

A Lesson from the Great Depression that the Fed Might have Learned:
A Comparison of the 1932 Open Market Purchases with Quantitative Easing

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Abstract

We examine the first QE program through the lens of an open-market operation undertaken by the Federal Reserve in 1932, at the height of the Great Depression. This program entailed large purchases of medium- and long-term securities over a four-month period. There were no prior announcements about the size or composition of the operation, how long it would be put in place, and the program ended abruptly. Using a dataset with weekly-level Treasury holdings of the Federal Reserve in 1932, and the corresponding yields, we first conduct an event study analysis. This indicates that the 1932 program significantly lowered medium- and long-term Treasury yields. We then use a segmented markets model to analyze the channel through which the open-market purchases affected the economy. Quarterly data from 1920-32 is used to estimate the model with Bayesian methods, employing the methodology of Chen, Cúrdia and Ferrero (2012). We find that the significant degree of financial market segmentation in this period made the historical open market purchase operation more effective than QE in stimulating output growth. Additionally, if the Federal Reserve had continued its operations in 1932, the upturn in economic activity during the Great Depression could have been achieved sooner.

JEL Classifications: E43, E44, E58

1 Introduction

During the recovery period following the financial crisis of 2007-09, there has been considerable debate about the effectiveness of the Quantitative Easing programs of the Federal Reserve, and their significance for the economic recovery. The primary mechanism used to examine the impact of the QE programs has been to estimate the effect of the programs on the term structure of different types of yields, and an expanding literature has examined the effect on Treasury yields³. In these analyses, there are two main challenges in analyzing the effects of the QE programs: first, the decline in the state of the economy during the crisis period was unprecedented, and the effects of the monetary policy intervention were complicated by the freezing up of credit markets; and second, there were several unconventional monetary policy tools deployed in the QE program: forward guidance which provided guidelines about the size and length of the programs, the presence of the zero-lower bound and the payment of interest rate on excess reserves.

In the analysis, we provide a new perspective on examining the effects of the QE programs, by comparing the size and effectiveness of the program to another policy initiative of the Federal Reserve during the Great Depression of 1929. After three years of severe recession, in the face of Congressional pressure, the Federal Reserve undertook a significant open market operation between April and August 1932, in which it bought a billion dollars of medium and long term securities (\$16 billion in today's prices or 2% of 1932 GNP). Although the purchase program was motivated by the economic and political conditions of a very different era, the program had important effects on the term structure of Treasury yields. The size of the intervention was comparable to the first QE program, conducted by the Federal

³Swanson (2011), Krishnamurthy and Vissing-Jorgensen (2011).

Reserve between November 2008 and March 2009. The states of the economy during the 1932 operation, and the first QE program were very similar in terms of key macroeconomic and financial terms. At the time of both operations, the Congress and the public were desperate for active intervention by the central bank. Therefore, we propose to use the 1932 operation as a natural experiment to examine the effectiveness of the QE program, and the importance of using tools such as forward guidance. In this analysis, we will only consider the first QE program, as the successive programs were already anticipated by financial market participants.

While the environment in which of these programs were conducted was similar, there were also some important differences. In 1932, there was no announcement by the Federal Reserve of its intention to conduct these open-market operations, nor any indication of how long they would last or what the size would be. There were other differences as well: the portfolio of the Federal Reserve contained a larger proportion of medium-term Treasury notes relative to bonds in 1932, and it did not pay interest rate on excess reserves. Finally, unlike the QE period, the 1932 operation was a pure open-market operation, i.e., it did not buy any other types of assets.

Despite these differences, we find that although the 1932 operation was significantly shorter in duration (and the balance sheet of the Federal Reserve was much smaller), the program had large impact effects on the economy. We first analyze the effect of the operation on the cross section of Treasury yields using an event study methodology. We then use quarterly data from 1920-32 to estimate the effects of the open-market operation in a general equilibrium model with segmented markets. There was a significant degree of market segmentation in the 1930s as the non bank public had limited access to the government securities markets which was dominated by a few investment banks (Garbade, 2012) Our

main hypothesis is that there were two types of financial market participants: the first type could hold both long- and short-term Treasury securities, and the second could only hold long-term assets. However, the former type of agents paid a transaction cost for buying long-term assets. Private domestic households had limited access to long-term bonds during the 1920s and 1930s, and therefore, we find this to be a plausible way to model their holdings of Treasury securities. Using data to estimate the degree of segmentation, we find that it was much higher for this period than for 2008; thus, agents were not able to substitute between the different types of Treasury securities as they would have without any frictions. The purchases of long-term securities by the central bank in this model then affects the long-term yield, and consequently, the savings and consumption decisions of households. The high segmentation explains why the open market operation in 1932 was effective in lowering Treasury yields and boosting output growth, even though it lasted less than two quarters. Our results suggest that since segmentation is substantially lower in modern financial markets, agents are able to balance their portfolios better, and therefore, the Federal Reserve had to utilize unconventional tools of monetary policy in order to affect the real economy during the 2008 crisis.

2 Context in the Literature

The first part of this paper analyzes the 1932 and QE1 operations using an event study methodology. The strategy is similar to the analyses of Krishnamurthy and Vissing-Jorgensen (2012) and Swanson (2011) for the QE1 period: we estimate the changes in Treasury yields around announcements by the Federal Reserve. In case of the 1932 operation, since no public announcements were made, we first identify weeks in which there were significant changes in

the Federal Reserve’s holdings of Treasury securities, and then analyze the changes in yields during these periods. This is similar to the strategy followed by Landon-Lane (2013). The results of the event study methodology suggest that the 1932 operation had a significant effect on yields.

In order to compare the effects of the purchase programs of the Federal Reserve during these two periods, it is necessary to ensure that the economies had similar characteristics. We provide evidence to show the remarkable similarities between the economies during the two episodes. Other than the depressed states of output and employment, Treasury yields were at historically low levels. Cecchetti (1988) estimates the term structure of Treasury yields from 1929 to 1949 using raw data on the prices of Treasury securities outstanding reported in the New York Times. Using the Nelson and Siegel (1985) methodology, Cecchetti shows that between May and October 1932 (at the time of the Federal Reserve operation), the three-month yields were between 10 and 25 basis points.⁴ In section 4.1 below, we further discuss the similarities in the term structure of yields between 1932 and the QE1 episode.

The second part of our analysis focuses on exploring the channel through which the purchase programs affected real variables in the economy. Segmentation was a common feature of financial markets in the 1920s and 1930s. As reported by the Banking and Monetary Statistics (1914-1941), discount rates of different Federal Reserve districts varied for the same time period. The disparity was as much as between 50 and 150 basis points (for example, in December 1930, the discount rate reported in New York was 2%, and San Francisco it was 3.5%).⁵ The difference in rates was also evident in other types of loans. For example, in December 1930, the rate charged on commercial loans by banks was 3.82% in New York,

⁴The three-month yield remained in this approximate range in the remaining period of Cecchetti’s study.

⁵Banking and Monetary Statistics of the Federal Reserve, 1914-1941, Table 115, pp. 441.

4.38% in seven other Northeastern cities and 5.01% in eleven Southern and Western cities.⁶

Therefore, to model the effects of the asset purchase programs on the economy, we use a segmented markets framework. This is based on the model of Andrés, López-Salido and Nelson (2004) and is the framework used by Chen, Cúrdia and Ferrero (2012). The approach of using segmented markets as a channel for analyzing the effects of open-market operations have been widely used. Occhino (2004) uses a model in which households are permanently excluded from the market in government securities, and is able to replicate the persistent decrease in money growth and increase in real interest rates following an unexpected increase in the nominal interest rate. Alvarez, Atkeson and Kehoe (2002) introduce endogenous market segmentation by introducing a fixed cost which agents must pay to exchange bonds and money. In our approach, one type of investor is excluded from holding short-term bonds, and the second type of households must pay a transaction fee for holding the longer bonds.

