron†	<i>Loss Per Deposit \$†</i>	<i>% and # Nat'l Bank Failures†</i>
Oct. 1873–Mar. 1879	Sept. 1873	14.53	–51.0	0.021	2.8 (56)
Mar. 1882–May 1885	Jun. 1884	8.8	–14.0	0.008	0.9 (19)
Mar. 1887–Apr. 1888	No Panic	3.0	–9.0	0.005	0.4 (12)
Jul. 1890–May 1891	Nov. 1890	9.0	–34.0	0.001	0.4 (14)
Jan. 1893–Jun. 1894	May 1893	16.0	–29.0	0.017	1.9 (74)
Dec. 1895–Jun. 1897	Oct. 1896	14.3	–4.0	0.012	1.6 (60)
Jun. 1899–Dec. 1900	No Panic	2.78	–6.7	0.001	0.3 (12)
Sep. 1902–Aug. 1904	No Panic	–4.13	–8.7	0.001	0.6 (28)
May 1907–Jun. 1908	Oct. 1907	11.45	–46.5	0.001	0.3 (20)
Jan. 1910–Jan. 1912	No Panic	–2.64	–21.7	0.0002	0.1 (10)
Jan. 1913–Dec. 1914	Aug. 1914	10.39	–47.1	0.001	0.4 (28)

* Percentage change of ratio at panic date to previous year's average.

† Measured from peak to trough.

Data sources provided in Appendix.

Two fundamentally different types of theories have been advanced to explain banking panics. The first type of theory, in its traditional form (e.g., Noyes (1909), Gibbons (1968), Kindleberger (1978)), views panics as random manifestations of "mob psychology" or "mass hysteria" rooted in individual and collective psyches. The modern version of the theory that panics are random events is articulated by Diamond and Dybvig (1983), and Waldo (1985). In these models depositors' expectations about the value of deposits are linked to extraneous variables because of an exogenously

¹ Of the seven panics during the National Banking Era five involved suspension of convertibility (1873; 1890, 1893, 1907, 1914) and six involved the issuance of clearinghouse loan certificates (1873, 1884, 1890, 1893, 1907, 1914). During the Panic of 1895 issuance of the loan certificates was authorized, but none were actually issued. Clearinghouse loan certificates are explained in Gorton (1985B) and Gorton and Mullineaux (1986). This definition is much more precise than others which include the nebulous idea of "periods of financial stringency." See, for example, Sprague (1915) and Kemmerer (1910). To be clear, a *bank run* refers to a situation in which depositors at a *single* bank seek to exchange their deposits for currency. A *banking panic* refers to the situation in which depositors at *all* banks want to withdraw currency.

imposed first-come-first-served rule for bank repurchases of their deposits, in which case the return a depositor receives depends on his place in line at the bank. If the face value of the deposits is larger than the liquidation value of the bank's assets, and there is such a first-come-first served rule, then there exist panic equilibria in which the banking system collapses in panic. Hence, in the Diamond and Dybvig model, for example. "... anything that causes [depositors] to anticipate a run will lead to a run." Possible causes include "a bad earnings report, a commonly observed run at some other bank, a negative government forecast, or even sunspots" (p. 410). I will subsequently refer to these alleged panic-causing events as "sunspots."

The second type of theory advanced to explain panics argues that panics are systematically related to the occurrence of other events which change perceptions of risk. If there is an information asymmetry between banks and depositors because bank assets and liabilities are nontraded, for example, then depositors might not be able to accurately assess the risk of individual bank's liabilities. They may be forced to use aggregate information. There are three versions of this theory, differentiated by what the relevant aggregate information is taken to be. These theories are: (i) panics are caused by extreme seasonal fluctuations (referred to here as "the Seasonal Hypothesis"); (ii) panics are caused by the (unexpected) failure of a large (typically financial) corporation (referred to as "the Failure Hypothesis"); (iii) panics are caused by major recessions (referred to as "the Recession Hypothesis"). As discussed below, these three hypotheses are not mutually exclusive.

The view that panics are manifestations of seasonal "crises" or seasonal "stringency" was first put forth by Jevons (1884) with reference to England, and later, by Andrew (1906) and Kemmerer (1910) for the United States. Kemmerer identified the seasons when the money market was most "strained" as the periods of the "spring revival" (March, April, May), and the crop-moving period of the fall (September, October, November). He points out that, of the six panics prior to 1910 (the date his work was published), four occurred in the fall and two occurred in the spring. In each case, Kemmerer cites high interest rates, depressed stock prices, and the failure of specific firms as the seasonal effects precipitating panics. He concluded that "the evidence ... points to a tendency for the panics to occur during the seasons normally characterized by a stringent money market" (p. 232). Andrew (1906) expresses a similar view, and Miron (1985) presents a modern articulation of this traditional view.

The Failure Hypothesis cites the unexpected failure of a large, typically financial, institution as the immediate cause of panics.² The argument of the

² The failures cited by contemporary observers of panics and subsequent researchers are as follows: 1873: Jay Cooke and Co.; 1884: Grand and Ward; 1890: Decker, Howell and Co.; 1893: The National Cordage Co.; 1907: The Knickerbocker Trust Co.; 1914: the closing of the stock exchange. Details can be found in the *Commercial and Financial Chronicle* and in many secondary sources.

Failure Hypothesis appears to be that because of an information externality such failures created distrust in the future solvency of all banks, leading to withdrawals as depositors sought to avoid expected capital losses on deposits. Since there are many examples of failures of large firms which did not result in panics, a failure *per se* cannot be the cause of a panic. Writers arguing the Failure Hypothesis generally point to the economic context in which the failure occurs. In general, the economic context of the failure cited is a recession.

The Recession Hypothesis emphasizes that panics occurred as features of severe recessions, presumably because depositors expected large numbers of banks to fail during recessions. During the National Banking Era every major business cycle downturn was accompanied by a banking panic. During this period seven of the eleven cycles (in the NBER chronology) contain panics (see Table 1). Writers articulating the Recession Hypothesis include Mitchell (1941) and Fels (1959). Mitchell, for example, argues that, "when prosperity merges into crisis ... heavy failures are likely to occur, and no one can tell what enterprises will be crippled by them. The one certainty is that the banks holding the paper of bankrupt firms will suffer delay and perhaps a serious loss on collection" (p. 74). Like Mitchell, Fels (1959, p. 224) sees panics as "primarily endogenous" parts of the business cycle. Gorton (1985A, 1987A) presents a model of the Recession Hypothesis.

The central common element of all these theories of banking panics is the hypothesized existence of an information asymmetry between banks and depositors which creates the possibility of (information) externalities which change perceptions of the risk of bank deposits, sometimes to the point of panic (e.g., Diamond and Dybvig (1983), Gorton (1987A)). Different explanations of banking panics differ on what variables change perceived risk, but agree that because of the information asymmetry the banking system cannot respond by adjusting the rate of return on deposits. Instead, if there is a panic, the banking system responds to the change in perceived risk by suspending convertibility of deposits into currency rather than adjusting the rate of return. (See Gorton (1985A).) This is because, due to the information asymmetry and consequent externalities, either the change in perceived risk is unrelated to "fundamentals" or it is not possible to credibly raise the rate of return.

III. The deposit-currency ratio

The view that panics are random events places no testable restrictions on the data. Consequently, the basic strategy of analysis followed here is to empirically examine a description of depositor behavior and test whether this description explains depositor behavior at panic dates. In this section the model to be examined is discussed and the hypotheses to be tested are explained. As Miron (1986) points out, data limitations severely constrain the sophistication of models of panics which can be feasibly tested. This

section first presents some theoretical motivation for a subsequent, basically ad hoc, model which will be estimated.

Consider the behavior of a representative consumer who lives in a Baumol-Tobin economy where consumption goods must be purchased with currency and where "trips" to the bank are costly. Let the number of trips chosen be m_t ; let X_t be real consumption, and let p_t be the price level. Under the usual Baumol-Tobin assumptions, currency (C) and deposit holdings (D) during period t are defined as follows:³

$$C_t \equiv X_t(1/m_t)p_t; \quad D_t \equiv X_t(1 - 1/m_t)p_t;$$

$$\bar{C}_t = (\frac{1}{2})C_t; \quad \bar{D}_t = (\frac{1}{2})D_t;$$

These definitions follow Baumol-Tobin in imposing a binding cash-in-advance constraint on the consumer. For simplicity deposits are the only way of saving.

