

**Bank Failures and the Cost of Systemic Risk:
Evidence from 1900-1930**

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Abstract:

We investigate the effect of bank failures on economic growth using data on bank failures from 1900 to 1930. The sample predates active government stabilization and includes several severe banking crises. We use VAR and difference-in-difference methods to estimate the impact of bank failures on economic activity. VAR results show bank failures have negative and long-lasting effects on economic growth. Three quarters after a bank failure shock involving one percent of total bank liabilities (primarily deposits), GNP is reduced by about 6.9 percent. Difference-in-difference results suggest that bank failures trigger an increase in non-bank failures.

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I. Introduction

The link between bank failures and economic growth continues to be an important topic in macroeconomics.¹ Economists and policy makers have long been interested in quantifying the degree to which bank failures create negative externalities that reduce economic growth. If these externalities are economically important, they are a manifestation of financial sector systemic risk.

Banks are a source of systemic risk if the social cost of a bank failure exceeds the direct losses of failing bank financial claimholders. One component of this social cost is the subsequent loss in output associated with bank failures.² The failure of any firm may create externalities and losses in output, but because of banks importance in the intermediation process, the costs and externalities associated with a bank failure are likely to be much larger than those associated with the failure of a non-bank entity.

The credit channel literature on monetary policy [Bernanke and Gertler (1989, 1990, 1995), Bernanke and Blinder (1992)] emphasizes the link between banks' cost of capital and the borrowing costs and final demands of bank-dependent borrowers. If a credit channel is operative under normal monetary conditions, should important banks fail, the externality on bank-dependent borrowers is likely to be substantial.

A number of studies including Hogart, Reis and Saporta (2002) [HRS], Boyd, Kwak and Smith (2005) [BKS], Gupta (2005), Krosner, Laeven and Klingebiel (2007), and Dell'Ariccia, Detragiache, and Rajan (2008) have used cross-country data on modern banking crises to estimate the loss in output associated with systemic banking crisis.

¹ Relevant citations as well as a brief overview of this literature are provided in Section II further below.

² Recent papers on bank systemic risk focus on the strength of correlation among bank defaults and mechanisms that can propagate shocks among banks or other financial institutions. Kaufman and Scott (2003) and Schwartz (2008) provide overviews of the literature. Few if any of these models directly address the economic growth consequences of systemic risk.

These studies find that banking crises are associated with output reductions for bank dependent borrowers and substantial losses in GDP. Cumulative loss estimates for GDP range from 11.5 [HRS] percent of pre-crisis GDP to as high as possibly 300 percent [BKS]. These estimates are specialized in that they focus on a sample of catastrophic banking crises that are often linked with currency crises and many of these studies do not include controls for nonfinancial business cycle imbalances that are associated with the crisis periods. Regardless, there is no consensus regarding the reduction in output that can be expected in the wake of an increase in bank failures.³

Outside of these cross-country studies on banking crisis, the modern literature on bank failures and economic activity is focused on two periods: the Great Depression (1930–1933) and the U.S. savings and loan and banking crises of the late 1980s and early 1990s (S&L crisis). There is consensus that a breakdown in the banking system intensified the Great Depression in the U.S., but Depression-era evidence from other countries as well as evidence from the S&L crisis is ambiguous. For example, the Canadian experience during the Great Depression does not suggest that there are large negative externalities associated with bank failures (Haubrich, 1990; White, 1984). Analysis of data from the S&L crisis has also produced conflicting results (see, *inter alia*, Ashcraft, 2005; Alton, Gilbert, and Kochin, 1989; or Clair and O’Driscoll, 1994).

This paper investigates the effect of bank failures on economic activity using new data on bank failures that occurred between 1900 and 1930. Prior to the enactment of federal deposit insurance legislation in 1933, there were no federal government

³ The costs we are referring to in this paper are the consequences of systemic bank failures on economic growth, not the fiscal costs of associated with the resolution of failed institutions or the costs associated with the implementation of new regulation aimed at preventing further failures. For an estimate of these costs see Honohan and Laeven (2003) and Claessens, Klingebiel, and Laeven (2003).

institutions or policies that were specifically implemented to counteract the economic effects of bank failures and exert a stabilizing influence on the economy.⁴ This historic period also included many separate episodes of banking crisis where many banks failed or temporarily suspended redemptions. Data from this period allows us to measure the economic effects of bank failures and suspensions without confounding effects from a systematic government reaction function.

We use vector autoregression analysis (VAR) to estimate the effect of bank failures on both the growth rate of industrial production and aggregate output (GNP). The severity of bank failures is measured using newly compiled data on the share of banking system liabilities (predominantly deposits) in failed banks and trusts including all state- and nationally-chartered institutions. We argue that the data are consistent with the hypothesis that bank failures create negative externalities if: (i) an increase in bank failures on average reduces subsequent economic growth; and, (ii) on average, poor economic growth is not followed by a higher incidence of bank failures. We use Granger causality tests and establish that an increase in the liabilities of failed banks, other things equal, reduces industrial production and GNP growth, but a decline in economic growth or industrial production does not lead to an increase in failed-bank liabilities.

Our estimates suggest that, over the period 1900–1930, the variation in failed-bank liabilities explains about 5 percent of the volatility in output growth. In addition, we find that, all else constant, a one standard deviation innovation (14.5 basis points) in the share of liabilities in failed banks results in a cumulative 2.4 percent decline in

⁴ We argue that, during this period, there were no coordinated government policies to offset business cycle fluctuations or the economic consequences engendered by bank failures and suspensions. There were, however, some governmental policies enacted to mitigate the probability of bank suspensions. For example, the Aldrich-Vreeland Act and its extension, and the establishment of the Federal Reserve were designed to provide liquidity to the banking system to reduce the probability of bank suspensions.

industrial production (IP) growth and a cumulative 1 percent decline in GNP growth over the following three quarters. The results also suggest that the effects of bank failures are long-lasting: even after 10 quarters the cumulative decline in both IP growth and GNP growth following the 1-standard deviation shock is still approximately 1 percent. A direct implication of these results is that, the failure of an important financial institution (or institutions), in the absence of intervention, is likely to have protracted macroeconomic effects.⁵

We provide additional evidence on the link between bank failures and economic growth by comparing the failure rates among non-bank firms in New York and Connecticut following the Panic of 1907. A year prior to the panic, business conditions in New York and Connecticut were similar to business conditions in the rest of the country and neither state had banking sector problems. 1907 brought important financial institution failures in New York, but none in Connecticut. Non-bank firm failures spiked in New York following the onset of the banking panic and non-bank failures remained elevated for another two quarters. In contrast, non-bank business failures in Connecticut remained stable throughout the period. When economic performance is measured by time series data on the liabilities of non-financial commercial enterprise failures in each state, a formal difference-in-difference analysis supports the hypothesis that bank failures cause an increase in non-bank commercial failures. We interpret this evidence as further support for the hypothesis that bank failures depress economic growth.

Taken together, our findings suggest that bank failures create significant negative externalities that reduce economic growth. The estimate of the loss in aggregate output is

⁵ Hogart, Reis, and Saporta (2002), Boyd, Kwak and Smith (2005) and Anari, Kolari, and Mason (2005) also find long lasting effects associated with bank failures. We elaborate on this result in Section IV.

a lower bound estimate of the cost of systemic risk in the banking sector as it excludes the direct deposit, equity and credit losses associated with bank failures.

This paper is only one of many that investigate the extent to which bank failures amplify economic distress. Section II reviews the contributions of several earlier studies. Subsequent sections discuss the importance of the sample period (Section III); the macroeconomic data, the VAR model, and the empirical results (Section IV); and the difference-in-difference analysis of New York and Connecticut during the Panic of 1907 (Section V). Section VI concludes.

II. Research on Bank Failures and Economic Activity: A Brief Overview⁶

Economists have studied the link between bank failures and subsequent economic growth for well over a century. Jevons (1884) speculates that volatility in sunspot activity affects climate, creating volatility in the agricultural and commodity prices, which in turn affects banks and the economy. Jevons's theory does not emphasize the importance of banks in the economic growth process and, as far as we know, it has not been tested.

In the aftermath of the Panic of 1907, a number of studies investigated aspects of banking sector stability as a prelude to new legislation and banking system reforms. Sprague (1910) studies bank failures and banking panics in the United States and finds that international gold outflows cause, simultaneously, bank failures and a decline in economic activity. Kemmerer (1910) finds that seasonal changes in the demand for money, stemming from changes in agricultural sector borrowing, explain the joint

⁶ The literature on this issue is vast. Our review is selective and not intended to be comprehensive.

variation of stock prices, commercial failures, and banking panics between 1890 and 1908.

