

Are unconventional monetary policies effective? *

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Abstract

This paper evaluates the impact of unconventional monetary policies on the Libor-OIS spread, long-term interest rates and long-term inflation expectations in the United States. To measure these effects we investigate the behavior of selected asset yields on the days of policy statements. We consider conventional and unconventional monetary policy releases as well as fiscal policy announcements. We find that government bailouts/recapitalizations and the liquidity facilities other than TAF reduced the three-month Libor-OIS spread. The outright purchases of Agency debt and MBS as well as the longer-term Treasury securities purchases within the framework of Quantitative Easing 1 (QE1) lowered long-term interest rates. Finally, we find evidence the Fed's rescue operations, Quantitative Easing 2 (QE2) and fiscal stimulus announcements raised long-term inflation expectations.

Keywords: unconventional monetary policy, inflation expectations, long-term interest rates, Libor-OIS spread, announcements effect

JEL codes: E43, E44, E52, E58

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1 Introduction

Unconventional monetary policies seemed to be an isolated experiment run by the Bank of Japan during the deflation period. However, recent financial crisis made it clear that the conventional monetary policy - the interest rates setting - was no longer enough to bring back the financial stability and economic recovery. Faced with severe tensions on financial and monetary markets the Federal Reserve was constraint to develop several unconventional monetary measures. First of all, they introduced new liquidity facilities which were gradually expanded to include wider range of collateral and bigger number of counter-parties. After the collapse of Lehman Brothers, the Fed lowered the federal funds target rate nearly to zero and implemented the unconventional monetary policies even more intensively. In particular, they started interventions in specific market segments and initiated the asset purchase programs including commercial papers, longer-term Treasury bonds and Agency debt and MBS. Figure 1 illustrates the way the unconventional policies affected the Fed's balance sheet. Since the beginning of the crisis the composition of the Fed's assets was significantly altered and the size of the balance sheet more then doubled.

In this paper we bring empirical evidence on the effectiveness of these new policies and on their impact on long-term inflation expectations. We focus on the effectiveness of unconventional policies in lowering long-term interest rates and reducing the Libor-OIS spread as these aspects were essential in stimulating economy in the context of the recent crisis. When short-term interest rates are close to zero, the Fed can still stimulate aggregate demand by reducing long-term rates. Furthermore, by reducing tension on interbank market the Fed encourage banks to extend credit and therefore counter the recession.

An important expansion of the Fed's balance sheet coupled with the government's fiscal stimulus raised the question of the impact of unconventional measures on long-term inflation expectations. Raising inflation expectations was not an objective of the Fed and throughout the crisis they emphasized the importance of maintaining price stability. Also, as shown in Figure 2, the monetary base expansion did not affect much the broader money aggregates. Nevertheless, there are several reasons to think that the unconventional monetary policies might affect the anchorage of long-run inflations expectations. First, expansion of monetary

base can encourage the doubts about the Fed's capacity to absorb the excessive liquidity once the crisis is overcome. Second, without explicit announcement of future taxes increase or expenditure reduction, agents might expect the growing public debt to be monetized. Also, the Fed's purchases of risky assets could potentially lead to credit losses. The resulting smaller transfers to the Treasury might trigger some political pressure on the conduct of monetary policy and threaten the independence of the Fed. The concerns about higher future inflation have become even stronger since the Fed started Quantitative Easing 2.

To assess the impact of unconventional monetary policies on inflation expectations, long-term interest rates and the Libor-OIS spread we investigate the behavior of selected asset yields over short periods surrounding the policy statements. We identify and classify unconventional monetary announcements made in the United States during the crisis. We also consider conventional monetary policy and fiscal policy announcements in order to compare the impact of unconventional measures to other policy actions employed during the crisis. We use the regression-based event study to evaluate the effect of each type of policy. If markets are rational the effect of the policy announcements should be reflected in asset prices observed over a short time period. First, we measure the impact of all announcements on the three-month Libor-OIS spread and ten-year nominal interest rates. Second, we evaluate their impact on far-ahead forward inflation compensation. We rely on dummy variables to discriminate between days with or without announcement. In line with the previous literature (Kuttner 2001) we assume that financial markets react only to the announcements that were not fully anticipated. We define the surprise component of dummy variables based on information included in specialized articles in Wall Street Journal and Reuters before and after the event.

Our contribution to the empirical literature on the effects of non-conventional monetary policies is three-fold. First, we create the database of monetary and fiscal announcements, and their surprise components, made in the United States during the crisis. Second, we provide the first empirical evidence on the impact of unconventional monetary policies on long-term inflation expectations. Third, we bring new evidence on the effectiveness of QE2 and other unconventional policies in lowering long-term interest rates and the Libor-OIS spread using regression-based event study methodology.

We find that government bailouts/recapitalizations and the liquidity facilities other than TAF reduced the Libor-OIS spread. The outright purchases of Agency debt and MBS as well as the longer-term Treasury securities purchases within the framework of Quantitative Easing 1 (QE1) lowered long-term interest rates. Finally, we find evidence the Fed's rescue operations, Quantitative Easing 2 (QE2) and fiscal stimulus announcements raised long-term inflation expectations.

The remainder of the paper is organized as follows. The literature is reviewed in the following section. The data and methodology are presented in section 3. In section 4 we estimate the impact of the announcements on long-term interest rates, the Libor-OIS spread and long-term inflation expectations and we present the main results. Section 5 concludes.

2 Literature review

There exists an extensive literature which evaluates the effects of unconventional monetary policies but the empirical evidence on this subject is yet not conclusive. Bernanke, Reinhart and Sack (2004) analyze the effectiveness of different unconventional monetary tools in lowering the long-term interest rates in the United States and in Japan. They consider the following nonstandard policies:

(I) Expectation management strategy: the central bank's commitment can affect the expectations of the future interest rates.

(II) Expansion of monetary base. When the financial frictions are present the quantitative easing is non-neutral. Money and other financial assets are no longer perfect substitutes. Agents want to trade money for non-money assets, and therefore the prices of non-monetary assets raise and the yields go down which stimulates the economy.

(III) Changes in the composition of the central bank balance. Credit easing changes the composition of the portfolio of securities left in the hands of the private sector and can substantially affect their yields.

The empirical evidence gathered by Bernanke, Reinhart and Sack (2004) confirms to the large extent the effectiveness of nonstandard policies in lowering long-term interest rates in the United States. However, the impact of the nonstandard policies implemented by the Bank of Japan during the deflation period is more ambiguous. Ugai (2006) surveyed the empirical

analyses which examine the effects of the unconventional monetary policies implemented in Japan during the deflation period. According to the studies surveyed, the commitment effect lowers considerably the long-term interest rates but monetary base expansion and altering the composition of the central bank balance sheet were found to have little impact or none impact at all.

During the recent economic crisis the unconventional monetary policies were extensively implemented by many central banks. Since then, several descriptive (Borio and Disyatat (2009), Bentoglio and Guidoni (2009)) and theoretical (Curdia and Woodford (2009), Gertler and Karadi (2009), Adrian and Shin (2009), Kiyotaki and Moore (2008)) studies contributed to the better comprehension of the non-standard monetary policies.

The empirical research focused on the impact of unconventional monetary policies on the reduction of interbank risk premia. Taylor and Williams (2009), McAndrews, Sarkar and Wang, (2008), Wu (2008) and Thornton (2010) investigated the impact of Term Auction Facility (TAF) on the Libor-OIS spread and showed opposing results. Aït-Sahalia et al. (2009) consider all macroeconomic and financial sector policy announcements in the United States, the United Kingdom, the euro area and Japan and find that both macroeconomic and financial sector policy announcements were associated with reductions in the Libor-OIS spreads. In this paper we also consider all policy announcements but we provide different classification of events and restrict our analysis to the United States. We also take different approach: regression-based event study which allows us to estimate the effect of all policies simultaneously.

The impact of the Fed's long-term debt purchases on long-term interest rates was analyzed by Hamilton and Wu (2010) and Gagnon et al. (2010). They found that these actions lowered nominal long-term interest rates. We contribute to the discussion on the effectiveness of long-term Treasury and Agency debt purchases via regression-based event study methodology. Moreover, we examine the impact of Quantitative Easing 2 and other unconventional monetary policies on long-term interest rates. Finally, we orthogonalize the expectations of future interest rates in order to measure what was the impact of different policies on particular segments of the yield curve.

While the impact of alternative monetary policies on interest rates and money market

distress was largely discussed in the previous literature, their effect on long-run inflation expectations is still poorly known. To our best knowledge this paper is the first empirical study that investigates the consequences of unconventional monetary policies on the long-run inflation expectations anchorage. Following Gürkaynak, Levin and Swanson (2006b) we use the measure of inflation expectations extracted from financial markets, and in particular the daily data on far-ahead forward inflation compensation.

3 Methodology

3.1 Regression-based event study

We apply regression-based event study methodology in order to evaluate the impact of monetary and fiscal policy announcements on long-term inflation expectations, long-term interest rates and the Libor-OIS spread in the United States during the 2007-2009 financial crisis. This approach was employed by Cook and Hahn (1998), Roley and Sellon (1995), Haldane and Read (2000), Kuttner (2001) to measure the response of nominal interest rates to the central banks' official rates changes. Event study methodology allows testing the impact of an economic event on financial market data. If markets are rational the effect of the event should be reflected in asset prices observed over a short period of time.

In this paper we examine the one or two-day response of ten-year interest rates, three-month OIS-Libor spread and far-ahead forward inflation compensation to different policy announcements. We take into account the FOMC interest rates decisions, unconventional monetary policy announcements, fiscal policy announcements and failures of big financial institutions. We rely on dummy variables to discriminate between days when announcements were made or not. In line with the previous literature (see for example Kuttner 2001) we assume that financial markets react only to the announcements that were not fully anticipated. Some previous studies use surprise dummy variables to take into account unanticipated announcements. Bernanke, Reinhart and Sack (2004) construct surprise dummy based on the set of commentaries written before and after each statement. We define our surprise dummy variables based on specialized articles in Wall Street Journal and Reuters before and after the event.

3.2 Data

In this study we use daily data sets from January 4, 1999 to December 31, 2010 with the exception of the OIS rates which were available only from November 26, 2003. The data on the one-year far ahead forward inflation were taken from

<http://www.federalreserve.gov/econresdata/researchdata.htm>¹. The data on other interest rates were obtained from Datastream, Bloomberg and Reuters.

3.3 Date and time of announcements

In order to carry out the above study, we put together a complete list of dates of monetary and fiscal policy announcements from 4 January 1999 until December 31, 2010. Until August 2007 the news concerning the monetary policy were released at 14:15 Eastern Time after regularly scheduled (since 1995) FOMC meetings. Since the beginning of the subprime crisis, the Federal Reserve introduced several new measures and intensified their communication. For instance, 12 announcements were made in 2006 vs. 80 announcements in 2008. Table 1 contains the list of the monetary policy announcements as well as the date of release.

3.4 Types of announcements

We classify unconventional monetary policy announcements into five categories: interest rates commitment, long-term Treasury bonds purchases, Agency debt and MBS purchases, liquidity facilities and the Federal Reserve's rescue operations. We also include conventional monetary policy and fiscal policy announcements into our analysis in order to compare the effectiveness of unconventional monetary policies to other types of policy responses.

Given the assumption of efficient financial markets, the asset prices react only to the unexpected component of the announcements. Therefore, for each kind of policy, we need a measure of deviation of the actual statements from what was expected by financial markets participants.

¹Dataset from Gürkaynak, Sack and Wright (2008)

3.4.1 Conventional monetary policy

FOMC interest rates decisions

The surprise component of the FOMC interest rates decisions is evaluated using federal funds futures (Kuttner 2001). These contracts are settled based on the average effective federal funds rate that is realized for the calendar month specified in the contract. It is therefore possible to infer from these instruments the market expectations of the FOMC decisions at future meetings. The daily changes in the current-month futures contract rate reflect the changes in market's expectations of the fed funds rate during the remainder of the month. The surprise component of the FOMC interest rates decision on day t of month s is given by:

$$\Delta x_{s,t} = \frac{m_s}{m_s - t} (ff f_{s,t}^0 - ff f_{s,t-1}^0)$$

where:

$ff f_{s,t}^0$ is the current month fed funds futures rate on day t of month s

m_s denotes the number of days in month s with $t = 1, \dots, m_s$ and $s = 1, \dots, 12$. Since the contract settlement price is based on the average of the effective fed funds rates, the scaling factor $\frac{m_s}{m_s - t}$ adjusts the unexpected component proportionally to the number of days in the month affected by the change.