The representative consumer finances current consumption (X_t) and "trips" (m_t) with last periods' savings and income:

$$\text{MAX}_{m_t} : E_t \left\{ \sum_{i=t}^{\infty} \beta^{i-t} U(X_i) \mid I_t \right\} \quad (I)$$

subject to:

$$X_t + \alpha m_t \leq (1 - r_{dt-1} - \pi_{t-1}) \frac{\bar{D}_{t-1}}{p_t} + Y_{t-1}$$

where:

- α is the real cost of a trip;
- r_{dt-1} is the real rate of return promised *ex ante* by banks on an average balance deposit dollar held during $t-1$;
- π_{t-1} is the real capital loss on an average balance deposit dollar;
- Y_{t-1} is real income earned during $t-1$;
- β is the subjective rate of time preference;
- I_t is the information set available at time t .

The budget constraint requires current consumption and current "trip" costs to be financed by income earned (Y_{t-1}) and the return on savings, which is the realized return on the average deposits held last period (\bar{D}_{t-1}). Since the cash-in-advance constraint is assumed binding, choice of m_t determines current consumption and, simultaneously, choice of savings (through choice of \bar{D}_t).

The first order condition for problem (I) is:

$$\alpha U'_{X_t} = E_t \{ \beta U'_{X_{t+1}} (1 + r_{dt} - \pi_t) (\frac{1}{2}) (X_t) (1/m_t)^2 \mid I_t \} \quad (1)$$

³ The usual assumptions are that "trips" are evenly spaced and that deposits are only drawn down when currency balances are exhausted. See Tobin (1956). Notice, also, that it is without loss of generality that the possibility of writing checks, i.e., using deposits as a medium of exchange, is not allowed. This could be included without changing the basic equation.

which is a stochastic Euler equation. Similar equations have been extensively studied, e.g., Lucas (1978). In this case, solving (1) for m_t and using the above definitions, the relation is a money demand function.

Let utility exhibit constant relative risk aversion where A is the coefficient of relative risk aversion. Then, solving (1) for m_t and using the solution in the above definitions, the deposit-currency ratio is obtained:

$$\left[\frac{\bar{D}_t}{\bar{C}_t} + 1 \right]^2 = E_t \left\{ \beta \left(\frac{X_{t+1}}{X_t} \right)^{-A(\frac{1}{2})} \frac{X_t}{\alpha} (1 + r_{dt} - \pi_t) \mid I_t \right\} \quad (2)$$

Or, alternatively, letting $S_t \equiv \beta(X_{t+1}/X_t)^{-A(\frac{1}{2})}(1/\alpha)X_t$, the deposit-currency ratio can be expressed as:

$$\begin{aligned} \left[\frac{\bar{D}_t}{\bar{C}_t} + 1 \right]^2 &= E_t \{ S_t \mid I_t \} E_t \{ (1 + r_{dt} - \pi_t) \mid I_t \} \\ &\quad + \text{COV} (S_t; (1 + r_{dt} - \pi_t) \mid I_t) \end{aligned} \quad (3)$$

Equation (3) is the basic description of the deposit-currency ratio to be studied. In (3) the deposit-currency ratio is a function of expectations about the rate of return on demand deposits, the intertemporal terms-of-trade, S_t , and the covariance between the two. An important feature of (3) is the specification that the covariance is not time invariant. It depends on the depositor's information. The task is to determine the information on which the expected rate of return and covariance are conditioned, and what, if any, information variables can be identified as causing changes in either the expected rate of return or covariance, such that the deposit-currency ratio declines to the extent of panic. The model does not explain panics, but offers a simple way of embedding the previous discussed models in a single, testable, framework.

The empirical model

Equation (3) contains a number of unobservable parameters. In particular, A , α , and β are not observable. There are, also, severe data problems. For the nineteenth century, there are no data on the promised rate of return (r_{dt}), the capital loss (π_t), consumption, or demand deposits. Data on currency are incomplete. An additional problem is that the data are not evenly spaced, as explained below. In principle, equation (2) could be estimated using the method of moments (Hansen and Singleton (1982)), ignoring the data problems by using proxies and constructed data. The fact that no consumption data is available, and that the banking data is unevenly spaced seem particularly troublesome. The proxy for consumption data is pig iron production, discussed below. Nothing can be done about the uneven data spacing, except to insure that, as far as possible, data are at the same, if unevenly spaced, dates. Given these problems the moment condition, implied by (2), is likely to be misspecified.

These considerations lead to the empirical strategy adopted here. In particular, most of the analysis is conducted using nonparametric methods, after projecting various measures of the covariance and rate of return on possible information variables to get expected values. However, some *ad hoc* versions of equation (3) will also be analyzed. Given the use of pig iron production as a proxy for consumption, the resulting equation is best viewed as a reduced form. It is worth stressing, in defense of this approach, that since there are many ways of constructing the different variables required, the reasons why different combinations of constructed variables produce robust results are laid bare.

A basic version of the *ad hoc* model to be estimated is:

$$\left[\frac{\bar{D}_t}{\bar{C}_t} + 1 \right]^2 = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \alpha_3 (1 + r_{dt} - \pi_t^e) + \alpha_4 \text{COV}_t^e + \mu t \quad (4)$$

$$\alpha_3 \equiv \text{EXP} [\beta_1 \ln(X_{t+1}/X_t) + \beta_2 \ln X_t]$$

$$\begin{aligned} \pi_t &= \mathbf{Z}_t \boldsymbol{\gamma} + \varepsilon_t & \text{if } \mathbf{Z}_t \boldsymbol{\gamma} + \varepsilon_t > 0 \\ &= 0 & \text{if } \mathbf{Z}_t \boldsymbol{\gamma} + \varepsilon_t \leq 0 \end{aligned} \quad (5)$$

$$\begin{aligned} \text{COV}_t &\equiv (X_{t+1} - X_t) \pi_t = \mathbf{W}_t \boldsymbol{\delta} + u_t & \text{if } \mathbf{Z}_t \boldsymbol{\gamma} + \varepsilon_t > 0 \\ &= 0 & \text{if } \mathbf{Z}_t \boldsymbol{\gamma} + \varepsilon_t \leq 0 \end{aligned} \quad (6)$$

The total expected rate of return on demand deposits consists of two components, the "promised" component (r_{dt}) and the expected capital loss component (π_t^e). The promised component is known at time t because it is contractually agreed upon by banks and depositors *ex ante*. Since demand deposits never earn capital gains, the capital loss component (π_t), realized at the end of period t , is constrained, in (5), to be positive or zero. Hence, equation (5) will be estimated using Tobit methods. The expected capital loss, estimated from (5), then enters equation (4). In equation (5) \mathbf{Z}_t is a matrix of predictors of the capital loss.

Perceived risk is taken as the estimated value of COV_t from equation (6) and entered into equation (4).⁴ In an abuse of terminology, the representative depositor's conditional forecast of how consumption and losses on deposits will covary is indicated as "expected covariance," COV_t^e . As shown, the asymmetry of the contract, namely that $\pi_t \geq 0$, must be taken into consideration when estimating (6). Note that equation (6) forecasts only part of the covariance term, the expected product of the change in consumption and the capital loss. The term $1 + r_{dt}$ is not included, and the cross product of the means is not present. The cross product of the means of the change in consumption and the capital loss term can be computed

⁴ Joint estimation of the model, (4)–(6), is not econometrically feasible because of the truncation of (5), and the affect of that truncation on (6). Gorton (1987B) reports on some joint estimates of (4) and (6) when the truncation of (5)'s affects on (6) are ignored. No results, subsequently reported, seem to turn on this issue.

separately. This requires predicting X_{t+1} . Computing the covariance is difficult because of the data problems mentioned above. In fact, none of the relevant data are available. The basic strategy adopted in this paper is to compute a weighted capital loss, as in (6), as a proxy. While Gorton (1987B) contains many other results, results reported here all use variations of equation (6). In equation (6), \mathbf{W}_t is a matrix of predictors, possibly different from \mathbf{Z}_t .

Note that while next period's consumption, X_{t+1} , appears in (4), the model does not contain an equation predicting next period's consumption.⁵ As discussed below, pig iron production is used as a proxy for consumption. Pig iron production can be directly substituted for consumption. Or it may be reasonable to think of current pig iron production as the best estimate of next period's consumption. Subsequently, both possibilities are investigated.

Finally, equation (4) contains time trends because data limitations require that deposits be restricted to nationally chartered bank deposits, a declining fraction of total deposits (which include state banks).⁶

Data considerations

The covariance term is constructed as the weighted loss on deposits, where the weights are the difference in consumption. Pig iron production is used in place of consumption. In what follows a great deal of attention is focused on the covariance term so it is worth briefly discussing each of its components in detail.

