Central Bank Balance Sheets and Inflation Expectations

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Introduction

In the three decades preceding the financial crisis of 2008, practitioners and academics achieved a substantial degree of consensus on the intellectual and institutional framework for the practice of central banking. Almost all advanced economies and many emerging markets central banks adopted monetary policy frameworks with price stability as the primary objective and inflation targeting as its technique. These monetary policy frameworks usually have the following two features: central bank independence to achieve price stability together with strong policy accountability, and an operating framework based on a single target rate implemented through market operations[1]. In a vastly simplified description of this framework, central banks act as the "banks for banks" by issuing credit to commercial banks, just as commercial banks issue private money by credit to economic agents. Commercial banks are required by law to keep a certain level of reserves at the central bank in proportion to their liabilities. If they fall short of this requirement, banks can choose to borrow overnight funds from fellow depositary institutions or from the central bank itself at an interest rate. Central banks implement monetary policy by manipulating this short term interest rate, which triggers a chain of events that affect other short-term interest rates, foreign exchange rates, long- term interest rates, the amount of money and credit in the economy, and, ultimately, a range of economic variables, including employment, output, and the prices of goods and services. The widespread adoption of this general policy framework contributed to a marked improvement in macroeconomic performance compared with the 1970s, to the extent that the period up until the financial crisis has been described as the "golden age" of central banking[2]. In addition to bringing inflation back down to levels not seen since the 1950s and early 1960s, monetary policies under this framework were also credited with contributing to an exceptionally long period of stable economic growth. The

[1] IMF, Central Banking Lessons from the Crisis, May 2010.
[2] Gerlach, Stefan, Alberto Giovannini, Cédric Tille, and José Viñals, 2009, "Are the Golden Years of Central Banking Over? The Crisis and the Challenges," Geneva Reports on the World Economy 10.

governor of the Bank of England proclaimed in 2005 "We have moved from the Great Inflation to the Great Stability[3]."

The global financial crisis, however, forced central banks into unprecedented interventions in both nature and magnitude. Following the crisis and the downturn in the global economy that started in 2008, central banks responded with a forceful application of their usual policy tools and sharply reduced policy rates. This time, however, banks were unresponsive to the changes and were unwilling to provide more credit to economic agents. This indicates that the usual channel of policy implementation had come to a stall. More importantly, reduction of policy rates could not be continued forever, as nominal interest rates cannot be lowered below zero. As a result central banks were forced to employ unconventional tools, namely forward guidance of ultra-low policy rates over extended policy horizons and large-scale financial market interventions, in particular huge asset purchases. In practice, central banks vowed to keep policy rates low for a certain period of time and to inject large amounts of liquidity into the financial market.

The theoretical support behind these unconventional monetary policies is the quantity theory of money, which in its simplest form states that there is a direct relationship between the quantity of money in an economy and the level of prices of goods and services sold. In equation form, it is expressed as:

$$MV = PT$$

M = Money Supply

V = Velocity of Circulation

P = Average Price Level

T = Real Volume of Transactions of Goods and Services

[3] Mervyn King "Monetary Policy: Practice Ahead of Theory", at the Mais Lecture, Cass Business School, London May 2005.

In practice, the velocity of money, a measure of the rate at which money in circulation is used for purchasing goods and service, was usually thought to be stable. It has in fact steadily decreased, as shown in figure one below.

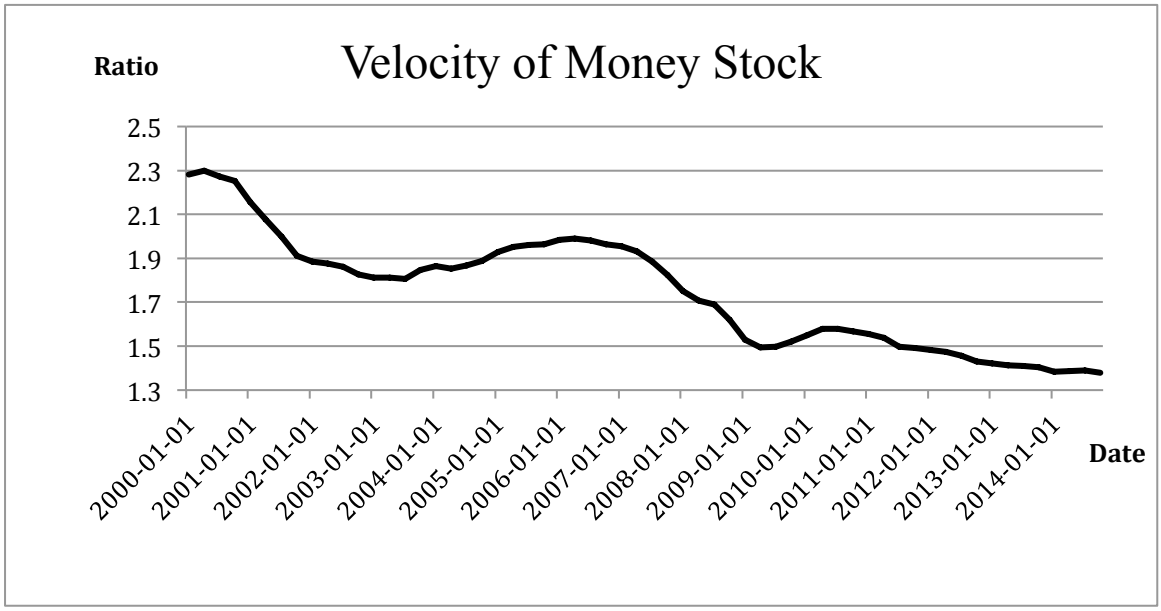

Figure 1 Velocity of Money Stock

Uncertainty and risk during the financial crisis broke down V, the velocity of circulation, leading to a decrease on the right hand side of the quantity theory model. Faced with this dilemma, central banks sought to increase the money supply by injecting large amounts of liquidity into the market in order to raise P and T, the price and volume of goods and services. Most advanced economy central banks cut policy interest rates to historical lows and several committed, at least conditionally, to maintaining them at these levels for prolonged periods. All advanced economy central banks provided large amounts of liquidity and many extended the duration of fund-supplying operations and eased access to liquidity by expanding eligible collateral. At the time of their introduction, these measures were understood to be extraordinary actions to address unique pathologies and to prevent them from spreading rapidly around the globe.[4] It is thus a fair question to ask how successful these measures have

[4] Hervé Hannoun, "Monetary policy in the crisis:testing the limits of monetary policy", 47th SEACEN Governors' Conference,Seoul, Korea, February 2012.

been in achieving the central bank's aim. This paper focuses on data from a central bank's balance sheet – in particular, large-scale asset purchasing programs – and attempts to evaluate how successful banks are in anchoring inflation expectations.

