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The Taper Tantrum of 2013: Momentum-Driven or a Return to Fundamentals?

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by

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Abstract

This study explores the driving force behind the Taper Tantrum of 2013. Following the Fed's announcements of potential QE tapering, investors poured of the bond market, causing yields to rise sharply. This analysis seeks to determine whether this was a momentum-driven reaction or a return to fundamental values. Throughout this paper, fundamental determinants of bond prices and investor returns are combined with trading volume and bid-ask spread data to determine the motivating market force. The findings suggest that the Taper Tantrum was a return to fundamental bond prices following an asset bubble burst, likely due to momentum trading.

Acknowledgements

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I. Introduction

A. Purpose of research

The road to recovery from the financial crisis that began in 2008 was plagued by economic contraction, volatility, and loss of investor confidence. Historically speaking, scared investors pour their money into government securities during economic crises, due to their risk-free nature. For this reason, government bond markets are deemed to be less risky and more stable than stock markets or other debt instruments, especially during a recession. While the Fed attempted to keep yields low and stable in the bond market following the crisis, the suggestion of tapering its massive security purchases triggered a four-month period of instability. This negative investor reaction and subsequent bond market volatility was characterized by a sharp spike in yields during the summer of 2013, in an episode that is now known as the Taper Tantrum (Graph 3). Why? Was the volatility in bond yields during this time characterized by irrational momentum trading? Or was it a rational response to overvalued bonds? The purpose of this Honors Thesis is to examine and explain what happened in the bond market during the Taper Tantrum.

B. Brief summary of research design

Asset prices are thought to be influenced both by rational investors and momentum traders. When stock prices are higher than fundamental prices (i.e. P/E ratio), the stock is said to be overpriced and rational investors will begin to sell, inducing the stock price back to its fundamental level. On the other hand, momentum traders are heavily influenced by recent price movements, so they wish to ride the wave, so to speak,

and buy stocks that have been rising. The same logic can be applied to actual and fundamental bond yields, as price is simply the inverse of the yield.

The research design utilized to answer the questions posed above occurs in three stages. The first step in determining the dominant bond market force during the Taper Tantrum was to calculate a proxy for the fundamental bond yield for 10-year U.S. Treasury bonds to compare with actual yields. According to the Federal Reserve Bank of San Francisco, Treasury security prices are influenced by supply and demand, economic conditions, monetary policy, and inflation. We defined the fundamental yield based upon fundamental characteristics such as inflation expectations, stock market returns, the Fed's total assets, and important bond market events. The inclusion of sixteen independent variables representing these factors was done to gauge an accurate calculation of the fundamental yield. Graph 7 displays the actual and fundamental yields on 10-year Treasury securities. Actual yields were above fundamental-value yields prior to November 2011, indicating that bonds were underpriced. The trend then reversed until June 2013 as actual bond yields were below fundamental-value yields, indicating that bonds were overpriced.

The second step of our research design was to apply the disparity between actual and fundamental yields from the first step, to future returns to existing bondholders. Because the bond market sustained a significant period of being overpriced by our measures, we expected bond prices to fall (yields to rise) in the future and forward-looking returns to existing bondholders to fall, which is exactly what happened during the Taper Tantrum. Graph 8 plots the difference between fundamental and actual yields (Yf-

Ya) and the forward-looking cumulative semi-annual return. Consistent with rational expectations trading, the return declined sharply during the period when bonds were overvalued (2011-2013). The graph also gives evidence that bond prices seemed to overcorrect, consistent with momentum trading, falling below fundamental value after mid-June 2013 as yields rose above fundamental values.

The third and final step was to incorporate trading volume data into our analysis of the driving forces of the bond market during the Taper Tantrum. As seen in Graph 9, trading volume surged in April 2013, peaking two months later in June, as yields were rising and bond prices falling. Returning to the stock market analogy, investors will sell their shares of overvalued stock to get out of the market before their returns take a hit. During this period, trading volume is high as investors are leaving the market and momentum picks up, then begins to decline as the market becomes less liquid. We expect the same behavior in the bond market where high trading volume as the bubble reaches its peak is followed by a period of declining trading volume as the market corrects and stabilizes. Overall, the evidence suggests that the Taper Tantrum was partially a return to fundamental values, and partially driven by momentum as explained by the overcorrection and subsequent surge in trading volume.

II. Background

A. Context

One of the main functions of the Federal Reserve is to administer monetary policy as a means of attaining the ultimate economic objectives of full employment, stable prices, and moderate long-term interest rates ("The Federal Reserve's Response"). When

the housing market slowdown of 2007 turned into a full-blown crisis in 2008, the Fed reacted aggressively in an effort to ease the economic pain and stimulate the economy. The primary actions taken by the Fed during this time to achieve its monetary policy goals can be broken into three broad categories: provide liquidity to banks as lender of last resort, provide liquidity to borrowers and investors, and expand traditional open market operations at an unprecedented level using LSAPs (large scale asset purchases) ("The Federal Reserve's Response"). These LSAPs consisted primarily of U.S. Treasury securities, agency securities, and MBS, and included the purchase of debt further out in the yield curve than what the Fed normally buys (i.e. 10 and 30-year government bonds). Graphs 1 and 2 display the amount of U.S. Treasury securities and total assets held by the Federal Reserve over the course of the financial crisis.

B. Quantitative Easing

The Fed's large-scale purchases of various debt and collateralized securities became collectively termed "quantitative easing", or QE. QE is an unconventional tool of monetary policy by definition and was employed to put downward pressure on (long-term) interest rates. The first round of QE, known as QE1, began on November 25, 2008 when the Fed announced it would purchase up to $1 billion in agency debt and up to $5 billion in agency MBS over the next several quarters. QE1 was expanded several months later to allow for the purchase of even more agency debt and MBS, and extended to longer-term Treasury securities. The Fed held assets of about $2 trillion when QE1 ended on March 31, 2010. Chairman Ben Bernanke saw the need for continued monetary easing and thus began QE2 on November 3, 2010. QE2 was more limited in both scope and

duration and included the purchase of $600 billion of longer-term Treasury securities over the following seven months. The final and most extensive round of quantitative easing, QE3, began on September 13, 2012 with no targeted end date or total purchase amount. The Fed initially announced that it would purchase $40 billion of MBS per month for as long as necessary, which was soon extended to include $45 billion of longer-term Treasury securities per month. Graph 4 provides further information and details of each QE program.

Bernanke and the Fed knew that QE could not go on forever and eventually signaled a future tapering of LSAPs as the nation's economic outlook continued to improve during the final round of QE. Bernanke addressed Congress' Joint Economic Committee on May 22, 2013 and mentioned that the Fed "could take a step down in the next two meetings", when asked about the future of its asset purchases (Fontevecchia). This comment piqued the interest of bond market investors who understood it to mean the Fed would soon be tapering and began to sell off their securities (Fontevecchia). The intentions of the Fed to consider tapering were confirmed during the FOMC press conference on June 19, 2012 when Bernanke stated "if the subsequent data remain broadly aligned with our current expectations for the economy, we would continue to reduce the pace of purchases in measured steps through the first half of next year, ending purchases around midyear" (The Economic Outlook).

Bernanke's FOMC statement was followed by a mass exit of investors from the bond market, causing yields to spike dramatically and prices to drop significantly. Coined the "Taper Tantrum", this bond market crisis that began in late May 2013 lasted until

yields stabilized in September 2013, four months later. Conventional wisdom holds that market participants overreacted to Bernanke's statements and the idea of LSAP tapering. The Taper Tantrum is assumed to have been a brief crisis exacerbated by the momentum trading of irrational investors. The purpose of our research is to test conventional wisdom and determine whether investors in the bond market acted in a manner consistent with fundamental value traders, or irrational momentum trading. Our hypothesis is that the Taper Tantrum was a return to fundamental bond price values from a previous state of being overpriced, likely due to momentum trading.