Consumption data for the nineteenth century are not available at observation intervals of less than a year. The available annual data are constructed. One possibility would have been to distribute the annual series across months using related series. This would mean using related monthly series to distribute a constructed series. In fact, one of the few monthly series available is pig iron production. Consequently, the second possibility of using pig iron in place of consumption was chosen.

How reasonable a proxy is pig iron production? Berry (1978) presents constructed annual personal consumption expenditures in constant dollars (see Berry's Table 7B). Gallman has also constructed annual estimates of the value of goods flowing to consumers (in constant 1860 prices). Gallman's estimates are unpublished, but are described in Gallman (1966). The correlation between Berry's annual consumption series and the annual average pig iron production, i.e., the average of monthly values, is 0.9270. The correlation between Gallman's annual consumption series and the average annual pig iron production is 0.8877. If, instead of averaging monthly pig iron values to obtain an average annual value, the last value is used, then the correlations are 0.8600 and 0.8260 between pig iron and the

⁵ Subsequent reported results were not changed when next period's consumption was predicted with an ARIMA model.

⁶ The time trend squared is included because the dependent variable is squared.

Berry and Gallman series, respectively. Thus, pig iron production is a very good proxy for real consumption.⁷

There are no data on the capital losses on deposits. The proxy for actual capital losses during the pre-1914 period is the "loss on assets compounded or sold under order of court" for national banks placed in the hands of receivers (see Appendix). In other words, when a bank failed, court appointed receivers would liquidate the bank over a period of years (sometimes ten or so years). Each year in which an asset was sold at some amount below book value, a loss was recorded. This stream of losses was assigned to the date the bank was closed as the capital loss of deposits.

During a banking panic banks suspend convertibility of deposits into currency. Banks' liabilities, however, continued to circulate in the form of loan certificates and certified checks. (See Gorton (1985B) and Gorton and Mullineaux (1986).) During the period of suspension these bank liabilities exchanged at small discounts against government currency. These discounts represent losses to depositors during suspension periods. Below inclusion of such losses does not change any results.

Hypothesis testing using the model

The model, (4)–(6), will be used to test three types of hypotheses. First, are banking panics systematic events? The basic claim that panics are systematic events requires testing the hypothesis that the characterization of the deposit-currency ratio estimated using all nonpanic observations (significantly) holds at the panic dates. If panics are random events caused by extraneous events such as sunspots, then the behavior of the deposit-currency ratio at panic dates should *not* be described by relations which hold at other dates. *From this point of view, economic theories of causal relations are not at issue.* Rather, the question is whether a set of correlations which significantly hold at nonpanic dates also hold at panic dates. If the correlations hold at panic dates, panics will be described as *systematic* events.

A stronger type of claim concerns hypothesized economic behavior, the second type of claim to be examined. In particular, are banking panics predictable? The above model is one of risk averse depositors who seek to optimally smooth consumption intertemporally. The model hypothesizes that losses on deposits which come during periods when depositors want to dissave will be given a lot of weight in utility terms. On the other hand, losses on deposits which occur during periods of rising consumption will be given little weight in utility terms. With respect to panics, if depositors expect a coincidence of declining consumption and high capital losses on

⁷ Data on pig iron production apparently doesn't exist beyond the series reported in Macaulay (1938). His last observation is dated January 1936. *Historical Statistics of the United States*, however, reports a series on pig iron shipments. The correlation between pig iron shipments and total real consumption over 1929–1970 is 0.7360.

deposits, then they will seek to withdraw deposits in advance of those periods. They do this in order to avoid the capital loss which they expect to occur during the period in which they expect to dissave. In other words, panics should not only be systematic, but should be *associated with movements in perceived risk predictable on the basis of prior information*. This hypothesis then requires that the predictors of COV_t not include contemporaneous information (unlike the first claim, above). In this case, panics will be said to be *predictable*.

The third, and final, type of claim concerns what is contained in the information set upon which expectations are conditioned. What type of news causes panics? If panics are systematic, and perhaps predictable, then which of the variables predicting π_t and COV_t are important at all points in time and, *if important at all points in time, which are important at panic dates*? In other words, conditional on panics being, at least, systematic, which of the predictors of the capital loss, π_t , and risk, COV_t , are important at panic dates. *Notice that this excludes predictors which are important at panic dates, but not at other dates*. This restriction, then, tests for "sunspots," if "sunspots" are events which do not occur at all dates. Below, however, the first two claims are re-examined by checking whether predictors found to be unimportant as predictors of COV are important at panic dates.

The three hypotheses that panics are predictable are given empirical form by including in the Z_t and W_t matrices of (5) and (6) variables (and lags) capturing seasonal effects, failures, and recessions. These variables are taken to be exogenous, and, in fact, are exogenous by Granger-causality tests (see Gorton (1987B)). The seasonal Hypothesis is represented by the rate of interest on commercial paper (from Macaulay (1938)). Short-term interest rates had strong seasonals during the pre-Fed period (e.g., Kemmerer (1910), Sargent (1971), Shiller (1980)). The inclusion of short-term interest rates is intended to capture the notion of "seasonal stringency" or "seasonal crisis." The Recession Hypothesis is represented by a leading economic indicator, liabilities of failed nonfinancial businesses.⁸

The Failure Hypothesis emphasizes the unanticipated failure of large, usually financial, institutions. This notion is the hardest to quantify. The Failure Hypothesis is represented by unanticipated capital losses on deposits, i.e., the residuals from the Tobit estimation of capital losses (see Gorton (1987B)). This measure seems close to what the failure hypothesis maintains, but it limits attention to national banks and ignores completely the idea that the failure of specific institutions is what counts.

The variables chosen to capture the content of each hypothesis are not pure representations. All three hypotheses, for example, involve business

⁸ The liabilities of failed businesses led peaks by one cycle phase, and led troughs by two cycle phases (Burns and Mitchell (1946)). Neftci (1979) has shown how the predictive ability of leading indicators can be evaluated by applying a test for Granger causality. By such a test the liabilities of failed businesses does not lead pig iron production, but does lead the risk measure.

failures, and short-term interest rates reflect more than seasonals. To some extent these effects can be disentangled. Failed business liabilities and short-term interest rates can be deseasonalized. It is, therefore, possible to test whether failed business liabilities have an impact on the risk measure independent of seasonal movements. Similarly, it is possible to test for effects of interest rates independent of seasonals.

IV. Analysis of the national banking era

The National Banking Era (1865–1914) is examined first because this period preceded the existence of the Federal Reserve System and the Federal Deposit Insurance Corporation, two institutions which may be expected to affect depositor behavior. During the National Banking Era national (though not state) banks were required to report a variety of information to the Comptroller of the Currency five times a year. The *Comptroller Reports* provide most of the data to test the hypotheses of the previous section.

An important drawback to using the *Comptroller Reports* is that information was recorded five times a year (at “call dates”). These reporting dates were not the same every year, but fell in different months. The observations, then, are not evenly spaced.⁹ *In what follows the data are treated as if they were evenly spaced.* Also, the information is limited to national banks. All data are described in the appendix. The fact that virtually every series is constructed or proxied has some potentially important implications discussed in particulars later.¹⁰

The first step in estimating the model of the currency-deposit ratio is estimation of the capital loss on deposits, equation (5), the fitted value of which enters equation (6). The expected capital loss series is the predicted value from an equation estimated using Tobit analysis due to the truncated distribution of π_t . The equation used in what follows contains a constant term, two lags of the capital loss, the contemporaneous and nine lags of the liabilities of failed businesses, and the contemporaneous and four lags of both pig iron production and the interest rate on commercial paper. The results are not sensitive to specification of this equation and details may be found in Gorton (1987B). In fact, subsequent results are not changed significantly, if, instead of predicted values of the capital loss, actual future capital losses are used. *The reason is that panics are not associated with spikes in the capital loss series. There are many dates at which capital losses are much higher!* There is, thus, prior evidence that the timing of the capital

⁹ This was precisely the intention of the Comptroller, who while monitoring banks attempted to keep the call dates from being predictable.

¹⁰ The fact that virtually every data series is constructed, proxied, or interpolated raises a large number of issues and makes the possible combinations of estimates very large. Many of the issues are discussed in Gorton (1987B) which is a large companion appendix to this text. In the text here only the sensitive issues are discussed.

losses with respect to changes in consumption, and not just the level of losses, is important.