In our regression we include the statements where the Federal Reserve did not change their target rate. The decisions to maintain the federal funds rate might have surprised the financial markets and make the bonds prices move.

3.4.2 Unconventional monetary policies

A. Interest rates commitment

The economic situation after the collapse of Lehman Brothers was constantly worsening. Therefore, on December 16, 2008 the FOMC cut the fed funds rate by three quarters of percentage point to 0.25 per cent. Additionally, the release said that "the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time". On March 18, 2009 the Fed made a stronger pledge announcing that the exceptionally low levels of fed funds rate would be maintained "for an

extended period” rather than ”for some time”. In this way, the Fed communicated to markets its commitment to lower the path for future interest rates. Expectations management has been proven effective in lowering long-term interest rates during the deflation period in Japan (Ugai 2006). In fact, according to New Keynesian models this kind of policy should stimulate the aggregate demand even in the zero-bound environment as the current demand depends not only on the current interest rate but also on the future expected short-term rates and expected inflation.

The interest rate commitment was reiterated seventeen times within our sample and was always announced after the scheduled FOMC meetings. The dates of the FOMC meetings were known in advance to the market participants so they were able to anticipate the information about lower future interest rates as long as the economy was weak. However, as the economic situation was gradually improving, market participants were reading with attention the Fed’s statement to see whether there would be a change in wording of the commitment, suggesting a future tightening. Given that only surprise interest rate commitment should have an impact on asset prices, we construct a surprise commitment dummy. It takes the value of 1 when the announcement came as a surprise, 0.5 when the financial markets were generally expecting the Fed to reiterate it’s commitment but there was some uncertainty about it and 0 on the days when the commitment was fully anticipated. The measure of ”surprise” part of the statement is based on articles from the Wall Street Journal and Reuters before and after the FOMC meetings. The details on the classification of each statement are included in Table 2.

B. Long-term Treasury bonds purchases

Another tool at the disposal of the central bank when the interest rates are close to zero is the outright purchase of long-term government securities. The effectiveness of this policy is based on the ”portfolio rebalancing effect”. By purchasing long-term securities, the central bank changes the composition of the portfolio of securities left in hands of private sector and therefore affects their yields. The theoretical basis for the effectiveness of open-market purchases of non standard assets were set by Eggertson and Woodford (2003). Their model, based on the assumptions of complete markets, predicts no effect for such operations on price

level or output. The empirical studies based on the experience of the Bank of Japan confirm that these purchases did not succeed in lowering the yields (Ugai etc). More recently, Gagnon et al. (2010) present evidence that the Fed's purchases of assets with medium and long maturities reduced longer-term interest rates. Moreover, Hamilton and Wu (2010) suggest that at the zero lower bound, purchases of long-term Treasury debt would lower the long-term rates without raising short-term yields.

On December 16, 2008 the Federal Reserve announced that they were "evaluating the potential benefits of purchasing longer-term Treasury securities". On January 28, 2009 they indicated that they were "prepared to purchase longer-term Treasury securities if evolving circumstances indicate that such transactions would be particularly effective in improving conditions in private credit markets". On March 16, 2009 the FOMC decided to purchase up to 300 billion dollars of longer-term Treasury securities over the following six months. This was the first time the Fed tried to change the relative supply of the long-term Treasury bonds since the "Operation Twist" in 1961.

Purchases of long-term bonds ended in October 2009 but were resumed the next year. On August 10, 2010 the Fed announced that they would reinvest principal payments from agency debt and agency mortgage-backed securities into longer-term Treasury securities. In addition to this reinvestment which represented from \$250 to \$300 billion, the Fed announced on November 3, 2010 that they would buy \$600 billion of longer-term Treasury securities. This second round of Treasury bonds purchases was called Quantitative Easing 2.

The Federal Reserve made most of the announcements concerning the purchases of longer-term securities after the scheduled FOMC meetings and the market participants could anticipate them. We construct surprise dummy based on the information included in specialized press articles (Wall Street Journal and Reuters). The dummy takes the value 1 when the announcements surprised financial markets and -1 when they were expecting the Fed to take the stronger action. Table 3 presents the details about the statements.

C. Agency debt and MBS purchases

In addition to longer-term Treasury bonds, the Fed purchased also the Fannie Mae and Freddie Mac debt and mortgage-backed securities. Fannie Mae and Freddie Mac operated since

1968 as government sponsored enterprises (GSE). Their principal activity consisted in expanding the secondary market in mortgages. They were both privately owned but benefited from the "implicit" government guarantees which insured them favorable interest rates. In July 2008 Freddie Mac and Fannie Mae faced serious problems in meeting their obligations as the U.S. housing crisis worsened. In response to that, on Sunday July 13, 2008 the Secretary of the Treasury announced that the U.S. government would provide the backstop to GSE. On September 7, 2008 the Federal Housing Finance Agency (FHFA) had put Fannie Mae and Freddie Mac under its conservatorship. Since the GSE were effectively nationalized, their debt and MBS became equivalent to Treasuries in terms of risk profile.

The surprise dummy, based on articles in Wall Street Journal and Reuters, takes the following values: 1 when the announcement is unexpected, 0.5 when it is expected but accompanied by the commitment to "expand the quantity of such purchases and the duration of the purchase program as conditions warrant" and is equal to zero when there was no announcement or when it was completely anticipated. Table 4 presents the details about the statements.

D. Liquidity facilities

Since the beginning of the crisis, the Fed established several liquidity facilities in order to restore the normal functioning of money markets. The additional funding sources were meant to encourage banks and non-banking institutions to lend more funds to each other and to bring down the borrowing costs. With the central bank liquidity at their disposal, the financial institutions have smaller incentive to hoard liquidity for precautionary reasons as they know they would be able to meet the unanticipated liquidity needs. On the other hand, the facilities should also bring down the default risk as the institutions' counter-parties would also benefit from the access to Fed's liquidity backstop.

Liquidity facilities creation and expansion were announced on unscheduled meetings so we always consider them as surprises (see Table 5). The only exceptions are the days on which the time extension of the facilities was announced. Most of the facilities were announced to end on specific dates but the economy was still in the recession and the agents were expecting the Fed to extend the facilities that were about to expire.

E. Federal Reserve's rescue operations

During crisis, the Fed rescued several financial institutions. Section 13(3) of the Federal Reserve Act allows the Fed to extend credit through discounts in "unusual and exigent circumstances" when a borrower is "unable to secure adequate credit accommodations from other banking institutions." The main beneficiaries were Bear Stearns/ JP Morgan and AIG but we include in this category also the loans granted to Fannie Mae and Freddie Mac and the conversion of Morgan Stanley and Goldman Sachs into traditional bank holding companies. The description of each operation is presented in Table 6. As these events could not be anticipated by market participants, we attribute the dummy equal to 1 to each event.

3.4.3 Fiscal policy

The severity of the crisis required numerous policy actions from both monetary and fiscal authorities. Therefore, in parallel to the Federal Reserve's monetary easing, the U.S. government introduced several fiscal measures to offset the downturn. We take into account these announcements as it seems important to compare the impact of unconventional monetary policies to other policy actions. We put fiscal policy actions into different categories: fiscal stimulus (Table 7) and government bailouts of individual troubled institutions (Table 8). Implementation of fiscal stimulus was multi-stage processes which requires approval of the U.S. House of Representatives and the Senate. We include the announcements corresponding to all validation stages by the U.S. Congress and attribute them surprise dummy equal to 1 as these packages were controversial and there was uncertainty concerning their approval. The dummy is equal to zero on the days of president's signature as at this stage the stimulus packages were certain to become a law.

During crisis, the U.S government provided also financial support to many troubled institutions to prevent them from failing. Market participants could not anticipate whether the government would bail out a particular financial institution so the dummy variable on the announcement day takes value equal to 1.

3.4.4 Failures of important financial institutions

Government's bailouts and Fed's rescue operations were the response to critical situation of important financial institutions. Therefore, very often on a same day, an announcement about the Fed's and/or government's rescue operation were preceded by the bad news related to insolvency of a given financial institution. We include these events in our study (Table 9).

4 Results

4.1 Effect of unconventional monetary policy announcements on Libor-OIS spread

Some of the unconventional monetary policies were designed to ease the tensions on interbank market that appeared in August 2007 and intensified after the collapse of Lehman Brothers. Indeed, the generalized uncertainty concerning the health of banks' balance sheet made the banks unwilling to lend to each other. As a consequence, the Libor-OIS spread which is considered as a barometer of interbank market distress widened significantly.² There is a discussion in the recent literature concerning the effects of new liquidity facilities on the Libor-OIS spread. Taylor and Williams 2008 claim the liquidity facilities like TAF (Term auction facility) cannot have an impact on the Libor-OIS spread because it is mostly due to credit risk and not the liquidity risk. On the other hand, Wu 2008 maintains that the spread was caused by the misallocation of liquidity and that the financial strains in the interbank money market were alleviated after TAF was implemented.

We use 3-month Libor-OIS rate to measure the effectiveness of TAF and other unconventional monetary policies in diminishing the tensions in interbank lending. There is a timing issue related to using this measure in our event study. The Libor rate is published at 06:00 Eastern Time while the OIS rate is taken from Datastream and the last update is from 14:15 Eastern Time. Therefore, most of the announcements on a given day were not be taken into account by Libor rate and some of them were not incorporated in the OIS rate either as they were made in the afternoon or in the evening. In particular, the FOMC statements

²The London interbank offered rate (Libor), is an average interbank borrowing rate published daily by the British Bankers' Association (BBA). The overnight-indexed swap (OIS) rate represents market expectations of the funds rate over the future months. There is no exchange of principal and only the net difference in interest rates is paid at maturity, so there is very little default risk in the OIS market.

announcing important unconventional monetary measures were issued at 14:15 EST. In order to ensure that the markets had the possibility to react to all announcements we consider 2-day event window and the changes in the three-month Libor-OIS spread are calculated in a following way:

$$\Delta Sp_t = \Delta LIBOR_t - \Delta OIS_t$$

where:

$$\Delta LIBOR_t = LIBOR_{t+1} - LIBOR_{t-1}$$

$$\Delta OIS_t = OIS_{t+1} - OIS_{t-1}$$

We test the impact of all non conventional monetary actions on the Libor-OIS spread:

$$\Delta Sp_t = \alpha + \gamma \Delta x_t + \sum_{i=1}^I \varphi_i NC_{i,t} + \sum_{j=1}^J \beta_j F_{j,t} + L_t + \epsilon_t \quad (1)$$

where:

ΔSp_t is a 2-day change in 3-month Libor-OIS spread

Δx_t is a surprise daily change in official rate

$F_{j,t}$ is a surprise component of fiscal policy announcement j

$NC_{i,t}$ is a surprise component of unconventional monetary policy announcement j

L_t is a failure of important financial institutions

ϵ_t is a stochastic error term

Table 10 reports the regression results. The spread rises after the failures of important financial institutions by 29 basis points and is reduced following the government rescue operations by 25 basis points. Announcements related to TAF do not affect the spread but those related to other liquidity facilities (TSLF, PDCF, AMLF, CPFF, MMIFF, AMLF) reduce the spread by 9 basis points. The facilities associated with a reduction in counterparty risk seem to have bigger impact on the OIS-Libor spread than measures aimed just at providing the liquidity.

4.2 Effect of unconventional monetary policy announcements on long-term interest rates

In order to measure the impact of all policy announcements on long-term interest rates we estimate the following regression:

$$\Delta i_t = \alpha + \gamma \Delta x_t + \sum_{i=1}^I \varphi_i NC_{i,t} + \sum_{j=1}^J \beta_j F_{j,t} + L_t + \epsilon_t \quad (2)$$

where:

Δi_t is a daily change in 10-year nominal rates ($\Delta i_t = i_t - i_{t-1}$)

Δx_t is a surprise daily change in official rate

$F_{j,t}$ is a surprise component of fiscal policy announcement j

$NC_{i,t}$ is a surprise component of unconventional monetary policy announcement j

L_t is a failure of important financial institutions

ϵ_t is a stochastic error term

In the first step we exclude the Quantitative Easing 2 and run the regression from January 4, 1999 until July 31, 2010. Regression results are reported in Table 11. The purchases of longer-term Treasuries lower the ten-year interest rates by 22 basis points and the purchases of long-term Agency debt and MBS reduce it by 17 basis points. This result is not surprising given that Fannie Mae and Freddie Mac were nationalized in September 2008. In term of the risk portfolio they are very similar to long-term Treasury bonds.

