

A Preliminary Assessment of the Effects of The Federal Reserve’s Large-Scale Asset Purchases on Interest Rates

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Executive Summary

This note presents an assessment of the effects of Federal Reserve purchases of long-term assets on long-term interest rates. These effects are assumed to be driven by changes in the share of long-term liabilities in net government debt, which in turn influence the term premium in long-term interest rates. In this view, Federal Reserve purchases of long-term assets reduce the net supply of long-term liabilities to private investors, thereby lowering long-term interest rates.

One way to estimate the size of this effect is to measure the movement of long-term interest rates in response to Federal Reserve communications about its plans to purchase long-term assets. Over the past several months, the 10-year Treasury yield declined a cumulative 100 basis points in windows around specific Federal Reserve communications, and other long-term yields declined even more. Relating these declines to changes in market expectations about the net supply of long-term debt provides one set of estimates of the impact of long-term asset purchases on long-term interest rates. The Desk’s survey of primary dealers provides another set of estimates. Overall, the estimates suggest that a \$1 trillion purchase of long-term assets lowers long-term Treasury yields between 50 and 100 basis points. All of the estimates, however, have unknown and potentially wide confidence intervals, as well as biases that may be large, implying that the true magnitude of the effects may lie outside of this range.

The staff recently reduced the assumed effect of long-term asset purchases on long-term interest rates used in its policy analysis.² There are several reasons for this change. First, the leading approach presented here supports a somewhat smaller estimate than the estimate previously used for the effect of the long-term debt share on the Treasury yield; still, both the previous estimate and the current estimate are within the range reported in earlier memos as well as the range in this note. Second, the previous estimates did not adjust for the rapid rise in federal debt since last fall. Because the interest rate effect depends on the ratio of long-term debt to total debt, higher total debt implies a smaller effect from a given dollar purchase of long-term debt. Third, the previous estimates assumed that purchases of agency MBS would have larger effects on MBS yields (and mortgage rates) than purchases of Treasury securities. The responses of these yields so far have been consistent with this assumption, but with the spread of the MBS yield to the Treasury yield having dropped substantially in the past few months, further MBS

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² Eileen Mauskopf and Jae Sim, “Optimal Paths for Large-Scale Asset Purchases,” memo to the FOMC, April 20, 2009.

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purchases probably would not continue to have outsized effects. Finally, the purchase programs so far have been associated with reductions in yields on other assets, such as corporate bonds, roughly the same as those on the targeted assets. Thus, the staff no longer assumes that the own-effect of purchases on yields is different from the spillover effect on the yields on other long-term assets. Of course, the staff will continue to assess and update these estimates and assumptions as new information becomes available.

Modeling the Effects of Long-Term Asset Purchases

One approach to modeling how long-term asset purchases affect long-term yields is based on the preferred habitat theory of investor maturity preferences. In this theory, investors have specific investment horizons (for example, based on time to retirement), and so wish to hold portfolios with specific maturities. To induce investors to hold portfolios with different maturities requires a change in relative yields. This theory can be incorporated as part of the term premium in a standard model of the yield curve that also depends on expectations of future short-term interest rates, as in equation 1. In this equation, the vector of yields (R) over maturities 2 through T depends on expected future one-period yields up to $T-1$ periods ahead and the supplies of assets (B) at each maturity from 1 to T . (E_t refers to expectations based on information available in period t .)

$$R_t^2, \dots, R_t^T = F\{R_t^1, E_t R_{t+1}^1, \dots, E_t R_{t+T-1}^1, B_t^1, \dots, B_t^T\} \quad (1)$$

Equation 2 is an implementation of equation 1 using two maturity buckets, short-term and long-term, with the 10-year interest rate standing as the representative long-term rate. The last three terms comprise the term premium, where u represents other variables that influence the term premium. The coefficient β is expected to be positive, as investors demand a higher long-term yield in order to hold a larger share of their assets at long maturities. It may be appropriate to include expectations of the future maturity structure of debt in place of, or in addition to, the current maturity structure.

$$R_t^{10} = E_t \sum_{i=0}^9 \left(\frac{R_{t+i}^1}{10} \right) + \alpha + \beta \left(\frac{B_t^L}{B_t^L + B_t^S} \right) + u_t \quad (2)$$