Literature Review

The key points of central banking and its policy background can be found in Alan S. Blinder's "Central Banking in Theory and Practice" in which the author summarizes the consensus policy-making framework of central banking prior to the financial crisis. A great overview on how this practice changed is Ben Bernanke's speech "The Effects of the Great Recession on Central Bank Doctrine and Practice." Although only a few years have passed since banks started implementing unconventional monetary policies, there is already a substantial amount of work evaluating their effectiveness. This policy has its fair share of both proponents and critics. Curdia and Woodford argued in their 2011 paper that quantitative easing in the strict sense is likely to be ineffective, but that targeted asset purchases by a central bank can instead be effective when financial markets are sufficiently disrupted and most likely to improve welfare at the interest rate zero lower bound. On the other hand, Hofman and Zhu used data from the Federal Reserve and the Bank of England to show that while asset-purchasing programs are important, their quantitative importance is uncertain. They argue that while short- and longer-term inflation expectation measures displayed sizeable upward movements towards pre-crisis levels during the implementation of asset purchase programs, the reaction of inflation swap rates on the days of program announcements suggests that central bank asset purchases were probably not the main driver of these shifts. Other critics, such as Thornton (2012) and Krishnamurthy (2012) have also voiced their concern that these programs entail significant risks to price stability and hence of inflation expectations through their potential to trigger a massive increase in money supply.

Data

A central bank's mandate usually includes price stability. The Federal Reserve's mandate states its goals of "maximum employment, stable prices and moderate long-term interest rates." The Bank of England's monetary policy mandate is to "keep prices stable and to maintain confidence in the currency." The European Central Bank's mandate assigns overriding importance to price stability, proclaiming that "without prejudice to the objective of price stability, the ECB shall also support the general economic policies in the Union with a view to contributing to the achievement of the objectives of the Union." Given this emphasis, it is crucial that central banks have a clear definition of what price stability constitutes. In practice, banks use around 2% inflation as a quantitative yardstick of long term price stability, leading to the term "inflation targeting banks." Most central banks, however, have failed to meet this target since the crisis and are taking monetary actions to reach it. The study of how inflation expectations are affected by such dealings is therefore a valid measurement of the successfulness of a central bank's policy.

Asset Purchase Programs

Most Central banks provide exhaustive data on their actions and decision-making process both for credibility and for the signal effect of their decisions. Comprehensive data on asset purchase programs of these central banks can be found on their respective websites. Central banks give reports on the amount of assets they purchased, the composition of their purchases, and how their overall holdings change. Each bank also publishes minutes of their asset purchasing committee meetings, which serve as signals to which direction policy-makers wish to guide the market. I gathered three types of data from official published sources: dates when purchasing plans were made, changes in type of asset purchased, and changes in purchase program magnitude. The figures below illustrate total change in size as well as percentage change in assets.

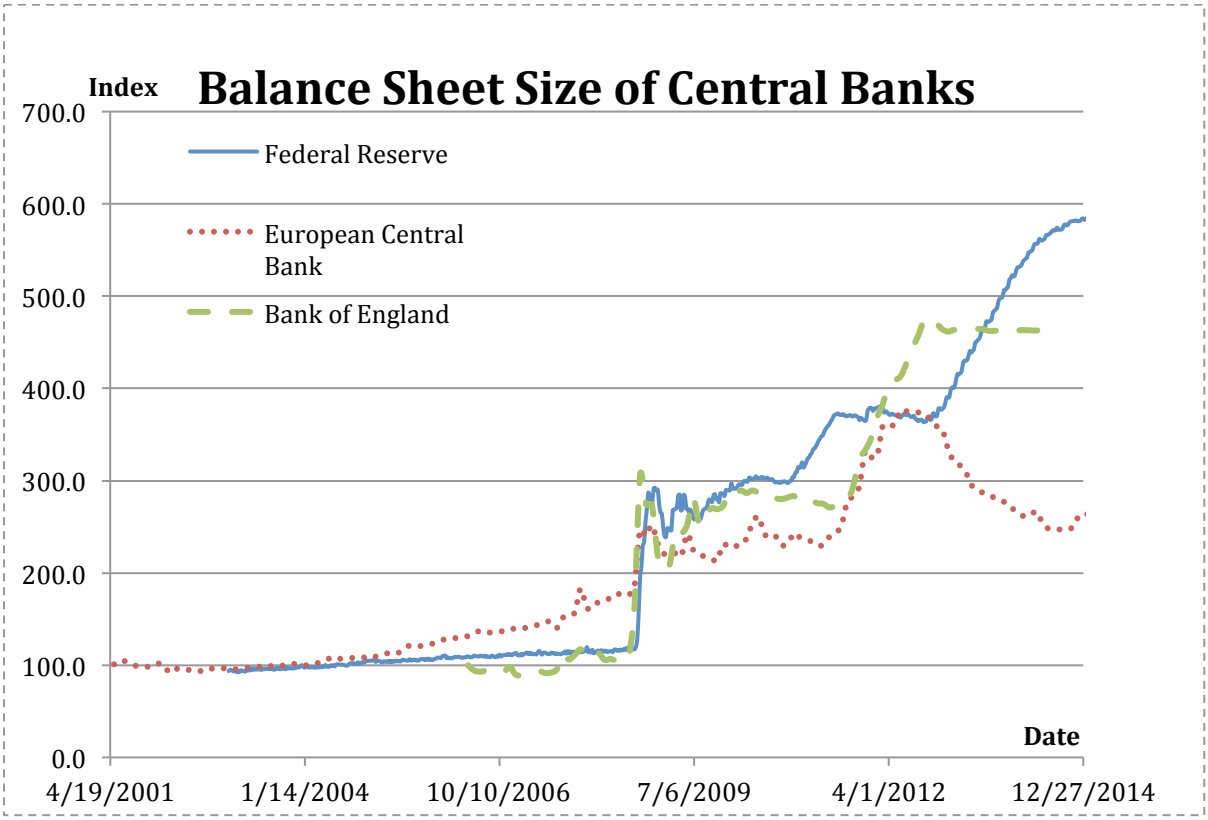

Figure 2 Balance Sheet Size[5]

Figure 1 shows the increase in size of central banks, using Jan 1st 2004 as the base date for the Federal Reserve and European Central Bank and Jan 1st 2006 as the base date for the Bank of England. Balance sheet size on the base date is 100. As we can see from the graph, all three central banks' balance sheet ballooned in late 2009 and continued to grow until 2012. The three graphs below show percentage changes in balance sheet size of each central bank. Each Δ_t is calculated by

$$\Delta_t = \frac{size_t - size_{t-1}}{size_{t-1}}$$

where t is a period of time. Note here that the Federal Reserve data is weekly but the European Central Bank data and Bank of England data is monthly. Therefore t, the time period, is one week for the Federal Reserve figure but one month for the other two.

[5] Source: Board of Governors of the Federal Reserve System, research.stlouisfed.org.

