

Bank Failures and the Cost of Systemic Risk:

Evidence from 1900-1930*

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Revised:

March 2010

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JEL Classification Codes: N11, N21, E44, E32

* The views and opinions expressed here are those of the authors and do not necessarily reflect those of the Federal Deposit Insurance Corporation. We are grateful to Mark Flannery, Ed Kane, Thomas Philippon, Peter Praet, Lee Davidson, Vivian Hwa, and Daniel Parivisini for helpful comments and suggestions. Ramirez acknowledges financial support from the FDIC's Center for Financial Research.

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**Bank Failures and the Cost of Systemic Risk:
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Abstract:

This paper investigates the effect of bank failures on economic growth using new data on bank failures from 1900 to 1930. The sample period predates active government stabilization policies 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. The evidence supports the hypothesis that bank failures reduce economic growth and provides a lower bound estimate of the cost of banking sector systemic risk.

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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), and Krosner, Laeven and Klingebiel (2007) and Dell'Araccia, Detragiache, and Rajan (2008) have used cross-country data on

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. A common feature of all discussions of systemic risk is the existence of a mechanism whereby losses to one financial institution create losses for many other financial institutions. Few of these models directly address the real economic consequences of systemic risk.

modern banking crises to estimate the loss in output associated with systemic banking crisis. These studies find that banking crisis are associated reductions in the final demands of 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 crisis many of which are linked with currency crisis. There is no consensus regarding the reduction in lost 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. There are at least two reasons why this sample period is likely to yield new insights. First, prior to the

³ It is worth pointing out that the costs we are referring to in this paper are the consequences of systemic bank failures on economic growth, not the fiscal costs 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).

enactment of federal deposit insurance legislation in 1933, the United States experienced repeated banking panics, some of which occurred when economic conditions were quiescent. While many banks failed or temporarily suspended redemptions during banking panics, many of the banks that failed during the panics were not insolvent because of deteriorating macro-economic conditions.⁴ If banking crises include a banking sector shock that is independent of shocks to the real economy then we can better identify the linkage between the health of the banking sector and subsequent economic growth. Second, as we document in more detail below, during this period there were no federal government institutions or policies implemented to counteract the effects of bank failures and exert a stabilizing influence on the economy. These two important characteristics of this sample period allow us to use new data on banking system distress to identify new estimates of the economic costs of bank failures.

In the analysis that follows, we use vector autoregression analysis (VAR) to estimate the effect of bank failures on both the growth rate of industrial production and aggregate output growth. 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

⁴ We argue that banking panics represent shocks to the health of the banking system are independent of contemporaneous shocks to economic growth during this period. Our assumption that banking crisis are in part generated by a banking sector shock that is independent of economic fundamentals is not above dispute. For example, Gorton (1988) argues that the banking panics during National Banking Era (1865-1914) can be explained by the rational responses of depositors reacting to new economic information that alters risk perceptions, whereas banking panics over the period 1914-1934 are more severe than can be predicted based on changing economic fundamentals alone. Calomiris and Mason (1997) [CM] analyze bank failures during the 1932 banking panic and reach a different conclusion. CM find that failed banks were financially weak and would likely have failed under non-panic conditions as well. Carlson (2008) takes issue with the CM analysis and concludes that there is a high probability that many of the banks that failed in 1932 would have been acquired, merged or recapitalized in a non-panic period.

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 economic 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 industrial production (IP) growth and a cumulative 1 percent decline in GNP growth over the following three quarters.⁵ 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 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.⁶

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

⁵ To put the magnitude of the shock into perspective, as of 2009 Q4, 14 U.S. banks held 1 percent or greater share of domestic U.S. deposits.

⁶ 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 further below.

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 and 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 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. Our findings predate active government policies aimed at mitigating the negative economic effects of bank failures—policies such as uniform standards for prudential bank supervision, federal deposit insurance, and efficient bank resolution policies. These policies may have helped to attenuate the negative costs associated with a bank failure, but they also may have promoted moral hazard and increased bank risk taking. Whether or not these policies have on balance reduced the negative externalities associated with banking sector distress is an open issue.⁷

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

⁷ Poorly designed government policies may alter bank risk taking incentives and create additional social costs not present in our sample period. See for example, Demirguc-Kunt and Kane (2002) and Kaufman and Scott (2003).

