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Credit Crises, Money, and Contractions: A Historical View

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The relatively infrequent nature of major credit distress events makes a historical approach particularly useful. Using a combination of historical narrative and econometric techniques, we identify major periods of credit distress from 1875 to 2007, examine the extent to which credit distress arises as part of the transmission of monetary policy, and document the subsequent effect on output. Using turning points defined by the Harding-Pagan algorithm, we identify and compare the timing, duration, amplitude, and comovement of cycles in money, credit, and output. Regressions show that financial distress events exacerbate business cycle downturns both in the nineteenth and twentieth centuries and that a confluence of such events makes recessions even worse.

Keywords: credit, monetary policy, business cycles.

JEL codes: E32, E50,G21.

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1. Introduction

Credit market distress arises in its more virulent form only in certain monetary environments, and has its most extreme effects when it exacerbates a business cycle downturn. Policy questions about a central bank's role as lender of last resort or regulator must be seen in the context of monetary policy.

The relatively infrequent nature of major credit distress events makes an historical approach to these issues particularly useful. Using a combination of historical narrative and econometric techniques, we identify major periods of credit distress from 1875 to 2007, examine the extent to which credit distress arises as part of the transmission of monetary policy, and document the subsequent effect on output.

These issues involve relationships between policy rates (monetary aggregates), credit spreads, and GDP growth. Using turning points defined by the Harding-Pagan algorithm, we compare the timing, duration, amplitude and co-movement of cycles in money, credit and output. For the period since the 1920s, this is most easily done with a risk spread between corporate and Treasury bonds, the discount rate, and real GDP. This allows us to pick out and compare periods of tight credit that result from tight monetary policy and those that have a more exogenous cause**.** For the period from 1875 to 1920, credit spreads are measured by differences between yields on different rail road bonds, and the conditions in the money market are measured by commercial paper yields. We also examine the patterns for real stock prices since stock market crashes also can act as an exacerbating factor in credit turmoil.

1.1 *Literature review*

The effect of credit on the broader economy has been of concern to economists since the early days of the profession. Nineteenth century authors often spoke of "discredit," a term Kindleberger (2000) adopts for the later phase of a financial crisis. Mitchell (1913) was an early expositor of the credit channel as was Hansen (1921), and J. Laurence Laughlin (1913) testified that "the organization of credit is more important than the question of bank notes." Disentangling the impact of credit supply from changes in demand as well as from the myriad channels of monetary policy remains a challenging empirical (and theoretical!) exercise even

today. The importance of expectations in forward-looking financial markets—indeed for economic behavior in general—further compounds the problem.

Much work has focused on isolating the "credit channel" of monetary policy from other transmission mechanisms. Bernanke and Gertler (1995) review the ways monetary policy can affect the "external finance premium" and the cost and amount of credit obtained by firms. The balance sheet (or broad lending) channel affects firm (and individual) credit worthiness by changing the value of available collateral (Bernanke and Gertler, 1989, Mishkin, 1978) The bank lending (or narrow lending) channel works by restricting banks' ability to borrow and subsequently lend to smaller firms (Bernanke and Blinder, 1988). Earlier, of course, Brunner and Meltzer (1972) emphasized the importance of distinguishing between money and bank credit.

Though agency problems, credit rationing, and other deviations from the Modigliani-Miller paradigm provide a basis for financial accelerator models that transmit the effects of monetary policy, such frictions also mean that credit markets can produce as well as transmit shocks. Rajan (1994) shows how banks can transmit business cycle shocks independently of monetary policy, as reputational concerns induce herding in credit availability. Gorton and He (2008) view credit tightening as an increase in monitoring by banks resulting from the need to enforce collusive behavior over time.

Empirically there have been several approaches to identifying credit effects. One looks at particular historical episodes for evidence, and our historical narrative takes a closer look at this section of the literature. A second strand uses microeconomic data of particular industries, often looking at regulatory or other changes that shift bank portfolios (Haubrich and Wachtel, 1993, Beatty and Gron, 2001) or demonstrate that financial constraints affect firm investment (Fazzari, Hubbard and Petersen, 1988, Lamont, 1997). A third strand examines the relationship between bank lending standards as a measure of the credit cycle. See eg. Asea and Blomberg (1998), Lown and Morgan (2006) and Dell'Arricia and Marquez **(**2006). And a fourth strand has worked to calibrate general equilibrium models with explicit financial frictions, looking to obtain tighter bounds of credit effects (Carlstrom and Fuerst 1997, Christiano, Motto and Rostogno 2008), building on the earlier work of Bernanke, Gertler and Gilchrist (1996). This fourth strand builds upon the real business cycle work that emphasizes the

importance of technology shocks as a driver of business cycles (Kydland and Prescott, 1982, Long and Plosser, 1983). This literature also suggests that the historical record of money and credit shocks may be endogenous responses to more fundamental technology shocks(Cole and Ohanian, 1999). We attempt to address these concerns by examining historical values of total factor productivity in our examination of cycles.

More recently, there has been renewed interest in observing correlations between macro variables across broad ranges of countries and time periods, as in Reinhart and Rogoff (2009) and Claessens, Kose, and Terrones (2008). Our work is closer to these latter papers and the related work of Mishkin (1990). Relative to Mishkin and Reinhart and Rogoff, we give greater attention to all business cycles, not just those associated with crises, giving a broader picture of the relations between money, credit and output. Relative to Claessens, Kose and Terrones and Reinhart and Rogoff, we look at one country, and are able to give greater detail on the institutional and historical factors at work in the economy. For example, we can compare how contemporary accounts of credit conditions compare with empirical measures of credit tightness.

Section 2 presents an historical narrative, providing descriptive evidence on the incidence of policy tightening, banking and stock market crashes, and credit market turmoil across 27 U.S. business cycles. This narrative is designed to complement the empirical evidence in the rest of the paper where we use empirical methods to discern significant patterns in the data. We focus on the relationship between monetary policy, credit cycles, asset busts and real GDP. Section 3 discusses our methodology. We use the Harding and Pagan (2002) algorithm to identify cycles in money credit, stock prices and real GDP and then examine the concordance of these cycles.

Section 4 presents the empirical results, first comparing the duration, timing, and amplitude of cycles in money, credit, and output. Several sets of regressions then compare the depth of recessions to the cyclical movements in other variables. Section 5 concludes.

2. Historical Narrative

Table 1 presents some salient qualitative features of the 29 U.S. business cycle recessions from 1875 to the present. We show evidence on the incidence of banking

crises, stock market crashes, real estate busts, tight monetary policy, credit crunches. We also provide brief comments on the underlying events. Figure 1 shows related data on real GDP, the price level, money supply (M2), bank lending, short-term interest rates, the quality spread, the Standard and Poor's stock price index, and Shiller's (2005) index of real house prices.

2.1.Classical Gold Standard Period 1875-1914

From 1875-1914[1] the U.S. was an open economy on the gold standard and had significant capital inflows from Europe, especially the U.K.. There was no central bank but the Treasury on occasion performed central banking functions. The country had frequent business recessions and also frequent banking panics which greatly worsened the contractions. Banking panics were endemic in a banking system characterized by unit banking (with prohibitions against branching or interstate banking) and the absence of an effective lender of last resort. Foreign interest rate shocks as the Bank of England periodically raised its discount rate led to sudden stops in capital inflows, gold outflows, declines in the money supply, bank lending and declines in real output and prices (Bordo, 2006).

These events were associated with stock market crashes and banking panics. The stock market was closely linked to the national banking system through the inverted pyramid of credit whereby national bank reserves in the country and reserve city national banks were concentrated in the New York banks. These reserves were held as call loans and were invested in the New York Stock exchange. Consequently shocks to the stock market would spread to the banking system and vice versa (Bordo, Rappoport and Schwartz 1992).

Contemporaries such as Sprague (1910) discussed the tightening of bank credit during these events. Calomiris and Hubbard (1989) present evidence of equilibrium credit rationing reflecting asymmetric information in the context of the Stiglitz and Weiss (1981) model.[2]

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[1]From 1875 to January 1, 1879 the U.S. was still on the floating Greenback Standard. However the Resumption Act of 1875 anchored expectations on the announced return to gold parity and the dollar pound exchange rate was very close to parity (Bordo, Erceg and Levin, 2007).

[2]Bordo, Rappoport and Schwartz (992) provide evidence doubting the presence of credit rationing in the National Banking era. They argue that it is difficult to distinguish credit shocks from shocks to the money supply. They explain most of the variation in national bank lending by the movement of stock prices held as collateral.

Of the ten business cycles for this period covered in Table 1, three had serious banking panics, with mild or incipient panics in another four. Deep recessions were associated with the banking panics. Seven downturns were associated with stock market crashes. There is no evidence of national real estate busts in this period although there were some famous regional busts, eg. California in the 1890s. In three of the recessions associated with panics, Bank of England tightening leading to a sudden stop of capital inflows was likely the source of the shock. In addition monetary tightening contingent on the fear that legislation associated with the Free Silver movement (Bland Allison Act of 1878 and the Sherman Silver Purchase Act of 1893) likely led to the panic of 1893 and the currency (and minor banking) crisis of 1896 (Friedman and Schwartz,1963, Gorton, 1987). According to Calomiris and Hubbard (1989) citing Sprague and others, credit crunches occurred in the major recessions.

2.2.Important Episodes

1873.

A serious international crisis with origins in a real estate bust in Vienna and Berlin was in the U.S. associated with corporate malfeasance in the dominant railroad sector (Benmelech and Bordo 2008), a stock market crash and a banking panic with widespread banking failures. The panic ended with the suspension of of convertibility of bank liabilities into currency. The evidence of fraud in railroads precipitated a sudden stop in capital inflows from England. The resultant recession lasted until 1879. Mishkin (1990) provides evidence that a quality spread between Moody's Baa corporate bond rate and the long-term Treasury bond rate spiked after the banking panic and stock market crash. This is cited as evidence for the presence of declining net worth and asymmetric information, which in turn increased agency costs and reduced bank lending.

1893.

A serious banking and stock market crash in the summer of 1893 was triggered by the passage of the Sherman Silver Purchase Act, which led to fears the U.S. would be forced off the gold standard and to capital flight. In the crisis hundreds of banks failed. Attempts by the New York Clearing House to issue clearing house loan

certificates did not stop the panic. It ended with the suspension of convertibility. As in the crisis of 1873, Calomiris and Hubbard cite evidence of equilibrium credit rationing, eg. Stevens (1894) "…wholesale transactions [are] usually done on credit. [New] general business was …being done almost on a cash basis" (page 141), and Mishkin (1990) shows the quality spread peaks with the crisis. "The contraction of lending by the banking system as a result of its trouble reduced its role in solving adverse selection and agency problems and clearly made these problems worse in the financial markets" (page 19).