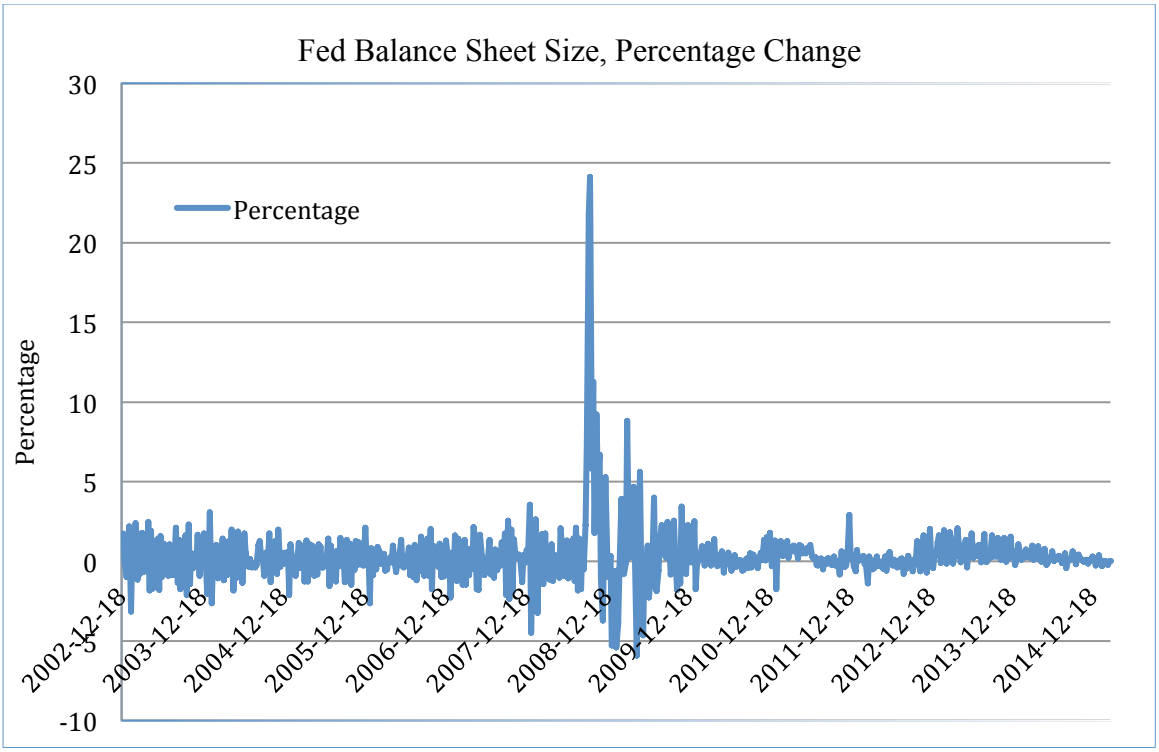

Figure 2 Federal Reserve Balance Sheet Size, percentage change

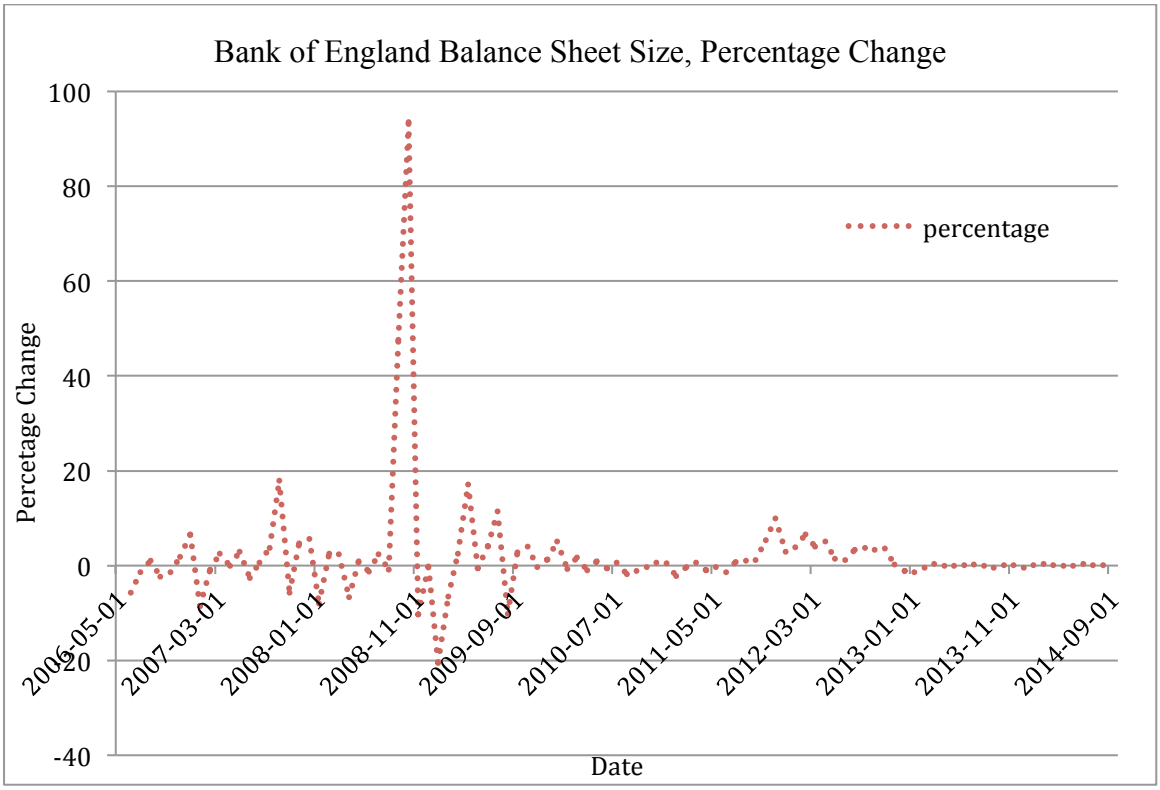

Figure 3 Bank of England Balance Sheet Changes, percentage

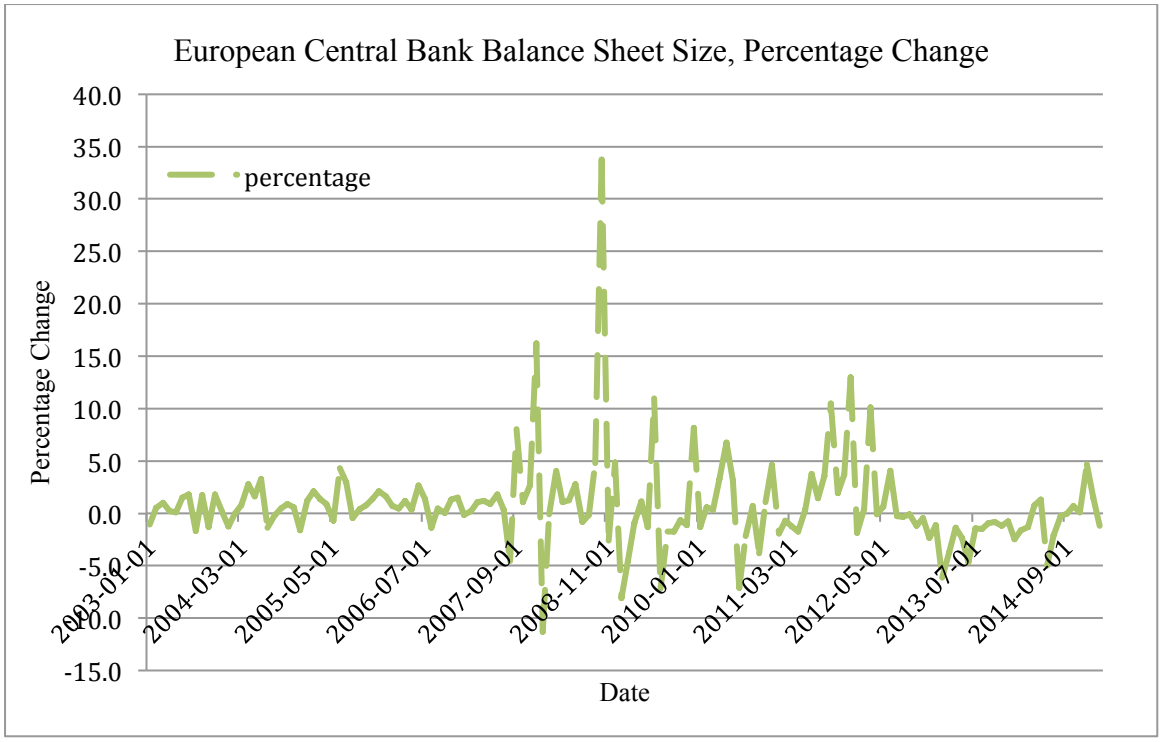

Figure 4 European Central Bank Balance Sheet Change, percentage

Balance sheet data can be found respective central banks' website. Fortunately due to the stress for clarity and openness of the past three decades in central bank policymaking, each bank published meticulous data on their decision-making process and results. Data on percentage size changes was gathered on a weekly basis and matched with the change in weekly inflation expectation changes. Since the other issue of interest is whether composition of a balance sheet would influence market expectation of inflation rates, data on the central banks' balance sheet composition of the highest possible frequency was also collected.

Inflation Expectations

In this study, inflation expectations are calculated using yield curves of inflation-indexed bonds and the Fisher equation. The yield curve is a graph that plots the interest rates, at a set point in time, of bonds having equal credit quality but differing maturity dates. Real interest rates are obtained from the index-linked bond market and nominal interest rates from

the conventional bond market. These nominal rates embody the real interest rate, plus a compensation for the erosion of purchasing power of this investment by inflation. This decomposition and the real and nominal yield curves can be used to calculate the implied expected inflation rate that is factored in to nominal interest rates. The theory behind this relationship between real and nominal interest rate is given by the Fisher equation:

$$r = R - \pi^e$$

where r is the real interest rate, R the nominal interest rate, and π^e the expected inflation rate. For example of calculation, consider the US Treasury Inflation Protected Securities (TIPS), an inflation-indexed security. At a basic level, the yield-to-maturity on a conventional Treasury bond that pays its holder a fixed nominal coupon and principal must compensate the investor for future inflation. Thus, this nominal yield includes two components: the real rate of interest and the inflation compensation over the maturity horizon of the bond. For TIPS, the coupons and principal rise and fall with the CPI, so the yield includes only the real rate of interest. Therefore, the difference, between the two yields reflects the inflation compensation over that maturity horizon. Comparing the yields between conventional Treasury securities and TIPS can provide a useful measure of the market's expectation of future inflation.

