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Fed buy?**

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Analyzing Federal Reserve Asset Purchases: From whom does the Fed buy?¹

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Abstract:

Asset purchases have become an important monetary policy tool of the Federal Reserve in recent years. To date, most studies of the Federal Reserve's asset purchases have tried to measure the interest rate effects of the policies. Several papers provide evidence that these programs do have important effects on longer-term market interest rates. The theory of how asset purchases work, however, is less well developed. Some of the empirical studies point to "preferred habitat" models in which investors do not have the same objectives, and therefore prefer to hold different types and maturities of securities. We exploit Flow of Funds data to assess the types of investors that are selling to the Federal Reserve and their portfolio adjustment after these sales, which could provide a view to the plausibility of preferred habitat models and the transmission of unconventional monetary policy across asset markets. We find that the Federal Reserve is ultimately buying from only a handful of investor types, primarily households, with a different reaction to changes in Federal Reserve holdings of longer-term versus shorter-term assets. Although not evident for all investors, the key participants are shown to rebalance their portfolios toward more risky assets during this period. These results can be interpreted as supporting, at least in part, the preferred habit theory and the view that the monetary policy transmission is working across asset markets.

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Introduction

Asset purchases and sales (“asset programs”) have become an important tool of the Federal Reserve in recent years. The intent of the asset programs to date is to put downward pressure on longer-term interest rates in order to provide additional monetary policy accommodation when further reductions in the federal funds rate are constrained by the zero lower bound. Whether and how these tools of monetary policy are effective are critical questions for the economics profession. Because the tools are still relatively new, substantially less research exists compared to the literature that traces the effects of traditional monetary policy on the economy.

To date, most studies of the Federal Reserve’s asset programs have tried to answer whether these actions are effective at lowering longer-term interest rates and try to calibrate the interest rate effects of the policies. Several papers, such as Gagnon et al. (2011), D’Amico and King (2010), Krishnamurthy and Vissing-Jorgensen (2011), and Ihrig et al. (2012) provide evidence that the asset programs do have important effects in lowering longer-term market interest rates. These studies employ a variety of techniques, from event studies, to time-series regression, to modeling the yield curve. Although some look to explicit measures of changes in the supply of longer-term securities to the markets as explanatory variables, they do not, in general, rely on a theoretical model as a basis for the estimation.

Indeed, the general theory of how asset purchases and sales by the central bank works is less well developed. Vayanos and Vila (2009) and Li and Wei (2012) point to “preferred habitat” models to provide a rationale. Preferred habitat models assume that there is a variety of investor types who have dissimilar objectives and, therefore, prefer to hold different types and maturities of securities. In such models, buying longer-term securities can affect longer-term rates because

some investors are less willing to substitute into other assets. As a result, the prices of longer-term assets increase when the central bank decreases the supply of those assets relative to other assets.

In this paper, we exploit Flow of Funds data (described in the next section) to identify which types of investors are selling to the Federal Reserve during four different asset programs: the large-scale asset purchase program (LSAP) that took place from November 2008 to June 2010 (LSAP1); LSAP2, from November 2010 to June 2011; the maturity extension program (MEP), from September 2011 to December 2012; and the reinvestment program for proceeds of maturing and prepaying mortgage-backed securities, from August 2010 to December 2012. Then, knowing how these investors adjust the remainder of their portfolio provides some guidance on how monetary policy is transmitted across asset classes. Understanding which investors are willing to sell securities when the Federal Reserve conducts purchases could offer some support for preferred habitat models. More generally, understanding how Federal Reserve purchases affect the portfolios of private-sector investors may provide insight into how the tool works in various settings. Understanding investor preferences could also provide some guidance as to how an unwinding of the Federal Reserve's balance sheet may affect financial markets and hence shed some light onto the likely market response as the Federal Reserve exits from its accommodative policy stance.

