

## BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM

DIVISION OF RESEARCH AND STATISTICS

---

**Date:** March 9, 2009

**To:** Federal Open Market Committee

**From:** Eileen Mauskopf and David Reifschneider<sup>1</sup>

**Subject:** Economic Effects of Large-Scale Purchases of Long-term Treasury Securities and Agency Debt and MBS

---

**Summary**

As has been discussed in several recent reports and presentations to the FOMC, large-scale asset purchases (LSAP) of long-term Treasury securities and agency debt and MBS provide a potential means of supplying additional monetary stimulus now that the federal funds rate has effectively fallen to zero. This memo provides additional background information on the economics underlying such LSAP programs; a forthcoming memo by Gagnon, Lucca, McCarthy and Roush will provide information on other aspects of large-scale asset purchases, including issues related to exit strategies.

Our main conclusions for the macroeconomic effects of a LSAP program are as follows:

- The efficacy of an LSAP program depends importantly on its ability to contribute to an improvement in overall financial conditions, thereby boosting demand throughout the economy. If the program were to lower interest rates and boost spending in only one sector, the net effect on economic activity would be notably smaller.
- Model simulations suggest that a \$1 trillion LSAP program could boost the level of real GDP about 2 percent after several years, and appreciably more if the program substantially lifted house prices. Model simulations also suggest that the amount of economic stimulus provided by the program depends more on the overall volume of asset purchases than on the specific asset market targeted.
- The current heightened level of economic uncertainty, coupled with unusually restrictive credit conditions, make it difficult to gauge the likely stimulus of an LSAP program.
- The ability of large-scale asset purchases on the order of \$1 trillion to limit an undesirable drift down in inflation is likely to be limited, because their impact on the

---

<sup>1</sup> We thank Charlie Thomas, Joe Gagnon, Shane Sherlund, Andreas Lehnert, Bill English, Jim Clouse, Chris Erceg, Steve Kamin, Michael Kiley, John Roberts, Laurie Pounder, Nellie Liang, Dave Stockton, Dan Sichel, and Steve Oliner for comments and help with data.

degree of economic slack likely would be modest. A larger program would, of course, make a bigger dent in slack. At any order of magnitude, however, enactment of such a program could bolster public confidence in the Federal Reserve's commitment to maintaining inflation near recent levels. In that case, more stable inflation expectations might moderate the decline in inflation.

### **Economic effects of an LSAP program—general considerations**

Although different money and capital markets show varying degrees of dysfunction, the overall effect of the ongoing financial turmoil has been to raise the price and lower the availability of credit in most sectors of the economy—a development that has had extremely adverse consequences for real activity in general. To combat the weakness, the FOMC has provided broad-based stimulus by cutting the federal funds rate aggressively. But now that the federal funds rate is near the zero bound, the Committee must consider other methods if it wishes to further stimulate overall spending and output. Large-scale purchases of long-term Treasury and GSE securities are possible ways of achieving this goal because such purchases, at least in principle, can lower borrowing costs for a broad swath of the private sector, as well as noticeably boost household wealth and reduce the foreign exchange value of the dollar.

The ability of an LSAP program to provide broad-based stimulus rests in large part on the assumption that investors view long-term Treasury securities, agency securities, and investment-grade corporate bonds as reasonably close substitutes. The historical evidence suggests that Federal Reserve purchases of one of these assets, if carried out on a sufficient scale, would materially lower the yield on the targeted asset. Whether such purchases would also reduce yields on the other assets is less obvious. If Treasury securities, agency MBS, and corporate bonds were perfect substitutes, arbitrage would always ensure that a reduction in the yield on one asset would pass one-for-one into reductions in yields on the other securities. However, these securities differ in important ways—for example, in default risk and liquidity—and as a result their yields do not move in lock step. Nonetheless, the historical correlations across assets of month-to-month changes in yields have been quite high, and for this reason recent staff analyses have assumed that a LSAP program would generate a coordinated decline in yields across these three markets. The staff has also assumed that any induced reduction in MBS yields would pass through fully into interest rates on conventional mortgages.<sup>2</sup>

In previous analyses presented to the Committee, the staff interpreted the historical evidence as suggesting that a \$500 billion purchase of long-term Treasury securities would reduce Treasury yields by 50 basis points, and corporate yields and mortgage rates by 30 basis points.<sup>3</sup> The staff also assumed that a \$500 billion purchase of agency MBS

---

<sup>2</sup> In the weeks after the November 25 announcement of the plan for purchases of GSE debt and MBS, the rate on conventional mortgages did not drop by as much as did the MBS yield. But, in recent weeks, this spread has returned most of the way to its level prior to the announcement.