1907.

This serious recession was also accompanied by a banking panic and stock market crash. It may have been triggered by Bank of England tightening in 1906 in reaction to a gold outflow to the U.S. to cover insurance claims from the San Francisco earthquake (Odell and Weidenmeir, 2004). In the U.S. the collapse of a corner of the copper market in October led to the failure of 8 banks, followed by the failure of the Knickerbocker Trust Company. This led to a run on the other trust companies and then a general panic. The issue of clearing house loan certificates, the transfer of funds from the Treasury to key New York banks and a rescue by a syndicate organized by J.P. Morgan alleviated the pressure, but the panic only ended with the suspension of convertibility. The panic was associated with hundreds of bank failures, a significant drop in money supply and a deep recession. As in other panic episodes, Calomiris and Hubbard cite contemporary evidence for a credit crunch. Persons (1920) discusses "a halt in further credit expansion" (page 147); Sprague (1910): "It would seem, then, past business distress from lack of credit facilities was due at least to three influences: the restriction of cash payments by the banks increased the requirements of borrowers; the supply of loans was reduced by a moderate amount of contraction; and the shifting of loans involved considerable uncertainty and inconveniences" (page 303). Mishkin (1990), as in the previous crisis shows a spike in the quality spread. According to him "the decline in the valuation of firms [in the stock market crash] raises adverse selection and agency problems for borrowing firms because it has in effect lowered their net worth. … The resulting increases in asymmetric information problems even before the October banking panic, should raise the spread between interest rates for high and low quality borrowers….The process of severe asymmetric problems even before the banking

panic suggests that they were … potentially important factors in creating a severe business cycle contraction." (pp 21-27).

1914.

The outbreak of World War I led to a massive capital outflow from U.S. financial markets to the belligerents. This massive sudden stop threatened the New York stock market, the banking system and U.S. gold reserves. Treasury Secretary McAdoo invoked the Aldrich Vreeland Act to issue emergency currency to allay the banking panic, closed the NYSE and pooled U.S. gold reserves. The crisis was largely averted. There is no narrative evidence of a credit crunch.

2.3 The Interwar years: 1918-1945

The Federal Reserve was established in 1914 in part to solve the absence of a lender of last resort in the crises of the pre-1914 National Banking era. In its first 25 years there were three very severe business cycle downturns: 1920-21, 1929-33 and 1937-38. All three were associated with very tight money. The 1929-33 recession had four banking panics producing the Great Contraction. The stock market crashed in 1920, 1929, 1930-32 and 1937. According to White (2008) there was a real estate boom and bust in the 1920s and another in 1929-33. There is considerable evidence for collapse of bank lending (a credit crunch) in 1930-33 and 1937-38. According to Bernanke (1983) both the numerous bank failures that occurred and the collapse in net worth brought about by bankruptcies, falling asset prices and deflation, increased the cost of credit intermediation and reduced real output over and above the efforts of a decline in money supply posited by Friedman and Schwartz (1963).

1920-21

The Fed tightened dramatically raising its discount rate in late 1919 to roll back the inflation that had built up during World War I and to restore effective adherence to the gold standard. This followed a severe but brief recession (industrial production fell 23%, wholesale prices fell 37% and unemployment increased from 4% to 12%) possibly because Fed actions were not anticipated (Bordo, Erceg and Levin, 2007). No banking crises occurred but there was a stock market crash, according to Mishkin and White (2002). Also there is no narrative evidence for a credit crunch;

the transmission of tight money occurred through a rise in real interest rates (Meltzer 2005 p.118).

1929-33

The Fed tightened beginning in early 1928 to stem the stock market boom which began in 1926. This tightening led to a recession in August 1929 and a stock market crash in October. The New York Fed initially followed expansionary policy to prevent a money market panic in October. It then stopped easing by the end of the year. Despite demands from New York, the Federal Reserve Board in Washington, following the real bills doctrine, was concerned about rekindling stock market speculation. A series of banking panics beginning in October 1930 ensued. The Fed did little to offset them, hence allowing the recession to become a depression. According to Friedman and Schwartz(1963), the banking panics reduced the money stock by a third and led to similar declines in real output and prices. The process was aggravated by debt and asset price deflation. According to Bernanke (1983) the bank failures and the collapse of net worth (Mishkin, 1978) raised the cost of credit intermediation seen in an increase in quality spreads. In addition, Calomiris and Mason (2003) and Calomiris and Wilson (2004) identify the shocks to bank lending (credit crunch) using, respectively, a panel of bank data by states and by New York City national banks.

1937-38

Recovery from the Great Contraction began with Roosevelt's Banking Holiday in early March 1933 and Treasury gold purchases (Romer, 1992). It was slowed somewhat by the supply shocks of the NIRA (Cole and Ohanian, 2004). A second severe recession in 1937-38 was produced by a major Fed policy error. It doubled reserve requirements in 1936 to sop up banks' excess reserves. This led to another collapse in money supply and a return to severe recession. Both Bernanke (1983) and Calomiris and Wilson (2004) see evidence for a decline in the supply of bank loans (a crunch) in response to deflation and declining net worth.

2.4 *The Post-War Period: 1945-1980*

The Fed emerged from World War II still pegging Treasury bond prices. This policy led to high inflation which ended with tightening in October 1947 (Romer and Romer, 1989) that led to a recession in 1948. The famous Federal Reserve Treasury accord of 1951 restored Fed independence. The next 15 years was characterized by relatively stable monetary policy (Meltzer, 2004). The Fed under William McChesney Martin in the 1950s viewed price stability as its primary objective. On several occasions, when facing incipient inflation, the Fed tightened, precipitating a recession.

In the postwar period there were no banking panics and no serious stock market crashes. However, according to Wojinlower (1980, 1982, 1992), credit crunches occurred when the Fed tightened, raising short term interest rates. As rates increased above the Regulation Q ceiling on time deposits (and later on CDs) this led to disintermediation of funds from the banking system and a decline in bank lending. Such disintermediation crunches were said to have occurred in 1953, 1957 and 1960.

The term "credit crunch" was coined in 1966. The Fed tightened in December 1965 at the beginning of the Great Inflation by raising the discount rate by 50 basis points to 4 ½ %. Disintermediation, as rates rose above the Regulation Q ceiling, was prevented by the Fed raising the ceiling rate to 5 ½%. Continued concern by the FOMC over inflationary pressure coming from higher rates led the Fed's bank regulating agencies to issue a statement in March urging lending restraint by the banks (Owens and Schreft, 1993, page 8.)

Further statements urging non price credit rationing came from the House Banking and Currency Committee. This was echoed in a report by the American Banking Association. Then in July 1966 in the face of rising prime rates, the FOMC allowed Regulation Q to bind and banks experienced an outflow of funds. On September 1, the Fed sent a letter to all member banks urging them to slow the growth of their business loan portfolios (Owens and Schreft, 1993, page 15.) The credit crunch led to a slowdown in bank lending and economic growth and on September 21 the Congress passed a law (which the Fed endorsed) urging it to " reduce interest rates as much as possible given prevailing economic conditions (Owens and Schreft 1993 page 16). The crunch ended.

A similar sequence of events occurred in 1969. In early 1969, the Fed began tightening to stem inflationary pressure. Disintermediation occurred as market rates

exceeded the Regulation Q ceilings . To discourage banks from raising their rates (which was deemed to be inflationary) the Fed and the Administration urged the banks in the spring to restrict their lending. Jawboning accelerated as the summer began. "Bowing to political pressure the major banks refrained from raising their prime rates further in the latter half of 1969 despite strong loan demand and rising loan rates . [The banks] instead relied more heavily on non price credit allocation methods" (Owens and Schreft, 1993, page 22). Loan demand slowed by the end of 1969 as the economy slipped into recession, ending the credit crunch.

In 1973, the Fed again tightened to fight inflation. To insure against a credit crunch the Fed in May suspended Regulation Q ceilings on large CDs and raised ceilings on other deposit categories. At the same time it raised marginal reserve requirements: apparently it had shifted to a policy based on the price mechanism rather than credit availability.[3] (Owens and Schreft 1993 page 26). Yet on May 22, Chairman Burns wrote a letter to bankers asking them to allocate credit through non price rationing instead of raising rates further (ibid). The Fed continued to tighten through 1974 by repeated hikes in the discount rate but ceased pressuring the banks with non price allocation techniques (ibid page 28).

2.5 Disinflation and Beyond: 1980-2007

Inflation continued unabated through the 1970s. Debate swirls over the causes of the Great Inflation, 1965-1982. Some observers attribute it to the accommodation of expansionary fiscal policy, others to the Phillips Curve tradeoff and an unwillingness driven by political pressure to raise unemployment at the expense of inflation, and others to measurement errors in estimating potential output (Bordo and Orphanides, 2009). Finally, in the face of an exchange rate crisis and growing popular discontent, President Carter in October 1979 appointed Paul Volcker as Chairman of the Federal Reserve. Monetary policy tightened significantly as Volcker effectively targeted monetary aggregates instead of interest rates, and produced a series of sizeable hikes in the federal funds rate. However the tight monetary stance was temporarily abandoned in mid-1980 as economic activity decelerated sharply.

In March 1980 at the request of the Carter Administration, as a signal to the public in an election year of its willingness to fight inflation, the Fed imposed

[3]According to Owens and Schreft (1993) the 1973-74 episode was not a true credit crunch which they define as non price credit rationing because bank lending rates were permitted to rise.

selective consumer credit controls. The controls involved direct restrictions on bank loan growth. The Fed provided broad guidelines for credit allocation suggesting for example that banks avoid making unsecured consumer loans (Owens and Schreft 1993 page 30). The program led to a marked decline in consumer credit as lending rates hit binding usury law ceilings. This reduced personal consumption, contributing to a very sharp decline in economic activity. The controls were lifted in July 1980.

The Federal Reserve embarked on a new round of monetary tightening in late 1980. The federal funds rate rose to 20 percent in late December, implying an ex post real rate of about 10 percent (Bordo, Erceg and Levin, 2007). Newly elected President Reagan's support of Volcker's policy was significant in giving the Federal Reserve the mandate it needed to keep interest rates elevated for a prolonged period, and provided some shield from growing opposition in Congress (Feldstein, 1993). This second and more durable round of tightening succeeded in reducing the inflation rate from about 10 percent in early 1981 to about 4 percent in 1983, but at the cost of a very sharp and very prolonged recession. In this episode there is no narrative evidence of a credit crunch.