Overall, our results suggest that the Federal Reserve is ultimately interacting with only a handful of investor types. Households (the group that includes hedge funds), broker-dealers, and insurance companies appear to be the largest sellers of Treasury securities when the Federal Reserve buys these securities. Households, investment companies, and to a lesser extent, pension funds, are the largest sellers of MBS when the Federal Reserve buys. With both the

Federal Reserve's Treasury and MBS purchases, our results suggest that households are the largest, ultimate seller. Moreover, different investor types appear to react dissimilarly to changes in Federal Reserve holdings of longer-term versus shorter-term assets. This latter result is relevant for considering the maturity extension program (MEP) under which the Federal Reserve has been selling shorter-dated Treasury securities and buying long-term Treasury securities. Overall, these results can be interpreted as supporting, at least in part, the preferred habitat theory.

Focusing on those investors that are participating in the Federal Reserve's asset programs, additional investigation shows how these investor types' portfolios are adjusting, which provides insight into the transmission of the Federal Reserve's asset purchases to broader financial markets. In particular, our results suggest that "households" – one of the investor classes most likely to sell to the Federal Reserve – reallocate their portfolios coincident with Federal Reserve purchases. Federal Reserve purchases of Treasury securities and MBS induce households to shift toward corporate bonds, commercial paper, and municipal debt and loans. In addition, when pension funds sell MBS to the Federal Reserve, they then shift their portfolio toward repurchase agreements, or very short-term assets. This evidence of shifting investors out of safe assets into riskier assets points to a credible monetary policy transmission channel for the effects of asset purchases on broader financial markets.

The remainder of this paper is as follows. We start with a discussion of the data. Then we focus on how the major investors and the Federal Reserve are interacting within the asset programs. From there we see how these investors rebalance their portfolios. Finally, we conclude.

Data

We focus our analysis on the low-frequency relationship of how securities move between the Federal Reserve and the ultimate counterparties. The Flow of Funds data published by the Federal Reserve Board provides, at a quarterly frequency, an accounting of holdings of different asset types by various entities.³ The data are measured in billions of dollars as a level at the end of the period, and are not seasonally adjusted. Of note, the actual asset purchases and sales—“open market operations”—that the Federal Reserve conducts are performed with the primary dealers as counterparties.⁴ However, the primary dealers may be, to some extent, a conduit between the Federal Reserve and the ultimate holder of the security. Specifically, for the primary dealers to be able to sell a substantial amount of securities to the Federal Reserve, they would have to buy those securities in the market. The purchases by the dealers could be done in anticipation of Federal Reserve purchases, and most programs have lasted several months to over a year. As such, a low-frequency analysis over a long period seems appropriate for uncovering the ultimate counterparties to the Federal Reserve. Additionally, for the sample covered in our analysis, there is not a series for agency MBS separate from that for agency debt. Consequently, our analysis focuses on changes in the holdings in both together for the different entity types. While this construction may bias our results to some degree, over this period, most of the Federal Reserve’s changes in holdings were of agency MBS, and as reported on selected GSE filings, the amount of agency MBS outstanding is about twice that of agency debt.

We use data beginning in 1991:Q1 and ending in 2012:Q3 for our analysis. As will be discussed below, we take a long sample to ensure that the results are not skewed by recent,

³ Flow of Funds data and information about the data are available at <http://www.federalreserve.gov/releases/z1/>.

⁴ The list of primary dealers is available on the website of the Federal Reserve Bank of New York. http://www.newyorkfed.org/markets/pridealers_current.html. A general discussion of open market operations is available at <http://www.newyorkfed.org/markets/openmarket.html>.

unusual actions by the Federal Reserve. To confirm that the results are indicative of the asset programs, however, we compare the results from this longer sample to various shorter samples, with some samples ranging from 2001 to present and others from 2007 to present. Because the data are quarterly, if we focus on the most recent period, the number of observations is necessarily limited and we must modify the specification.