<sup>3</sup> These assumptions were discussed in several of the notes distributed to the Committee on December 5, 2009: “Purchases of Longer-Term Treasury Securities” (Cabana, Forster, Frost, Gagnon, Hilton, Rodrigues, and Steinberg), “Purchases of Agency MBS and Debt” (Gagnon and Hilton), and “Quantitative Analysis of Policy Alternatives Using the FRB/US Model” (Erceg, Kiley and Levin).

would reduce MBS yields and conventional home mortgage rates by 75 basis points, corporate bond yields by 50 basis points, and Treasury yields by 30 basis points. The assumption of larger own-yield effects for MBS purchases reflects, in part, the staff's view that directly intervening in this market might help to relieve some of the strains afflicting housing finance to a degree that purchasing Treasuries (for which demand is already extraordinarily strong) would not.

While we continue in this memo to use these same assumptions, it is worth emphasizing that the actual magnitude of spillover effects across debt markets is highly uncertain.<sup>4</sup> In fact, there is a risk that such spillovers could be small in the current context. This risk arises because the high historical correlation of yields on these assets may simply reflect an important shared common influence on their prices—the expected future path of the federal funds rate. The influence of an LSAP program on this expected path may be small, given that the federal funds rate is already seen as likely to remain close to zero for some time. Instead, the LSAP program may in the first instance work by reducing the term and liquidity premiums embedded in the yield of the targeted asset; for example, the primary effect of large-scale purchases of agency MBS might be to increase the liquidity of mortgage-related securities. In this event, the decline in the own yield might be larger than we have allowed because, in the absence of a diffusion to other asset markets, the rate in the targeted market would bear the full brunt of the reduction in the supply of long-term assets.

Assuming that large-scale asset purchases would indeed lower the overall level of long-term interest rates, the total stimulus provided by the LSAP program would also depend on the extent of further spillovers into other financial markets. Such spillovers would be consistent with standard arbitrage considerations, such as those embedded in the FRB/US model. For example, the rate of return on corporate equity should fall as investors bid up stock prices until their risk-adjusted rate has fallen in line with that on other financial assets. And, to the extent that U.S. bonds and foreign bonds are substitutes, the decline in rates of return on U.S. debt should lower the exchange value of the dollar, *ceteris paribus*.

If an LSAP program yielded a general improvement in financial conditions, as the staff expects, it would stimulate aggregate spending and output through several channels. Lower mortgage rates would increase the demand for housing and ultimately lead to greater residential investment, while lower corporate financing costs in debt and equity markets would raise business investment. Higher stock prices would increase household net worth and thus consumption spending. And a lower dollar would increase net exports.

Changes in household income flows and household resources, more broadly, would also play a role in defining the response of spending. For example, a decline in interest rates on government debt would reduce household income relative to what it would otherwise be by reducing the return on gross new debt issuance. By contrast, a reduction in rates on corporate debt would reduce household interest income but generally leave domestic

---

<sup>4</sup> The forthcoming memo by Gagnon et al discusses the response of various interest rates to recent announcements by both the Federal Reserve and the Bank of England concerning large-scale asset purchases, and concludes that spillover effects have been substantial.

households better off. Abstracting from the imperfect integration of corporate and personal tax liabilities in the U.S. tax code, this offset occurs because lower interest payments to households raise profits dollar for dollar (and households ultimately receive the profit income). And, because foreigners own a smaller share of U.S. corporate equity than they do of U.S. corporate bonds, U.S. households benefit from the decline in rates on corporate debt at the expense of foreigners.<sup>5</sup> However, these income changes are very gradual because they affect only new debt issuance; that is, the change in the average interest rate on long-term government and corporate debt varies with the share of the new debt in the outstanding stock of debt.

### **Gauging the importance of financial spillovers using model simulations**

FRB/US simulations support the claim that the efficacy of an LSAP program depends importantly on its ability to influence a broad range of financial conditions. Table 1 summarizes model predictions for the response of real activity to enactment of a program to purchase an additional \$500 billion in agency MBS under different assumptions about financial spill-over effects; table 2 does the same for a program of buying \$500 billion in long-term Treasury debt. For each table, all the simulation results incorporate the same assumptions used in previous staff analyses and discussed above for the direct effect of these purchases on own-yields; specifically, all the table 1 simulations assume that the LSAP program would lower MBS yields (and mortgage rates) about 75 basis points, while all the table 2 simulations assume that the LSAP program would lower long-term Treasury yields 50 basis points. Controlling for these common effects, each table's simulations are then sequenced to allow for a progressively expanding range of financial spillovers, first to other interest rates, then to the stock market, and finally to the real exchange rate. In these sequenced simulations, the spillovers to other interest rates are calibrated to match the staff estimates reported above, while the spillovers to corporate equity and the dollar are derived using standard FRB/US asset valuation equations. The full change in the prices of financial assets occurs in the second quarter of 2009 when the program is first announced; these shifts persist through 2011 and then begin to fade in 2012 as the Federal Reserve's positions in MBS and long-term Treasury debt are assumed to be gradually unwound.<sup>6</sup>

