The “Great” Bank Failures

Judge Glock
College of Business & Economics
West Virginia University
Morgantown, WV 26501
Judge.glock@mail.wvu.edu

Eric Olson
College of Business & Economics
West Virginia University
Morgantown, WV 26501
Eric.olson@mail.wvu.edu

ABSTRACT

We use a new measure of the output gap proposed by Hamilton (2017) in conjunction with Taylor’s (1979) efficiency frontier to evaluate monetary policy during the last two “Great” contractions. Our results suggest that two periods of widespread bank failure, coinciding especially with the failure of the Bank of United States in December 1930 and the failure of Lehman Brothers in September 2008, impeded the transmission of subsequent monetary policy. Our results show that in both cases the Federal Reserve failed in containing and mitigating the macroeconomic effects of the bank failures. However, our results also suggest that after the major bank failures, the Federal Reserve’s responses were substantially better during the Great Recession compared to that of the Great Depression.

Key words: Great Depression, Monetary Policy, Output-stability frontier, Bank Failures

1.0 Introduction

The work of Friedman and Schwartz (1963), Bernanke (1983), Romer (1992), and many others have demonstrated the myriad of ways in which the collapsing money supply, failing banks, and significant deflation, as well as the seeming passivity of the Federal Reserve, impacted the overall economy during the Great Depression. The literature examining Federal Reserve policy and practices in the Great Recession has likewise ballooned over the subsequent decade (See, e.g., Erceg and Levin 2014; Wu and Xia 2016). However, previous work evaluating monetary policy during both the Great Depression and the Great Depression have not used either Taylor's (1979) output stability frontier or Hamilton's (2017) new output gap measure to evaluate monetary policy. We use these tools to compare monetary policy and economic outcomes in each period.

To preview our results, we find that the economy moved dramatically away from its efficiency frontier immediately after the failure of the Bank of United States in December 1930 and the failure of Lehman Brothers in September of 2008. Our results confirm previous evidence, including Friedman and Schwartz (1963) and Blinder and Zandi (2015), that the failures of these banks was a significant cause in the breakdown of the monetary policy transmission mechanism which amplified the severity of the contractions. Additionally, we find that the unconventional policies (QE programs) undertaken by the Federal Reserve after both bank failures did partially restore the efficacy of monetary policy in terms of shifting the economy back towards its efficiency frontier, but that overall monetary policy efficacy remained low. Our results suggest that the key in central banks maintaining their monetary policy efficacy is the *prevention*, rather than the responses, to financial crises.

Our results also suggest that the Federal Reserve repeated the same mistake in 2008 that it committed in 1930 in letting Lehman Brothers fail, as they let the Bank of United States fail. However, whereas many banking institutions failed after the Bank of the United States in the Great Depression, moving the economy further away from its output stability frontier, our results do suggest that the Fed's actions in stabilizing other weak institutions during the late 2008 and 2009 substantially stabilized the economy and moved it back towards the output stability frontier. The rest of the paper proceeds as follows. Section two discusses our measure of the output gap and methodology, section three displays our results, and section four concludes.

2.0 Methodology

2.1 Output Gaps

Many previous empirical papers use the Hodrick Prescott (HP) filter in constructing their measures of the output gap. Hamilton (2017) strongly argues against using this filter. Hamilton instead proposes an alternate concept of a cyclical component, and states that the cyclical component should be interpreted as *"how different is the value at date t+h from the value that we would have expected to see based on its behavior through data t?"* That is, Hamilton proposes a projection of y_{t+h} on a constant and the four most recent values of y as of date t. For our quarterly data, we follow Hamilton (2017) and estimate the following regression for the log of real GNP and real GDP data:[1]

$$y_{t+8} = \alpha_0 + \alpha_1 y_t + \alpha_2 y_{t-1} + \alpha_3 y_{t-2} + \alpha_4 y_{t-3} + \varepsilon_t \qquad (1)$$

The cyclical component (i.e. the output gap) is then defined as the residuals from (1). Figures 1 and Figures 2 display the output gap from using the two methodologies over the (1915 – 1940)

[1] We use real GNP because of data of its availability prior during the 1910-1940 time period

and the (1987 – 2017) time periods. The black line in each Figure represents the output gap from using Hamilton's (2017) methodology and the blue line is the output gap from using the HP filter. The first thing to note about Figures 1& 2 is the substantial difference in the two output gaps. The HP filter is substantially less volatile than the Hamilton filter over the entire sample periods. Moreover, the output gap suggested by the HP filter over the Great Recession does not seem plausible given that it suggests that output declined by only 2.5% in 2008. The Hamilton output gap suggests much severer recessions and expansions than the HP filter in both the Great Depression and the Great Recession.

[Insert Figure 1 & 2]

We believe a strong argument in favor of using the new Hamilton filter is that its results coincide more closely to the narrative and empirical evidence of monetary policy in the Great Depression than the HP filter. For instance, as noted in Figure 1, the HP filter implies that there was not a significant output gap until early 1932, at which period prices were 29% below their 1929 peak, and output had dropped 26% from its peak (Balke and Gordon 1986). The new Hamilton filter, by contrast, agrees with the narrative and empirical evidence found in such works as Friedman and Schwartz (1963), Romer (1992), Wheelock (1992), Wicker (1996), and Meltzer (2003) that the output gap had grown significantly from at least 1930.

2.1 Output-Stability Curves

As noted in Taylor (2016), the Output-stability frontier results from a central bank trying to minimize the expected value of the following loss function (L):

$$L = \lambda(\pi_t - \pi_t^*)^2 + (1-\lambda)(y_t - y_t^*)^2 \qquad (3)$$

where π_t is the inflation rate, π_t^* is the target inflation rate, λ is the central bank's preference for inflation stability, y_t is output, and y_t^* is the target level of output. Given the structural equations of the economy and a weight assigned to inflation stability, it is possible obtain a point on the output-stability frontier. This point represents the optimized values of the variance of inflation and the variance of output for a given value of λ. Varying λ allows one to plot out an efficiency frontier as the locus of points indicating the smallest variance of inflation obtainable for any given variance of the output gap. Consider the output-stability curve depicted in Figure 2. Monetary policy that is optimal would result in the economy operating on its output-stability curve. As noted in Taylor (2016), monetary policy which is sub-optimal, or time periods in which the monetary policy transmission mechanism is obstructed would result in large variations of the observed volatilities in the space to the right of the output-stability frontier, such as point A.[2] Thus, movement towards the output-stability frontier represents an improvement in monetary policy and movements away from the frontier represent disruptions in monetary policy efficacy.

[Insert Figure 2]

Taylor (1979), Cecchetti, Stephen, Flores-Lagunes, Krause (2006), Mishkin and Hebbel (2007), Olson and Enders (2012), Hebbel (2016), and Olson and Wohar (2016) have used the output-stability frontier to evaluate central bank performance. For instance, Cecchetti, Flores-Lagunes and Krause(2006), Mishkin and Hebbel (2007) and Hebbel (2016) use shifts in the output-stability frontier to evaluate the effectiveness monetary policy after the adoption of inflation targeting in countries that formally adopted an inflation target. Taylor (1979) derives the output-stability frontier and uses it to evaluate Friedman's *k-percent* rule. Yet no researcher

[2] Points to the left of the stability frontier are not attainable.

to our knowledge, except for a brief mention in Olson and Enders (2012), has used the output-stability frontier to evaluate policy during the Great Depression. Moreover, a possible shortcoming of previous output-stability frontier papers (Mishkin and Hebbel (2007), Olson and Enders (2012), Hebbel (2016)), is the use of the Hodrick-Prescott (HP) filter to measure output gaps. Our paper uses the above Hamilton (2017) methodology to generate our output gap to use in the Taylor curve.

