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Abstract

In 2008, U.S. demand collapsed and triggered deflation. The U.S. Federal Reserve (Fed) employed large-scale asset purchases (LSAP) to fight deflation. How did news of LSAP affect inflationary expectations? If investors believed that LSAP would raise inflation, they would sell assets exposed to inflation and purchase inflation hedges. This would lower the prices of assets that are exposed to inflation and raise the prices of assets that benefit from inflation. Examining the relationship between asset price changes and inflation sensitivities can thus shed light on how financial markets process LSAP news. The results indicate that initially LSAP announcements lowered expected inflation. Only as inflation approached its target did news of LSAP raise expected inflation.

Keywords: Large-scale asset purchases, Quantitative easing, Inflation expectations, Credibility

JEL classification: E58, G12, E44

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1. Introduction

The 1970s demonstrated that 10 percent inflation can harm the economy by raising risk premia in bond markets (Greenspan, 1993). The 1930s demonstrated that 10 percent deflation can devastate the economy by causing debtors to default and financial institutions to fail (Bernanke, 2002). In late 2008 aggregate demand in the U.S. collapsed, triggering deflation. The Federal Reserve, vigilant about deflation and unable to lower short-term interest rates, turned to large-scale asset purchases (LSAP) to stimulate the economy. The Fed purchased housing agency debt, mortgage-backed securities, and longer-term Treasury bonds. How did these actions affect financial markets and deflationary expectations?

Glick and Leduc (2012) investigated how Fed announcements of LSAP affected asset prices. They collected 10 events, either statements by the Federal Open Market Committee (FOMC) or speeches by Fed Chairman Bernanke, between November 2008 and November 2010. They included five events from the first round of asset purchases (QE1) and five from the second round (QE2). They reported that news of looser monetary policy caused the 10-year Treasury rate, the value of the dollar against several currencies, and the S&P Goldman Sachs Commodity Index to fall. They suggested that a possible explanation for these responses is that LSAP announcements signaled lower future economic growth in the United States.

Gagnon, Raskin, Remache, and Sack (2011) noted that Fed asset purchases reduce the available supply of long duration assets and increase the supply of bank reserves with zero duration. Assuming that longer-term assets and bank reserves are not perfect substitutes, these purchases should reduce the risk premiums on longer-term assets and thus reduce longer-term yields. They examined the response of interest rates using one-day windows around eight important announcements during QE1. They found cumulated interest rate drops of 91 basis points for ten-year Treasury yields, 156 basis points for ten-year agency debt yields, and 113 basis points for

mortgage-backed security yields. They also reported a 57 basis point drop in the ten-year Treasury yield relative to the two-year Treasury yield. Using Kim and Wright's (2005) estimates of the term premium that investors require to hold longer-term assets, they concluded that the drops in long-term Treasury yields primarily reflected declines in the term premium rather than declines in expected future short-term interest rates.

Kozicki, Santor and Suchanek (2015) culled 20 events related to unconventional Fed monetary policy. In addition to announcements during QE1 and QE2, they included events from the third round of LSAP that began in August 2012 (QE3). They found that news of LSAP lowered gold and silver prices during QE1 and QE2 and raised gold and silver prices during QE3. The response was not statistically significant during QE1 and QE2, but was during QE3.

Roache and Rousset (2013) employed what they labeled as the standard event dates for QE1, QE2, and QE3. Their events were primarily FOMC announcements and speeches by Chairman Bernanke. They examined how these events affected asset price risk by employing risk-neutral density functions estimated from options prices. They reported that "tail risk" fell after announcements of unconventional monetary easing by the Fed and concluded that LSAP increased market confidence during times of uncertainty.

In spite of the work cited above, Brainard (2017) observed that there is still much that policymakers do not understand about how large-scale asset purchases affect financial markets and the economy. In contrast, she noted that the effects of short-term interest rates have been extensively investigated.

In one study using short-term rates, Cook and Hahn (1989) found that increases in the federal funds rate target over the September 1974 – September 1979 period raised Treasury rates of all

maturities. Similarly, Kuttner (2001) reported that unexpected increases in the funds rate target over the June 1989 – February 2000 period increased interest rates at all horizons.
Cook and Hahn's (1989) and Kuttner's (2001) results could imply that contractionary monetary policy raises longer-term real interest rates. The nominal interest rate equals the real interest rate plus the expected inflation rate. If contractionary monetary policy lowers expected inflation or leaves it unchanged, then evidence that it increases the nominal interest rate implies that it must be increasing the real interest rate also.

As Romer (2006) discussed, contractionary monetary policy should raise short-term rates because of a liquidity effect and lower long-term rates because it reduces expected inflation. It is thus puzzling that increases in the Federal Reserve's target for the federal funds rate raised interest rates on long-term Treasury securities.