The recession of 1990-91 was preceded by Fed tightening beginning in December 1988(Romer and Romer, 1994). It coincided with the first Gulf War. There was no banking crisis but there was a stock market crash in August 1990. There also was not a real estate bust, although real house prices declined 13% 1989-1993. According to Bernanke and Lown (1991) there was a credit crunch which they define as "a significant leftward shift in the supply of bank loans holding constant the safe real interest rate and the quality of potential borrowers". According to them a collapse in New England real estate reduced their equity capital and forced banks to scale back their lending. This reduced aggregate demand via the lending channel (Bernanke and Blinder, 1988) and contributed to the recession.

Owens and Schreft (1993), who define a credit crunch as "non price credit rationing," also posit that there was a credit crunch in the commercial real estate market, a "sector specific credit crunch that prevented commercial real estate developers and business borrowers using real estate as collateral from getting credit at any price" (page 50).

The recession of 2001 was preceded by a mild tightening of monetary policy (the funds rate was raised from 4 1/2% in November 1998 to 6% in May), and the

collapse of the tech boom in the stock market in the spring of 2001. There is no narrative evidence of a real estate bust or a credit crunch.

Finally the recession which began in December 2007 was preceded by Fed tightening beginning in June 2004 following 3 years of excessively low rates. The low policy rates as well as a global savings glut helped fund a housing boom which began deflating at the end of 2006. The ensuing housing bust initially centered on the U.S. subprime mortgage market in the spring of 2007. Factors behind the boom in addition to low interest rates include U.S. government initiatives to extend home ownership, changes in financial regulation, lax oversight and the relaxing of prudent standards (Bordo, 2008).

The default on subprime mortgages produced spillover effects around the world via the securitized mortgage derivatives into which these mortgages were bundled, to the balance sheets of investment banks, hedge funds and conduits which intermediate between mortgage and other asset-backed commercial paper and long-term securities. The uncertainty about the value of the securities collateralized by these mortgages led to the freezing of the interbank lending market in August 2007 and subsequently to a massive credit crunch. The collapse in credit reflected a severe drop in asset prices which eroded net worth and collateral, greatly increasing agency costs and quality spreads. In addition the weakening of major banks' balance sheets has impaired their lending. This has been greatly aggravated by a more than 50% drop in stock prices. Despite extensive central bank liquidity injections and the creation of a number of facilities at the Fed to rejuvenate the credit markets, the crunch still prevails. The credit crunch has produced a serious recession in the U.S. which has spread to the rest of the world.

3. Empirical Methodology

With an aim of examining cycles in money, credit and output since 1875, data availability and consistency become key issues. For business cycles, we use the NBER chronology (at a quarterly frequency). For Real Gross National Product (note it is GNP, not GDP) we use the numbers from Balke and Gordon (1986), extended via the NIPA accounts. Likewise for the money supply, we use the M2 numbers from Balke and Gordon, spliced and update with the M2 numbers from the Board of Governors. For many other series, 1919 becomes a natural break point. For the interest rate (risk) spread in 1919 and after, we use Moody's Seasoned Baa Corporate

Bond Yield (% p.a.) less Long-Term Treasury Composite, Over 10 Years (% p.a.). For the earlier period, we construct a difference between averages of the high yielding and low yielding rail road bond yields taken from MaCaulay (1938)[4]. MaCaulay is also the source for early values of commercial paper. The discount rate since 1945 is the rate from the Board of Governors and prior to that is the rate at the Federal Reserve Bank of New York, from Banking and Monetary Statistics (1943). The stock price index for 1875-1917 is the Cowles Commission index, its level adjusted to match the Standard and Poor's index, which begins in 1917. Real estate prices are from Shiller (2005). Before 1954, our measure of total factor productivity is taken from Kendrick (1961) and since then calculated from standard BLS series.[5]

3.1 Methods

A focus on recessions and contractions, credit crunches, and monetary policy makes it natural that the empirical techniques should be consistent with such a cyclical focus. Fortunately, the suite of techniques developed by Harding and Pagan (2002, 2006) provides a ready fit with the classical NBER discussion of business cycles. In this paper we will use the methods of Harding and Pagan to extract turning points in the series for money, credit spreads, and stock prices and compare the characteristics of those cycles to the NBER cycle, concentrating on contractions.

The first step must be to identify cycles via their turning points. The NBER does this via the business cycle dating committee, but Bry and Boschan (1971) develop an algorithm that closely mimics the committee's decisions at a monthly frequency. Harding and Pagan (2002) extend the algorithm to a quarterly frequency, which matches the frequency of our data.

Any such algorithm needs three components. First, a way to identify turning points, essentially choosing local maximums and minimums. For a quarterly frequency, Harding and Pagan looks for a data point that is a local max

[4] For 1914 quarter 3, the markets were closed, and we entered a judgmental value of 1% for the spread. As this was a time of turmoil in the markets, it is not an innocuous assumption.

[5] Quarterly data is a linear interpolation from the annual data in Table A-XIX in Kendrick (1961), re-indexed. TFP since then is calculated using log(TFP)=log(Y)-0.3log(K)-0.7log(L), with Y the BLS measure of "Nonfarm Business Sector: Output," L is "Nonfarm Business Sector: Hours of All Persons," and K is "Net Capital Stock of Private Fixed Nonresidential Assets" from the Bureau of Economic Analysis, linearly interpolated to obtain a quarterly series. See Levy and Chen (1994) or Cooley and Prescott (1995) for comparisons of construction techniques.

or min for two quarters on either side, that is, y_t is a cyclical peak if $y_t = \max\{y_{t-2}, y_{t-1}, y_{t,} y_{t+1,} y_{t+2}\}$.

Secondly, the procedure must make sure peaks and troughs alternate. Finally, it should impose censoring rules to obtain cycles of the appropriate length (for example, without these an algorithm may pick out seasonal cycles, though this is less likely in quarterly data.) We use the RATS quarterly implementation (bryboschan.src).

Once defined, it becomes possible to measure cycle characteristics. Primarily, these are

i) Duration: the length of the cycle and its phases (along with noting the asymmetry between phases)
ii) Amplitude: change in value between turning points
iii) Shape, sometimes called cumulative movement, to distinguish how steeply the economy contracts or recovers.

To measure co-movement in what are often non-stationary series, Harding and Pagan propose a measure of synchronization between cycles which they term *concordance*, essentially a measure of how often two series are in the same phase of the cycle. Denote the periods that series Y_t spends in an expansion as $S_{yt} = 1$ and the time spent in contraction as $S_{yt} = 0$. Then the concordance C_{xy} between series x and series y is defined as

$$C_{xy} = \frac{1}{n}\left[\#\{S_{xt} = 1, S_{yt} = 1\} + \#\{S_{xt} = 0, S_{yt} = 0\}\right].$$

Two perfectly procyclical series would have a concordance of 1, with perfect countercylcality having a concordance of 0. Such perfect alignment is never seen in economic time series, so it is more useful to compare the series to the standard of independence, or what Harding and Pagan term strong non-synchronization. The concordance associated with non-synchronization depends strongly on the asymmetry of the phases; if both series were in contractions 99 percent of the time, they would show a high concordance even if they were independent. The most useful comparison is then with the expected concordance

$E[C_{xy}] = E[S_{xt}]E[S_{yt}] + (1 - E[S_{xt}])(1 - E[S_{yt}])$

where of course $E[S_{xt}] = prob(S_{xt} = 1)$. A higher concordance indicates procyclicality and a lower concordance indicates countercyclicality. Harding and Pagan (2006) also provide a regression-based test of independence that we report below.

Two cycles may be strongly non-synchonized and still influence each other; for example, an overlapping contraction might influence the depth of the recession.

Looking at the cycle overlaps provides more information about the empirical linkages between money, credit, and the business cycle over the years from 1875 to 2007. We explore how money, credit, and asset prices behave in recessions and look at how recessions differ according to the whether or not they are associated with credit crunches, tight money, and asset price drops. In this we are broadly following the methods of Reinhardt and Rogoff (2008) and Claessens, Kose, and Terrones (2008). By also incorporating total factor productivity, our regressions attempt to separate out the effects of technology shocks (Long and Plosser, 1983, Cole and Ohanian, 1999) from financial turbulence in business cycles.

We present two sets of regressions.

The first set regresses the amplitude of the percentage peak-to-trough change in Real GNP against the changes in credit spreads, measures of money, and the stock index between the same NBER turning points.

The second set of regressions looks at how monetary, credit, and asset cycles affect the business cycle. For example, do recessions that start during a credit crunch look different than those that do not? Each NBER contraction is associated with the money, credit, or asset cycle phase that it starts in. The amplitude of the contraction is then regressed against the amplitude of the other cycle phases. For example, a recession that starts in a period of tightening credit and tightening monetary policy is associated with the amplitudes of those two "contraction" phases.

4. Empirical Results

Cycles can be described both by their individual characteristics and by their relation to each other. In our sample, from 1875:I to 2007:III, we have 27 (NBER) recessions, counted as complete peak to trough episodes.

4.1 Cycle characteristics

Tables 2 and 3 report the mean amplitude and duration of cycles for the 1875:I-1918:IV period, and tables 4 and 5 report the amplitude and durations for 1919:I-2007:IV, calculated for the peak-to-trough and trough-to-peak. If the beginning quarters belong to a contraction that started before our sample, those are not counted. Likewise for an expansion that continues beyond our sample.

The average duration of a recession (peak to trough) is 15.4 months, that of an expansion 39 months. Because of data limitations, we separately look at two sub-samples, from 1875:I to 1918:IV and from 1919:I to 2007:IV, the period for which we have Federal Reserve discount rate data. For the later period, recessions have shortened and expansions lengthened. For the early period, the average duration of a recession is 6 quarters (8.3 for expansions). For the later period, the durations are 4.5 for contractions, 17.7 quarters for expansions.[6]

Credit shows a longer cycle. For the earlier sample, our measure of credit is the spread between different rail road bonds. These show a mean peak-to-trough duration of 8.25 quarters, and a trough-to-peak duration of nearly 10 quarters, as well as showing noticeably longer maximum cycles. Also note the greater symmetry between expansions and contractions in the credit spread series. For consistency, the P-T of rates and spreads should be compared to the T-P of RGNP. For the later sample, using the spread between Moody's seasoned Baa corporate bond yield less the long-term treasury composite, "contractions," or periods of generally falling spreads, last an average of 11.1 quarters, longer than the NBER contractions, but the periods of "expansion" or rising spreads, lasts only 8.4 quarters, significantly shorter than the 17.7 of NBER expansions.