2.2 Estimating the Output-Stability Curve

In order to construct the curve, we estimate a variant of the aggregate demand and supply model developed in Mishkin and Hebbel (2007), Cecchetti, Flores-Lagunes and Krause (2006) and Olson and Enders (2012). Consider:

$$y_t = \sum_{i=1}^{n} \alpha_{1,i}\, y_{t-i} + \sum_{i=1}^{n} \beta_{1,i}\, \pi_{t-i} + \sum_{i=1}^{n} \phi_{1,i}\, m_{t-i} + \varepsilon_{1,t} \tag{4}$$

$$\pi_t = \sum_{i=1}^{n} \alpha_{2,i}\, y_{t-i} + \sum_{i=1}^{n} \beta_{2,i}\, \pi_{t-i} + \sum_{i=1}^{n} \phi_{1,i}\, m_{t-i} + \varepsilon_{2,t} \tag{5}$$

Equation (1) represents an aggregate demand function, where the output gap (y_t) is obtained as described above, and a function of its own lags, lags of the growth rate in M2 (m_t) (we substitute the federal funds rate for M2 for the Great Recession time period), and lags of the inflation rate (π_t). Equation (2) represents an aggregate supply curve in which inflation is a function of its own lags, lags of the output gap, and lags of the money growth rate (m_t) (or interest rates). As such, it is important to note that we are using the growth rate of the money supply as our control variable rather than nominal interest rates for the Great Depression era. Since the Federal Reserve did not attempt to target a precise financial market in this era, such as the Federal Funds market, a variety of potential measures of short-term interest rates could give a biased view of the stance of Fed policy. Also, the problems with measuring expected inflation or deflation in a gold-standard era makes it difficult to understand how nominal interest rates corresponded to inflation-anticipated rates, and therefore makes them an inappropriate measure of monetary ease (see Hamilton 1992, Evans and Watchel 1993). Therefore, we follow previous works in focusing on the nominal money stock (Romer 1992) for the Great Depression era. In order to estimate a VAR in the form of (1) and (2), we obtained data from Balke and Gordon (1988) for the period 1915Q1-1940Q1. Inflation was defined as year-over-year percentage change in the GNP deflator. The lag length of the VAR was selected according to the multivariate generalizations of the Akaike Information Criterion (AIC).

In order to construct the output stability frontier, the VAR is rewritten in its state-space representation,

$$\mathbf{X_t} = \mathbf{B}\,\mathbf{X_{t-1}} + \mathbf{c}\,\mathbf{m_{t-1}} + \mathbf{v_t} \tag{7}$$

and the loss function is written as:

$$\mathbf{X_t'}\boldsymbol{\Lambda}\mathbf{X_t} \tag{8}$$

where Λ is a square weighting matrix. The goal of policy makers is to pick the growth rate of the money supply so as to minimize the loss function (8) subject to the equations (7). The solution for money growth rate path is linear and written as:

$$\mathbf{m_t} = \mathbf{g}\,\mathbf{X}_{t-1}. \tag{9}$$

The control vector **g** in the steady state is solved using optimal control as in Chow (1979) where:

$$\mathbf{g} = -(\mathbf{c'Dc})^{-1}\mathbf{c'DB} \tag{10}$$

and $\mathbf{H}$ is the solution of the equations

$$\mathbf{D} = \mathbf{\Lambda} + (\mathbf{B} + \mathbf{cg})'\mathbf{D}(\mathbf{B} + \mathbf{cg}). \tag{11}$$

For a given estimated values of the parameters in B and c (which are the estimated coefficients from the VAR), $\mathbf{D}$ and $\mathbf{g}$ can be solved for any value of λ (the central bank's preference for price stability). Thus, the steady state covariance matrix of $\mathbf{X_t}$ is given by $\mathbf{\Sigma}$ which satisfies

$$\mathbf{\Sigma} = \mathbf{\Phi} + (\mathbf{B} + \mathbf{cg})'\mathbf{\Sigma}(\mathbf{B} + \mathbf{cg}). \tag{12}$$

where $\mathbf{\Phi}$ is the covariance matrix of the residuals in $\mathbf{V}$. This procedure determines a single point on the output-stability frontier; the entire frontier is derived by changing the weight assigned to inflation stability. We use the entire sample period (1915-1940) in estimating the efficiency frontier. We subsequently calculate the sample standard deviation of inflation and the standard deviation of the output gap to gauge the time path of the efficacy of monetary policy.

The methodology we use to estimate the stability curve for the Great Recession is very similar to that outlined above. However, there are some key differences. First, we use the Federal funds rate as our control variable given that that was policy tool used. That is, we replace the growth rate of money with the Federal funds rate in (4) and (5) such that the policy rule is

$$\mathbf{i_t} = \mathbf{g}\,\mathbf{X_{t-1}}. \tag{13}$$

Also, given that the target federal funds rate was near zero from 2008 - 2015, we use the Wu and Xia (2015) shadow federal funds rate over the 2008 – 2015 time period to account for the QE programs as well as the forward guidance that the Fed provided. Additionally, we use RGDP to obtain our output gap as defined in section 2.1 and the GDP deflator as our measure of inflation rather. In order to estimate the output stability frontier, we use the 1987 – 2017 time period. We chose to begin at the end of the Volker disinflation and the beginning of the Greenspan era. However, our results are robust to additional sample periods.

3.0 Results

3.1 Bank Failures

Figures 3 (Panels A & B) display the output stability curves and the actual volatility of the U.S. economy using data before and throughout the Great Depression (from 1929-1940) and Figure 4 (Panels A & B) display the output stability curve and actual volatilities before and throughout the Great Recession (2007 – 2017). It is important to note the differences in the scales between Figures 3 and 4. While the range for the *x* axes (inflation volatility) in both Figures is from 0 – 4 standard deviations, note that the range of the *y* axis (output volatility) in Figure 3 is 6-14 whereas the range in Figure 4 is 1.75 – 3.50. Not surprisingly, this reflects the fact that the U.S. output stability frontier substantially shifted towards the origin; while not the focal point of this paper, the causes of the inward shift are likely, the U.S. leaving the gold standard, better technology and more transparent monetary policy.[3]

Figure 3 Panels A and B display the results of our analysis from the Great Depression. Panel A displays the output stability curve along with the *yearly* average standard deviations of the output gap and inflation. Panel B displays the quarterly standard deviations of output and inflation. Note that the shift of the economy away from the efficiency frontier began in what Friedman and Schwartz (1963) called the first banking panic of the Depression. This banking panic began in October 1930 and culminated with the December 11, 1930 failure of the Bank of United States, then the largest bank failure in United States history. While banks with $180

[3] See Mishkin and Hebbel (2007) for a discussion regarding the causes of why the stability frontier has shifted inward

million in deposits, including the large Southern Caldwell and Company bank chain, collapsed in November 1930, the Bank of United States alone, whose name falsely gave some domestic and foreign investors the impression of government ownership, contained $200 million in deposits, leading the total failure of 352 banks with $370 million in deposits in December (Friedman and Schwartz 1963). Note in Panels A and B of Figure 3 that monetary policy efficacy also significantly worsens in the second and third quarters of 1931 which coincides with the second and third banking crises of the Depression as identified by Friedman and Schwartz (1963) and Wicker (1996). The fall in monetary efficacy during the third quarter of 1931 also overlaps with the British government leaving the gold standard in September 1931, which Friedman and Schwartz (1963) recognize one of the most significant crises of this era.