Estimates of perceived risk

The results of estimating equation (6) are all contained in Gorton (1987B). Here those results are summarized. Subsequently, predicted values of COV_t will be used so the importance of equation (6) lies in what variables are important predictors of perceived risk (COV_t). In this regard, the results are basically robust to how COV_t is defined, and to whether data are deseasonalized or not.¹¹ The best fits are achieved with ten lags of COV , nine lags of the liabilities of ailed nonfinancial businesses, and four lags of the commercial paper rate.¹² The R -squared's are all in the range of 0.30. (Estimated coefficients, unimportant for purposes here, can be found in Gorton (1987B).¹³)

¹¹ Recall that since pig iron is being used as a proxy for consumption, as discussed in the main text, there is the question of the appropriate empirical definition of COV_t . Recall that throughout we are restricting attention to definitions in which the cross product of the means component of COV is ignored. Possible definitions are: (1) $COV_t = (X_{t+1} - X_t)(r_{dt} - \pi_t)$; (2) $COV_t = (X_{t+1} - X_t)\pi_t$; (3) $COV_t = (X_t - X_{t-1})(r_{dt} - \pi_t)$; (4) $COV_t = (X_t - X_{t-1})\pi_t$. The main text argued that the last definition is the appropriate definition. The results discussed in the text are basically robust to which definition is used, though the R^2 in the case of the third definition is more than twice the other cases, whether data are deseasonalized or not, and whether contemporaneous predictors are included or not. The high R^2 does not occur in the case of definition (2), though definitions (1) and (2) give similar results. The likely reason is the way r_{dt} was constructed. See Gorton (1987B) for the full set of results.

¹² When tests for whether panics are systematic events, as defined in the main text, contemporaneous values of the liabilities of failed businesses and the commercial rate are also included. Contemporaneous values are excluded when analyzing whether panics are predictable on the basis of prior information.

¹³ A typical example is as follows:

$$\begin{aligned}
 COV_t = & 0.004 + 0.049COV_{t-1} - 0.185COV_{t-1} + 0.006COV_{t-3} \\
 & (0.002) (0.074) \quad (0.074) \quad (0.073) \\
 & + 0.074COV_{t-4} - 0.102COV_{t-5} + 0.089COV_{t-6} + 0.001COV_{t-7} \\
 & (0.070) \quad (0.070) \quad (0.070) \quad (0.070) \\
 & + 0.020COV_{t-8} + 0.013COV_{t-9} - 0.128COV_{t-10} - 1.44BLIA_t \\
 & (0.070) \quad (0.068) \quad (0.067) \quad (1.56) \\
 & - 4.34BLIA_{t-1} + 1.09BLIA_{t-2} - 7.33BLIA_{t-3} - 1.1BLIA_{t-4} \\
 & (1.7) \quad (1.8) \quad (1.81) \quad (1.79) \\
 & + 2.9BLIA_{t-5} - 2.2BLIA_{t-6} + 3.46BLIA_{t-7} - 2.77BLIA_{t-8} \\
 & (1.77) \quad (1.77) \quad (1.77) \quad (1.76) \\
 & + 4.81BLIA_{t-9} - 0.011COMP_t - 0.105COMP_{t-1} \\
 & (1.67) \quad (0.025) \quad (0.027) \\
 & + 0.091COMP_{t-2} - 0.057COMP_{t-3} + 0.041COMP_{t-4} \\
 & (0.028) \quad (0.028) \quad (0.027)
 \end{aligned}$$

$$R^2 = 0.28; \quad SSE = 0.0026; \quad F = 2.89; \quad df = 186.$$

BLIA = Liabilities of failed businesses; COMP = interest rate on commercial paper. This example uses nondeseasonalized data.

In all cases, the liabilities of failed businesses variables, deseasonalized or not, are always jointly significant. When short-term interest rates are added to the equation, the liabilities variables, deseasonalized or not, remain jointly significant. Seasonality, as captured by the interest rate variables are always jointly significant. But, notably, when the interest rate on commercial paper is deseasonalized, the interest rates are not jointly significant!

Unanticipated capital losses (representing the Failure Hypothesis) do not appear in any of the final equations used because this variable and lagged values were never jointly significant. There is the possibility that the failure of a single institution occurring in conjunction with business failures is what is important, but attempts to separate these effects did not improve the predictive power of the equation.¹⁴

It is perhaps important to point out that the information used to predict COV and capital losses on deposits separately was available to agents living during the National Banking Era. The liabilities of failed businesses were published as were interest rate data. In addition, the telegraph, invented in the 1840s, had spread nationwide by the National Banking Era.

Test results for the deposit-currency ratio equation

The main results of interest are estimates of the nonlinear deposit-currency ratio equation, (4), using predicted perceived risk measures, and expected capital loss measures from the Tobit procedure. Table 2 presents a sample of the results. Table 2 considers a variety of different COV predictions. In Table 2, rows (1), (2) and (5) use nondeseasonalized data to predict COV; the remaining rows use deseasonalized data. Rows (1)–(4) use contemporaneous variables, as well as lags, to predict COV; rows (5) and (6) only use lagged variables.¹⁵

Consider the first hypothesis to be examined: that panics are systematic events. Table 2 addresses this issue by including a dummy variable for the panic dates. If the estimated model cannot explain panics then the dummy variable should be significant. But, the dummy is not significant.¹⁶ The implication is that nothing is happening at panic dates which is not being explained by the model. This conclusion is very strong. It does not depend

¹⁴ The contemporaneous liabilities of failed businesses, proxying for both effects, would be mismeasured. OLS estimates, columns (1), (2), and (4), would then be biased and inconsistent. Columns (3) and (5) address this potential problem by using instrumental variables. The instruments were the current value and four lags of loans and discounts at national banks and the current value and four lags of Frickey's Index of Production for Transportation and Communication. (See Gorton (1987B) for details.) Inspection of Table 2 does not reveal any important differences when the instruments are used, but subsequently the Failure Hypothesis is reexamined, and the measures of perceived risk estimated using instruments.

¹⁵ Rows (1) and (3) use instruments to predict COV, as discussed above in footnote 14.

¹⁶ The dummy variable is set to one at the panic dates and zero otherwise. The panic dates in the data are: December 26, 1873; June 20, 1884; December 19, 1890; July 12, 1893; October 6, 1896; December 3, 1907; September 12, 1914. The results are not sensitive to perturbations of these dates. The dummy variable was not significant in any functional specification attempted. In a log-linear deposit-currency ratio equation, reported on in Gorton (1987B), dummies for the individual panic dates were never significant, individually or as a group. The nonlinear estimation procedure would not converge when individual panic dummies were included.

TABLE 2
Deposit-Currency Ratio Test Results, 1870-1914

	$\left[\frac{D_t}{C_t} + 1\right]^2 = \alpha_0 \text{Dummy} + \alpha_1 + \alpha_2 t + \alpha_3 t^2 + \text{Exp}[\alpha_4 \ln(X_{t+1}/X_t) + \alpha_5 \ln X_t](1 + r_{dt} - \pi_t^e) + \alpha_6 \text{COV}_t^e$								
	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2	σ
1)	0.6349 (0.5731)	3.74 (0.151)	-0.0084 (0.0029)	0.0002 (0.00002)	-0.1971 (0.2619)	0.9789 (0.0304)	85.99 (19.89)	0.9686	0.4681
2)	0.5495 (0.5530)	3.737 (0.15)	-0.0081 (0.0029)	0.0002 (0.00002)	-0.1901 (0.2601)	0.982 (0.0303)	110.34 (24.26)	0.9689	0.4660
3)	-0.4526 (0.5044)	3.689 (0.1555)	-0.0079 (0.0030)	0.0002 (0.00002)	-0.066 (0.2668)	0.9881 (0.0303)	53.15 (21.14)	0.9668	0.4820
4)	-0.5260 (0.4918)	3.696 (0.1534)	-0.0076 (0.0029)	0.0002 (0.00002)	-0.0849 (0.2623)	0.9882 (0.030)	87.35 (27.61)	0.9673	0.4778
5)	0.3765 (0.5485)	3.729 (0.15485)	-0.0080 (0.0029)	0.0002 (0.00002)	-0.1440 (0.2612)	0.9831 (0.0303)	101.69 (24.42)	0.9684	0.4690
6)	-0.7739 (0.4888)	3.712 (0.1553)	-0.008 (0.003)	0.0002 (0.00002)	-0.0315 (0.2661)	0.9844 (0.0307)	90.93 (30.68)	0.9671	0.4792

Standard errors are in parentheses. Dummy = 1 at panic dates and zero otherwise.

on the definition of COV, on whether data are deseasonalized, on whether contemporaneous predictors of COV are used, or on the functional specification of the deposit-currency equation. (See Gorton (1987B).)