We take the investor types that are available in the Flow of Funds and construct eight investor categories for our analysis. Those categories are: the rest of the world, depository institutions (DIs), insurance companies, investment funds, pension and retirement funds, state and local governments, broker-dealers, and households. Much attention in popular press has been given to the amount of U.S. debt, especially federal debt that is held by foreign investors. As a result, the “rest of the world” category is of particular interest. Because the asset programs have resulted in a large increase in the quantity of reserve balances in the banking sector, understanding if DIs have sold assets to the Federal Reserve sheds some light on the evolution of banks’ balance sheets over the course of the programs. Finally, it should be noted that the “household” category is perhaps a bit different than the label might imply. Given the conventions and information available in generating the Flow of Funds data, hedge funds are usually included in the “household” category. As a result, instead of reflecting the actions of “true” households which may be less sophisticated investors, this group in fact contains some of the more sophisticated investors who may be expected to arbitrage across markets.

Figure 1 displays the underlying data used in the analysis. As is evident from the plots, there are groups whose holdings fell off considerably after the start of the Federal Reserve’s asset programs, while others that did not to the same degree. This phenomenon was perhaps less pronounced for Treasury securities holdings than for MBS. As shown below, we find that,

controlling for other factors, there appears to be some reallocation of assets concurrent with Federal Reserve actions.

In measuring the Federal Reserve's purchases, we use various indicators of the Federal Reserve's holdings of assets, shorter-term, longer-term or total Treasury securities and agency MBS. These data come from the Federal Reserve Board's H.4.1 publication, in which the Federal Reserve's balance sheet is published on a weekly basis. The data used in the analysis are as of the quarter-end date, the same basis as the other Flow of Funds data.

Federal Reserve purchases from whom

This section walks through two general specifications to determine which entities sell securities to the Federal Reserve. The first is our baseline analysis, using an OLS specification, and the second is a modification to allow for panel estimation. We discuss each in turn. *Baseline specification*

To determine which investor types sell assets to the Federal Reserve, we begin with a series of regressions in which the dependent variables reflect changes in the asset holdings of a particular class of investor, and the independent variable of interest is changes in the Federal Reserve's holdings of securities. First, we consider a baseline regression where changes in each investor type's holdings of Treasury securities or mortgage-backed securities (MBS) are regressed on an autoregressive term as well as the change in the Federal Reserve's holdings of that particular security, after controlling for changes in the outstanding issuance of that security. That is,

$$D(Investor_{ij})_t = \alpha + \beta_2 D(Investor_{ij})_{t-1} + \beta_3 D(Fed_j)_t + \beta_4 D(Outstanding_j)_t + \varepsilon_t \quad (1)$$

where i is an index for the investment type that indicates the rest of the word, depository institutions (DIs), insurance companies, investment funds, pension and retirement funds, state and local governments, brokers and dealers, and households (HH); j indicates the security type, Treasury securities or MBS, such that $D(Investor_{ij})$ is the change in investor i 's nominal holdings of security j ; $D(Fed_j)$ is the change in the Federal Reserve's nominal holdings of security j ; and $D(Outstanding_j)$ is the change in the total outstanding nominal amount of security j . Finally, t is the time index at the quarterly frequency.

Table 1 shows the results from this baseline specification for Treasury securities. Each column in Table 1 refers to an investor type, as specified in equation (1). Tables 1-4 are estimated for two sub-samples: The first set of tables (Tables 1a-4a) is estimated from 1991:Q1 to 2012:Q3 and the second set (Tables 1b-4b) is estimated from 2001:Q1 to 2012:Q3 to focus more closely on the Federal Reserve asset purchase period.⁵ Our preliminary results in Table 1a suggest that households (which include hedge funds), broker-dealers, and insurance companies tend to be the ultimate sellers when the Federal Reserve buys Treasury securities (row 3). In addition, because we have a lagged dependent variable, the long-run effect needs to account for the partial adjustment. As a result, we also report $\frac{\beta_3}{1-\beta_2}$. (row 7). Of course, that sample period is significantly longer than the Federal Reserve's asset purchase programs, and dynamics in financial markets could have changed. However, as shown in the results presented in table 1b, the results are robust to a shorter sample.