A common approach to estimating models such as equation 2 is to focus only on the supply of Treasury securities. There are two justifications for such a focus: first, the Treasury market is the largest single market for debt securities; and second, it may be reasonable to assume that the supply of Treasury securities, both in the aggregate and across different

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maturities, is exogenous with respect to the yield curve.³ If the Federal Reserve and the Treasury are viewed as a consolidated government sector from the point of view of private investors, Federal Reserve purchases of long-term assets can be viewed as reductions in B^L and corresponding increases in B^S in equation 2. The increases in B^S reflect the issuance of reserve balances, a short-term liability of the government, to pay for the long-term assets purchased.^{4 5}

Estimating the Effects

Event Study Approach

The event study approach to estimating the effects of the Federal Reserve's long-term asset purchase programs uses movements in yields following recent communications about such purchases to provide estimates of the parameter β in equation 2. The first public communication concerning the programs was the announcement on November 25, 2008, that the Federal Reserve planned to purchase up to \$500 billion of agency MBS and up to \$100 billion of agency debt over the next several quarters. Since November 25, there have been four more instances in which policymakers communicated notable new information to the public about Federal Reserve policy regarding purchases of long-term assets.⁶ Purchases of agency debt began in December; purchases of agency MBS began in January; and purchases of Treasury debt began in late March. As of April 15, purchases of assets with maturities greater than two years were roughly \$440

³ See, for example, Robin Greenwood and Dimitri Vayanos, "Bond Supply and Excess Bond Returns," National Bureau of Economic Research Working Paper No. 13806, February 2008 and Robin Greenwood, Samuel Hanson, and Jeremy Stein, "A Gap-Filling Theory of Corporate Debt Maturity Choice," National Bureau of Economic Research Working Paper No. 14087, June 2008.

⁴ With reserve balances paying an interest rate similar to that on short-term Treasury debt, it seems reasonable to include them in B^S . It is less clear whether currency should be included in B^S given that it does not pay interest and is less of a close substitute for Treasury bills. Nevertheless, currency is a short-term liability of the consolidated federal government, and it is included in B^S in the Mauskopf and Sim memo.

⁵ This analysis ignores one potentially significant difference between reserve balances and short-term Treasury debt, namely that only depository institutions can hold reserve balances. As a result, Federal Reserve purchases of long-term assets increase the aggregate size of depository institution balance sheets, and these institutions, facing regulatory and market pressures to reduce leverage, may contract their other asset holdings in response. The first assets likely to be sold would be short-term Treasury and agency securities, as these assets are most similar to reserves in terms of maturity and liquidity; such sales would have only limited macroeconomic effects. However, if depository institutions were forced to sell off private securities and to contract their loan books, there could be significant upward pressure on interest rates.

⁶ In a speech on December 1, Chairman Bernanke confirmed plans to purchase agency debt and agency MBS and he also raised the possibility of buying longer-term Treasury securities. In its December 16 policy statement, the FOMC stated that it stood ready to expand purchases of agency debt and agency MBS and that it was evaluating the potential benefits of purchasing longer-term Treasury securities. In its January 28 policy statement, the FOMC reiterated that it stood ready to expand purchases of agency debt and agency MBS and it also stated that it was prepared to purchase longer-term Treasury securities if it seemed likely that such purchases would improve conditions in private credit markets. Finally, in its March 18 policy statement, the FOMC announced increased purchases of agency debt and agency MBS and the initiation of substantial purchases of longer-term Treasury securities.

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billion, out of a projected total of \$1.75 trillion by year-end.⁷

As listed in the final column of Table 1, between November 24, 2008 and April 21, 2009, the yield on off-the-run 10-year Treasury securities declined about 50 basis points, while yields on other long-term assets generally declined even more. The asset purchase programs are likely to have been among the important factors behind these declines. In addition to the purchase programs, weak economic data and the FOMC decision to lower the target federal funds rate in December probably pushed down expectations of short-term interest rates over the next few years. The December FOMC statement noted that the federal funds rate was likely to remain exceptionally low “for some time” and the March FOMC statement increased the expected duration of exceptionally low rates to “an extended period.” On the other hand, the massive increase in expected future issuance of Treasury securities probably pushed up expectations of short-term interest rates in periods after the next few years and may have raised the term premium. In addition, the marked deceleration in the accumulation of foreign exchange reserves by foreign central banks since last summer may be placing some upward pressure on U.S. interest rates, given that about two-thirds of foreign exchange reserves are denominated in dollars.