Romer and Romer (2000) offered an alternative explanation for these findings.
They demonstrated that the Fed has more information about future inflation than commercial forecasters do. They also found that Federal Reserve policy actions reveal some of this information (the inflation revelation channel). An increase in the funds rate target could thus raise interest rates by increasing expectations of future inflation.

One way to test whether monetary policy surprises affected inflation expectations differently beginning in the 1980s than in the 1970s is to look at how they impacted daily traded commodity prices. Commodities such as gold and silver are hedges against inflation. Frankel (2008) and others demonstrated that if monetary policy actions are expected to increase real interest rates they will lower commodity prices and if they are expected to increase inflation they will raise commodity prices. Thorbecke and Zhang (2009) reported that funds rate increases in the 1970s raised gold and silver prices and that increases in the later sample period lowered gold

and silver prices. For the 1970s, these results suggest that R&R's explanation is correct. For more recent years, they indicate that funds rate increases affect real rates.

Hardouvelis and Barnhart (1989) investigated the response of commodity prices to money supply announcements over the 1979 to 1982 period. They showed that if the Fed had credibility as an inflation fighter, unexpected positive money supply announcements would lower commodity prices and if the Fed did not have credibility, positive innovations would raise commodity prices. Using a random coefficients Kalman filter model they reported that the response of commodity prices was initially positive and turned negative only in 1981. This indicates that the Fed gradually gained credibility. Hardouvelis and Barnhart also reported that inflation is a state variable that helps explain the time-varying response of commodity prices to policy announcements. This implies that Federal Reserve credibility increases as actual inflation approaches the Fed's desired inflation rate.

This paper investigates how news of unconventional monetary policy affected investors' perceptions of inflation. If investors believed that LSAP would raise inflation, they would sell assets exposed to inflation and purchase assets that hedge against inflation. This would lower the prices of assets that are harmed by inflation and raise the prices of assets that benefit from inflation. Thus examining the relationship between assets' returns and their inflation exposures following LSAP news can shed light on how investors process news of large-scale asset purchases.

To do this, this paper first estimates a multi-factor model with 60 assets and with inflation included as a systematic macroeconomic variable. The results indicate that inflation is a state variable with an associated risk price and that there is wide variation across the assets in their

sensitivities to inflation. Returns on the 60 assets on LSAP event days are then regressed on the assets' inflation betas.

The evidence indicates that the first seven announcements during QE1 did not raise inflationary expectations at all despite the fact that four of them clearly indicated to investors that monetary policy would be much more expansionary. The first five announcements came when the consumer price index was declining, and investors did not trust the Fed's new approach to lift the economy out of deflation. By contrast, during QE3, announcements of LSAP caused inflationary expectations to rise. When news of QE3 arrived in August and September of 2012, the economy had been out of deflation for 24 of the previous 26 months and inflation was close to its target. These positive inflationary outcomes lent credibility to the Fed and its unconventional policies.

The next section presents the data and methodology. Section 3 contains the results. Section 4 concludes and draws policy implications.

2. Data and Methodology

In a multi-factor asset pricing framework the required return on an asset equals the risk-free rate plus the inner product of a vector of factor loadings with a vector of risk premia:

$$Ei = \lambda_0 + \Sigma_j \beta_{ij}\lambda_j \qquad (1)$$

where E_i is the *ex-ante* required return on asset i, λ_0 is the risk-free rate, β_{ij} is the factor loading or beta of asset i to factor j, and λ_j is the risk premium associated with factor j. The *ex-post* return then equals the sum of the *ex-ante* return, a beta-weighted vector of factor innovations, and an error term capturing idiosyncratic risks:

$Ri = \lambda_0 + \Sigma_j \beta_{ij}\lambda_j + \Sigma_j \beta_{ij}f_j + \varepsilon_i$ (2) where f_j represents news about macroeconomic factor j and ε_i is a mean-zero error term.

Following McElroy and Burmeister (1988), equation (2) can be estimated using iterated nonlinear seemingly unrelated regression techniques. This method makes it possible to simultaneously estimate the risk premia and the betas associated with observable macroeconomic factors and to impose the nonlinear cross-equation restrictions that the intercept terms depend on the risk premia. It delivers consistent estimates of the risk premia and the betas.

The left hand side variables are total returns on 60 assets over the January 1973 to December 2015 period. These data are obtained from Datastream and include the assets listed in Table 2. A wide variety of assets are included to increase the cross-sectional variation in expected returns. The returns on one-month Treasury bills, obtained from Duff and Phelps (2016), are subtracted from asset returns to obtain excess returns.