In the second step we include the QE2 period. Table 12 shows the regression results from from January 4, 1999 until December 31, 2010. The purchases of long-term Treasury bonds still reduce long-term interest rates but their impact is smaller (10 basis point compared to 22 before the QE2) and the coefficient is less significant. Regression results from August 12, 2009³ until December 31, 2010 show indeed that the QE2 bond purchases did not lower long-term nominal rates (Table 13).

In order to evaluate the impact of unconventional monetary policies on the different parts of the yield curve, we orthogonalize the expectations of interest rates for different maturities.

³The FOMC statement of that day announced that the full amount of bonds would be purchased by the end of October 2009

We separate the expectations by constructing three independent factors:

Factor 1: changes in expectations of the current month interest rates

Factor 2: changes in expectations of the next year interest rates that are not already explained by the changes in current month expectations

Factor 3: changes in expectations of the interest rates over the next 10 years that are not explained by the changes in the 1-year expectations

The factors are given by the following relations:

$$\Delta y_1 = F_1$$

$$\Delta y_{12} = \alpha_1 F_1 + F_2$$

$$\Delta y_{120} = \alpha_2 F_1 + \beta_1 F_2 + F_3$$

where:

Δy_1 are changes in Fed Funds Futures (monetary policy surprises as defined by Kuttner 2001)

Δy_{12} are changes in 1-year OIS

Δy_{120} are changes in 10-year nominal bond

We test the impact of all announcements on the second and the third factor before QE2 was introduced.⁴ The results presented in Table 14 confirm that the purchases of long-term Treasuries and Agency debt and MBS contribute to lowering medium and long-term interest rates (factor 3) by respectively 16 and 22 basis points. This evidence confirms the results of Hamilton and Wu (2010) and Gagnon et al. (2010) who also find that altering the maturity structure of publicly held Treasury debt lowered long-term interest rates in the United States during the QE1 period.

Table 15 reports the results for the period including QE2. The purchases of Agency bonds and MBS still reduce the third factor by 16 basis points but the impact of Treasury bonds purchases diminishes to 10 basis points and becomes less significant. In the period including only QE2, the impact of longer-term Treasury bonds purchases on the third factor is no longer significant (Table 16).

Finally, we do not find evidence that interest rates commitment succeeded in lowering

⁴The sample period is from November 26, 2003 until July 31, 2010 as the data on OIS rates necessary to calculate factors were available from the end of 2003 only.

the expectations of interest rates from 1 month to 1 year (factor 2).

4.3 Effect of unconventional monetary policy announcements on long-term inflation expectations

4.3.1 Some preliminary evidence on a change in inflation expectations

The expansion of the Federal Reserve's balance sheet (see Figure 1) was viewed by some observers as a threat to the Fed's commitment to low and stable inflation. At the same time, the worsening economic conditions, especially after the collapse of Lehman Brothers, raised concerns about future deflation. In order to get a preliminary view of the evolution of inflation expectations, we examine a few indicators.

A. Spread between 10-year Treasury bonds and average Fed Funds

The term spread increased significantly since the crisis started in August 2007 (Figure 3). However, the term spread is a very crude measure of inflation expectations as it is also influenced by changes to expected real interest rate and term premia (inflation risk premium + real risk premium). It is very likely that the term premia went up since the crisis started.

B. 10-year breakeven inflation compensation

10-year breakeven inflation compensation is measured by the difference in yields between 10-year nominal and inflation-indexed bonds (10-year TIPS rate). In recent years, the market participants, analysts and policy makers were using the inflation-indexed financial instruments to gauge inflation expectations.

Ten-year breakeven inflation compensation rates declined strongly after the bankruptcy of Lehman Brothers. Although this might reflect deflationary expectations related to the worsening of economic situation, this preliminary evidence must be viewed with some caution. Inflation compensation is also affected by inflation risk premium and the relative TIPS-nominal bonds liquidity. It seems likely that during the peak of the crisis, the relative liquidity of TIPS and nominal bonds played important role in the inflation compensation evolution. Figure 4 presents the evolution of the 10-year nominal, real and breakeven rates.

Indeed, there seems to be a disruption in TIPS and nominal bonds market in autumn 2008. The sudden increase in TIPS yields suggests that they become less appealing as an investment vehicle. At the same time, nominal yields fall which probably reflects investors' preference for holding nominal Treasury debt.

C. Forward inflation compensation

The 10-year breakeven inflation rate incorporates also short-term developments of inflation compensation. One way to measure specifically long-term expectations is to focus on the evolution of the far-ahead forward inflation compensation. Figure 5 shows 1-year forward inflation compensation from 9 to 10 years ahead. The far-ahead forward inflation has been changing over time and became particularly volatile in autumn 2008. In the beginning of 2009 it returns to its usual volatility. In January 2010 it starts declining but the trend reverses in August 2010 which coincides with the beginning of Quantitative Easing 2.

Figure 6 shows the 1-year nominal and real (TIPS) forward rates ending in 10 years. Both TIPS and nominal forward rates are very volatile in autumn 2008. The TIPS forward rate rises suddenly after Lehman Brother collapse but to a much smaller extent than spot 10-year real rate. The nominal forward rate rises even more. This is in contrast with the nominal spot 10-year rate that declined significantly at the same time. This provides some tentative evidence that the disruption in TIPS liquidity relative to nominal bonds affected mostly short and medium term inflation compensation.

D. Survey-based inflation expectations

One way to measure the informative content of market-based inflation expectations is to compare them to survey-based inflation expectations. Figure 7 shows the University of Michigan survey of forward inflation expectations from 5 to 10 years. Figure 8 shows the market-based 5-year forward inflation compensation ending in 10 years and the survey-based inflation expectations at the same horizon.

The survey-based forward inflation expectations were also unusually volatile during the peak of the current crisis. Furthermore, the market-based measure is available on a daily basis while the survey is conducted once a month. For these reasons, we decide to use market-

based inflation expectations.

4.3.2 Extracting the inflation expectations

The measure of long-run inflation expectations that we use is constructed based on Treasury securities⁵. As shown in Gürkaynak, Sack and Swanson (2004) the inflation linked bonds or swaps can provide a reasonable measure of agents' inflation expectations provided there is a liquid market for these instruments. Long-term inflation expectations can be extracted by comparing the nominal bonds yields to the inflation-linked bonds (break-even inflation rates).

Our measure of the long term inflation expectation is constructed as follows:

$$\pi_t^e = f_{1,t+9y}^n - f_{1,t+9y}^i$$

where:

π_t^e denotes the nine-year-ahead one-year forward inflation compensation.

$f_{1,t+9y}^n$ denotes the nine-year-ahead one-year forward nominal yield.

$f_{1,t+9y}^i$ denotes the nine-year-ahead one-year forward yield of inflation-indexed bond.

The forward rates can be calculated based of nine- and ten-year yields. The relationships are the following:

$f_{1,t+9y}^n = 10 \cdot y_{10,t}^n - 9 \cdot y_{9,t}^n$ where $y_{10,t}^n$ and $y_{9,t}^n$ are respectively the logarithms of the ten-year and nine-year nominal bond yields.

$f_{1,t+9y}^i = 10 \cdot y_{10,t}^i - 9 \cdot y_{9,t}^i$ where $y_{10,t}^i$ and $y_{9,t}^i$ are respectively the logarithms of the ten-year and nine-year yields to maturity of an inflation indexed bond.

However, the daily changes in forward inflation compensation rates may be driven not only by long-term inflation expectation ($IE_{1,t+9y}$) but also by forward inflation risk premium ($IP_{1,t+9y}$) or forward TIPS/nominal bonds liquidity premium ($LP_{1,t+9y}$):

$$\Delta\pi_t^e = \Delta IE_{1,t+9y} + \Delta IP_{1,t+9y} + LP_{1,t+9y}$$

⁵Dataset from Gürkaynak, Sack and Wright (2008)

The Figure 4 shows that during the recent financial crisis, there were some important changes in the relative liquidity between TIPS and nominal bonds. The participants of the two markets are quite different. The main contributors in the TIPS market are institutional investors like pension funds or insurance companies with long-term liabilities who treat TIPS as buy-and-hold assets. The emergency rescue of AIG by the Fed led to some uncertainty concerning the financial health of insurance companies. The fire sales of their assets might explain the falling prices of TIPS. In contrast, the most important participants in the Treasury nominal bonds are primary dealers for whom nominal bonds play a role as hedging and trading vehicle. The sudden increase in uncertainty concerning the value of many financial instruments made the safe instruments like nominal bonds more attractive to investors.

However, there are still two reasons for which breakeven inflation rates should be informative about expected inflation during the recent crisis. First, we measure the long-run inflation expectations by taking difference between the nominal and inflation-indexed forward rate and not the yield to maturity. As discussed earlier, the relative TIPS liquidity worsened in autumn 2008 but impacted mostly short and medium maturities. One-year far-ahead forward rates provide cleaner indication of long-horizon inflation expectations as they filter out the effects of short-term expectations. Second, the survey-based inflation expectations are also volatile during crisis which suggests that fluctuations in forward compensation can be also viewed as changes in expected inflation.

In order to verify whether the relative liquidity premium and inflation premium impacted far-ahead inflation compensation, we add into our regression model the proxies for TIPS liquidity premium and inflation risk premium. Following Söderlind (2010), we use VIX to approximate the TIPS liquidity premium (Figure 9) and bond options to account for inflation uncertainty (Figure 10).

Given that the nominal bonds' liquidity might also have changed during crisis (see Figure 4), we construct another proxy for the relative TIPS/ nominal bonds liquidity. The liquidity of each type of bond is approximated by its bid-ask spread. Therefore, the relative liquidity proxy is a difference between the bid-ask spread for TIPS and nominal bonds (Figure 11):

$$Bidask_t = Bidask_t^{TIPS} - Bidask_t^{Nom}$$

where:

$Bidask_t$ is a relative TIPS / nominal bonds liquidity proxy

$Bidask_t^{TIPS}$ is a bid-ask spread for TIPS

$Bidask_t^{Nom}$ is a bid-ask spread for nominal bonds

We estimate the following regressions:

$$\Delta\pi_t^e = \alpha_1 + \phi_1\Delta VIX_t + \gamma_1\Delta BO_t + \epsilon_t$$

$$\Delta\pi_t^e = \alpha_2 + \beta_1\Delta Bidask_t + \gamma_2\Delta BO_t + \epsilon_t$$

$$\Delta\pi_t^e = \alpha_3 + \phi_2\Delta VIX_t + \beta_2\Delta Bidask_t + \gamma_3\Delta BO_t + \epsilon_t$$

where:

$\Delta\pi_t^e$ is a daily change in one-year forward inflation from 9 to 10 years ahead ($\Delta\pi_t^e = \pi_t^e - \pi_{t-1}^e$)

ΔVIX_t is a daily change in the VIX index ($\Delta VIX_t = VIX_t - VIX_{t-1}$)

ΔBO_t is a daily change in options on 30-year bond futures ($\Delta BO_t = BO_t - BO_{t-1}$)

$\Delta Bidask_t$ is a daily change in relative TIPS / nominal bonds liquidity proxy ($\Delta Bidask_t = Bidask_t - Bidask_{t-1}$)

If this regression models are to explain much in the movement of the far-ahead forward inflation compensation, we would expect the sign of ϕ_1 and ϕ_2 to be negative. In fact, systemic risk approximated by the VIX index should increase the TIPS illiquidity and diminish inflation compensation. We would also expect the relative liquidity proxy to have negative sign as the bigger bid-ask spread for nominal bonds increases the inflation compensation and that the bigger TIPS bid-ask spread on the contrary diminishes it. On the other hand the inflation risk premium increases inflation compensation so the coefficients this proxy should be positive.

Table 17 shows that both proxies for TIPS liquidity and relative liquidity are significant and have the expected sign. We add both of them into regression. The proxy for inflation uncertainty, the implied bonds volatility, has a positive impact but is not significant. Therefore do not include this proxy into our regression model. Even though inflation expectations and inflation risk premium cannot be easily decomposed, they can be both associated with

the capacity of the central bank to control inflation and it is not necessary to separate out these effects.