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 Overview⁸

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 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

⁸ The literature on this issue is large and our selected review highlights only the key issues in the literature.

multiplier and the money supply. Because the decline in the money supply was not offset by monetary policy, nominal economic activity declined.⁹

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.¹⁰

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 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

⁹ 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.

¹⁰ 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).

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.¹¹ 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 1935.¹² While there were no Canadian bank failures in 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.

¹¹ 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.

¹² 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 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.

Many countries in Central and Eastern Europe also experienced banking crisis during the Great Depression era.¹³ 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.¹⁴

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 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

¹³ 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.

¹⁴ 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.

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 supervisory resolution process, undercapitalized depository institutions continued to fund lending activity.¹⁵ 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.¹⁶ 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 during the National Banking Era (1863–1914), Grossman (1993) 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. Grossman notes that these estimated magnitudes are large, but he argues that they are reasonable when compared to the historical record.

Grossman analyzes the effects of the number of national bank failures. Over the period he examined (1863-1914), roughly a third of banking system assets were held by state-chartered institutions and in many years, state-chartered banks outnumbered

¹⁵ See for example Kane (1989), or Romer and Weingast (1991).

¹⁶ See for example Clouse (1994), or Mussa (1994).

national banks (White 1983, pp.12-13). Importantly, in some periods, banking distress was concentrated in the state-chartered institutions that are excluded from Grossman's study.¹⁷ The Grossman study, moreover, does not account for the size of failed institutions. The importance of the negative externality generated by a bank failure should be related to the size of a bank as institution size is a proxy for the number (and size) of valuable relationships with bank-dependent borrowers as well as indicator of the bank's importance in providing transactions services.¹⁸ 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 effects 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, another one in October of 1907, and one during the early 1920s. In addition, it endured eight minor crises.¹⁹ Many of the banking crises were not preceded by large negative shocks to economic activity. Moreover, during this period, no federal government policies were used to stimulate the economy, counteract recessions, or offset the negative economic impacts of bank failures. We use a simple econometric

¹⁷ An important example is the Banking Panic of 1907. Measured by the failure rate among national banks, the 1907 Banking Panic was a mild event as the crisis was concentrated in state-chartered depository institutions. Calomiris and Gorton (1991, p. 150) identify only six national bank failures during this episode while Wicker (2000, p. 87) reports that 17 state-chartered trusts and 18 state-chartered banks either failed or suspended redemptions as a result of the crisis. Wicker, moreover, estimates that the trust failures accounted for 57 percent of the liabilities of all institutions that failed during this period.

¹⁸ 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.

¹⁹ Calomiris and Gorton (1991), p. 114; Miron (1986), p. 131; Kremmerer (1910), pp. 222-223.

model to help illustrate why these two data features enhance our ability to identify the economic cost of bank failures.²⁰

Consider a simplified model in which the health of the banking system affects economic activity, and economic activity also affects the health of the banking system. Let Y_t and B_t represent, respectively, economic activity and banking system health at time t . Let G_t represent the government contribution to economic activity. G_t captures the effects of monetary, fiscal, and banking regulatory and resolution policies. Let X_t (a vector) represent all other factors which are assumed to be exogenous or predetermined in this example and \tilde{u}_t , \tilde{v}_t and \tilde{w}_t represent, respectively, shocks to economic activity (\tilde{u}_t), the health of the banking sector (\tilde{v}_t), and government activity, (\tilde{w}_t). In most circumstances, these shocks will be correlated.

Beginning in the 1930s, government began introducing policies that were designed to offset direct shocks to economic activity as well as negative shocks to the health of the banking sector. The government reaction function has undergone many changes since the 1930s. As the public and their elected officials became more comfortable with a government role in aggregate demand management, countercyclical fiscal and monetary policies became an important feature of the macroeconomic environment and regulatory measures were undertaken to mitigate the economic impacts of bank failures. To capture these time dependent effects, we write the government reaction function as $g_t(X_t, \tilde{u}_t, \tilde{v}_t)$. Using these definitions, we can model the relationship between economic activity, exogenous factors, banking sector health, and government responses as,

²⁰ We are indebted to Thomas Philippon for suggesting that we include this discussion.