This inflation compensation is referred to as the breakeven inflation rate since, if future inflation were at this rate, the realized returns of holding a conventional bond and an inflation-indexed bond would be exactly the same, thus "breaking even." The break-even inflation rate gives a somewhat accurate measure of inflation expectations Here, the inflation data is for five-year bonds, mainly because these are the most readily available.
Inflation expectations are calculated from yield curves for United States and United Kingdom. I used data on Treasury Inflation-Protected Securities (TIPS) for the States and inflation-linked government bonds (gilts) for the UK. Unfortunately, the European central bank does not appear to publish data on inflation linked yield curves; thus my data for ECB is Barclays

Euro Government Inflation-Linked Bond Index (EGILB), which includes capital indexed bonds issued by EU member governments linked to domestic inflation or the harmonized EU HICP index, the Eurozone version of the CPI index. These data provide information on the market's inflation expectation for the future period of the maturity of the bond. Using the Fisher Equation described above, the inflation expectation can be calculated as

$$\pi^e = R - r$$

where π^e is the inflation expectation, R is the nominal interest rate, and r is the real interest rate.[6] Here, R is the yield on a 5-year maturity bond on one specific date, while r is the yield on an inflation-index linked 5-year maturity bond of similar credit quality on the same day. π^e, the difference between R and r, is hence know as the 5-year breakeven inflation rate, i.e. the level of inflation needed for an investor to breakeven between these two investments on that day. It is a measure of what market participants expect inflation to be in the next 5 years. The figures here represent percentage change. Hence each entry is calculated by

$$\Delta_t = Breakeven_t - Breakeven_{t-1}$$

With daily data, t represents one day for each central bank. Thus, Δ_t is a measure of how inflation expectation for the next five year period changed in one day.

[6] This is usually calculated with expected real and nominal interest rates, but here the data is available.