3 Comparing the Institutional Setup of the 1932 Operation and QE1

3.1 General Economic Conditions and Announcement of the Programs

The economy in the United States at the time of implementation of the two programs were very similar. The unemployment rate in April 1932 was 21.03%, and it had risen to 25.02% in August 1932. In the 2008-09 episode, the unemployment numbers were also rising, from 6.8% in November 2008 to 8.7% in March 2009. Real GDP had declined by more than 20%

⁶Banking and Monetary Statistics of the Federal Reserve, 1914-1941, Table 125, pp. 464.

in 1932 since the start of the Great Depression, and in December 2008, real GDP in the U.S. had fallen by approximately 4% since December 2007. Table 1 shows the comparison between the two periods on two dimensions - the states of the economy, as well as the size of the Federal Reserve programs.

3.1.1 The 1932 Operation

The Federal Reserve began its massive (for the time) open market purchases in April 1932. This was after two and a half years of recession in which the Fed had followed a very passive policy. It did not prevent three banking panics. Friedman and Schwartz (1963) attribute the Fed's failure to act to serious flaws in the organization of the System which impeded coordination between the Reserve banks and the Federal Reserve Board in Washington DC, especially after the death of Benjamin Strong in 1928. Meltzer (2003) largely attributes it to adherence to a flawed policy doctrine - the Burgess Rieffler Strong doctrine (a variant of the real bills doctrine) that relied on nominal interest rates and the level of discount window borrowing as policy guides. Others attribute it to adherence to the gold standard and the absence of a clear lender of last resort policy (Bordo and Wheelock 2013).

According to Friedman and Schwartz,⁷ the Fed, under the leadership of Governor Harrison of the New York Federal Reserve voted to begin purchases of government securities on April 13, 1932 in the amount of \$100 million per week for 5 weeks. Then on May 17, another \$500 million was voted on.

Friedman and Schwartz argue that the Fed adopted this dramatic change in policy to forestall several radical pieces of legislation in the Congress including the Thomas bill which would have created \$2.4 billion dollars in greenbacks and a veterans bonus. Meltzer (pp.

⁷See pps 385-389.

360) posits that the open market purchases would have been consistent with the Burgess Rieffler Strong doctrine since member bank borrowing was high as were short-term interest rates. He also states that the passage of the Glass Steagall Act of 1932 and the beginning of Reconstruction Finance lending to troubled banks in February encouraged the Fed to act.

The policy was short lived. By July 1932 mounting opposition within the Federal Reserve System to continued purchases overwhelmed Harrison's pleas to continue. Many Fed officials, following real bills thinking, were worried that continued purchases would be inflationary and would stimulate an asset boom. Others worried that further purchases would severely reduce the System's holding of free gold and threaten the U.S. adherence to the gold standard. When the Congress recessed for the summer in July the Fed stopped the program.

Both Friedman and Schwartz and Meltzer provide evidence that the expansionary policy led to a turnaround in the economy⁸. They posit that had the Fed continued the policy that the Great Depression would have ended significantly earlier than it did.

3.1.2 Quantitative Easing in 2008-09

The 2007 financial crisis was the largest shock to global financial markets since the Depression. Bank were hit hard by enormous liquidity pressures, and as demands for cash from different sources peaked (counterparties, existing borrowers and short-term creditors), credit fell, and these markets froze.⁹ By the third quarter of 2007, international financial institutions were reporting concerns with valuation and liquidations of US mortgage related assets, leading to sharp increases in the LIBOR rate. As tight credit conditions carried on into 2008, Fannie Mae and Freddie Mac were placed under conservatorships and the Fed ex-

⁸M2 stopped declining and flattened out; Federal Reserve Credit picked up as did bank credit. Industrial production and real GDP began expanding after a lag. Interest rates reversed their rise and dropped precipitously. See Bordo 2013.

⁹Strahan (2012), SF Economic Letters, Liquidity Risk and Credit in the Financial Crisis.

panded existing liquidity programs, and introduced new ones, such as the Commercial Paper Funding Facility.¹⁰ Concerns about the weakening state of the economy began to appear in the minutes and statements of the Federal Open Markets Committee (FOMC) meetings in August 2007, and the first cut in the federal funds rate was implemented in September 2007 (from 5.25% to 4.75%). Successive statements continued to lower the federal funds rate, and the communications of the Federal Reserve noted, with increasing emphasis, that the strains in financial markets were increasing, consumer and business spending were softening and the housing market correction was intensifying. In March 2008, along with a further reduction in the federal funds rate, the FOMC also announced the Term Securities Lending Facility (TSLF) to promote liquidity in financial markets, and foster their functioning. The statements of September and October 2008 (which included a joint statement by the Federal Reserve, Bank of England, Bank of Canada, the Sveriges Riksbank, the Swiss National Bank and the ECB) continued to lower the federal funds rate, and the December 2008 statement finally reduced the rate to the zero-lower bound.

The timeline for the first QE program included several important dates, and these have been identified by Gagnon, Raskin, Remache and Sack (2010):

1. On November 25, 2008, the Federal Reserve announced creation of the Term-Asset Backed Securities Loan Facility "to support the markets for asset-backed securities collateralized by student loans, auto loans, credit card loans, and loans guaranteed by the Small Business Administration. The facility, developed jointly with the Treasury, was expected to be operational by February 2009, [...]." It also announced a program to purchase "up to \$100 billion in direct obligations of housing-related government-sponsored enterprises and up to \$500 billion in MBS backed by Fannie Mae, Freddie

¹⁰Lopez (2009), Gauging Aggregate Credit Market Conditions, SF Fed Economic Letters.

Mac and Ginnie Mae." This was undertaken to reduce the cost and increase availability of residential mortgage credit.

2. On December 1, 2008, Chairman Bernanke, in a speech at the Greater Austin Chamber of Commerce, Austin, Texas announced that "...although conventional interest rate policy is constrained by the fact that nominal interest rates cannot fall below zero, the second arrow in the Federal Reserve's quiver—the provision of liquidity—remains effective. Indeed, there are several means by which the Fed could influence financial conditions through the use of its balance sheet, beyond expanding our lending to financial institutions. First, the Fed could purchase longer-term Treasury or agency securities on the open market in substantial quantities. This approach might influence the yields on these securities, thus helping to spur aggregate demand [...]."
3. The FOMC statement on December 16, 2008, reiterated the Federal Reserve's commitment to purchase large quantities of agency debt and MBS. It further noted "...it [the Federal Reserve] stands ready to expand its purchases of agency debt and mortgage-backed securities as conditions warrant. The Committee is also evaluating the potential benefits of purchasing longer-term Treasury securities."
4. The January 28, 2009 statement noted the Federal Reserve's commitment to the expand the quantity of purchases and the duration of the purchase program for agency debt and mortgage-backed securities, as conditions warrant.
5. The statement on March 18, 2009, announced the increase in the size of the Federal Reserve's balance sheet by purchasing up to an additional \$750 billion of agency mortgage-backed securities. This bought the total purchases of these securities to up to \$1.25 trillion. It further increased its purchases of agency debt to a total of up to

\$200 billion. The Committee also decided to purchase up to \$300 billion of longer-term Treasury securities over the next six months.

The subsequent FOMC statements in August, September and November 2009 announced gradual slowing down of these purchases.

4 Analyzing Channels for the Effects of the Purchase Programs

Before analyzing the two programs, we discuss the channels through which these asset purchase programs are hypothesized to affect yields. The portfolio balance and signalling channels have been primarily used to explain the effects of the expansionary programs of the Federal Reserve. Here, we discuss the effects of the operations of 1932 and 2008 on the nominal yield curve and its slope for U.S. Treasuries. In our analysis below, we focus on the Federal Reserve purchases of U.S. Treasury bonds of different maturities; although the 2008 operation was significantly larger in the scope of securities that were involved, the 1932 operation was primarily concerned with Treasury bonds. In order to ensure a comparative analysis, we restrict our discussion to these securities.