Friedman and Schwartz (1963) (FS) study the U.S. Great Depression and find that bank failures triggered a loss of public confidence in the banking system leading consumers to hold more currency and fewer bank deposits which reduced the money multiplier and the money supply. Because the decline in the money supply was not offset by monetary policy, nominal economic activity declined.⁷

Bernanke (1983) extends the FS analysis to incorporate the effect of bank failures on investment spending. In Bernanke's bank-centered model of business finance, firms depend on bank lending for investment and working capital funding. Firms typically have a long-term relationship with a single bank and when the bank fails, the relationship is dissolved and the information gained through the relationship is lost. When firms seek funding from new bankers, they face increased costs while they establish the new banking relationship. Thus, for some period after a bank failure, investments by bank-dependent firms are discouraged by increased funding costs and investments may be limited by the availability of internal funds.⁸

Bank failures can also have secondary effects on the lending behavior of surviving banks (Bernanke, 1983). Heightened uncertainty regarding deposit redemptions induces surviving banks to increase their reserves by reducing loans to bank-dependent businesses. Unable to tap external capital markets, businesses are forced to reduce

⁷ FS argue that the banking failures of the Great Depression era could have been avoided, or at least mitigated, if the Federal Reserve System had been more generous in providing discount window lending to troubled banks, which would have given solvent banks access to liquidity without changing their need to hold currency reserves thereby stabilizing the money supply.

⁸ For more evidence on how bank affiliations facilitated access to capital markets in the pre-Depression era, see Ramirez (1999) and Calomiris and Hubbard (1995).

investment spending which results in a magnified reduction in GDP through the Keynes (1936) investment multiplier.

Other studies confirm the importance of the bank-dependent borrower channel. Calomiris and Mason (2003) focus on local banking markets and find that a significant portion of the decline in economic activity from 1930 to 1932 is explained by reduced bank loan supply which reduced investment spending. Anari, Kolari, and Mason (2005) use VAR methods to investigate the relationship between the liquidation of failed banks and the depth and duration of the Great Depression. They find that bank failures have a long-lasting negative effect on economic activity partly because bank failures restrict access to the deposits in failed institutions. During this period, depositors at failed banks were precluded from accessing their funds for an extended time, and when their accounts became liquid, depositors generally faced sizable losses.⁹ The loss in depositors' liquidity resulted in reduced consumption and investment spending.

In contrast to the U.S. experience, the experience of other countries during the Great Depression is not consistent with strong bank failure externalities. Haubrich (1990) studies the Great Depression in Canada using Bernanke's methodology. During the depression, Canada experienced a monetary contraction and a decline in output almost as dramatic as the one in the United States. Unlike the U.S., Canada did not experience a single bank failure during its Great Depression era notwithstanding the fact that there was no central bank in Canada until 1935.¹⁰ While there were no Canadian bank failures in

⁹ Goldenweiser et al. (1932) estimate that between 1921 and 1930 the deposit recovery rate was 55.7 percent (table 25, page 195). Although this figure does not cover the Depression period, it illustrates the gravity of the situation before the establishment of federal deposit insurance.

¹⁰ The source of the Canadian system's resilience remains in dispute but some scholars have attributed it to the diversification benefits from branch banking (FS 1963; Bordo, 1986; Ely, 1988; O'Driscoll, 1988); the effective lender of last resort function provided by the Canadian Bankers Association (CBA) (Bordo, 1986); and the existence of a 100 percent implicit government guarantee on deposits (Kryazanowski and

the Great Depression, the number of bank branches in Canada did decline by about 10 percent. Still, Haubrich finds no measurable effect of branch closures on Canadian GDP.

Many countries in Central and Eastern Europe also experienced banking crisis during the Great Depression era.¹¹ Similar to Canada, the United Kingdom, Czechoslovakia, Denmark, Lithuania, the Netherlands and Sweden experienced depression conditions without breakdowns in their banking systems (Grossman, 1994). The literature hypothesizes factors that may have provided stability to these national banking systems during the Great Depression, but to our knowledge, existing studies have not analyzed whether banking system distress magnified real sector weakness.¹²

Banking scholars also reach conflicting conclusions when studying data from the U.S. S&L crisis period. For example, Ashcraft (2005) investigates FDIC-induced closures of 38 subsidiaries of First Republic Bank Corporation in 1988 and 18 subsidiaries of First City Bank Corporation in 1992. He concludes that, as a result of the closures, real income declined by about 3 percent in areas served by these banks. In contrast, Alton, Gilbert and Kochin (1989), using county-level data from Kansas, Nebraska, and Oklahoma over the period 1981–1986, do not find any significant relationship between bank failures and measures of local economic activity. Clair and O'Driscoll (1994) use Gilbert and Kochin's methodology to study the impact of bank

Roberts, 1993). These explanations are, however, not beyond dispute. For example, Carr, Matherson and Quigley (1995) argue that the CBA did not arrange mergers for insolvent institutions nor were depositors protected by a government guarantee (or a perception thereof) as some faced losses when banks were suspended.

¹¹ Grossman (1994) identifies a banking crisis if any one of the following occurs: (1) a large proportion of a country's bank's fail; (2) a large important bank fails; or (3) or extraordinary government intervention prevents (1) or (2) from occurring. Using this definition, the Great Depression was associated with banking crisis in Switzerland, Yugoslavia, France, Belgium, Latvia, Hungary, Poland, Estonia, Romania, Germany, Italy and Norway in addition to the United States.

¹² This gap in the literature likely reflects the fact that few countries have high quality measures of aggregate economic activity available for this historical period.

failures on local economic activity in several Texas counties between 1981 and 1991. Like Gilbert and Kochin, they do not find any significant relationship.

The results of studies based on data from the S&L crisis period are not directly comparable to the results derived from Great Depression era data. During the S&L crisis period, both the Federal Reserve and banking regulators took actions to attenuate the economic impacts of banking system distress. Bank failures were delayed (relative to what would have happened in the Great Depression) as weak institutions continued funding themselves with insured deposits which reduced the risk of a bank run. While legislative inaction ensured that resource constraints slowed the resolution process, undercapitalized depository institutions continued to fund lending activity.¹³ Deposit insurance quelled the public's demand for precautionary currency holdings while the Federal Reserve discount window was available to provide liquidity to solvent banks which mitigated their need to call in loans. The Federal Reserve also pursued a monetary policy designed to offset problems in depository institutions.¹⁴ All of these factors likely helped to offset any negative effects of bank failures on economic growth.

Among existing studies, Grossman (1993) is the most closely related to our study. Using data on the fraction of national banks that failed over the period 1863–1914, Grossman estimates a structural IS-LM model that includes the effects of bank failures. His estimates suggest that a “small” shock in bank failures can erase 8 percentage points of GDP growth, whereas a “large” shock in bank failures can reduce the GNP growth rate by 26 percentage points. These estimates are surprisingly large and have not been independently confirmed in any other study. The Grossman analysis ignores the size of

¹³ See for example Kane (1989), or Romer and Weingast (1991).

¹⁴ See for example Clouse (1994), or Mussa (1994).

failed banks and focuses on the impact of the national bank failure rate over a period in which state-chartered institutions held more than a third of the banking system assets, outnumbered national banks, and were often the institutions experiencing distress. (White (1983), pp.12-13).

The importance of the negative externality generated by a bank failure should be related to the size of a bank as size is a proxy for the importance an institution's valuable relationships with bank-dependent borrowers as well as indicator of the bank's provision of transactions services.¹⁵ Large banks also are more likely to have correspondent banking relationships which were particularly important during this era. The failure of a key correspondent bank can have wide-ranging affects on the reserves and lending capacity of many smaller state-chartered institutions (White pp. 68-9).

III. The Importance of the Sample Period

During the period 1900-1930, the United States experienced three major banking crises: one in May of 1901, one in October of 1907, and one during the early 1920s. In addition, it endured eight minor crises.¹⁶ During this period, there were virtually no systematic federal government policies that were used to stimulate the economy, counteract recessions, or offset the adverse economic effects of bank failures.¹⁷ In the

¹⁵ Wicker (2000, p. 85) also notes the number of failed institutions is unlikely to be an accurate measure of banking system distress and the size of failed institutions must matter as well. Wicker, however, does not systematically exploit this observation.