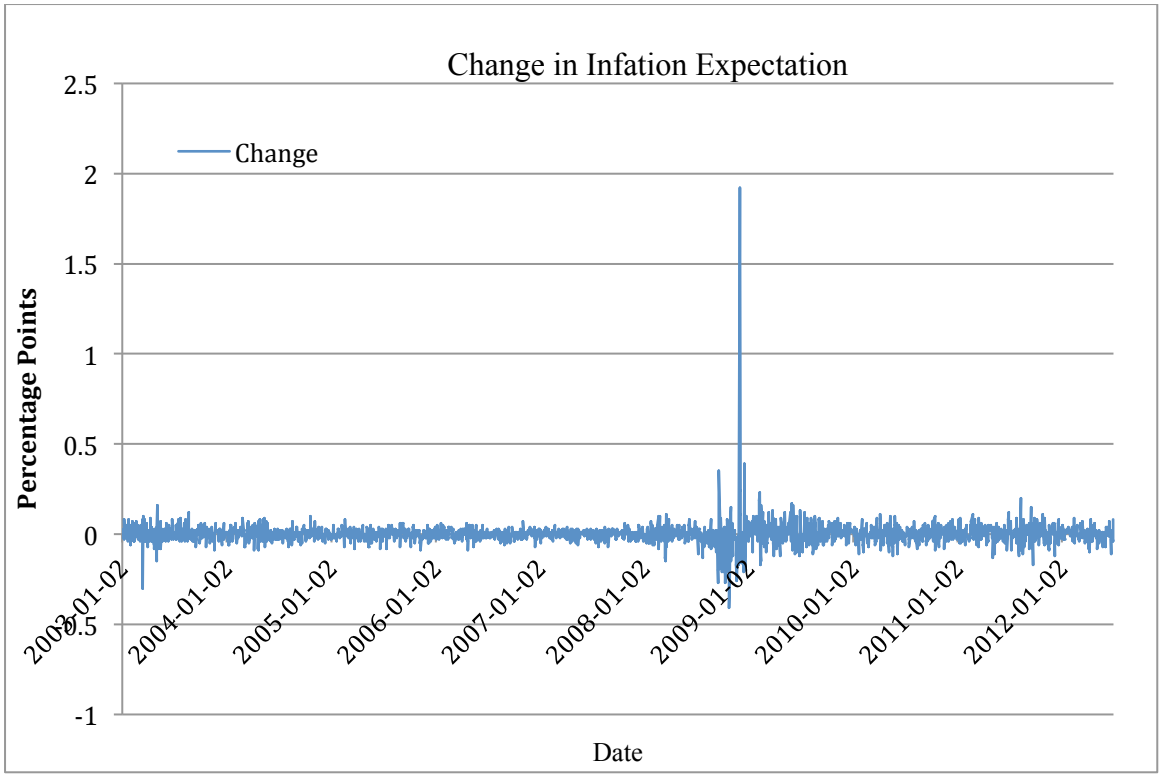

Figure 5 Federal Reserve five-year break-even inflation rate, change

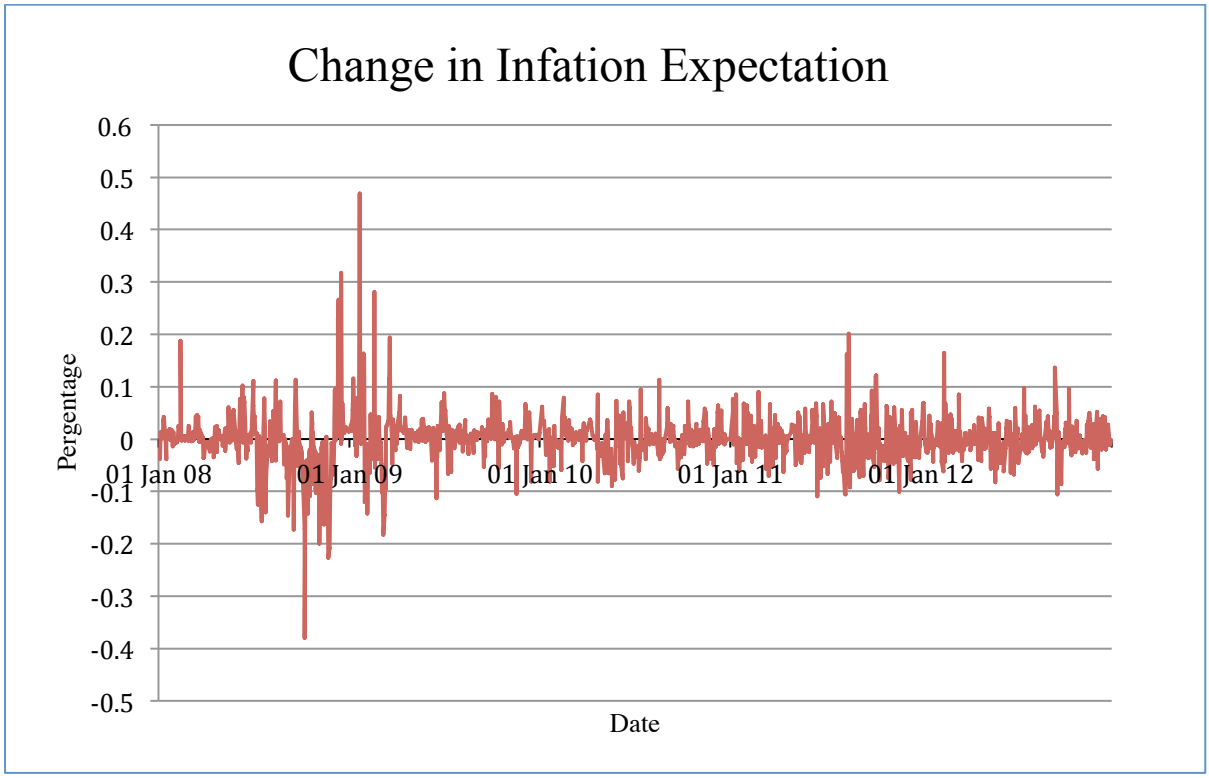

Figure 6 Bank of England five-year break-even inflation rate, change

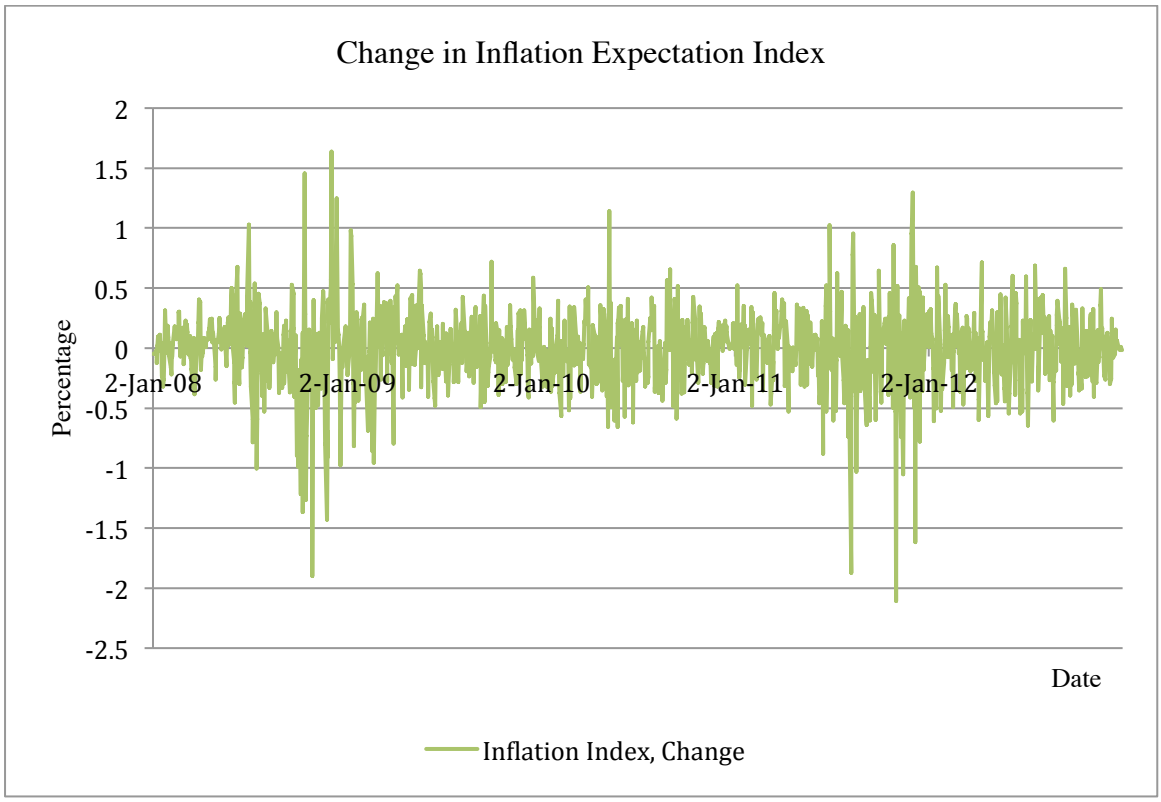

Figure 7 Euro Zone five-year break-even inflation index, change

It is also interesting to see how inflation expectations measure against actual inflation for that period. The figure below plots monthly five-year break-even inflation rates against actual inflation for the United States. We can see from the filled blue line that in January 2003 the five-year break-even inflation rate is around 1.5%. This means that investors expect inflation to be around 1.5% annually for the next five years. The dotted red line is the actual rate of annual inflation over the next five years; in this case, it depicts the average annual rate of inflation during the period January 2003 to January 2008, which is near 2.8%. The red line for real inflation only goes on until February 2011 since we only have real inflation data until February 2015. We can see that real inflation has roughly the same trend as inflation expectation.