As shown in the upper portion of table 1, purchasing agency MBS has only a small effect on the overall economy in the absence of financial spillovers that extend beyond the

---

<sup>5</sup> In the FRB/US model, the propensity to consume out of profits (whether in the form of dividends or retained earnings) is the same as the propensity to consume out of interest income. So, this income transfer from foreigners to U.S. residents means that there is, on net, a positive impact on consumption spending from a decline in yields on corporate debt.

<sup>6</sup> In the simulations, monetary policy is assumed to hold the federal funds rate close to zero through 2012 (consistent with the extended outlook presented in the January Greenbook) and to follow the prescriptions of the Taylor rule thereafter. For computational convenience, private agents are assumed to have an incomplete understanding of the effects of an LSAP program, in that they base their expectations for the future on the forecasts of an estimated small-scale VAR model; other analysis (not shown) shows that allowing agents to have model-consistent expectations, and thus a complete understanding of the program, does not greatly change the results reported in tables 1 and 2. Under either expectational assumption, the initial reduction in long-term interest rates erodes somewhat over time as investors, recognizing the medium-run implications of the LSAP policy for real activity and inflation, price in the expectation of a higher path of the federal funds rate beyond 2012.

mortgage market. Under these conditions, the only noticeable stimulus to aggregate demand in the simulation comes through residential investment, which has only a small effect on overall activity because housing represents such a small share of nominal GDP at present. The stimulus from the LSAP program is larger if the decline in MBS yields leads to a fall in a broad range of long-term interest rates, because then the general reduction in borrowing costs gives rise to a more appreciable increase in business capital spending, residential investment, and household purchases of durable goods. As shown in the bottom portion of the table, if the MBS purchases also boost stock market wealth and cause the dollar to depreciate, thereby increasing the stimulus to household spending and net exports, the total effect on the level of real GDP climbs to roughly double that of the effect on interest rates alone.

This same general pattern characterizes results for large-scale purchases of long-term Treasury debt. As shown in the upper portion of table 2, FRB/US predicts essentially no stimulus from such purchases if there are no financial spillovers beyond the Treasury market, because government yields do not factor directly in the spending and production decisions of households and firms. At the other extreme, if declines in Treasury yields do result in lower private borrowing costs, higher corporate equity valuations, and a lower foreign exchange value of the dollar, then the overall stimulus from a Treasury LSAP program would be appreciable. In fact, based on these FRB/US simulations, its real GDP effects would be almost as large as those of a MBS purchase program. This result, however, depends crucially on the exchange-rate effect; in the absence of spillovers to the exchange rate, the stimulus from an MBS purchase program is almost twice as great after three years as that provided by a Treasury purchase program.

### **The potential effects of house price appreciation and mortgage refinancing**

The FRB/US simulations likely capture many important channels through which an LSAP program would influence household and business spending. In particular, the results reported in tables 1 and 2 take account of the stimulus from changes in the cost of capital, wealth, and the exchange rate. But some potentially important links involving house prices and mortgage refinancing are not included in the model's structure.

In theory, the price of a house should be determined in the same manner as the price of corporate equity or other assets—by capitalizing the expected flow of services or income from the asset. FRB/US does not capture this expected capital gain on housing from a change in interest rates but instead assumes that the relative price of a house is invariant to interest rates. Based on calculations using an asset valuation model in tandem with time series estimates of house prices and house rents, a \$1 trillion LSAP program (evenly divided between purchases of Treasury securities and agency MBS) would raise house prices by about 15 percent, given the assumptions discussed above about the direct and spillover effects of such a program on interest rates. (See the appendix for this calculation.)

Ample reason exists to question the size of the interest-sensitivity that results from this method. For one, households may purchase homes for reasons other than their expected return, implying that the average house price may depend less on factors included in the asset valuation model and more on other factors. Second, the estimate that derives from

the asset valuation model is very sensitive to the data applied to the model. In any event, other empirical evidence indicates a much smaller influence of interest rates on house prices. Indeed, reduced-form models of house prices suggest that a percentage point decline in the 30-year mortgage rate—the effect implied by our assumptions for the direct and indirect effects of purchasing \$500 billion in Treasury securities and \$500 billion in agency MBS—would raise house prices by only 2½ percent, although the statistical precision of this estimate is such that the true figure could be twice as large.