¹⁶ Calomiris and Gorton (1991), p. 114; Miron (1986), p. 131; Kremmerer (1910), pp. 222-223.

¹⁷ There were government policies designed to reduce the probability of bank failures or suspensions. For example, the Aldrich-Vreeland Act (1908) allowed large national banks (with at least \$5 million in capital) to issue bank notes in excess of their capital as emergency currency if so authorized by the Treasury. This act was used to provide liquidity and in effect allowed a partial temporary devaluation of the dollar in the face of foreign demands for US gold stocks following the suspension of the gold standard in 1914. Wells (2004) and Silber (2007) argue that this act may have prevented a financial crisis in 1914 as a result of war in Europe. This act was used to provide temporary liquidity to large national banks to prevent bank suspensions. By Congressional design, this act expired on June 30, 1915.

remainder of this section we review the historical features of fiscal and monetary policy over this period.

Fiscal Policy

From 1900 to 1916, federal government fiscal policy had little impact on U.S. aggregate demand. Over this period, federal expenditures varied between 1.5-2.5 percent of GDP (Romer, 1999) and budget surplus or deficits were of negligible size (DeLong, 1998). With the onset of World War I, federal government expenditures increased dramatically, to 20 percent of GDP by 1918, before declining throughout the 1920s (Romer, 1999).

Prior to the federal programs created under the New Deal, there is little evidence that federal expenditure policies were intentionally designed to counteract weak aggregate demand; indeed even New Deal programs do not appear to have been motivated by Keynesian economic ideas. Romer (1999) argues that the Employment Act of 1946 was the first law enacted that explicitly embraced the idea of using fiscal policy to regulate aggregate demand. More importantly, no fiscal stimulus policies were designed or implemented to counteract the economic impacts of any of the banking panics of this era.

Monetary Policy

The Federal Reserve System, created in 1913, was established to smooth regional credit cycles associated primarily with agricultural borrowing demands.¹⁸ Miron (1986) argues that Federal Reserve policies were successful in dampening the seasonal variation of nominal interest rates which reduced the frequency of banking panics.

¹⁸ The Federal Reserve did not begin operations until 1914. Throughout the early years, Federal Reserve officials believed that monetary policy should follow a “real bills” doctrine focused on discounting commercial paper at penalty rates and providing lender of last resort facilities when needed.

Notwithstanding its impact on the seasonal agricultural cycle, early Federal Reserve policies did not include an explicit counter-cyclical (business cycle) role for monetary policy (White, 1983, p.115 ff).

In practice, the earliest coordinated Federal Reserve policies were dictated by the U.S. Treasury's desire to finance World War I on favorable terms. Under pressure from Treasury, the Federal Reserve abandoned the "real bills" doctrine and allowed member banks to discount Treasury certificates issued to finance the war at rates below those on the Treasury certificates (Meltzer, 2003, pp. 84-90). This discounting policy created monetary expansion and inflation. It was not until late 1919 that the Federal Reserve System banks were permitted to raise discount rates and penalize excessive borrowing.¹⁹ A severe recession followed with widespread unemployment, declines in industrial production and substantial deflation.²⁰ The wholesale price index fell from 100 in 1920, to 62.8 in 1923.

Federal Reserve operating policies were modified following the 1920-22 recession, but as late as 1924, few officials in the Federal Reserve System believed that open market operations should be used to attenuate recessions (White, 1983, p.122). Throughout the remainder of the 1920s, Federal Reserve policies were guided by three perceived goals: (1) to re-establish the pre-World War I gold standard as the international system of exchange; (2) to maintain price stability and avoid repeating the events of 1920-22; and, (3) to curb the growth of speculative credit (i.e., credit used to purchase

¹⁹ Following WWI, several regional Federal Reserve Banks had attempted to raise discount rates but were prohibited from doing so by the Federal Reserve Board (see Meltzer 2003).

²⁰ The severity of this recession has been in part attributed to a failure of Federal Reserve policy (Meltzer, 2003, p. 120-ff).

securities).²¹ The Federal Reserve did not embrace countercyclical monetary policies and indeed the system could not effectively coordinate monetary policy until after the Banking Act (1935) established the Federal Open Market Committee to coordinate operations among the reserve banks (Meltzer, 2003, p.5).

The well-known Bagehot (1906) rule for furnishing liquidity during panics is a policy designed to mitigate the probability of bank suspensions. While there is evidence that the Federal Reserve used its lender of last resort powers to ease liquidity pressures in some circumstances²² different Federal Reserve Districts pursued different policies regarding lending to troubled institutions (Richardson and Troost (2009)). Regardless, while the Federal Reserve may have undertaken temporary emergency liquidity policies in some specialized situations to mitigate the frequency of bank suspensions, there is no evidence that the Federal Reserve pursued coordinated monetary policy to offset weakness in aggregate demand including the negative demand shock that may follow an increase in bank failures.

IV. Banking System Distress and Economic Growth: Granger Causality Evidence

A. The Data

We employ a vector autoregressive model (VAR) to estimate the linkages between bank failures and subsequent economic growth. Our VAR model includes the share of liabilities in failed institutions (SLFI), a measure of aggregate economic activity, and two additional economic series that are used to control for non-bank failure related

²¹ See for example, the discussions in Costigoliola (1977) or Meltzer (2003).

²² Carlson, Mitchener, and Richardson (2010) argue that there is evidence that the Federal Reserve District of Atlanta provided exceptional liquidity support to slow down the spread of a banking panic in Florida in 1929 following the outbreak of a Mediterranean fruit fly infestation.

shocks to aggregate economic activity: an estimate of the inflation rate, and an estimate of the prevailing risk premium in credit markets. The data sources for the variables used in the VAR analysis are listed in Table A of the appendix. We discuss the characteristics of each data series in the remainder of this section.

We use three measures of banking system distress. Our primary measure, SLFI, is constructed from data on the liabilities (primarily deposits) of failed depository institutions as reported in issues of *Dun's Review*. These data include nearly 6,000 quarterly observations for the 48 states from the first quarter of 1900 through the second quarter of 1931.²³ State figures are aggregated to produce national data for each quarter. The data include failed national banks as well as failed state-chartered banks and trust companies.²⁴ The failed depository liability series is normalized by total deposits as reported in Flood (1998).²⁵

We also construct two alternative failure rate series. One series, the total bank failure rate series is constructed from data on bank depository institution failures as reported in *Dun's Review* and the quarterly estimates of the number of banking institutions from data reported in *Historical Statistics of the United States* (1975).²⁶ The total bank failure-rate series measures the percentage of depository institutions that were closed, either temporarily or permanently, between 1900 and 1930. A second series, the

²³ *Dun's Review* reports failure data beginning in 1895, but there are periods in the 1800s when the data are unreported. From 1900, the data are reported regularly for each quarter. *Dun's Review* stopped reporting these data after the second quarter of 1931. The original data are corrected for typographical errors.

²⁴ *Dun's Review* does not clarify whether bank suspensions are included in bank failures. Compared to the aggregate number of U.S. bank failures reported by Goldenweiser (1933, table 1), our numbers are marginally higher than Goldenweiser's before 1921 but smaller thereafter. Because the Goldenweiser data excludes national bank suspensions before 1921 (and includes them thereafter), the comparison suggests that our data may include a few (but not all) suspensions. This feature of the data is unlikely have any significant effect on our results since the largest proportion of bank suspensions occurred after 1931 (Calomiris and Mason, 2003).

²⁵ The primary source for the data reported in Flood is *All Bank Statistics*. The denominator in our measure is a quarterly estimate of total liabilities interpolated from annual figures.

²⁶ Again, the denominator is a quarterly estimate interpolated from annual figures.

national bank failure rate, is constructed as the number of national banks placed into receivership during a quarter as a percentage of the number of operating national banks in that quarter as reported by the Comptroller of the Currency.²⁷

Exhibit 1 shows the quarterly values of the two failure-rate series and the SLFI series. Exhibit 1 also includes estimates of the recessionary periods (shaded bars) as identified by the National Bureau of Economic Research (NBER). The series plotted in Exhibit 1 suggest a significantly different record of banking system distress with the bank failure rate series giving misleading indications of banking sector health in at least two important periods. In the first instance, the bank failure rate data suggests that banking conditions were comparable during the 1903–1904 and 1907–1908 recessions, whereas the SLFI data clearly identifies the true severity of the banking panic of 1907. The 1907 panic involved the failure or temporary suspension of a few large money-center institutions that accounted for about 1.5 percent of all system deposits.²⁸ This level of banking system distress was not exceeded until the Great Depression. In the second instance, the bank failure rate series clearly overstates the degree of stress in the banking system over the period 1922–1929. Although a large number of banks failed during this period, the failed institutions were relatively small and often state-chartered.