The evidence is also strong that panics are predictable on the basis of prior information. In Table 2, the perceived risk variable is significant in all equations. In particular, it is significant when the contemporaneous predictors of COV are omitted as in rows (5) and (6). This means that if, on the basis of prior information, COV_t^e is negative, then depositors shift from deposits to currency in order to avoid the capital loss which they expect to occur when consumption is declining.¹⁷ This conclusion is slightly sensitive to the definition of COV_t .¹⁸

The final caveat concerns the functional form of the deposit-currency ratio equation in the face of the multitude of data assumptions that have been made. Unfortunately, because of the presence of the time trends in the deposit-currency equation, White (1981, 1982) specification tests are inappropriate.¹⁹ The results here are robust to a number of other specifications, however. (See Gorton (1987B).)

¹⁷ There is an important data timing problem, discussed subsequently in the main text, which slightly colors these results. The quarterly liabilities of failed businesses observations were assigned to the nearest call date (and the missing value estimated) because of seasonals. In order to avoid mixing up seasons, the resulting series sometimes assigns future values to the current date and sometimes past values. This means that, strictly speaking, including the contemporaneous business liabilities variable as a predictor of COV_t is not inconsistent with the hypothesis that panics are predictable on the basis of prior information.

¹⁸ In particular, when r_{dt} is included, the perceived risk measure is not significant. See Gorton (1987B).

¹⁹ One possible way to circumvent the problem is to first detrend the data and then test the functional specification. This biases the test in favor of rejection since the White test is now testing the joint hypothesis of correct specification of the detrending function and correct specification of the deposit-currency ratio equation. Gorton (1987B) reports the results of this procedure. In general, the joint hypothesis of correct specification is not accepted.

Considering the multitude of assumptions about data construction, variable definition, and specification of functional form, and the fact that many of the usual tests cannot be conducted, the robustness of the results is, perhaps, more suspect than usual.²⁰ Nevertheless the robustness of the results is worth stressing. It seems difficult to argue that there is something special about panics in the sense that the above specification of consumer behavior does not capture behavior during panics. However, the next section re-analyzes the data by concentrating on the panic dates, and avoiding, at least, the specification of the deposit-currency ratio equation. In that sense, the tests in the next section are nonparametric. Such tests also allow for a more precise, and intuitive, sense of what is happening during a banking panic.

V. The timing and severity of panics

In this section the actual panic dates are the focus of attention. By focusing on the panic dates it is possible to identify anything “special” which may have occurred. To confirm the above hypotheses, it should be the case that the special event is a large change, a spike, in a variable predicting COV, which in turn, causes a change in the deposit-currency ratio. The special event is the arrival of information which causes depositors to reassess the riskiness of deposits, and to withdraw currency from banks as a consequence. In this section, the channel of causation is analyzed. It is shown that panics did correspond to spikes in the predictors of deposit riskiness, but in a rational way.

The hypotheses that panics are systematic and predictable have testable implications for the timing and severity of panics. With respect to the timing of panics, the hypotheses imply that *at the panic dates* there should be specific, identifiable, movements in the predictors of risk which result in movements in perceived risk and, hence, in the deposit-currency ratio. *Movements in the predictors at panic dates should imply that the perceived risk variable achieves some critical (negative) value at the panic dates. Also, the movements in the risk predictors and in perceived risk should occur at*

²⁰ Entering the perceived risk measure into the deposit-currency ratio equation imposes a set of restrictions on the manner in which the predictors of the risk measure are allowed to influence the deposit-currency ratio. If the measure of perceived risk is appropriate, then the imposition of the restrictions should not significantly worsen the fit of the deposit-currency ratio equation. It is well-known that such cross-equation restrictions can be tested (e.g., Barro (1981)). In effect, the test is for whether there is additional information in the predictors of COV, which affects the deposit-currency ratio through some channel other than perceived risk. Unfortunately, this type of test is inappropriate here because it is not possible to impose the restriction that $\pi_t \geq 0$, i.e., that there are no capital gains to deposits. That is, the truncated value of COV, shown in (6), cannot be imposed. Gorton (1987B) discusses this issue in greater detail and conducts some experiments concerning its importance. It turns out to be important, so the cross-equation restriction tests are not conducted.

panic dates and not at other dates. If such movements occurred at other dates, then there should have been panics at those dates.²¹

At the panic dates the magnitudes of the movement of variables can be tested. In effect, the flow of information through the channel of perceived risk at panic dates can be tested. If the information in the predictors of risk is accurate, then the severity of the panic should be related, through the perceived risk measure, to measures of the information content of the predictors. The larger the movement in the predictors, and hence the larger the movements in perceived risk, the larger should be the movements in the deposit-currency ratio.

In addition, if the movements in the predictors are accurate, then the size of these movements, and the associated movements in perceived risk, should be statistically related to the magnitude of downturns in income, rises in capital losses, and the risk measure. The size of the movement in the deposit-currency ratio should be related, through the channel of perceived risk, to the size of income declines and to capital losses. Each of the three hypotheses about what the relevant predictive information is can be examined with respect to the above implications for the predictors of risk.

Tests of timing relations

At a panic date the perceived risk variable should achieve a critical or threshold value not achieved at other dates. Using five different measures of perceived risk, Table 3 lists the number of times the perceived risk measure achieved a lower value *before* the panic date (i.e., previous business cycle peak to panic date) and after the panic date (i.e., panic date to subsequent business cycle trough).²² As a reference, the first column of the table lists the number of data points between the previous peak and the panic date (labelled "before") and between the panic date and the subsequent trough (labelled "after"). The results are quite striking: negative spikes in the perceived risk measures tend to occur at panic dates.

Is there a threshold value of perceived risk which, when reached, results in a panic? The evidence, while sensitive to the perceived risk measure, supports the existence of such a critical value. In the case of the first perceived risk measure, $COV_t^r(1)$, for example, there are a total of four values lower (i.e., "more" negative) than those occurring at the panic

²¹ This statement, however, is subject to an important caveat. Following panic dates deposits may be perceived as even riskier, as depositors get more information, but depositors have already withdrawn their deposits, the banking system has suspended convertibility, or depositors have converted their deposits into clearinghouse loan certificates. On clearinghouse loan certificates see Gorton (1985B), Gorton and Mullineaux (1986), and Cannon (1910).

²² The five measures of perceived risk all define $COV_t = (X_t - X_{t-1})\pi_t$, where X_t is pig iron production at date t , and π_t is the capital loss on deposits at date t . See footnote 11. All the equations use the lags of COV, nine lags of the liabilities of failed businesses, and four lags of the commercial paper rate. In Table 3, $COV_t^r(1)$, $COV_t^r(2)$, and $COV_t^r(3)$ use nondeseasonalized data, $COV_t^r(4)$ and $COV_t^r(5)$ use deseasonalized data. $COV_t^r(5)$ was estimated jointly with the deposit-currency ratio equation. The estimated equations are provided in Gorton (1987B).

TABLE 3
Timing of Measures of Perceived Risk†

<i>Panic of</i>	<i># Data Points</i>		$COV^e_i(1)$		$COV^e_i(2)$		$COV^e_i(3)$		$COV^e_i(4)$		$COV^e_i(5)$	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
1873	0	26	0	0	0	0	0	0	0	2	0	0
1884	13	4	3	1	6	3	1	1	1	1	1	1
1890	2	2	0	1	1	1	0	0	1	1	0	0
1893	2	4	0	1	0	1	0	1	0	1	0	0
1896	4	3	0	0	0	1	0	0	0	0	0	0
1907	2	2	0	1	0	1	0	0	0	0	0	0
1914	8	2	1	1	2	1	0	0	0	0	0	0

† The five measures, $COV^e_i(1)$, $COV^e_i(2)$, etc., are defined in footnote 22.

* Number of times the perceived risk measure is lower, i.e., "more negative," than the value at the panic date, from previous peak to panic date (Before), and from panic date to subsequent trough (After).

dates, three associated with the Panic of 1884. $COV_i^e(2)$ also has some problem with the Panic of 1884. The last three perceived risk measures indicate that spikes do, indeed, tend to occur at the panic dates. It is rare for there to be a spike in the perceived risk variable before or after the panic.

What causes the large negative values or spikes in the perceived risk measure at panic dates? Do these spikes correspond to identifiable movements or spikes in the predictor variables? In order to test these implications for the three hypotheses, measures of the information content of the (contemporaneous) predictors of perceived risk are needed. Three measures of the liabilities of failed businesses are used in subsequent tests. The first measure attempts to capture the new information in the liabilities of failed businesses, movements in the variable not predictable on the basis of prior information (its own history). This measure is unanticipated changes in the liabilities of failed business (UNLIA), measured by the residuals from an estimated ARIMA model (see Gorton (1987B)). The second measure is the cyclic component of the liabilities of failed businesses series (CCBUS), measured as the log of the observation minus the mean of the logged series. The third measure, using deseasonalized data, is the observation minus the mean of the series (DECC).