$$\begin{aligned}
Y_t &= \alpha X_t + \lambda B_t + G_t + \tilde{u}_t \\
B_t &= \gamma Y_t + \tilde{v}_t \\
G_t &= g_t(X_t, \tilde{u}_t, \tilde{v}_t) + \tilde{w}_t
\end{aligned}
\tag{1}$$

The system of equations specified in (1) is inherently complex. To estimate this system directly, one would have to specify a model for the evolution of the government's reaction function, $g_t(X_t, \tilde{u}_t, \tilde{v}_t)$, as the government's role in economic stabilization expanded dramatically since the 1930s. Without properly controlling for government reactions to recessions and banking sector distress, the relationship between banking sector health and economic activity cannot be accurately identified.

One important characteristic of our sample period is the role government played in shaping aggregate economic activity. During this period, the federal government and the Federal Reserve eschewed any policies to stabilize economic activity or mitigate the effects of banking sector distress. The details of the historical record are reviewed in the following subsections, but for purposes of this econometric example, the lack of any government stabilization activities allow us to ignore the effects of government and write the system as,

$$\begin{aligned}
Y_t &= \alpha X_t + \lambda B_t + \tilde{u}_t \\
B_t &= \gamma Y_t + \tilde{v}_t
\end{aligned}
\tag{2}$$

The second important feature of the sample period is a prevalence of bank panics in which banks experienced wide-spread unanticipated depositor runs, financial distress and failures that were not fully consistent with contemporaneous economic conditions. Banking panics are equivalent to a large negative shock to the health of the banking system, \tilde{v}_t , that are independent of the shocks to economic activity, \tilde{u}_t . The independent nature of the banking panic shocks in our data sample allows us to obtain more precise

estimates of the magnitude of the health of the banking sector's independent affect of economic activity.²¹

This simple structural econometric model is used to formalize our arguments about features of the data that enhance our ability to detect a relationship between the health of the banking system and the level of economic activity. In the sections that follow, we will estimate the relationship between banking system health and economic activity using VAR and difference-in-difference methods.

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.

²¹ An analytic illustration of how the banking crisis shocks help to identify the bank health effect on GDP appears in the appendix.

Monetary Policy

The Federal Reserve System, created in 1913, was established to smooth regional credit cycles associated primarily with agricultural borrowing demands.²² 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. 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.²³ A severe recession followed with widespread unemployment, declines in industrial production and substantial deflation.²⁴ 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

²² 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.

²³ 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).

²⁴ The severity of this recession has been in part attributed to a failure of Federal Reserve policy (Meltzer, 2003, p. 120-ff).

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 securities).²⁵ 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).

IV. Granger Causality Evidence

Data

A vector autoregressive model (VAR) is used to estimate the linkages between bank failures and subsequent economic growth. The 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 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 two 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

²⁵ See for example, the discussions in Costigoliola (1977) or Meltzer (2003).

quarterly observations for the 48 states from the first quarter of 1900 through the second quarter of 1931.²⁶ 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.²⁷ The failed depository liability series is normalized by total deposits as reported in Flood (1998).²⁸

We also construct an estimate of the time series of the failure rate of depository institutions. The 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).²⁹

Exhibit 1 shows the depository institution failure-rate series and the SLFI series on an annualized basis. The bank failure-rate series measures the proportion of depository institutions that were closed, either temporarily or permanently, between 1900 and 1930. Exhibit 1 also includes estimates of the recessionary periods (shaded bars) as identified by Romer (1999).

The two deposit institution failure series, plotted in Exhibit 1 suggest a significantly different record of banking system distress. The bank failure rate series is strongly procyclical with increases in the recessions of 1900, 1903, 1907, 1910, 1920,

²⁶ *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.

²⁷ *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).

²⁸ 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.

²⁹ Again, the denominator is a quarterly estimate interpolated from annual figures.

1924, and 1929. It reaches a local peak at the end or shortly following most of the recessions in the sample period.³⁰ In contrast, the SLFI series declines during the recessions of 1900, 1903, 1907, 1910, 1915, and 1927. It also has local peaks immediately prior to or very early into the recessions of 1900, 1907, 1910 and 1923. Exhibit 1 shows that the failure rate and SLFI series diverge in the early 1900s when failures were dominated by larger institutions and in the 1920s, when smaller institutions failed at a relatively higher rate.