It is well-known that measures of aggregate economic activity over the period 1900–1930 are imperfect (e.g., Romer, 1999) and alternative measures of aggregate output differ as to their historical volatility characteristics. We focus on two measures of aggregate economic activity, the Miron and Romer (1990) industrial production series and the Balke-Gordon (1986) estimates of real GNP.

²⁷ These data are reported in serial volumes of The Report of the Comptroller of the Currency.

²⁸ The institutions included Knickerbocker Trust, Hamilton Bank, International Trust Company, and United Exchange Bank.

The Federal Reserve did not publish a series on aggregate industrial production until 1919, and real GNP estimates were not reported by the U.S. Commerce Department until 1929. Among available measures of industrial production for the period 1900–1930, the Miron and Romer (1990)'s series is arguably the most comprehensive, as it is derived from production indices on at least 13 sectors of the economy. We use the Balke-Gordon real GNP series because it is (to our knowledge) the only series that estimates quarterly GNP for the period 1900-1930.

Exhibit 2 shows estimates of the quarterly changes in the alternative measures of aggregate activity. Within this era, industrial production is a much more volatile measure of aggregate economic output compared to GNP. The volatility difference between these series may be explained in part by a tendency for asynchronous changes in the outputs of the services, transportation, and other non-commodity sectors (Romer, 1999).

Time series studies in macroeconomics using post-World War II data highlight the importance of the interest rate spread between risky and safe debt instruments in forecasting real GNP growth (Stock and Watson, 1989; Friedman and Kuttner, 1993). Indeed, this literature finds that the interest rate spread does a better job in predicting subsequent output growth, than does money, interest rate levels, or other financial variables. Under the pre-World War I gold standard, Calomiris and Hubbard (1989) find that the interest rate spread had a positive effect on business failures and a negative effect on output growth. Following this literature, we use data on the spread between the commercial paper rate and the call money rate as a proxy for the risk premium in financial markets.

Bank lending and economic activity are likely to decline in reaction to an increase in the risk premium in credit markets. If, for example, investors became more risk averse when there is a significant gold outflow or a general deterioration in economic activity, the risk premium will have output effects independent of banking failures. The volatility of this interest rate spread is pronounced during the 1907 panic when the U.S. experienced heavy outflows of gold and again around the second quarter of 1914 when the classical gold standard collapsed and World War I began.

We use the NBER inflation rate series as a measure of the ease of monetary conditions. We expect tight monetary conditions to lead to deflation and a decline in industrial production irrespective of the degree of distress in the banking sector. The inflation rate is remarkably stable before 1914 as a consequence of the gold standard. After the United States suspended the gold standard in 1914 and World War I began, prices increased and became much more volatile. Following the war, prices declined sharply reflecting in part the worldwide collapse in the price of agricultural commodities.

VAR Analysis

We estimate two VAR models. One model includes: (1) the growth rate in Miron-Romer's index of industrial production (IP growth); (2) the spread between the commercial paper rate and the call money rate (Spread); (3) the inflation rate (Inflation); and, (4) the change in the share of system liabilities in failed banks (SLFI).²⁹ The second

²⁹ The VAR system was also estimated using money growth instead of inflation, and the results did not change significantly. We also estimated the model without the interest rate spread variable. The results were similar to those reported which include the spread. For robustness purposes, we also estimated the VAR without inflation or the spread, leaving only our measure of bank failures and output growth. The effect of bank failures on output became stronger. Lastly, eigenvalue stability tests show that all the eigenvalues lie inside the unit circle and so the estimated VAR satisfies dynamic stability conditions.

VAR specification substitutes the growth rate in the Balke-Gordon GNP series for the IP growth series.³⁰ Both VAR models are estimated using three lags.³¹

B. Granger-causality

The VAR estimates identify the temporal relationships among the model's variables. The existence of temporal relationships need not imply economic causality, but causal relationships are expected to generate temporal relationships that can be identified in the data. We construct Granger-causality tests to determine whether the SLFI series Granger-causes changes in IP and GNP growth. The SLFI series Granger-causes economic growth if lagged values of SLFI are helpful in explaining changes in economic growth, but lagged values of economic growth do not have a statistically significant influence on subsequent values of SLFI.

Exhibit 3 reports the Granger causality Chi-squared test statistics and the corresponding level of statistical significance (p-values) for the hypothesis that all coefficients of the individual lagged explanatory variable in the equation are jointly zero. For example, in equation 1, IP growth is the dependent variable; spread, inflation, and SLFI are the independent variables. The effect of SLFI on output growth is summarized by the Chi-squared statistic of 10.94 (p-value of 0.01) which indicates that the lagged values of SLFI are jointly statistically significant in explaining output growth at the 1 percent level.

³⁰ Dickey Fuller tests suggest that all series used in the VAR models are stationary.

³¹ The lag order was selected using the standard information criteria: the Final Prediction Error (FPE), the Akaike information criterion (AIC), the Bayesian (Schwarz) information criterion (BSIC), and the Hannan-Quinn information criterion (HQIC). Both BSIC and HQIC generally recommend a lag order of 2 or 3, while FPE and AIC recommend a lag order of 4 or 5. Lutkepohl (2005) shows that SBIC and HQIC give consistent estimates of the true lag order, while the AIC and the FPE tend to overestimate it. We estimate both models with 3 lags. The results do not change significantly if the lag order is increased to 4 or 5, but the number of degrees of freedom is reduced considerably. The results are only modestly weaker if the model includes only 2 lags.

Equation 4 tests the reverse causality, where the dependent variable is SLFI and the independent variables are IP growth, spread, and inflation. The Chi-squared statistic on lags of output growth is 0.67 (p-value of 0.88) and so the lagged values of IP growth are not statistically significant in explaining SLFI. Thus, it is possible to conclude that SLFI Granger-causes variation in IP growth, even after one has controlled for shocks to interest rate spread and the inflation rate, both of which are also statistically significant predictors of output growth.³²

Exhibit 4 reports the results of the Granger causality tests when economic activity is measured by the growth rate in the Balke-Gordon estimate of GNP. From equation 1, it is clear that the lagged values of SLFI are significant explanatory factors for explaining the variation in GNP growth holding the lagged values of inflation and the credit spread constant (Chi-squared statistic 8.16, p-value 0.04). Estimates of equation 4 show that reverse causality does not hold; lagged values of GNP growth do not help to explain the variation in SLFI (Chi-squared statistic 1.44, p-value 0.70). Thus, SLFI Granger-causes variation in GNP growth, even after one has controlled for shocks to interest rates and the inflation rate.

C. Impulse Response Functions

The quantitative effect of a bank-failure shock can be illustrated using cumulative orthogonalized impulse response (COIR) functions. COIR functions trace out the change that occurs over time to the value of one variable in the system as another variable in the

³² The Chi-square test results in Table 1 show that both the spread and inflation also Granger-cause movements in IP growth.

system is shocked.³³ Exhibit 5 plots the cumulative impulse response function estimates of the IP growth rate effects of a one-standard deviation rate shock to SLFI (an unexpected increase of about 14.6 basis points) along with 90 percent confidence intervals around the cumulative impulse response estimates. The COIR estimates suggest that a SLFI shock has a statistically significant and long-lasting effect on industrial production. In terms of magnitudes, a one standard deviation increase (0.146 percent) translates to a cumulative decline of about 2.4 percentage points after three quarters, before converging to the 1 percentage point decline after 10 quarters.³⁴

Exhibit 6 plots the COIR estimates for GNP growth along with the 90 percent confidence bands. The COIR estimates suggest that a one-standard deviation unexpected increase to SLFI (an increase of 14.5 basis points) has a statistically significant, long-lasting depressing effect on GNP growth, causing a cumulative decline of about 1 percentage point after three quarters with lingering effects for more than 10 quarters.³⁵

Our results indicate that bank failures have a sizable, negative and protracted effect on both IP growth and GNP growth. These long-lasting effects are not a consequence of anomalous data conditions. The eigenvalues of the moving average representation of the VAR model matrix have modulus less than one, a condition required for dynamic stability in the VAR process (Lutkepohl, 2005).