What about monetary policy? For the earlier period, we use two measures. The first is Balke and Gordon's measure of M2, taken as the year-over-year log difference. Mean peak-to-trough duration is 7.5 quarters, measuring 9.9 quarters for the trough-to-peak expansions. This indicates a cycle length similar to the NBER cycle and a bit shorter than the credit cycle. We also use the commercial paper rate as a measure of monetary tightness. This seems to exhibit a shorter and less variable cycle, with expansions and contractions of 6.75 and 5.5 quarters. For the later period, we continue with the Balke and Gordon M2 series, splicing in the Board of Governors M2 when it becomes available.

[6] Total Factor Productivity also shows an asymmetric cycle, with mean peak-to-trough time for two periods of 5.1 and 5.2 quarters, with a trough-to-peak means of 8 and 16 quarters. It shows a concordance with the NBER cycle of only 45% in the early period, but 82% for the later.

Like the NBER cycle, it is rather asymmetric, and perhaps not surprisingly, with contractions nearly twice as long as expansions. The discount rate, our other measure of policy, exhibits even more asymmetry, with mean peak-to-trough duration of nine quarters and mean trough-to-peak duration of over twenty. (again note that a "contraction" in the money supply probably corresponds to an "expansion" in the discount rate.). Overall it is noticeably longer than the business cycle.

In the later period, recessions tend to occur in an environment of monetary tightening and tighter credit. Of the 17 NBER business cycle peaks in the subsample, 4 occurred in the same quarter as the peak in the monetary policy (discount rate) cycle, another 9 occurred during the tightening phase of policy, and 2 occurred in the quarter immediately after a peak in the discount rate cycle. Fourteen of the 17 occurred in periods of credit tightening.

In the earlier period, the pattern repeats. Recessions tended to occur in time of monetary tightening, with all eleven NBER recessions occurring in a contractionary phase of M2 growth, and ten of the eleven occurring in an environment of rising commercial paper rates. These were also generally periods of tightening credit, though the pattern is not quite so obvious: in seven of the eleven cases rail road spreads were increasing.

Tables 6 reports the concordances and tests of synchronicity for the 20th century. Recall that an actual concordance above expected concordance indicates series that move procyclically. Most interesting for our purposes is concordance with the NBER cycle, though we find it gratifying that the discount rate moves countercyclically with M2. For the 19th century, we find evidence for the importance of credit in that the Baa spread moves countercylically to the business cycle: increasing risk spreads are associated with recessions. The evidence for money is mixed, with the discount rate showing procyclical concordance, but we cannot reject independence for the log difference of M2.

Table 7 reports on concordance and synchronicity tests for the 19th century. The risk spread (on rail road bonds) is again procyclical, but significant only at the 10 percent level. Money is again mixed, with short rates showing procyclicality but quantity showing independence.

4.2 Regressions

The questions of whether larger changes in money, credit or asset prices are somehow associated with different amplitudes of contractions can be addressed in several ways. Following Claessens, Kose and Terrones, Tables 8 and 9 report regressions of recession amplitude against changes in the risk spread, money measures, and stock prices over the same dates as the NBER peak-to-trough phase. Such a regression of course does not determine causality, but to attempt to partially control for other factors, we also include the change in total factor productivity over the cycle. For both time periods, the coefficient on the risk spread is generally negative, though not always significant indicating that larger changes in risk spreads are associated with larger amplitudes. (To be clear, a rise in the spread from the business cycle peak to trough comes in as negative, while for RGNP, measured as peak minus trough, is positive.) The positive (and often significant) coefficient on the change in the stock index indicates larger stock price drops are associated with larger contraction amplitudes, that is, deeper recessions. Of further interest are the two interaction terms, one for the risk spread and the money growth, and the second for risk and the short-term interest rate. Both are significant only for the later period. The coefficient on Interaction1 indicates that times of rising risk spreads and tight money are particularly associated with high amplitudes. Interaction2 confirms that, when tight money is measured by high discount rates.

Another approach is to relate the amplitude not to changes over the NBER contraction, but over the cycle phases for money, credit and stock prices that the Harding-Pagan algorithm identifies. Claessens, Kose and Terrones compare the depth of recessions with large and small credit crunches. With fewer recessions, we take a more multivariate approach, and regress recession amplitude against cycle amplitude for the risk spread, the money measure (either quantity or short-term interest rate) and the stock price. For example, if a recession begins (e.g. a peak occurs) when the money supply is in a contraction phase, we associate the amplitude of the NBER recession with the amplitude of that monetary contraction (which will rarely have the same turning points or duration). Tables 10 and 11 report the results for the 19th and 20th centuries. The results are broadly similar to those in the NBER focused regression of Tables 9 and 10, but there are some differences. The coefficient on the risk spread shows up as positive in the

20th century. Few coefficients are significant in the 20th century, except when the risk-spread-money-growth interaction is included. TFP growth tends to be negatively associated with recessions.

Both the historical narrative and the empirical results suggest that a confluence of financial shocks—in risk spreads, assets prices and money supply—will exacerbate a contraction, or at least be associated with deeper contractions. A closer look that the deeper recessions in our sample bears this out, even though the correspondence between financial shocks and depth of recession is not one-to-one. Figures 2 and 3 provide scatterplots of recession amplitude against the risk spread, short-term rates, money supply, and stock movements.

Since the First World War, four recession are particularly deep (measured as percent change in real GNP from peak to trough): those of 1929, 1945, 1920, and 1937. These were at least triple the size of any other contraction (with a possible exception of the combined 1980-1981 drop). 1945 stands out as an anomaly, but the other three stand out as having the three largest drops percentage drops in the money supply and stock prices, and two of the three largest increases in the risk spread. Contemporary accounts of the 1920 contraction do not mention a credit crunch in line with the only moderate increase in the risk spread in that contraction. While the 1929 contraction also shows the largest drop in total factor productivity, TFP actually grew in the contractions of '45, '20, and '37.

Prior to the First World War, three contractions stand out, all over twice as deep as the others: 1907, 1893, and 1913. The connections with financial shocks are perhaps not as striking as for the later period, but still strong. The three contractions have two of the top three declines in stock prices, and the top two changes in money and bond spread. These contractions also show three of the top four declines in TFP. Contemporary accounts noted a credit crunch in 1893 despite only a small movement in the risk spread.

An alternative approach is to sort on the size of movements in risk spreads, money and stock prices, looking to see if larger movements in these variables leads to larger recessions. Since World War I, four contractions had particularly large increase in the Baa spread, four had particularly large drops in M2 (in fact only four saw actual drops) and four had particularly large drops in

stock prices. Table 12 compares the mean recession amplitude for these extreme events with recession amplitudes without those events. If you will, it picks out the credit crunches and the stock crashes from the mere corrections. It makes a similar comparison between the three largest events in each category for the pre-WWI cycles. In every case, the contractions associated with a large crunch or crash are noticeably larger than those without, though this difference is statistically significant only for the pre-WWI years.

5. Conclusions

The evidence, though not conclusive, indicates both that more severe financial events are associated with more severe recessions, and that a confluence of such events also indicates increased severity.

The empirical results complement the cross country evidence of Claessens Kose and Terrones, and Reinhart and Rogoff. Causality is of course always hard to determine, but the narrative evidence strongly suggests, and the empirical work is at least consistent with, the claim that credit turmoil worsens recessions. The timing of cycles is likewise consistent with the work of Gilchrist, Yankov and Zakrajsek (2008) and others on the ability of corporate bond spreads to predict recession in more recent periods.

The results are consistent with work, such as Barro and Ursua (2009), who find a high association between stock market crashes and large contractions, and Claessens Kose, and Terrones, who find an interaction between stock market crashes and tight money and credit**.**

Somewhat paradoxically, the cycles in the quantity of money appear not to be synchronized with business cycles, but when the cycles do coincide, monetary tightening has a significant effect, and seems implicated in major recessions. Money market measures, such as the discount rate, show greater synchronicity, but not more significant correlations. The historical evidence of banking panics associated with credit turmoil makes a case for the central bank acting as a lender of last resort.

The current episode combines elements of a credit crunch, asset price bust and banking crisis. It is consistent with the patterns we find using 140 years of US data. How does the current crisis measure up? Between August, 2007, and

April, 2009, the difference between the yield on Baa bonds and long-term Treasuries has moved up 342 basis points, a larger increase than seen in the 1929 contraction, and approaching the combined increase of 436 bp over both the Depression contractions. The percentage drop in S and P index of 42% is second only to the 78% of the Great Contraction. Money supply, however, is a different matter, with an increase of 13% in the current period, the largest increase of M2 seen in any contraction. This should not be particularly surprising, however. As Friedman and Schwartz point out, prior to deposit insurance banking panics would cause a collapse in the money multiplier, driving M2 down. Zarnowitz (1992) shows that business cycles downturns with panics are much more severe than others. Today because of deposit insurance, financial turmoil does not lead to panics and collapses in the money multiplier, and credit turmoil is less likely to feed into the money supply. The credit disturbance thus becomes relatively more important, given that disturbances on the asset side of the balance sheet no longer have as strong an influence on the money supply.

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TABLE 1:Descriptive Data 1873-2008

	NBER Business Cycle Peak	Banking Crises	Stock Market Crash	Real Estate Bust	Tight Monetary Policy	Credit Crunch	Comments
1	October 1873	September 1873	September 1873	no	Bank of England tightens	?	International Financial Crisis; real estate bust in Germany, Austria; Railroad scandal stock market crisis and serious recession focused on railroads. Panic ends with suspension of convertibility.
2	March 1882	June 1884	February 1884	no	no	yes[1]	Minor panic consequent upon failure of Grant and Ward, attenuated by NY clearing house.
3	March 1887	no	no	no	no	no	Minor recession
4	July 1890	November 1890	November 1890	no	Bank of England tightens	no	Baring crisis in London caused by Argentine defaults. Bank of England tightening leads to sudden stop, minor banking panic attenuated by NY clearing house.
5	January 1893	May 1893	May 1893	no	Silver risk	yes[1]	Major U.S. banking panic related to fears U.S. would be found off gold standard after passage of Sherman Silver Purchase Act. Panic ends with suspension of convertibility.
6	December 1895	October 1896[2]	no	no	Silver risk	no	Gorton(1987) identifies a banking panic but Sprague and Friedman and Schwartz (1963) do not. Silver risk induced run on U.S. Treasury gold reserves stemmed by Belmont Morgan Syndicate(Friedman and Schwartz)
7	June 1899	no	no	no	no	no	Minor recession
8	September 1902	no	October 1903	no	no	no	Minor recession. Rich man's panic (Friedman and Schwartz p.151)

	NBER Business Cycle Peak	Banking Crises	Stock Market Crash	Real Estate Bust	Tight Monetary Policy	Credit Crunch	Comments
9	May 1907	October 1907	October 1907	no	Bank of England tightens	yes[1]	Major recession and banking panic, rescue by JPMorgan, suspension of convertibility. Contemporaries discuss credit squeeze.
10	January 1910	no	no	no	no	no	Minor recession
11	January 1913	August 1914 (incipient)	August 1914 (incipient)	no	no	no	Outbreak of World War I
12	August 1918	no	Fall 1917	no	no	no	Mild recession, Mishkin and White(2002) attribute stock market crisis to rising interest rates and controls on new issues.
13	January 1920	no	Fall 1920	no	yes	no	Major recession induced by Fed tight money to roll back wartime inflation.
14	May 1923	no	no	no	yes	no	Minor recession. Fed followed policy of moderate restraint(Friedman and Schwartz 1963. p.287) to offset incipient inflation.
15	October 1926	no	no	no[3]	yes	no	Minor recession. Fed takes "moderate restraining measures"(Friedman and Schwartz 1963. p.288)
16	August 1929	October 1930 April 1931 Sept/Oct 1931 Jan/Feb 1933	October 1929	yes[4]	yes	yes[5]	Great contraction. Tight Fed policy 1928-29 to stem stock market speculation for Banking crises. Contraction in net worth, debt deflation, bank capital crunch.
17	May 1937	no	February 1937 May 1940	no	yes	yes[6]	Major recession. Fed doubles reserve requirements in 1936, Contraction in net worth, bank capital crunch.
18	February 1945	no	September 1946	no	no	no	End of World War II. Sharp decreases in government expenditures. Adjustment from war to peace.