In response to these crises, Congress passed the first Glass-Steagall Act in February 1932 which decreased the gold ratio on new Federal Reserve reserves, and allowed the Federal Reserve to purchase approximately $800 hundred million dollars in Treasuries, more than doubling their total of purchased government debt (Meltzer 2003), which, as we explain below, did somewhat improve monetary efficacy. Note also that although the output gap hits its nadir in early 1933, after Roosevelt left the gold standard, monetary policy does not really move back towards its efficiency frontier up until 1934. Monetary policy does worsen with the gradual increase in reserve requirements on commercial banks which Friedman and Schwartz (1963) identify as the reason for the steep recession in 1937, the third deepest in U.S. history.

One interpretation of our results is that they reflect a breakdown in the transmission mechanism of monetary policy as outlined in Bernanke and Gertler (1995). That is, the failure of the Bank of United States dramatically increased the external finance premium between the expected return of banks and the costs of borrowers which essentially muted any positive monetary policy effects. The failure certainly had balance sheet effects on borrowers but likely more important, was that a bank failure the size of the Bank of the United States made all banks cautious in lending due to the possibility of a run on their deposits. Allowing the failure to occur significantly impacted the bank lending channel component of monetary policy transmission mechanism which is evident in our results in that the Fed could not stabilize inflation or output around targets despite some attempts at unconventional policies (i.e. the movement away from its Taylor curve).[4]

Figure 4 Panels A and B display the results from the Great Recession. As noted above, Panel A displays the output stability curve along with the *yearly* average standard deviations of the output gap and inflation whereas Panel B displays the quarterly standard deviations of output and inflation. Note in Figure 4 that prior to the crisis in the third quarter of 2008, monetary policy was not actually operating very far from its efficiency frontier; however, as can been seen in Panel B of Figure 4, the economy continually moves away from the frontier beginning in late 2008 and throughout 2009. Note that most estimates of the financial crisis began in the summer of 2007 when two Bear Stearns hedge funds that had bet on subprime mortgages had to suspend redemptions. Somewhat surprisingly, the economy does not begin to move away from its efficiency frontier until *after* the Lehman Brothers failure in the third quarter of 2008. Interestingly, and similar to the results from the Great Depression, the substantial decline in the stock market from the fall of 2007 through the summer of 2008 is not what triggers the movement of the economy away from its efficiency frontier. Note that the Dow Jones was above

[4] In both cases the relationship between the monetary base and overall macroeconomic variables, such as inflation, output, and bank intermediation, broke down after these bank failures. Friedman and Schwartz point out that although the monetary base carried a close correlation with overall variables up to December 1930, after that period an increase in the monetary base coincided with a continuing collapse in output and deflation (Friedman and Schwartz 1963, 303, 336-338). Of course a similar increase in the monetary base after September 2008 also coincided with a collapse in output and disinflation.

14,000 in October 2007 and was 11,000 in July of 2008. It was after the Lehman bankruptcy that the economy moves away from its efficiency frontier throughout 2009 and 2010. After 2010, the economy begins to move back towards its efficiency frontier but has not recovered to its previous position.

3.2 Idiosyncratic Factors in the Failure of the Large Banks

An interesting feature of both the failures of The Bank of the United States and Lehman Brothers was that neither bank was insolvent at the time of its failure. While there is little doubt that the Bank of the United States was solvent in 1930, there is some debate regarding the solvency of Lehman brothers. The debate primarily centers around the valuations of the illiquid assets on Lehman's balance sheet. Bernanke (2015) argues that Lehman brothers did not have enough quality collateral to secure a loan from the Federal Reserve under the Federal Reserve Act's Section 13-3 clause, whereas many Lehman executives and the Examiner of the Chapter 11 bankruptcy proceedings argued otherwise.[5] Ball (2016) also makes a convincing argument that Lehman Brothers was not insolvent as Federal Reserve officials have publically stated, and that the Federal Reserve on its own could have saved the bank if it was willing.[6]

One salient, but often overlooked, commonality between the failure of the Bank of United States and Lehman Brothers was the financial sector's dislike of the leadership of each of the banks. For instance, although the Federal Reserve Bank of New York, and New York State

---

[5] The examiner stated:

> "The Examiner finds insufficient evidence to support a finding that Lehman's valuations of its RWL, RMBS, CDO or derivative positions were unreasonable during the second and third quarters of 2008. Although the Examiner identifies, and discusses below, certain problematic issues related to the price testing of these asset classes, these problems either did not impact the ultimate asset values determined or the resulting valuation errors were immaterial."

[6] Bernanke (2015) argues that Lehman brothers did not have enough quality collateral to secure a loan from the Federal Reserve under the Federal Reserve Act's Section 13-3 clause, whereas many Lehman executives argued otherwise. In the Report of the Examiner in the Chapter 11 Lehman Brother's proceedings, the examiner states the following: "Although the Examiner identifies, and discusses below, certain problematic issues related to the price testing of these asset classes, these problems either did not impact the ultimate asset values determined or the resulting valuation errors were immaterial."

Lieutenant Governor Herbert H. Lehman (ironically, a founding brother of Lehman Brothers), actively pushed a plan in which the Bank of the United States would merge with several other banks; these private banks refused. The government pointed out that these bankers had only weeks before saved two large banks in New York that required more funds for lower quality assets; however, the bankers refused to participate in the rescue of the Bank of the United States after an all-night meeting on December 10th, 1930 resulting in its failure the next day. Friedman and Schwartz (1963) strongly suggest that the Bank of United States failure was in part a result of Wall Street refusing to provide liquidity because of the banks primarily Jewish ownership and clientele. Friedman and Schwartz (1963) argue that the bank was disliked and resented because of its name (i.e. it implied it was a governmental agency) and the fact that the bank attracted a substantial number of deposits from Jewish immigrants in New York City because of its Jewish ownership.[7]

Similarly, several Wall Street participants also have pointed to the fact that the CEOs of Lehman Brothers and Bear Stearns were disliked. For example, in a 2012 editorial in Forbes magazine entitled "Why Knight Capital Was Saved And Lehman Brothers Failed," John Taft, the CEO of RBC Wealth Management states:

> "Character still counts in the financial services industry. Don't believe me? Just compare the way Wall Street treated the recent travails of Knight Capital Group Inc. and its well-respected CEO Thomas Joyce to the way it *watched, abetted and even enjoyed the slow, brutal demise of Bear Stearns and its CEO, Jimmy Cayne, and Lehman Brothers and its CEO, Dick Fuld*……. Tom Joyce is a man of character. That's why the financial services industry went out of its way to save Knight Capital."[8]

As in the Great Depression, the New York Federal Reserve bank actively tried to broker a deal to save the large tottering bank. As is well documented, over the weekend of September 12-14,

[7] See the footnotes in on page 310 of Chapter 7 of Friedman and Schwartz (1963) for an in depth discussion
[8] https://www.forbes.com/sites/advisor/2012/08/20/why-knight-capital-was-saved-and-lehman-brothers-failed/#3f27abab4d37

2008 Timothy Geithner, President of the New York Federal Reserve, Hank Paulson the U.S. Treasury Secretary and Ben Bernanke the Chairman of the Federal Reserve tried to arrange a sale of Lehman Brothers at the New York Federal Reserve's headquarters but ultimately failed. Our point is that it is possible that widespread personal animus against both these large financial institutions' leadership may have played a significant role in the inability of regulators to find a private sector solution as they had done they had done to rescue Long Term Capital Management (LTCM).