III. Research Methodology

A. Variables

Our hypothesis was tested using U.S. 10-year Treasury bond data. To determine the driving force behind the Taper Tantrum, the dependent variable was regressed against three independent variables. The dependent variable, actual semi-annual cumulative returns, is the forward-looking moving average of UST10Y returns, smoothed on a semi-annual basis. This variable considers future semi-annual returns based on the current yield spread. The three independent variables are: Yf-Ya, bid-ask spread, and trading volume. Yf-Ya is defined as the difference between the "fundamental yield" and actual yield on UST10Y bonds. The UST10Y bid-ask spread and trading volume ($ billions) are both daily values. In short, our model defines the actual and fundamental yield differential, bid-ask spread, and trading volume to be the fundamental drivers of the actual semi-annual cumulative return on UST10Y bonds.

Integral to the regression defined above and the results of this research, is the calculation of the fundamental yield (Yf), defined as what the UST10Y yields *should* have been if the bond market exhibited fundamental values. Yf was calculated in a separate regression where the dependent variable was defined as a function of sixteen independent variables: inflation expectations, S&P 500 return, Federal Reserve assets, announcement of QE1a, announcement of QE1b, announcement of QE2, announcement of QE3a, announcement of QE3b, tapering of QE1, tapering of QE2, first tapering of QE3, second tapering of QE3, announcement of CBPP1, announcement of CBPP2, tapering of CBPP1, and tapering of CBPP2. The dependent variable, daily UST10Y yield to maturity, was converted from nominal values to the daily change in YTM to reflect the persistence of the independent variables on yield. The independent variables of inflation expectations, S&P500 return, and Federal Reserve assets were also adjusted from nominal values to daily change values for consistency within the model. All QE announcement and tapering dates were included in the model as fundamental drivers of the daily change in yield and assigned a dummy variable of either 0 or 1. A value of 1 was assigned to each of the six-day ranges spanning from the day before the event to the four days following. A value of 0 was assigned to all other days. The announcements and tapering of the two rounds of the Covered Bond Purchase Programme (CBPP), the ECB's version of QE, were included in the model to capture the reaction of foreign bond markets to similar monetary stimulation. The dummy variables assigned the CBPP events follow the same rule as for QE. All sixteen of these independent variables were included to determine the most accurate representation of the UST10Y fundamental bond yield as possible. The results of this regression are found in Graph 11.

B. Sample period

The sample period used for the overall regression (actual semi-annual cumulative returns) was constricted by the limited availability of trading volume data. We sampled a 31-month period beginning in May 2011 and lasting until January 2014. This sample period was then divided into 3 sub-periods revolving around the Taper Tantrum to further analyze the potential build up and correction of a bond market bubble. The first sub-period, "Pre-Taper Tantrum", includes the 6 months before the onset of the Taper Tantrum, from October 19, 2012-April 18, 2013. The second sub-period, "Taper Tantrum Onset", is the 3 months before the Taper Tantrum (bubble peak) from April 19, 2013-June 18, 2013. The final sub-period, "Post-Taper Tantrum", includes the 6 months after the FOMC tapering announcement (bubble correction) from June 19, 2013-December 17, 2013.

The sample period used for the fundamental bond yield regression was much broader, ranging from January 2003-Jauary 2016. All available data was used to ensure the most accurate representation of the fundamental yield as possible.

C. Data collection

The data used in both regressions was collected primarily from Federal Reserve databases. As previously mentioned, a few adjustments were made from the nominal data to fit the regression models. In the fundamental bond yield regression, the daily change in UST10Y yield to maturity was regressed to determine how each of the sixteen independent variables tested impacted the day-to-day change in yield. This required the conversion of levels to daily change data for the appropriate variables. After the

regression was run, each coefficient was applied to the appropriate variables to find the "predicted" or fundamental daily UST10Y yield to maturity. These values were then adjusted by setting the coefficients for TQE3a and TQE3b equal to 0, in order to predict what *should* have happened to the yield when tapering of QE3 was announced. This adjustment was made to reflect what a rational investor would expect to happen to bond prices when QE3 was tapered based on the market non-responses to the previous tapers of QE1 and QE2. Finally, the adjusted predicted daily changes in UST10Y yield to maturity values were initialized to the yield to maturity level in January 2, 2003 to derive the yield to maturity levels of the fundamental bond yield. The daily return of UST10Y bonds was calculated over the broader sample period (2003-2016) using the Morningstar (2008) methodology. Because markets are forward-looking, the daily returns were summed as a forward moving average over a 6-month period.

D. Fundamental bond yield

To analyze what happened in the bond market during the Taper Tantrum and to determine the dominant motivating force, the fundamental yield must be estimated. The fundamental bond yield indicates our prediction of what UST10Y yields to maturity *should* have been if the market was operating at fundamental values. The calculation of the variable was very important to the overall regression model in measuring how far the markets deviated from the fundamental levels we predicted. Graph 7 plots both the actual yield and predicted fundamental yield over the period of Fed intervention following the economic downtown of the financial crisis (2008-2014). The most significant periods of deviation between actual and predicted yields are seen during each of the QE

installments. Interestingly, fundamental yields surpassed actual yields after the ending of QE2, for the first time since the beginning of QE in 2008, indicating that bonds were overpriced and that a bubble was building in the market, likely due to momentum trading. Actual yields caught back up to predicted yields just as the Taper Tantrum was beginning and continued to rise throughout the summer of 2013. This behavior is indicative of a market correction, perhaps even an overcorrection, and return to fundamental value pricing rather than an irrational reaction as conventional wisdom claims.

Graph 5 displays the deviation between actual and fundamental quarterly cumulative returns, taken from the difference between actual and fundamental returns found in Graph 10. The fundamental quarterly cumulative returns were calculated using the predicted fundamental bond yield rather than actual values. The areas shaded red mark the periods where the difference between actual and fundamental returns was greater than 2 standard deviations away from the mean. Graph 6 summarizes the time periods and magnitude of the deviations. The two most significant periods are observations 2 and 8, with observation 8 being the Taper Tantrum. Using a weighted average, we determined that approximately 3 months elapsed from the time the deviation first entered the red zone to when it returned to and crossed the mean. An average of 4 months elapsed from the time the period of deviation first departed the mean to when it returned, which is approximately the duration of the Taper Tantrum. These findings provide further evidence that the deviation between actual and fundamental returns was alleviated by a market correction and return to fundamental values.

IV. Results

Once the determination of the fundamental yield (Yf) was complete, our overall regression model could be run. The three independent variables used, Yf-Ya, bid-ask spread, and trading volume, were statistically significant in explaining the behavior of actual semi-annual cumulative returns. The difference between fundamental and actual yields (Yf-Ya) indicates how far actual bond market yields deviated from their fundamental levels; the higher the absolute value difference, the greater the deviation. When the difference is positive, the bond is overpriced; when the difference is negative, the bond is underpriced. We expect the bursting of a bubble to occur when securities are overpriced and we expect the coefficient of Yf-Ya to be negative, indicating that the bond market was correcting and returning back to fundamental yield levels during the Taper Tantrum. There is no strong theory of the behavior of the bid-ask spread during a bubble correction, thus we had no prediction for the coefficient of that variable. Trading volume is the final important indicator of bond market bubble activity. The bursting of a bubble is typically accompanied by high trading volume as investors begin to panic and leave the market (Gjerstad and Smith). This behavior should be reflected by a positive coefficient when the bubble builds, and a negative coefficient when the bubble corrects. Therefore, we expect the coefficient for trading volume to be negative in our model, indicating a market correction.