4.3.3 Unconventional monetary policy and fiscal policy announcements

As mentioned earlier, some of the unconventional monetary policies implemented by the Fed during crisis were perceived as inflationary. In order to verify the impact of these policies on far-ahead inflation expectations, we test the response of far-ahead forward inflation compensation over the one-day period surrounding monetary policy actions and statements. We also measure its response to fiscal policy announcements during the crisis.

$$\Delta\pi_t^e = \alpha + \phi_1\Delta VIX_t + \phi_2\Delta Bidask_t + \gamma\Delta x_t + \sum_{i=1}^I \varphi_i NC_{i,t} + \sum_{j=1}^J \beta_j F_{j,t} + L_t + \epsilon_t \quad (3)$$

where:

$\Delta\pi_t^e$ is a daily change in one-year forward inflation from 9 to 10 years ahead ($\Delta\pi_t^e = \pi_t^e - \pi_{t-1}^e$)

ΔVIX_t is a daily change in the VIX index

$\Delta Bidask_t$ is a daily change in a relative liquidity proxy

Δx_t is a surprise daily change in official rate

$F_{j,t}$ is a surprise component of fiscal policy announcement j

$NC_{i,t}$ is a surprise component of unconventional monetary policy announcement j

L_t is a failure of important financial institutions

ϵ_t is a stochastic error term

As in the case of long-term nominal rates we run the regression for two periods: including and excluding Quantitative Easing 2. Table 18 reports the regression results for the period from January 4, 1999 to July 31, 2010, before QE2 was implemented. First of all, the failures of big financial institutions diminish long-term inflation expectations. On the other hand, news related to Fed's rescue operations increases far-ahead forward inflation compensation. Announcements related to other unconventional monetary policies and news about fiscal measures do not significant impact on long-term inflation compensation. Fiscal stimulus announcements are only significant at 10% level at this stage.

In the second step we include in our regression the period of Quantitative Easing 2 and estimate the sample from January 4, 1999 to December 31, 2010. Table 19 shows that the effect of the Fed's rescue operation is still positive and significant. However, this time the fiscal stimulus and purchases of longer-term Treasury bonds raise long-term inflation expectations by 6 basis points.

This result provides evidence that the second round of Quantitative Easing 2 had quite different effect on long-term nominal interest rates and long-term inflation expectations than Quantitative Easing 1. QE1 reduced long-term interest rates without raising inflation, whereas QE2 raised inflation expectations without diminishing long-term interest rates.

5 Conclusions

The implementation of unconventional monetary policies required the huge expansion of the Federal Reserve's balance sheet and the change of its composition. These policies proved effective in many ways. The government's recapitalization/ bailouts reduced strains on the interbank markets by 25 basis points while the liquidity facilities other than TAF by 9 basis points. Purchasing long-term Treasury debt and Agency debt and MBS within the framework of QE1 lowered long-term interest rates by respectively 17 and 22 basis points. QE2 did not reduce long-term interest rates. Finally, we find evidence that the Fed's rescue operations, the QE2 bonds purchases and fiscal stimulus announcements raised long-term inflation expectations by 6 basis points.

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Table 1: Dates of announcements

| Date | 1* | 2* | 3* | 4* | 5* | 6* | 7* | 8* | 9* | 10* | Comment |
|----------|----|----|----|----|----|----|----|----|----|-----|---|
| 20070809 | | | 1 | | | | | | | | BNP Paribas suspends 3 investment funds that invested in subprime mortgage market |
| 20070918 | 1 | | | | | | | | | | FOMC statement |
| 20071031 | 1 | | | | | | | | | | FOMC statement |
| 20071206 | | | | | | | | | 1 | | President Bush unveils the plan to ease pressure on the mortgage market |
| 20071211 | 1 | | | | | | | | | | FOMC statement |
| 20071212 | | | | 1 | | | | | | | TALF created |
| 20080122 | 1 | | | | | | | | | | FOMC statement |
| 20080129 | | | | | | | | | 1 | | Economic Stimulus Act of 2008 approved by the U.S. House of Representatives |
| 20080130 | 1 | | | | | | | | | | FOMC statement |
| 20080207 | | | | | | | | | 1 | | Economic Stimulus Act of 2008 approved by the Senate |
| 20080213 | | | | | | | | | 1 | | President Bush signs the Economic Stimulus Act of 2008 |
| 20080307 | | | | | 1 | | | | | | TAF increased to \$100 billion |
| 20080311 | | | | 1 | | | | | | | TSLF created |
| 20080314 | | | 1 | | | 1 | | | | | Bear Stearns shares decline by 47%. Board authorizes the New York Fed to extend credit to JPMC to provide nonrecourse loan to Bear Stearns. |
| 20080317 | | | 1 | 1 | | 1 | | | | | Bear Stearns bailed out. PDCF creation. Fed grants a loan to JPMC for acquiring Bear Stearns. (News on Sunday, September 16). |
| 20080318 | 1 | | | | | | | | | | FOMC statement |
| 20080430 | 1 | | | | | | | | | | FOMC statement |
| 20080502 | | | | | 1 | | | | | | Expansion of the collateral in Schedule 2 TSLF auctions. |
| 20080625 | 1 | | | | | | | | | | FOMC statement |
| 20080711 | | | 1 | | | | | | | | Bad news about Government Sponsored Enterprises (GSE)/ talks about GSEs nationalization |
| 20080714 | | | 1 | | | 1 | 1 | | | | Indymac Bank's failure on July 11 in the evening (Friday). Treasury increases the credit line for Freddie Mac and Fannie Mae. Board grants Federal Reserve Bank of New York the authority to lend to Fannie Mae and Freddie Mac should such lending prove necessary. (News on Sunday, July 13). |
| 20080723 | | | | | | | | | 1 | | The Housing and Economic Recovery Act passed by Congress |
| 20080730 | | | | | 1 | | | | | 1 | TAF maturity extended. President Bush signs into law the Housing and Economic Recovery Act of 2008. |
| 20080805 | 1 | | | | | | | | | | FOMC statement |
| 20080908 | | | 1 | | | | 1 | | | | Fannie Mae and Freddie Mac nationalized |
| 20080915 | | | 1 | | 1 | | | | | | Lehman Brothers collapsed. Important expansion of TSLF and PDCF: collateral, frequency, amount. (News on Sunday, September 14). |
| 20080916 | 1 | | 1 | | | | | | | | FOMC statement. Moody's and Standard and Poor's downgrades ratings on AIG's credit. |
| 20080917 | | | 1 | | | 1 | | | | | Failure of AIG. Fed bailouts AIG (News on September 16, late in the evening). |
| 20080919 | | | | 1 | | | | 1 | | 1 | AMLF created. Fed plans to buy short-term Agency debt. Paulsons financial rescue plan is unveiled (Emergency Economic Stabilization Act of 2008) |
| 20080922 | | | | | | 1 | | | | | The Fed agrees to convert Morgan Stanley and Goldman Sachs Group into traditional bank holding companies and extends credit to their subsidiaries (News on Sunday, September 21) |
| 20080925 | | | 1 | | | | | | | | Washington Mutual seized by the Federal Deposit Insurance Corporation |
| 20080929 | | | 1 | | 1 | | 1 | | | | Emergency Economic Stabilization Act defeated 228-205 in the United States House of Representatives. Wachovia's failure. TAF expansion. Acquisition of Wachovia by Citigroup is facilitated by the FDIC and concurred with by the Fed and the Treasury. |
| 20081001 | | | | | | | | | | 1 | Emergency Economic Stabilization Act of 2008 passed in Senate |
| 20081003 | | | | | | | | | | 1 | President George W. Bush signs the Emergency Economic Stabilization Act |

1* FOMC statements 2* Interest rates commitment 3* Failures of important institutions 4* Liquidity facility creation 5* Liquidity facility extension
6* Feds rescue operations 7* Governments bailouts 8* Purchases of Agency debt/MBS 9* Purchases of long-term Treasury securities 10* Fiscal stimulus

| Date | 1* | 2* | 3* | 4* | 5* | 6* | 7* | 8* | 9* | 10* | Comment |
|----------|----|----|----|----|----|----|----|----|----|-----|--|
| 20081006 | | | | | 1 | | | | | | TAF expansion. |
| 20081007 | | | | 1 | 1 | | | | | | CPFF creation. TAF expansion. |
| 20081008 | 1 | | | | | | | | | | FOMC statement. |
| 20081009 | | | 1 | | | 1 | | | | | AIG's critical financial situation. FED lends to AIG late on October 8. |
| 20081014 | | | | | | | | | | 1 | Secretary of the Treasury Paulson and President Bush separately announce revisions in the TARP |
| 20081021 | | | | 1 | | | | | | | MMIFF creation |
| 20081029 | 1 | | | | | | | | | | FOMC statement |
| 20081110 | | | 1 | | | 1 | 1 | | | | AIG's critical financial situation. FED and Treasury lend to AIG |
| 20081124 | | | 1 | | | | 1 | | | | The US government agrees to rescue Citigroup after an attack by investors causes the stock price to plummet 60% over the last week. |
| 20081125 | | | | 1 | | | | 1 | | | TALF created. Fed announced purchases of Agency debt and MBS. |
| 20081202 | | | | | 1 | | | | | | Extension of PDCF, AMLF, TSLF up to April 30,2009 |
| 20081216 | 1 | 1 | | | | | | 1 | 1 | | FOMC statement. Interest rate commitment. Fed repeats its intention to buy agency debt and MBS and stands ready to expand the purchase. Fed evaluates the benefits from purchasing longer-term Treasury securities. |
| 20081230 | | | | | | | | 1 | | | Date of purchase of agency debt and agency MBS announced, the purchase plan will be realized in 6 months not several quarters as previously announced |
| 20090116 | | | 1 | | | | 1 | | | | Bailout of the Bank of America. |
| 20090128 | 1 | 1 | | | | | | 1 | 1 | | FOMC statement. Interest rate commitment. Fed repeats its intention to buy Agency debt and MBS and stands ready to expand the purchase. Fed is prepared to buy longer-term Treasury securities. |
| 20090203 | | | | | 1 | | | | | | Extension of facilities until October 30, 2009 instead of April 2009 |
| 20090210 | | | | | 1 | | | 1 | | | Increase of the size of the TALF and expansion of the eligible asset classes. Fed repeats its intention to buy Agency debt and MBS and stands ready to expand the purchase. |
| 20090213 | | | | | | | | | | 1 | American Recovery and Reinvestment Act of 2009 passed in the House and in the Senate |
| 20090217 | | | | | | | | | | 1 | American Recovery and Reinvestment Act of 2009 signed by President Obama |
| 20090302 | | | 1 | | | 1 | 1 | | | | AIG reports the largest quarterly loss in US corporate history in the final three months of 2008. AIG receives rescue package from the US government. The Fed and the Federal Reserve Bank of New York plan to take up to a \$26 billion preferred interest in two AIG life insurance subsidiaries |
| 20090303 | | | | | 1 | | | | | | TALF launched |
| 20090318 | 1 | 1 | | | | | | 1 | 1 | | FOMC statement. Interest rate commitment. Additional purchases of Agency debt and MBS. Fed will buy longer-term Treasury securities. |
| 20090429 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20090624 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20090812 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20090923 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20091104 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20091216 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20100127 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20100316 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20100428 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20100623 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. |
| 20100810 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. The fed announces its plan to reinvest principal payments from agency debts and MBS in longer-term Treasury securities |
| 20100827 | 1 | 1 | | | | | | | | | en Bernanke's speech in which he said that the Fed could increase its purchases of Treasury securities. |
| 20100921 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. The Fed stated that it "was prepared to provide additional accommodation if needed to support the economic recovery", displaying a bias towards easing that was absent from its last policy statement. |
| 20101103 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. The pledge to buy an additional \$600 billion in long-term Treasury bonds by the middle of next year was slightly larger than the median expectation of \$500 billion in a Reuters poll. |
| 20101214 | 1 | 1 | | | | | | | | | FOMC statement. Interest rate commitment. The Fed reiterates its intension to purchase its \$600 billion of longer-term Treasury securities. |

1* FOMC statements 2* Interest rates commitment 3* Failures of important institutions 4* Liquidity facility creation 5* Liquidity facility extension
6* Feds rescue operations 7* Governments bailouts 8* Purchases of Agency debt/MBS 9* Purchases of long-term Treasury securities 10* Fiscal stimulus