3.3 Unconventional Monetary Policy (i.e. QE)

Our methods also allow us to gauge the effectiveness of the QE programs in moving the economy back towards its efficiency frontier. Although little noted today, the Federal Reserve in the Great Depression carried out several programs that were similar in design and intention to the Federal Reserve programs in the recent Great Recession (for discussion of similarities of one such program, see Bordo and Sinha (2016)). In January of 1932, Congress created the Reconstruction Finance Corporation, which was effectively an adjunct of the Federal Reserve meant to purchase long-term financial assets (a type of early Term Asset-Backed Loan Facility (TALF), such as that instituted by the Federal Reserve in November 2008). This corporation would advance $2 billion for assets up to March 1933, at which point it began also purchasing bank debt directly. From April 1932 until August 1932, the Federal Reserve also engaged in extensive open-market programs under the Glass-Steagall Act. Under the open-market operations the Fed increased security holdings by $1 billion (an early Quantitative Easing, or QE, program) (Friedman and Schwartz (1963)). Nearing the end of that program, the Federal Reserve began lengthening the maturity of its balance sheet (a type of early "Operation Twist"). In June of 1932, the Federal Reserve purchased their first government bonds of over one year maturity, and these increased until they stabilized around 34% of the Fed's portfolio in April 1933, with 20% of this in bonds of over three years maturity, totaling $568 million in long-term bonds (Glock (2017)).

During the Great Recession, the Quantitative Easing (QE) programs were implemented by the Fed from December 2008 to March 2010, November 2010 to June 2011, and September 2012 to December 2013. On November 25th, 2008, the Federal Reserve announced it would purchase $100 billion in Government-Sponsored Enterprise (GSE) debt, and $500 in Mortgage Backed Securities (MBS), which became known as QE1. On March 18, 2009, the Fed extended QE1 by saying it would purchase $300 billion in long-term treasuries, $750 billion in MBS, and $100 billion in GSE debt. On November 3, 2010, the Federal Reserve announced it would purchase $600 billion in Treasuries, which became known as QE2. On September 21, 2012, the Federal Reserve announced it would purchase $400 billion in long-term Treasuries while selling an equivalent amount of short-term treasuries, a version of an earlier Federal Reserve's Operation Twist strategy. On June 20, 2012, the Federal Reserve extended its purchases of long bonds and sales of short-term bonds. On September 13, 2012, the Federal Reserve announced it would purchase $40 billion in Mortgage Backed securities per month. On December 12, 2012, the Federal Reserve announced it would purchase $45 billion in long-term Treasuries per month, but without the sale of short-term securities (Fawley and Neely, 2013). Except for QE1 in 2008, the financial panic had subsided by the time the Federal Reserve undertook unconventional policies in order to stimulate the economy.

In order to measure the effectiveness of the QE programs we measure the amount of the lost distance that the economy moved back towards its efficiency frontier during the time periods that the QE programs were in progress. If a program began or ended in the middle of a quarter, we assume that the program began or ended in the respective quarter. For example, QE2 began in November of 2010 and ended in June of 2011; because we use quarterly data, we assume that the program was in place from the beginning of 2010Q4 – 2011Q2. As noted above, the efficiency frontier is derived by varying λ, the central bank's preference for inflation (output) stability. If we knew exactly what the central bank's actual λ was, we could calculate the actual distance of the economy from optimal monetary policy; however, λ is not known. As such, we thought a reasonable approach was to calculate the distance of the economy from every point on the efficiency frontier for a given quarter and then take the average of all the calculated distances. That is,

$$Average\ Distance_t = \frac{\sum_{i=1}^{n} \sqrt{(Ovol\_i_i - Avol\_i_t)^2 + (Ovol\_y_i - Avol\_y_t)^2}}{n} \quad (14)$$

where $Ovol\_i_i$ and $Ovol\_y_i$ are the optimal volatilities of inflation and output (i.e. each *i* is a point the output stability curve) and $Avol\_i_t$ and $Avol\_y_t$ are the actual volatilities of inflation and output in each quarter *t*. Table 1a and Table 1b display the average distances for each quarter over the (1929 – 1939) and (2007 – 2017) time period. Table 1 mirrors the results from Panel B of Figures 3 and 4.

Note in Table 1a, that the maximum distance occurs in 1937Q3 at a value of (7.11) and in 2010Q3 with a value of (1.25). In order to gauge how effective the QE programs were, we calculate the average distance the economy moved towards its efficiency frontier during time periods in which the respective QE program was in operation. That is, we calculate

$$\Delta\ QE\ Distance = \left(\frac{\sum_{i=1}^{n} \sqrt{\left(Ovol_{i_i} - Avol_{i_t}\right)^2 + \left(Ovol_{y_i} - Avol_{y_t}\right)^2}}{n} \right) - \left(\frac{\sum_{i=1}^{n} \sqrt{\left(Ovol_{i_i} - Avol_{i_{t+h}}\right)^2 + \left(Ovol_{y_i} - Avol_{y_{t+h}}\right)^2}}{n} \right) \quad (15)$$

where $Avol_{i_t}$ and $Avol_{y_t}$ are the actual volatilities of inflation and output at the beginning of each quarter *t* for the respective QE program, and $Avol_{i_{t+h}}$ and $Avol_{y_{t+h}}$ are the actual volatilities of inflation and output of the last quarter in which the QE program was active. We define $Total\ Distance = \max(Average\ Distance_t)$ and subsequently define QE effectiveness as

$$QE\ effectiveness = \frac{\Delta\ QE\ Distance}{Total\ Distance} \tag{16}$$

Table 2 displays the results for the QE during the Great Depression and during the Great Recession. For comparison purposes, we also calculated the QE effectiveness measures for the equal time period before and after the QE actions were taken (for example, QE3 spanned 5 quarters; as such, we calculate our QE effectiveness measure during the 5 quarters prior to and after QE3). During the Great Depression note that the economy moved 5.5% further away from its efficiency frontier in the quarter before QE, it moved 3.5% during the quarter in which QE took place, and moved 1.9% in the quarter after the program ended. During the Great Recession, note that the economy moved 4.8% away from its efficiency frontier in the 3 quarters prior to the QE, moved -2.4% back towards its efficiency frontier during the three quarters of QE2, moved an additional -3.2% towards its efficiency frontier after QE2. Again, during QE3, the economy moved -2.4% back towards its efficiency frontier and moved an additional -4.0% in the subsequent 5 quarters.

If monetary policy affects the economy with a lag, the results in Table 2 suggest that the QE measures undertaken were successful in improving monetary policy efficacy, especially during the Great Recession. While the economy did not move back towards its efficiency frontier during the Great Depression in the quarter in which QE was undertaken, note that it substantially slowed its outward movement. As suggested by Friedman and Schwartz (1963), if the RFC would have continued with their asset purchase program for more than one quarter, the results in Table 2 may have been different. In any case, our results do suggest that the QE2 and QE3 were instrumental in improving monetary policy efficacy after the Great Recession. However, the QE programs were not able to return the economy to its region prior to the failure of the two banks.

There are several caveats to our results that need to be mentioned. While we believe that our results are reasonable, they are conditional on the loss function specified in equation (3), and our parameter estimates obtained from our VAR. Given that our loss function only includes deviations of output and inflation from their target values, we are not taking into account the decline in the unemployment rate or increases in the stock market that may have resulted from the unconventional policies.