The data on macroeconomic factors follow Chen, Roll, and Ross (1986). They employed the Treasury bond/Treasury bill spread (the horizon premium), the corporate bond/Treasury bond spread (the default premium), the monthly growth rate in industrial production, the change in expected inflation, and unexpected inflation. This paper calculates unexpected inflation in two ways. The preferred specification, following Boudoukh, Richardson, and Whitelaw (1994), comes from the residuals of a regression of inflation on lagged inflation and current and lagged Treasury bill returns. The second specification involves first calculating the expected real return on a one-month Treasury bill using the method of Fama and Gibbons (1984). This is subtracted from the nominal Treasury bill return (known at the beginning of the month) to calculate expected inflation. Unexpected inflation is set equal to the difference between actual inflation and expected inflation. For both specifications, the change in expected inflation is calculated as

the first difference of the expected inflation series. Chen, Roll, and Ross argued that each of the macroeconomic factors that they used, being either the difference between asset returns or very noisy, can be treated as innovations. The data to calculate the systematic factors come from Duff and Phelps (2016).

For LSAP announcement dates, what Roache and Rousset (2013) called the standard event dates for QE1, QE2, and QE3 are employed. These are listed in Table 1.

If investors believed that LSAP would raise inflation, they would respond to news of LSAP by selling assets exposed to inflation and purchasing assets that hedge against inflation. This would lower the prices of assets that are harmed by inflation and raise the prices of assets that benefit from inflation, generating a positive relationship between inflation betas and asset returns as shown in Figure 1a. If investors instead interpreted LSAP news to imply lower inflation, they would buy assets exposed to inflation and sell assets that hedge against inflation. This would raise the prices of assets that are harmed by inflation and lower the prices of assets that benefit from inflation, generating a negative relationship between inflation betas and asset returns as shown in Figure 1b.

Returns on the 60 assets listed in Table 2 are thus regressed on the assets' inflation betas over the 24-hour period bracketing news on each LSAP event listed in Table 1. A positive coefficient implies that investors expected the event to positively impact inflation, and a negative coefficient implies the opposite.

3. Results

Table 2a reports the inflation betas using the preferred measure of unexpected inflation. For gold, silver, and gold mining, the coefficients are 3 or above and highly statistically significant.

This implies that news of a 1 percent unexpected increase in inflation will raise returns on these assets that benefit from inflation by 3 percent or more. There are also 12 assets with negative inflation betas that are significant at at least the 10 percent level. For the asset most exposed to inflation, a 1 percent unexpected increase in inflation will lower returns by 3.56 percent. News of inflation thus has a large impact on many of the assets in Table 2a, and there is huge cross sectional variation in how assets are affected by inflation. This should help to identify the effects of LSAP announcements on inflationary expectations in the cross sectional regressions. Table 2b reports the inflation betas using the other measure of unexpected inflation. The results in Table 2b are similar, except that the negative betas are smaller in absolute value than they are in Table 2a and are not statistically significant.

Table 3 presents estimates of the risk premia. Except for the default premium, all of the risk prices are statistically significant at the 1 percent level. For the risk premium associated with unexpected inflation, the results indicate that the asset most harmed by inflation in Table 2a has to pay an additional return of 0.5 percent per month to compensate for its exposure to inflation. They also imply that the asset that benefits the most from inflation in Table 2a can return 0.5 percent less per month.

Table 4a reports the results from regressing returns for the 60 assets on the assets' inflation betas on LSAP event days using the preferred inflation measure. Table 4b reports these results using the other inflation measure. The results in both cases are similar, and the discussion below focuses on results using the preferred measure. Positive values of the coefficients indicate that investors are seeking to purchase assets that benefit from inflation and sell assets that are harmed by inflation and negative values imply the opposite.

For the first seven events, the coefficients in Table 4a are always negative. This implies that news of LSAP caused investors to expect less inflation. For the first five of these events, Wright (2011) calculated the degree of monetary surprise using interest rate futures and high-frequency data. He found that events 1, 2, 3, and 5 were episodes when the policy was more expansionary than investors expected. The surprise expansionary components were especially strong for events 3 and 5. Swanson (2017), using principal component analysis to investigate the response of markets to LSAP news, reported that the fifth event corresponded to a surprise 5.6 standard deviation expansionary shock.

These events influenced financial markets both by causing them to expect expansionary policies that might raise output and inflation and by indicating that the Fed was expecting lower inflation through the inflation revelation channel highlighted by Romer and Romer (2000). The negative coefficients indicate that markets did not expect LSAP to raise inflation. In the months when events 1, 2, 3, and 5 occurred, the consumer price index was experiencing deflation. The deflation rate when events 1 and 2 were announced was easily the highest the U.S. economy had witnessed over the last 60 years, and was almost 6 standard deviations away from zero. The combination of deflation and untried policy tools left investors unconvinced that the Fed could raise inflation.

For the fourth event, the coefficient in Table 4a equals -0.0078 and is significant at the 1 percent level. This coefficient implies that the assets that benefit the most from inflation in Table 2a fell on average by 2.8 percent and the assets that are most harmed by inflation rose by 2.8 percent. There was thus a large movement out of assets that hedge against inflation and into assets that are harmed by inflation.