Table 2: Interest rate commitment

| Date | Time | Surprise dummy | Comments |
|-------------|-------------|-----------------------|--|
| 16/12/2008 | 14:15 (ET) | 1 | The phrase "the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time" was introduced for the first time. |
| 28/01/2009 | 14:15 (ET) | 0 | Economy had weakened and markets expected the Fed to reiterate the commitment. |
| 18/03/2009 | 14:15 (ET) | 1 | Commitment expected but the Fed introduced of the term "for an extended period" perceived as stronger than the phrase "for some time". |
| 29/04/2009 | 14:15 (ET) | 0 | Economy had weakened, markets expected the Fed to reiterate the commitment |
| 24/06/2009 | 14:15 (ET) | 0 | Economy had weakened, markets expected the Fed to reiterate the commitment |
| 12/08/2008 | 14:15 (ET) | 0 | Economy had weakened, markets expected the Fed to reiterate the commitment |
| 23/09/2009 | 14:15 (ET) | 0.5 | Some economist expected the sign of "exit strategy" |
| 04/11/2009 | 14:15 (ET) | 0.5 | Economy improved |
| 16/12/2009 | 14:15 (ET) | 0.5 | Deceleration in the pace of jobs losses but experts do not think Fed will try to destabilize expectations |
| 27/01/2010 | 14:15 (ET) | 0 | Hoening dissent confirmed some experts expectations about the implementation of exit strategy |
| 16/03/2010 | 14:15 (ET) | 0.5 | No one joint Hoening as some feared, statement was reiterated |
| 28/04/2010 | 14:15 (ET) | 0,5 | Some experts speculated the Fed would indicate a rate increase in the coming months in the statement |
| 23/06/2010 | 14:15 (ET) | 0 | Economy had weakened, markets expected the Fed to reiterate the commitment |
| 10/08/2010 | 14:15 (ET) | 0 | Economy had weakened, markets expected the Fed to reiterate the commitment |
| 21/09/2010 | 14:15 (ET) | 0 | Economy had weakened, markets expected the Fed to reiterate the commitment |
| 03/11/2010 | 14:15 (ET) | 0 | Economy had weakened, markets expected the Fed to reiterate the commitment |
| 14/12/2010 | 14:15 (ET) | 0 | Economy had weakened, markets expected the Fed to reiterate the commitment |

Table 3: Longer-term Treasury bonds purchases

| Date | Surprise dummy | Comments |
|----------|----------------|--|
| 20081201 | 1 | Ben Bernanke's speech in which he announces that the Fed "could purchase longer-term Treasury securities in substantial quantities". |
| 20081216 | 1 | Fed evaluates the benefits from purchasing longer-term Treasury securities |
| 20090128 | -1 | Fed is prepared to buy longer-term Treasury securities (market participants disappointed as they expected the decision about the purchases : -1) |
| 20090318 | 1 | Fed will buy \$300 billion of longer-term Treasury securities. |
| 20100810 | 1 | Fed will reinvest principal payments from agency debts and MBS in longer-term Treasury securities. |
| 20100827 | 1 | Ben Bernanke's speech in which he said that the Fed could increase its purchases of Treasury securities. |
| 20100921 | 1 | Fed stated that it "was prepared to provide additional accommodation if needed to support the economic recovery", displaying a bias towards easing that was absent from its last policy statement. |
| 20101103 | 1 | The pledge to buy an additional \$600 billion in long-term Treasury bonds by the middle of next year was slightly larger than the median expectation of \$500 billion in a Reuters poll. |

Table 4: Agency debt and MBS purchases

| Date | Surprise Dummy | Comments |
|----------|----------------|---|
| 20081125 | 1 | Fed announces purchases of GSE debt up to \$100 billion and MBS backed by GSE up to \$500 billion |
| 20081216 | 0,5 | Fed repeats it's intention to buy agency debt and MBS and stands ready to expand the purchase. |
| 20081230 | 1 | Date of purchase announced, the purchase plan will be realized in 6 months not several quarters as previously announced |
| 20090128 | 0,5 | Fed repeats it's intention to buy agency debt and MBS and stands ready to expand the purchase. |
| 20090210 | 0,5 | Fed repeats it's intention to buy agency debt and MBS and stands ready to expand the purchase |
| 20090318 | 1 | Additional 750 billion of agency MBS and additional purchase 100 \$billion of agency debt. |

Table 5: Liquidity facilities

| Date | Creation | Extension | Surprise Dummy | Comment |
|----------|----------|-----------|----------------|---|
| 20071212 | 1 | 0 | 1 | TAF created |
| 20080307 | 0 | 1 | 1 | TAF's auction amount increased |
| 20080311 | 1 | 0 | 1 | TSLF created |
| 20080317 | 1 | 0 | 1 | PDCF created |
| 20080502 | 0 | 1 | 1 | Expansion of the collateral in Schedule 2 TSLF auctions |
| 20080730 | 0 | 1 | 1 | TAF's maturity extended |
| 20080915 | 0 | 1 | 1 | Important expansion of TSLF and PDCF |
| 20080919 | 1 | 0 | 1 | AMLF created |
| 20080929 | 0 | 1 | 1 | TAF's expansion |
| 20081006 | 0 | 1 | 1 | TAF's expansion |
| 20081007 | 1 | 1 | 1 | CPFF created. TAF's expansion |
| 20081021 | 1 | 0 | 1 | MMIFF created |
| 20081125 | 1 | 0 | 1 | TALF's creation |
| 20081202 | 0 | 1 | 0 | Extension of PDCF, AMLF, TSLF up to April 30, 2009 |
| 20090107 | 0 | 1 | 1 | Expansion of MMIFF |
| 20090203 | 0 | 1 | 0 | Extension of most facilities until October 30, 2009 |
| 20090210 | 0 | 1 | 1 | Increase of the size of the TALF. |
| 20090303 | 0 | 1 | 1 | TALF launched |
| 20090319 | 0 | 1 | 1 | Expansion of TALF |
| 20090501 | 0 | 1 | 1 | Expansion of TALF |
| 20090519 | 0 | 1 | 1 | Expansion of TALF |

Table 6: Federal Reserve's rescue operations

| Date | Dummy | Comment |
|----------|-------|---|
| 20080314 | 1 | Federal Reserve Bank of NY extends credit to JPMC to provide nonrecourse loan to Bear Stearns. |
| 20080317 | 1 | Fed grants a loan to JPMC for acquiring Bear Stearns. (Announced on Sunday September 16). |
| 20080714 | 1 | Board grants Federal Reserve Bank of New York the authority to lend to Fannie Mae and Freddie Mac should such lending be necessary |
| 20080917 | 1 | Fed bailouts AIG (announced on September 16 late in the evening). |
| 20080922 | 1 | The U.S. Fed agreed to convert Morgan Stanley and Goldman Sachs Group into traditional bank holding companies and extended credit to their subsidiaries (announced on Sunday, September 21) |
| 20081009 | 1 | FED lends to AIG late on October 8. |
| 20081110 | 1 | FED and Treasury lend to AIG |
| 20090302 | 1 | The Fed and the Federal Reserve Bank of New York plan to take up to a \$26 billion preferred interest in two AIG life insurance subsidiaries. |

Table 7: Fiscal stimulus announcements

| Date | Surprise Dummy | Comment |
|----------|----------------|---|
| 20071206 | 1 | President Bush unveils the plan to ease pressure on the mortgage market |
| 20080129 | 1 | Economic Stimulus Act of 2008 was passed by the U.S. House of Representatives |
| 20080207 | 1 | Economic Stimulus Act of 2008 approved by the Senate |
| 20080213 | 0 | President Bush signs the Economic Stimulus Act of 2008 |
| 20080723 | 1 | The Housing and Economic Recovery Act was passed by Congress |
| 20080728 | 1 | The Housing and Economic Recovery Act was passed by Congress on Saturday July 26, 2008 |
| 20080730 | 0 | President Bush signs into law the Housing and Economic Recovery Act of 2008. |
| 20080919 | 1 | Paulson financial rescue plan is unveiled (Emergency Economic Stabilization Act of 2008) |
| 20081002 | 1 | Emergency Economic Stabilization Act of 2008 passes in Senate late on October 1, 2008 |
| 20081003 | 1 | Emergency Economic Stabilization Act was passed by the House of Representatives and President George W. Bush signed it into law. |
| 20081014 | 1 | Secretary of the Treasury Paulson and President Bush separately announced revisions in the TARP program |
| 20090210 | 1 | American Recovery and Reinvestment Act of 2009 passed in the Senate |
| 20090213 | 1 | American Recovery and Reinvestment Act of 2009 passed in the House and in the Senate late on Friday February 13, 2009 |
| 20090217 | 0 | American Recovery and Reinvestment Act of 2009 signed by President Obama |
| 20101215 | 1 | Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010. The Senate passed the legislation on \$858 billion tax-cut plan |
| 20101217 | 1 | Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010. House voted 277-148 for final passage on the tax-cut agreement vote late on December 16, 2010 and President Obama signs it into law on December 17, 2010. |

Table 8: Government's recapitalization

| Date | Dummy | Comment |
|----------|-------|--|
| 20080714 | 1 | Treasury increases the credit line for Freddie Mac and Fannie Mae. |
| 20080908 | 1 | Fannie Mae and Freddie Mac placed into conservatorship of the FHFA |
| 20080929 | 1 | Acquisition of Wachovia by Citigroup is facilitated by the FDIC |
| 20081110 | 1 | FED and Treasury lend to AIG |
| 20081124 | 1 | The US government agrees to rescue Citigroup |
| 20090116 | 1 | Bailout of Bank of America. |
| 20090302 | 1 | AIG is to receive an extra \$30bn from the US government |

Table 9: Failures of important financial institutions

| Date | Dummy | Comment |
|----------|-------|--|
| 20070809 | 1 | BNP Paribas suspends three investment funds |
| 20080314 | 1 | Bear Stearns Shares decline by 47%. |
| 20080317 | 1 | Bear Stearn's failure. (news on September 16 SUNDAY). |
| 20080711 | 1 | Bed news about GSE/ talks about GSE' nationalization |
| 20080714 | 1 | Indymac Bank's failure on July 11 in the evening (Friday). |
| 20080908 | 1 | Fannie Mae and Freddie Mac nationalized |
| 20080915 | 1 | Lehman Brothers collapsed. Announcement made on September 14, SUNDAY. |
| 20080916 | 1 | Moody's and Standard and Poor's downgrade ratings on AIG's credit. |
| 20080917 | 1 | Failure of AIG (September 16 late in the evening). |
| 20080925 | 1 | Washington Mutual's failure |
| 20080929 | 1 | Emergency Economic Stabilization Act is defeated 228-205 in the House of Representatives + Wachovia's failure. |
| 20081009 | 1 | AIG's critical financial situation. FED lends to AIG late on October 8. |
| 20081110 | 1 | AIG's critical financial situation. FED and Treasury lend to AIG. |
| 20081124 | 1 | Citigroups stock price declined by 60% over the week |
| 20090116 | 1 | Bailout Bank of America. |
| 20090302 | 1 | AIG reports the largest quarterly loss in US corporate history of \$61.7bn in the final three months of 2008. |

Table 10: Impact of monetary and fiscal announcements on 3-month Libor-OIS spread

| | 3-month Libor-OIS spread |
|--|--------------------------|
| FOMC rate decisions | -0.03 [0.78] |
| Failures of important financial institutions | 0.29*** [0.00] |
| Fed's rescue operations | -0.01 [0.85] |
| Agency debt and MBS | 0.03 [0.51] |
| Long-term Treasury bonds purchases | -0.02 [0.22] |
| Government's recapitalizations/ bailouts | -0.25*** [0.00] |
| Fiscal stimulus | 0.02 [0.53] |
| Interest rate commitment | -0.07* [0.10] |
| TAF creation and extensions | 0.10 [0.14] |
| Other liquidity facilities | -0.09** [0.02] |
| Constant | -0.00 [0.32] |
| Observations | 1,851 |
| R-squared | 0.12 |