3.4 Discussion

We are not able to make definitive causal statements regarding the failure the Bank of United States and Lehman Brothers and the failure of the decline in monetary policy efficacy in Figures 3 & 4. One would need higher frequency output gap and inflation data to make more definitive statements. Moreover, there were certainly other financial firm failures during the fourth quarter of 1930 and 2008 that contributed to the decline in monetary policy efficacy. However, our results certainly support the claims of Friedman and Schwartz (1963) and Blinder and Zandi (2015) that the bank failures in these periods were catalysts which greatly exacerbated each crisis. Our results suggest that the Fed lost ability to control the volatility of inflation and output in both cases, despite an increase in the monetary base.

Also, if monetary policy was grossly inadequate in the years leading up to the crises in 1930 and 2008, under our monetary policy efficacy measures, the economy should have been moving away from its efficiency frontier during these time periods. But our results do not support that assertion. In both the Great Depression and Great Recession, the economy only begins moving away from its efficiency frontier in the quarters when these bank failures occurred. As such, we suggest that the mistake the Federal Reserve made in both cases was in not finding a suitable way to wind down two important institutions with leadership disliked by many other market participants. Put simply, while the line between a liquidity crisis and a solvency crisis for a firm is often murky, if a firm is disliked (regardless of whether it is because of a firm's earned reputation as in Lehman's case, or bigotry as in the case of the Bank of the United States) the ability of regulators and officials to salvage such a bank becomes even more difficult.

4.0 Conclusion

Our aim has been to use output stability frontiers in order to evaluate monetary policy in the Great Depression and The Great Recession. Consistent with previous narrative evidence, our results agree with the notion that the events which moved the economy away from its efficiency frontier were the failure of the Bank of United States and the failure of Lehman Brothers. In both cases, the leadership of each firm was disliked by many other market participants, which we believe likely hindered private sector help. The stock market crash in 1929 and the bear market before Lehman Brothers collapsed do not appear to be the catalyst for the economy moving away from its optimal point. Yet the unconventional policies undertaken by the Federal Reserve during the 1930s, and Federal Reserve QE2 and QE3 in the Great Recession, did begin to move the economy back towards its efficiency frontier.

References

Ball, L. (2016). The Fed and Lehman Brothers: Introduction and Summary (No. w22410). National Bureau of Economic Research.

Balke, Nathan, and Robert Gordon. (1986). “Appendix: Historical Data,” in R. Gordon, ed.: *The American Business Cycle*. University of Chicago Press.

Bernanke, B. S. (1983). “Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression.” *The American Economic Review*, *73*(3), 257-276.

Bernanke, B. S. (2015). *The courage to act: A memoir of a crisis and its aftermath*. WW Norton & Company.

Blinder, A., & Zandi M. (2015). The financial crisis: lessons for the next one. *Report by the Center on Budget and Policy Priorities (October 2015).*

Bordo, M., & Sinha, A. (2016). *A Lesson from the Great Depression that the Fed Might have Learned: A Comparison of the 1932 Open Market Purchases with Quantitative Easing*(No. w22581). National Bureau of Economic Research.

Cecchetti, Stephen G., Alfonso Flores-Lagunes, and Stefan Krause. (2006). “Has Monetary Policy Become More Efficient? A Cross-Country Analysis.” *Economic Journal* 116, 408–33.

Chow, Gregory C. (1979). *Analysis and Control of Dynamic Economic Systems.* New York, NY: Wiley.

Erceg, Christopher J. & Levin A. (2014) “Labor Force Participation and Monetary Policy in the Wake of the Great Recession.” *Journal of Money, Credit and Banking* 46, S2, 3-49.

Fawley, Brett, and Christopher Neely. (2013). “Four Stories of Quantitative Easing.” *Federal Reserve Bank of St. Louis Review* 95, 1, 51-88.

Frieden, Jeffry A. (2002). “Real Sources of European Currency Policy: Sectoral Interests and European Monetary Integration.” *International Organization* 56, 4, 831–61.

Friedman, M., & Schwartz, A. J. (1963). *A monetary history of the United States, 1867-1960*. Princeton University Press.

Hamilton, J.D. (1992). “Was Deflation During the Great Depression Anticipated? Evidence from the Commodity Futures Market.” *American Economic Review* 82, 1, 157-78.

Hamilton, J. D. (2017). Why You Should Never Use the Hodrick-Prescott Filter. *Review of Economics and Statistics (forthcoming)*

Meltzer, Allan H. (2003). *A History of the Federal Reserve, Volume 1: 1913-1951*. University of Chicago Press.

Mishkin, Federic and Klaus Schmidt-Hebbel. (2007). “Does Inflation Targeting Make a Difference?” *NBER Working Paper No.* 12876.

Olson, Eric and Walter Enders. (2012). “A Historical Analysis of the Output-stability frontier.” *Journal of Money, Credit and Banking* 44, 1285-1299.

Romer, Christina D. “What Ended the Great Depression?” *Journal of Economic History,* 52, 4, 757-784.

Schmidt-Hebbel, K., & Carrasco, M. (2016). The Past and Future of Inflation Targeting.

Taylor, J. B. (1979). “Estimation and Control of a Macroeconomic Model with Rational Expectations.” *Econometrica* 47, 5, 1267–86.

Taylor, J. B. (2016). The Staying Power of Staggered Wage and Price Setting Models in Macroeconomics.

Wheelock, David. (1992). “Monetary Policy in the Great Depression: What the Fed Did, and Why,” *Federal Reserve Bank of Saint Louis Review*, 74, 2, 3-28.

Wicker, Elmus. (1996). *The Banking Panics of the Great Depression.* Cambridge University Press.

Wu, Jing Cynthia & Xia, F.D. (2016). “Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound,” *Journal of Money, Credit and Banking* 48, 2, 253-291.

Figure 1: Quarterly Output Gap (1915 – 1940) using HP Filter and Hamilton (2017) Methodology

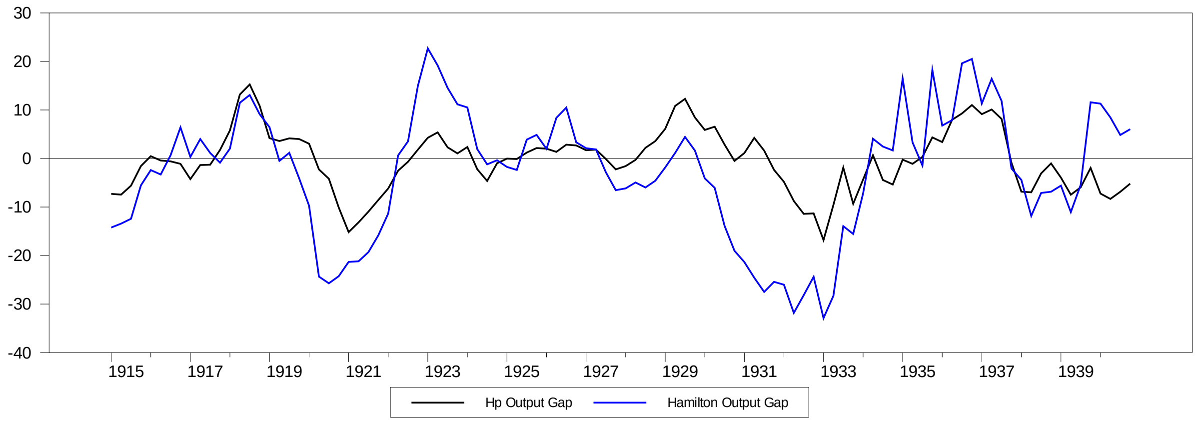


Figure 2: Quarterly Output Gap (1987 – 2017) using HP Filter and Hamilton (2017) Methodology

