Financial Panics, the Seasonality of the Nominal Interest Rate, and the Founding of the Fed

By JEFFREY A. MIRON*

After the founding of the Fed in 1914,[1] the frequency of financial panics and the size of the seasonal movements in nominal interest rates both declined substantially. Since the Fed was established in part to "furnish an elastic currency,"[2] it is natural to hypothesize that the Fed caused these changes in the behavior of financial markets. There were, however, a number of other major changes in the economy and in the financial system during this period including World War I, the shift from agriculture to manufacturing,[3] and the loosening of the gold standard.[4] Moreover, Robert Shiller (1980) has examined the effect of the Fed's founding on the seasonal in real interest rates and has concluded that the Fed's actions had little or no effect.

This paper investigates the relationship between financial panics, seasonal movements in nominal interest rates, and the open market operations of the Fed after 1914. The paper establishes that the Fed, by carrying out the seasonal open market policy that eliminated the seasonal in nominal interest rates, caused the decrease in the frequency of panics. Since seasonal movements are anticipated and financial panics are probably real events, the results show that an anticipated monetary policy had real effects on the economy.

The issue of whether anticipated monetary policy can affect real variables, which is at the heart of monetary economics, has received much recent attention following the well-known contributions by Robert Barro (1977, 1978). His results have been subjected to a barrage of critical review, much of it supporting his finding that only unanticipated changes in money have real effects (for example, Barro and Mark Rush, 1980; Robert Litterman and Lawrence Weiss, 1985; Robert Lucas, 1973; Shiller; Christopher Sims, 1980),[5] some of it arguing that the evidence rejects the neutrality of anticipated money (for example, Robert Gordon, 1982; Frederic Mishkin, 1982, 1983).[6] The generally inconclusive nature of the debate reflects the difficulty of determining whether policy caused or responded to changes in the economy and of distinguishing anticipated from unanticipated policy actions. Thomas Sargent (1976), when describing the possible observational equivalence of classical and nonclassical models, suggested that identification would be aided if it were possible to draw data from two different policy regimes.

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[1] The Federal Reserve Act was passed by Congress on December 23, 1913. The Board of Governors took office and began planning the organization of the System on August 10, 1914. The twelve banks opened for business on November 16, 1914.

[2] This quote is from the preamble to the Federal Reserve Act.

[3] The share of agriculture in Gross Domestic Product fell from 24 percent in the period 1897–1901 to 12 percent in 1922. See *Historical Statistics of the United States*,...(1976, Series F125–129, p. 232).

[4] During World War I, several countries (including Great Britain) left the gold standard, so the United States was less affected by external conditions.

[5] The approach to testing neutrality in Barro and Rush is the same as in Barro (1977, 1978). Litterman-Weiss and Sims use vector autoregressive techniques and base their conclusions on the failure of money to be Granger causally prior for real income. Lucas shows in a cross section of countries that the variance of money shocks is negatively correlated with the variance of output movements.

[6] Barro (1978) introduced the use of cross-equation restrictions into this literature. This more powerful way of testing neutrality has been exploited extensively by Mishkin (1982, 1983), who has usually found that the data reject neutrality, contrary to the results of Barro.

The founding of the Fed and the subsequent smoothing of the seasonal pattern in nominal interest rates was a clear case of a change in regime, and the seasonal movements in the Fed's open market purchases were clearly an anticipated policy. It is the combination of these two things that I exploit in examining the neutrality of anticipated money.

I. A Model of the Banking System

This section presents a model of the banking system in which the magnitude of the seasonal movements in nominal interest rates is positively correlated with the frequency of financial panics.[7] The model shows that the Fed can reduce the frequency of panics by carrying out the seasonal open market policy that eliminates seasonal fluctuations from nominal rates. The model therefore suggests a channel through which anticipated monetary policy can have real effects.

The starting point is the Milton Friedman-Anna Schwartz (1963, pp. 50–53) textbook model of the money supply:

$$H = R + C \tag{1}$$

$$M = C + D \tag{2}$$

$$L = M - H \tag{3}$$

where H is high-powered money, M is money, C is currency, D is deposits, and L is loans. In this framework the money supply is determined by the interaction of the nonbank public (through the desired currency-deposit ratio), banks (through the desired reserve-deposit ratio), and the monetary authority (through high-powered money). The model presented here explicitly examines the bank's choice of reserve-deposit ratio and then makes standard assumptions about the remaining terms.

The banking system consists of a fixed number of identical banks, each of which is sufficiently small that it acts as a price taker. The representative bank holds two types of assets: reserves, R; loans, L. There is one type of liability: deposits, D. The bank accepts deposits infinitely elastically and pays out currency on demand.[8] The only decision it faces is what proportion of its assets to hold as reserves and what proportion as loans. The larger the proportion of loans, the greater the costs to the bank of managing its portfolio.

There are costs to the bank of holding a large proportion of its assets as loans because it can suffer unexpected deposit withdrawals. Under fractional reserve banking, a sufficiently large amount of withdrawals causes the bank to fail because some of its assets are tied up in loans and it takes time to convert these into cash. If the bank experiences withdrawals, therefore, it liquidates some of its loans to bolster its reserve position. This imposes costs since the bank accrues capital losses and/or incurs excess brokerage fees when it calls in loans unexpectedly.

The bank's cost function takes the form

$$c\left(\frac{R}{D}\right) = \frac{(W - E(W))^2}{2}\left(\left(\frac{R}{D}\right) - 1\right)^2, \tag{4}$$

where W is the amount of withdrawals that the bank experiences. Costs depend on the amount of unexpected withdrawals and on the ratio of reserves to deposits. They increase with the amount of unexpected withdrawals but decrease with the reserve-deposit ratio. The cost function described by (4) assumes that unexpected withdrawals and unexpected deposits have the same effect on costs. It also assumes that the distribution of withdrawals is independent of the level of deposits. Both of these assumptions are probably unrealistic, but they simplify the presentation of the results. The results do not depend on these two assumptions.

[7] For other recent examples of models of panics see John Bryant (1980), Douglas Diamond and Philip Dybvig (1983), and Gary Gorton (1982).