The commercial paper rate is examined by looking at deviations from seasonals. In other words, at panic dates the observed rate of interest should be higher than the expected seasonal movement. Such a deviation is intended as a measure of "seasonal stringency." The unanticipated losses on deposits, intended to capture the Failure Hypothesis, are also re-examined.

First, the timing of movements in the liabilities of failed businesses predictor is examined. Table 4 lists the largest positive values of unanticipated increases in the liabilities of failed businesses (UNLIA) and the largest positive values of the cyclical component of liabilities of failed businesses (CCBUS for nondeseasonalized data; DECC for deseasonalized data). *In each case there are no positive shocks larger than those listed in the table.* For each measure of the information in the liabilities variable, the values listed are equal to or higher than the lowest value at a panic date.

The results in Table 4 are striking: panics tend to correspond to the largest values of the liabilities shocks. By the CCBUS measure, every time a shock greater than or equal to 0.8264 occurred after a business cycle peak, there was a panic. Also, the panics correspond to the first large shock following the latest business cycle peak. There are some exceptions. For example, by the UNLIA measure, the shock in November 1887 did not cause a panic, while a smaller one did in June 1884.²³

²³ The Panic of 1895–96 was the mildest panic of those discussed and constitutes a borderline case. The New York Clearing House Association authorized the use of loan certificates on December 23, 1895, but no member banks applied for them. In late August 1896 the loan certificate process was again activated in response to panic conditions. (See New York City Clearing House Loan Committee *Minutes*.) The *Commercial and Financial Chronicle* describes September to December 1895 and December 1896 as "panicky periods". Spikes in the liabilities variable in October 1896 would then be accurate since December 1896 is not a data point.

TABLE 4
Timing of Liabilities of Failed Businesses Shocks

<i>NBER Chronology Peak Trough</i>	<i>Largest Values of UNLIA</i>	<i>Largest Values of CCBUS</i>	<i>Largest Values of DECC</i>	<i>Panic Date</i>
Oct. 1873–Mar. 1879	(Sep. 1873:1.1474) Dec. 1873:1.5028 (Feb. 1874:1.272)* (Oct. 1878:0.7587) (Oct. 1883:0.782)	Dec. 1873:1.4012 (Feb. 1874:1.1511) (Mar. 1878:0.9397)	Dec. 1887:0.08187 (Feb. 1874:0.05181)* Jun. 1878:0.04086)	Dec. 1873
Mar. 1882–May 1885	Jun. 1884:1.0535	Jun. 1884:0.9653	Jun. 1884:0.07631	Jun. 1884
Mar. 1887–Apr. 1888	Nov. 1887:1.307	Nov. 1887:0.8223		No Panic
Jul. 1890–May 1891	Dec. 1890:1.1249	Dec. 1890:1.0216	Dec. 1890:0.03956	Dec. 1890
Jan. 1893–Jun. 1894	Jul. 1893:1.4340	Dec. 1893:1.3323	Jul. 1893:0.11365 (Jul. 1895:0.03313)	Jul. 1893
Dec. 1895–Jun. 1897	Oct. 1896:0.8780	Oct. 1896:0.8264	Jul. 1896:0.03255 (Jul. 1897:0.03579) Jun. 1900:0.03383	Oct. 1896
Jun. 1899–Dec. 1900				No Panic
Sep. 1902–Aug. 1904				No Panic
May 1907–Jun. 1908	Dec. 1907:0.8712 (Feb. 1908:0.8763)*	Dec. 1907:0.9308	Dec. 1907:0.03183	Dec. 1907
Jan. 1910–Jan. 1912	Mar. 1910:1.041	Mar. 1910:0.8236 (Apr. 1913:0.8736)	Jun. 1911:0.03615 (Jun. 1913:0.0482)	No Panic
		(Jan. 1914:0.8618)	(Mar. 1914:0.0396)	
		(Jun. 1914:1.1558)	(Jun. 1914:0.0940)	
Jan. 1913–Dec. 1914	Mar. 1914:0.7545	(Jun. 1914:1.1558) Sep. 1914:0.9958 (Dec. 1914:0.9863) (Mar. 1914:0.9535)	Sep. 1914:0.0434 (Dec. 1914:0.0986)	Sept. 1914

*During suspension.

The deviation of the commercial paper rate from its seasonals is positive at all the panic dates, but there are *larger* deviations at many other dates. In fact, at 33 nonpanic dates there are positive deviations higher than the lowest positive deviation at a panic date. Nor is there any particular (e.g., business cycle) pattern to the seasonal shocks. This evidence suggests that seasonality in interest rates is not important for panics, though it is important for movements in perceived risk and, hence, the deposit-currency ratio over the whole cycle.

The results for unanticipated losses on deposits are similar to those for seasonal deviations in the commercial paper rate. At three of the panic dates there were no unanticipated losses on deposits. At eight nonpanic dates the unanticipated losses were higher than the *highest* unanticipated loss at a panic date. There are many cases of positive unanticipated losses, with no apparent pattern. By this measure the Failure Hypothesis again seems unimportant. The timing evidence with respect to the predictors of perceived risk suggests that for panics the liabilities of failed businesses is the important variable. Banks hold claims on firms, and when firms begin to fail in sufficiently large numbers, it signals the onset of a recession and a panic is likely to occur.

Remarkably, the data support the notion of a critical or threshold value of the liabilities of failed businesses variable, and a threshold value of the perceived risk measure, at the panic dates. The seemingly anomalous event of a panic appears to be no more anomalous than recessions.

Severity tests

While strongly suggestive, the timing of variables discussed above does not constitute a test. However, Spearman's rank correlation coefficient can be used to test the implications of the systematic hypothesis for timing and severity. The rank correlation test is important because it can check that the above hypotheses explain panics when the data are unconstrained by nonpanic relations. The test is conducted by ranking the measures of the information content of the predictors, the perceived risk measures, the currency-deposit ratio, measures of the severity of recessions, and measures of losses on deposits. The Spearman rank correlation coefficient can then be used to test whether the correlations between the movements of these variables *at the specified dates* are significant.

The results are presented in Table 5. The Spearman rank correlation coefficients are shown for seventeen variables which were ranked at eleven dates.²⁴ The first three variables are measures of the severity of the eleven

²⁴ Seven of the dates were the panic dates. The remaining four dates correspond to the remaining four business cycles during the National Banking Era. These four dates were selected according to the largest spikes in the measures of the information in the liabilities variable. The dates used were: December 26, 1873; June 20, 1884; October 5, 1887; December 19, 1890; July 12, 1893; October 6, 1896; June 29, 1900; January 22, 1904; December 3, 1907; March 29, 1910; September 12, 1914.

TABLE 5
Spearman Rank Correlation Coefficients

	Eckler (Overall)	Eckler (Pig Iron)	Achinstein (Amplitude)	% ΔM	% $\Delta \frac{C}{D}$	UNLIA	CCBUS	DECC	Losses	Total Losses	Post-panic Losses	RES	DECOMP	COV ^e (1)	COV ^e (2)	COV ^e (3)	COV ^e (4)
(1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(2)	0.90		0.818	0.564	0.609	0.888	0.618	0.582	0.818	0.935	0.913	0.782	0.445	0.636	0.591	0.718	0.636
(3)			0.827	0.50	0.755	0.867	0.668	0.527	0.627	0.909	0.873	0.605	0.455	0.70	0.618	0.691	0.60
(4)				0.65	0.632	0.877	0.682	0.609	0.782	0.944	0.914	0.536	0.591	0.709	0.618	0.645	0.536
(5)					0.564	0.862	0.736	0.755	0.691	0.818	0.764	0.482	0.464	0.445	0.336	0.445	0.409
(6)						0.872	0.70	0.273	0.391	0.914	0.879	0.282	0.727	0.836	0.755	0.773	0.682
(7)							0.65	0.491	0.605	0.956	0.962	0.268	0.482	0.591	0.555	0.536	0.436
(8)								0.673	0.545	0.949	0.91	0.345	0.482	0.809	0.673	0.673	0.60
(9)									0.436	0.60	0.509	0.345	0.264	0.518	0.30	0.355	0.345
(10)										0.791	0.782	0.682	0.527	0.627	0.573	0.664	0.727
(11)											0.989	0.473	0.718	0.759	0.736	0.755	0.709
(12)												0.382	0.627	0.636	0.664	0.645	0.645
(13)													0.355	0.491	0.364	0.582	0.391
(14)														0.855	0.891	0.818	0.80
(15)															0.918	0.882	0.827
(16)																0.982	0.873
(17)																	0.855

The rank correlation can range from -1 (completely uncorrelated) to +1 (perfectly correlated). The correlation is significant at the 5% level if the calculated coefficient is higher than 0.553, and at the 1% level if the calculated coefficient is higher than 0.684.