With total residential real estate in the range of \$22 trillion in 2009Q1, a 2½ percent increase in house prices would add roughly \$550 billion to real estate wealth relative to baseline. Assuming the same propensity to consume out of housing wealth as other wealth, this increase would directly boost consumer spending by about \$17 billion. By contrast, if the decline in interest rates instead boosted house prices relative to baseline by around 15 percent, as suggested by the asset-valuation calculation, residential real estate values would increase by \$3.3 trillion, and consumption would increase by about \$105 billion. In addition to this direct wealth effect, such a large boost to house prices could significantly improve bank balance sheets and thereby increase the availability of bank credit. Also, by importantly checking the decline in home prices embedded in the baseline outlook, the LSAP program might convince potential buyers that house prices have hit bottom and that nothing is to be gained by postponing a house purchase. Such a change in perceptions would accelerate the recovery of the housing market.

Mortgage refinancing and related income redistribution effects represent another omitted channel that could help to stimulate real activity by more than shown in the model simulations. Refinancing at a lower interest rate raises the disposable income of borrowers but lowers the interest received by creditors, dollar for dollar. If borrowers have a higher propensity to consume than creditors, this redistribution stimulates consumption even with no change in the aggregate disposable resources of households. Empirical evidence suggests that such differences in consumer behavior exist. The stimulus to consumption will be even larger if foreigners finance some share of U.S. mortgage debt, via their direct holdings of U.S. mortgages and mortgage securities or via their ownership of U.S. banks or other U.S. institutions that may hold such debt. In this instance, every dollar less in mortgage interest payments following a refinancing reduces interest received by U.S. households and domestic banks and institutions by 80 cents, based on an estimate that suggests the foreign ownership share of U.S. mortgage debt is approximately 20 percent.<sup>7</sup>

The staff estimates that about \$2.6 trillion in mortgage debt will be refinanced over the remainder of this year and through the end of 2010, based on recent and projected declines in mortgage rates, and taking into account the Administration's plan that raises the maximum loan-to-value permitted on GSE refinances. An LSAP program that

---

<sup>7</sup> When a loan in an agency MBS is refinanced, that loan disappears from the MBS. The owner of the MBS is repaid the principal on that loan and may choose to invest those funds anywhere. Thus, interest received by the foreign owner of the MBS does not necessarily fall in proportion to the decline in MBS yields because the investor may invest the repaid funds in something other than another MBS. However, as long as foreign investors reinvest those funds in U.S. debt securities, the quantitative estimates suggested in the text are in the ballpark.

shaved a percentage point off mortgage rates would likely boost the volume of refinancing to roughly \$3.1 trillion, thereby lowering mortgage interest payments around \$27 billion by the end of this year and \$36 billion next year.<sup>8</sup> With the share of mortgage debt owned by foreign entities at 20 percent, the interest received by domestic entities would decline over \$21 billion this year and almost \$29 billion next year. If the propensity to consume of borrowers is 1.0 and of creditors is 0.5, aggregate consumption would be boosted almost \$19 billion later this year and \$22 billion by the end of 2010. However, this estimate probably understates the effect an LSAP program would have on consumer spending through this channel. First, the spending response of creditors probably appreciably lags that of borrowers because the lower interest receipts mainly show up in the returns to institutional holders of mortgage debt—financial institutions and pension funds—rather than directly or immediately in household disposable income. Second, some homeowners may take advantage of refinancing to extract equity from their homes in order to finance an increase in consumption.

Table 3 illustrates that these potential effects from higher home prices and mortgage refinancings could significantly boost the macroeconomic stimulus provided by an LSAP program. The table reports simulation results for a \$1 trillion program, with purchases evenly divided between long-term Treasury securities and agency MBS. Consistent with the assumptions discussed earlier, we assume that such a program would subtract 105 basis points from MBS yields and mortgage rates, and 80 basis points from yields on Treasuries and investment-grade corporate bonds. Using the standard version of FRB/US—that is, the version that excludes the direct spur to consumption from higher home prices and mortgage refinancing just discussed—the program is estimated to boost the level of real GDP about 2 percent over the next few years, lower the unemployment rate  $\frac{3}{4}$  percentage point, and provide a modest boost to inflation. Taking at face value the calibrated impetus to consumption from higher household net worth and mortgage refinancings described above, the boost to the level of real GDP could be as much as  $5\frac{1}{4}$  percent relative to baseline, reducing the unemployment rate by 2 percentage points, and raising the inflation rate  $\frac{1}{2}$  percentage point.