Robust pval in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 11: Impact of monetary and fiscal announcements on 10-year nominal rates: before QE2

| | 10-year nominal rates |
|--|-----------------------|
| FOMC rate decisions | 0.18*** [0.00] |
| Failures of important financial institutions | -0.01 [0.83] |
| Fed's rescue operations | -0.01 [0.86] |
| Agency debt and MBS purchases | -0.17*** [0.00] |
| Long-term Treasury bonds purchases | -0.22*** [0.00] |
| Government's recapitalizations/ bailouts | -0.03 [0.63] |
| Fiscal stimulus | 0.05 [0.10] |
| Interest rate commitment | 0.01 [0.83] |
| Liquidity facilities | -0.02 [0.47] |
| Constant | 0.00 [0.77] |
| Observations | 3,013 |
| R-squared | 0.05 |

Robust pval in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 12: Impact of monetary and fiscal announcements on 10-year nominal rates:including QE2

| | 10-year nominal rates |
|--|-----------------------|
| FOMC rate decisions | 0.19*** [0.00] |
| Failures of important financial institutions | -0.01 [0.83] |
| Fed's rescue operations | -0.01 [0.86] |
| Agency debt and MBS purchases | -0.17*** [0.00] |
| Long-term Treasury bonds purchases | -0.10** [0.05] |
| Government's recapitalizations/ bailouts | -0.03 [0.63] |
| Fiscal stimulus | 0.04 [0.16] |
| Interest rate commitment | -0.07 [0.22] |
| Liquidity facilities | -0.02 [0.49] |
| Constant | 0.00 [0.57] |
| Observations | 3,122 |
| R-squared | 0.04 |

Robust pval in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 13: Impact of monetary and fiscal announcements on 10-year nominal rates: since QE2

| | 10-year nominal rates |
|------------------------------------|-----------------------|
| FOMC rate decisions | 0.65 |
| | [0.40] |
| Long-term Treasury bonds purchases | -0.01 |
| | [0.84] |
| Fiscal stimulus | -0.02 |
| | [0.73] |
| Interest rate commitment | 0.03 |
| | [0.42] |
| Constant | -0.00 |
| | [0.85] |
| Observations | 362 |

Robust pval in brackets
 *** p<0.01, ** p<0.05, * p<0.1

Table 14: Impact of monetary and fiscal announcements on Factor 2 and Factor 3: before QE2

| | Factor 2 | Factor 3 |
|--|------------------|--------------------|
| Failures of important financial institutions | -0.07* [0.08] | 0.04 [0.27] |
| Fed's rescue operations | 0.01 [0.78] | -0.01 [0.85] |
| Agency debt and MBS purchases | -0.02 [0.20] | -0.16*** [0.00] |
| Long-term Treasury bonds purchases | 0.00 [0.88] | -0.22*** [0.00] |
| Government's recapitalizations/ bailouts | 0.05 [0.21] | -0.07 [0.13] |
| Fiscal stimulus | 0.05* [0.08] | 0.02 [0.29] |
| Interest rate commitment | 0.02 [0.45] | -0.00 [0.98] |
| Liquidity Facilities | -0.03 [0.18] | -0.00 [0.87] |
| Constant | 0.00 [0.50] | 0.00 [0.87] |
| Observations | 1,723 | 1,722 |
| R-squared | 0.03 | 0.07 |

Robust pval in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 15: Impact of monetary and fiscal announcements on Factor 2 and Factor 3: including QE2

| | Factor 2 | Factor 3 |
|--|------------------|--------------------|
| Failures of important financial institutions | -0.07* [0.08] | 0.04 [0.27] |
| Fed's rescue operations | 0.01 [0.78] | -0.01 [0.85] |
| Agency debt and MBS purchases | -0.02 [0.21] | -0.16*** [0.00] |
| Long-term Treasury bonds purchases | 0.00 [0.86] | -0.10** [0.04] |
| Government's recapitalizations/ bailouts | 0.05 [0.21] | -0.07 [0.13] |
| Fiscal stimulus | 0.04* [0.08] | 0.01 [0.47] |
| Interest rate commitment | 0.02 [0.41] | -0.08 [0.17] |
| Liquidity Facilities | -0.03 [0.20] | -0.00 [0.90] |
| Constant | 0.00 [0.52] | 0.00 [0.57] |
| Observations | 1,832 | 1,831 |
| R-squared | 0.03 | 0.05 |

Robust pval in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 16: Impact of monetary and fiscal announcements on Factor 2 and Factor 3: since QE2

| | Factor 2 | Factor 3 |
|------------------------------------|-----------------|-----------------|
| Long-term Treasury bonds purchases | 0.00 [0.68] | -0.01 [0.82] |
| Fiscal stimulus | 0.01 [0.41] | -0.02 [0.66] |
| Interest rate commitment | -0.02 [0.11] | 0.05 [0.29] |
| Constant | -0.00 [0.56] | -0.00 [0.90] |
| Observations | 362 | 362 |
| R-squared | 0.01 | 0.00 |

Robust pval in brackets
 *** p<0.01, ** p<0.05, * p<0.1

Table 17: Impact of liquidity and inflation risk premium proxies on far-ahead forward inflation compensation

| | (1) | (2) | (3) |
|--|--------------------|--------------------|--------------------|
| Far-ahead forward inflation compensation | | | |
| VIX | -0.09*** [0.00] | | -0.09*** [0.00] |
| bond | 0.13 [0.58] | 0.04 [0.86] | 0.12 [0.60] |
| Relative liquidity proxy | | -0.30*** [0.00] | -0.30*** [0.00] |
| Constant | 0.00 [0.82] | 0.00 [0.93] | 0.00 [0.81] |
| Observations | 2,760 | 2,760 | 2,760 |
| R-squared | 0.01 | 0.01 | 0.02 |

Robust pval in brackets
 *** p<0.01, ** p<0.05, * p<0.1

Table 18: Impact of monetary and fiscal announcements on far-ahead forward inflation compensation: before QE2

| | |
|--|----------|
| VIX | -0.06*** |
| | [0.00] |
| Relative liquidity proxy | -0.29*** |
| | [0.00] |
| FOMC rate decisions | -0.06* |
| | [0.08] |
| Failures of important financial institutions | -0.04** |
| | [0.04] |
| Fed's rescue operations | 0.05** |
| | [0.04] |
| Agency debt and MBS | 0.04 |
| | [0.47] |
| Long-term Treasury bonds purchases | 0.03 |
| | [0.41] |
| Government's recapitalizations/ bailouts | -0.03 |
| | [0.35] |
| Fiscal stimulus | 0.06* |
| | [0.07] |
| Interest rate commitment | -0.00 |
| | [0.99] |
| Liquidity facilities | -0.01 |
| | [0.67] |
| Constant | 0.00 |
| | [0.91] |
| Observations | 2,897 |
| R-squared | 0.02 |
| Robust pval in brackets *** p<0.01, ** p<0.05, * p<0.1 | |

Table 19: Impact of monetary and fiscal announcements on far-ahead forward inflation compensation: including QE2

| | |
|--|----------|
| VIX | -0.07*** |
| | [0.00] |
| Relative liquidity proxy | -0.29*** |
| | [0.00] |
| FOMC rate decisions | -0.06* |
| | [0.07] |
| Failures of important financial institutions | -0.04** |
| | [0.04] |
| Fed's rescue operations | 0.05** |
| | [0.04] |
| Agency debt and MBS | 0.04 |
| | [0.48] |
| Long-term Treasury bonds purchases | 0.06*** |
| | [0.01] |
| Government's recapitalizations/ bailouts | -0.03 |
| | [0.34] |
| Fiscal stimulus | 0.06** |
| | [0.04] |
| Interest rate commitment | -0.02 |
| | [0.69] |
| Liquidity facilities | -0.01 |
| | [0.69] |
| Constant | 0.00 |
| | [0.86] |
| Observations | 3,001 |
| R-squared | 0.03 |
| Robust pval in brackets *** p<0.01, ** p<0.05, * p<0.1 | |