In economic terms, as reported in the bottom panel of Table 1, we interpret these results to suggest that for LSAP1's \$300 billion purchase of Treasury securities, the Federal Reserve ultimately purchased about \$180 billion (roughly 60 percent) of these securities from

⁵ A sample that extends earlier than 1991 would have involved changes in the definition of investor types, without increasing the information on the period of asset purchases.

households, about \$45 billion from broker-dealers, and a smaller sum from insurance companies. The broker-dealer result is somewhat surprising, as the broker-dealers should in principle be simply a conduit. However, dealers changed the composition of their balance sheets over this period, and this phenomenon may influence our results to some degree.

To further assess whether some investors view different types of assets as more or less substitutable than others, we explore the sensitivity of our results by analyzing separately longer-term and shorter-term Treasury securities. In Table 2, we decompose the holdings of the Federal Reserve's Treasury securities into bills and coupon securities. Very early in the financial crisis the Federal Reserve ran down its holdings of bills as it offset the increase in reserves of depository institutions from the expansion of Federal Reserve lending. In contrast, the LSAPs involved purchases of longer-term Treasury securities, and the MEP had both sales of short-dated securities and purchases of longer-dated ones. The breakdown in Table 2 allows us to distinguish between shorter-term (row 3) and longer-term (row 4) securities. Our findings suggest that different investors are on the opposite sides of the transaction for bills than for coupon securities. Specifically, investment funds and insurance companies were the investor types that absorbed the decline in the Federal Reserve's holdings of bills, while households, broker-dealers, depository institutions, and insurance companies tended to be the ultimate sellers in transactions with the Federal Reserve. Focusing more closely on the asset program period in table 2b, the results are similar; in the shorter sample period, the results suggest that the rest of the world also increased bill holdings as Federal Reserve holdings declined. Tables 3a and 3b focus more specifically on the period when the Federal Reserve ran down its holdings of bills by adding an interactive dummy variable which is negative when the Federal Reserve reduced its bill holdings (row 4).

These results are similar to those reported above, and seem to suggest that insurance companies responded the most significantly to the runoff in the Federal Reserve's bill holdings.

Similar analysis is conducted for the Federal Reserve's purchases of MBS. As shown in Tables 4a and 4b, households (again, including hedge funds), investment companies, and pension and retirement funds are the ultimate sellers of these securities to the Federal Reserve (row 3). Based on the estimates from these regressions, of the \$1.25 trillion MBS purchases during LSAP1, we estimate that the Federal Reserve ultimately purchased nearly half of these securities from households and a bit over \$200 billion from investment companies.

Panel specification

The results reported above are suggestive, however, they do rely on sample periods that include a substantial amount of time that is a different regime from the asset programs. With quarterly data, restricting the sample to only the most recent years would severely restrict the degrees of freedom in the estimation. To address the concern that the results may not be fully indicative of the relevant period and yet have enough observations to allow for statistical inference, we estimate panel regressions with fixed effects where we pool the different investor types together but interact a dummy variable for each investor type with the change in the Federal Reserve's holdings of the securities. Doing so conserves degrees of freedom but comes at the expense of imposing that some of the coefficients are constant across investor types. We estimate this model for both Treasury securities and for MBS, and we estimate the model over the sample period 2001:Q1 to 2012:Q3 (as in Tables 1b-4b) and from 2007:Q1 to 2012:Q3. The longer period gives us more degrees of freedom for the estimation, whereas the shorter period focuses more directly on the Federal Reserve's programs. The results are fairly similar to the

previous ones, so we believe we are capturing results that are applicable to the asset program period.