The results of the actual cumulative return regression support our hypothesis that the Taper Tantrum was a period of falling bond prices returning to fundamental values, followed by a market overcorrection likely due to momentum trading. The coefficient for Yf-Ya is negative as expected, indicating that the bond market was indeed overpriced as

the bubble was building and experienced a period of correction during the Taper Tantrum. The coefficient for the bid ask spread is positive, indicating that a positive relationship exists between the spread and return for bond investors during a bubble correction period. The coefficient for trading volume is also negative as expected, a further indication of a market correction. Graph 12 includes the results of this regression model.

To put the output into context of what was actually happening in the bond market at the time of the Taper Tantrum, the impact of the Fed's LSAPs must be examined. The massive and unprecedented purchases of debt, namely UST10Y bonds, lasted for over four years and had significant impacts on the bond market. The Fed continually injected huge sums of money into the bond market creating an artificially high demand for 10Y bonds in an effort to keep interest rates close to zero. A speculative bubble is defined as "a situation in which the market price of investment instruments or other properties has risen to a point which exceeds reasonable valuation and is not sustainable", which is exactly what had occurred in the bond market as a result of the Fed's actions. Although this was intentional, a bubble had built up nonetheless. The rational response to a speculative bubble peak is to get out of the market before it collapses/corrects. When Bernanke mentioned the future tapering of the Fed's QE program, meaning an imminent increase in interest rates, the rational response for market participants was to sell. This widespread sell-off of UST10Y bonds in response to Bernanke's testimony triggered a market correction and return to fundamental values from the previous state of overpriced bonds due to momentum trading. Conventional wisdom would have you believe that the Taper Tantrum was caused by investor panic and irrationality, however; the presence of a

speculative bubble in the bond market induced by the Fed's LSAPs indicates that the Taper Tantrum was rather a fundamentally-driven market reaction.

Another point to consider is the timing of the Taper Tantrum. It is clear that overvalued bonds must eventually return to fundamental values after an intermediate period of deviation, but why did this occur in June 2013? In their paper on "Bubbles and Crashes", Abreu and Brunnermeier address coordination as an economic theory, which provides a possible answer to the question of timing. A bubble burst is characterized by a sufficient number of investors leaving the market; a single investor cannot accomplish this alone. News events often function as the synchronizing element allowing investors to successfully burst an asset bubble. The almost-immediate yield increase following Bernanke's tapering announcement suggests that his testimony before Congress and the FOMC meeting shortly after, serve as "coordination devices" for the bond market reaction. Both news events were widely reported and speculated amongst bond market investors, and were followed by the inevitable bursting of an asset bubble. Thus, characterizing Bernanke and the Fed's news events as coordination devices allowing investors to synchronize a mass exit from the bond market, provides a possible explanation for the timing of the Taper Tantrum.

The same regression model was run within the smaller sample periods previously defined to provide further evidence in support of our hypothesis. These regression outputs can be found in Graphs 13-15. The independent variable coefficients in the Post-TT regression (Graph 15) are consistent with those in the overall model, confirming the classification of the Taper Tantrum as a market correction rather than overreaction.

V. Conclusion

QE3 wrapped up on October 29, 2014 after the Fed had accumulated over $3.5 trillion in assets on its balance sheet. The administration and effects of QE are controversial and widely debated, but the Federal Reserve did succeed in keeping interest rates historically low (Kearns). More recently, the bond market has continued to operate in state of volatility over the uncertainty of the Fed and raising interest rates due to economic improvement and stability. The findings of our research indicate that the Fed's massive injection of money into the bond market did indeed create an asset bubble by definition, and that market participants were rational in their response to the Fed's signaled withdrawal of funds. It is important to remember Sir Isaac Newton's wisdom of "what goes up, must come down" when considering asset bubbles. When the Fed artificially inflated bond prices using unconventional and temporary monetary policy tools, investors were correct in realizing that when the Fed stepped out, prices would fall. Thus, we have properly defined the Taper Tantrum as a rational market correction and return to fundamental values.

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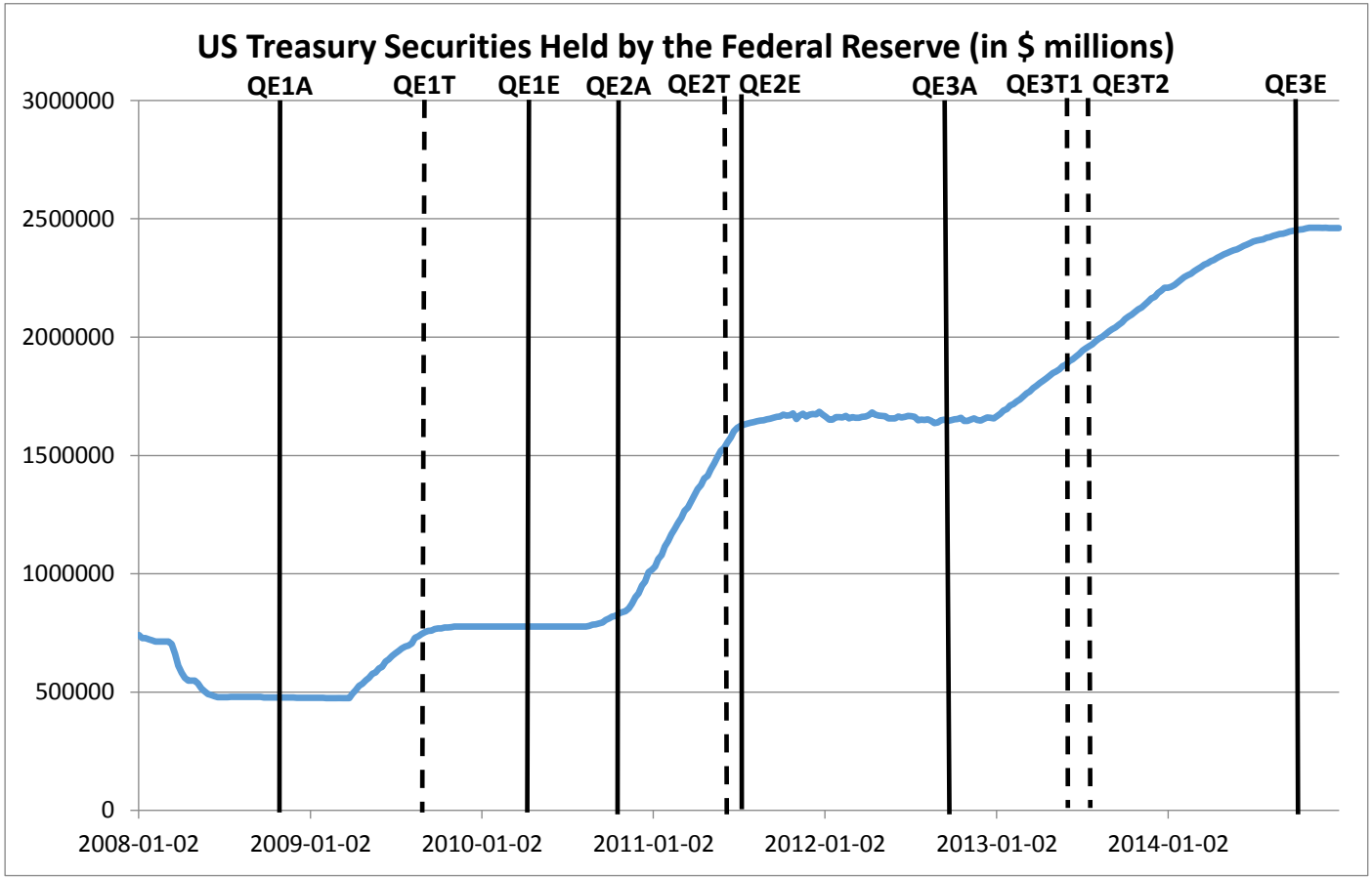
Graph 1