According to Wright's calculation, the fourth event was a contractionary surprise to markets. Kozicki *et al.* (2015) reported that this announcement disappointed markets because the FOMC did not announce any concrete purchases. So this event both underwhelmed investors in terms of what the Fed was doing to fight deflation and conveyed news of low inflation through the inflation revelation channel.

The last event of QE1 occurred nine months later, on 11/4/2009. The coefficient in Table 4a is positive and significant at the 1 percent level. As Swanson (2017) noted, the U.S. economy had started to recover by this time. It had also exited from deflation. The announcement that the Fed would complete its purchases of mortgage-backed securities and government-sponsored enterprise debt evidently reassured investors that the inflationary environment was returning to normal. On average the assets most exposed to inflation increased by 1.6 percent on this day and the assets most harmed by inflation fell by 1.6 percent.

For QE2, the last two events in October and November 2010 caused returns on assets that hedge against inflation to fall. The announcements caused the assets that benefit the most from inflation to fall by between 0.8 and 0.9 percent and the assets that are harmed the most to rise by the same amount. Both of these announcements were classified by Wright (2011) as events when monetary policy was more contractionary than expected. This contractionary policy news, combined with forecasts of lower inflation through the inflation revelation channel, caused market participants to revise their perceptions of inflation downwards.

QE3 began two years later, in August and September of 2012. At this point, the U.S. economy had recovered and been out of deflation for 24 of the previous 26 months. The seasonally adjusted annual change in the price index for personal consumption expenditures excluding food and energy equaled 2.1 percent in 2012Q1 and 1.9 percent in 2012Q2, close to

the Fed's target of 2 percent. Both of the QE3 announcements in 2012 caused investors to expect higher inflation. In both cases the news caused returns on assets that are most exposed to inflation in Table 2a to rise by 1.1 percent, and returns on assets most harmed by inflation to fall by 1.1 percent. Monetary policy at this point thus succeeded in raising inflation expectations.

The important implication of these results is that the Fed only slowly gained credibility with unconventional monetary policies. Its credibility grew as actual inflation approached the Fed's inflation target.

4. Conclusion

Brainard (2017) stated that, as the federal funds rate normalizes, the Fed will once again be able to use short-term interest rates as its chief policy instrument. She observed that there may be circumstances where its balance sheet should still be used as a complementary tool. However, she noted that short-term interest rate policies have been more extensively investigated and are far better understood than balance sheet policies. This paper examines how balance sheet policies affect the economy by investigating how news of large-scale asset purchases influence inflation expectations.

The results indicate that even a six standard deviation expansionary surprise did not increase inflationary expectations when the consumer price index was declining. However, after the economy had recovered and inflation had remained positive for a couple of years, news of expansionary monetary policy increased expected inflation. The Fed thus gained credibility after it helped the U.S. economy to navigate through its bout with deflation.

These results shed light on Glick and Leduc's (2012) and Kozicki *et al*.'s (2015) findings. Glick and Leduc (2012) reported that news of looser monetary policy during QE1 and QE2 caused the

10-year Treasury rate, the value of the dollar against several currencies, and the S&P Goldman Sachs Commodity Index to fall. Kozicki *et al.* found that news of LSAP lowered gold, silver, and other commodity prices during QE1 and QE2 and raised these prices during QE3. Glick and Leduc suggested that a possible explanation for their findings during QE1 and QE2 is that LSAP announcements signaled lower economic growth and lower inflationary pressures in the United States. The negative coefficients on most announcements during QE1 and QE2 in Table 4 of this paper support Glick and Leduc's explanation, as they indicate that this news lowered anticipated inflation. These negative coefficients are also consistent with Kozicki *et al.'s* findings that LSAP news during QE1 and QE2 decreased commodity prices. Similarly, the positive coefficients on the announcements during QE3 in Table 4 of this paper are consistent with Kozicki *et al*.'s findings that LSAP news raised commodity prices during the third round of LSAP.

The results in this paper thus indicate that, as actual inflation approached its target, the Fed was better able to influence inflationary expectations in the desired direction. The ability to affect expected inflation is important for monetary policy. At the zero lower bound, increases in expected inflation cause one-for-one decreases in the real interest rate. This provides needed stimulus when the economy faces deflationary risks. At higher interest rates, the ability to keep inflationary expectations anchored reduces the extra return that bondholders require to compensate for the risk of inflation. This keeps long-term interest rates from rising too high and choking economic activity. To influence inflation expectations, the Fed should remember the time-honored lesson that inflationary credibility increases as inflationary outcomes improve.