As in the previous specification, the dependent variable is the change in holdings for the entity type. The independent variables are lagged changes in holdings, and changes in Fed holdings, allowing for a different coefficient for each entity type. For each holdings type, we estimated an Arellano–Bover/Blundell–Bond linear dynamic panel data estimator to account for the lagged dependent variable in our specifications. All specifications have cluster-robust standard errors. The single lag included in all of the specifications seems to be appropriate, according to results from an Arellano-Bond autocorrelation test.

As shown in Table 5, our panel specification suggests that a number of different entity types changed their holdings of Treasury securities and MBS in response to Fed purchases. The results are broadly similar across the two sample periods. For Treasury holdings, the results suggest that broker-dealers, households, and investment companies all experienced the opposite direction of a change in holdings in response to Fed changes in holdings – that is, if Fed holdings went down, then that entity type’s holdings went up, and vice versa. For MBS holdings, we also find instances of significant responses, and somewhat more frequently than for Treasury holdings. Broker-dealers, GSEs, households, investment companies, pension funds, and the rest of world, experienced opposing direction flows. These results bolster those reported above, as we generally find the same groups significantly changed holdings in response to Federal Reserve actions.

Portfolio rebalancing

Understanding what entity types sell securities to the Federal Reserve is instructive in discriminating across competing hypotheses for how the asset purchases work, especially in understanding the direct effect on Treasury securities. Krishnamurthy and Vissing-Jorgensen (2011) also ask how declines in Treasury yields spill over to yields on other assets. In principle, when the Federal Reserve buys safe, longer-term assets, it could induce investors to shift their portfolios toward other, potentially riskier assets, pushing down those yields. To examine that portfolio rebalancing effect, we investigate whether investor-types' portfolios changed in response to Federal Reserve actions.

The setup is as follows. We estimate a seemingly unrelated system of equations (SUR) for each investor type that appears to react significantly to Federal Reserve actions based on the previous regression results. We allow holdings of Treasury securities, MBS, corporate equity, corporate bonds, commercial paper, municipal securities and loans, and checkable deposits and currency to characterize the portfolios. We estimate the holdings of each of these assets as a separate equation in a system of seemingly unrelated regressions, regressing the asset holdings on Federal Reserve actions as we have done above, but also on other market measures that could affect portfolio holdings, such as the slope of the yield curve, risk spreads, and equity market volatility, all measured in basis points.

Table 6 shows the results from the SUR estimation. The results are only reported for those investor types that exhibit significant portfolio rebalancing behavior. The results are broadly consistent with those in the previous section. On the issue of whether there is evidence of portfolio rebalancing in the wake of Federal Reserve asset purchases, we examine whether an investor type increases their holdings of other assets when that investor's holdings of Treasury

securities (row 3) or MBS (row 4) declines in response to Federal Reserve asset purchases. We investigate this possibility for those entity types that showed significant decline in their holdings of Treasury securities or MBS in some of our earlier specifications. We are interested in finding out whether these investors increase their holdings of riskier assets. The only investor type for which there is a decline in the holdings of both Treasury and MBS in response to Federal Reserve asset purchases is the household category. Recall, from the analysis above, households are the largest seller to the Federal Reserve for both Treasury securities and MBS. Now we find that purchases of Treasury securities by the Federal Reserve induce households to shift these asset holdings toward corporate bonds, commercial paper, municipal debt and loans, and bank deposits; MBS purchases drive all of the same substitutions, except for bank deposits. In addition, when pension funds sell MBS to the Federal Reserve, they then shift their portfolio toward repurchase agreements, or very short-term assets. This evidence of shifting investors out of safe assets into riskier assets points to a credible channel for the effects of asset purchases on broader financial markets.