4.1 Portfolio Balance Channel

The main thesis of the portfolio balance channel is that assets of different maturities are not perfect substitutes. As Gagnon et. al. (2010) and Bauer and Rudebusch (2013) note, the purchases of medium- and long-term securities by the Federal Reserve altered the supply of these bonds available to these private investors. As the holdings of the risk-free short-term

bank reserves by the private investors increased, the yields on the bonds being purchased by the Federal Reserve would fall, to ensure that private investors are willing to make an adjustment in their holdings. Thus, the term premia (the largest component of risk premia) will be lowered, as the assets of longer duration are removed from the supply available to private investors. In contrast, in a frictionless asset pricing model, a change in the supply of long-term or short-term bonds will not have an effect on Treasury bond yields. In this case, the term premia will be a function of the riskiness of the bonds, and the risk aversion of investors. Both these characteristics are unaffected by changes in the supply of bonds.

In order to examine the operation of the portfolio balance channel in these episodes, we first analyze the holdings of U.S. Treasury bills, notes and bonds by the Federal Reserve, as a fraction of the total holdings. As figure 1 shows, the fraction of the Federal Reserve's holdings of U.S. Treasury Notes increased from 10% of total holdings to more than 20%, between April and August 1932. The fraction of Bill holdings stayed fairly constant, fluctuating between 54% and 63%, and the fraction of Bond holdings *decreased* from 36% to 23%. Therefore, the largest purchases by the Federal Reserve during this episode. In contrast, during the 2008 episode, the Federal Reserve's holdings of Notes (with 1 to 5 years to maturity) increased from 36% to 39% approximately, and the fraction of Bond holdings (with maturity 15 years or more) increased from 20% to 21% between July 2008 and March 2009. Thus, the operation by the Federal Reserve in 1932 was more significant on the medium-term securities, relative to the long-term operation, unlike the more recent 2008 operation. Both operations caused a compositional difference in the Bank's portfolio of securities. In section 5 below, we use the event-study methodology to examine the effects of changes in the portfolio composition of the Federal Reserve at a weekly frequency over the 1932 and 2008 operations.

To analyze the changes in the overall supply of these Treasury securities to the rest of

the economy, and evaluate the contraction of supply effect, is also useful to consider the holdings of the Federal Reserve as a fraction of the total marketable debt outstanding from the Treasury. In the 1932 operation, the Bank's holdings of Treasury Notes averaged 13% of the total marketable debt issued in Notes, and Bond holdings were approximately 7% of the total debt issued in Bonds. In contrast, in the 2008-09 episode, the respective fractions were 6% and 33%. Thus, the Federal Reserve's holdings of Bonds during the latter episode were more than four times its holdings in the 1932 operation.

4.2 Signaling Channel

Following the Expectations Hypothesis, the long yields can be expressed as a function of average expected short yields and the risk premium. The signaling channel focuses on the effect of the expansionary programs on the expectations of the short yields: the large-scale purchases of Treasury securities may be interpreted by the private economy as a signal that the Federal Reserve expects the economic conditions to remain weak, and this would lower the expectations of future short-term yields. Bauer and Rudebusch (2013) argue that the signaling channel not only affected the expectations of investors about future short term rates, but it also lowers the term premium. Using DTSM with risk correction models, the authors find that over a set of eight announcements that introduced and implemented the LSAP programs, the ten-year yield dropped by 89 b.p, and the five-year yield declined by 97 b.p. For the ten-year yield, the range of the signaling effect is estimated to be between 30% and 35%; for the five-year yield, signaling contributes between 32% and 45% of the total decline observed in the actual level of yields. The remaining is attributed to the change in the term premia. This decomposition between the change in expectations and term premia can be heuristically thought of as the relative importance of the signaling and portfolio balance

channel.¹¹ Additionally, Swanson and Williams (2014) find that between 2008 and 2011, while the federal funds rate was at the zero-lower bound, the Federal Reserve was able to influence interest rates for medium and long-term Treasury securities by managing policy expectations of investors and conducting large scale purchases of assets. The authors do not distinguish between the importance of these two channels, but find that sensitivity of the medium and long-term yields to news between 2008 and 2011 was very similar to the responses of these yields to surprise macroeconomic news between 2004 and 2006. This is attributed to the ability of the Federal Reserve to influence expectations for upto the two-year horizon through its communications and implementation of the purchase programs. Finally, Woodford (2012) finds that there was strong model-free evidence of the signaling channel during the purchase programs, as do Campbell et al. (2012).

During the 1932 episode, the sudden implementation of the Federal Reserve asset purchase program, along with very few indications of how low these were expected to remain, implied that the signaling channel was, at best, very weak. While it is difficult to empirically distinguish between the effects of the portfolio balance and signaling channels without the availability of overnight swaps and other instruments, the institutional setup of the 1932 operation lead to us to conclude that the channel was not important during this operation

4.3 Additional Channels

There are other channels through which the Federal Reserve's operation would have an effect on the term structure of yields. Most of these channels focus on the changes in the relative supply of safe and risky securities: during the 2008-09 operation, the Bank was also purchasing other agency debt, such as Mortgage Backed Securities (MBS).

¹¹Bauer and Rudebusch (2013) point out the cases in which this decomposition may not be fully applicable.

According to the Duration Risk channel¹², if the investors have a preference for an asset of specific duration (irrespective of whether it is the U.S. Treasury or a corporate bond of the same maturity), then the QE program will lead to a reduction in asset yields. During the 1932 operation, the purchases of the Federal Reserve were concentrated on Treasury securities, and there were no significant assets of comparable duration and security that were available to investors. Thus, this channel would not be significant during the 1932 episode.

The Liquidity channel implies that the expansionary operation by the Federal Reserve involves increasing the holdings of medium- and long-term bonds, while paying for the operation by increasing reserve balances. The higher reserve balances act as extra liquidity in the hands of the investors, and will increase yields. According to Vissing-Jorgensen and Krishnamurthy, the effect of the Liquidity channel during the QE period was not to increase yields on Treasury debt. However, the authors note that the decrease in yields on Treasury securities was smaller than the decrease in yields on less liquid assets, such as agency debt.

The Safety channel is a special case of the preferred habitat channel, but only in the space of safe bonds and assets. Within the set of the safest assets available to private investors in the economy, as the Federal Reserve's holdings of the long-term Treasury securities increases, it lowers the yield on the ultra safe or investment grade securities, relative to less safe assets in which the operation is conducted. As the relative comparison is difficult in the 1932 episode, due to the scant availability of comparable securities, we conclude that this channel was not significant during this episode.

¹²This is similar to Vayanos and Vila's preferred habitat model.

5 Effects of the 1932 and QE1: Event Study Methodology

We use the event study methodology to examine the effects of the Federal Reserve operations on the term structure of yields. To our knowledge, the 1932 operation has not been analyzed from this perspective before. For our analysis, we construct a weekly series of the holdings of the Federal Reserve, along with corresponding yields of different maturities, using data from the Federal Reserve Bulletins and Annual Reports. Although the most recent applications of the event study methodology to analyses of the Quantitative Easing programs use time series at the daily frequency, obtaining this level of frequency for the 1932 operation is difficult. However, the use of a weekly time series allows us to examine the Federal Reserve operation in a more rigorous manner, as changes in expectations of inflation and the federal funds rate are less likely over this time horizon, relative to a monthly or quarterly series¹³.

The other main difference between the current event-study methodologies and our approach is the determination of the dates around which the effects on yields are being examined. Studies such as Gagnon et al. (2010) and Swanson (2012) determine key dates on which the Federal Reserve announcements were made, and examine the effect on yields in one- and two-day windows around the announcements. These dates correspond to announcements about the size of the program, and explicit indications about the Federal Reserve's expectations about how long the operation would continue. However, in the 1932 episode, there was no equivalent forward guidance about the program, its size or the duration. Therefore, to analyze the effects of the operation, we choose the dates that correspond to significant change in the Federal Reserve's holdings of Treasury securities. These significant changes

¹³These time series are more common in the literature for analyzing the Great Depression.

are defined as a more than 5% change in the Federal Reserve's holdings of the Treasury security, relative to the week before. In the robustness section below, we also consider other benchmarks.