	Nov. 25	Dec. 1-2	Dec. 16-17	Jan. 28-29	Mar. 18-19	Event Windows	Entire Period
6-Mo. Treasury	-1	-1	-9	4	-5	-12	-20
12-Mo. Treasury	-8	-6	0	5	-12	-21	-38
10-Yr. Treasury	-21	-24	-35	26	-48	-102	-54
10-Yr. Swap	-29	-23	-35	35	-31	-83	-48
10-Yr. Agency	-60	-52	-40	27	-55	-179	-122
30-Yr. MBS Curr. Coupon*	-67	-49	-26	35	-28	-135	-141
10-Yr. Corp. AA	-26	-30	-46	24	-47	-125	-152
10-Yr. Corp. High-Yield	-46	-55	-43	1	-89	-232	-499

*MBS event windows are one day longer than others.

I attempt to control for movements in interest rates that are not related to the asset purchase program by adding up the changes in long-term yields only over windows around the five episodes of Federal Reserve communications. For episodes in which the communication occurred in the morning, I set the window equal to one day, from the previous day’s market close to the market close on the day in question. For episodes in which the communication occurred in

⁷ This figure excludes purchases under agreement to resell in the MBS dollar roll market. Some of the \$1.75 trillion total will be in shorter-term maturities. Indeed, purchases already include \$28 billion of assets with maturities less than two years; these assets were purchased to support market functioning and to avoid distortions in the yield curve. For purposes of this note I am assuming that only longer-term assets are purchased.

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the afternoon, the window is two days, from the previous day's market close to the following day's market close.⁸ These windows are longer than typical event study windows in staff analysis. Given the unprecedented nature of the Federal Reserve's programs, the market may have taken longer than usual to respond to the news. Market commentary within these windows appeared consistent with a more drawn-out adjustment. Table 1 presents the movements of various interest rates in each of these windows; the second-to-last column displays the sums of the movements across all five windows.⁹

The numbers in the "Event Windows" column of Table 1 can be viewed as measures of the net effects on interest rates of announced Federal Reserve programs to purchase long-term assets under the following assumptions:

- 1) markets fully price in the effects within a day or two of the communication and no further move is expected when purchases actually take place;
- 2) market expectations about Federal Reserve asset purchases did not change on days other than those in the event windows;
- 3) the market expectation of long-term asset purchases prior to November 25 was zero;
- 4) the market expectation of long-term asset purchases as of March 19 equaled the announced total of \$1.75 trillion; and
- 5) the net effect of other factors on long-term rates within these windows was zero.

There are reasons to doubt all of these assumptions. Fortunately, the likely errors appear to offset each other to some extent. However, the net effect of the errors in these assumptions is unknown.

Assumption (1) appears unlikely to be true in the current financial environment because it relies on the willingness of financial market participants to accept a shift in rates of return across assets without any immediate shift in the actual holdings of those assets. This shift involves an element of risk for which investors presumably need to be compensated.¹⁰ One way to compensate investors is for there to be an expectation of further movements in relative yields as Federal Reserve purchases take place in the future. To be specific, holders of long-term bonds may be induced to continue to hold the existing stock of bonds despite a decline in yields if they expect further declines in yields, and therefore capital gains, as the Federal Reserve purchases

⁸ MBS yields appeared to have particularly long-lasting adjustment periods, so their windows were set one day longer than the others.

⁹ Shortening all the windows to one day reduces the cumulative change in the 10-year Treasury yield by only 6 basis points, although it has larger, and offsetting, effects in the Dec. 16-17 and Jan. 28-29 windows. Shorter windows noticeably reduce the cumulative effects on yields for agency, MBS, and high-yield corporate bonds.