The bank failure rate series is a misleading indicator of banking sector health in at least two important periods in the sample. 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 severity of the banking panic of 1907. The 1907 panic involved the failure or temporary suspension of only a few large money-center institutions, but these failures accounted for about 1.5 percent of all system deposits.³¹ This level of banking system distress was not exceeded until the Great Depression. The bank failure rate series also 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.

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.

³⁰ This pattern is clearly evident in 7 of the 9 recessions in the chart.

³¹ 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. Calomiris and Hubbard (1989), using pre-World War I data, 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).³² The second

³² 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 model substitutes the growth rate in the Balke-Gordon GNP series for the IP growth series.³³ Both VAR models are estimated using three lags.³⁴

A. 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.

³³ Dickey Fuller tests suggest that all series used in the VAR models are stationary.

³⁴ 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.³⁵

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.

B. 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

³⁵ 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.³⁶ 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.³⁷

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.³⁸

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

³⁶ 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.

³⁷ Alternatively, a 1 percentage point unexpected increase in SLFI will result in a 16.5 percent cumulative decline in IP after 3 quarters.

³⁸ Alternatively, a 1 percentage point unexpected increase in SLFI will result in a 6.9 percent cumulative decline in GNP after 3 quarters. The magnitude of the respective SLFI shocks differ slightly because the VAR systems are different (one includes GDP growth, the other IP growth).

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] also find substantial costs associated with banking crises. BKS find that many economies operate well-below estimates of long-run trend GDP for many years following a banking crisis. BKS estimate that, over the years following a banking crisis, cumulative lost growth could be as large 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 bank-runs (à la Diamond and Dybvig, 1983) 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 banking crisis reduce consumer confidence in banks for many years subsequent to the crisis. He shows that the Panic of 1893 lead depositors to move liquid assets away from bank deposits and into rudimentary forms of savings, including "money under the mattress,"

literally and figuratively. Following the Panic of 1893, people simply stopped trusting banks which reduced bank's lending capacity, and growth.

C. 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.

D. VAR Results with the Number of Bank Failures, instead of SLFI

Recall that Grossman (1993) examined the effect of national bank failures over period 1863-1914 and found strong negative effects of bank failures on aggregate output using an alternative measure of bank failures—the number of failed national banks relative to the total number of national banks. For purposes of comparison, Exhibit 8 presents Granger causality test results when the change in the bank failure rate is used in place of SLFI, our preferred measure of bank distress.

When banking system distress is measured by the changes in the failure rate, bank failures no longer Granger-cause reductions in IP growth; the Chi-square value in

Exhibit 8, equation 1 (5.18) is not longer statistically significant at conventional levels.³⁹ Moreover, the estimates in equation 4 suggest that lagged values of IP growth are statistically significant in explaining the bank failure rate. The Chi-square statistic of 29.63 is statistically significant.

These results highlight the importance of the proxy variable used to measure banking system distress. When banking system distress is measured by the depository institution failure rate instead of SLFI, banking system distress appears to be caused by real-side economic disruptions whereas IP growth seems to be unaffected by changes in the bank failure rate.

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).⁴⁰ 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

³⁹ The causality results for GNP growth are similar, so they are omitted in the interest of parsimony.

⁴⁰ Moen and Tallman (1992) highlight the role of trust companies in aggravating this panic. See also Moen and Tallman (1990).

increased from 2.8 percent to 8 percent.⁴¹ While no official GNP estimates are available for this period, estimates constructed by Romer (1989) suggest that GNP declined by 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

⁴¹ These data are quoted from Bruner and Carr (2007), pp. 141-142 from primary sources.

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, the data suggests 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.⁴² 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

⁴² 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.

is minor compared to New York and, the Connecticut series reverts to its 1906 level by 1908.

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,

$$c_{it} = \sum_{i=1}^{48} \mu_i State_i + \alpha_1(Quarter_j) + \alpha_2(NY * Quarter_j) + \varepsilon_{1t} \quad (3)$$

$$c_{it} = \sum_{i=1}^{48} \mu_i State_i + \alpha_1(Quarter_j) + \alpha_3(Conn * Quarter_j) + \varepsilon_{2t} \quad (4)$$

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, -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, -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.⁴³ 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.