[8] In the pre-Fed period, demand and time deposits were much closer substitutes than they are today. Demand deposits sometimes paid interest, and time deposits could be transferred by check. The data do not distinguish between demand and time deposits (Friedman and Schwartz, p. 4). I assume here that all deposits are demand deposits and that they do not pay interest.

The bank's problem is

$$\max E(iL - c(R/D)) \tag{5}$$

subject to

$$R + L = D, \tag{6}$$

where i is the nominal interest rate. The solutions for R and L are

$$R^d = D(1 - (iD/s^2)) \tag{7}$$

$$L^s = D(iD/s^2), \tag{8}$$

where $s^2 = E(W - E(W))^2$. These solutions imply a desired loan-reserve ratio of

$$L^s/R^d = iD/(s^2 - iD). \tag{9}$$

When the interest rate or the level of deposits is high, the bank would like to hold a small proportion of its assets as reserves and a large proportion as loans. When the variance of withdrawals, s^2, is high, the bank wishes to hold a small proportion as loans and a large proportion as reserves.

To close the model I assume that the demand for loans is negatively related to the real interest rate and that the demand for deposits is interest inelastic:

$$L^d = P(Y - b(i - \pi^*)) \tag{10}$$

$$D^d = Pd, \tag{11}$$

where P is the price level and π^* is expected inflation. Real loan demand is negatively related to the real interest rate and positively related to Y, a measure of the real demand for credit in the economy. The demand for deposits, d, does not depend on the interest rate or on the state of the economy.

I assume for now that $P = 1$ and $\pi^* = 0$; this simplifies the presentation without affecting the results. I also assume that the level of high-powered money is fixed and independent of the behavior of the economy. The United States and its major trading partners were on the gold standard during the period 1890–1914, but there was sufficient sluggishness in gold flows so that the U.S. interest rate could move independently of the world rate in the short run.[9] In addition, as shown by Truman Clark (1983), there were seasonal movements in the world rate that corresponded closely to those in the United States.

Equations (7), (8), (10), and (11) jointly determine the equilibrium values of the endogenous variables in the model. The two exogenous variables Y and d parameterize the solutions. By noting how the solutions depend on these variables, we can see how they depend on external conditions. I interpret these external conditions as the effects of different seasons. Determining the sensitivity of the solutions to Y and d therefore tells us how equilibrium in financial markets depends on the seasonal movements in loan and deposit demand.

The equilibrium value of the interest rate is

$$i = Ys^2/(bs^2 + d^2). \tag{12}$$

The interest rate is high in seasons in which loan demand is high or deposit demand is low. When the variance of deposit withdrawals is high, the level of the interest rate is also high.

The equilibrium values for loans, reserves, and the loan-reserve ratio are

$$L = Yd^2/(bs^2 + d^2) \tag{13}$$

$$R = (bds^2 + d^3 - d^2Y)/(bs^2 + d^2) \tag{14}$$

$$L/R = Yd^2/(bds^2 + d^3 - d^2Y). \tag{15}$$

The quantity of loans is high when demand for them is high and when the deposits at banks are high; they are low when the variance of withdrawals is high. Reserves are low when loan demand is high and high when deposit demand is high. The ratio of loans to reserves increases with loan demand, decreases with deposit demand, and decreases with the variance of withdrawals.

The seasonal movements in Y and d also affect the distribution of costs of running the

[9] Friedman and Schwartz (pp. 89–90).

banking system:

$$(16)\quad c\left(\frac{R}{D}\right)=\frac{(W-E(W))^2}{2}\,\frac{d^2Y^2}{(bs^2+d^2)^2}.$$

These costs are high when d is low and when Y is high, given the distribution of W. That is, a withdrawal of a given size imposes higher costs on the banking system in periods when loan demand is high or deposit demand is low.

Panics can be thought of as periods when the costs of running the banking system are especially high. Since the distribution of costs shifts upward with the seasonal increases in loan demand and the seasonal decreases in deposit demand, the probability that costs exceed any given level is higher in seasons when loan demand is high or deposit demand is low. Thus panics are more likely to occur in these seasons.

This result, that panics are more likely to occur in seasons with high-loan demand or low-deposit demand, is the first key result provided by the model. The explanation is as follows. In some seasons there is an exogenous increase in loan demand that forces up nominal rates. Banks respond by loaning out a higher proportion of their reserves, which increases expected costs but also produces more revenue. The increase in loan-reserve ratios means a decrease in reserve-deposit ratios, so the distribution of costs, and thus the frequency of panics, is higher, even though the distribution of unexpected withdrawals is unchanged. It is the seasonal increase in loan demand and the resulting decrease in reserve-deposit ratios that causes an increased frequency of panics, not any change in the variance of deposit withdrawals.

I now examine the cost of running the banking system when the Fed intervenes by conducting open market operations. An open market purchase increases the supply of loans by an amount F. Assuming that this has no effect on P or π^*, the costs are

$$(17)\quad c\left(\frac{R}{D}\right)=\frac{(W-E(W))^2}{2}\,\frac{d^2(Y-F)^2}{(bs^2+d^2)^2}.$$

Costs decrease with F when $F<Y$. Since $c(R/D)$ is convex in F, the Fed can lower the average number of panics per year by conducting an open market policy that is seasonal and averages out to zero over the year. If open market operations affect P or π^*, then the derivation given above needs to be modified accordingly. In general, however, the Fed can still affect the behavior of nominal interest rates and therefore the frequency of panics.[10]

The conclusion that the Fed can reduce the frequency of panics by eliminating nominal interest rate seasonality is the second key result of the model. By supplying loans in periods when loan demand is high, the Fed accommodates the increase in demand and lessens the increase in the interest rate that would otherwise occur. This lessens the decrease in the reserve-deposit ratio and therefore the upward shift in the distribution of costs. Open market purchases in a season with high-loan demand thus decrease the probability of a panic.