¹⁰ To some extent, this risk may derive from uncertainty about the timing and magnitude of Federal Reserve purchases. Perhaps a greater source of risk is uncertainty about the ultimate effects of the Federal Reserve program on yields.

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take place.¹¹ Expectations of further declines in yields would violate assumption (1) and lead to underestimation of the net effect of the Federal Reserve programs.

A possible violation of assumption (2), on the other hand, might lead to an overestimation of the net effect of asset purchases. Market commentary during late January and February suggested a gradual marking down of market expectations of Federal Reserve purchases of longer-term Treasury securities. This commentary was associated with a drift up in bond yields that is not captured in the event windows and thus implies an upward bias to the magnitude of the estimated effect. To some extent, however, market expectations about future Federal Reserve purchases may have been moving in the opposite direction outside the event windows in December.

Violations of assumptions (3) and (4) probably offset each other to some extent. Even before November 25, some market participants likely believed that there was a possibility of large-scale asset purchases by the Federal Reserve. Thus, assuming that expected purchases equaled zero before November 25 leads to a downward bias of the estimated effect of the program. On the other hand, if expected purchases as of the final event window exceeded the announced total of \$1.75 trillion, then assuming that the market expected purchases to cumulate to only \$1.75 trillion would bias the estimated effect upward. Indeed, the Desk's April 2009 policy survey of primary dealers asked questions concerning expectations of cumulative Federal Reserve purchases of long-term assets. The median response was for purchases to reach \$1.825 trillion by 2009Q4 and \$1.9 trillion by 2010Q4, modestly more than the announced total.

With regard to assumption (5), the total net movement of the on-the-run 10-year Treasury yield in the half hour following each U.S. economic data release within these windows was an increase of about 10 basis points, suggesting a downward bias in the magnitude of the estimated effect of the purchase program from other economic news within the event windows. There were no notable news releases concerning future federal deficits during these event windows. However, these event windows did contain new information regarding the future path of the federal funds rate, particularly the December 16 FOMC statement which announced a reduction in the target federal funds rate and the March 18 FOMC statement which noted that rates would remain low for an extended period. The top two lines of Table 1 present changes in short-term Treasury interest rates, which convey some information about changes in market expectations of the future federal funds rate. On balance, these short-term Treasury rates declined modestly, suggesting some reduction in the expected future federal funds rate over the next few years. These declines are much smaller than the declines in long-term interest rates. Moreover, they may overstate the component of the long-term rate change attributable to expectations of the federal funds rate because they include a term premium that could have been affected by the

¹¹ Federal Reserve purchases of these assets are expected to occur several days a week for most of this year, so measuring the effect on yields as purchases occur is unlikely to be successful in general. However, the MBS yield declined 35 basis points during the first three days of MBS purchases, January 5-7.

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asset purchase news.¹² The semiannual *Blue Chip Economic Indicators* survey of long-term expectations provides some information on changes in expected future short-term interest rates five to ten years ahead. Between early October 2008 and early March 2009, expected short-term interest rates over this horizon declined 20 basis points. However, it is not possible to parse out the component of this decline attributable to Federal Reserve communications. In particular, some of the decline may reflect developments before the Federal Reserve programs were announced, as the Blue Chip forecast for the three-month Treasury rate in 2009Q4 dropped 80 basis points between the October 10 and November 10 publications. On balance, the downward bias to the estimated effects of asset purchases caused by data releases may have roughly offset the upward bias caused by communications about the future federal funds rate.

Overall, the measures in the “Event Windows” column of Table 1 suggest that the Federal Reserve’s asset purchase program has lowered the long-term Treasury yield about 100 basis points and has lowered other long-term yields even more. However, a substantial margin of error surrounds these estimates.

Under the methodology outlined above, the second step in estimating the effectiveness of the asset purchase program is to evaluate the implications of the program for the maturity structure of federal debt. A key assumption in this calculation is that it is the federal government’s *net* supply of assets to the private sector that matters. In other words, B^L and B^S in equation 2 refer to the net position of the government versus the private sector in each maturity bucket. Under this assumption, Federal Reserve purchases of long-term agency debt and agency MBS count as subtractions from B^L in the same manner as purchases of long-term Treasuries. Total Federal Reserve and Treasury net liabilities to the public are projected to average roughly \$7 trillion this year. Replacing \$1.75 trillion of the long-term assets outstanding with an equivalent value of short-term assets lowers the ratio of net long-term assets in total government assets by 25 percentage points.