US Treasury Securities Held by the Federal Reserve (in $ millions)
QE1A
QE1T
QE1E
QE2A
QE2T
QE2E
QE3A
QE3T1
QE3T2
QE3E
3000000
2500000
2000000
1500000
1000000
500000
0
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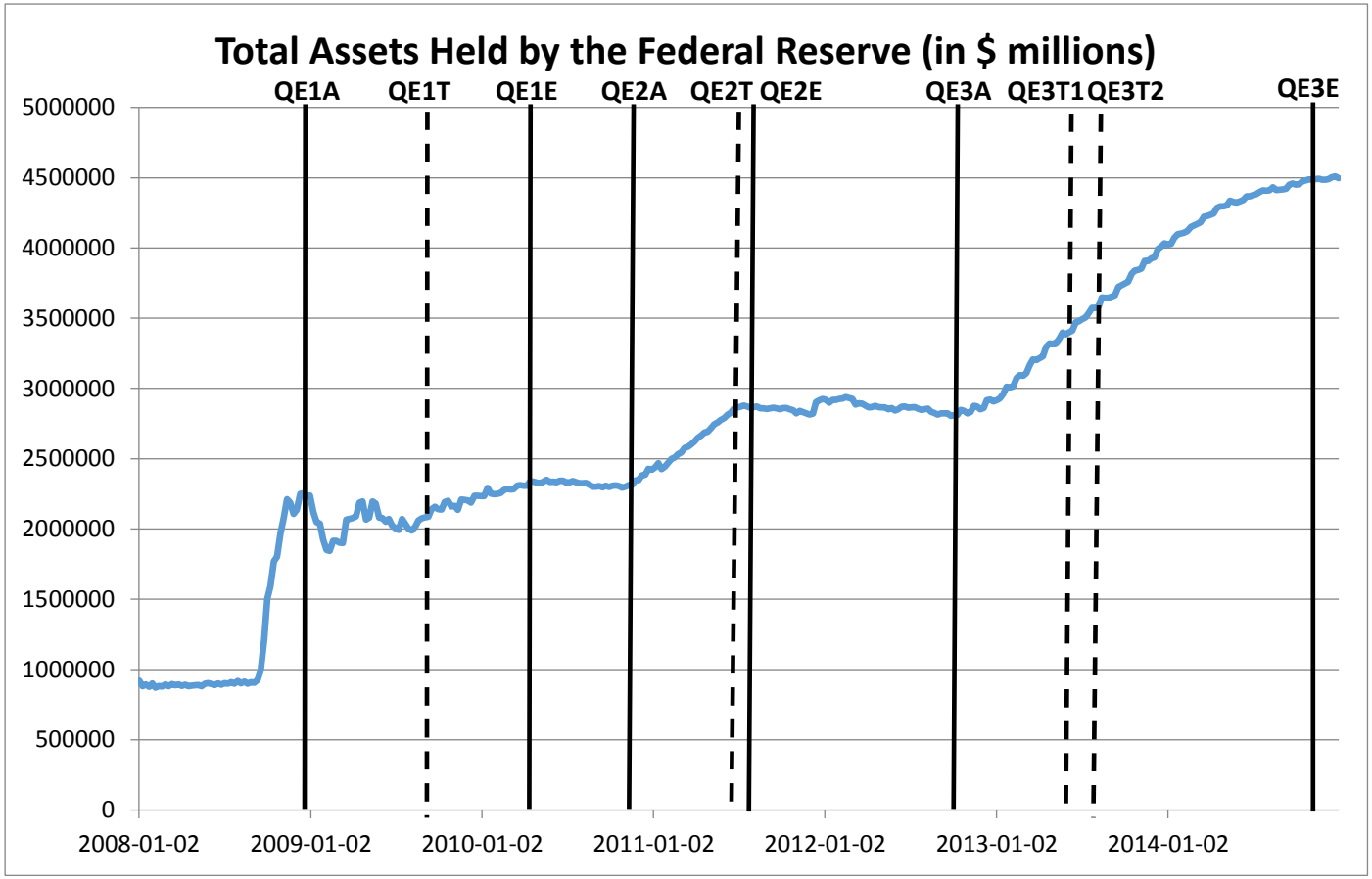
2009-01-02
2010-01-02
2011-01-02
2012-01-02
2013-01-02
2014-01-02

Graph 2


Total Assets Held by the Federal Reserve (in $ millions)
QE1A
QE1T
QE1E
QE2A
QE2T
QE2E
QE3A
QE3T1
QE3T2
QE3E
5000000
4500000
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
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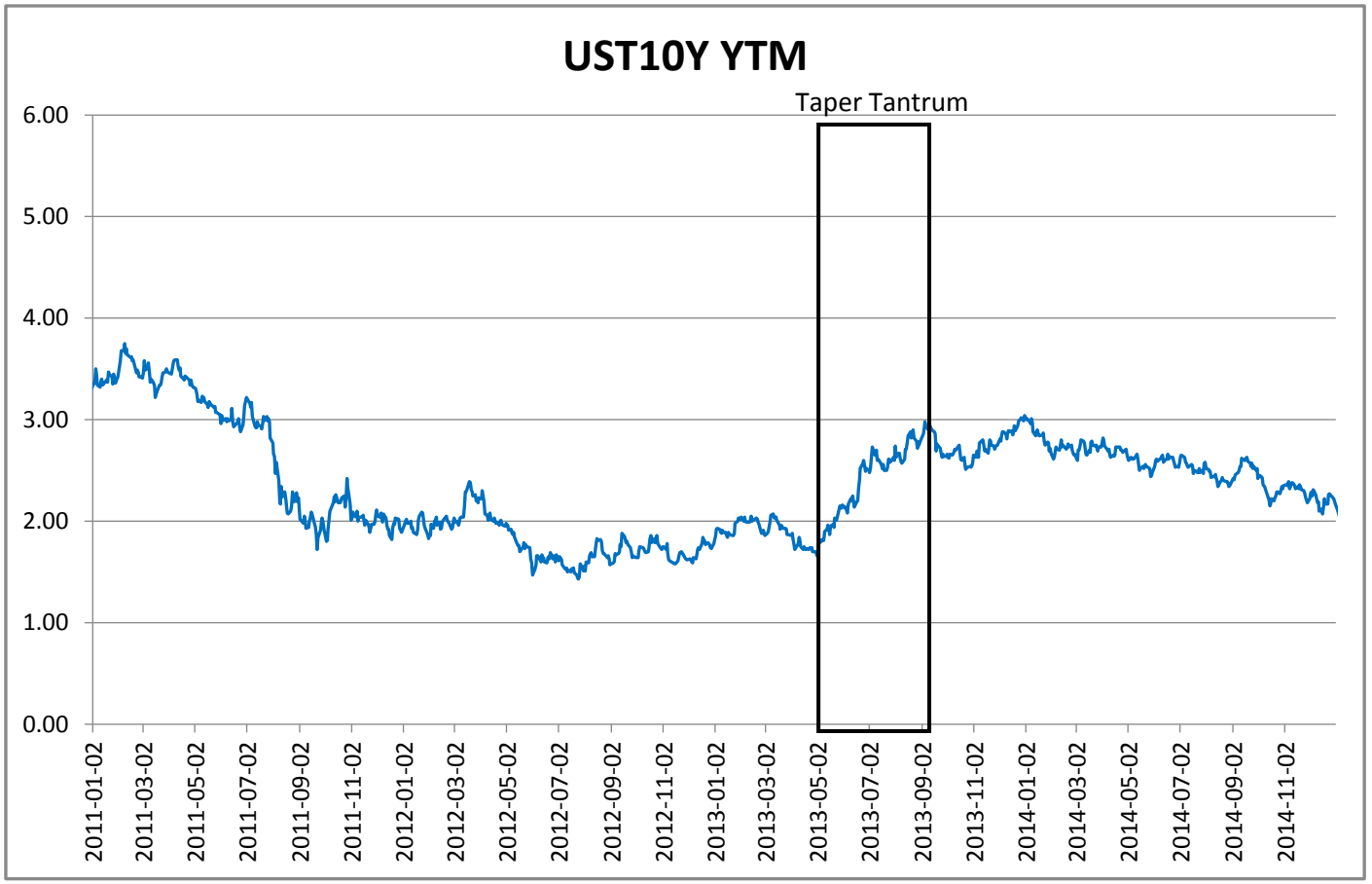
2009-01-02
2010-01-02
2011-01-02
2012-01-02
2013-01-02
2014-01-02