	NBER Business Cycle Peak	Banking Crises	Stock Market Crash	Real Estate Bust	Tight Monetary Policy	Credit Crunch	Comments
19	November 1948	no	no	no	yes[7]	no	Fed tightens to offset post war inflation.
20	July 1953	no	no	no	yes	yes[8]	Mild recession. Moderate tightening reflecting Fed concern of inflation. Bond crisis raises rates.
21	August 1957	no	no	no	yes[9]	yes[10]	Significant recession induced by Fed tightening. Evidence of credit rationing.
22	April 1960	no	Spring 1902[11]	no	yes	yes[12]	Mild recession induced by Fed tightening. Disintermediation as market rates pierced Regulation Q. ceilings leads to reduced bank lending.
						August - Sept 1966[13]	"Credit crunch" of 1966 background of Fed tightening monetary policy end of 1965. Fed bank regulators urged restraint on bank lending. Disintermediation Regulation Q. ceilings bound.
23	December 1969	no[14]	May 1970	no	yes[15]	yes[16]	Mild recession. Fed tightening and jawboning by Fed and government to restrain lending. Disintermediation as market rates exceed Regulation Q. ceilings.
24	November 1973	no[17]	November 1973[18]	no	yes	yes[19]	Fed tightening. OPEC shock. Significant recession. Arthur Burns May 1974 urges banks to allocate credit through non price rationing.

	NBER Business Cycle Peak	Banking Crises	Stock Market Crash	Real Estate Bust	Tight Monetary Policy	Credit Crunch	Comments
25	January 1980	no	no[20]	no[21]	yes	yes[22]	Significant Fed tightening begins October 1979 (Volcker shock). March 1980 Fed at Carter's administration request imposes selective consumer credit controls. Controls lifted July 1980.
26	July 1981	no[23]	no	no	yes	no[24]	Tight Fed policy induces serious recession.
27	July 1990	no	August 1990	no[25]	yes[26]	yes[27]	Fed tightening. Gulf war. Mild recession. Evidence of non price credit rationing and a capital crunch.
28	March 2001	no	Spring 2001	no	yes	no	Fed restraint leads to mild recession, tech bust
29	December 2007	September	October[28]	yes[29]	yes[30]	yes	Fed tightening beginning in June 2004 may have helped trigger a real estate bust, Lehman Brothers failure, credit crunch, stock market slide, and severe recession.

Endnotes

[1] Calomiris and Hubbard(1989) Citing Sprague and others.
[2] Gorton(1987).
[3] Florida land bust, White(2008).
[4] White(2008).
[5] Bernanke(1983), Calomiris and Mason(2003), Calomiris and Wilson(2004).
[6] Bernanke(1983), Calomiris and Wilson(2004).
[7] Romer and Romer(1989) pick October 1947 as the start of Fed tightening.
[8] Wojnilower(1992) states that bank lending was impaired by the collapse in Treasury bond prices.
[9] Romer and Romer(1989) date tightening as beginning September 1955.
[10] Wojnilower(1980, 1982, 1992), Eckstein and Sinai(1985) discuss credit rationing as leading to the 1957-58 recession.

[11] Real stock prices decline by 29% January 1966 to October 1966(Bordo, Dueker and Wheelock 2008).
[12] According to Wojnilower(1980, 1992), Fed tightening pushed T-bill rates above the Regulation Q ceiling leading to disintermediation.
[13] Wojnilower(1980), Owens and Schreft(1993).
[14] Penn Central collapse in July 1970. The Fed averted a crisis by backstopping the money center banks' support of the commercial paper market.
[15] Romer and Romer(1989) date Fed tightening as beginning in December 1968.
[16] Owens and Schreft(1993).
[17] Failures of Franklin National Bank October 1974 and Germany's Herstatt Bank June 1974.
[18] Romer and Romer(1989) date monetary tightening as beginning in April 1974.
[19] Owens and Schreft(1993).
[20] Real stock prices decline by 20%, November 1980 to July 1982(Bordo, Dueker and Wheelock 2008).
[21] Shiller(2005) figure 2.1 shows a 13% decline in real house prices 1979-1993.
[22] Owens and Schreft(1993).
[23] Failures of Continental Illinois and Penn Square banks in 1984. Also Savings and Loan crisis in 1984.
[24] Owens and Schreft(1993).
[25] Shiller(2005) figure 2.1 shows a 13% decline in real house prices 1989-1993.
[26] Romer and Romer(1989) give December 1988 as the beginning of tight policy.
[27] Bernanke and Lown(1991) provide evidence of a capital crunch in New England. Bonds reduced lending to replenish their capital to meet regulatory standard. Owens and Schreft(1993) document non price credit rationing in the real estate sector.

[28] The Standard and Poor stock price index declined 55%. July 2007 to March 2009.
[29] The Case and Shiller real home price index declined 33% from December 2006 to October 2008.
[30] The Federal Funds rate increased from a trough in May 2004 at 1.00% to a peak of 5.26% in July 2007.

Sources

Banking Crises: Bordo(1986), Friedman and Schwartz(1963), Gorton(1987).

Stock Market Crashes: Bordo(1985), Bordo, Dueker and Wheelock(2008), Friedman and Schwartz(1963), Mishkin and White(2002), Sprague(1910)

Real Estate Busts: Shiller(2005), White(2008).

Tight Monetary Policy: Friedman and Schwartz(1963), Meltzer(2004), Romer and Romer(1989).

Credit Crunch: Bernanke(1985), Bernanke and Lown(1991), Calomiris and Hubbard(1987), Calomiris and Mason(2003), Calomiris and Wilson(2004), Eckstein and Sinai(1985), Owens and Schreft(1993), Wojnilower(1980, 1985, 1992).

Amplitude	**Peak-Trough**	**P-T %**	**Trough-peak**	**T-P %**
RGNP (NBER cycles)	-11.13	-7.8%	36.37	34.1%
Rail Road Spread	-0.28		0.27	
CP	-2.63		2.51	
M2 growth	10.4%		12.1%	

Table 2: Cycle Amplitudes, 1875:1-1918:4, quarterly

Duration (Quarters) 19th	**Peak-Trough**		**Trough-peak**
RGNP (NBER cycles)	mean	6	8.3
	max	13	12
	min	3	5
Rail Road Spread	mean	8.25	9.89
	max	18	36
	min	2	2
CP	mean	5.54	6.75
	max	11	14
	min	3	3
M2 growth	mean	7.45	6.91
	max	18	12
	min	4	3

Table 3 Cycle durations, 1875:1-1918:4, quarterly

Amplitude	Peak-Trough	P-T %	Trough-peak	T-P %
RGNP (NBER cycles)	-28.69	-5.9%	238.52	29.0%
Baa Spread	-1.18		1.14	
Discount Rate	-2.18		2.18	
M2 growth	-2.9%		3.1%	

Table 4: Cycle Amplitudes, 1920:1 to 2007:4

Duration 20^{th}	**Peak-Trough**		**Trough-peak**
RGNP (NBER cycles)	mean	4.5	17.7
	max	14	40
	min	2	4
Baa Spread	mean	11.1	8.4
	max	30	21
	min	4	2
Discount Rate	mean	8.8125	20.8
	max	18	66
	min	2	9
M2 growth	mean	11	6
	max	65	15
	min	3	2

Table 5: Cycle Durations, 1920:1 to 2007:4

	Baa	Discount	M2 (log dif)	NBER
Baa Spread concordance Expected concordance Prob. Of independence	1	 54.0% 48.8% 26%	 40.3 50.5 0.5%	 34.4% 45.5% 0.005%
Discount Rate		1	38.1 49.5 0.4%	61.6 54.6 0.9%
M2 (log difference)			1	50.3 48.0 35.4%
NBER cycle				1

Table 6: Concordances, expected concordances, and probability of independence (regression method) for 20th century series: 1920:1 to 2007:4, quarterly, M2 is annual log difference, using data from 1919:1 calculated from Balke-Gordon, spliced with Board of Governors M2 data.
Moody's Seasoned Baa Corporate Bond Yield (% p.a.) less Long-Term Treasury Composite, Over 10 Years (% p.a.)
Discount Rate: Pre 1945, FRB NY rate, then BOG rate.

	NBER	Rail spread	CP rate	M2 (log dif)
NBER Cycle concordance Expected concordance Prob. Of independence	1	 59.7% 50.1% 8.1%	 63.6 51.0 1.3%	 50.6% 49.8% 80.9%
Railroad Spread		1	54.0 50.1 37.9%	50.0 50.0 84.3 %
Commercial Paper rate			1	39.2 49.7 6.4%
M2 (log difference)				1
Real GNP				67.0 54.1% 0.000%

Table 7: same as above, for 19th century data, 1875:1 to 1918:4 (quarterly).