If the asset purchase program is assumed to be responsible for the 1 percentage point decline in the 10-year Treasury rate listed in the “Event Windows” column of Table 1, the above calculations imply $\beta=4$ in equation 2. The analogous estimates for most other long-term yields would be larger, up to $\beta=9$ for the yield on high-yield corporate debt. However, it is likely that the greater decline in non-Treasury yields reflects the positive impact on market sentiment of the prospective Federal Reserve purchases, which helped to reduce the abnormally high yield spreads that existed last fall. As yield spreads shrink toward historically normal levels, additional asset purchases are not likely to push non-Treasury yields down by much more than Treasury yields, implying values of β for non-Treasury yields closer to that estimated for Treasury yields going forward.

An alternative event study analysis focuses on the most recent Federal Reserve

¹² On the other hand, it is possible that declines in expected short-term rates two or three years ahead are larger than declines in rates one year ahead.

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communication episode: the FOMC statement of March 18. Focusing on one event allows us to dispense with assumption (2) concerning the evolution of expectations about Federal Reserve programs during days between the event windows. However, it forces us to replace assumption (3) with an estimate of what markets expected for future Federal Reserve asset purchases immediately prior to the March 18 FOMC statement. In the Desk's March policy survey of primary dealers, the median probabilities that the Federal Reserve would increase purchases of agency debt and agency MBS were 70 percent and 75 percent, respectively.¹³ Most respondents did not mention a likely amount of increase, but three respondents did mention an amount for MBS purchases, two of these mentioned \$500 billion and one said \$300-400 billion. The median probability that the Federal Reserve would begin large-scale purchases of long-term Treasury securities was just over 50 percent; no potential purchase amounts were mentioned. One rough estimate of the overall expected value of additional purchases is the sum of $0.70 \times \$100$ billion (agency), $0.75 \times \$400$ billion (MBS), and $0.50 \times \$300$ billion (Treasury), for a total of \$520 billion. The announced increase on March 18 was \$1.15 trillion, representing a potential surprise of \$630 billion. However, as discussed above, the market may have continued to place some probability on further increases beyond this total. Based on the Desk's April survey of primary dealers, median estimates of such additional expected purchases are \$75 billion (through 2009Q4) to \$150 billion (through 2010Q4). (Of course, it is possible that views on additional purchases changed between March 19 and the time of the April survey.) Overall, a reasonable range of estimates for the surprise component of expected future Federal Reserve asset purchases in the March 18 FOMC statement is \$500 billion to \$1 trillion.

As shown in Table 1, the 10-year Treasury yield dropped 48 basis points in the March 18-19 event window (the drop was 50 basis points for March 18 only) and this equals the median decline for the long-term interest rates listed. A 50 basis point drop in the long-term yield in response to a \$500 billion increase in expected purchases of long-term assets implies $\beta=7$ in equation 2. A 50 basis point drop in the long-term yield in response to a \$1 trillion increase in expected purchases implies $\beta=3.5$.

Survey Approach

The Desk's April policy survey of primary dealers asked for views on the likely effect of a \$100 billion increase in Federal Reserve purchases. For purchases of Treasury securities, the median expected effect on 2-to-10-year Treasury yields is 8.5 basis points. For purchases of agency debt, the median expected effect on 2-to-10-year agency yields is 10 basis points. For purchases of agency MBS, the median expected effect on the 30-year current coupon MBS yield is 7.5 basis points. For Treasury securities and agency debt, the distribution of the purchases across maturities was not specified, and it is not clear whether the dealers expected the effects to be similar across the yield curve or whether their responses reflect an average of effects at different maturities. In general, one would expect larger effects at the longer maturities.

¹³ No time horizon was specified for when the increase might occur.

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However, if the dealer responses reflect expectations for movements in the 10-year yields for Treasury and agency purchases, then they imply values of $\beta=6$ for Treasury purchases, $\beta=7$ for agency purchases, and $\beta=5$ for MBS purchases.