Columns (1)-(3) are measures of the severity of the eleven recessions during the National Banking Era. Column (1) is an overall measure from Eckler (1933). Column (2), also from Eckler (1933), is a measure based only on pig iron production. Column (3) is a measure of the amplitude of each cycle from Achinstein (1961). Columns (4) and (5) are the percentage changes in the money stock and currency-deposit ratio from the selected date through the trough. Columns (6), (7), and (8) are the measures of the liabilities variable, UNLIA, CCBUS, and DECC, respectively. Column (9) is the loss per deposit dollar at the selected date, while column (10) is the loss per deposit dollar from peak through the trough (Total Losses). Column (11) is the loss per deposit dollar from selected date through the trough (Post-panic Losses). Column (12) is the unanticipated loss on deposits measure (RES). Column (13) is the deviation from the seasonal for the rate of return on commercial paper (DECOMP). Columns (14)-(17) are four measures of perceived risk. (See footnote 26.)

recessions during the National Banking Era. Columns (4) and (5) are the percentage changes in the money stock and currency-deposit ratio for the selected dates through the subsequent recession.²⁵ Columns (9)–(11) are measures of losses on deposits. Columns (14)–(17) are four measures of perceived risk.²⁶ The notes to the table explain the other variables.

The results in Table 5 broadly confirm the earlier conclusion that panics are systematic. The nondeseasonalized measures of failed business liabilities (UNLIA, CCBUS) are significantly correlated with the measures of risk which do not use deseasonalized data (COV^e(1), COV^e(2)). The cyclical component, CCBUS, is significantly correlated with all the measures of perceived risk.²⁷ The deviations of the commercial paper rate from its seasonals (DECOMP) are significantly correlated with all the measures of perceived risk, though not with any measure of the liabilities variable. The unanticipated losses on deposits (RES) are correlated with one measure of perceived risk, COV^e(3).

The business cycle aspect of panics is also revealed again. The percentage change in the currency-deposit ratio is significantly correlated with all the measures of perceived risk. Both the currency-deposit ratio and the perceived risk measures are significantly correlated with the measures of recession and losses on deposits.

The results of this section confirm the earlier conclusion that panics are systematic. The stronger hypothesis that panics are predictable is problematic. Causal inferences would be stronger if it could unambiguously be stated that panics are predictable on the basis of *prior* information, rather than on the basis of contemporaneous information. But there is an important data timing problem. The quarterly liabilities of failed businesses observations were assigned to the nearest call date (and the missing value estimated) because of seasonals. The resulting series then sometimes assigns future values to the current date and sometimes past values.²⁸ If the contemporaneous value of the liabilities variable is omitted in equations (5)

²⁵ Results are unaffected if percentage changes are computed from peak to trough.

²⁶ The four measures of perceived risk correspond to the first four measures described in footnote 22. Gorton (1987B) contains similar results using other measures of perceived risk.

²⁷ Notice, however, that seasonality in the liabilities variable seems important. The nondeseasonalized measure (UNUA, CCBUS) are significantly correlated with the measures of risk, but the deseasonalized liabilities measure (DECC) is *not* significantly correlated with any of the perceived risk measures.

²⁸ Three dates are relevant: the actual date of the panic; the dating of the Comptroller's Reports; the assignment of the quarterly liabilities of failed businesses variable. The call date in the Comptroller's Reports immediately after the panic date is assigned to the panic in the data (though "immediately after" varies by up to almost three months). At these call dates, corresponding to the panics, the liabilities variable is dated *after*, but in the same month, in four cases, and before, in the immediately preceding month in two cases. These were the closest assignments. In the case of the Panic of 1873 the liabilities variable was estimated from railroad bond defaults (see Gorton (1987B)). The problem is further complicated by the fact that the liabilities variable is cumulative over the quarter.

and (6), estimates of equation (4) are basically unaffected, but the analysis *at the panic dates* using only lags of the liabilities variable to predict COV_t results in insignificant correlations.²⁹ The problem seems to be that the liabilities observations lagged once are “too far away.” In short, the data are not fine enough to adequately draw stronger inferences.

VI. The federal reserve system, deposit insurance, and panics

The Federal Reserve System, begun in 1914, and deposit insurance, initiated in 1934, were both introduced primarily to prevent banking panics. This section examines the effects of these two monetary regimes on depositor behavior by estimating the model over these subsequent periods. All data, estimated equations, and test statistics for this section are detailed in Gorton (1987B).

The period 1873–1934

The introduction of the Federal Reserve System significantly altered depositor behavior. Both the perceived risk equations and the deposit-currency ratio equations exhibit significant structural changes after 1914.³⁰ A more precise sense of the difference made by the existence of the Federal Reserve System may be obtained by examining the timing of the measures of the information content of the liabilities of failed businesses variable during the period of 1914–1934. Table 6 lists the largest liabilities shocks for the peak to trough phase of the business cycles during this period. The table presents two measures. The unanticipated liabilities measure (UNLIA) was estimated over the period 1873–1934 and is, thus, comparable with the earlier period (Table 4). The cyclical component of the liabilities shock (CCBUS) was computed as the logged value minus the mean of the logged value over the years 1914–1934.

Examining the table, the UNLIA shock in June 1920 was large enough to have precipitated a panic had it come during the National Banking Era, but there was no panic under the Federal Reserve system. The UNLIA shock in December 1929 also did not precipitate panic, though it would have during the National Banking Era. The December 1929 shock coincides with the stock market crash since October 1929 is not a data point. By the other measure, CCBUS, which is not comparable with the earlier period, there is also a spike in December 1929.

²⁹ More accurately, the perceived risk estimates are often zero at several panic dates, so that there is no way to rank them and conduct the tests. In the one case where this is not true, however, the perceived risk measure is significantly correlated with the percentage change in the currency-deposit ratio. See Gorton (1987B).

³⁰ Tests for structural change after the introduction of the Federal Reserve System, and deposit insurance in 1934, were done on the equations predicting COV_t , the deposit-currency ratio equation, and a log-linear deposit-currency ratio equation. The evidence favored the existence of structural change under all data definitions, using the usual Chow tests.

TABLE 6
Timing Relations During the Period 1914–1934

<i>Peak-Trough</i>	<i>UNLIA Shock</i>	<i>CCBUS Shock</i>	<i>Panic</i>
Aug. 1918–Mar. 1919	Nov. 1918 0.2435	No Positive Shocks	No Panic
Jan. 1920–July 1921	June 1920 1.1341	Mar. 1921 0.7767	No Panic
May 1923–July 1924	Nov. 1923 0.5199	Mar. 1924 1.1473 (Oct. 1923 0.9392)	No Panic
Oct. 1926–Nov. 1927	Apr. 1927 0.2685	Mar. 1927 0.6584	No Panic
Aug. 1929–Mar. 1933	Dec. 1929 0.7687	Dec. 1929 0.7775 Jan. 1931 1.1157 Jan. 1932 1.1392 Feb. 1932 1.0074 Mar. 1932 1.1061 Apr. 1932 1.1817 Jan. 1933 0.9366	Oct. 1930 Mar. 1931 Jan. 1933

UNLIA was estimated over the period 1873–1934. CCBUS was estimated over 1914–1934.

Notably, the timing of the UNLIA shocks in June 1920 and December 1929 are the same as the pre-Fed era. Both shocks come just following the business cycle peaks. Simple tests on processes generating the failure liabilities do not reject the null hypothesis of no structural change (see Gorton (1987B)). In other words, the introduction of the Federal Reserve System did not alter the process driving failure liabilities. Depositor behavior changed. In deposit-currency ratio equations over the 1914–1934 sample period, measures of perceived risk are always insignificant though the perceived risk equations perform best over this period (see Gorton (1987B)). The panics of the 1930s happened in October 1930, March 1931, and January 1933, well after the business cycle peak. So the existence of the Fed did prevent a panic in June 1920, but only altered the timing of the later panic.