Finally, in order to compare the QE1 program with the 1932 operation, we estimate the effects of QE1 on the term structure of yields using both strategies: first, we present our analysis using the announcement dates of Gagnon et al. (2010). In the robustness section below, we use the dates on which there were changes in the Federal Reserve's of more than 5%.¹⁴

5.1 Yields and Holdings during the 1932 Operation

Table 2 shows the changes in the Fed's holdings of the Treasury notes and bills during the 1932 episode. The weeks for which the holdings of the Treasury Notes by the Federal Reserve Board changed by more than 5% (in either direction) are highlighted. The corresponding level and changes in the 3-5 year Treasury yields is shown in columns 4 and 5. A continuous series on weekly data for the yields on Bills is not available. Between April and August 1932, there were 10 weeks during which the Federal Reserve's holdings of Notes changed by more than 5% relative to the preceding week. The holdings of Bills recorded large changes in 6 weeks over the 24 month period, and the holdings of bonds changed significantly in 4 different weeks, as shown in table 3. The evolution of the Federal Reserve's holdings of these Treasury securities, and their respective yields are also shown in figure 1.

¹⁴These dates will be different from the announcement dates - but if the announcements are explicit, then financial markets will internalize the changes, and expectations will adjust at the time of the announcement. Therefore, we should not expect to see too much action around the dates when the Fed's holdings actually changed during the QE1 period

The Importance of Different Channels

Since there were no significant announcements during the 1932 episode, we hypothesize that the portfolio balance channel was most significant. The reduction in supply of medium term securities to the domestic economy, as the holdings of the Bank increased, lowered yields in successive weeks. The lack of another security of comparable characteristics in terms of safety makes it difficult to analyze whether the duration risk channel was important.

5.2 Yields and Holdings during QE1

Using the announcement dates discussed in section 3.1.2 above, we determine the weekly changes in the yields for Bonds and Notes around the events. The cumulative changes for the ten-, five- and one-year yields are computed, and the former experiences the largest decline, as shown in table 4. These estimates are comparable with other analyses, such as Vissing-Jorgensen and Krishnamurthy (2012) and Gagnon et al. (2010). Unlike those studies, we focus on the weekly changes to use a similar time period for computing the changes as the 1932 operation.

The Importance of Different Channels

The portfolio balance and signaling channels are both important during this episode. The explicit forward guidance by the Federal Reserve communicated its strategy about the size and implementation of the program, and had significant consequences for the expectations of financial markets. The QE1 announcement on March 18, 2009 was especially significant. According to Campbell et al. (2012), on this day, although the ten-year yield fell by 51 b.p. in a one-day window around the announcement, there was an opposite reaction in the expectations of financial markets. The authors decompose the change in the ten-year yield

into a factor attributed a change in the target federal funds rate, and the factor associated with a change in the path of the rate. This latter factor *increased* by 32 b.p. around the QE1 announcement, indicating that the markets interpreted the FOMC statement as implying that the economy would recover faster than previously expected. This implies that the federal funds rate lift-off was expected to be earlier than anticipated. In contrast, for the QE2 announcement, the signaling effect of the FOMC statement was that markets expected the federal funds rate to remain low (and the path factor was positively correlated with the change in the actual yields). Thus, the QE1 announcement was distinctly different from the successive announcements in the manner in which it affected financial market expectations.

6 Consequences for the Real Economies in 1932 and 2008-09

The event study methodology above presents evidence that the two purchase operations had significant effects on Treasury yields. In the present section, we use a general equilibrium framework to further explore the channels through which the monetary policy actions affected the real economy. To do this, we use the modeling framework of Andrés, López-Salido and Nelson (2004) and Chen, Cúrdia and Ferrero (2012). This is a segmented markets model in which there are two types of households: the unrestricted households trade in long and short bonds, and the restricted only trade in long term bonds. The unrestricted households are required to pay a transaction cost for every long bond purchased. This transaction cost for long bonds gives rise to a risk premium, which has two components: the first arises because the households face a portfolio adjustment cost (this is modeled as a function of the relative quantity of the short and long bonds). The second component is an exogenous error. This

model is used to analyze the 1932 episode. We first present the optimization decisions and policy rules of the households, firms, central bank and the government. Following a brief description of the numerical strategy, we analyze the two programs using the model.

6.1 Model

6.1.1 Households

A continuum of households $i \in [0, 1]$ have access to long and short-term bonds. Financial market segmentation is introduced by assuming there are two types of households: the unrestricted households can participate in long and short-term bond markets; the restricted households can only buy long-term bonds. Both types of households derive utility from consumption, and disutility from labor. There are identical in all respects, other than their access to financial markets. The utility function of household $i \in \{u, r\}$ is:

$$E_t \sum_{j=0}^{\infty} \beta_i^j b_{t+j}^i \left[\frac{1}{1 - \sigma_i} \left(\frac{C_{t+j}^i}{Z_{t+j}} - h \frac{C_{t+j-1}^i}{Z_{t+j-1}} \right)^{1 - \sigma_i} - \frac{\varphi_{t+j}^i (L_{t+j}^i(k))^{1 + \nu}}{1 + \nu} \right]. \quad (1)$$

Here β_i^j is the discount factor of type j , b_t^i is the preference shock, σ_i is the coefficient of relative risk aversion, C_t^i is the consumption, h is the habit formation parameter, φ_t^i is the labor supply shock and ν is the inverse of the labor supply elasticity.

The budget constraint of the unrestricted household is:

$$P_t C_t^u + B_{S,t}^u + (1 + \zeta_t) P_{L,t} B_{L,t}^u \leq R_{S,t-1} B_{S,t-1}^u + \sum_{j=1}^{\infty} \kappa^{j-1} B_{L,t-j}^u + W_t^u(k) L_t^u(k) + \mathcal{P}_t - T_t^u. \quad (2)$$

Here P_t is the price of the consumption good, $B_{S,t}^u$ are the holdings of the one-period (short) bond, ζ_t is the transaction cost paid by the unrestricted household to purchase the long

bond, $P_{L,t}$ and $B_{L,t}^u$ are the price and holdings of the long-term bond respectively, κ is the rate of exponential decay of the long-term bond, W_t^u is the wage paid by firm k , \mathcal{P}_t is the sum of profits accruing to the household from ownership of final, intermediate and capital producers. The household pays lumpsum taxes T_t^u . The constraint of the restricted household does not include the transaction cost ζ_t for the purchase of long-term bonds, along with their corresponding choices of consumption, bond holdings, labor supply and tax burden.

The households optimally choose consumption, holdings of long and short-term bonds and labor supply. The Euler equations are central to the effects of the financial market segmentation, and are shown here. The remaining optimizing conditions are shown in the appendix.

For the short-term bond, the Euler equation is:

$$1 = \beta_u E_t \left[\frac{MU_{t+1}^u}{MU_t^u} \frac{R_{S,t}}{\Pi_{t+1}} e^{-\gamma-z_{t+1}} \right], \quad (3)$$

where MU_t^u is the marginal utility of consumption, and $e^{-\gamma-z_{t+1}}$ accounts for growth in productivity. Finally, $\Pi_{t+1} = P_{t+1}/P_t$. For the long bond, the presence of transaction costs for the unrestricted households modifies the Euler equation to:

$$1 + \zeta_t = \beta_u E_t \left[\frac{MU_{t+1}^u}{MU_t^u} \frac{R_{L,t}}{\Pi_{t+1}} \frac{P_{L,t+1}}{P_{L,t}} e^{-\gamma-z_{t+1}} \right]. \quad (4)$$

Finally, the pricing equation for the restricted households is given by:

$$1 = \beta_r E_t \left[\frac{MU_{t+1}^r}{MU_t^r} \frac{R_{L,t}}{\Pi_{t+1}} \frac{P_{L,t+1}}{P_{L,t}} e^{-\gamma-z_{t+1}} \right]. \quad (5)$$

Following Chen, Cúrdia and Ferrero (2012), the transaction cost is modeled as a function of

the ratio of long and short-term debt held by the public, and an exogenous error term:

$$\zeta_t = \zeta \left[\frac{P_{L,t} B_{L,t}}{B_{S,t}}, \varepsilon_{\zeta,t} \right]. \quad (6)$$

Assuming that the function ζ and its first derivative are positive, a reduction the outstanding debt held by the public will result in a fall in the yield on long-term bonds. This is the mechanism through which asset purchases by the central bank will affect the term structure of yields: a change in the holdings of outstanding debt will affect the savings decisions of the restricted households through a change in the long-term yield, and consequently, output and inflation in the economy.