Conclusions and further research

In this paper, we tried to uncover the investor classes are the ultimate source of the securities that the Federal Reserve buys and how these investors then rebalance their portfolios. Understanding these questions points to parts of the mechanism through which the Federal Reserve's asset programs affect financial markets. We find that not all investor types sell to the Fed uniformly. Households (the group that includes hedge funds), broker-dealers, and insurance companies appear to be the largest sellers of Treasury securities when the Federal Reserve buys these securities. Households, investment companies, and to a lesser extent, pension funds, are the largest sellers of MBS when the Federal Reserve buys. When selling to the Fed, the

households seem to rebalance their portfolios toward corporate bonds, commercial paper, and municipal debt and loans, while pension funds shift their portfolio toward repurchase agreements, or very short-term assets.

These results suggest that there is some segmentation in the markets for these securities and so a preferred-habitat motivation may be plausible. In addition, we find evidence that Federal Reserve purchases do not simply affect the yields on the assets purchased, but also induce investors to buy other assets, putting downward pressure on other market rates, as well. We do not intend to say this is the last word on this topic but we aim to generate interest and start a fruitful discussion on this critical topic. A greater understanding of the time lag of how Federal Reserve asset purchases eventually affect private sector holdings is still required. Moreover, although these results may be consistent with a preferred habitat theory and the portfolio rebalancing channel to monetary policy transmission, the link is not definitive and more work will need to be done to tie these empirical results to theoretical work.

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Table 1a: Holdings of Treasury Securities (1991.Q1-2012.Q3)

	I	II	III	IV	V	VI	VII	VIII
	D(Rest of the World)	D(DIs)	D(Insurance)	D(Investment)	D(Pension and Retirement)	D(State and Local Gov't)	D(Brokers and Dealers)	D(HH)
1. Constant	12060.16**	-3627.41*	-202.10	1008.92	282.29	439.32	-7329.04*	-8101.26
	2.60	-1.78	-0.27	0.43	0.32	0.29	-1.65	-1.30
2. Lagged Dependent Variable	0.20**	0.03	0.58**	0.14	0.35**	0.26	-0.33**	0.04
	3.31	0.32	4.72	0.81	3.12	1.62	-4.87	0.45
3. D(Treasury_Fed) _t	-0.13	-0.04	-0.02*	-0.13	0.01	-0.01	-0.15**	-0.60**
	-1.49	-0.95	-1.81	-1.14	0.90	-0.77	-2.99	-3.89
4. D(Treasury_Outstanding) _t	0.36**	0.06**	0.01**	0.09	0.03**	0.00	0.13**	0.22**
	7.47	3.01	3.23	1.52	4.94	0.49	2.53	2.62
5. Adjusted R ²	0.64	0.16	0.41	0.23	0.43	0.04	0.23	0.26
6. Number of Observations	87	87	87	87	87	87	87	87
7. Memo: $\frac{\beta_3}{1-\beta_2}$	-0.16	-0.04	-0.04	-0.15	0.02	-0.01	-0.11	-0.62

t-statistics (based on Newey-West heteroskedasticity consistent standard errors) are below the coefficient estimates. *** indicates significance at 90%/95% level of significance

Implications of Coefficient Estimates (in \$billions)

	D(Treasury_Fed)	D(Insurance)	D(Brokers and Dealers)	D(HH)
		$\beta_3 \times D(\text{Treasury_Fed})$	$\beta_3 \times D(\text{Treasury_Fed})$	$\beta_3 \times D(\text{Treasury_Fed})$
LSAP1	\$300	-\$5	-\$45	-\$179
LSAP2	\$600	-\$10	-\$90	-\$358

Table 1b: Holdings of Treasury Securities (2001.Q1-2012.Q3)