The model presented above provides an explanation for the change in the behavior of panics and interest rates that occurred after 1914. The Fed accommodated the seasonal movements in loan demand, thereby smoothing the seasonal pattern in nominal interest rates. In response to the reduction in the seasonality of interest rates, banks reduced the seasonal variation in their desired reserve-deposit ratios, so in equilibrium these were smoother. Finally, the fact that reserve-deposit ratios were smoother meant that, on average, banks were less exposed to unexpected deposit withdrawals and so the frequency of panics fell.

The central implication of the hypothesis that the behavior of financial panics and interest rates changed after 1914 because of the Fed's seasonal open market operations is that there should have been seasonal movements in the amount of credit extended by the Fed. Additional implications are as follows: the total amount of credit outstanding in the economy should have become more seasonal after 1914; the loan-reserve ratio of banks should have become less seasonal; and

[10] I show this explicitly in my dissertation, ch. IV, which discusses seasonal movements in real rates.

the loans made by private banks should have become less seasonal.

Section II examines empirically the implications of the model and the hypotheses it suggests about the behavior of the Fed. These results come from a simple model, but they do not depend on the particular assumptions made in order to keep the analysis simple.[11] The model presented above is the most complicated one that can be tested empirically; it is not possible to test the additional implications of more complicated models because of data limitations.

II. The Evidence

A. *Historical Background: The National Banking System and the Founding of the Fed*

The period from 1863 through 1913 is known as the period of the National Banking System because the provisions of the National Banking Acts of 1863, 1864, and 1865 determined the banking and financial structure in several critical ways. The National Banking Acts were both a response to problems of the financial system that existed before the Civil War and a measure designed to raise revenue for the North during the war. The Acts successfully generated revenue and cured some prewar financial ills (notably the multiplicity of note issue). During the National Banking Period, however, those in academia, the banking community, and government still regarded the financial system as fundamentally flawed because of the "perverse elasticity of the money supply" and the high frequency of financial panics.

The term perverse elasticity of the money supply referred to the tendency of the money supply to contract in precisely those periods when it was "needed" most. This occurred in the spring and fall of each year when seasonal increases in loan and currency demand forced interest rates up and reserve-deposit ratios down. These seasonal movements in loan and currency demand were attributed mainly to the need for both currency and credit by the agricultural sector of the economy in the spring planting season and the fall crop-moving season, and to the need for currency and credit by the corporate sector for quarterly interest and dividend settlements. Additional currency was needed because the volume of transactions was higher in these periods. Credit demand was high because farmers borrowed to finance the planting and harvesting of the crops.[12]

The financial panics that occurred in this period were combinations of bank failures, bank runs, and stock market crashes. A typical panic began after an individual bank was hit by either an unexpectedly large deposit withdrawal or a large loan default. If the bank had a small amount of reserves, it would need to call in some of its loans. This might concern other banks enough so that they would call in some of their loans, many of which were in stock market call loans, and the cumulative effect of loan recall by many banks tended to depress the stock market. At the same time, the fact that banks were calling in loans caused the nonbank public to increase its desired currency-deposit ratio, and this could cause either individual bank failures or runs on many banks. Eventually the process either reversed itself or ended in a suspension of convertibility.[13]

There were, of course, differences in the dynamics of various panics. Some began in New York as the result of a large loan default at a New York bank and then were transmitted West as New York banks tried to acquire additional reserves from the country banks. Others started in the West when crop failures damaged the liquidity positions of country banks who then tried to recall

[11] Appendices A and B to ch. IV of my disseration show that the conclusions are still valid if one allows for a pyramided banking system, or for the general equilibrium interactions of the economy.

[12] E. W. Kemmerer (1910, pp. 223–24) mentions increased rail and barge activity during warm weather and holiday seasons as additional reasons for seasonal activity in the financial markets. A. Piatt Andrew (1906) discusses the influence of agriculture on economic activity during the pre-Fed period, and J. Laurence Laughlin (1912, pp. 309–42), discusses the seasonal cycle in general economic activity. See also O. M. W. Sprague (1910), C. A. E. Goodhart (1969), and John James (1978, pp. 127–37) for discussions of the seasonal flows within the country that accompanied the seasonal changes in interest rates and reserve positions of banks.

[13] Sprague (pp. 1–225).

balances from reserve cities. Nevertheless, the key element of a panic was the same in all of the major episodes. This key element was a generally increased demand for reserves that could not be satisfied for all parties simultaneously in the short run.

The likelihood that an event such as a large loan default would precipitate a panic depended on the initial position of the banking system. If such an event happened at a time when loan demand was high or deposit demand was low, so that the reserve-deposit ratios of banks were low, then the costs imposed by the loan default were higher. Since there were seasonal movements in loan and deposit demands that produced seasonal movements in reserve-deposit ratios, panics tended to occur in the fall and spring, when high-loan demand and low-deposit demand produced low reserve-deposit ratios. Thus the problems of perverse elasticity and the accompanying financial panics were partly a result of and coincided with the seasonal movements in asset demands.

The academics, bankers, and government officials of the time understood this phenomenon. J. Laurence Laughlin, a professor of economics at the University of Chicago, commented in detail on this relation between panics and seasonality in his 1912 treatise on reform of the banking system (pp. 309–42). Paul Warburg, a Wall Street banker who later served on the Federal Reserve Board, wrote in 1910 that "there can be no doubt whatever that the basis for healthy control by a central bank must exist in a country where regular seasonal requirements cause, with almost absolute regularity, acute increased demand for money and accommodation" (1930, p. 156). Leslie Shaw, Secretary of the Treasury from 1902 to 1906, actively attempted to accommodate the seasonal demands in financial markets, although the funds available to him were not sufficient to allow him to be successful.[14]

The panic of 1907 precipitated sufficient concern about panics and elasticity that Congress passed the Aldrich-Vreeland Act of 1908. This Act addressed the problems of the banking system by granting certain emergency powers to New York City banks and by creating the National Monetary Commission. This Commission was assigned to undertake a detailed study of the U.S. banking system. Its *Report*, published in 1910, contained in depth examinations of every aspect of banking theory and practice in the United States and abroad.