Table 8 **NBER 19 Recession Amplitude, 19th Century.**
Recession amplitude (Peak-trough Real GNP as a fraction of Peak RGNP) for NBER contractions, regressed against the Peak-Trough change in other variables. Money supply and Stock index are also measured as fractional changes.
Dependent Variable: RNGP
Data is for the NBER recessions starting in 1893,1895,1899,1902,1907,1910, and 1913.
With Heteroscedasticity-Consistent (Eicker-White) Standard Errors
(t-statistics in parentheses)

Independent Variables	1	2	3	4
Constant	0.518*** (3.89)	-0.032 (1.19)	-0.038 (-1.18)	0.041 (1.43)
RR Spread	-0.145 (-1.18)	-0.884*** (-7.65)	-.1.43* (-1.67)	-0.340* (-0.611)
Commercial Paper	0.624*** (5.65)			0.616*** (5.69)
Stock Index	0.083 (0.563)	0.412** (2.49)	0.352* (1.73)	0.178 (0.58)
M2 growth		0.044 (5.43)	0.053*** (3.01)	
TFP growth	0.558** (2.46)	0.088 (0.47)		0.349 (0.516)
Interaction 1			0.317 (0.632)	
Interaction 2				-1.61 (-0.41)
Observations	8	8	8	8
R^2	0.887	0.791	0.800	0.888
R-bar^2	0.736	0.513	0.301	0.609

* 10% significance level
** 5% significance level
*** 1% significance level

TABLE 9 NBER 20 Recession Amplitude, 20th century.
Recession amplitude (Peak-trough Real GNP as a fraction of Peak RGNP) for NBER contractions, regressed against the Peak-Trough change in other variables. Money supply and Stock index are also measured as fractional changes.
Dependent Variable: RNGP
Data is for the NBER recessions starting in 1920, 1923,1926,1929, 1937, 1945, 1948, 1953, 1957, 1960, 1969, 1973, 1980, 1981, 1990, 2001.
Dependent Variable: RNGP
With Heteroscedasticity-Consistent (Eicker-White) Standard Errors
(t-statistics in parentheses)

Independent Variables	1	2	3	4
Constant	0.077*** (2.54)	0.064*** (4.35)	0.025 (1.58)	0.081*** (3.74)
Baa Spread	0.045** (2.39)	-0.003 (-0.156)	-0.051* (-1.84)	0.048** (2.21)
Discount Rate	-0.011 (-1.36)			-0.033** (-2.56)
Stock Index	0.209*** (3.78)	0.014 (0.28)	-0.074 (-0.81)	0.178*** (3.26)
M2 growth		0.590*** (4.34)	-0.001 (-0.001)	
TFP growth	1.57*** (4.59)	0.487 (1.43)	-0.918 (-1.39)	0.841 (2.40)**
Interaction 1			-0.4738** (-2.01)	
Interaction 2				-0.029** (-2.41)
Observations	16	16	16	16
R^2	0.719	0.752	0.8534	0.803
R-bar^2	0.616	0.662	0.779	0.705

* 10% significance level
** 5% significance level
*** 1% significance level

TABLE 10: PAGAN 19 Recession Amplitude associated with cycles in other variables.
This shows the results of regression of RGNP percent amplitude in an NBER contraction (P-T) against the change other variables over their individual Harding-Pagan cycle.
Dependent Variable: RNGP
For the recessions of the 19th century.
With Heteroscedasticity-Consistent (Eicker-White) Standard Errors
(t-statistics in parentheses)

Independent Variables	1	2	3	4
Constant	-0.175 (-1.32)	-0.004 (-0.04)	0.007 (0.087)	1.88** (1.99)
RR Spread	0.038 (0.16)	-0.209 (-1.23)	-0.045 (-0.155)	-2.62*** (-6.63)
Commercial Paper	0.029* (1.78)			-0.202*** (5.95)
Stock Index	0.553** (2.42)	0.400 (1.32)	0.210 (0.663)	0.539*** (5.43)
M2 growth		-0.137 (-0.516)	-1.28 (-0.95)	
TFP growth	-0.097 (-0.27)	0.217 (0.98)	0.17 (0.71)	-0.567*** (3.05)
Interaction 1			3.74 (0.86)	
Interaction 2				1.44*** (7.39)
Observations	7	7	7	7
R^2	0.701	0.648	0.663	0.941
R-bar^2	0.104	-0.05	-1.0	0.649

* 10% significance level
** 5% significance level
*** 1% significance level

Table 11: PAGAN 20 Recession Amplitude associated with cycles in other variables.
This shows the results of regression of RGNP percent amplitude in an NBER contraction (P-T) against the change other variables over their individual Harding-Pagan cycle.

Dependent Variable: RNGP
With Heteroscedasticity-Consistent (Eicker-White) Standard Errors
(t-statistics in parentheses)

Independent Variables	1	2	3	4
Constant	0.070* (1.84)	0.056*** (2.64)	0.021* (1.77)	0.029 (0.68)
Baa Spread	0.019 (0.88)	0.013 (0.82)	0.029*** (6.56)	0.040 (1.40)
Discount Rate	-0.011* (-1.74)			0.021 (1.19)
Stock Index	0.013* (1.88)	0.005 (1.55)	0.001 (0.61)	-0.003 (-0.28)
M2 growth		0.096 (0.45)	0.094* (1.77)	
TFP growth	-0.039 (-0.53)	-0.096 (-1.56)	-0.186*** (-8.46)	-0.032 (-0.52)
Interaction 1			0.146*** (22.41)	
Interaction 2				-0.015 (-1.58)
Observations	15	15	15	15
R^2	0.297	0.192	0.952	0.403
R-bar^2	0.015	-0.131	0.924	0.071

* 10% significance level
** 5% significance level
*** 1% significance level

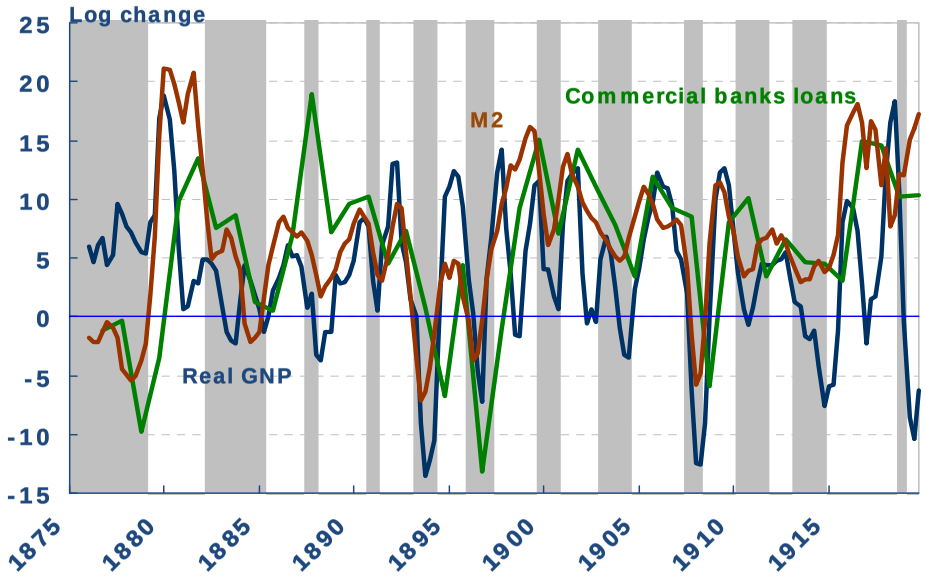
Table 12 Recession Amplitudes with and without large financial events.

P-T RGNP Amplitude, 20th	credit	M2	Stock
With crunch	10.4%	14.8%	15.2%
Without crunch	3.8%	2.9%	2.8%
t-statistic	0.98	1.57	1.34

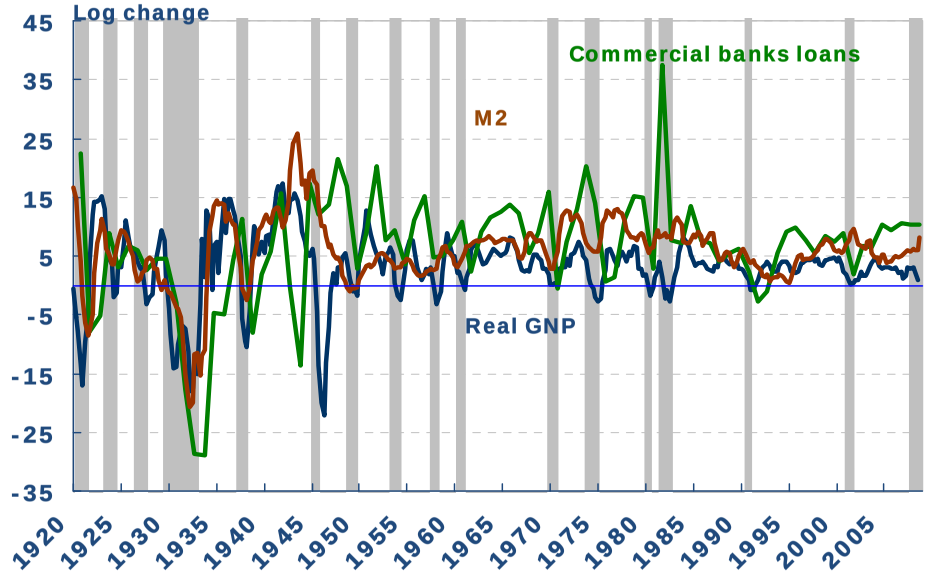
P-T RGNP Amplitude, 19th	credit	M2	Stock
With crunch	7.1%	6.9%	5.4%
Without crunch	0.1%	-0.7%	0.8%
t-statistic	1.83**	3.12**	0.94

t-tests for equal mean with unequal variances.
*significant at 10% level
**significant at 5% level
***significant at 1% level