	I	II	III	IV	V	VI	VII	VIII
	D(Rest of the World)	D(DIs)	D(Insurance)	D(Investment)	D(Pension and Retirement)	D(State and Local Gov't)	D(Brokers and Dealers)	D(HH)
1. Constant	22982.67**	-6228.77*	172.55	1152.97	772.75	4926.98**	-17069.44**	-18528.26*
	3.36	-1.94	0.14	0.22	0.47	5.55	-2.37	-1.68
2. Lagged Dependent Variable	0.13**	-0.08	0.64**	0.15	0.44**	-0.01	-0.33**	0.03
	2.16	-0.98	4.95	0.78	3.85	-0.06	-4.14	0.26
3. D(Treasury_Fed) _t	-0.13	-0.03	-0.02**	-0.13	0.01	0.00	-0.15**	-0.57**
	-1.49	-0.74	-2.10	-1.08	0.63	0.15	-2.69	-3.76
4. D(Treasury_Outstanding) _t	0.37**	0.06**	0.01**	0.09	0.03**	-0.01	0.16**	0.24**
	6.74	2.48	2.31	1.30	3.86	-0.97	2.70	2.42
5. Adjusted R ²	0.58	0.15	0.46	0.17	0.47	-0.04	0.24	0.23
6. Number of Observations	47							
7. Memo: $\frac{\beta_3}{1-\beta_2}$	-0.15	-0.03	-0.05	-0.15	0.01	0.00	-0.12	-0.59

t-statistics (based on Newey-West heteroskedasticity consistent standard errors) are below the coefficient estimates. ** indicates significance at 90%/95% level of significance

Table 2a: Holdings of Treasury Securities (1991.Q1-2012.Q3)

	I	II	III	IV	V	VI	VII	VIII
	D(Rest of the World)	D(DIs)	D(Insurance)	D(Investment)	D(Pension and Retirement)	D(State and Local Gov't)	D(Brokers and Dealers)	D(HH)
1. Constant	12052.64**	-3413.39*	-257.34	399.88	217.01	418.42	-7189.12*	-7293.71
	2.62	-1.65	-0.33	0.17	0.25	0.27	-1.66	-1.19
2. Lagged Dependent Variable	0.19**	0.03	0.60**	0.09	0.34**	0.26	-0.33**	0.01
	3.01	0.35	4.40	0.52	2.88	1.61	-4.66	0.15
3. D(Treasury_Fed_Bill) _t	-0.28	0.07	-0.06*	-0.54**	-0.03	-0.02	-0.06	-0.12
	-1.45	1.50	-1.75	-4.43	-1.43	-0.66	-0.41	-0.42
4. D(Treasury_Fed_Coupon+TIPS) _t	-0.11	-0.06*	-0.01**	-0.08	0.02	0.00	-0.16**	-0.68**
	-1.16	-1.65	-2.05	-0.96	0.98	-0.41	-2.41	-4.91
5. D(Treasury_Outstanding) _t	0.36**	0.06**	0.01**	0.09	0.03**	0.00	0.13**	0.24**
	7.35	3.08	2.77	1.41	4.82	0.45	2.44	2.64
6. Adjusted R ²	0.64	0.16	0.42	0.27	0.43	0.02	0.22	0.26
7. Number of Observations	87	87	87	87	87	87	87	87

t-statistics (based on Newey-West heteroskedasticity consistent standard errors) are below the coefficient estimates. ** indicates significance at 90%/95% level of significance

Table 2b: Holdings of Treasury Securities (2001.Q1-2012.Q3)

	I	II	III	IV	V	VI	VII	VIII
	D(Rest of the World)	D(DIs)	D(Insurance)	D(Investment)	D(Pension and Retirement)	D(State and Local Gov't)	D(Brokers and Dealers)	D(HH)
1. Constant	22415.11**	-5716.94*	-224.34	-1139.02	635.96	5109.51**	-17018.81**	-15657.96
	3.37	-1.69	-0.17	-0.20	0.38	5.83	-2.45	-1.39
2. Lagged Dependent Variable	0.12*	-0.07	0.71**	0.09	0.43**	-0.01	-0.32**	0.00
	1.85	-0.84	5.05	0.49	3.57	-0.04	-4.05	0.03
3. D(Treasury_Fed_Bill) _t	-0.34**	0.05	-0.08**	-0.57**	-0.02	0.03**	-0.14	-0.07
	-2.07	1.11	-2.70	-4.43	-0.97	2.04	-0.91	-0.25
4. D(Treasury_Fed_Coupon+TIPS) _t	-0.10	-0.04	-0.01**	-0.08	0.01	0.00	-0.16**	-0.66**
	-1.05	-1.17	-2.06	-0.87	0.70	-0.25	-2.13	-4.53
5. D(Treasury_Outstanding) _t	0.37**	0.06**	0.01*	0.09	0.03**	-0.01	0.16**	0.25**
	6.63	2.47	1.89	1.22	3.82	-0.89	2.62	2.33
6. Adjusted R ²	0.58	0.14	0.49	0.21	0.46	-0.06	0.22	0.23
7. Number of Observations	47	47	47	47	47	47	47	47