Table 1. Announcements of Large-Scale Asset Purchases between 2008 and 2010

Event Number	Date	Phase	Announcement
1	11/25/2008	QE1	The Fed announces it will purchase $100 billion in government-sponsored enterprise debt and $500 billion in mortgage-backed securities.
2	12/1/2008	QE1	Fed Chairman Bernanke states that the Fed may purchase long-term Treasury securities.
3	12/16/2008	QE1	The Federal Open Market Committee (FOMC) first mentions it may purchase long-term Treasury securities.
4	1/28/2009	QE1	The FOMC says it is ready to increase purchases of mortgage-backed securities and agency debt and to purchase long-term Treasury securities.
5	3/18/2009	QE1	The FOMC states that it will purchase $300 billion in long-term Treasury securities and increase its purchases of mortgage-backed securities by $750 billion and its purchases of government-sponsored enterprise debt by $100 billion.
6	8/12/2009	QE1	The FOMC says it will purchase a total of up to $1.25 trillion of mortgage-backed securities and up to $200 billion of government-sponsored enterprise debt and $300 billion in Treasury securities.
7	9/23/2009	QE1	The FOMC says Fed purchases of $300 billion of Treasury securities will be finished by the end of October 2009.
8	11/4/2009	QE1	The FOMC says purchases of agency debt will be reduced to $175 billion. Purchases of mortgage-backed securities and government-sponsored enterprise debt will be completed by the end of the first quarter of 2010.
9	8/10/2010	QE2	The Fed will maintain current holdings of securities by re-investing principal payments from mortgage-backed securities and government-sponsored enterprise debt into longer-term Treasury securities. The Fed will also roll over its holdings of Treasury securities.
10	8/27/2010	QE2	Chairman Bernanke says the Fed will roll over its holdings of existing long-term Treasury securities and buy more long-term securities to provide additional stimulus
11	10/15/2010	QE2	Chairman Bernanke says the Fed will provide more quantitative easing and keep interest rates low.
12	11/3/2010	QE2	The FOMC says the Fed will buy $75 billion of long-term Treasury securities per month until June 2011.
13	8/31/2012	QE3	Chairman Bernanke says the Fed will provide additional accommodation.
14	9/13/2012	QE3	The FOMC states the Fed will purchase $40 billion of mortgage-backed securities per month.

Source: Roache and Rousset (2013).
Note: QE1 refers to the first round of asset purchases, QE2 to the second round and QE3 to the third round.

Table 2a. Iterated Nonlinear Seemingly Unrelated Regression Estimates of Assets' Sensitivities to Inflation (Preferred Measure of Unexpected Inflation)

Asset	Inflation Beta	Standard Error
S&P Goldman Sachs Commodity Index - Silver	3.52***	1.35
Gold Mining	3.33**	1.37
Gold Bullion	2.97***	0.85
Gold Mining in the Americas	2.15	1.45
Oil and Gas Exploration and Production	0.83	1.04
Basic Resources	0.53	1.07
Oil and Gas	0.51	0.79
Gold Mining in Australasia	0.45	3.23
Defense	0.11	0.94
Automobiles	0.08	1.26
Technology	-0.09	0.98
Real Estate Investment Trust	-0.09	1.05
Asset Managers	-0.22	1.51
Computer Services	-0.32	0.89
Computer Hardware	-0.40	1.02
Electronic Equipment	-0.41	1.23
Distillers and Vintners	-0.62	1.02
Automobiles and Parts	-0.64	1.03
Construction and Materials	-0.70	0.99
Basic Materials	-0.74	0.89
Utilities	-0.76	0.59
Financial Services (3)	-0.76	0.95
Aluminum	-0.78	1.35
Financial Services (4)	-0.83	0.98
Electricity	-0.95	0.60
Conventional Electricity	-0.96	0.60
Financials	-0.97	0.81
Consumer Goods	-1.00	0.77
Electronic and Electric Equipment	-1.04	0.92
Commercial Vehicles and Trucks	-1.05	1.07
Health Care	-1.08	0.64
Consumer Discretionary	-1.09	0.76
Business Support Services	-1.13	0.84
Food Producers	-1.14	0.63
Telecommunications	-1.14	0.71
Diversified Industrials	-1.14	0.85
Electrical Equipment and Components	-1.18	0.90
Pharmaceuticals and Biotechnology	-1.25*	0.74

Building Materials and Fixtures	-1.27	1.00
Consumer Services	-1.28*	0.77
Consumer Finance	-1.31	1.05
Chemicals	-1.38	0.85
Commodity Chemicals	-1.38	0.91
Clothing and Accessories	-1.39	1.21
Brewers	-1.44	0.90
Food and Drug Retail	-1.55**	0.75
Consumer Staples	-1.56	0.62
Aerospace and Defense	-1.56*	0.88
Auto Parts	-1.65	0.93
Broadcast and Entertainment	-1.67	1.43
Durable Household Products	-1.77*	1.01
Drug Retailers	-1.88	1.23
Broadline Retailers	-1.97**	0.93
Beverages	-1.98***	0.77
Food Retailers and Wholesalers	-1.99**	0.83
Apparel – Retail	-2.06	1.52
Aerospace	-2.28**	0.94
Containers and Packaging	-2.31***	0.91
Financial Administration	-2.99***	1.01
Airlines	-3.56***	1.28

Note: The table presents iterated nonlinear seemingly unrelated regression estimates of exposures to unexpected inflation from a multi-factor model including returns on the 60 assets listed in the table on the left hand side and the Treasury bond/Treasury bill spread, the corporate bond/Treasury bond spread, the monthly growth rate in industrial production, the change in expected inflation, and unexpected inflation on the right hand side. Unexpected inflation comes from the residuals of a regression of inflation on lagged inflation and current and lagged Treasury bill returns.