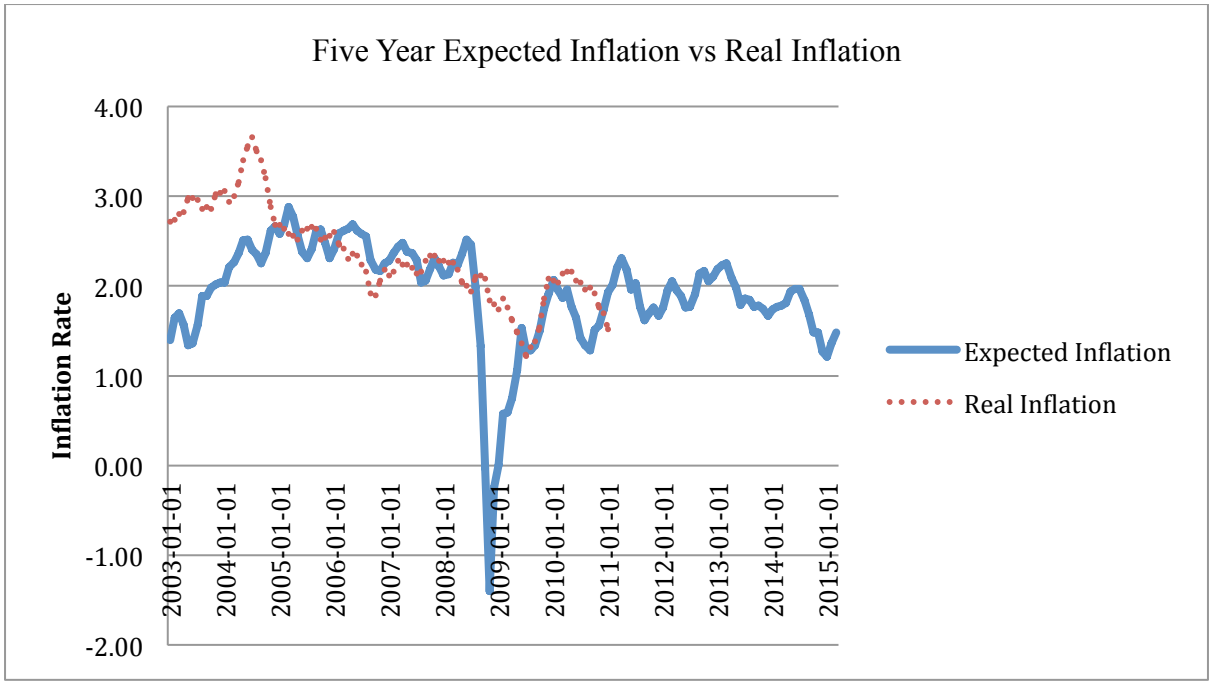

Figure 8 United States Five-year Break-even Inflation Rate vs Real Inflation Rates

Analysis

I. *Does the announcement of a policy change immediately influence expectations?*

I first used the dates of central bank policy announcements to see if there is an instantaneous effect on inflation expectation. To do this, I created a dummy variable for dates when an announcement was made. This means that for each individual announcement date, a dummy variable takes on the value one on the day of the announcement and zero in all other periods. In this way, the model shows the immediate effect of a new asset-purchasing plan. I ran regressions of inflation expectation changes against this dummy variable.

$$\Delta \inf = \alpha + \beta_1 Z + \epsilon$$

Here, Δinf is the change in daily inflation expectation. Z is the dummy variable that takes on 1 when an announcement was on that day and 0 otherwise. This regression uses daily inflation data from January 1st, 2008 to the end of 2011. The results are shown in Table 1.

	Beta	s.d.	T value	P value
Fed Dates	0.0224	0.0129	1.73	0.083
BOE Dates	0.0001	0.0005	0.23	0.817
ECB dates	-0.0048	0.0427	-0.11	0.911

Table 1[7]

This table shows that policy announcement days do not necessarily have a positive correlation with raising inflation expectation. One possible explanation for this result could be that banks have pre-scheduled days for making major policy announcements and that the market had already responded before the announcement. This means that market actors have already taken the fact that a purchasing announcement is in the near future into account when making their decisions, resulting in a less noticeable jump in expectations. Another could simply be that the market was not confident in the central bank's ability to influence that market to the point that it simply did not respond to this stimulus.

What happens, however, if we square the inflation expectation data to see if a policy announcement had any results at all? After all, the effect of a policy announcement is not necessarily positive.

$$\Delta inf^2 = \alpha + \beta_1 Z + \epsilon$$

The results are as shown below:

	Beta	s.d.	T value	P value
Fed dates	-0.0013	0.017	-0.07	0.94
BOE dates	0.0003	0.0008	0.36	0.717
ECB dates	-0.0281	0.0377	-0.75	0.456

Table 2

We can see that the results here are different from the first regression results. Most noticeably the Federal Reserve's beta coefficient changed from positive to slightly negative with a much higher P-value. This suggests that overall policy announcements do not have a large impact on the fluctuation levels of that day's inflation expectations.

[7] In this regression, the Federal Reserve, Bank of England, and European Central Bank daily information data (inflation expectation change and announcement date dummy variable) respectively had 1199, 1049, and 1282 observations.

Another consideration is that there could be a drag in response, since economic agents might not instantaneously act when a policy announcement was made. The table below reports the regression with a drag of one workweek, allowing time for the market to sufficiently respond. Here, the model is again

$$\Delta \inf = \alpha + \beta_1 Z + \epsilon$$

	Beta	s.d.	T value	P value
Fed dates	0.2957	0.02579	1.15	0.253
BOE dates	0.0009	0.0188	0.48	0.631
ECB dates	-0.0055	0.1146	-0.05	0.962

Table 3

and $$\Delta inf^2 = \alpha + \beta_1 Z + \epsilon$$

	Beta	s.d.	T value	P value
Fed dates	-0.0121	0.0212	-0.57	0.568
BOE dates	0.019	0.0089	2.13	0.034
ECB dates	0.5415	0.2213	2.45	0.015

Table 4

except in this case Δinf^2 and $\Delta\ inf$ are weekly inflation expectation changes. Z, as well, can be seen as a variable that takes on 1 when a policy is announced in that week and 0 otherwise. In this case we can see that squaring the inflation expectation makes a significant difference for the Bank of England and European Central Bank results. This tells us that for these two banks, policy announcements have a slightly positive correlation with the magnitude of the inflation expectation changes.