Graph 3


UST10Y YTM
Taper Tantrum
6.00
5.00
4.00
3.00
2.00
1.00
0.00
2011-01-02
2011-03-02
2011-05-02
2011-07-02
2011-09-02
2011-11-02
2012-01-02
2012-03-02
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2014-07-02
2014-09-02
2014-11-02

Graph 4

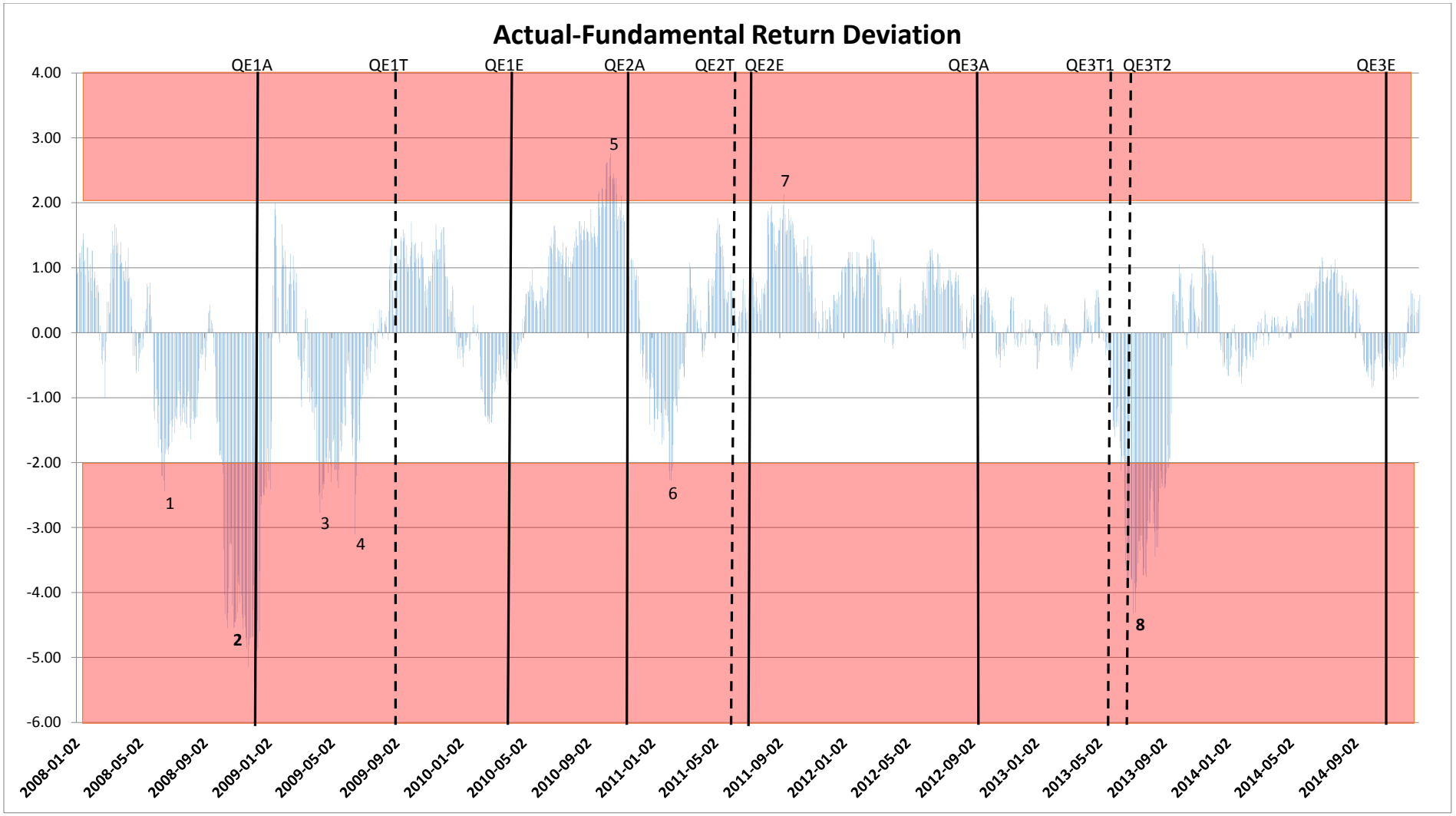
Figure 1: Monetary Policy: Large-Scale Asset Purchase Programs – QE1, QE2, QE3, and Operation Twist

Program	Announcement Date	Targeted End Date	Targeted Total Purchase	Composition of Purchases	Program Details as Announced
Quantitative Easing 1 (QE1)	November 25, 2008	Over Several Quarters	Agency Debt: Up to $100 bil Agency MBS: Up to $500 bil	Agency Debt and Agency MBS	Purchase up to $100 bil of agency debt and up to $500 bil of agency MBS. Purchases expected to take place over several quarters.
	March 18, 2009	Treasury Securities: September 30, 2009 Agency Debt and MBS: December 31, 2009	Agency Debt: Additional $100 bil Agency MBS: Additional $750 bil Longer-Term Treasuries: $300 bil	Agency Debt, Agency MBS, and Longer-Term Treasury Securities	Total purchases of agency MBS will now be to up to $1.25 trillion, and agency debt up to $200 bil. Purchase up to $300 bil of longer-term Treasury securities over next 6 months.
Quantitative Easing 2 (QE2)	November 3, 2010	June 30, 2011	$600 bil	Longer-Term Treasury Securities	Purchase $600 bil of longer-term Treasury securities by the end of the second quarter of 2011, a pace of about $75 bil per month.
Maturity Extension Program (Operation Twist)	September 21, 2011	June 30, 2012	$400 bil	Longer-Term Treasury Securities[1]	Purchase, by the end of June 2012, $400 bil of Treasury securities with remaining maturities of 6-30 years and sell an equal amount of Treasury securities with remaining maturities of 3 years or less.
	June 20, 2012	December 31, 2012	Amount Limited by Remaining Shorter-Term Treasury Securities[1]	Longer-Term Treasury Securities[1]	Purchase Treasury securities with remaining maturities of 6-30 years at the current pace and sell or redeem an equal amount of Treasury securities with remaining maturities of approximately 3 years or less.
Quantitative Easing 3 (QE3)	September 13, 2012	None Given	None Given	Agency MBS and Longer-Term Treasury Securities	Purchase agency MBS at pace of $40 bil per month and continue Twist through yearend, increasing holdings of longer-term securities in aggregate by $85 bil.
	December 12, 2012	None Given	None Given	Agency MBS and Longer-Term Treasury Securities	Purchase agency MBS at a pace of $40 bil per month and longer-term Treasury securities initially at a pace of $45 bil per month after Twist ends at yearend.