Two parts of the *Report* deserve particular notice. O. M. W. Sprague, a professor of economics at Harvard, wrote *History of Crises Under the National Banking System*. This book examined in detail the operation of the banking system during five of the worst financial crises (1873, 1884, 1890, 1893, and 1907). Sprague wrote that "with few exceptions all our crises, panics, and periods of less severe monetary stringency have occurred in the autumn" (p. 157). E. W. Kemmerer of Cornell contributed the volume *Seasonal Variations in the Relative Demands for Money and Capital in the United States*. He noted that "the evidence accordingly points to a tendency for the panics to occur during the seasons normally characterized by a stringent money market" (p. 232). Thus two parts of the *Report* mentioned explicitly the tendency for panics to occur in certain seasons of the year.

The Federal Reserve Act established the Federal Reserve System in 1913, three years after the publication of the Commission's *Report*. The preamble to the Act states that it is "an act to... furnish an elastic currency." It was to be expected, therefore, that the Fed would try to eliminate panics by accommodating the seasonal demands in financial markets.

B. *Evidence of the Changes in Financial Markets*

I now document the two facts cited in the introduction: the frequency of financial panics diminished after the founding of the Fed; and the size of the seasonal fluctuations in nominal interest rates diminished also.

Table 1 shows the starting dates of the financial panics that occurred during the period 1890–1908 according to Sprague and

[14] See Andrew (1907, p. 559), and Richard Timberlake (1978, p. 181). See Andrew (1907) also for an interesting analysis of Shaw's other activities and Timberlake (1963) for a critique of Andrew's analysis.

TABLE 1—STARTING DATES AND CLASSIFICATION OF FINANCIAL PANICS ACCORDING TO SPRAGUE AND KEMMERER

Classification	Year	Month
Sprague		
Financial Stringency	1890	August
Crisis	1893	May
Crisis	1907	October
Kemmerer		
Major Panics	1890	September
	1893	May
	1899	December
	1901	May
	1903	March
	1907	October
Minor Panics	1893	February
	1895	September
	1896	June
	1896	December
	1898	March
	1899	September
	1901	July
	1901	September
	1902	September
	1904	December
	1905	April
	1906	April
	1906	December
	1907	March
	1908	September

Sources: Sprague (pp. 1–225); Kemmerer (pp. 222–23).

Kemmerer.[15] Sprague classified periods of financial strain as either crises or "periods of financial stringency." A crisis was the more serious situation in his terminology and necessarily involved a suspension of convertibility of deposits into currency. There were three periods of serious strain according to Sprague, which amounted to one every six and one-third years. Kemmerer's classification system distinguished major from minor panics and included a larger number of episodes than Sprague's system. He determined the starting dates by reading the *Commercial and Financial Chronicle* and the *Financial Review*, two periodicals that were the *Business Weeks* of their day. Kemmerer found six major and fifteen minor panics during the 1890–1908 period. If only major panics are included, the frequency was slightly more than one every three years. Including minor panics raises the frequency to more than one per year.

Between 1915 and 1933, the banking system experienced financial panics only during the subperiod 1929–33.[16] There were several recessions during the subperiod 1915–28 (1918–19, 1920–21, 1923–24, 1926–27), one of which was quite severe (output fell 9 percent from 1920 to 1921). Nevertheless, until 1929 there were no financial disruptions of the types that occurred in the pre-Fed period, even during the recessions. The 1921 *Annual Report* of the Fed makes a point of noting that the financial market failures that had been symptomatic of earlier downturns did not occur during the 1920–21 recession.[17]

The question of whether the frequency of financial panics diminished after the founding of the Fed, therefore, consists of determining the probability that it would have taken fifteen years for the economy to experience its first panic after 1914 if in fact the tendency of the economy to panic had been unchanged. The appropriate data to use to estimate the frequency of panics during the pre-Fed period are Kemmerer's on the number of major panics; Sprague's definition of panics omits periods often cited elsewhere while Kemmerer's data on minor panics include periods that were not noted by many observers. Assuming that the distribution of panics was Bernoulli, Kemmerer's data provide an estimate of the probability of having a panic in a given year of .316. This implies that the probability of obtaining a sample of fourteen years with no panics was .005. The data therefore reject the hypothesis of no change in the frequency of panics at the 99 percent level of confidence.

Figure 1 shows the estimated seasonal pattern in the interest rate on stock market call loans for the periods 1890–1908 and 1919–

[15] Sprague and Kemmerer also give starting dates for panics for the 1873–89 period. Those data are qualitatively similar to those provided in Tables 2 and 3. I have not presented them because the interest rate and money market data are only available beginning in 1890.

[16] See Friedman and Schwartz (pp. 305, 308, 313, 324).

[17] Friedman and Shwartz (p. 235) and Phillip Cagan (1965, p. 225) also note the absence of financial crises during this recession.

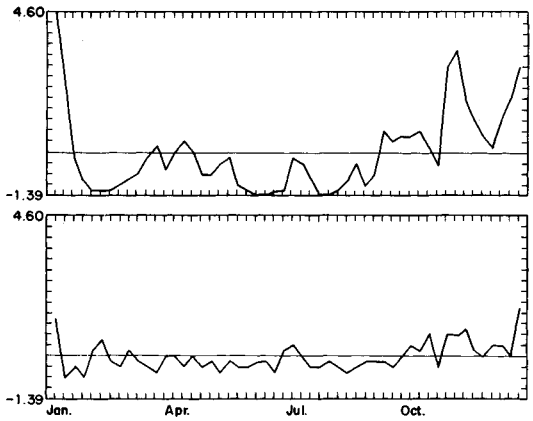

FIGURE 1. SEASONAL PATTERN IN NOMINAL INTEREST RATES, BEFORE (TOP) AND AFTER (BOTTOM) 1914

TABLE 2—TESTS OF THE NULL HYPOTHESIS OF NO SEASONAL FLUCTUATIONS IN FINANCIAL MARKET VARIABLES

Sample Period	Dependent Variable	*F*-Statistics	Significance Level
1890–1908	Nominal Interest Rate	1.68	.003
	Loans-Reserve Ratio	4.28	.000
	Loans	2.46	.000
	Reserves	4.90	.000
1919–28	Nominal Interest Rate	2.05	.000
	Loans-Reserve Ratio	4.90	.000
	Loans	3.65	.000
	Reserves	1.90	.000
1922–28	Reserve Credit	7.09	.000
	Total Credit	5.54	.000

28.[18] The patterns were calculated using weekly data by computing the unconditional mean in each week, after subtracting a trend. The top portion is for 1890–1908 and the bottom for 1919–28. Both are plotted in hundreds of basis points per year and show fifty-two coefficients. The patterns are statistically significant in each period, as reported in Table 2.