Our findings are consistent with the results of a number of other studies that find long-term effects of bank failures. For example, Anari, Kolari, and Mason (2005) find

³³ To obtain a structural model with orthogonal innovations we employ the Cholesky decomposition with the equations ordered as they appear in Exhibits 3 and 4. Changing the order of the variables had minimal effects on the results.

³⁴ Alternatively, a 1 percentage point unexpected increase in SLFI (a very large shock) will result in a 16.5 percent cumulative decline in IP after 3 quarters.

³⁵ Alternatively, a 1 percentage point unexpected increase in SLFI will result in a 6.9 percent cumulative decline in GNP after 3 quarters.

that a one-standard deviation shock to failed-bank deposits during the Depression Era had negative effects that lasted up to five years. This can be explained, in part, because bank failures during this period had a long-lasting effect on transactions balances. It took years to recover failed bank deposits and loss rates were typically large.

There are other studies that find long term effects of bank failures during a different historical period. Using a cross-country sample of modern systemic banking crisis, Hogart, Reis and Saporta (2005) find that, on average, banking crises effect GDP growth for about 3 years and result in a cumulative decline in GDP of about 11.5 percent relative to trend. Using similar data but a different methodology, Boyd, Kwak and Smith (2005) [BKS] find that many economies operate well-below estimates of long-run trend GDP for many years following a banking crisis with cumulative lost growth possibly as large as 300 percent of pre-crisis GDP in some cases.

There are plausible mechanisms that can explain why bank failures have long-lived effects. Ennis and Keister's (2003) develop an endogenous growth model in which Diamond and Dybvig (1983) bank runs reduce capital accumulation and growth. Banking crisis can also leave a lasting impact on consumer and investor expectations with negative effects on growth. Giuliano and Spilimbergo (2009) use survey evidence and demonstrate that consumer and investor expectations are permanently altered by the economic environment they experience. Ramirez (2009) finds evidence that the Panic of 1893 eroded consumer confidence in banks for many years subsequent to the crisis which reduce banks' lending capacity, and growth.

D. Forecast Error Variance Decomposition

One way to measure the importance of bank-failure shocks for explaining variations in IP and GNP growth is the forecast error variance decomposition (FEVD). FEVD measures the extent to which innovations in a particular variable in the VAR system contribute toward generating time-variation in a particular VAR dependent variable over a selected time horizon. Exhibit 7 plots the FEVD for SLFI on IP growth (left panel) and GNP growth (right panel). Our estimates suggest that time variation in SLFI is responsible for generating about 5 percent of the volatility of the IP growth rate over an ten-quarter horizon and about 5 percent of the volatility in GNP growth over the same interval.

E. Bank Failure Rates as Measures of Banking System Distress

Grossman (1993) examined the effect of national bank failures over period 1863-1914 and found strong negative growth effects of bank failures on aggregate output using an alternative measure of bank failures—the failure rate among national banks. Exhibit 8 presents the results of Granger causality test results when two alternative measures of the bank failure rate are used in place of the SLFI measure of banking system distress: the change in the total bank failure rate (left column of Exhibit 8), and the change in the failure rate of national banks (right column of Exhibit 8).

When banking system distress is measured by either failure rate series, the bank failure rates do not Granger-cause reductions in IP growth or GNP growth. The Chi-square values for the bank failure rate in Exhibit 8, Equation 1 are not statistically significant in any of the VAR specifications. Moreover, the Chi-Square estimates in

Equation 4 suggest that lagged values of IP growth are statistically significant in explaining the alternative bank failure rate series. In contrast, lagged GNP growth has no explanatory power for either of the bank failure rate series. Thus, when banking system distress is measured by the frequency of bank failures instead of SLFI, the rate at which banks fail appears to be caused by real-side economic disruptions whereas IP growth and GNP growth are unaffected by the frequency of bank failures. Banking system distress is not properly measured unless the size of failing banks is taken into account.

V. New York, Connecticut and the Panic of 1907

The Panic of 1907 began in New York in October after an unsuccessful investment ploy to corner the stock of the United Copper Company. The failed attempt at cornering the market caused the failure of two brokerage houses. In the days following the attempt, a number of banks and trusts with direct and indirect links to the cornering scheme experienced depositor runs. Ultimately, 42 depository institution failures have been linked to the 1907 Panic (Wicker, 2000, p.87) including 13 depository institution suspensions in New York in October 1907 (*ibid.* p.86).³⁶ In contrast to the New York experience, there were no suspensions of depository institutions in Connecticut.

The financial panic of 1907 occurred against the backdrop of a steep recession that likely began in the early summer. Industrial production fell by 11 percent between May 1907 and June 1908; commodity prices fell 21 percent; and unemployment increased from 2.8 percent to 8 percent.³⁷ While no official GNP estimates are available for this period, estimates constructed by Romer (1989) suggest that GNP declined by

³⁶ Moen and Tallman (1992) highlight the role of trust companies in aggravating this panic. See also Moen and Tallman (1990).

³⁷ These data are quoted from Bruner and Carr (2007), pp. 141-142 from primary sources.

about 4.2 percent while alternative estimates constructed by Balke-Gordon (1989) put the decline at 5.5 percent. In another measure of economic activity, the dollar volume of bankruptcies increased by almost 50 percent November 1907, the month following the onset of the banking panic.

Banking and economic conditions were largely similar in New York and Connecticut in the years leading up to the panic of 1907. Exhibit 9 presents statistics that compare economic and banking conditions between New York and Connecticut. At the turn of century, income per capita estimates suggest that New York was slightly poorer than Connecticut, but both states enjoyed income levels and literacy rates that were well above the rest of the country. Both states were heavily involved in the manufacturing sector: New York's capital-to-output ratio was more than twice as high as the national average whereas Connecticut's was nearly three times as large. In addition, both states enjoyed high levels of financial depth—bank assets per capita and deposits per capita were 6 to 7 times larger than the levels for the rest of the country. These figures, along with the number of banks per 10 thousand inhabitants suggest that banks in New York and Connecticut were, on average, larger institutions than those in the rest of the country; New York institutions, moreover, were larger than those in Connecticut.

There are no statistics that can be used to directly assess the *ex ante* relative risk of banks in New York compared to those in Connecticut. New York institutions were larger than those in Connecticut which, holding constant other things, should make them safer institutions. Although the capital-asset ratio was slightly lower in New York, banks in that state were allowed to open branches at the time and the literature supports the hypothesis that branching reduced the probability of failure. Double liability laws have

also been shown to discourage bank risk-taking (Grossman, 2001), and the shareholders of failing banks in New York were subject to double liability. On balance, there is no strong reason to believe that bank risk exposures differed significantly across these states. Overall, we argue that conditions in New York and Connecticut are sufficiently similar prior to 1907 to justify using a difference-in-difference (DID) methodology to estimate the effect of the Panic of 1907 on economic conditions at the state level.

Exhibit 10 presents summary statistics for the data used to isolate the effect of the Panic on 1907 on non-bank commercial failures in New York and Connecticut. In 1906, the liabilities of failed banks in New York amounted to \$0.28 per capita. This figure increased to an average of \$10.15 for 1907, and \$8.18 for 1908, before returning to approximately normal (1906) levels in 1909. During this period, Connecticut saw no failures at all while the remainder of the country experienced bank failures, but at an intensity level far below the New York experience.

We use the liabilities of non-bank commercial failures per capita (commercial failures) to measure the effect of bank failure on economic activity.³⁸ Exhibit 10 also reports these figures for New York, Connecticut, and the rest of the country. Commercial failures per capita are roughly comparable across the three geographic regions in 1906, but they increase sharply in New York in 1907 and remain elevated in 1908. While the commercial failure series more than doubles in Connecticut in 1907, the relative increase is minor compared to New York and, the Connecticut series reverts to its 1906 level by 1908.

³⁸ Liabilities of bank failures are from *Dun's Review*, year-end figures. Liabilities of commercial failures are also from *Dun's Review*, year-end figures, and are defined as the sum of the classified failures for manufacturing, trading, and other commercial entities.

Difference-in-Difference (DID) Test

A DID approach is used to estimate the effect of bank failures on these two states economies. The approach uses a control group to eliminate the effect of confounding factors. The variables used in the test are defined in Exhibit 11.