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-

⁴³ 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).

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 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 they place a lower bound on the cost of banking sector systemic risk during this period. Given the magnitude of our estimates, it is perhaps not surprising that banking policy was an active source of political debate during this era.⁴⁴

It is tempting to extrapolate our results into modern times and argue that some form of intervention is necessary to avoid the protracted costs of banking sector systemic risk. Such inferences, however, are not as straightforward as they may seem. There have been many important structural changes in the banking sector that may have altered the cost of systemic risk. These include industry consolidation, the development of bank holding companies, the removal of prohibitions against interstate branching, and the growth of international and non-interest sources of bank income and the growth of the so-called shadow banking sector including securitized lending and money market substitutes

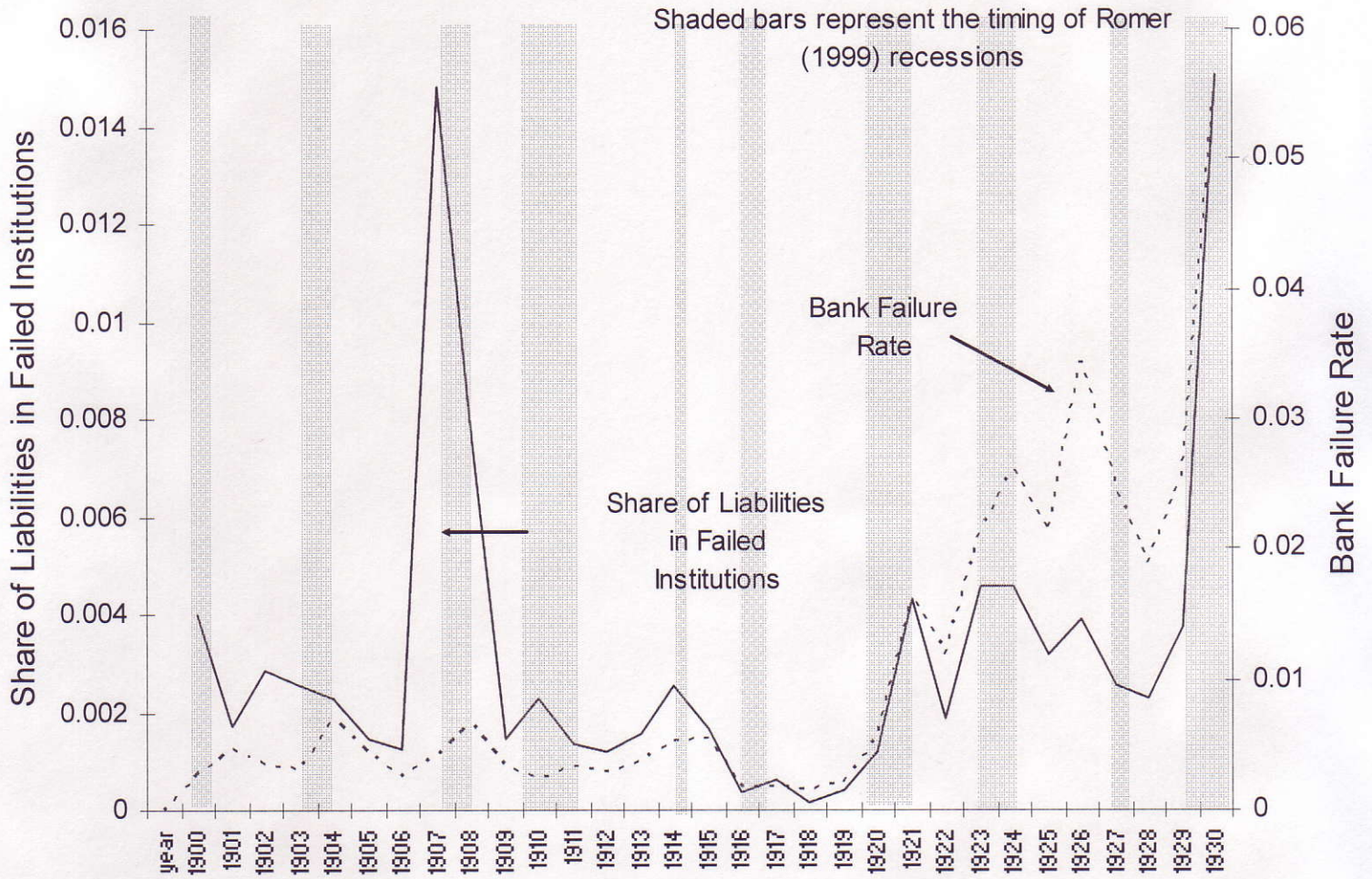
⁴⁴ Public debate on banking policies began well before the period studied in this paper. State deposit insurance began in 1829 (White, 1983, p. 190) with the founding of the New York Safety Fund. The first national debate on the merits of deposit insurance likely occurred in 1893 when William Jennings 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.