[1]Shorter-term Treasury securities are sold or redeemed while an equal amount of longer-term Treasury securities are purchased, resulting in no net increase in balance-sheet size.

Source: Federal Open Market Committee (FOMC)

Graph 5


Actual-Fundamental Return Deviation
QE1A
QE1T
QE1E
QE2A
QE2T
QE2E
QE3A
QE3T1
QE3T2
QE3E
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
1
2
3
4
5
6
7
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2012-01-02
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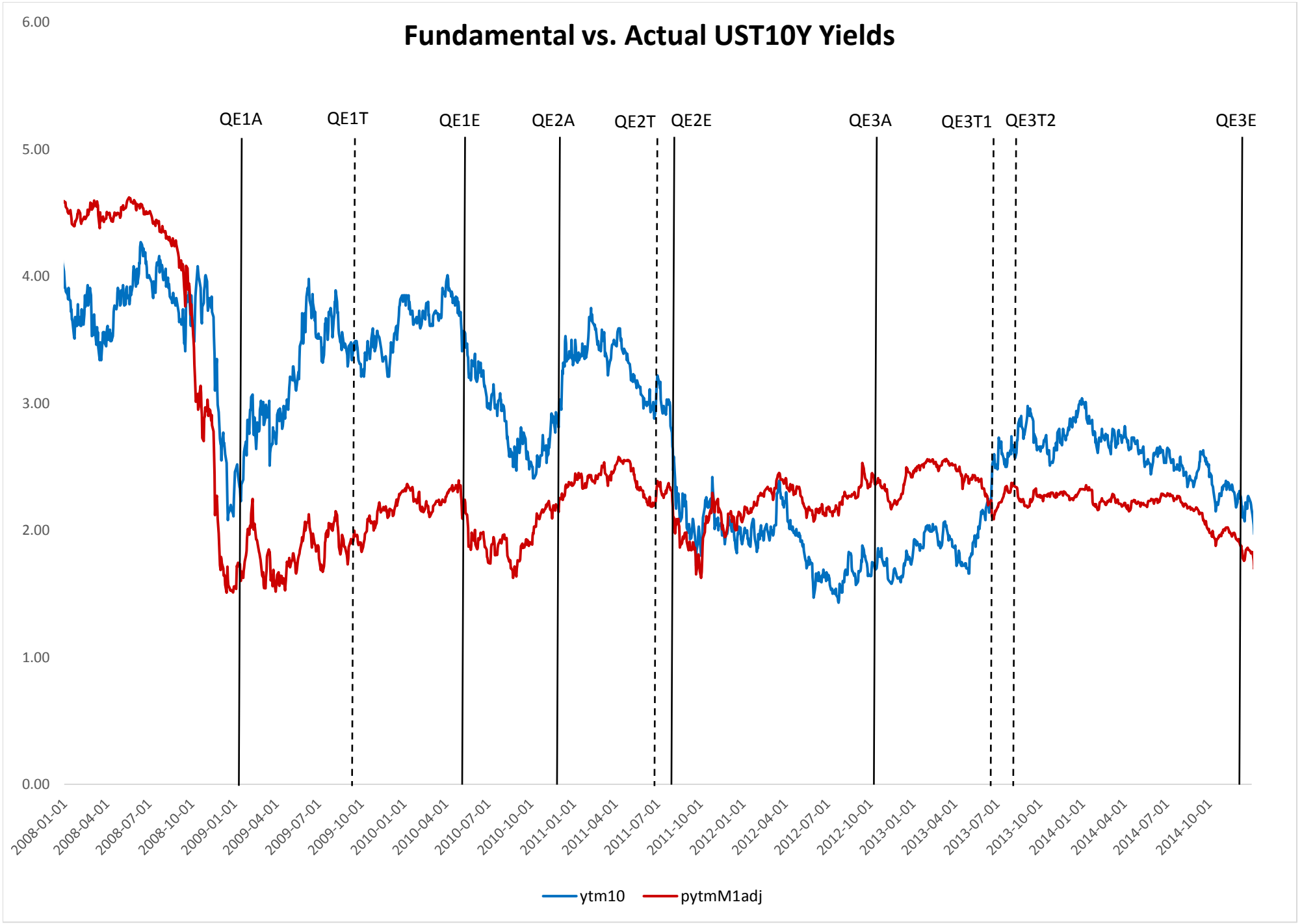
2013-01-02
2013-05-02
2013-09-02
2014-01-02
2014-05-02
2014-09-02