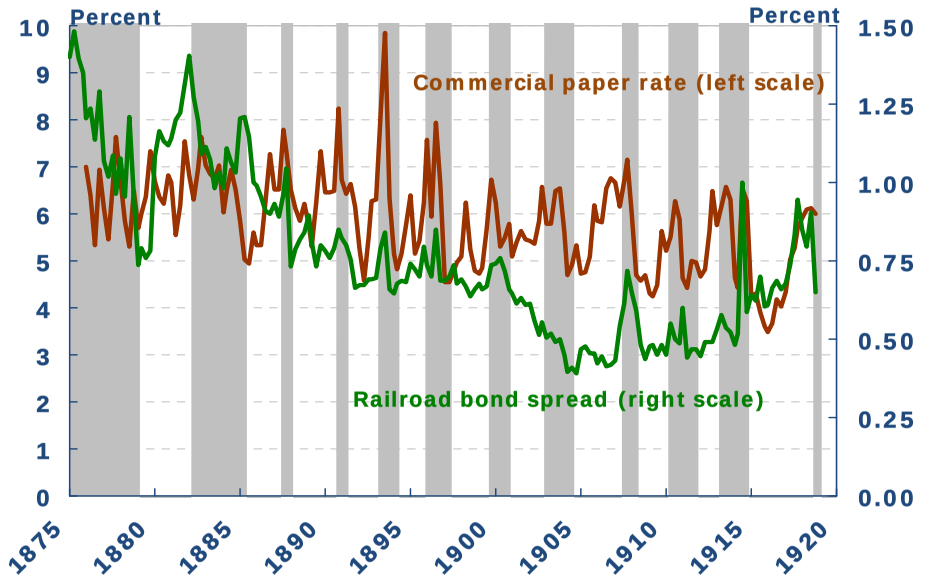
Figure 1



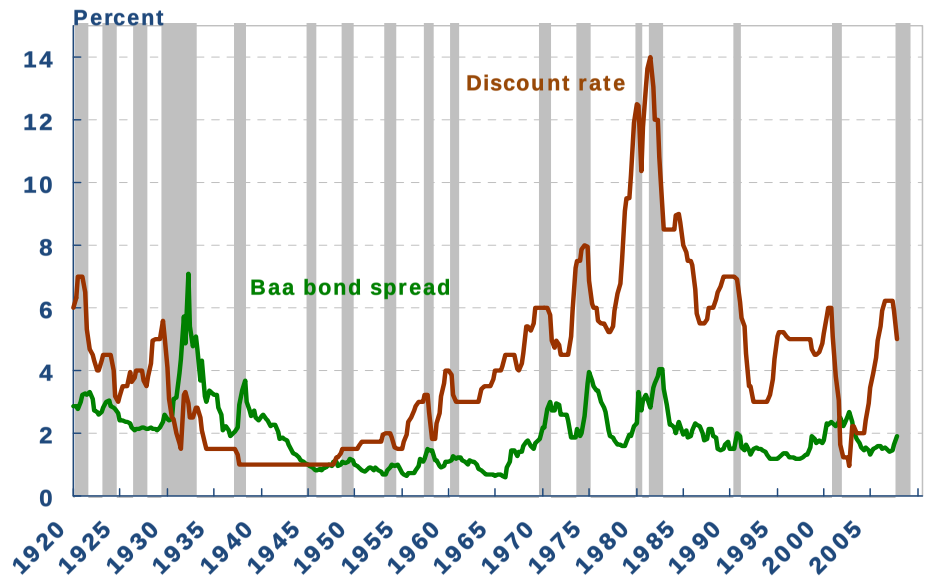
Source: Balke & Gordon, NBER, Federal Reserve Board, FDIC, Friedman & Schwartz, Author's calculations



Source: Balke & Gordon, NBER, Federal Reserve Board, FDIC, Friedman & Schwartz, Author's calculations

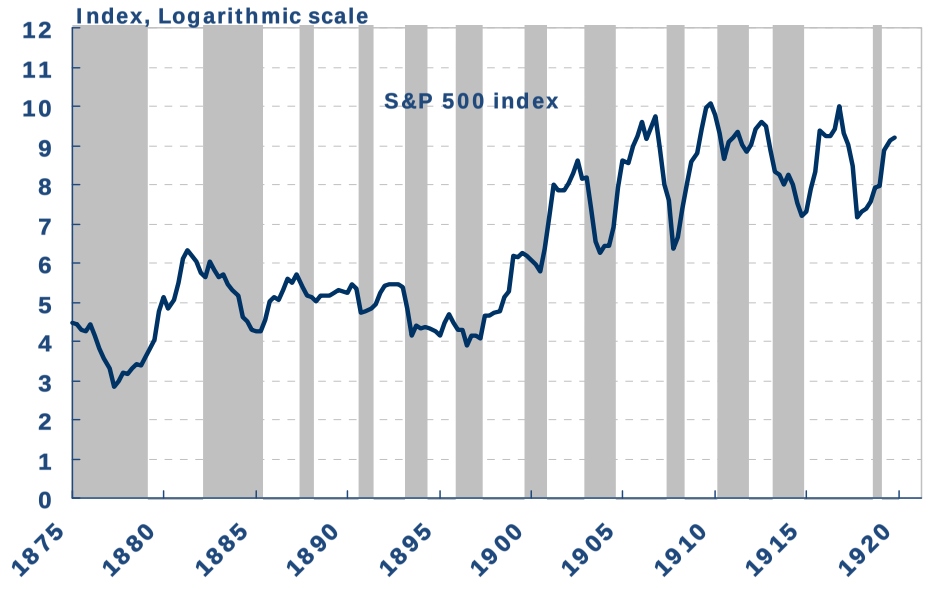


Source: Macaulay, Federal Reserve Board of Governors

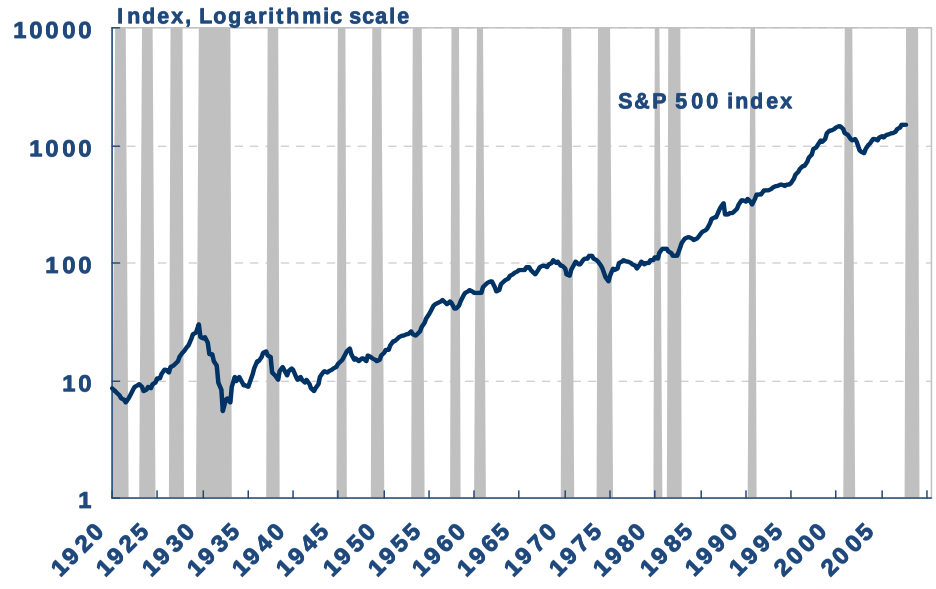


Source: Federal Reserve Board of Governors

Figure 1 continued



Source: Standard and Poor's



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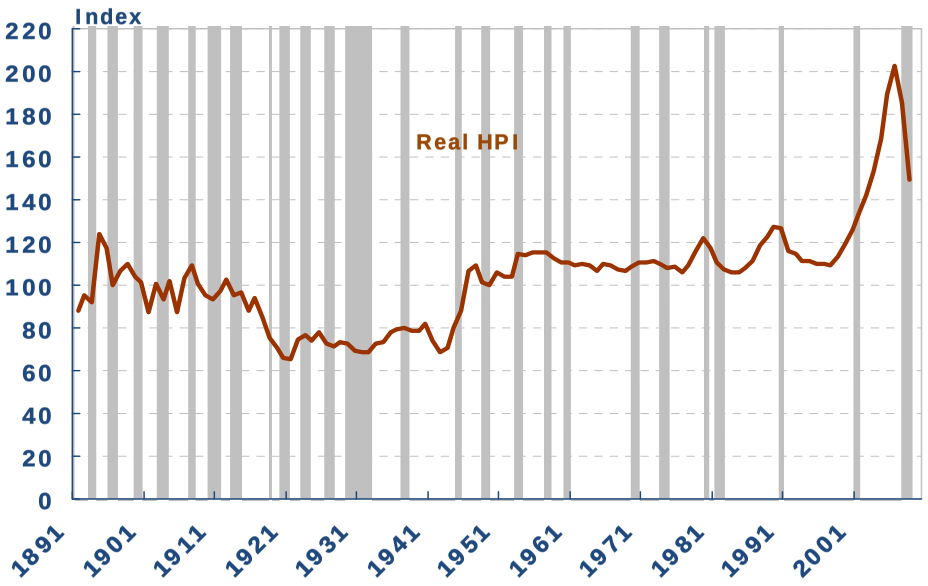
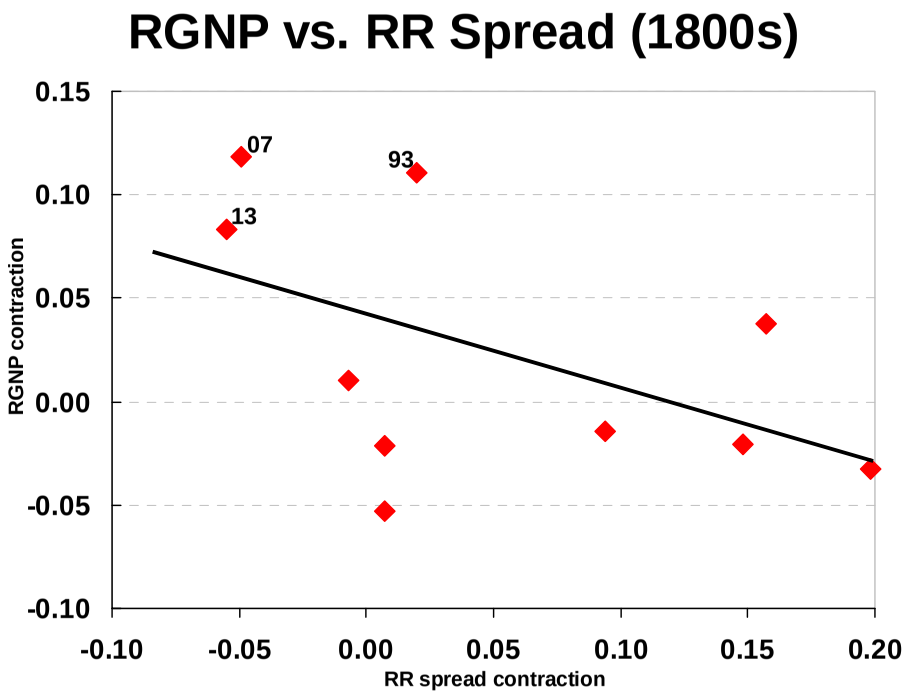
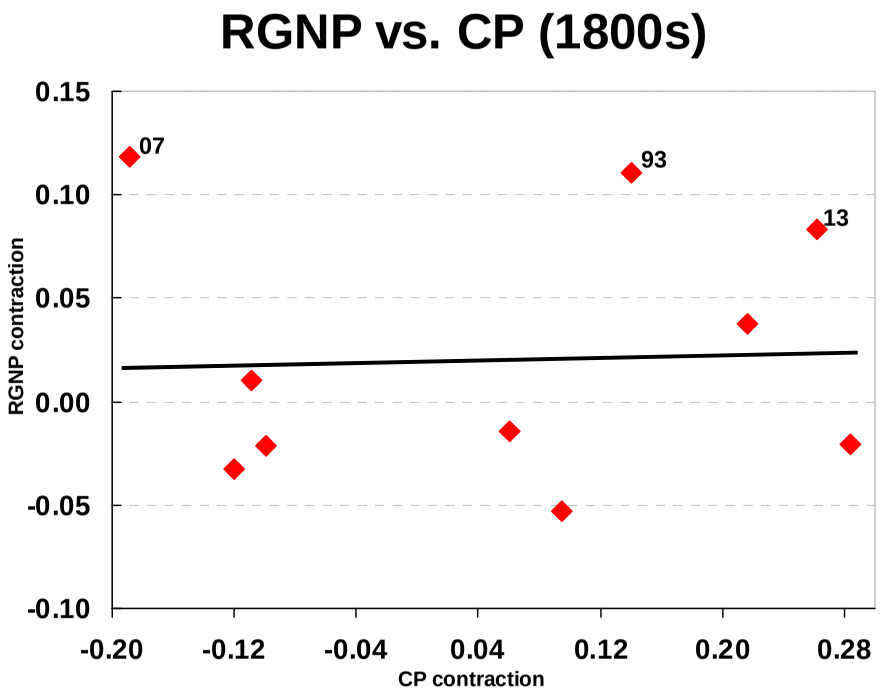
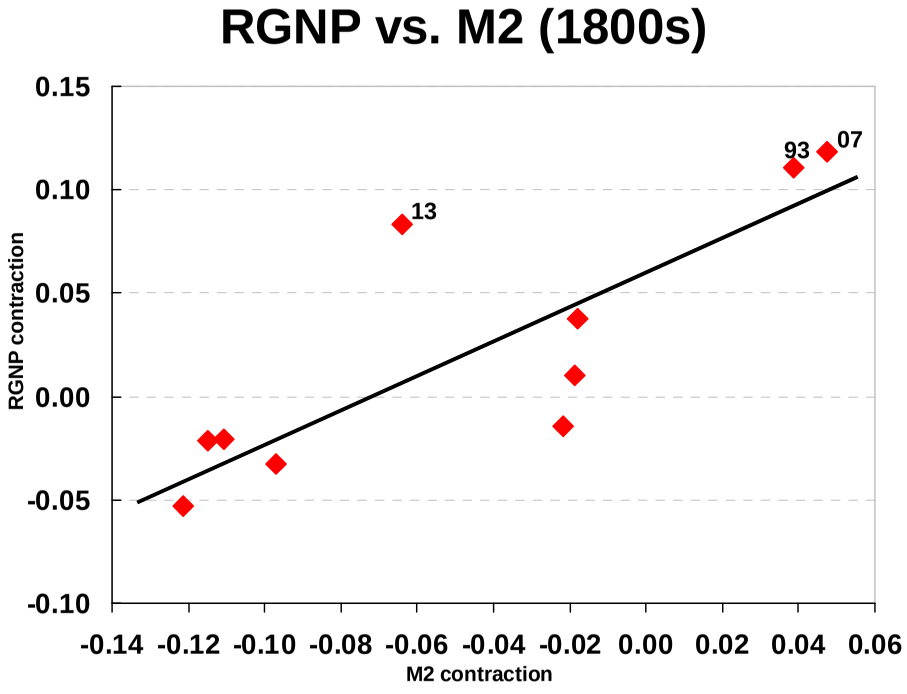