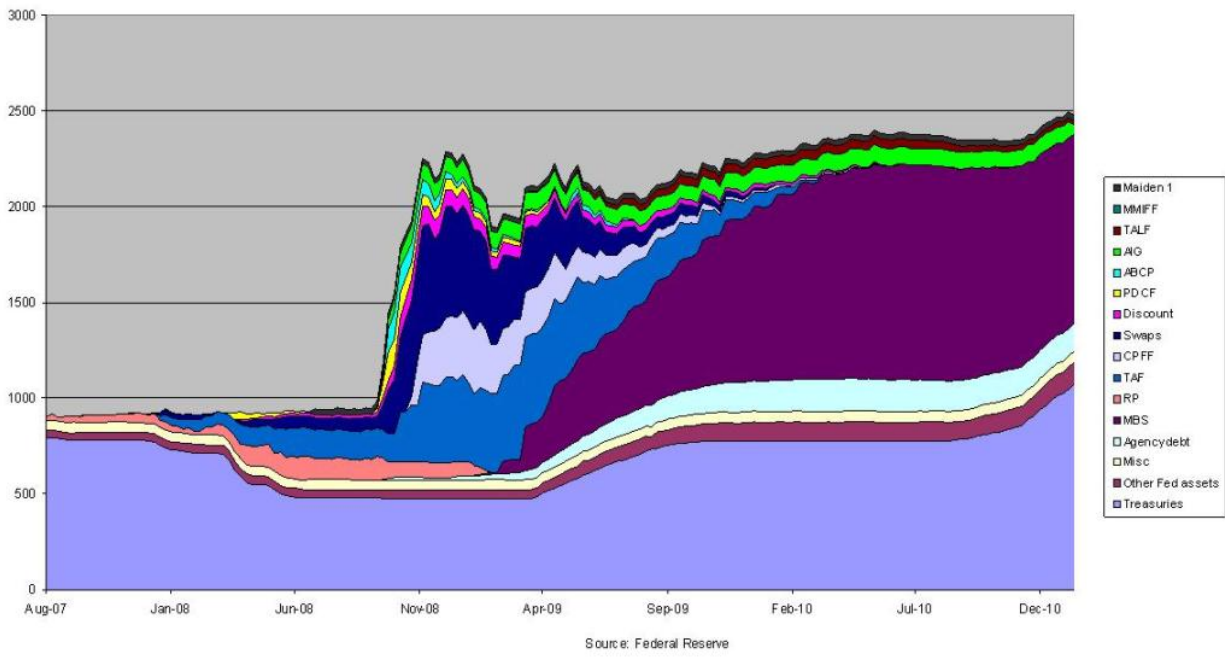


Figure 1: Fed's assets

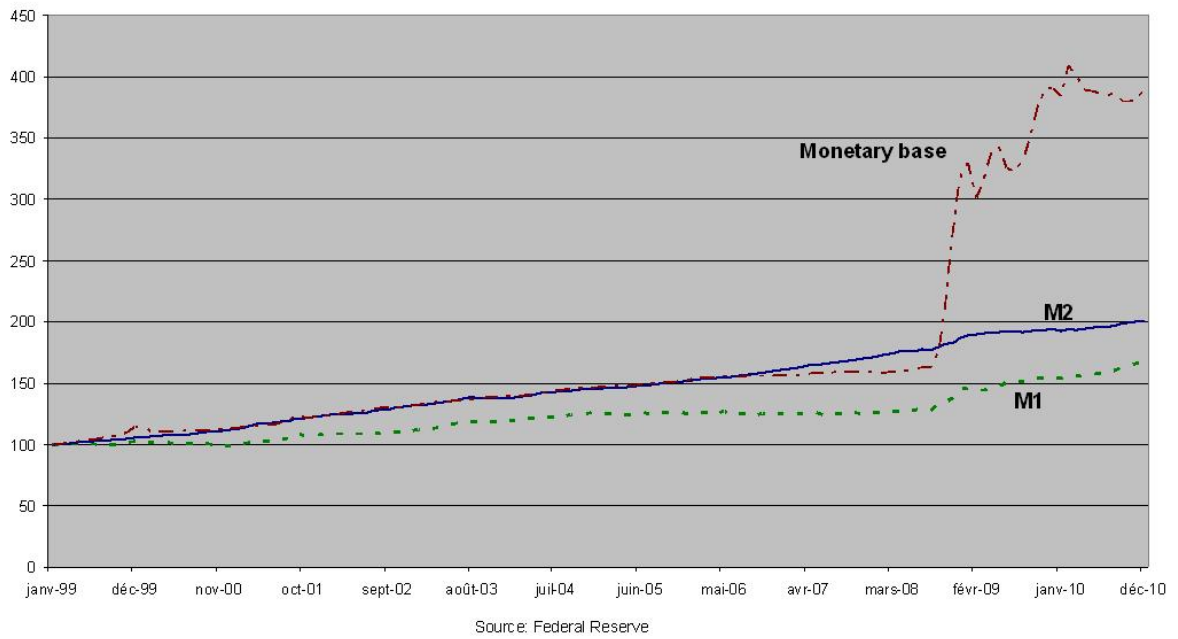


Figure 2: M2, M1 and monetary base in the US

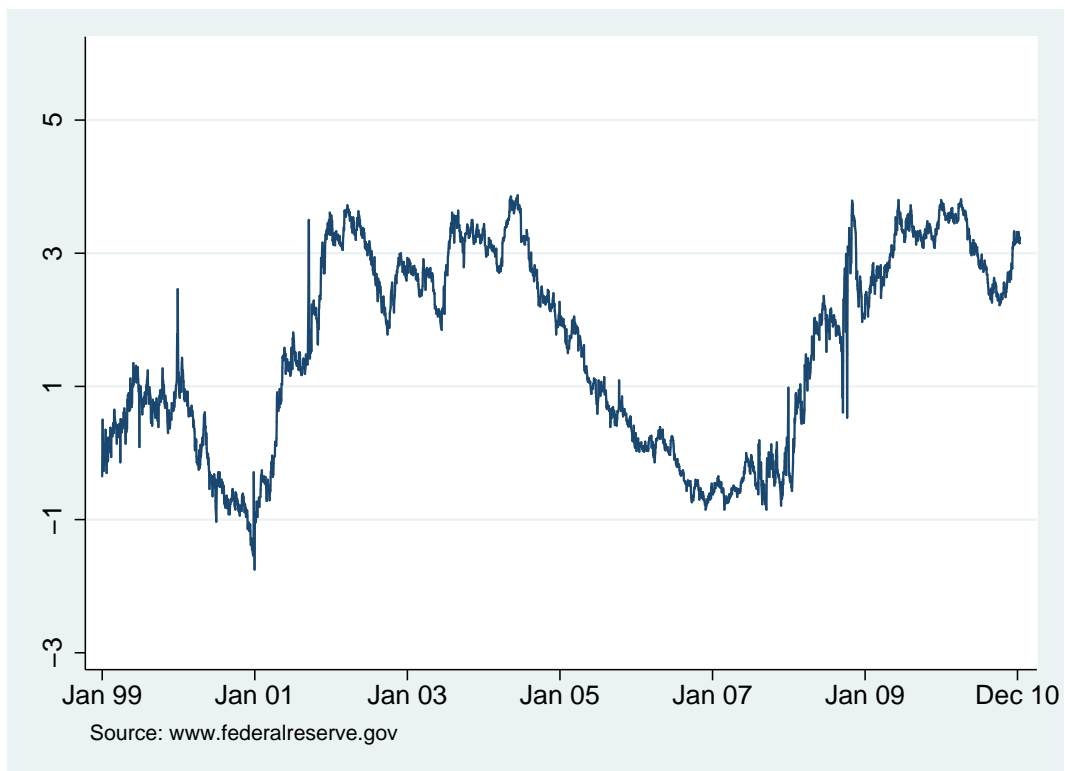


Figure 3: Spread between 10-year Treasury bonds and average Fed Funds

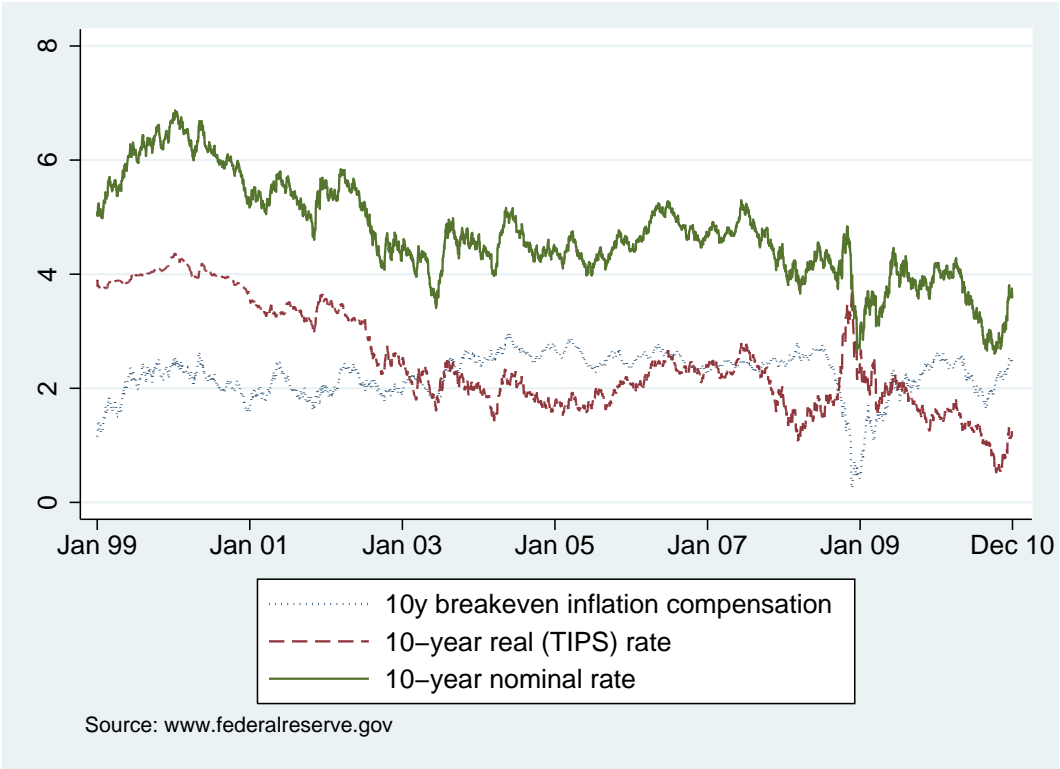


Figure 4: 10-year rates

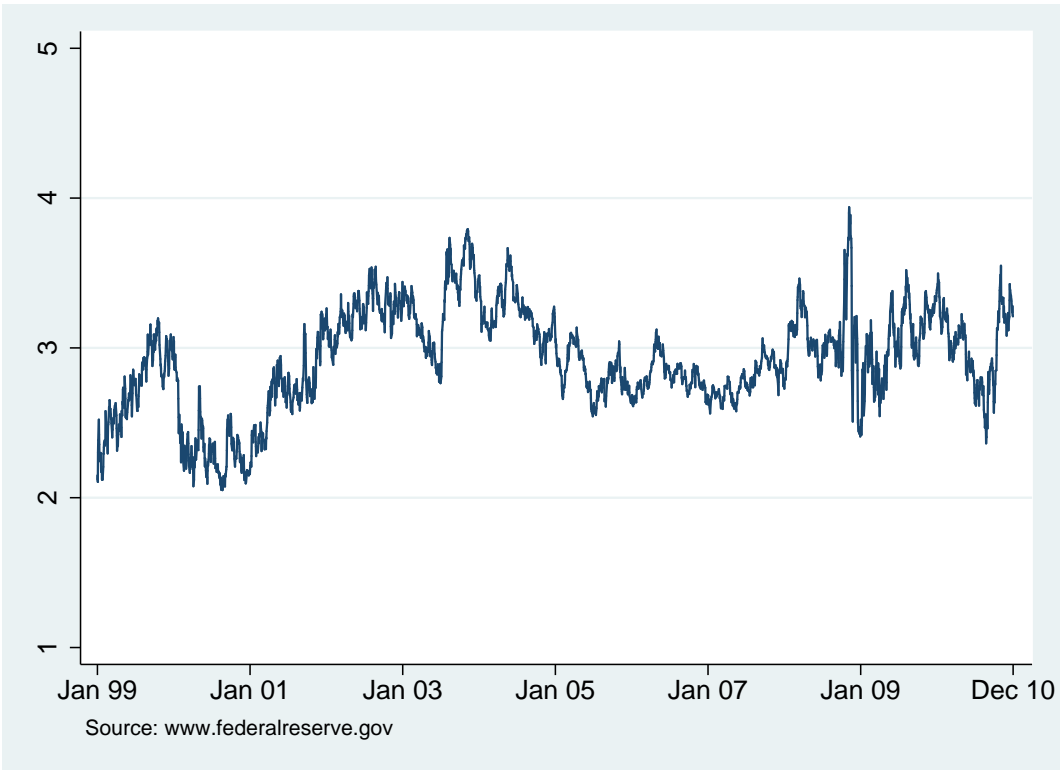


Figure 5: 1-year inflation compensation ending in 10 years

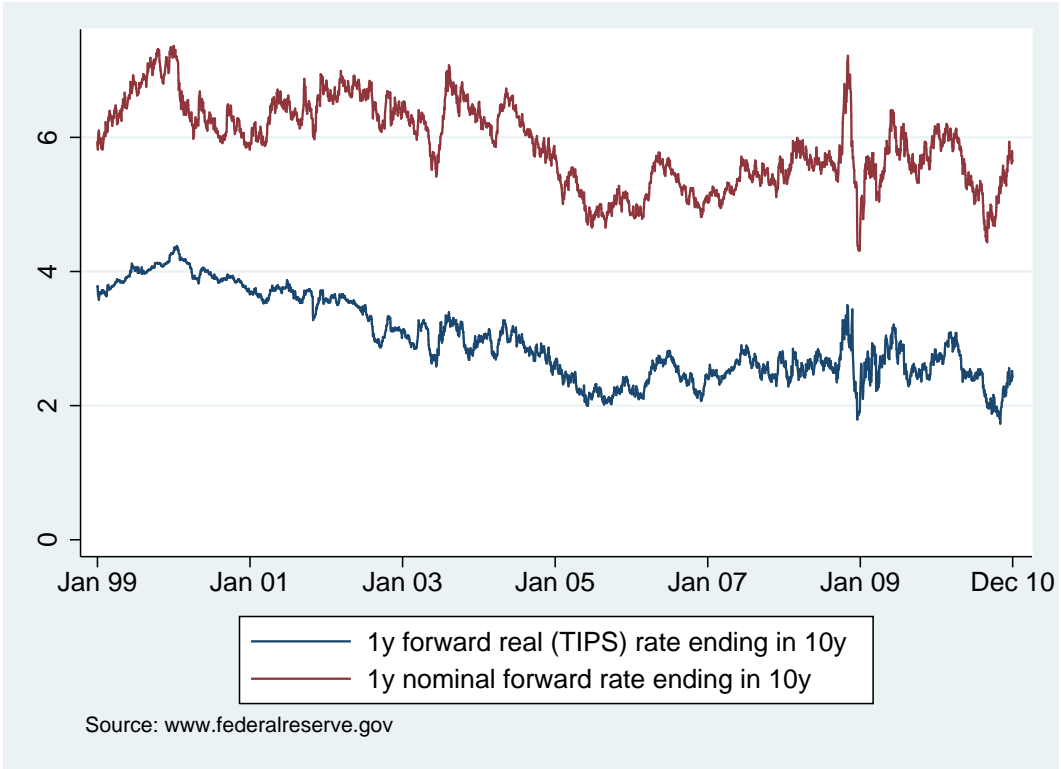