The DID methodology isolates the commercial failure rate in a specific quarter and estimates the difference in the incidence of commercial failures for New York and then separately for Connecticut relative to the rest of the country in that specific quarter. The econometric specification is,

$$c_{it} = \sum_{i=1}^{48} \mu_i \text{State}_i + \alpha_1 \text{Quarter}_j + \alpha_2 \text{NY} * \text{Quarter}_j + \varepsilon_{1t} \quad (3)$$

$$c_{it} = \sum_{i=1}^{48} \mu_i \text{State}_i + \alpha_1 \text{Quarter}_j + \alpha_3 \text{Conn} * \text{Quarter}_j + \varepsilon_{2t} \quad (4)$$

c_{it} is a measure of commercial distress in state i on date t . Following Card and Krueger (1994), the coefficient estimates $\hat{\alpha}_2$ and $\hat{\alpha}_3$, are used to construct the DID estimate of the effect of bank failures on commercial failures in Connecticut and New York. Because of the functional form, the coefficient estimates are elasticities.

The sample includes 576 quarterly estimates of the commercial failure rate per capita, one for each quarter over the period 1906 Q1-1908 Q4 for each of the 48 contiguous states. We estimate treatment effects separately for four individual quarters: 1906 Q4 (exactly a year before the panic), 1907 Q4 (panic quarter), 1908 Q1 (first quarter after the panic), and 1908 Q2 (second quarter after the panic).

Exhibit 12 presents the regression results for the different quarters, starting with 1906 Q4, continuing with 1907 Q4, and 1908 Q1 and 1908 Q2. The first column of Exhibit 12 reports the treatment effect when the “state” is equal to New York, and the

quarter of interest is 1906 Q4. The estimates suggest that the change in the rate of commercial failures in New York during the last quarter of 1906 was not statistically different from the change in the commercial failure rate experienced in all other states. The coefficient estimate, $\hat{\alpha}_2 = -0.073$, is not statistically significantly different from zero.

The second column of Exhibit 12 estimates the treatment effect for Connecticut in 1906 Q4. For Connecticut, the estimated treatment effect, $\hat{\alpha}_3 = -0.042$ is also not significantly different from zero indicating that the quarterly change in commercial failures in Connecticut was close to the change experienced by all other states in 1906 Q4. Thus, exactly one year before the panic took place, business conditions as measured by the log of business failure liabilities per capita were normal in both New York and Connecticut relative to conditions in the rest of the country.

The remaining columns in Exhibit 12 show the effects of the banking failures associated with the Panic of 1907. Beginning in 1907 Q4, the quarter of the banking panic, the commercial failure experiences of New York and Connecticut diverge markedly. Column 3 in Exhibit 12 shows that New York experienced a tremendous increase in commercial distress ($\hat{\alpha}_2 = .757$), while column 4 shows that Connecticut experienced a *decline* in commercial failures ($\hat{\alpha}_3 = -.314$). A t-test of the difference of these two coefficients confirms that commercial failures in New York in 1907 Q4 are elevated relative to those in Connecticut.³⁹ Thus, during the panic, it is evident that New York suffered disproportionately more than the other states in terms of commercial distress, while Connecticut, if anything, experienced more benign economic conditions.

³⁹ The t-test of the difference of these two coefficients is 6.31, which is statistically significant at the less than 1 percent level. The t-test of the difference of these two coefficients at t+1 is 1.68, which is statistically significant at the 5 percent level by a one-tailed test. The coefficients are not statistically different from each other in the other two quarters (t-4 and t+2, where t is the panic quarter).

The regression results reveal that the effects of the banking panic on commercial distress in New York continued for at least another quarter. The treatment estimate for 1908 Q1 ($\hat{\alpha}_2 = .233$) is also positive and statistically significant. It is also statistically different from the 1908 Q1 estimate for Connecticut ($\hat{\alpha}_3 = -.069$). The estimates indicate that economic distress associated with the 1907 banking panic continued in New York while Connecticut remained unaffected by the crisis. It is not until 1908 Q2 that the New York treatment coefficient ($\hat{\alpha}_2 = .078$) indicates that business conditions in New York returned to normal relative to those prevailing in the rest of the country. These estimates do not necessarily indicate that business conditions *everywhere* return to normal levels during the second quarter of 1908. If commercial distress had spread to the rest of the nation by 1908 Q2, the situation in New York had converged with conditions in the rest of the country, but economic conditions could be more challenging than average in all states.

VI. Concluding Remarks

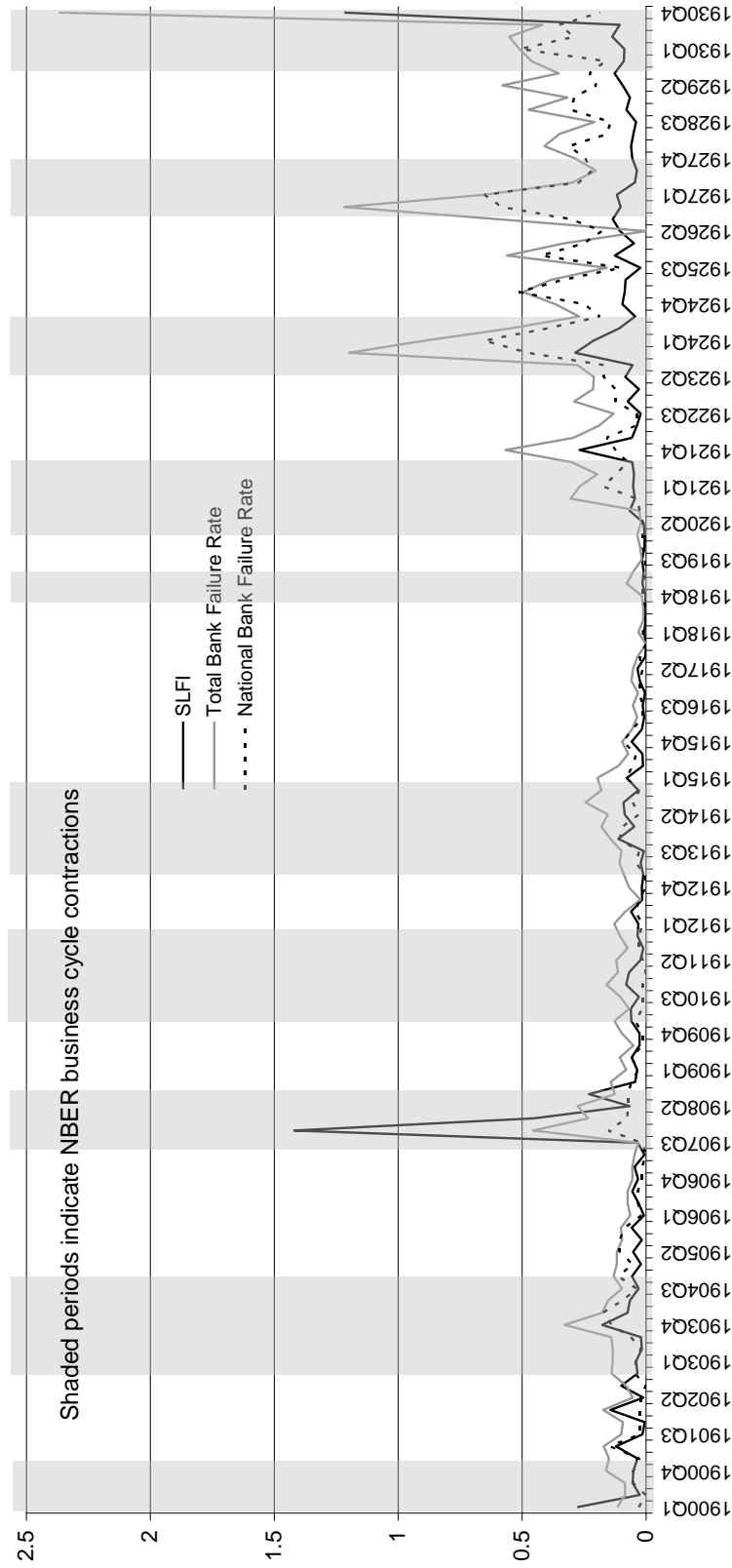
Using data from 1900 to 1930, a period that predates active government stabilization policies, we have shown that bank failures have a statistically and economically important negative effect on economic activity. Our results suggest that an increase in the share of liabilities in failed depository institutions has a negative and long-lasting effect on the growth rate of industrial production and GNP growth. Within three quarters of the shock, a 1 percent unexpected increase in the liabilities of failed banks (an exceptionally large shock) is estimated to cause industrial production to contract by 16.5 percentage points and GNP to contract by 6.9 percentage points. Estimates suggest that, absent government intervention to offset the impact of failures, bank failures impose a

drag on real economic activity for at least 10 quarters. To put the magnitude of this shock into perspective, according to regulatory data, as of 2009 Q4, 14 individual U.S. banks held in excess of 1 percent of total domestic U.S. deposits.