for transactions balances. In addition, the banking sector is now subject to many government policies and regulations—bank deposit insurance, efficient bank resolution policies, and prudential bank supervision—that likely help mitigate the cost of bank systemic risk. Given these changes, it is unclear whether a banking crisis in modern times would result in a protracted contraction in output growth, even in the absence of active fiscal and monetary policies, typically taken in the aftermath of such events.⁴⁵

There is another reason for remaining cautious about the necessity of intervention in the aftermath of banking crises. While government policies may help to mitigate the effect of bank failures on economic growth, some argue (ourselves included) that these government policies may also encourage moral hazard and additional bank risk-taking. The additional risk may create social costs by distorting resource allocation and partly offset the attenuating effect of government policies on the probability of banking sector distress. Thus, on balance, it remains unclear whether modern government banking sector policies should be expected to reduce the costs of systemic risk in the banking sector relative to those that prevailed in the early twentieth century.

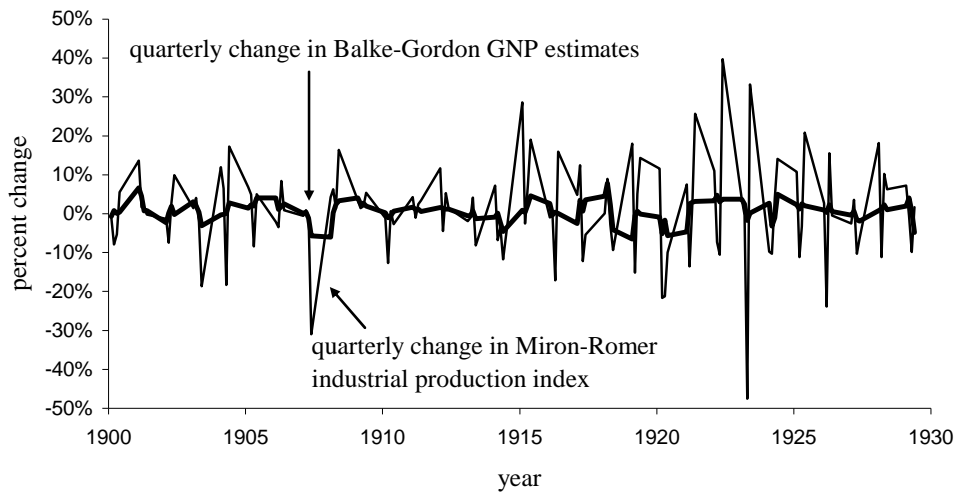
⁴⁵ Examples of such events in the context of the 2007-09 crisis includes the 2008 federal income tax rebate, the subsidized purchase of Bear Stearns and other open bank assistance programs for institutions under the Federal Reserve, the Treasury, and the FDIC jurisdiction.

Exhibit 1: Depository Institution Failure Rate and Liabilities of Failed Institutions Relative to Total Deposits, 1900–1930



Source: *Dun's Review* (1900-1930), *Historical Statistics of the United States* (Series X585), *All Bank Statistics*, Romer (1999), 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 (lagged) variable	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 (lagged) variable	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