### **Caveats**

There are many reasons to be cautious in using FRB/US and other models to gauge the likely stimulus provided by large-scale asset purchases. For one, the ability of our models to predict the macroeconomic effects of an unprecedented policy action is necessarily quite limited, even under normal conditions. Moreover, conditions today are far from normal. Given the heightened degree of uncertainty, and the unusually restricted availability of credit, the average historical behavior embedded in FRB/US and other models may be a poor predictor of how agents would respond to an LSAP program in today's environment.

---

<sup>8</sup>Given the baseline assumptions for refinancing activity, the 100 basis point reduction in mortgage rates generated by the LSAP program would reduce interest costs by \$17 billion in 2009Q4 and \$26 billion in 2010Q4 for homeowners who would have refinanced in the absence of the program. For homeowners who only refinance because of the program, the interest savings would be about \$10 billion by late 2009 (and beyond), assuming that all the additional \$500 billion in refinancing occurs this year, and that the average interest rate on these refinanced mortgages falls from 6 percent to 4 percent.

For example, business investment in the FRB/US model depends only on output and the price of capital; credit constraints play no explicit role, even though they may account for much of the current unexplained weakness in capital spending. The lack of a clear credit channel suggests that the model may overstate the ability of many firms to finance increased investment at present, even if the LSAP program stimulates demand to the point that firms would like to increase capacity. The current heightened level of uncertainty may also make many firms extremely reluctant to invest even if borrowing conditions improve substantially.

Similar considerations may also limit the responsiveness of many consumers, who may not be able to obtain the financing necessary to take advantage of lower interest rates, or may be unwilling to spend because of fears about the future. On the other hand, it is possible that credit-constrained households may prove to be unusually responsive at the moment to any additional income or employment generated by the large-scale asset purchases. Thus, it is difficult to say whether the model simulations presented above over- or understate the consumption effect of an LSAP program.

Another area of uncertainty concerns the response of the dollar, which FRB/US models using an “open-interest-parity” condition. Although this approach—which relates movements in the foreign exchange value of the dollar to the spread between domestic and foreign interest rates—is standard, its empirical track record is quite poor (although no other approach does any better). Unpredictable movements in the premium investors are willing to pay to hold dollar assets is one reason for this poor performance, and the model simulations may understate the degree to which a LSAP program might lead investors to look favorably on the prospects for the U.S. economy. To the extent that sentiment shifts toward the dollar, the simulation may overstate the amount of exchange rate depreciation that would be expected from the decline in U.S. interest rates.

### **The inflation effects of an LSAP program**

The FRB/US model of inflation falls into the group of new Keynesian Phillips curve models. In particular, current inflation depends on the gap between the actual and desired price level, where the desired price level in turn depends on unit labor costs (a proxy for marginal cost) and the desired markup of prices over marginal costs. Both factors vary pro-cyclically. In addition, because prices are sticky, inflation also depends importantly on expected inflation.

In the version of FRB/US used for these simulations, agents are assumed to form their expectations under a form of limited-information rationality. In particular, agents form expectations of future movements in output, inflation, and interest rates using a reduced-form VAR model of the economy. In both this VAR model and the FRB/US model, long-run inflation expectations are ultimately tied to the public’s perception of the policymakers’ inflation target. The public updates its perception of the inflation target based on the realization of inflation as well as on deviations of the federal funds rate from historical norms. As seen in the tables, the stimulus to economic growth provided by the LSAP program makes only a modest dent in economic slack. Moreover, because the

public looks exclusively to the setting of the federal funds rate (relative to current resource utilization and inflation) to draw inferences about the inflation target, the announcement of an LSAP program does not by itself influence the perception of the inflation target and expected rates of inflation. As a consequence, this program fails to significantly slow the down-drift in inflation expectations that occurs in the baseline projection, as illustrated by a comparison of the black and blue lines in figure 1.

In theory, the public's expectation of the policymakers' inflation target could be directly influenced by the very announcement of a program like the LSAP program. The announcement itself might impress the public with the authorities' commitment to keeping inflation on a stable path. Thus, rather than relying only on the federal funds rate to infer policymakers' desired inflation target, the public might instead look to large-scale asset purchases. Of course, with no historical experience of large-scale asset purchases, evidence on how much policymakers can directly influence inflation expectations is essentially nonexistent. To give some idea of the possible benefits of such effects, we make the assumption that, upon implementation of the LSAP program, long-run inflation expectations become firmly anchored and independent of the evolution of the economy—similar to the assumption in recent Greenbook alternative scenarios. As can be seen from the red line in figure 1, under this assumption, inflation outcomes are considerably better. But it bears repeating that these better-anchored inflation expectations are purely illustrative because we have no empirical evidence to suggest that an LSAP program would alter expectations in this way.