Our estimates demonstrate that bank failures have important negative externalities that reduce economic growth and the magnitude of these externalities are linked directly to the share of banking system liabilities of the failing institutions. Given the magnitude of our estimates, it is perhaps not surprising that banking policy was an active source of political debate during this era and eventually the government promulgated policies and institutions, including bank deposit insurance, new more efficient bank resolution policies, and prudential bank supervision-to help mitigate the cost of bank systemic risk.⁴⁰ In more modern banking crisis, government policies that counterbalance the negative economic effects of bank failures have been in force. Government bank safety net and regulatory policies may however have encouraged moral hazard and additional bank risk-taking which magnified the size of banks and the losses generated by bank failures in more recent periods. On balance, it is an open issue whether government safety net and regulatory policies have resulted in smaller contractions in output growth in more recent periods of U.S. banking system distress.

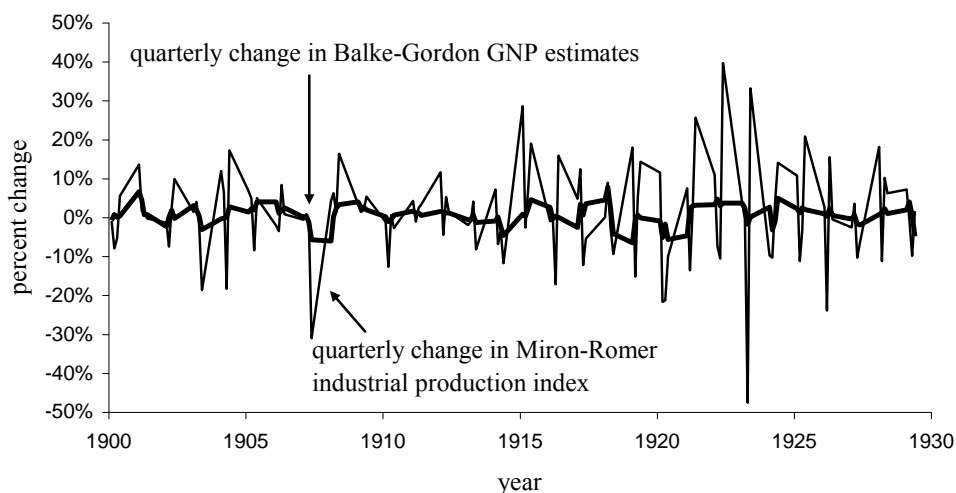
⁴⁰ Public debate on banking policies began well before the period studied in this paper. State deposit insurance began in 1829 (White, 1983, p. 190) with the founding of the New York Safety Fund. The first national debate on the merits of deposit insurance likely occurred in 1893 when William Jennings Bryan introduced a bill that would establish a national deposit insurance fund (*ibid.*). Following the Panic of 1907, there was an important national debate focused on banking system reforms designed to enhance bank stability that led ultimately to the creation of the Federal Reserve System in 1913.

Exhibit 1: Alternative Measures of Banking System Distress



Source: *Dun's Review* (1900-1930), *Historical Statistics of the United States* (Series X585), *All Bank Statistics*, NBER business cycle dates, and authors' calculations.

Exhibit 2: Alternative Measures of the Change in Aggregate Economic Activity



Source: Gordon (1986, p.781), Miron and Romer (1990, pp. 336-7), and the authors' calculations.

Exhibit 3: Granger causality when economic activity is measured by IP growth and banking system distress is measured by the share of liabilities in failed institutions

Left-hand-side variable	Right-hand-side variable (lagged)	Chi-squared	p-value
Equation 1: IP growth	Spread	8.08	0.04
	Inflation	16.67	0.00
	SLFI	10.94	0.01
	All Variables	35.50	0.00
Equation 2: Spread	IP growth	0.89	0.82
	Inflation	2.95	0.40
	SLFI	4.17	0.24
	All Variables	9.41	0.40
Equation 3: Inflation	IP growth	0.72	0.87
	Spread	11.12	0.01
	SLFI	1.47	0.69
	All Variables	14.44	0.11
Equation 4: SLFI	IP growth	0.67	0.88
	Spread	5.74	0.13
	Inflation	0.07	0.99
	All Variables	6.61	0.68

Exhibit 4: Granger causality when economic activity is measured by GNP growth and banking system distress is measured by the share of liabilities in failed institutions

Left-hand-side variable	Right-hand-side variable (lagged)	Chi-squared	p-value
Equation 1: GNP growth	Spread	12.78	0.01
	Inflation	6.86	0.08
	SLFI	8.16	0.04
	All Variables	28.92	0.00
Equation 2: Spread	GNP growth	0.45	0.93
	Inflation	2.63	0.45
	SLFI	4.44	0.22
	All Variables	8.93	0.44
Equation 3: Inflation	GNP growth	1.09	0.78
	Spread	12.72	0.01
	SLFI	1.33	0.72
	All Variables	14.85	0.09
Equation 4: SLFI	GNP growth	1.44	0.70
	Spread	5.34	0.15
	Inflation	0.41	0.94
	All Variables	7.42	0.59

Exhibit 5: Cumulative Orthogonalized Impulse Response of IP Growth to a One-Standard Deviation Shock in SLFI

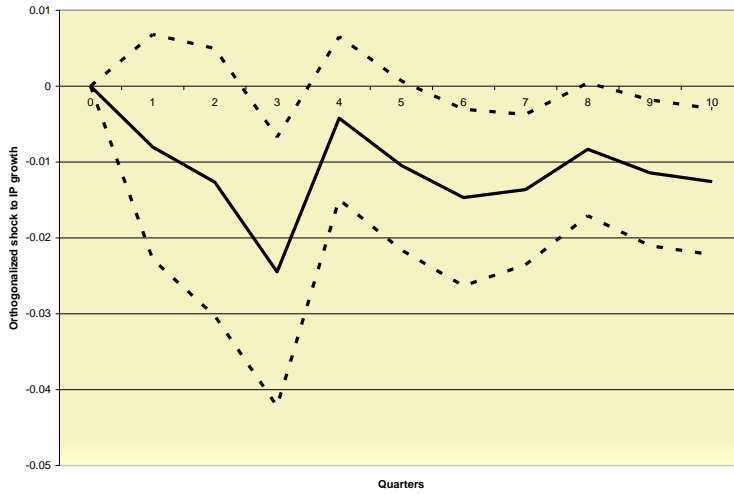


Exhibit 6: Cumulative Orthogonalized Impulse Response of GNP Growth to a One-Standard Deviation Shock in SLFI

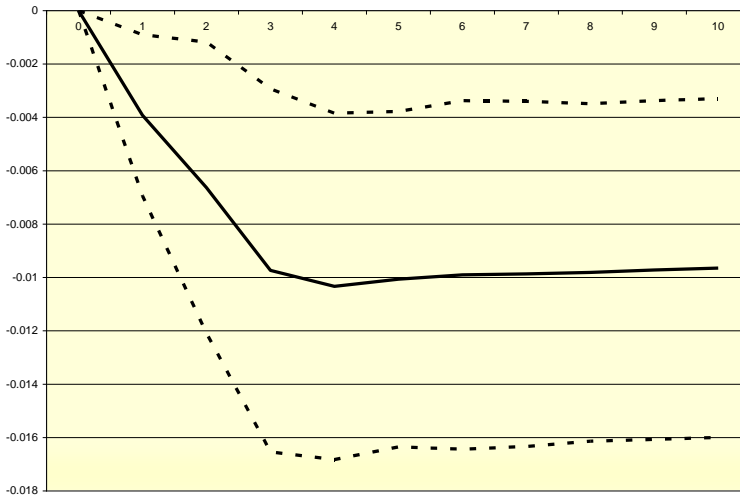


Exhibit 7: Forecast error variance decomposition for IP growth and GNP growth for innovations in the share of liabilities in failed institutions