The size of the seasonal cycle clearly decreases from the earlier period to the latter.

[18] I present results for the 1890–1908 period in the text because that is the period for which Kemmerer and Sprague identified the dates of financial panics. Data for the entire 1890–1914 period confirm the results presented in the text.

TABLE 3—TESTS OF THE NULL HYPOTHESIS OF NO CHANGE IN THE PATTERN OF SEASONAL FLUCTUATIONS IN FINANCIAL MARKET VARIABLES

Sample Period	Dependent Variable	*F*-Statistics	Significance Level
1890–1908 vs. 1919–28	Nominal Interest Rate	2.05	.000
	Loans-Reserve Ratio	4.90	.000
	Loans	3.65	.000
	Reserves	1.90	.000

The standard deviation of the seasonal cycle was 130 basis points before 1914, but only 46 basis points afterwards. The amplitude of the cycle dropped from 600 basis points before 1914 to 230 after. The change in the patterns is statistically significant, as shown in Table 3.

C. *Implications of the Model for the Pre-Fed Data*

The next step in the analysis is to confirm that the model presented in Section I is consistent with the data for the pre-Fed period. The central implication of that model is that the distribution of financial panics should have been seasonal, with periods of high frequency corresponding to periods of high interest rates. Table 4 summarizes the data in Table 1 on the starting dates of panics by showing the number of panics that began in each month of the year. It is clear that the distribution was seasonal and that the periods of high frequency were spring and fall. This result is confirmed by a χ^2 goodness-of-fit test of the null hypothesis that the number of panics that occurred in each month was the same; that is, a test of the null hypothesis of no seasonality. The calculated test statistic for the data in the table is 36.25 while the 99 percent critical value of the χ^2 statistic with 11 degrees of freedom is 24.73.

Figure 2 provides additional support for the model. It shows the estimated seasonal pattern in the call money loan rate (top) and the loan-reserve ratio (bottom) for the period 1890–1908. (The scale on the bottom is in percent and shows the percentage change in

TABLE 4—DISTRIBUTION OF FINANCIAL PANICS BY MONTH, 1890–1908

January	0
February	1
March	3
April	2
May	2
June	1
July	1
August	0
September	6
October	1
November	0
December	4

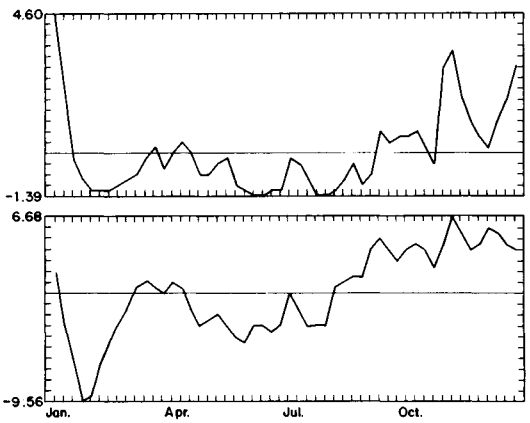

FIGURE 2. SEASONAL PATTERN IN NOMINAL INTEREST RATE (TOP) AND LOAN-RESERVE RATIO (BOTTOM) BEFORE 1914

the level of the loan-reserve ratio in each week.) The peaks in both variables occur in approximately the same two periods of the year, spring and fall, and the correlation between the estimated seasonal patterns is .63. Both the timing of the peaks, which coincides with that in financial panics, and the positive correlation between the seasonal patterns are results implied by the model.

Note that the pre-Fed seasonal movements in the loan-reserve ratio were large, with the standard deviation of the cycle being 3.5 percent and the amplitude 16.2 percent. In the post-World War II period, the elasticity of loan supply with respect to the interest rate has been small (Robert Rasche, 1972), and excess reserves have been kept near zero. The explanation for this change in behavior may be either the advent of FDIC or the smoother behavior of nominal interest rates. To the extent that the explanation is the lack of seasonal fluctuations in interest rates, this result also confirms the model.

D. *Implications of the Hypothesis that the Fed Caused the Changes in Financial Markets*

The hypothesis that the Fed caused the decrease in both the frequency of financial panics and the size of the seasonal movements in nominal interest rates implies that the actions of the Fed should have been seasonal, with the peaks of accommodation coming at those times of the year that had previously tended to be ones of financial stress. From 1915 to 1918, the Fed accommodated seasonal strain mainly by subsidizing loans for agricultural purposes, since the problems of financing World War I constrained its ability to conduct discretionary open market operations. Then, in 1918, it began to engage in significant seasonal open market operations.

The Fed established its loan subsidy program during the first full year of its existence, 1915. The program rediscounted bills backed by agricultural commodities at preferential rates in order to assure "that whatever funds might be necessary for the gradual and orderly marketing of the cotton crop" would be available. (The subsidy was not limited to bills backed by cotton, however.) The *Annual Reports* for the years 1916–18 all note that the program was working well and that the usual seasonal strain in financial markets had been avoided. The Fed discontinued the program in 1918 when it gained better control over its open market operations due to the end of the war.

Figure 3 shows the estimated seasonal pattern in Federal Reserve credit outstanding for the period 1922–28.[19] The periods of peaks in reserve credit outstanding coincide with the periods during which there were peaks in interest rates and loan-reserve ratios

[19]Weekly data are only available starting in 1922. Monthly data, which begin in August, 1917, confirm the results discussed here.