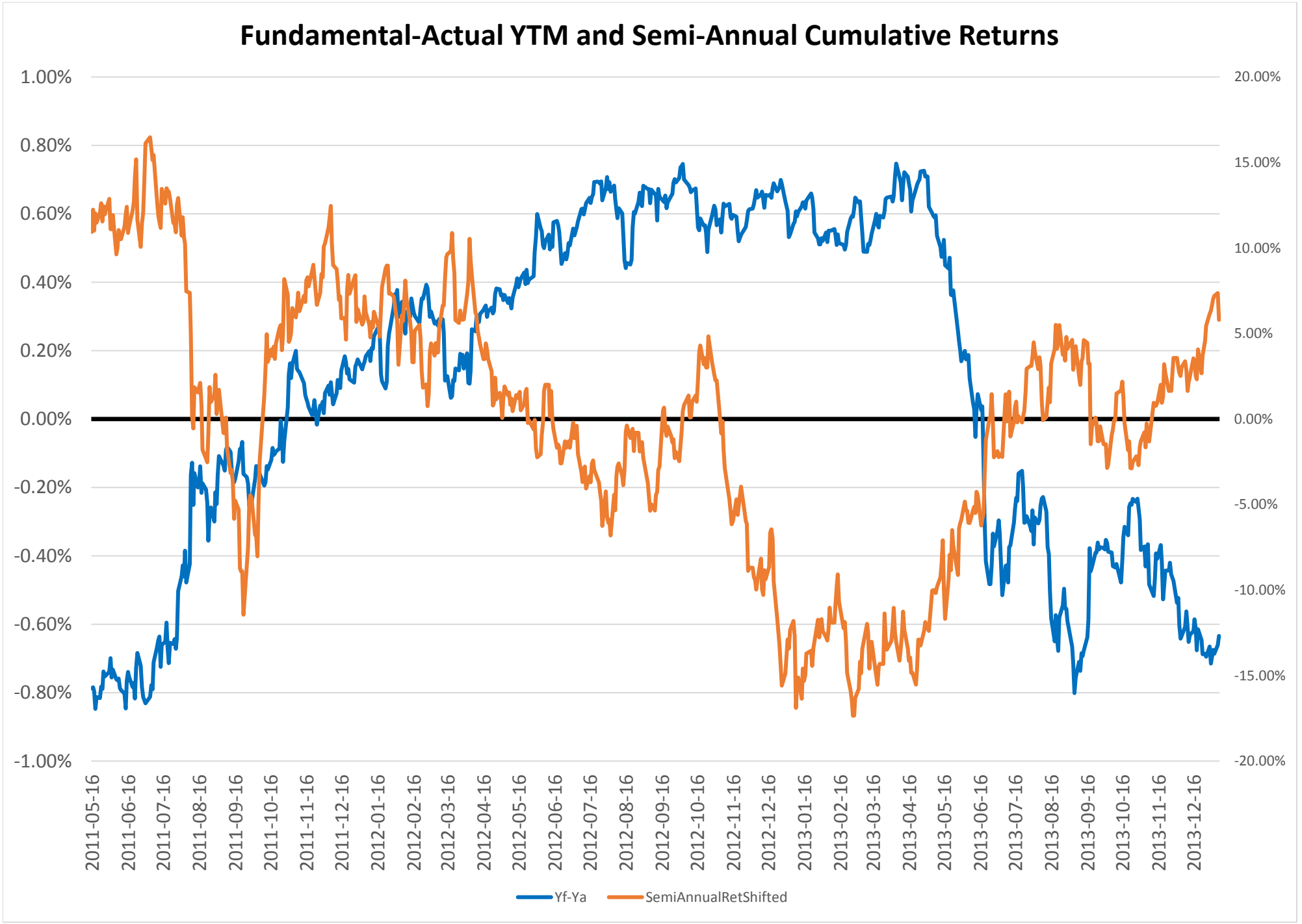
Graph 6

Observation	Start date	Duration (days)	Days in red	Peak value	Peak date	End date	Return to mean date	Return value	Days elapsed	Weights	Depart from mean date	Mean to mean days elapsed
1	6/12/2008	4	4	-2.44	6/17/2008	6/17/2008	9/8/2008	0.07	88		5/27/2008	104
2	10/6/2008	61	60	-5.15	11/24/2008	1/5/2009	1/9/2009	0.73	95	0.375	9/18/2008	113
3	4/7/2009	28	19	-2.77	4/9/2009	5/15/2009	7/20/2009	0.15	104	0.07	3/17/2009	125
4	6/15/2009	4	3	-3.1	6/15/2009	6/18/2009	7/20/2009	0.15	35		3/17/2009	125
5	9/21/2010	25	20	2.76	10/14/2010	10/26/2010	12/10/2010	-0.33	80	0.07	4/29/2010	225
6	2/3/2011	5	5	-2.28	2/7/2011	2/9/2011	3/8/2011	0.15	33		12/10/2010	88
7	9/9/2011	1	1	2.13	9/9/2011	9/9/2011	11/15/2011	-0.09	67		6/15/2011	153
8	6/12/2013	64	60	-4.33	7/5/2013	9/11/2013	9/18/2013	0.59	98	0.375	5/10/2013	131
								Average days	**94.135**			**128.34**

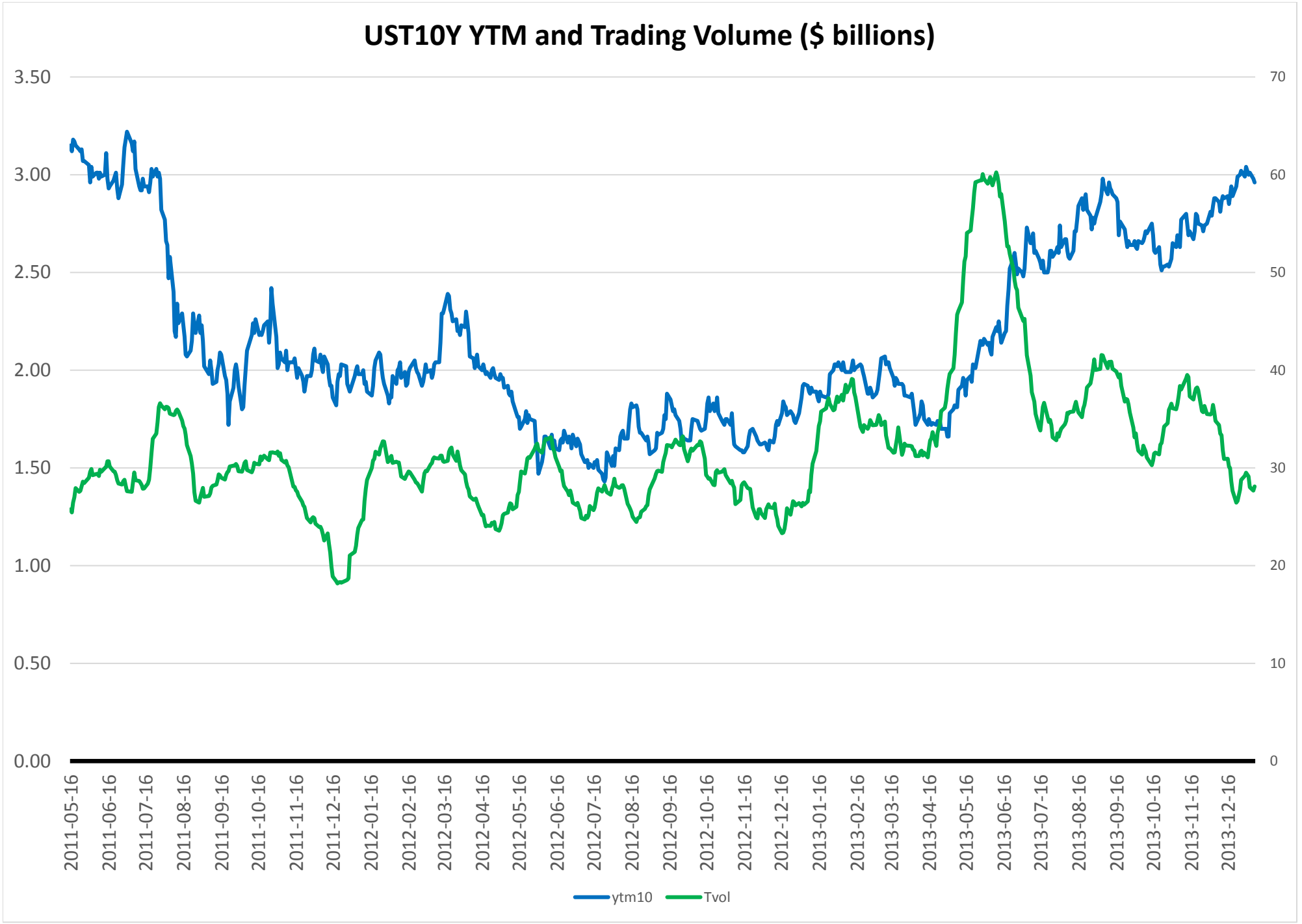
Graph 7


Fundamental vs. Actual UST10Y Yields
6.00
5.00
4.00
3.00
2.00
1.00
0.00
QE1A
QE1T
QE1E
QE2A
QE2T
QE2E
QE3A
QE3T1
QE3T2
QE3E
2008-01-01
2008-04-01
2008-07-01
2008-10-01
2009-01-01
2009-04-01
2009-07-01
2009-10-01
2010-01-01
2010-04-01
2010-07-01
2010-10-01
2011-01-01
2011-04-01
2011-07-01
2011-10-01
2012-01-01
2012-04-01
2012-07-01
2012-10-01
2013-01-01
2013-04-01
2013-07-01
2013-10-01
2014-01-01
2014-04-01
2014-07-01
2014-10-01
ytm10
pytmM1adj

Graph 8


Fundamental-Actual YTM and Semi-Annual Cumulative Returns
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
-0.20%
-0.40%
-0.60%
-0.80%
-1.00%
20.00%
15.00%
10.00%
5.00%
0.00%
-5.00%
-10.00%
-15.00%
-20.00%
2011-05-16
2011-06-16
2011-07-16
2011-08-16
2011-09-16
2011-10-16
2011-11-16
2011-12-16
2012-01-16
2012-02-16
2012-03-16
2012-04-16
2012-05-16
2012-06-16
2012-07-16
2012-08-16
2012-09-16
2012-10-16
2012-11-16
2012-12-16
2013-01-16
2013-02-16
2013-03-16
2013-04-16
2013-05-16
2013-06-16
2013-07-16
2013-08-16
2013-09-16
2013-10-16
2013-11-16
2013-12-16
Yf-Ya
SemiAnnualRetShifted