*** (**) [*] denotes significance at the 1% (5%) [10%] level.

Table 2b. Iterated Nonlinear Seemingly Unrelated Regression Estimates of Assets' Sensitivities to Inflation (Alternate Measure of Unexpected Inflation)

Asset	Inflation Beta	Standard Error
S&P Goldman Sachs Commodity Index - Silver	3.45***	1.14
World Gold Mining	2.85**	1.15
Gold Mining in the Americas	2.29*	1.21
Gold Bullion	2.26***	0.72
Basic Resource	1.50*	0.90
Oil and Gas Exploration and Production	1.46*	0.87
Automobiles	1.23	1.04
Oil and Gas	0.85	0.66
Computer Services	0.67	0.74
Automobile and Parts	0.65	0.85
Gold Mining in Australasia	0.64	2.68
Basic Materials	0.60	0.74
Clothing and Accessories	0.48	1.01
Technology	0.47	0.82
Financial Services (3)	0.46	0.80
Real Estate Investment Trust	0.44	0.88
Financial Services (4)	0.43	0.82
Aluminum	0.41	1.12
Diversified Industrials	0.35	0.71
Commercial Vehicles and Trucks	0.34	0.90
Computer Hardware	0.32	0.85
Commodity Chemicals	0.31	0.76
Chemicals	0.24	0.71
Electronic Equipment	0.23	1.01
Consumer Finance	0.12	0.87
Consumer Goods	0.12	0.64
Business Support Services	0.08	0.70
Consumer Discretionary	0.07	0.64
Apparel – Retail	0.07	1.27
Auto Parts	0.01	0.77
Brewers	0.04	0.77
Construction and Materials	0.04	0.836
Utilities	-0.05	0.50

Durable Household Products	-0.07	0.85
Consumer Services	-0.07	0.65
Financials	-0.08	0.67
Food Producers	-0.08	0.53
Asset Managers	-0.11	1.27
Beverages	-0.13	0.65
Health Care	-0.13	0.54
Electricity	-0.19	0.52
Conventional Electricity	-0.20	0.52
Defense	-0.21	0.78
Consumer Staples	-0.22	0.53
Electrical Equipment and Components	-0.27	0.76
Electrical Equipment and Components	-0.35	0.75
Food and Drug Retailers	-0.40	0.64
Distillers and Vintners	-0.41	0.85
Telecommunications	-0.46	0.60
Pharmaceuticals and Biotechnology	-0.48	0.63
Building Materials and Fixtures	-0.52	0.83
Broadline Retailers	-0.56	0.77
Containers and Packaging	-0.90	0.75
Aerospace and Defense	-0.97	0.73
Food Retail and Wholesale	-0.98	0.71
Financial Administration	-1.02	0.84
Drug Retailers	-1.15	1.02
Aerospace	-1.19	0.78
US-DS Broadcast and Entertainment	-1.34	1.20
Airlines	-1.57	1.07

Note: The table presents iterated nonlinear seemingly unrelated regression estimates of exposures to unexpected inflation from a multi-factor model including returns on the 60 assets listed in the table on the left hand side and the Treasury bond/Treasury bill spread, the corporate bond/Treasury bond spread, the monthly growth rate in industrial production, the change in expected inflation, and unexpected inflation on the right hand side. Unexpected inflation is obtained by first calculating the expected real return on a one-month Treasury bill using the method of Fama and Gibbons (1984). This is subtracted from the nominal Treasury bill return (known at the beginning of the month) to calculate expected inflation. Unexpected inflation is set equal to the difference between actual inflation and expected inflation.

*** (**) [*] denotes significance at the 1% (5%) [10%] level.

Table 3. Iterated Nonlinear Seemingly Unrelated Regression Estimates of the Risk Premiums Associated with Macroeconomic Factors

Macroeconomic Factor	Risk Premium	Standard Error	Risk Premium	Standard Error
Unexpected Inflation (Boudoukh *et al.* Method)	-0.002***	0.0005		
Unexpected Inflation (Fama and Gibbons Method)			-0.003***	0.0007
Default Premium	-4.08*	2.28	-1.27	2.60
Horizon Premium	-0.009***	0.003	-0.010***	0.003
Industrial Production Growth	-0.006***	0.001	-0.006***	0.002
Change in Expected Inflation (Boudoukh *et al.* Method)	-0.0007***	0.0003***		
Change in Expected Inflation (Fama and Gibbons method)			-0.00055***	0.00017