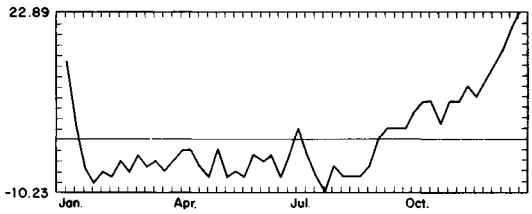

FIGURE 3. SEASONAL PATTERN IN FEDERAL RESERVE CREDIT OUTSTANDING

before the founding of the Fed, and the seasonal pattern is statistically significant (see Table 2). There was an increase of 32 percent in the level of reserve credit outstanding over the seasonal cycle, which amounted to roughly $400 million in a typical year. Since the total amount of loans outstanding at New York City banks was $6000 million, this was a substantial increase. It is clear that the actions of the Fed were seasonal and that they were likely to alleviate the seasonal strain that existed before 1914.

There are additional implications of the hypothesis of Fed responsibility that can be verified quantitatively. The seasonal variation in the total amount of credit outstanding should have increased after 1914 since, according to the hypothesis, the Fed's policy was one of subsidizing loan demand. Also, the seasonal variation in loan-reserve ratios should have decreased because this produced the seasonal variation in costs that the Fed wished to eliminate. Figure 4 shows the seasonal in loans by banks before 1914 and in the total amount of credit outstanding (banks and the Fed) after 1914. The total amount of credit outstanding became more seasonal after the founding of the Fed, with the standard deviation increasing from 1.4 to 1.8 percent and the amplitude rising from 4.8 to 7.7 percent. Figure 5 shows the estimated seasonal pattern in the loan-reserve ratio of banks before and after 1914. The figures show that the seasonal pattern diminished considerably, with the amplitude falling from 16.2 to 7.8 percent and the standard deviation dropping from 3.5 to 1.5 percent. Note in particular that those periods that showed the most significant seasonal strain before 1914 in all cases show almost none after 1914.

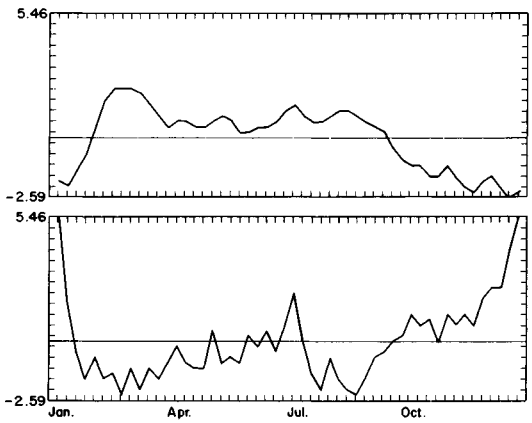

FIGURE 4. SEASONAL PATTERN IN TOTAL CREDIT OUTSTANDING BEFORE (TOP) AND AFTER (BOTTOM) 1914

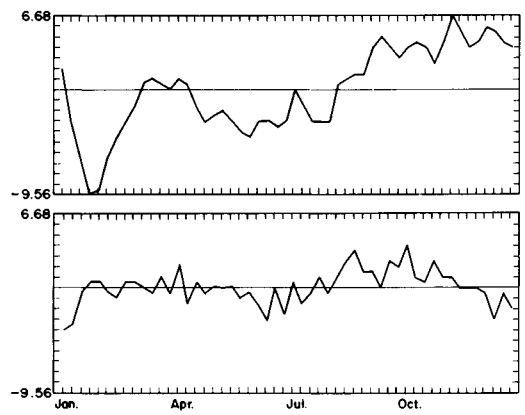

FIGURE 5. SEASONAL PATTERN IN LOAN-RESERVE RATIO BEFORE (TOP) AND AFTER (BOTTOM) 1914

The other implication of the hypothesis that the Fed caused the changes in financial markets is that the seasonal variation in loans made by private banks should have decreased. The seasonal pattern in loans by banks before and after 1914 is shown in Figure 6. The amount of seasonal variation diminishes, as implied by the hypothesis of Fed causation. The timing of the seasonal pattern also changes, however, and this is not implied by the hypothesis.

The explanation for the change in timing is probably that the pattern of deposits at banks changed after 1914 because the Treasury began keeping some of its deposits

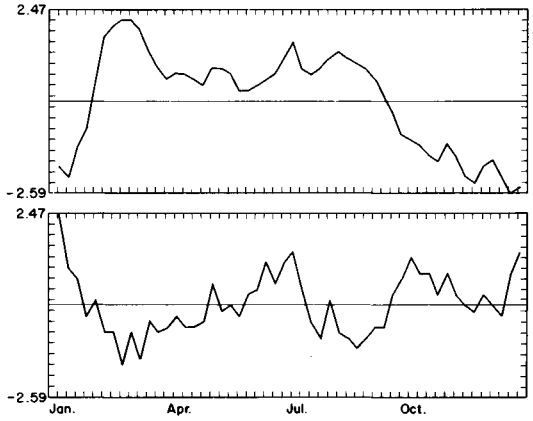

FIGURE 6. SEASONAL PATTERN IN LOANS BEFORE (TOP) AND AFTER (BOTTOM) 1914

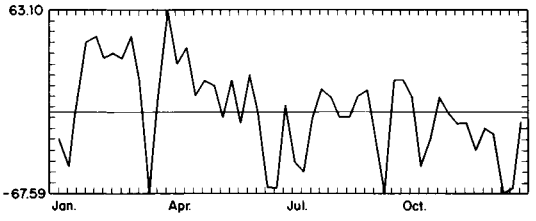

FIGURE 7. SEASONAL PATTERN IN TREASURY DEPOSITS AT THE FED

at the Fed. Before 1914, the Treasury kept its holdings of currency in either Treasury offices or private banks, and movements of cash between these two places affected the stock of high-powered money. After 1914 the Treasury also kept some of its deposits at the Fed. Since Treasury deposits at the Fed are not part of high-powered money, increases in Treasury deposits decrease high-powered money. If the Treasury kept at the Fed money that it had previously kept at private banks, the seasonal movements in the Treasury's holdings of cash would have produced different seasonal movements in high-powered money after 1914.