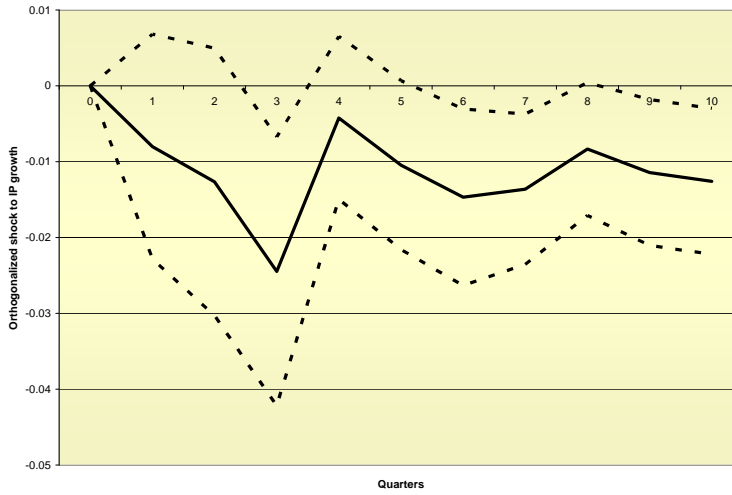


Exhibit 6: Cumulative Orthogonalized Impulse Response of GNP Growth to a One-Standard Deviation Shock in SLFI

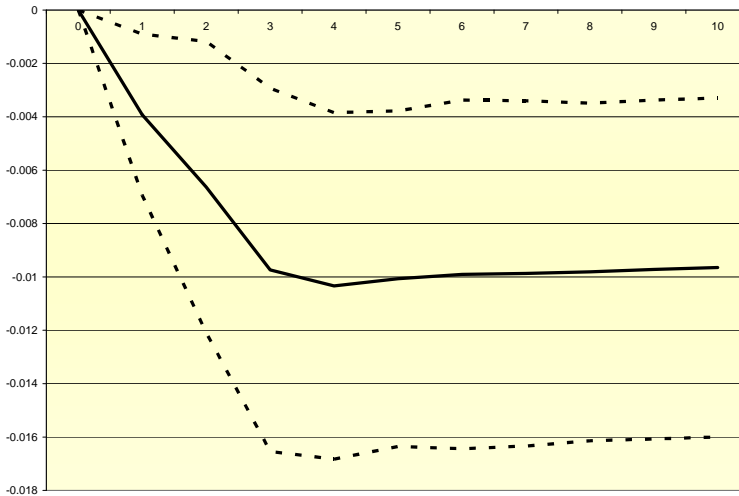


Exhibit 7: Forecast error variance decomposition for IP growth and GNP growth for innovations in the share of liabilities in failed institutions

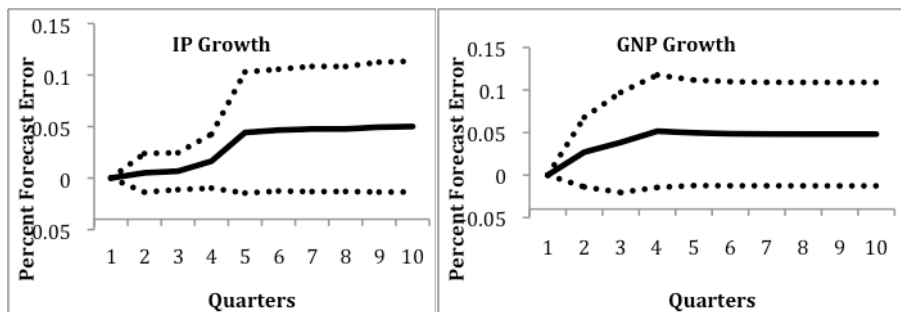


Exhibit 8: Granger causality when economic activity is measured by industrial production growth and banking system distress is measured by the bank failure rate

Left-hand-side variable	Right-hand-side variables (lagged)	Chi- Squared	p-value
Equation 1: IP growth	Spread	5.97	0.11
	Inflation	12.76	0.00
	Change in Bank Failure Rate	5.18	0.16
	All Variables	28.62	0.00
Equation 2: Spread	IP growth	1.86	0.60
	Inflation	2.19	0.54
	Change in Bank Failure Rate	2.08	0.56
	All Variables	7.22	0.61
Equation 3: Inflation	IP growth	1.47	0.69
	Spread	8.51	0.04
	Change in Bank Failure Rate	2.56	0.46
	All Variables	15.65	0.08
Equation 4: Change in Bank Failure Rate	IP growth	29.63	0.00
	Spread	6.82	0.08
	Inflation	0.72	0.87
	All Variables	36.49	0.00