6.1.2 Firms

There are three types of firms in the economy: capital goods producers, which are competitive and make investment decisions. These firms rent capital to intermediate goods producers, and the amount of capital rented is determined by the utilization rate chosen by the capital goods producer. The intermediate goods producers combine labor hired from households and the rented capital to produce output using the Cobb-Douglas production function. In the production of intermediate goods, technology is assumed to be labor augmenting. Prices of intermediate goods are set using the Calvo staggered price mechanism. The last type of firms are the perfectly competitive final goods producers: these combine differentiated intermediate goods into a homogeneous product, with a price markup. The firms' optimizations are presented in the appendix.

6.1.3 Central Bank

Orphanides (2003) analyzes the historical behavior of the interest rates of the Federal Reserve, and finds that for the 1920s, the interest rate rule could be well approximated using the Taylor rule. Therefore, the central bank is assumed to set the interest as:

$$\frac{R_{S,t}}{R_S} = \left(\frac{R_{S,t}}{R_S}\right)^{\rho_m} \left[\left(\frac{\Pi_t}{\Pi}\right)^{\phi_\pi} \left(\frac{Y_t/Y_{t-4}}{e^{4\gamma}}\right)^{\phi_y} \right]^{1-\phi_m} e^{\varepsilon_{m,t}}. \quad (7)$$

The Taylor parameters are $\phi_\pi > 1$, and $\phi_y \geq 0$. The interest rate smoothing parameter $\rho_m \in (0, 1)$.

6.1.4 Government

The government finances its purchases by collecting lump-sum taxes and issuing long and short-term bonds:

$$B_{S,t} + P_{L,t}B_{L,t} = R_{S,t-1}B_{S,t-1} + (1 + \kappa P_{L,t})B_{L,t-1} + P_tG_t - T_t. \quad (8)$$

Long-term debt is issued in non-zero supply, and the real value of this debt assumed to evolve as:

$$\frac{P_{L,t}B_{L,t}}{P_tZ_t} = \left(\frac{P_{L,t-1}B_{L,t-1}}{P_{t-1}Z_{t-1}}\right)^{\phi_B} e^{\varepsilon_{B,t}}.$$

The issuance of long-term debt is financed according to the following fiscal policy rule:

$$\frac{T_t}{P_tZ_t} - \frac{G_t}{Z_t} = \left(\frac{P_{L,t-1}B_{L,t-1}}{P_{t-1}Z_{t-1}}\right)^{\phi_T} e^{\varepsilon_{T,t}}. \quad (9)$$

Following Davig and Leeper (2006), the fiscal parameter $\phi_T > 0$

6.2 Equilibrium strategy and Numerical Solution

In equilibrium, the households and firms maximize utilities and profits respectively, subject to the corresponding budget constraints. The first-order log linearized model is estimated using Bayesian methods, following the strategy of Cúrdia, Chen and Ferrero (2012).

6.2.1 Data

In order to estimate the model, the relevant macroeconomic time series are constructed for January 1920 to December 1934. Balke and Gordon's (1986) Real GNP and GNP deflator series are used for the output and inflation measure. Population numbers are taken from the U.S. Census Bureau. The construction of the number of labor hours supplied entails two different data sources. From Beney's (1936) study, the series of average hours worked per week per worker in manufacturing is used to construct average actual hours per quarter per wage earner. This is multiplied with the average number of workers in manufacturing, available from the Bureau of Labor Statistics. Yields on bonds and notes are taken from the Banking and Monetary Statistics for 1914-1941 publication of the Federal Reserve, and the Federal Reserve's holdings of Treasury debt is constructed from the tables on Factors affecting bank reserves and condition statement of the Federal Reserve Banks.

6.2.2 Parameters

In the numerical simulations, for the 1932 period, the prior on output growth in steady state is assumed at 1%, on inflation it is 1%, and the standard deviation is 0.5. The degree of segmentation is assumed at 0.7, with a standard error of 0.2. Using the data on the Federal Reserve's holdings of Treasury securities, the average duration of debt is found to be approximately 15 quarters, and the steady state level of debt is 10% of GDP. The priors

on the remaining parameters are shown in the appendix.

We obtain mean posterior estimates of market segmentation of 0.76¹⁵. This degree of segmentation confirms our original hypothesis of large degree of financial segmentation during the 1920s. Cúrdia, Chen and Ferrero (2012) estimate the market segmentation parameter to be 0.94, and thus find significantly smaller effects of the asset purchase program of the Federal Reserve.

6.3 Simulations

In our benchmark simulation presented in figure 5, we consider an increase of \$350 million of long-term security holdings of the Federal Reserve. This was the initial increase in the Federal Reserve’s holdings, and we first analyze the case of the effect on the economy if the purchases had stopped there. Although the Bank did not explicitly follow a policy of setting the Federal Funds Rate at the zero-lower bound, as noted in sections 2 and 5 above (and table 2) the Treasury yields were effectively at this bound. Thus, we assume that the zero-lower bound was active for a year after the start of the operation. Initially, the bound is only applied for four quarters, and in the robustness section below, we consider the effects of varying the length of this constraint. Consistent with the historical experience, the operation is only assumed to last for two quarters. Given the unexpected nature of the operation, and no indications that it would continue, we assume that agents only expect the operation to last for this period. In this simulation, the Fed is assumed to not hold the assets on its balance sheets, and divests of the long-term assets in the following two quarters. Following an increase in the Federal Reserve’s holdings of the long-term securities,

¹⁵Following Cúrdia et al. (2012), the posterior distribution is obtained in the following way: after obtaining the posterior mode, the normal approximation around the mode is used to form a jump distribution. This is used to generate a sample of parameter vector draws representative of the posterior, based on the Metropolis random walk MCMC simulation process.

we observe approximately a 0.1% increase in output growth, and the effect dissipates after four quarters.

Figure 6 considers an alternate scenario: suppose the Federal Reserve had purchased assets over two quarters, held onto these on its balance sheet for another two, and then divested its holdings over the remaining two quarters. In this case, we find a 0.24% increase in output growth. If the Federal Reserve had continued the bond buying operation for a period that was comparable to the QE program, then as figure 7 shows, the impact effect on output growth is approximately three times larger. Finally, if the size of the operation was larger - we consider the case where it was three times as large - then output growth increases to 0.29%. This is shown in figure 8.

These results suggest that although the 1932 operation was significantly smaller in magnitude than the QE program, it had substantial effects on the economy. For the LSAP program conducted by the Fed during the crisis of 2008, Cúrdia, Chen and Ferrero (2012) find that the effect on output growth was approximately 0.13%.

6.4 Robustness

[To be completed]

7 Conclusion

We find that the 1932 open market operations conducted by the Federal Reserve, during the severe economic crisis, were effective in lowering Treasury yields and boosting output growth. We attribute this to the large degree of segmentation present in financial markets during the 1920s. Our results suggest that since markets were significantly more integrated during the

QE operation in 2008, open-market purchases, of the magnitude that were conducted, may have proved insufficient to affect the economy. Thus, the other facets of the QE program, such as purchases of other types of securities, were also important.

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Table 1: Comparison of the 1932 and 2008 Economies

Characteristic	1932	2008
Real GDP	787,518 million	14,833,557 million
Unemployment	21.03%-25.02%	6.8%-8.7%
Size of the program:		
% change in Bills	114%	-0.05% ^a
- % change in Notes	370%	7% ^b
% change in Bonds	32%	-1.5%
As a fraction of U.S. Treasury Marketable Debt:		
Short term	32.5%	2.1%
- Medium term	67.5%	5.8%
Long term	22.9%	7.8%

Notes: The real GDP series is evaluated at 2009 dollars, on an annual basis. The unemployment numbers are monthly and seasonally adjusted. *a* : This is the average change in the Federal Reserve's holdings of bills with maturity 15 days or less, 15 to 90 days and 91 days to 1 year; *b* : this is the change in the Federal Reserve's holdings of Notes of maturity 5 to 10 years. The last row shows the change in the fraction of different Treasury securities of the Federal Reserve, as a fraction of Marketable Debt between November 2008 and May 2009.