Figure 7 shows the seasonal pattern in Treasury deposits at the Fed for the period 1922:1–1928:12. There is a large peak at about the time of year (February/March) when the loan seasonal diminishes. Thus the change in the behavior of the Treasury may explain the change in the timing of the loan seasonal.

The quantitative evidence therefore establishes that the Fed caused the changes in the behavior of financial markets. Two quotes from the Fed's first *Annual Report* confirm this evidence. In discussing the proper role for monetary policy, the *Report* says,

> What is the proper place and function of the Federal Reserve Banks in our banking and credit system? On the one hand, it is represented that they are merely emergency banks to be resorted to for assistance only in time of abnormal stress; while on the other, it is claimed that they are in essence simply additional banks which should compete with the member banks, especially with those of the greatest power. The function of a reserve bank is not to be identified with either of these extremes. ...Its duty is not to await emergencies but by anticipation, to do what it can to prevent them. So also if, at any time, commerce, industry or agriculture are, in the opinion of the Federal Reserve Board, burdened unduly with excessive interest charges, it will be the clear and imperative duty of the Reserve Board acting through the discount rate and open market powers, to secure a wider diffusion of credit facilities at reasonable rate. ...The more complete adaptation of the credit mechanism and facilities of the country to the needs of industry, commerce, and agriculture—with all their seasonal fluctuations and contingencies—should be the constant aim of a Reserve Bank's management. [1914, p. 17]

Further, the *Report* states,

> It should not, however, be assumed that because a bank is a Reserve Bank its resources should be kept idle for use only in times of difficulty. ...Time and experience will show what the seasonal variates in the credit demand and facilities in each of the Reserve Banks of the several districts will be and when and to what extent a Reserve Bank may, without violating its special function as a guardian of banking reserves, engage in banking and credit operations. [1914, p. 18]

It is clear that the Fed considered the elimination of both seasonal strain and financial panics as essential parts of its function.

The statements of H. Parker Willis and Carter Glass provide additional support for this proposition. Willis, an economist at Columbia University, was an expert consultant to the House Banking and Currency Committee in 1912–13 while the Federal Reserve Act was being written, and he later became Secretary of the Federal Reserve Board. He wrote in 1915 that the potential benefits of the System were that "there will be no such wide fluctuations of interest rates ... from season to season as now exist ... and no necessity of emergency measures to safeguard the country from the possible results of financial panic or stringency" (p. 75). Carter Glass, who sponsored the Federal Reserve Act as a member of the House of Representatives in 1913, wrote in 1927 (p. 387) that two of the most important accomplishments of the System were the removal of panics and the elimination of seasonal interest rate fluctuations.

E. *Seasonality and the Financial Panics during the Great Depression*

The United States did not experience any financial panics from 1915 through 1928. There were, however, five financial panics during the period 1929–33, and these five were among the most severe in the country's history. Since the preceding sections have shown that the Fed successfully eliminated panics from 1915 to 1928, it is necessary to explain why panics recurred during the period 1929–33.

Figure 8 shows the actual level of Federal Reserve credit outstanding during the year 1929 as well as the level projected on the basis of the pattern that obtained from 1922 through 1928. The actual level is below the projected level starting in March. Further, the points at which the discrepancy increases correspond to periods that experienced peaks in loan demand during the 1890–1908 period. Figure 9 shows the estimated seasonal patterns in reserve credit outstanding for the two periods 1922–28 and 1929–33. The seasonal pattern is dampened in the later period, with the standard deviation of the cycle falling from 7.5 to 6.9 percent and the amplitude falling from 33.1 to 26.1 percent.

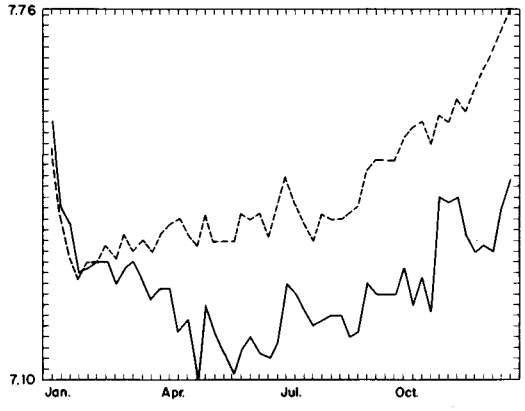

FIGURE 8. ACTUAL (SOLID LINE) AND FORECAST (BROKEN LINE) VALUE OF RESERVE CREDIT OUTSTANDING, 1929

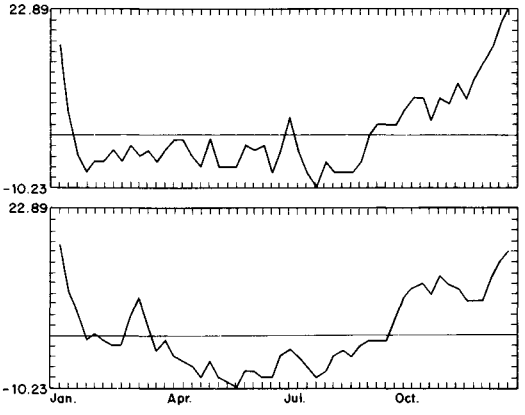

FIGURE 9. SEASONAL PATTERN IN RESERVE CREDIT OUTSTANDING, 1922–28 (TOP) AND 1929–33 (BOTTOM)

These results show that the Fed accommodated the seasonal demands in financial markets to a lesser extent during the 1929–33 period than it had previously. This means that the frequency of panics *should* have increased, as it did. It also means that the panics should have occurred in the spring and the fall, and this is exactly what happened: three of the panics were in the fall

(1929, 1930, 1932) while two were in the spring (1931, 1933).[20] Thus the recurrence of panics during this period corroborates the hypothesis that the Fed caused the reduction in the frequency of panics after 1914.

The decreased accommodation of the seasonals in asset demands was probably the result of a generally restrictive open market policy that the Fed initiated in late 1928.[21] During much of the 1920's, there was fear that speculation by participants in the stock market was "excessive," and those who objected to the speculation most encouraged the Fed to restrain the growth of credit, particularly loans by banks to stock market brokers. The officials at the Fed differed in their view of how much to restrain credit. On balance, however, they opposed restraining speculation so much that it might adversely affect general business activity.