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

A1. Identification of the Bank Health Coefficient Using a Covariance Restriction

The structural equations of interest, repeated from equation (2), are,

$$\begin{aligned} Y_t &= \alpha X_t + \lambda B_t + \tilde{u}_t \\ B_t &= \gamma Y_t + \tilde{v}_t \end{aligned} \tag{a1}$$

The reduced form of the system is,

$$\begin{aligned} Y_t &= \frac{\alpha}{1-\lambda\gamma} X_t + \frac{\lambda}{1-\lambda\gamma} \tilde{v}_t + \frac{1}{1-\lambda\gamma} \tilde{u}_t \\ B_t &= \gamma \frac{\alpha}{1-\lambda\gamma} X_t + \left(\gamma \frac{\lambda}{1-\lambda\gamma} + 1 \right) \tilde{v}_t + \gamma \frac{1}{1-\lambda\gamma} \tilde{u}_t \end{aligned} \tag{a2}$$

The reduced form equations to be estimated are,

$$\begin{aligned} Y_t &= AX_t + \tilde{\varepsilon}_{1t} \\ B_t &= GY_t + \tilde{\varepsilon}_{2t} \end{aligned} \tag{a3}$$

Let the ordinary least squares parameter estimates be represented by: \hat{A} , \hat{G} , $\hat{\sigma}_{\varepsilon_1}^2$, $\hat{\sigma}_{\varepsilon_2}^2$, and $\hat{\sigma}_{\varepsilon_1\varepsilon_2}$, where the final three terms are, respectively, the OLS estimates of the variance of $\tilde{\varepsilon}_1$ and $\tilde{\varepsilon}_2$, and the covariance between $\tilde{\varepsilon}_1$ and $\tilde{\varepsilon}_2$.

Under the restriction $Cov(\tilde{v}_t, \tilde{u}_t) = 0$, the following relationships hold:

$$\begin{aligned} \hat{\sigma}_{\varepsilon_1}^2 &= \lambda^2 \left(\frac{1}{1-\lambda\gamma} \right)^2 \sigma_v^2 + \left(\frac{1}{1-\lambda\gamma} \right)^2 \sigma_u^2 \\ \hat{\sigma}_{\varepsilon_2}^2 &= \left(\gamma^2 \lambda^2 \left(\frac{1}{1-\lambda\gamma} \right)^2 + 1 \right) \sigma_v^2 + \gamma^2 \left(\frac{1}{1-\lambda\gamma} \right)^2 \sigma_u^2 \\ \hat{\sigma}_{\varepsilon_1\varepsilon_2} &= \left(\frac{\lambda}{1-\lambda\gamma} + \gamma \lambda^2 \left(\frac{\lambda}{1-\lambda\gamma} \right)^2 \right) \sigma_v^2 + \gamma \left(\frac{1}{1-\lambda\gamma} \right)^2 \sigma_u^2 \end{aligned} \tag{a4}$$

Recall that λ is the structural parameter of interest. From the OLS estimates, it can be shown,

$$\hat{\gamma} = \frac{\hat{G}}{\hat{A}}$$

$$\hat{\sigma}_v^2 = \hat{\sigma}_{\varepsilon_2}^2 - \hat{\gamma}^2 \hat{\sigma}_{\varepsilon_1}^2 \quad . \quad (a5)$$

$$\hat{\lambda} = \left(\frac{\hat{\sigma}_{\varepsilon_1 \varepsilon_2} - \hat{\gamma} \hat{\sigma}_{\varepsilon_1}^2}{\hat{\sigma}_v^2} \right) \left(1 + \hat{\gamma} \frac{\hat{\sigma}_{\varepsilon_1 \varepsilon_2} - \hat{\gamma} \hat{\sigma}_{\varepsilon_1}^2}{\hat{\sigma}_v^2} \right)^{-1}$$

A2. Data

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/macroeconomy/contents/chapter13.html
Great Britain Open Market Rates of Discount, London 01/1824-11/1939 (m13016)	http://www.nber.org/databases/macroeconomy/contents/chapter13.html
U.S. Index of the General Price Level 01/1860-11/1939 (m04051)	http://www.nber.org/databases/macroeconomy/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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