Table 2: Fed's holdings of Notes and Bills and Corresponding Yields

Week	% change in Bill Holdings	% change in Note Holdings	Yields levels on 3-5 year notes	Changes in yields on 3-5 year notes (in b.p.)
April 27, 1932	15.9	11.7	0.64	-36
May 4, 1932	10.7	16.5	0.53	-11
May 11, 1932	0.7	38.2	0.56	3
May 18, 1932	12.8	7.6	0.46	-10
June 15, 1932	2.7	11.7	0.2	8
June 22, 1932	0.7	15.2	0.4	20
June 29, 1932	2.1	19.3	0.53	13
August 3, 1932	-4.3	20.3	0.29	3
August 10, 1932	-2.1	8.7	0.12	-17
August 17, 1932	-1.7	5.1	0.25	13
Cumulative change				-14

Table 3: Fed's holdings of Bonds and Corresponding Yields

Week	% change in Bond Holdings	Yields levels on Bonds	Changes in yields on Bonds (in b.p.)
April 20, 1932	7.8	3.59	-8
May 25, 1932	5.4	3.82	8
June 1, 1932	5.9	3.85	3
June 8, 1932	8.4	3.84	-1
Cumulative change			2

Table 4: Fed's holdings of Bonds and Corresponding Yields

Week	Change in yields on 10-year Bonds	Change in yields on 5-year Notes	Changes in yields on 1-year Notes
November 25, 2008	-28	-6	-3
December 1, 2008	-44	-43	-24
December 16, 2008	-18	-20	-1
January 28, 2009	19	16	6
March 18, 2009	-17	-18	-6
Cumulative change	-88	-71	-28

Figure 1: US Treasury Notes and Yields

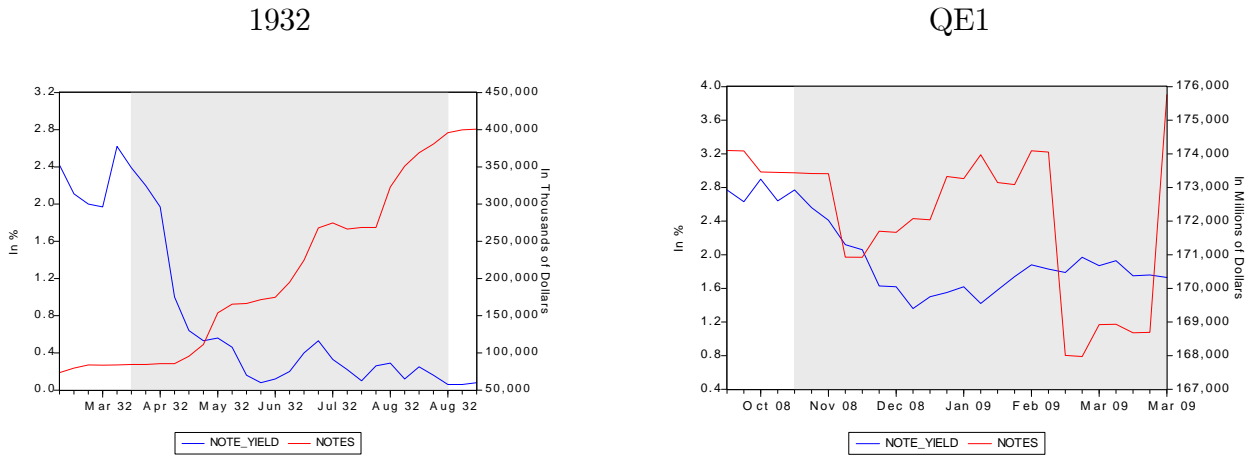


Figure 2: US Treasury Bonds and Yields

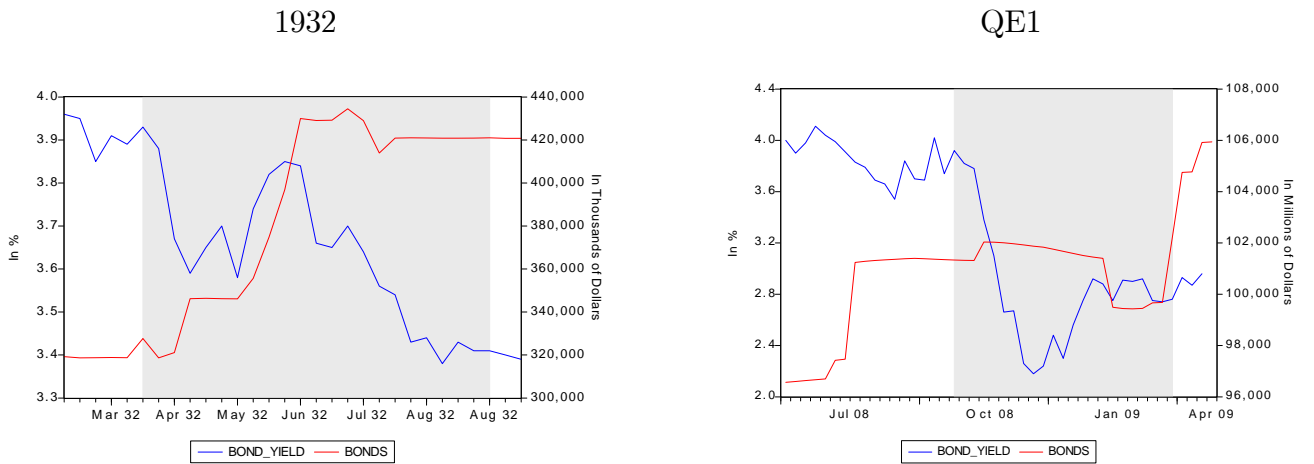


Figure 3: Treasury Holdings of the Federal Reserve as a Fraction of Total Holdings