II. *Does balance sheet size influence inflation expectations?*

Having observed no obvious correlation in the previous exercise, this next step then incorporated the increasing size of balance sheets into the regression formula. Fluctuations in balance sheet size are accounted for in percentage changes. The most evident problem here is that daily inflation expectation data from the previously analysis had to be compressed into weekly data, since balance sheet sizes are only reported once per week. This is accomplished

by averaging the change in inflation expectation for each week. Thus the regression equation changed into

$$\Delta \inf = \alpha + \beta_1 Z + \beta_2 X + \epsilon$$

Where X is the percentage change in balance sheet size and Z is still the dummy variable for announcement dates, except in this regression, I gave a specific week the value of 1 if a purchasing announcement was made in that seven-day period. If no such announcements were made, the variable takes on the value 0. The results can be seen in the table below:

		Coefficient	Standard Error	T value	P value
Federal	Announcement date	-0.0143	0.0211	-0.67	0.501
Reserve	Balance sheet size	0.005	0.0028	1.78	0.076
Bank of	Announcement date	0.0182	0.009	2.03	0.044
England	Balance sheet size	-0.0007	0.0009	-0.76	0.446
European	Announcement date	0.5329	0.2208	2.41	0.017
Central Bank	Balance sheet size	0.0647	0.0436	1.48	0.14

Table 4

This time there appears to be a strong correlation between the policy announcement dates of the ECB and BOE with their inflation expectations. There is, however, still no strong result about balance sheet size and inflation expectations, suggesting that the increase in liquidity injection was not sufficient for inflation expectations to rise.

Another attempt was made to measure how the balance sheet size change would affect the magnitude of the inflation expectation changes. Using the same variables as above, we have

$$\Delta inf^2 = \alpha + \beta_1 Z + \beta_2 X + \epsilon$$

the results are shown in table 4 below.

		Beta	s.d	T value	P value
Federal	Announcement date	0.0336	0.0255	1.31	0.19
Reserve	Balance sheet size	-0.0093	0.0034	-2.74	0.007
Bank of	Announcement date	0.0029	0.0186	0.16	0.876
England	Balance sheet size	-0.0061	0.0019	-3.31	0.001
European	Announcement date	-0.0029	0.1147	-0.03	0.98
Central Bank	Balance sheet size	-0.0197	0.0227	-0.87	0.385

Table 4

This gives us much more significant results for the balance sheet size variable of the Federal Reserve and the Bank of England. The numbers here suggest that an increase in balance sheet size by the Fed and the BOE is correlated with a slightly negative change in magnitude of the inflation expectations.

III. *Focusing only on assets purchasing announcements*

Focusing only on the announcement of major assets purchasing programs would perhaps shed more light. There are two reasons for doing so. First of all, assets purchasing programs are a major, even crucial part, of a central bank's arsenal during the financial crisis. These programs have received much media and academic decisions for good reason, since they are the most direct and visible part of a bank's monetary policy. The other reason is that the announcement date of a major asset purchase is relatively more unpredictable than a policy decision announcement date. As asset purchases are neither scheduled nor absolutely required, they can be decided upon and announced at the discretion of the issuing central bank. The following figure shows four major asset purchases of the Fed and how inflation expectation changed over the duration of the program. This graph shows the summed up changes in inflation expectation over each single day of a particular asset purchase announcement. Large Scale Asset-Purchase (LSAP), which went through three rounds in this

time frame; Maturity Extension Program (MEP) in which the Federal Reserve sold or redeemed shorter-term Treasury securities and used the proceeds to buy longer-term Treasury securities. In total, these four programs of asset purchases had 15 announcement dates.

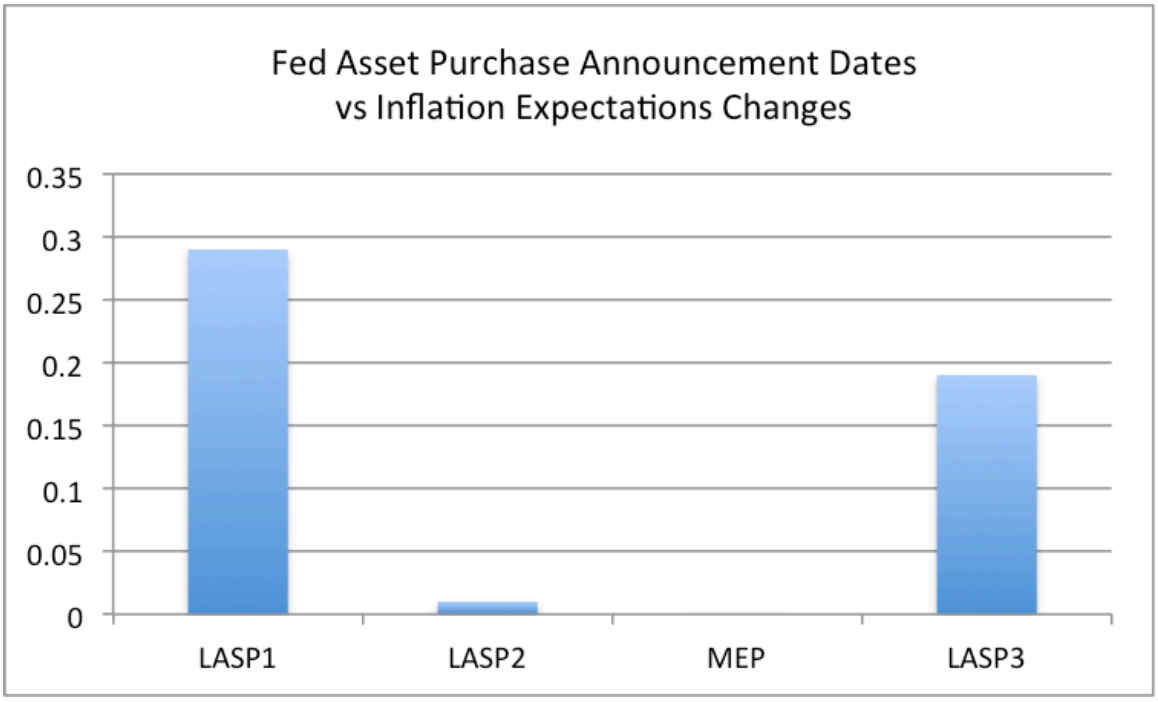

Figure 8

We can see that both LASP1 and 3 had significant positive influence on inflation expectations while LASP2 and MEP did not. Attempts to recreate this exercise for the Bank of England's asset purchasing facility (APF), however, yield less positive. Over the course of its six announcement dates, inflation expectation decreased across the board; in fact, all observations save one experienced a decrease.