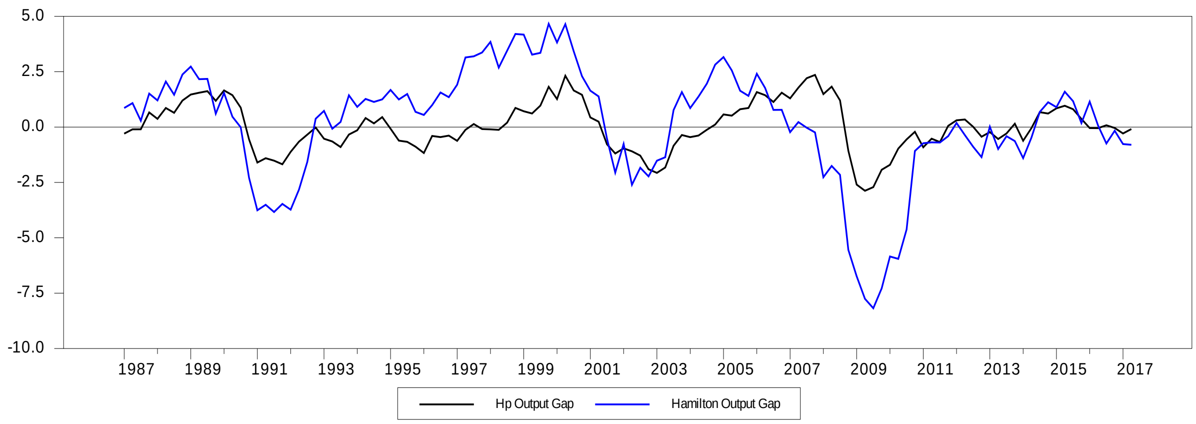
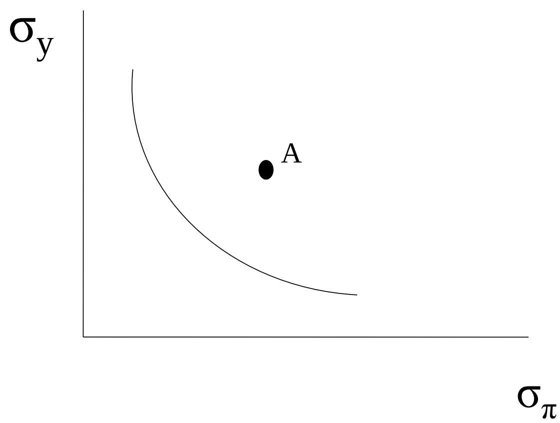


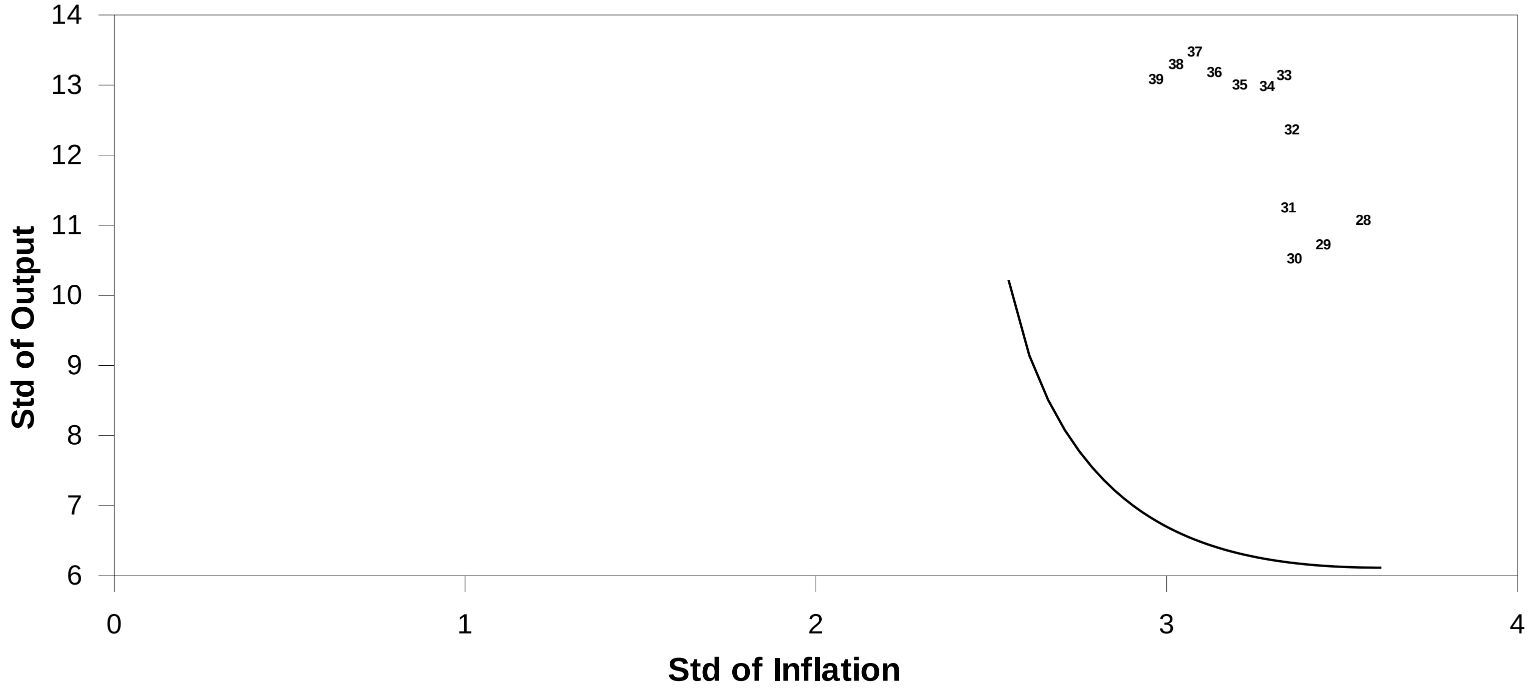
Figure 2: The Output-Stability Curve



Notes: The output-stability curve above displays a frontier for optimal monetary policy. That is, points on the frontier represent optimal policy whereas points to the right of the frontier, such a point A, are suboptimal. Points to the left of the frontier are not obtainable.