Note: The table presents iterated nonlinear seemingly unrelated regression estimates of risk premia from a multi-factor model including returns on 60 assets on the left hand side and the Treasury bond/Treasury bill spread, the corporate bond/Treasury bond spread, the monthly growth rate in industrial production, the change in expected inflation, and unexpected inflation on the right hand side. Unexpected inflation (Boudoukh *et al.* method) comes from the residuals of a regression of inflation on lagged inflation and current and lagged Treasury bill returns. Unexpected inflation (Fama and Gibbons method) is obtained by first calculating the expected real return on a one-month Treasury bill using the method of Fama and Gibbons (1984). This is subtracted from the nominal Treasury bill return (known at the beginning of the month) to calculate expected inflation. Unexpected inflation is set equal to the difference between actual inflation and expected inflation.

*** [*] denotes significance at the 1% [10%] level.

Table 4a. Relationship between Assets' Returns and their Inflation Betas on Days of Large-Scale Asset Purchase Announcements (Preferred Measure of Unexpected Inflation)

Event Number	Date	Phase	Coefficient on Inflation Beta	Standard Error
1	11/25/2008	QE1	-0.0032	0.0021
2	12/1/2008	QE1	-0.0039	0.0037
3	12/16/2008	QE1	-0.0033	0.0023
4	1/28/2009	QE1	-0.0078***	0.0023
5	3/18/2009	QE1	-0.0006	0.0049
6	8/12/2009	QE1	-0.0011	0.0008
7	9/23/2009	QE1	-0.0008	0.0011
8	11/4/2009	QE1	0.0044***	0.0012
9	8/10/2010	QE2	0.0005	0.0007
10	8/27/2010	QE2	-0.0016	0.0010
11	10/15/2010	QE2	-0.0022***	0.0006
12	11/3/2010	QE2	-0.0025***	0.0008
13	8/31/2012	QE3	0.0032***	0.0010
14	9/13/2012	QE3	0.0034**	0.0014

Note: The table presents coefficients from a cross sectional regression of returns on 60 assets on the days of announcements of large-scale asset purchases on inflation betas for the 60 assets. Inflation betas are obtained from iterated nonlinear seemingly unrelated regression estimates of a multi-factor model including returns on the 60 assets listed in the table on the left hand side and the Treasury bond/Treasury bill spread, the corporate bond/Treasury bond spread, the monthly growth rate in industrial production, the change in expected inflation, and unexpected inflation on the right hand side. Unexpected inflation comes from the residuals of a regression of inflation on lagged inflation and current and lagged Treasury bill returns.

*** (**) denotes significance at the 1% (5%) level.

Table 4b. Relationship between Assets' Returns and their Inflation Betas on Days of Large-Scale Asset Purchase Announcements (Preferred Measure of Unexpected Inflation)

Event Number	Date	Phase	Coefficient on Inflation Beta	Standard Error
1	11/25/2008	QE1	-0.001	0.0033
2	12/1/2008	QE1	-0.010**	0.0047
3	12/16/2008	QE1	-0.0040	0.0030
4	1/28/2009	QE1	-0.0084**	0.0037
5	3/18/2009	QE1	0.0019	0.0073
6	8/12/2009	QE1	-0.0021*	0.0012
7	9/23/2009	QE1	-0.0016	0.0016
8	11/4/2009	QE1	0.0033*	0.0018
9	8/10/2010	QE2	0.0000	0.0010
10	8/27/2010	QE2	-0.0010	0.0016
11	10/15/2010	QE2	-0.0030***	0.0008
12	11/3/2010	QE2	-0.0024	0.0015
13	8/31/2012	QE3	0.0052***	0.0012
14	9/13/2012	QE3	0.0057***	0.0017

Note: The table presents coefficients from a cross sectional regression of returns on 60 assets on the days of announcements of large-scale asset purchases on inflation betas for the 60 assets. Inflation betas are obtained from iterated nonlinear seemingly unrelated regression estimates of a multi-factor model including returns on the 60 assets listed in the table on the left hand side and the Treasury bond/Treasury bill spread, the corporate bond/Treasury bond spread, the monthly growth rate in industrial production, the change in expected inflation, and unexpected inflation on the right hand side. Unexpected inflation is obtained by first calculating the expected real return on a one-month Treasury bill using the method of Fama and Gibbons (1984). This is subtracted from the nominal Treasury bill return (known at the beginning of the month) to calculate expected inflation. Unexpected inflation is set equal to the difference between actual inflation and expected inflation.