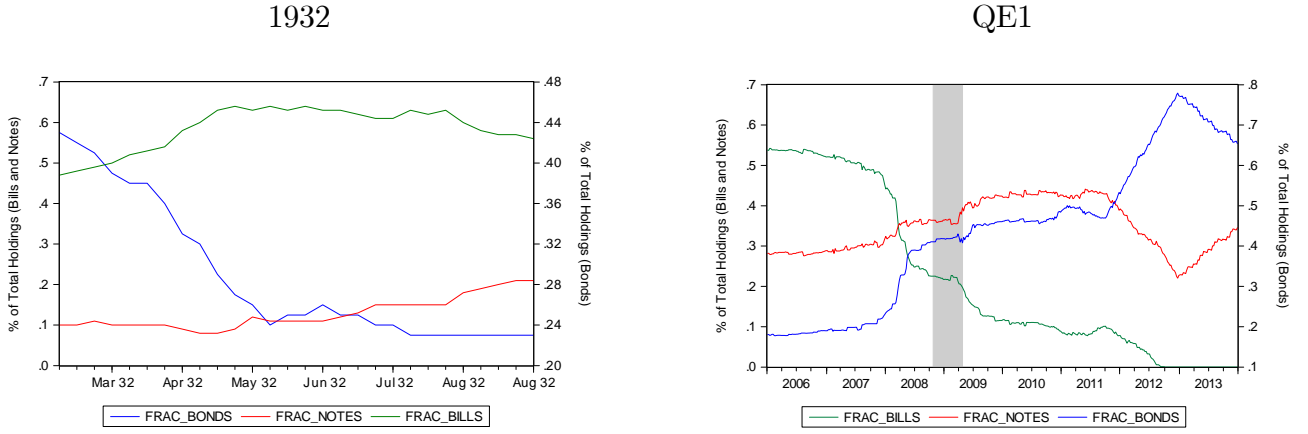


Figure 4: Output growth and Inflation

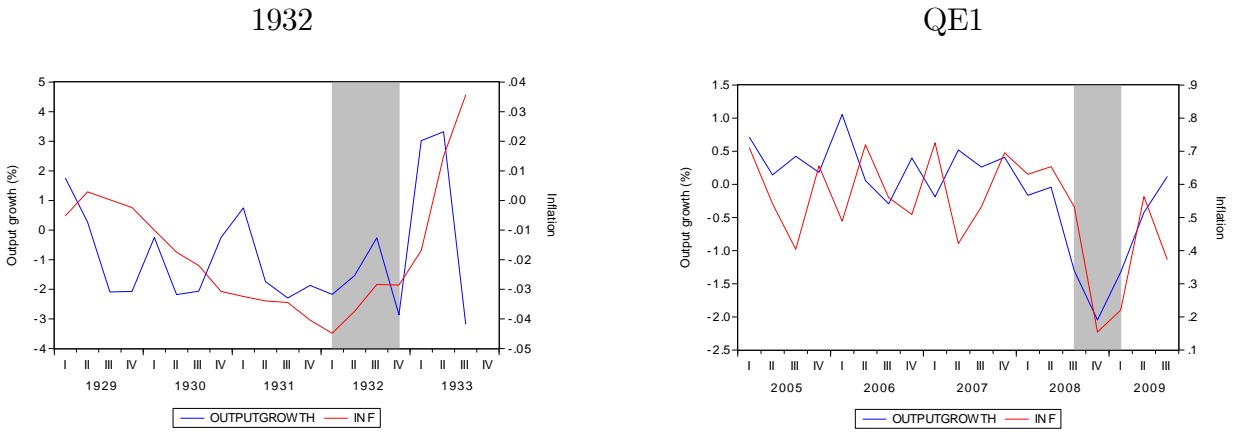
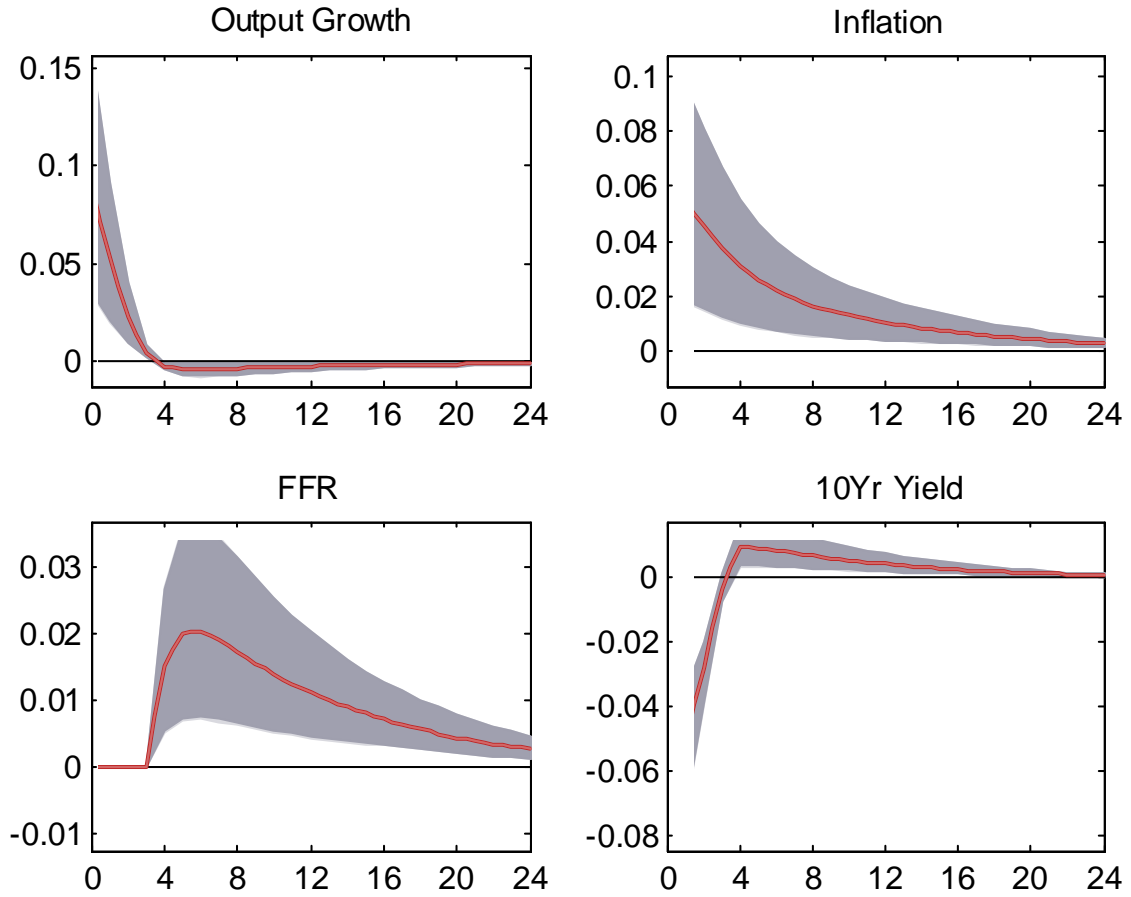
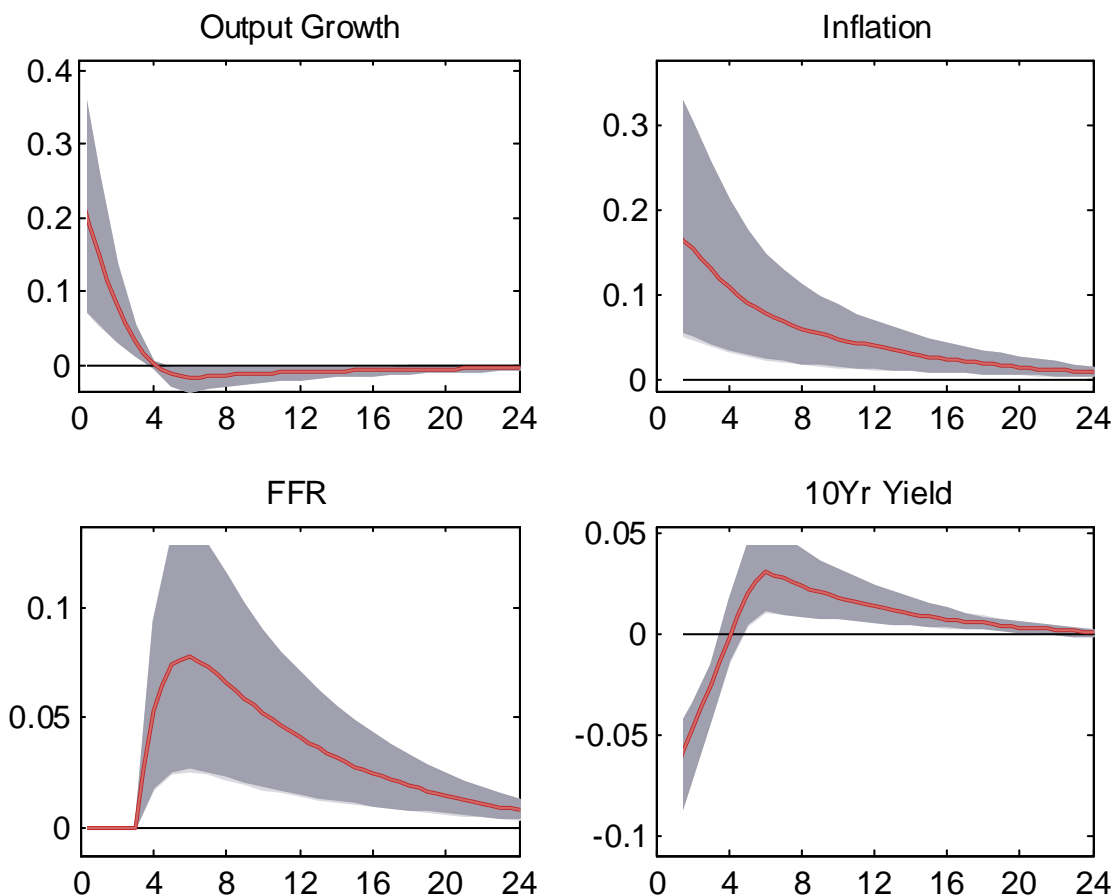