The period 1914–1972

The introduction of deposit insurance again significantly altered depositor behavior. Both the perceived risk equations and the currency-deposit ratio equations exhibit significant structural changes after 1934. Following the introduction of deposit insurance there were several cases of large failed business liabilities shocks, none of which precipitated panics. Like the results for the 1914–1934 period, the perceived risk measure is insignificant in the deposit-currency ratio equation estimated over the 1935–1972 sample period. Over the 1914–1934 period the sign on the perceived risk measure is positive as it is over the pre-Fed period. That is, in response to an expected coincidence of capital losses on deposits with declining consumption, i.e.,

$COV_t < 0$, depositors reduced their deposit-currency ratios. However, over the 1935–1972 sample period the sign on the perceived risk measure is consistent with the success of deposit insurance. Expecting to dissave during recessions, when the perceived risk measure is negative, depositors increased their deposit-currency ratios.

VII. The 1920s and 1930s without the Fed

What would have happened during the 1920s and 1930s if the Federal Reserve System had not come into existence? This question can be partly answered if it is assumed that depositors would have reacted to the liabilities of failed businesses signal during the 1920s and 1930s in the same way as during the National Banking Era. Recall that tests of the null hypothesis that the process generating the liabilities variable is not stable over the 1873–1934 sample period are rejected. As previously indicated, the UNLIA shock estimated over the period 1873–1934 is appropriate for the counterfactual. According to this UNLIA series (see Table 6), there would have been a panic in June 1920, and another panic in December 1929. These panics would have followed the timing pattern of the panics during the National Banking Era. The June 1920 spike comes shortly after the business cycle peak of January 1920 (the trough was July 1921). The December 1929 spike follows the August 1929 peak (trough: March 1933).

To construct the counterfactual, two further reduced form equations must be estimated to characterize the effects of depositor responses to changes in perceived risk during panics. Using the observations on the seven panics during the National Banking Era, the percentage of failing banks in the system and the percentage losses on deposits can be predicted using the UNLIA shock. The estimated reduced form relations are:

$$\begin{aligned} \%FAIL_t &= 0.010023 UNLIA_t \\ &\quad (0.0027) \end{aligned} \tag{7}$$

$$R^2 = 0.6973 \quad DW = 1.7019 \quad d.f. = 6$$

$$\begin{aligned} \%LOSS_t &= 0.062942 UNLIA_t \\ &\quad (0.0204) \end{aligned} \tag{8}$$

$$R^2 = 0.6129 \quad DW = 1.7097 \quad d.f. = 6.$$

Standard errors are in parentheses. The observations on losses and failures are cumulative from the panic date through the trough date, divided by total deposits and total number of national banks, respectively, at the panic date.

Table 7 compares the actual percentages of failures and losses, from the panic dates through the troughs, with the values predicted using (7) and (8). For the actual percentages of banks failing from December 1929 through March 1933, two numbers are listed. The first uses the Federal Reserve System's definition of suspension which is not strictly comparable (see Gorton (1987B)). The second number, in the case of National Banks,

TABLE 7
Actual and Predicted Losses and Failures, 1920s and 1930s

Date	Failures		
	Predicted % of National Banks Failing	Actual % of National Banks Failing	Actual % of All Banks Failing
June 1920	1.137	0.27	0.91*
Dec. 1929	0.77	26.24; 13.36	36.08; 30.76
Date	Losses		
	Predicted Losses at National Banks (%)	Actual Losses at National Banks (%)	
June 1920	7.14	0.42	
Dec. 1929	4.84	18.407	

* Covers the period Jan. 1921–July 1921 and uses the number of all banks in June 1921 as the base. Data on all banks begin in 1921.

All data described in Gorton (1987B).

uses the number of receiverships closed during 1930–1933. The second number, in the case of all banks, uses the number of banks which did not reopen after the March 1933 banking holiday (2, 132), instead of the Federal Reserve number for suspensions during March 1933 (3,460) (see Gorton (1987B)). Neither of these measures is strictly comparable. The two numbers, however, are the upper and lower limits. The loss measures, however, are comparable.

Table 7 shows that *if there had been a panic in June 1920, the percentages of banks failing and losses on deposits would have been higher than those which actually happened.*³¹ However, *if there had been a panic in December 1929, failure and loss percentages would have been an order of magnitude lower.* Losses and failures from June 1920 through the trough (July 1921) were lower than predicted perhaps because there was no panic. Between December 1929 and April 1933, there were three panics which came near the trough (October 1930; March 1931; January 1933). Losses and failures, however, were much higher than predicted. Table 7 indicates that the magnitudes of the losses and failures during the 1930s cannot be explained by the relations operating prior to the existence of the Federal Reserve System. The existence of the Federal Reserve System altered depositors'

³¹ Moreover, prior to 1920 state bank failure rates were about three times the rates for National banks (Bremer (1935)). This would increase the differences between the actual and predicted values for June 1920.

perceptions of risk, as indicated by the insignificance of the perceived risk measures in the deposit-currency ratio equations estimated over the 1914–1934 sample period (see Gorton (1987B)).

VIII. Conclusion

The results of this study are a set of stylized facts about banking panics, which, while extremely important since their reoccurrence motivated bank regulation, are not well understood. The main stylized fact is that panics are systematic (as previously defined) events linked to the business cycle. Panics turn out not be mysterious events after all. The evidence favors the conclusion that panics were a manifestation of consumption smoothing behavior on the part of cash-in-advance constrained agents. Panics seem to have resulted from changes in perceived risk predictable on the basis of prior information. The recession hypothesis best explains what prior information is used by agents in forming conditional expectations. Banks hold claims on firms and when firms begin to fail, a leading indicator of recession (when banks will fail), depositors reassess the riskiness of deposits.

Depositors panic when the liabilities signal is strong enough. In fact, during the National Banking Era, whenever the information measure of the liabilities of failed businesses reached a “critical” level, so did perceptions of risk and there was a banking panic. In this sense panics were special events. The cyclical behavior of the liabilities variable made panics an integral part of the pre-1914 business cycle.

As with all statistical inference, the above results cannot reject the notion that there exists an unknown variable(s) causing simultaneous increases in the currency-deposit ratio, risk, and the liabilities of failed businesses. *However, we can say that the influence of such unknown factors must happen the same way at panic and nonpanic dates, which is not consistent with sunspot theories of panics.* Sunspot theories argue that there is something special going on at the panic dates which does not occur at other dates, i.e., sunspots, but this is not consistent with the above evidence.

Could the causality be reversed in the above conclusions? Might it not be the case that depositors panic because of sun spots, run the banks, and thereby, cause the banker to call in loans, causing firms to fail? This scenario can be eliminated for three reasons. First, capital losses on demand deposits do not Granger-cause the liabilities of failed businesses, but liabilities of failed businesses do Granger-cause losses on deposits.³² In other words, the mechanism of causality running from depositors withdrawing currency from “illiquid” banks and causing businesses to fail is not

³² In regressions with ten lags of each variable, the F statistic for the liabilities variable with capital losses on deposits as the dependent variable was 2.11 (d.f. = (11, 184)), significant at the 5% level. In other words, the liabilities variable Granger-causes losses. The reverse test results in an F statistic of 0.38. Losses on deposits do not cause business failures.

present, at least when all dates are examined. Second, the response of banks to panics was not to liquidate loans, but to issue circulating private money which insured depositors against the failure of individual banks. (See Gorton (1985B, 1987A).) Finally, call loans do not seem to have been sizable enough to be the mechanism, and do not seem to have been loaned to nonfinancial businesses, in general. (See Myers (1931).)

At the panic dates the important shock seems to be the liabilities of failed businesses (with a seasonal component). This result was the basis of the counterfactual about the 1920s and 1930s. After 1914 the private insurance arrangements of commercial bank clearinghouses were replaced by the Federal Reserve System (see Gorton (1985B)). The counterfactual reveals the inadequacies of drawing policy conclusions about private market failures from the experience of the Great Depression. The evidence suggests that the private insurance arrangements of clearinghouses compare favorably to the Federal Reserve System in responding to banking panics.

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APPENDIX

Gorton (1987B) contains complete details of data sources and data construction methods, as well as further results. The basic data sources are as follows. Currency in the hands of the public and demand deposit data are from the *Annual Report* of the Secretary of the Treasury, Friedman and Schwartz (1963), *Survey of Current Business* (Supplements), *Banking and Monetary Statistics*, and the *Annual Statistical Digest* of the Federal Reserve System. The liabilities of failed businesses series is from *Financial Review* and from *Survey of Current Business*, for the later period. Pig iron production is from Macaulay (1938). Capital losses on demand deposits are constructed from the *Comptroller Reports* and from *FDIC Annual Reports*. Data on bank suspensions are from the Federal Reserve *Bulletin*, September 1937. Earlier data on the number of national banks failing are from the *Comptroller Report* of 1925 and 1935.

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