Figure 6: 1-year forward nominal and TIPS rates ending in 10 years

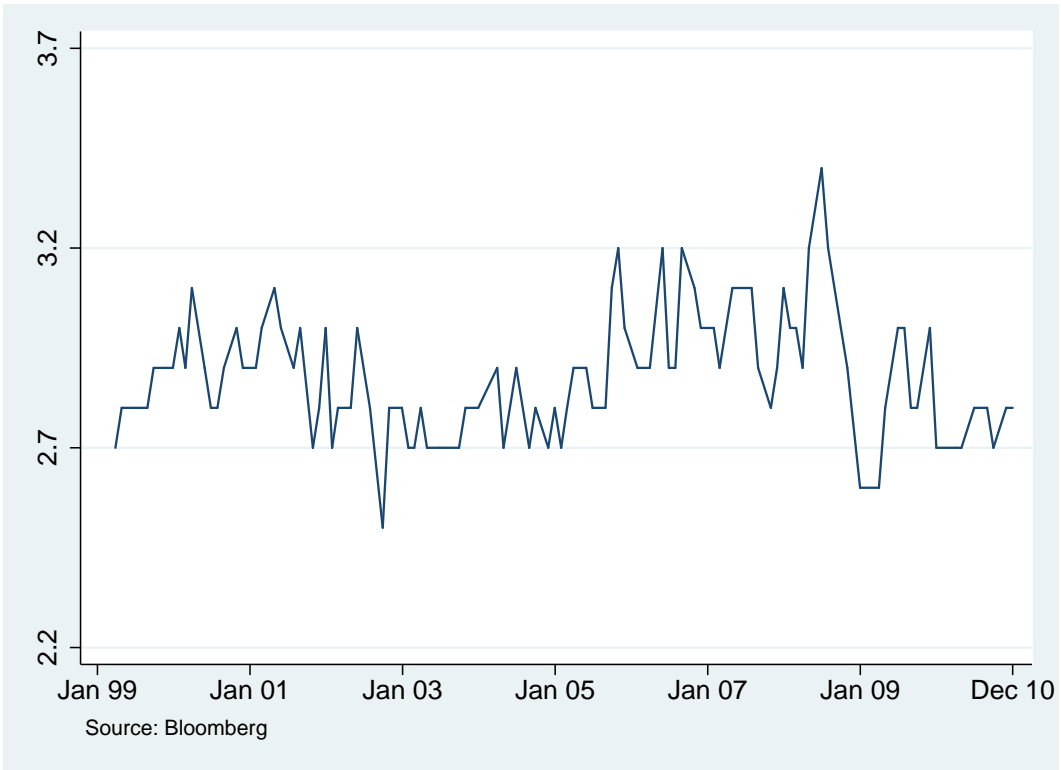


Figure 7: Survey: 5-10 Year Ahead Inflation Expectations

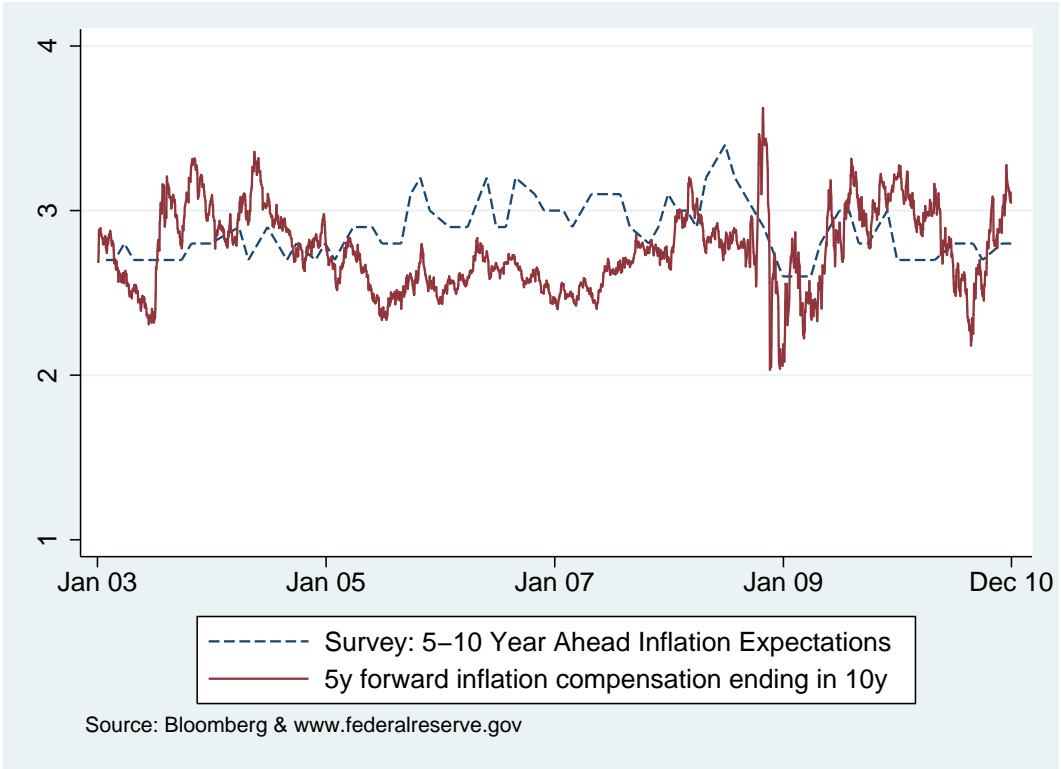


Figure 8: Forward Inflation Compensation and the University of Michigan Survey

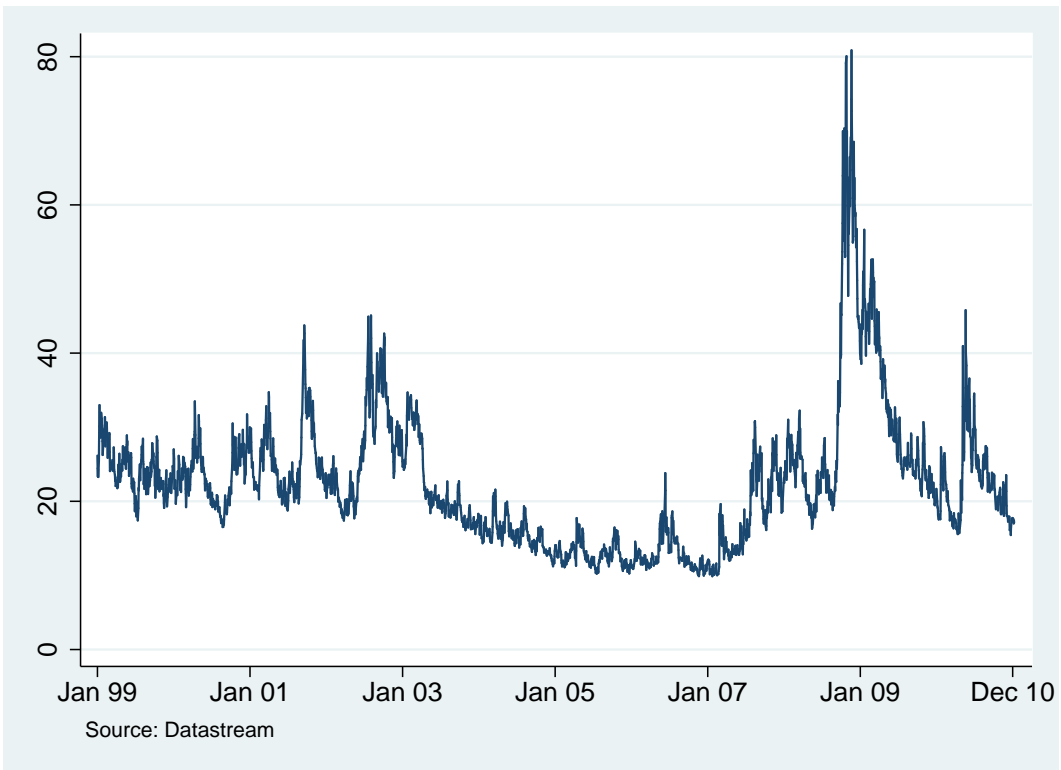


Figure 9: VIX Index

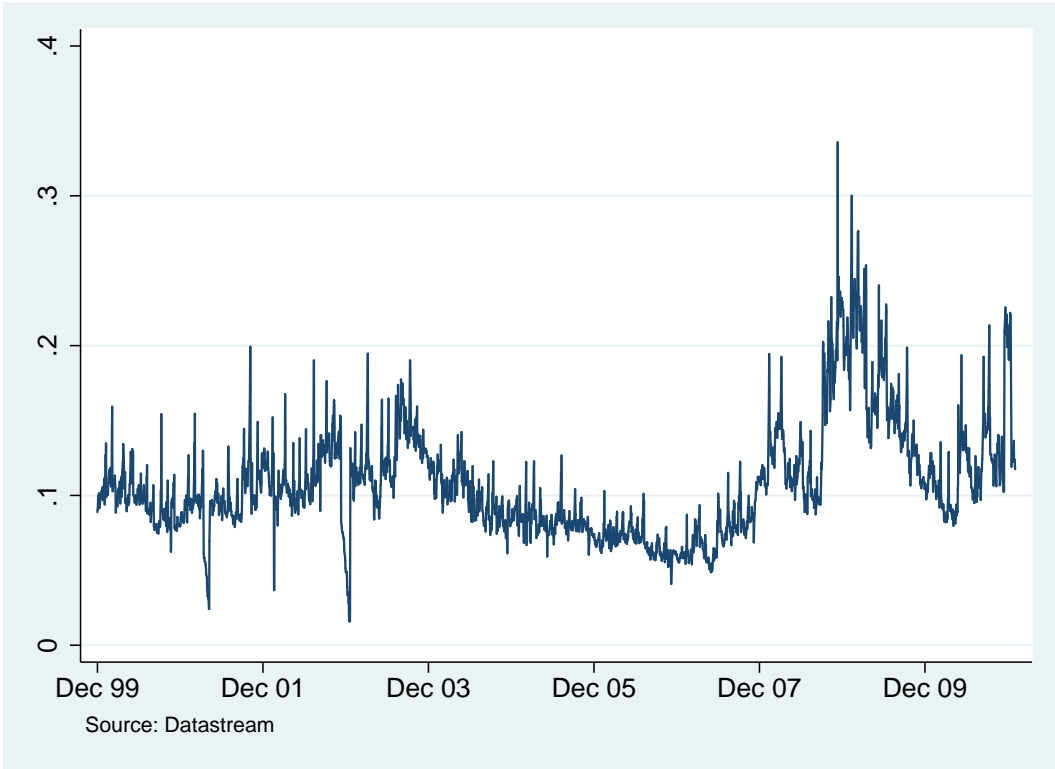


Figure 10: Options on 30-year bonds futures

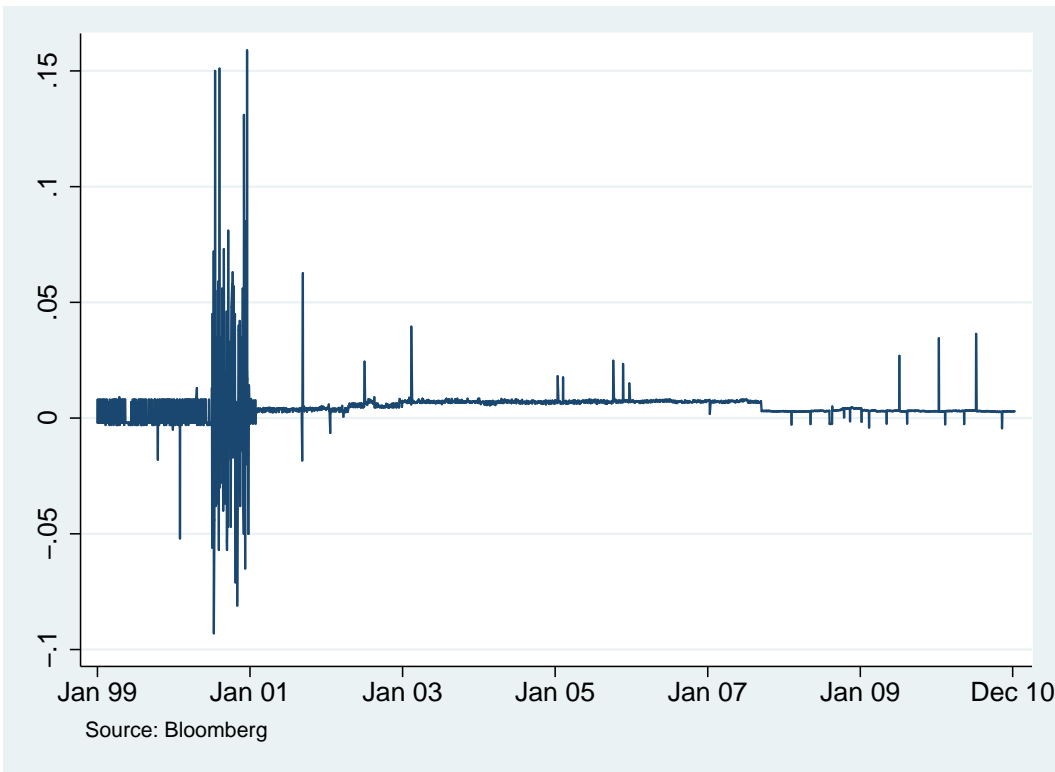


Figure 11: Relative liquidity proxy