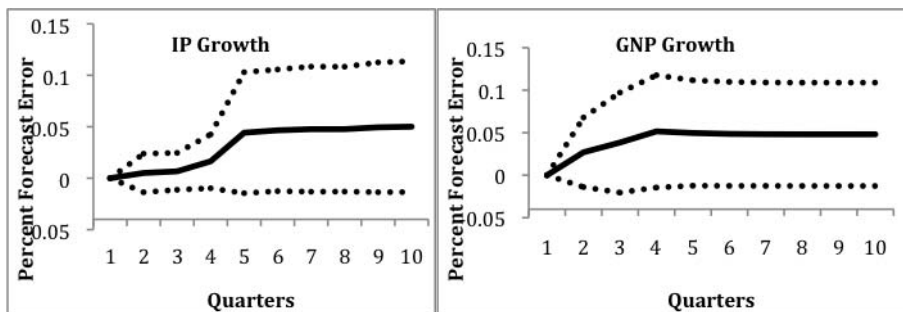


Exhibit 8: Granger causality when banking system distress is measured by the total bank failure rate and national bank failure rate

Industrial Production Growth Rate VARs				GNP growth Rate VARs			
Left-side variable	Right-side lagged variables	Chi-Squared	p-value	Left-side variable	Right-side lagged variables	Chi-Squared	p-value
Equation 1: IP growth	Spread	5.97	0.113	Equation 1: GNP growth	Spread	13.95	0.003
	Inflation	12.76	0.005		Inflation	6.51	0.089
	Change in total bank failure rate	5.18	0.159		Change in national bank failure rate	1.60	0.659
	All variables	28.62	0.001		All variables	21.42	0.011
Equation 2: Spread	IP growth	1.86	0.601	Equation 2: Spread	GNP growth	0.65	0.885
	Inflation	2.19	0.535		Inflation	2.23	0.526
	Change in total bank failure rate	2.08	0.557		change in national bank failure rate	2.88	0.411
	All variables	7.22	0.614		All variables	7.33	0.602
Equation 3: Inflation	IP growth	1.47	0.689	Equation 3: Inflation	GNP growth	0.73	0.866
	Spread	8.51	0.036		Spread	11.35	0.010
	Change in total bank failure rate	2.56	0.464		Change in national bank failure rate	3.47	0.324
	All variables	15.65	0.075		All variables	17.06	0.048
Equation 4: Change in total bank failure rate	IP growth	29.63	0.000	Equation 4: Change in national bank failure rate	GNP growth	2.16	0.540
	Spread	6.82	0.078		Spread	0.62	0.892
	Inflation	0.72	0.868		Inflation	2.15	0.542
	All variables	36.49	0.000		All variables	4.00	0.911

Exhibit 9: Selected statistics for New York, Connecticut and the rest of the country

VARIABLE	NEW YORK	CONNECTICUT	REST OF COUNTRY
Income per capita, 1900	\$490	\$540	\$407
Illiteracy rate, 1900	1.6%	1.0%	2.8%
Manufacturing Capital/State Income, 1900	1604	2216	750
Bank Asset per capita, 1896	\$1,249	\$1,062	\$187
Deposits per capita, 1896	\$1,000	\$827	\$111
Bank capital-Asset Ratio, 1896	7.3%	10%	22.2%
1900 Branching dummy	1	0	0.35
Min Capital Requirement (\$1,000)	25	na	18
Num Bank per 10,000 pop, 1896	1.35	2.4	1.7
Double Liability dummy	1	0	0.58

Sources: Income per capita in 1900—Easterlin (1960), figures are in 1967 dollars; Illiteracy rate in 1900—defined as the number of illiterate persons over 21 years of age in 1900 divided by population in 1900, U.S. Bureau of the Census (1900); Manufacturing capital—U.S. Bureau of the Census (1900); Bank Assets (all banks)—Flood (1998), figures are in 1967 dollars; Bank Deposits (all banks)—Flood (1998), figures are in 1967 dollars; Capital Asset ratio—defined as total equity divided by total assets, equity figures are from Flood (1998); 1900 branching dummy—Dehejia and Lleras-Muney (2007); Minimum capital requirements—White (1983); Number of banks per 10,000 habitants—number figures are from Flood (1998); 1910 Double liability dummy—Welldon (1910), Table A.

Exhibit 10: Bank failures and commercial failures between 1906 and 1909 in New York, Connecticut, and the rest of the country

year	Bank Failures Per Capita			Commercial Failures Per Capita		
	New York	Connecticut	Rest of Country	New York	Connecticut	Rest of Country
1906	\$0.88	\$0.00	\$0.44	\$5.94	\$3.47	\$2.72
1907	\$30.21	\$0.00	\$2.92	\$20.12	\$7.89	\$2.98
1908	\$25.25	\$0.00	\$0.59	\$15.99	\$3.49	\$4.44
1909	\$1.06	\$0.00	\$0.52	\$9.68	\$4.18	\$2.89

Source: *Dun's Review*, year-end figures for 1906, 1907, 1908 and 1909. All figures are in 1967 dollars. Conversion is done using Wholesale Price Index, Series E23, U.S. Bureau of the Census (1975). Population figures are from U.S. Bureau of the Census (1900).

Exhibit 11: Variable definitions for differences-in-differences analysis

c_{it}	$Log\left(1 + \frac{\text{liabilities of commercial failures in state } i}{\text{population in state } i}\right)$
$State_i$	An indicator variable for each of the 48 states
$Quarter_j$	an indicator variable that identifies the quarter for which we are estimating the economic impact of bank failures
NY	an indicator variable equal to 1 if the state is New York
$Conn$	an indicator variable equal to 1 if the state is Connecticut
$NY * Quarter_j$	Interaction term for quarter and New York State
$Conn * Quarter_j$	Interaction term for quarter and Connecticut

Exhibit 12: Difference-in-difference regression results: New York vs. Connecticut

Effect in Quarter	1906 Q4	1906 Q4	1907 Q4	1907 Q4	1908 Q1	1908 Q1	1908 Q2	1908 Q2
$\hat{\alpha}_1$ (average quarter effect)	-0.066 (0.040) [0.098]	-0.066 (0.040) [0.095]	0.136 (0.047) [0.004]	0.158 (0.049) [0.001]	0.251 (0.042) [0.000]	0.258 (0.043) [0.000]	0.063 (0.036) [0.085]	0.067 (0.036) [0.063]
$\hat{\alpha}_2$ (NY effect)	-0.073 (0.144) [0.613]		0.757 (0.122) [0.000]		0.233 (0.139) [0.094]		0.078 (0.143) [0.587]	
$\hat{\alpha}_3$ (Conn. effect)		-0.042 (0.114) [0.712]		-0.314 (0.118) [0.008]		-0.069 (0.114) [0.548]		-0.155 (0.113) [0.171]
R^2 -within	0.006	0.006	0.044	0.032	0.085	0.084	0.005	0.006
R^2 -between	0.261	0.012	0.261	0.012	0.264	0.012	0.261	0.012
R^2 -overall	0.002	0.003	0.047	0.018	0.057	0.05	0.005	0.003

Notes: The dependent variable is $Log(1 + (\text{liabilities of commercial failures}/\text{population}))$. Each regression is estimated with 576 observations. “NY effect” is the interaction term for New York and the specific quarter indicated in the column heading. “Conn. effect” is the interaction term for Connecticut and the specific quarter indicated in the column heading. Fixed effects for each state are estimated but the estimates are not reported. White (1980) robust standard errors are presented in parenthesis under each estimated coefficient. P-values are presented in brackets.

Appendix

Table A: Data and Sources

Data Series	Source
U.S. Commercial Paper Rates, New York City 01/1857-12/1971 (m13002)	http://www.nber.org/databases/macrohistory/contents/chapter13.html
Great Britain Open Market Rates of Discount, London 01/1824-11/1939 (m13016)	http://www.nber.org/databases/macrohistory/contents/chapter13.html
U.S. Index of the General Price Level 01/1860-11/1939 (m04051)	http://www.nber.org/databases/macrohistory/contents/chapter04.html
Miron-Romer Industrial Production Series, JEH	Journal of Economic History, Vol. 50, June 1990, p. 321-337
Balke-Gordon GNP Series	Gordon (1986), <u>The American Business Cycle, Continuity and Change</u>
Num of Bank Failures	Banking and Monetary Statistics, 1943, p. 283
Total Number of Banks, All banks	HSUS, Series X580
Deposits at Failed or Suspended Banks	<u>Dun's Review</u> , various years
Total Deposits, All Banks	HSUS, Series X585

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