Relating These Estimates to Those Used in Previous Staff Analyses

The December 5, 2008, FOMC note by Cabana, et al., implicitly uses equation 2 to summarize the results of a wide range of previous studies.¹⁴ According to Cabana, et al., the range of the previous estimates of β (the coefficient on the ratio of net long-term debt to net overall debt in equation 2) that appear most reliable is from 2 to 10 (in percentage points, or 200 to 1000 in basis points). To translate this finding into a range of possible yield effects for a given dollar purchase of long-term assets, Cabana et al. used total Treasury debt held by the public (excluding Federal Reserve holdings) of about \$5 trillion as of end-August 2008. Thus, a \$50 billion purchase of long-term Treasury securities (1 percent of the stock) was expected to reduce the long-term Treasury yield 2 to 10 basis points. However, Treasury debt is growing rapidly and, as noted earlier, is projected to average \$7 trillion this year.¹⁵ Thus, the range of yield effects for a \$50 billion purchase in 2009 should be adjusted downward to roughly 1½ to 7 basis points.

The December 5, 2008, FOMC note by Erceg, Kiley, and Levin assumed that each \$500 billion of purchases of long-term Treasuries would lower the long-term Treasury yield 50 basis points and would lower long-term corporate yields and mortgage rates 30 basis points.¹⁶ These assumptions were based on a value of $\beta=5$, roughly the midpoint of the range in Cabana et al., and an assumed debt stock of \$5 trillion. The smaller effect on other yields reflected an assumption of imperfect substitution across these assets. Erceg, Kiley, and Levin also assumed that \$500 billion of purchases of agency MBS would lower the mortgage rate 75 basis points, the high-grade corporate yield 50 basis points, and the Treasury yield 30 basis points. The higher effect of MBS purchases on mortgage rates reflected an assumption that Federal Reserve operations in this market would be especially effective given the unusually high yield spread that existed in the fall of 2008. As can be seen from the final column of Table 1, the MBS yield spread to the 10-year Treasury yield has dropped considerably since the first announcement of the asset purchase program and the primary mortgage spread (not shown) also has dropped more than 50 basis points. Currently, the option-adjusted spread of the MBS yield over the

¹⁴ Mark Cabana, Jeremy Forster, Josh Frost, Joseph Gagnon, Spence Hilton, Tony Rodrigues, and Michelle Steinberg, “Purchases of Longer-Term Treasury Securities,” note to FOMC, December 5, 2008.

¹⁵ As discussed above, the staff is currently basing its analysis on the net liabilities of the federal government, which is equivalent to the conventional measure of Treasury debt held by the public (including Federal Reserve holdings) because Federal Reserve assets roughly equal Federal Reserve liabilities.

¹⁶ Christopher Erceg, Michael Kiley, and Andrew Levin, “Quantitative Analysis of Policy Alternatives using the FRB/US Model,” note to FOMC, December 5, 2008. The March 9, 2009 FOMC memo by Eileen Mauskopf and David Reifschneider, “Economic Effects of Large-Scale Asset Purchases of Long-Term Treasury Securities and Agency Debt and MBS,” used the same assumptions about the yield effects of dollar volumes of asset purchases that were used by Erceg, Kiley, and Levin.

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comparable-maturity Treasury yield is about 70 basis points, somewhat below its 2000-2007 average of around 100 basis points.¹⁷ Thus, further increases in MBS purchases have only limited scope to reduce the MBS yield more than the Treasury yield.

As discussed in the Mauskopf and Sim memo, the staff is now employing equation 2 in its modeling of the effects of the asset purchase program, with a default value of $\beta=4$, consistent with the estimate for the effect on the long-term Treasury yield from the multi-window event study, which is within the range of the other estimates in this note and in Cabana, et al. Given the high degree of co-movement across the various yields within the event windows, particularly those on high-grade corporate bonds which are not among the assets being purchased, we believe that it is appropriate to assume that all long-term yields respond roughly equally to purchases of any of the three targeted classes of assets.

¹⁷ The option-adjusted yield subtracts the estimated value of the prepayment option in mortgages to facilitate the comparison of MBS yields with standard bond yields.