Table 1  
Economic Effects of a Program to Purchase a Further \$500 Billion of Agency MBS  
Under Different Assumptions for the Extent of Financial Spillover

	2009	2010	2011	2012
<i>Financial spillovers limited to home mortgage rates</i>				
Real GDP <sup>1</sup>	.08	.15	.17	.14
Unemployment rate <sup>2</sup>	-.02	-.05	-.07	-.06
<i>Financial spillovers limited to home mortgage rates, bond yields, and other long-term interest rates</i>				
Real GDP <sup>1</sup>	.12	.30	.48	.60
Unemployment rate <sup>2</sup>	-.03	-.10	-.16	-.19
<i>Financial spillovers limited to home mortgage rates, bond yields, other loan rates, and corporate equity prices</i>				
Real GDP <sup>1</sup>	.16	.46	.74	.88
Unemployment rate <sup>2</sup>	-.04	-.15	-.25	-.31
<i>Full financial spillover (including the real exchange rate)</i>				
Real GDP <sup>1</sup>	.22	.65	1.06	1.26
Unemployment rate <sup>2</sup>	-.05	-.22	-.37	-.46

Note: Results shown in the table are from FRB/US simulations using staff estimates for the interest rate effects of large-scale asset purchases. Announcement of the program is assumed to subtract 75 basis points from MBS yields and conventional home mortgage loan rates, 50 basis points from yields on corporate bonds, and 30 basis points from long-term Treasury securities. These direct effects on the level of long-term interest rates are assumed to persist through the end of 2011 but fade away in 2012 as the Federal Reserve's position in MBS is gradually unwound. Accompanying spillover effects on corporate equity prices and the real exchange are based on standard FRB/US asset-valuation equations. In all the simulations, the federal funds rate follows the Taylor rule subject to the zero bound constraint (which in the baseline binds through 2012).

1. Percent change from baseline in the Q4 level of real GDP.
2. Change from baseline in the Q4 level of the unemployment rate.

Table 2  
Economic Effects of a Program to Purchase \$500 Billion in Long-term Treasury Securities  
Under Different Assumptions for the Extent of Financial Spillover

	2009	2010	2011	2012
<i>Financial spillovers limited to Treasury yields</i>				
Real GDP <sup>1</sup>	.00	.00	.01	.01
Unemployment rate <sup>2</sup>	.00	.00	.00	.00
<i>Financial spillovers limited to Treasury yields, corporate bond yields, and mortgage and other long-term loan rates</i>				
Real GDP <sup>1</sup>	.05	.15	.25	.33
Unemployment rate <sup>2</sup>	-.01	-.05	-.08	-.10
<i>Financial spillovers limited to Treasury yields, corporate bond yields, mortgage and other long-term loan rates, and corporate equity prices</i>				
Real GDP <sup>1</sup>	.08	.24	.39	.50
Unemployment rate <sup>2</sup>	-.02	-.08	-.13	-.17
<i>Full financial spillover (including the real exchange rate)</i>				
Real GDP <sup>1</sup>	.17	.52	.83	1.00
Unemployment rate <sup>2</sup>	-.04	-.17	-.30	-.39

Note: Results shown in the table are from FRB/US simulations using staff estimates for the interest rate effects of large-scale asset purchases. Announcement of the program is assumed to subtract 50 basis points from yields on long-term Treasury securities and 30 basis points from yields on corporate bonds and conventional home mortgage loan rates. These direct effects on the level of long-term interest rates are assumed to persist through the end of 2011 but fade away in 2012 as the Federal Reserve's position in long-term Treasury securities is gradually unwound. Accompanying spillover effects on corporate equity prices and the real exchange are based on standard FRB/US asset-valuation equations. In all the simulations, the federal funds rate follows the Taylor rule subject to the zero bound constraint (which in the baseline binds through 2012).

1. Percent change from baseline in the Q4 level of real GDP.
2. Change from baseline in the Q4 level of the unemployment rate.