Source: Shiller

Figure 2


RGNP vs. RR Spread (1800s)
RGNP contraction
RR spread contraction
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
07
93
13


RGNP vs. CP (1800s)
RGNP contraction
CP contraction
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.20
-0.12
-0.04
0.04
0.12
0.20
0.28
07
93
13


RGNP vs. M2 (1800s)
RGNP contraction
M2 contraction
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.14
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
93
07
13

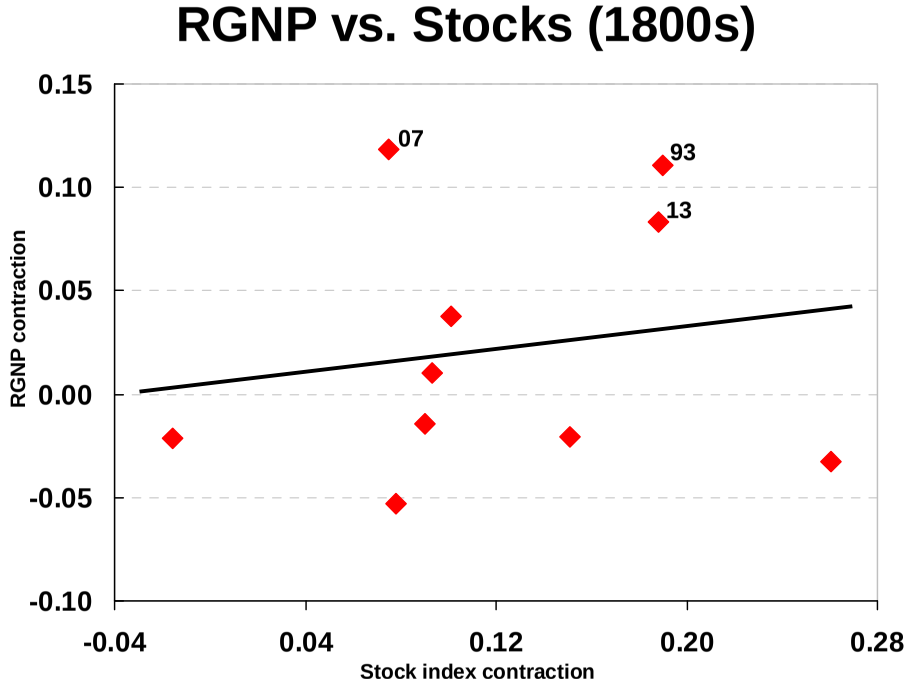
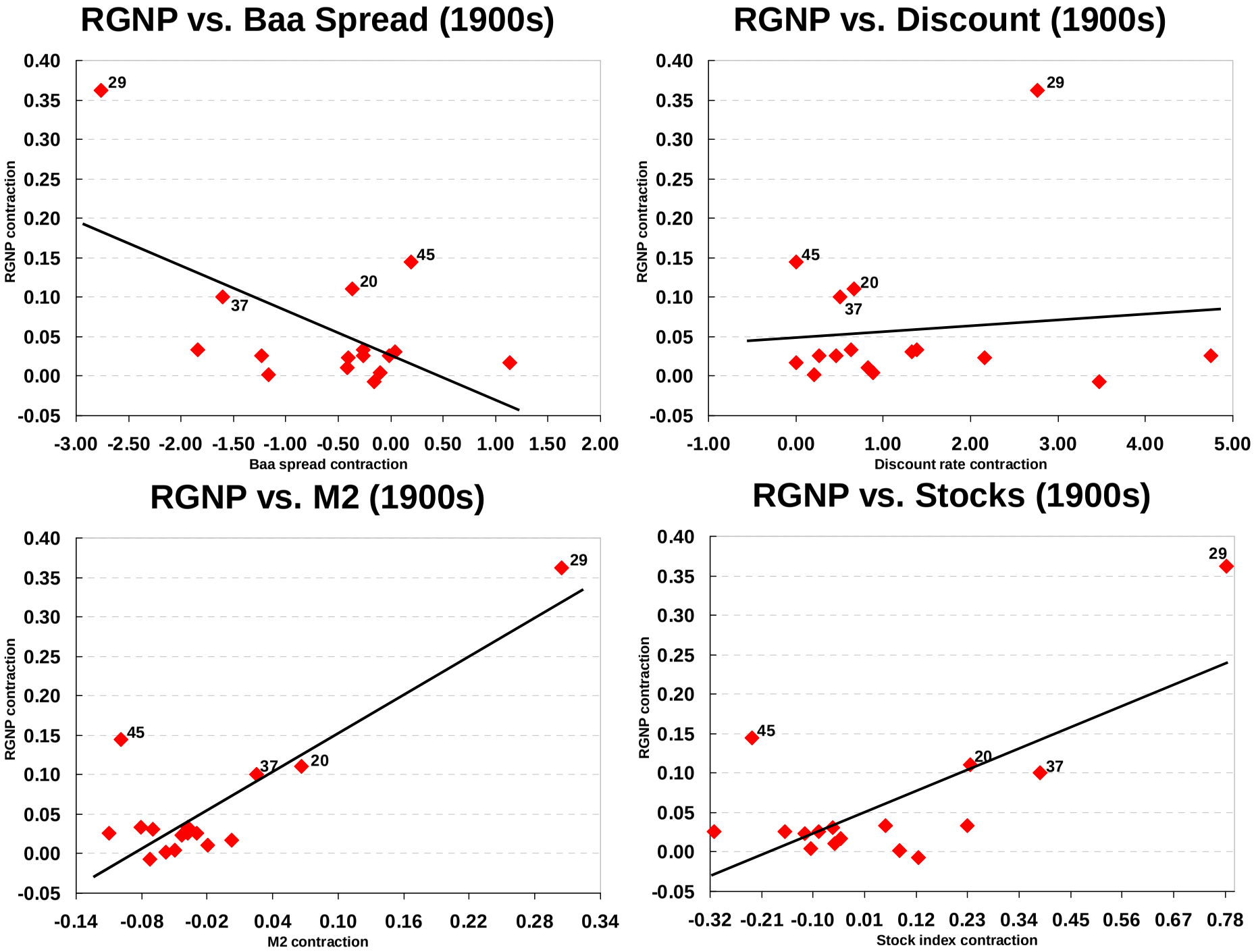

RGNP vs. Stocks (1800s)
RGNP contraction
Stock index contraction
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.04
0.04
0.12
0.20
0.28
07
93
13

Figure 3


RGNP vs. Baa Spread (1900s)
RGNP contraction
Baa spread contraction
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-3.00 -2.50 -2.00 -1.50 -1.00 -0.50 0.00 0.50 1.00 1.50 2.00
29
45
20
37
RGNP vs. Discount (1900s)
RGNP contraction
Discount rate contraction
-1.00 0.00 1.00 2.00 3.00 4.00 5.00
29
45
20
37
RGNP vs. M2 (1900s)
RGNP contraction
M2 contraction
-0.14 -0.08 -0.02 0.04 0.10 0.16 0.22 0.28 0.34
29
45
37
20
RGNP vs. Stocks (1900s)
RGNP contraction
Stock index contraction
-0.32 -0.21 -0.10 0.01 0.12 0.23 0.34 0.45 0.56 0.67 0.78
29
45
20
37