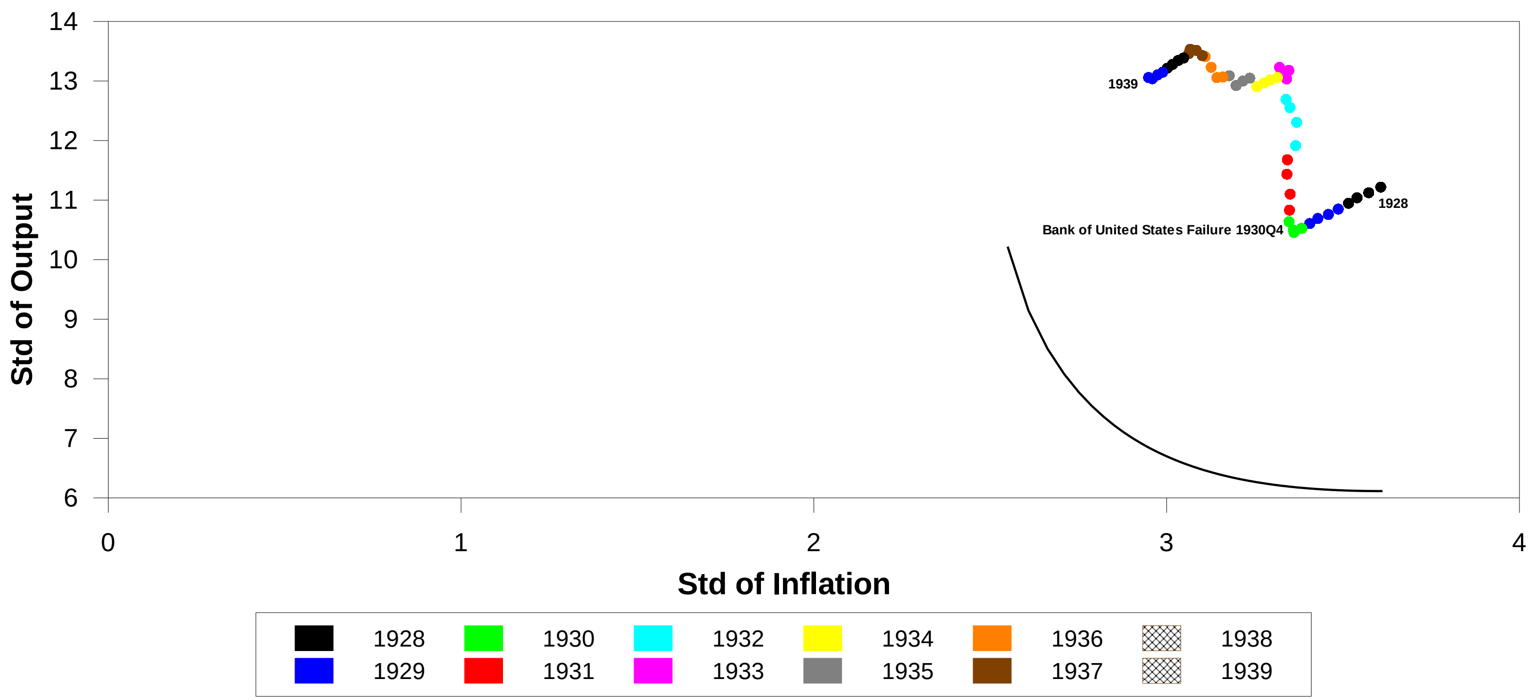
Figure 3: Inflation Output Stability Curve Through the Great Depression

Panel A: Yearly Averages



Notes: The output-stability curve is denoted by the line in the above figure which represents optimal policy. The numbers in the graph corresponds to yearly averages of the actual volatilities of inflation and the output gap. Movements towards the output-stability curve represent improvements in monetary policy and movements away from the frontier suggest poorer monetary policy. Note that the Bank of the United States failed in the fourth quarter of 1930.

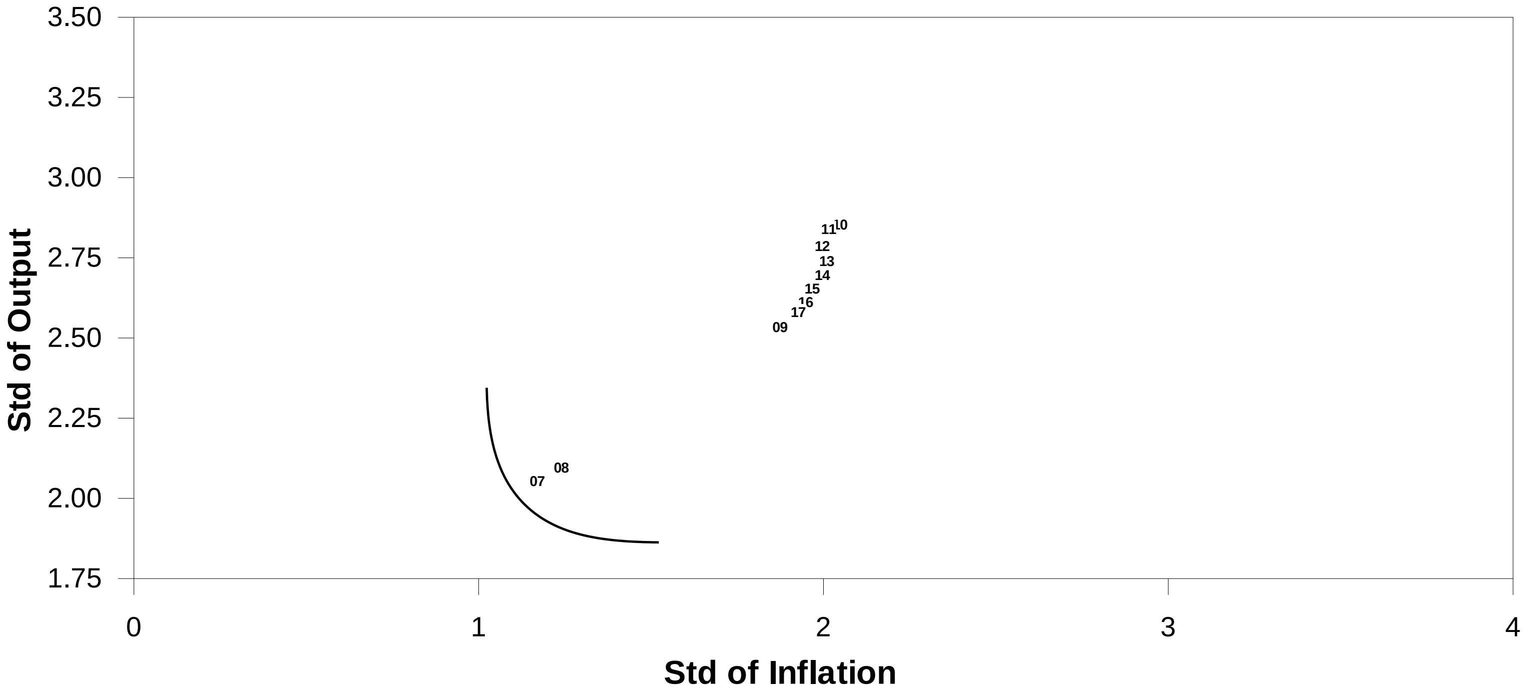
Panel B: Quarterly Results



Notes: The output-stability curve is denoted by the line in the above figure which represents optimal policy. The dots in the graph corresponds to the quarterly volatilities of inflation and the output gap. Movements towards the output-stability curve represent improvements in monetary policy and movements away from the frontier suggest poorer monetary policy. Note that the Bank of the United Stats failed in the fourth quarter of 1930.