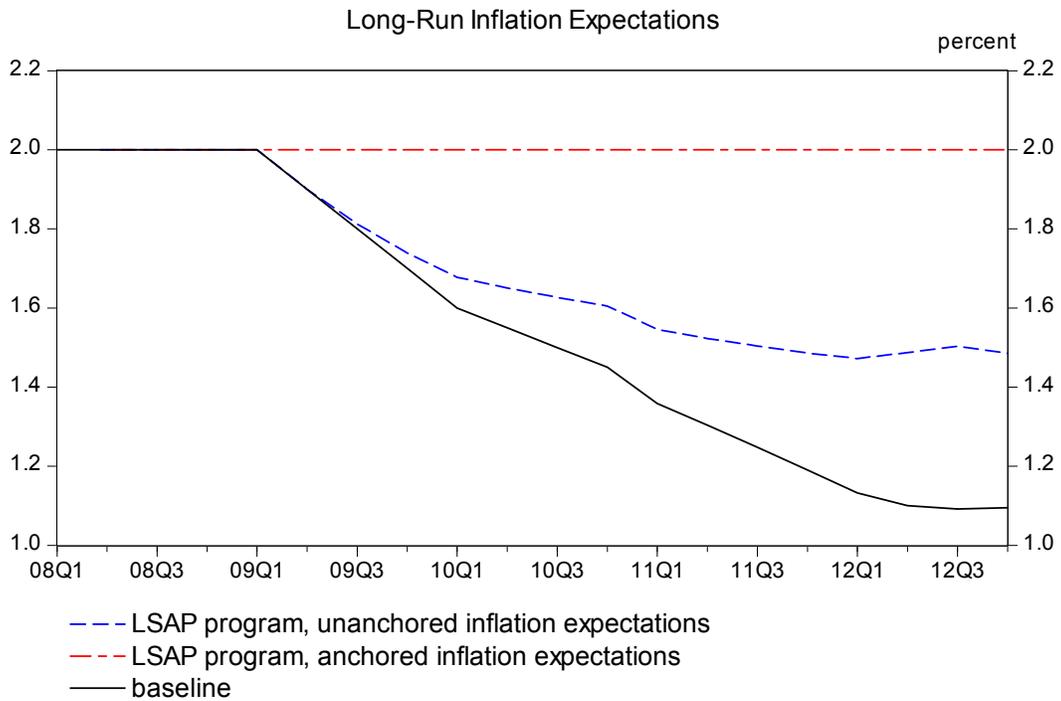
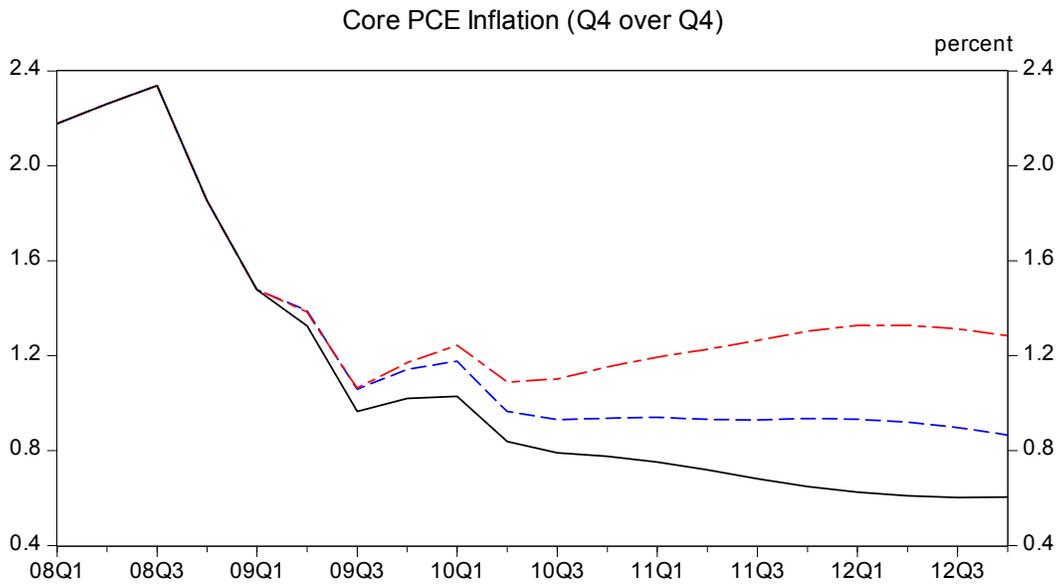
Table 3  
 Macroeconomic Effects of a \$1 Trillion LSAP Program,  
 Equally Divided Between Purchases of Treasury Securities and Agency MBS,  
 Under Different Assumptions for House Prices and Mortgage Refinancing Effects