IV. *Do different assets affect inflation expectations?*

Broadly speaking, asset purchase programs focus mainly on two types of products: government backed securities and liquidity products targeted at private firms. Banks do this since they want to influence of the risk premia by making public assets purchases, and circumvent the broken credit market by directly purchasing private assets. The ECB, for example, buys both sovereign bonds and covered bonds. For this analysis, the main

composition of each central bank's balance sheet is identified and a simple regression is used to see if any specific component had influence over inflation expectation data.

$$\Delta \inf = \alpha + \beta_i A_i + \gamma X + \epsilon$$

As before, the left hand side is the change in weekly inflation expectation, while the right hand side is various balance sheet components plus the change in balance sheet size. X is the percentage change in balance sheet size. i takes on different values for various balance sheet components. The results are summarized in the table below:

		Coefficient	Standard Error	T value	P value
Federal Reserve	Balance Sheet Size	-0.0036	0.0051	-0.71	0.476
	Treasury Securities	0.0081	0.0066	1.21	0.228
	Mortgages Backed Securities	-0.0001	0.0001	-1.08	0.283
	Maiden Lane	-0.0082	0.0013	0.55	0.582
Bank of England	Balance Sheet Size	-0.0075	0.0027	-2.83	0.005
	Long Term Repo	-0.0002	0.0002	-1.07	0.286
	Market Transactions	-0.0098	0.0051	-1.9	0.058
	Government Securities	0.0054	0.0012	0.86	0.39
European Central Bank	Balance Sheet Size	-0.0217	0.0227	-0.96	0.339
	Loans	-0.0134	0.0147	-0.91	0.363
	MRO	0.0023	0.0035	0.65	0.517
	LTRO	-0.0062	0.0082	0.07	0.946

Table 6

Maiden Lane was a limited liability company created by the Fed to facilitate transactions for the former Bear Stearns and AIG. Long term repo, short for long term repurchasing agreement, is where the BOE sells private entity bonds with the agreement of purchasing them back at a later date for a specific price. Loans in the ECB's balance sheet are mostly loans to commercial banks. The Eurosystem's regular open market operations consist of one-week liquidity-providing operations in euro (main refinancing operations, or MROs) as well as three-month liquidity-providing operations in euro (longer-term refinancing operations, or LTROs). MROs serve to steer short-term interest rates, to manage the liquidity situation and

to signal the monetary policy stance in the euro area, while LTROs provide additional, longer-term refinancing to the financial sector. Here, the negative and significant coefficient for Bank of England balance sheet size concurs with the negative results in III.

What happens if we used the squared inflation expectation? The equation and results are shown below.

$$\Delta inf^2 = \alpha + \beta_i A_i + \gamma X + \epsilon$$

		Coefficient	Standard Error	T value	P value
Federal Reserve	Balance Sheet Size	-0.016	0.0007	-2.27	0.024
	Treasury Securities	0.0014	0.0009	1.57	0.118
	Mortgages Backed Securities	0.00005	0.000017	2.85	0.005
	Maiden Lane	0.0005	0.0018	0.28	0.777
Bank of England	Balance Sheet Size	-0.0029	0.0013	-2.25	0.025
	Long Term Repo	-0.00009	0.0001	0.83	0.405
	Market Transactions	-0.0054	0.0025	2.18	0.030
	Government Securities	0.0013	0.0006	2.14	0.033
European Central Bank	Balance Sheet Size	0.0676	0.0438	1.54	0.124
	Loans	0.0673	0.0283	2.38	0.018
	MRO	-0.0041	0.0068	-0.61	0.544
	LTRO	-0.0022	0.0159	-1.41	0.159

Table 7

Compared with the results in Table 6, we again see that the Fed and BOE have statistically significant results for balance sheet size. For the Federal Reserve, mortgages backed securities have a significant but very small correlation with inflation expectations. The Bank of England has significant results in both market transactions and government securities, while the European Central Bank sees more influence in loans to commercial banks. Note here that these results concern the magnitude that inflation expectations have changed instead of the desired increase.

Conclusion

In a speech dated 2005 before the hell and high water of the financial crisis, then Bank of England governor Mervyn King postulated the "Maradona theory of interest rates." He explained that:

> "The great Argentine footballer, Diego Maradona, is not usually associated with the theory of monetary policy. But his performance against England in the World Cup in Mexico City in June 1986 when he scored twice is a perfect illustration of my point…His second goal, however, was an example of the power of expectations in the modern theory of interest rates. Maradona ran 60 yards from inside his own half beating five players before placing the ball in the English goal. The truly remarkable thing, however, is that, Maradona ran virtually in a straight line. How can you beat five players by running in a straight line? The answer is that the English defenders reacted to what they expected Maradona to do. Because they expected Maradona to move either left or right, he was able to go straight on.
> Monetary policy works in a similar way. Market interest rates react to what the central bank is expected to do. In recent years the Bank of England and other central banks have experienced periods in which they have been able to influence the path of the economy without making large moves in official interest rates. They headed in a straight line for their goals. How was that possible? Because financial markets did not expect interest rates to remain constant. They expected that rates would move either up or down."[8]

In essence, the conventional assumption is that market expectations react to what the central bank is trying to accomplish. Just as Maradona was able to use the expectation of opposition defense to score, central banks have used market expectations to implement their monetary policy. This forward guidance method is the result of thirty-plus years of increasing openness and transparency on the part of central banks, so that markets can better understand and react to central banks' policy signals. It is based on the belief that central banks are in control of the financial situation and are capable of carrying out policies to fulfill their mandated purposes. What happens, however, when this belief is shaken and the channel of influence broken down? As seen in the results above, 5-year inflation expectations are not highly influenced by policy announcements or assets purchasing plans, with the exception of LASP1

[8] *Monetary Policy: Practice Ahead of Theory*. Mervyn King, Governor of the Bank of England, At the Mais Lecture, Cass Business School, London 17 May 2005.

in the United States. Inflation expectations have been low and showed no significant signs of recovery during this period. It seems that central banks have not been effective in raising inflation expectations to their pre-crisis levels.

One major limitation of this study is that it uses breakeven inflation rates as a measure of expected inflation. There are two important caveats in doing so. First, the breakeven inflation rate measures the compensation that conventional bondholders receive for expected inflation and for bearing the risk that realized inflation might deviate from expected inflation. Thus the breakeven inflation rate has two components: expected inflation and the inflation risk premium. Ideally, one would like to subtract the inflation risk premium from the breakeven inflation rate to obtain a "pure" measure of inflation expectations. We can only the changes in the breakeven inflation rate capture the changes in inflation expectations if we assume the inflation risk premium to be fairly stable over a short period of time. Secondly, inflation-indexed bond yields contain a liquidity premium since its market is still relatively small compared to the market for conventional bonds. Therefore, to the extent that inflation-indexed bonds are less liquid than conventional bonds, investors would demand a liquidity premium for holding inflation-indexed bonds over conventional ones. Because the breakeven inflation rate is obtained by comparing the yields on inflation-indexed bonds and similar maturity conventional bonds, the breakeven rate captures not only the inflation compensation but also the liquidity premium demanded by TIPS investors.

To better understand the situation, two more investigations could be made. The first is to look at long run inflation expectations and see how they react to policy or asset purchase announcements. I have not been able to carry out this exercise due to the lack of available data, but its result should be more positive since short run expectations are more influenced by the then dismal financial climate. Studies have shown that long run swap rates are

positively influenced by asset purchases.[9] The second would be to incorporate macroeconomic data of economic conditions into the study. It is not difficult to believe that inflation expectations would be influenced by elements such as unemployment rates, growth rates, or other indicators of economic health.

[9] Hofmann, Boris, and Feng Zhu. "Central bank asset purchases and inflation expectations." BIS Quarterly Review March (2013).

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