*** (**) [*] denotes significance at the 1% (5%) [10%] level.

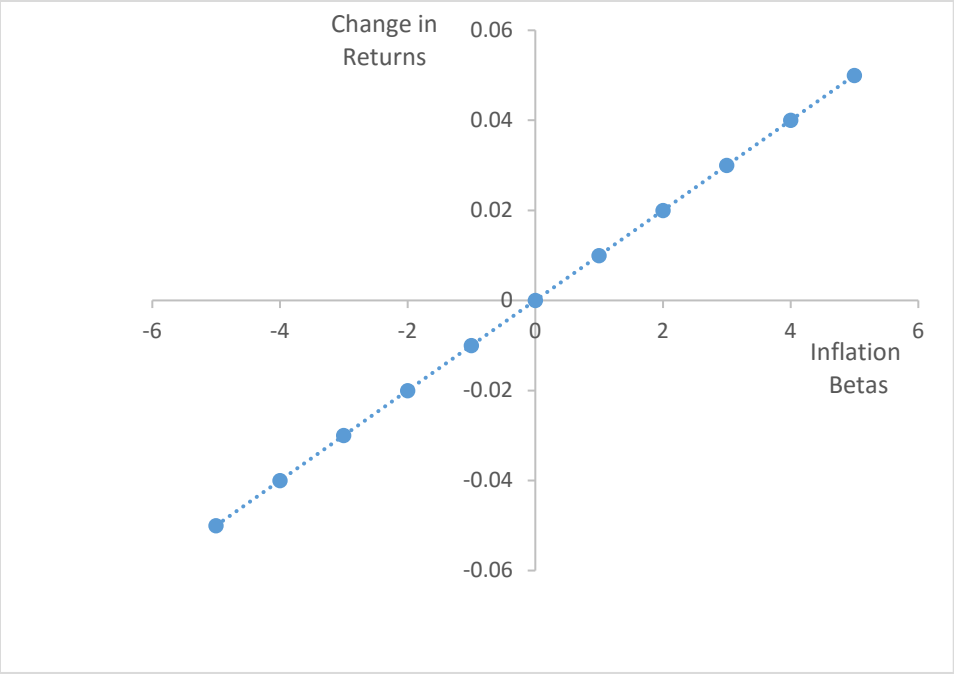

Figure 1a. Positive Relationship between Changes in Asset Returns and Inflation Betas when News of Large-Scale Asset Purchases Raises Inflation Expectations

Note: The table shows a positive relationship between changes in asset returns and inflation betas when news of large-scale asset purchases by the Federal Reserve raises expected inflation. The actual numerical values in the figure are for illustration purposes only.

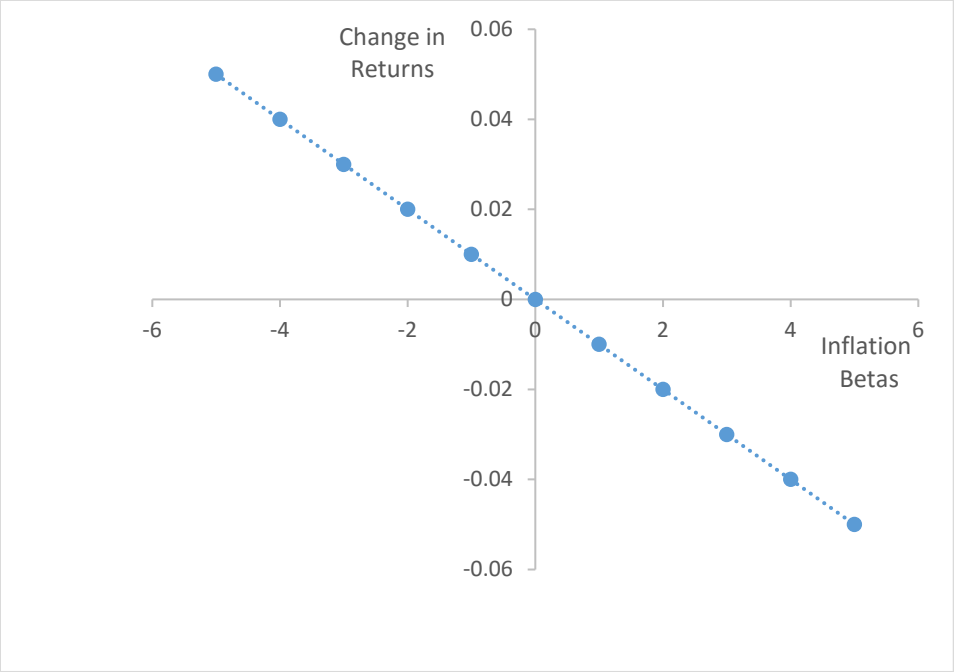

Figure 1b. Negative Relationship between Changes in Asset Returns and Inflation Betas when News of Large-Scale Asset Purchases Lowers Inflation Expectations

Note: The table shows a negative relationship between changes in asset returns and inflation betas when news of large-scale asset purchases by the Federal Reserve lowers expected inflation. The actual numerical values in the figure are for illustration purposes only.

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