	2009	2010	2011	2012
<i>Real GDP<sup>1</sup></i>				
Without house price and mortgage refinancing effects	.40	1.19	1.94	2.15
With refinancing effect and 2½% rise in house prices	.59	1.52	2.49	2.80
With refinancing effect and 15% rise in house prices	.63	2.03	4.11	5.30
<i>Unemployment rate<sup>2</sup></i>				
Without house price and mortgage refinancing effects	-.09	-.39	-.67	-.80
With refinancing effect and 2½% rise in house prices	-.15	-.51	-.87	-1.05
With refinancing effect and 15% rise in house prices	-.16	-.65	-1.39	-1.95
<i>Core PCE inflation<sup>3</sup></i>				
Without house price and mortgage refinancing effects	.12	.16	.29	.26
With refinancing effect and 2½% rise in house prices	.13	.20	.38	.35
With refinancing effect and 15% rise in house prices	.13	.22	.47	.50
<i>Federal funds rate<sup>2</sup></i>				
Without house price and mortgage refinancing effects	.00	.00	.00	2.15
With refinancing effect and 2½% rise in house prices	.00	.00	.30	2.97
With refinancing effect and 15% rise in house prices	.00	.00	2.06	5.93

Note: Results shown in the table are from FRB/US simulations using staff estimates for the interest rate effects of large-scale asset purchases. Announcement of the program is assumed to subtract 105 basis points from MBS yields and conventional home mortgage loan rates and 80 basis points from yields on corporate bonds and long-term Treasury securities. These direct effects on the level of long-term interest rates are assumed to persist through the end of 2011 but fade away beginning in 2012 as the Federal Reserve's position in long-term Treasury securities and agency MBS is gradually unwound. In all the simulations, the federal funds rate follows the Taylor rule subject to the zero bound constraint (which in the baseline binds through 2012). See text for details about the size of the refinancing effect.

1. Percent change from baseline in the Q4 level of real GDP.
2. Change from baseline in Q4 level.
3. Change from baseline in Q4-over-Q4 change in the PCE price index excluding food and energy.

**Figure 1**  
**Inflation Consequences of a \$1 Trillion LSAP Program**  
**Under Different Assumptions for Long-Run Inflation Expectations**



## Appendix

### The Effect of Interest Rates on House Prices In an Asset Valuation Model

Under a standard model of asset valuation, the price of a house,  $P$ , is expressed as

$$P = E / [(1-t)i - \pi + \delta + \rho],$$

where  $E$  is the current period service flow (akin to what the house would rent for),  $t$  is the marginal personal income tax rate,  $\pi$  is the expected rate of change in the price of housing services,  $\delta$  is the rate of depreciation on the house, and  $\rho$  is the “equity premium” on housing. The nominal rate of interest,  $i$ , is a weighted average of the mortgage rate and the opportunity cost of funds to the homeowner, where the weights represent the homeowner’s debt and equity respectively relative to the value of the house. The percentage change in the house price with respect to a percentage point change in the interest rate is thus  $(1-t) / [(1-t)i - \pi + \delta + \rho]$ .

If we observed  $\pi$  and  $\rho$  directly, we could use this expression to calibrate the expected sensitivity of house prices to interest rate changes from this expression. But, we do not have direct observations on either. However, because this expression is equivalent to  $(1-t) P/E$ , measures of house prices and imputed or actual rents can be used to estimate the interest-sensitivity. Data on house prices and rents compiled by Davis, Lehnert and Martin (“The Rent-Price Ratio for the Aggregate Stock of Owner-Occupied Housing,” 2008) suggest that the  $P/E$  ratio stood at just over 24 in the second quarter of 2008, compared to an average of about 20 since 1960. Allowing for a 10 percent decline in house prices since the middle of last year, the ratio would now be about 22.<sup>9</sup>

Assuming a marginal personal income tax rate of homeowners of 25 percent, a percentage point decline in long-term interest rates would imply a 16½ percent increase in house prices. Under an LSAP program of \$500 billion in Treasury securities and \$500 billion in agency MBS, the mortgage rate declines by 105 basis points and the yield on Treasuries by 80 basis points (the sum of the direct and spillover effects we assume for the separate LSAPs). Applying a weight of 55 percent to the decline in the mortgage rate (based on a ratio of aggregate mortgage debt to aggregate house values) and a weight of 45 percent to the decline in the Treasury yield (where we assume that the Treasury yield measures the opportunity cost of funds for homeowners), the change in the relevant interest rate for this calculation is 93 basis points. Thus, house prices would rise a bit more than 15 percent, given the staff assumptions for financial spillover effects discussed above.

---

<sup>9</sup> Time series for  $P$  and  $E$  were constructed from indexes of percent changes in prices and rents and converted to dollar figures by estimating the levels of price and rent for a base-year. Note that the base-year estimates permanently affect  $P/E$ ; that is, an estimate of base-year rent that is 5 percent lower results in a time series for  $P/E$  that is everywhere 5 percent higher. Accordingly, the sensitivity of house prices to interest rates would be estimated to be 5 percent higher. This sensitivity of  $P/E$  to the estimates of base-year price and rent should be kept in mind when using the constructed  $P/E$  ratio to gauge interest-sensitivity of house prices.