Graph 9


UST10Y YTM and Trading Volume ($ billions)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
70
60
50
40
30
20
10
0
2011-05-16
2011-06-16
2011-07-16
2011-08-16
2011-09-16
2011-10-16
2011-11-16
2011-12-16
2012-01-16
2012-02-16
2012-03-16
2012-04-16
2012-05-16
2012-06-16
2012-07-16
2012-08-16
2012-09-16
2012-10-16
2012-11-16
2012-12-16
2013-01-16
2013-02-16
2013-03-16
2013-04-16
2013-05-16
2013-06-16
2013-07-16
2013-08-16
2013-09-16
2013-10-16
2013-11-16
2013-12-16
ytm10
Tvol

Graph 10


Actual-Fundamental Returns
QE1A
QE1T
QE1E
QE2A
QE2T
QE2E
QE3A
QE3T1
QE3T2
QE3E
40.00%
30.00%
20.00%
10.00%
0.00%
-10.00%
-20.00%
-30.00%
-40.00%
-50.00%
-60.00%
2008-01-01
2008-04-01
2008-07-01
2008-10-01
2009-01-01
2009-04-01
2009-07-01
2009-10-01
2010-01-01
2010-04-01
2010-07-01
2010-10-01
2011-01-01
2011-04-01
2011-07-01
2011-10-01
2012-01-01
2012-04-01
2012-07-01
2012-10-01
2013-01-01
2013-04-01
2013-07-01
2013-10-01
2014-01-01
2014-04-01
2014-07-01
2014-10-01

Graph 11

UST10Y Fundamental Bond Yield Regression

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.532687871
R Square	0.283756368
Adjusted R Square	0.27990171
Standard Error	0.05109003
Observations	2990

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	16	3.074341233	0.192146	73.61389	1.7161E-201
Residual	2973	7.760098366	0.00261		
Total	2989	10.8344396			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.013854105	0.020717091	0.668728	0.503721	-0.026767185	0.054475396	-0.026767185	0.054475396
dinflation_expectations	0.628056588	0.026924627	23.32647	1.2E-110	0.575263796	0.680849379	0.575263796	0.680849379
Sp500Return	1.30132047	0.080854375	16.09462	6.02E-56	1.142784263	1.459856676	1.142784263	1.459856676
lnFedAssets	-0.001040716	0.001452345	-0.71658	0.473692	-0.003888419	0.001806987	-0.003888419	0.001806987
AQE1a	-0.138602183	0.020948274	-6.6164	4.35E-11	-0.179676768	-0.097527598	-0.179676768	-0.097527598
AQE1b	-0.086441352	0.020916056	-4.13277	3.68E-05	-0.127452765	-0.045429938	-0.127452765	-0.045429938
AQE2	0.009225513	0.020890111	0.441621	0.658796	-0.031735027	0.050186053	-0.031735027	0.050186053
AQE3a	-0.0042994	0.020908799	-0.20563	0.837097	-0.045296583	0.036697783	-0.045296583	0.036697783
AQE3b	0.03127988	0.020900851	1.496584	0.134608	-0.009701719	0.072261479	-0.009701719	0.072261479
TQE1	-0.018281335	0.020907777	-0.87438	0.381982	-0.059276515	0.022713844	-0.059276515	0.022713844
TQE2	-0.002851359	0.02090735	-0.13638	0.89153	-0.043845701	0.038142984	-0.043845701	0.038142984
TQE3a	0.036023211	0.020911381	1.722661	0.085054	-0.004979035	0.077025458	-0.004979035	0.077025458
TQE3b	0.085260535	0.020917446	4.076049	4.7E-05	0.044246396	0.126274674	0.044246396	0.126274674
ACBPP1	-0.010069455	0.019339835	-0.52066	0.602643	-0.047990273	0.027851363	-0.047990273	0.027851363
ACBPP2	0.040534991	0.020911333	1.938422	0.052666	-0.00046716	0.081537143	-0.00046716	0.081537143
TCBPP1	0.014588178	0.020901297	0.697956	0.48526	-0.026394295	0.055570652	-0.026394295	0.055570652
TCBPP2	-0.006841621	0.02089848	-0.32737	0.743408	-0.047818571	0.034135329	-0.047818571	0.034135329

Graph 12

UST10Y Return Regression: Full Sample

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.746645048
R Square	0.557478827
Adjusted R Square	0.555461254
Standard Error	0.050363092
Observations	662

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	2.102543466	0.700847822	276.312	4.983E-116
Residual	658	1.668978183	0.002536441		
Total	661	3.771521648			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.084282809	0.029341934	-2.872435353	0.0042	-0.14189792	-0.026667697	-0.14189792	-0.026667697
Yf-Ya	-0.100588294	0.004116646	-24.43452888	2.5E-94	-0.108671639	-0.092504948	-0.108671639	-0.092504948
BidAskSpread	0.116991559	0.015136472	7.72911678	4.1E-14	0.087269949	0.146713168	0.087269949	0.146713168
Tvol	-0.003338769	0.00028487	-11.72031947	6E-29	-0.003898133	-0.002779405	-0.003898133	-0.002779405

Graph 13

UST10Y Return Regression: Pre-Taper Tantrum (October 19, 2012-April 18, 2013)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.558539279
R Square	0.311966127
Adjusted R Square	0.29447374
Standard Error	0.045948044
Observations	122

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.112957141	0.03765	17.8344	1.30147E-09
Residual	118	0.249124289	0.00211		
Total	121	0.36208143			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.222318477	0.249358721	-0.89156	0.37444	-0.716116631	0.271479678	-0.716116631	0.271479678
Yf-Ya	-0.341434339	0.076391602	-4.46953	1.8E-05	-0.492710508	-0.19015817	-0.492710508	-0.19015817
BidAskSpread	0.314861462	0.141157187	2.23057	0.0276	0.035331801	0.594391123	0.035331801	0.594391123
Tvol	-0.006121522	0.001141381	-5.36326	4.1E-07	-0.008381767	-0.003861278	-0.008381767	-0.003861278

Graph 14

UST10Y Return Regression: Taper Tantrum Onset (April 19, 2013-June 18, 2013)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.93774985
R Square	0.879374781
Adjusted R Square	0.869851738
Standard Error	0.011595769
Observations	42

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.037249343	0.01242	92.3418	1.66398E-17
Residual	38	0.005109551	0.00013		
Total	41	0.042358894			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.122437611	0.097090979	-1.26106	0.21497	-0.318988022	0.0741128	-0.318988022	0.0741128
Yf-Ya	-0.057193183	0.015571257	-3.673	0.00074	-0.088715546	-0.025670821	-0.088715546	-0.025670821
BidAskSpread	-0.018565833	0.060605895	-0.30634	0.76102	-0.141256053	0.104124386	-0.141256053	0.104124386
Tvol	0.001744689	0.000404324	4.31507	0.00011	0.000926178	0.002563201	0.000926178	0.002563201

Graph 15

UST10Y Return Regression: Post-Taper Tantrum (June 19, 2013-December 17, 2013)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.652385123
R Square	0.425606349
Adjusted R Square	0.411365184
Standard Error	0.017775055
Observations	125

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.028327336	0.00944	29.8856	1.57538E-14
Residual	121	0.038230261	0.00032		
Total	124	0.066557597			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.054263146	0.080594249	-0.67329	0.50205	-0.21382072	0.105294428	-0.21382072	0.105294428
Yf-Ya	-0.102355054	0.011115698	-9.20815	1.2E-15	-0.124361509	-0.080348598	-0.124361509	-0.080348598
BidAskSpread	0.041024654	0.053744257	0.76333	0.44675	-0.065376279	0.147425586	-0.065376279	0.147425586
Tvol	-0.001258549	0.000429479	-2.93041	0.00405	-0.002108815	-0.000408282	-0.002108815	-0.000408282