Figure 5: Effects of Treasury bond purchases by the Federal Reserve
(Benchmark)



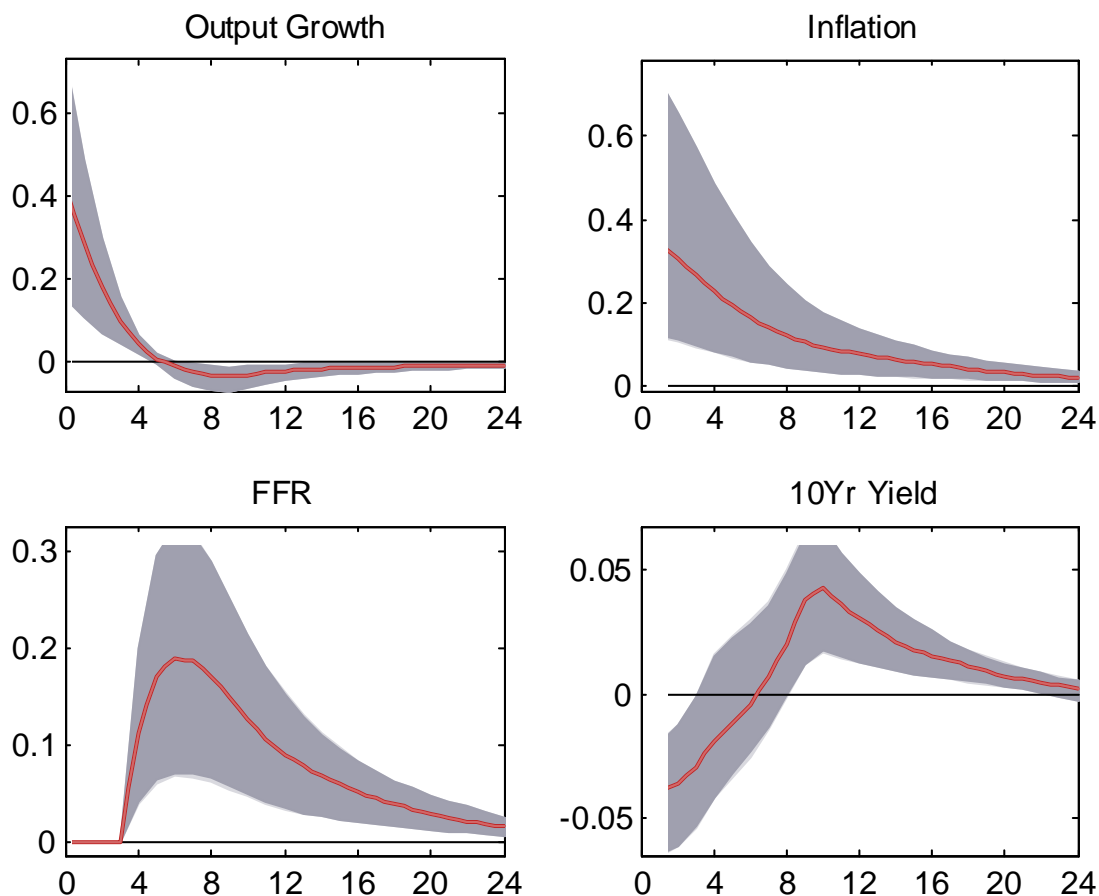
Notes: In this simulation, the average duration of debt is 15 quarters, and the purchase operation lasts for two quarters. The Fed then divests its holdings over two quarters. The shaded regions show the 90 percent confidence bands. The zero-lower bound operates for 4 quarters.

Figure 6: Effects of Treasury Bond purchases by the Federal Reserve
(Long-term securities are not immediately divested)



Notes: In this simulation, the average duration of debt is 15 quarters, and the purchase operation lasts for two quarters. The Fed holds onto the long-term assets for two quarters, and then divests these over the next two quarters. The shaded regions show the 90 percent confidence bands. The zero-lower bound operates for 4 quarters.

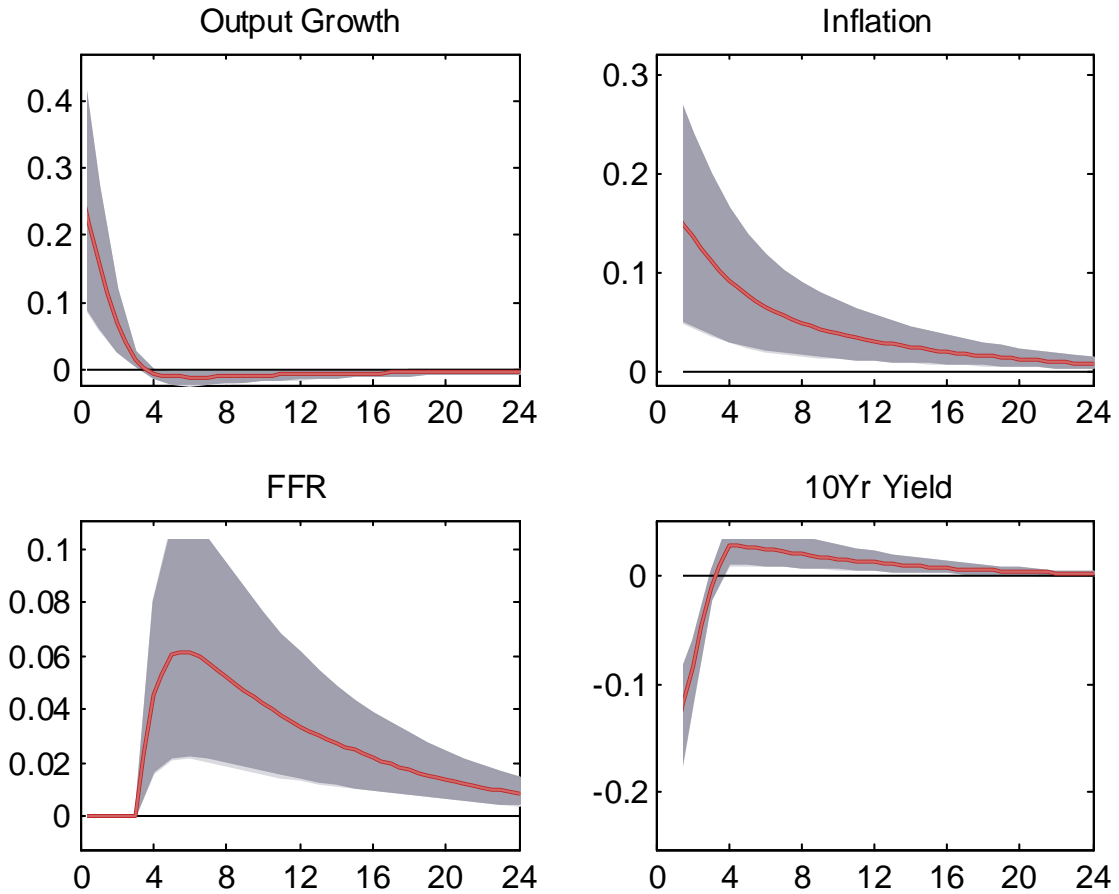
Figure 7: Effects of Treasury Bond purchases by the Federal Reserve
(Duration of Operation is Two years)



Notes: In this simulation, the average duration of debt is 15 quarters, and the purchase operation lasts for eight quarters. The Fed then divests its holdings over two quarters. The shaded regions show the 90 percent confidence bands. The zero-lower bound operates for 4 quarters.

Figure 8: Effects of Treasury Bond purchases by the Federal Reserve

(Size of the operation is larger)



Notes: In this simulation, the average duration of debt is 15 quarters, and the purchase operation lasts for two quarters, and the size of the operation is three times larger than in the benchmark simulation. The Fed then divests its holdings over two quarters. The shaded regions show the 90 percent confidence bands. The zero-lower bound operates for 4 quarters.