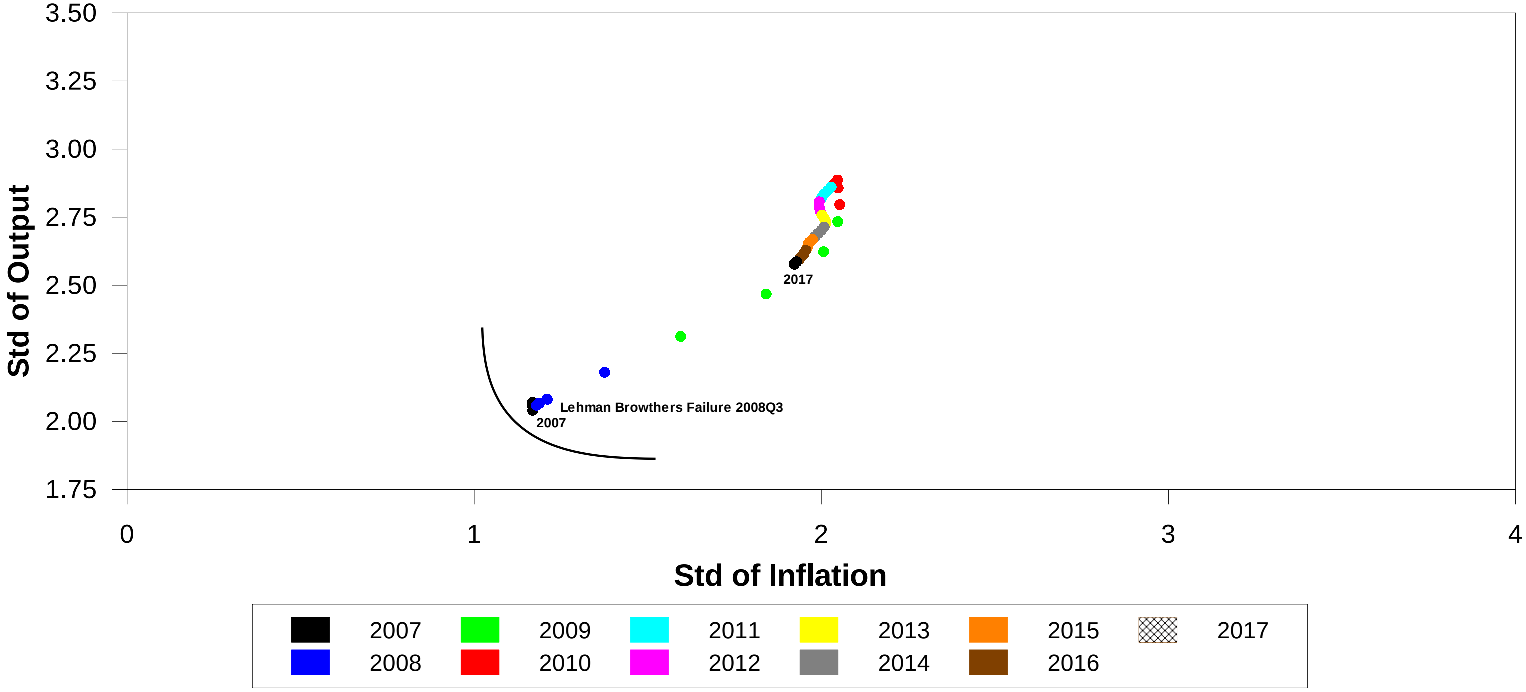
Figure 4: Inflation Output Stability Curve in the Great Recession

Panel A: Yearly Averages



Notes: The output-stability curve is denoted by the line in the above figure which represents optimal policy. The numbers in the graph corresponds to yearly averages of the actual volatilities of inflation and the output gap. Movements towards the output-stability curve represent improvements in monetary policy and movements away from the frontier suggest poorer monetary policy. Note that the Bank of the United States failed in the fourth quarter of 1930.

Panel B: Quarterly



Notes: The output-stability curve is denoted by the line in the above figure which represents optimal policy. The dots in the graph corresponds to the quarterly volatilities of inflation and the output gap. Movements towards the output-stability curve represent improvements in monetary policy and movements away from the frontier suggest poorer monetary policy. Note that the Lehman Brothers failed in the third quarter of 2008.

Table 1a: Average Distance to the Output Stability Curve 1928 - 1939

Time Period	Average Distance	*Time Period*	Average Distance	*Time Period*	Average Distance	*Time Period*	Average Distance
192801	4.81	*193101*	4.42	*193401*	6.64	*193701*	7.01
192802	4.72	*193102*	4.69	*193402*	6.60	*193702*	7.10
192803	4.63	*193103*	5.02	*193403*	6.54	*193703*	7.11
192804	4.54	*193104*	5.26	*193404*	6.49	*193704*	7.04
192901	4.44	*193201*	5.50	*193501*	6.63	*193801*	6.97
192902	4.35	*193202*	5.89	*193502*	6.58	*193802*	6.93
192903	4.28	*193203*	6.14	*193503*	6.50	*193803*	6.86
192904	4.20	*193204*	6.27	*193504*	6.67	*193804*	6.80
193001	4.12	*193301*	6.62	*193601*	6.65	*193901*	6.73
193002	4.05	*193302*	6.81	*193602*	6.64	*193902*	6.69
193003	4.08	*193303*	6.76	*193603*	6.81	*193903*	6.63
193004	4.23	*193304*	6.72	*193604*	6.99	*193904*	6.65

Table 1b: Average Distance to the Output Stability Curve 2007 - 2017

Time Period	Average Distance	*Time Period*	Average Distance	*Time Period*	Average Distance	*Time Period*	Average Distance
200701	0.19	*201001*	1.19	*201301*	1.12	*201601*	1.00
200702	0.18	*201002*	1.23	*201302*	1.12	*201602*	0.99
200703	0.18	*201003*	1.25	*201303*	1.12	*201603*	0.98
200704	0.17	*201004*	1.23	*201304*	1.11	*201604*	0.97
200801	0.18	*201101*	1.22	*201401*	1.10	*201701*	0.96
200802	0.19	*201102*	1.20	*201402*	1.09	*201702*	0.95
200803	0.20	*201103*	1.18	*201403*	1.07		
200804	0.32	*201104*	1.17	*201404*	1.06		
200901	0.54	*201201*	1.15	*201501*	1.04		
200902	0.82	*201202*	1.14	*201502*	1.03		
200903	1.04	*201203*	1.14	*201503*	1.02		
200904	1.14	*201204*	1.13	*201504*	1.01		

Notes: As noted in the paper, we use the average distance of the economy from the Output Stability curve because we do not know the actual central bank's preference for inflation (output) stability. That is, we do not know λ.

Table 2: Success of Unconventional Policies in Moving Economy Towards Output Stability Frontier

	Great Depression			Great Recession				
	Pre - Comparison Time Period (1 quarters)	**QE (1quarter)**	Post- Comparison Time Period (1 quarters)	Pre - Comparison Time Period (3 quarters)	**QE2 (3quarters)**	Time Period Between QE programs (5 quarters)	**QE3 (5 quarters)**	Post- Comparison Time Period (5 quarters)
	January 1932 – March 1932 (1 quarters)	**April 1932 – August 1932 (1 quarters)**	September 1932 – December 1932 (1 quarter)	January 2010 – September 2010	**November 2010 – June 2011**	July 2011 – August 2012	**September 2012 – December 2013**	January 2014 – March 2015
QE effectiveness	+5.5%	**+3.5%**	+1.9%	+4.8%	**- 2.4%**	-3.2%	**- 2.4%**	- 4.0%

Notes: This table displays the percentage movement of the economy from its efficiency frontier during the time periods mentioned. We compare the QE time periods (**in bold**) to equivalent time periods before and after to gauge the effectiveness of the QE programs. We used the following calculations:

$$\Delta\, QE\ Distance = \left(\frac{\sum_{i=1}^{n}\sqrt{\left(Ovol_{i_i} - Avol_{i_t}\right)^2 + \left(Ovol_{y_i} - Avol_{y_t}\right)^2}}{n}\right) - \left(\frac{\sum_{i=1}^{n}\sqrt{\left(Ovol_{i_i} - Avol_{i_{t+h}}\right)^2 + \left(Ovol_{y_i} - Avol_{y_{t+h}}\right)^2}}{n}\right)$$

where $Avol_{i_t}$ and $Avol_{y_t}$ are the actual volatilities of inflation and output at the beginning of each quarter t for the respective QE program, and $Avol_{i_{t+h}}$ and $Avol_{y_{t+h}}$ are the actual volatilities of inflation and output of the last quarter in which the QE program was active. We define $Total\ Distance = \max(Average\ Distance_t)$ and subsequently define QE effectiveness as

$$QE\ effectiveness = \frac{\Delta\, QE\ Distance}{Total\ Distance}$$