This policy changed toward the end of 1928. Stock market speculation had been especially virulent, and the Fed responded with a strongly restrictive policy. The explanation for the change in policy is that Benjamin Strong, the governor of the New York Fed, died in October of 1928.[22] During the period 1915–28, Strong was a dominant force in the Federal Reserve System and in the entire financial community. In the words of his biographer, Lester Chandler, Strong was "one of the world's most influential leaders in the fields of money and finance. During the first fourteen turbulent, formative years of the Federal Reserve System, his was the greatest influence on American monetary and banking policies" (1958, p. 3). Strong intensely disliked stock market speculation, but was an outspoken critic of restraining speculation at the cost of causing a recession. His death allowed the balance of opinion at the Fed to shift toward greater restraint, and a highly restrictive policy resulted. One of the manifestations of this policy was the incomplete accommodation of the seasonal demands in financial markets.

F. *The Real Effects of Financial Panics*

The final issue discussed in this section is whether financial panics had real effects on the economy. It is not possible to test an explicit model of the real effects of panics because of data limitations.[23] It is possible, however, to demonstrate support for the proposition that panics had real effects if one is willing to make assumptions about what these effects might have been. I assume here that panics affected the distribution of output by decreasing the average level of real activity, increasing the variance of real activity, and increasing the length of business cycles.[24]

In the context of this paper there are two implications of the proposition that panics were real events. First, the distribution of output in the pre-Fed period should have been worse in panic years than in nonpanic years; second, the distribution of output post-Fed should have been better than that pre-Fed.

Table 5 shows the mean and variance of the rate of growth of annual real *GNP* for the period 1890–1908 and for this period minus the years in which panics occurred (Kemmerer's major panic definition). The average level of *GNP* growth is higher and the variance of real growth lower for nonpanic years, so these facts support the hypothesis that panics altered the distribution of output. They do not, of course, prove that hypothesis, since panics might be the result of negative output shocks. Nevertheless, the facts in the table lend plausibility to the proposition that panics changed the distribution of output during the pre-Fed period.

[20] See Friedman and Schwartz (pp. 305, 308, 313, 324).

[21] See Paul Trescott (1982) for a more detailed examination of this aspect of Fed policy.

[22] Friedman and Schwartz (pp. 411–19 and pp. 692–93) discuss in detail the effects of Strong's death on the power structure of the Fed.

[23] The data in Gordon are interpolations.

[24] See Ben Bernanke (1983) for an analysis of the effects of the financial crises during the Great Depression, Cagan for a discussion of the real effects of panics during the pre-Fed period, and Gorton (1983) for work on the general relation between panics and business cycles.

TABLE 5—THE EFFECTS OF PANICS ON REAL *GNP* GROWTH (Shown in Percent)

	Mean	Standard Deviation
1890–1908	3.75	5.83
1890–1908[a]	6.82	5.46

Notes: The definition of panics is Kemmerer's major panics.

[a]1890–1908 minus the years with panics and the years immediately following panics.

TABLE 6—THE EFFECT OF THE ELIMINATION OF PANICS ON THE LENGTH OF BUSINESS CYCLES

Peak	Trough	Length
July 1890	May 1891	11
January 1893	June 1894	18
December 1895	June 1897	19
June 1899	December 1900	19
September 1902	August 1904	24
May 1907	June 1908	14
August 1918	March 1919	9
January 1920	July 1921	19
May 1923	July 1924	15
October 1926	November 1927	14
Average for Pre-Fed Period = 17.5 months		
Average for Post-Fed Period = 14.25 months		

Source: Citibank Economic Database.

Table 6 compares the length of business cycles before and after the founding of the Fed. The measure of the length of a cycle is the number of months from peak to trough according to the dating of the National Bureau of Economic Research. I use this measure of the distribution of output rather than real *GNP* growth because the data on real *GNP* are not available on a consistent basis for the entire 1890–1928 period.

The data in the table show that the length of a typical recession fell after the founding of the Fed. The average length during the period 1890–1908 was 17.5 months while during the period 1919–28 it was only 14.25 months. More impressively, three of the four post-Fed recessions were as short or shorter than four of the six pre-Fed recessions. There are naturally many possible explanations for these facts, but they do provide basic support for the proposition that eliminating panics had real effects on the economy.[25]

III. Conclusions

It is well known that it is difficult to draw conclusions about the operation of monetary policy when data are drawn from a single policy regime. The founding of the Fed and the subsequent smoothing of the seasonal pattern in nominal interest rates constituted a clear shift in regime. In this paper I have exploited that change in regime, along with the fact that seasonal movements are anticipated, to reach conclusions about the effects of monetary policy, namely, that anticipated open market operations by the Fed probably had real effects.

The conclusion of this paper clearly raises the question of what current monetary policy should do about nominal interest rate seasonals. During the post-World War II period there has been substantial seasonality in both open market operations and the stock of money, but virtually no seasonality in nominal rates. This suggests that the Fed has accommodated seasonal fluctuations in asset demands since World War II in much the same way that it did following its inception in 1914. It also suggests that if the Fed produced a nonseasonal money stock, as Friedman (1959, 1982) has suggested it should, there would be a return of interest rate seasonals.

The return of nominal interest rate seasonals, however, would probably not cause a return of financial panics. Congress imposed deposit insurance on the banking system in 1934, and the presence of deposit insurance probably eliminates panics independently of the Fed's seasonal policy. Thus the analysis

[25]In ch. IV of my dissertation, I also discuss three alternative explanations for the disappearence of interest rate seasonality after 1914. In particular, I address Clark's claim that the reduction in seasonality could not have been due to the Fed, since seasonality in nominal rates disappeared worldwide after 1914. I show that this was probably the result of attempts by many central banks to eliminate interest rate seasonals. It therefore supports rather than contradicts my explanation of the U.S. experience.

above does not necessarily imply that continued elimination of interest rate seasonals is desirable. The analysis does show that an important aspect of Fed policy is its seasonal behavior, and it demonstrates that this aspect of policy can have substantial real effects on the economy.

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