t-statistics (based on Newey-West heteroskedasticity consistent standard errors) are below the coefficient estimates. ** indicates significance at 90%/95% level of significance

Table 3a: Holdings of Treasury Securities (1991.Q1-2012.Q3)

	I	II	III	IV	V	VI	VII	VIII
	D(Rest of the World)	D(DIs)	D(Insurance)	D(Investment)	D(Pension and Retirement)	D(State and Local Gov't)	D(Brokers and Dealers)	D(HH)
1. Constant	11533.67**	-2216.69	-1569.73*	-2081.87	902.06	628.64	-6621.04	-4014.71
	2.36	-0.98	-1.70	-0.75	0.74	0.41	-1.35	-0.56
2. Lagged Dependent Variable	0.19**	0.04	0.56**	0.09	0.33**	0.27*	-0.33**	0.01
	2.99	0.40	4.25	0.49	2.79	1.64	-4.51	0.16
3. D(Treasury_Fed_Bill) _t	-0.14	-0.24	0.28**	0.12	-0.21	-0.07	-0.21	-0.99
	-0.19	-0.81	1.98	0.31	-1.14	-0.31	-0.26	-0.72
4. D(Treasury_Fed_Bill) _t × $D^{Negative}$	-0.15	0.35	-0.37**	-0.72*	0.20	0.06	0.16	0.95
	-0.21	1.11	-2.56	-1.77	1.04	0.25	0.19	0.67
5. D(Treasury_Fed_Coupon+TIPS) _t	-0.11	-0.06*	-0.01	-0.07	0.02	0.00	-0.16**	-0.69**
	-1.13	-1.77	-1.03	-0.87	0.88	-0.50	-2.31	-4.91
6. D(Treasury_Outstanding) _t	0.36**	0.06**	0.01**	0.09	0.03**	0.00	0.13**	0.23**
	7.45	3.00	3.39	1.47	4.76	0.42	2.46	2.64
7. Adjusted R ²	0.63	0.15	0.44	0.27	0.42	0.01	0.21	0.25
8. Number of Observations	87	87	87	87	87	87	87	87

t-statistics (based on Newey-West heteroskedasticity consistent standard errors) are below the coefficient estimates. */** indicates significance at 90%/95% level of significance

$D^{Negative}$ is a dummy variable that is one when D(Treasury_Fed_Bill)<0.

Table 3b: Holdings of Treasury Securities (2001.Q1-2012.Q3)

	I	II	III	IV	V	VI	VII	VIII
	D(Rest of the World)	D(DIs)	D(Insurance)	D(Investment)	D(Pension and Retirement)	D(State and Local Gov't)	D(Brokers and Dealers)	D(HH)
1. Constant	19927.22**	-4282.13	-1875.71	-4989.74	643.77	4490.90	-14106.92*	-10293.28
	2.50	-1.13	-1.32	-0.72	0.27	4.14	-1.80	-0.71
2. Lagged Dependent Variable	0.11*	-0.08	0.62**	0.09	0.43**	-0.01	-0.33**	0.00
	1.82	-0.87	4.96	0.47	3.46	-0.07	-3.99	-0.05
3. D(Treasury_Fed_Bill) _t	0.29	-0.30	0.35**	0.37	-0.02	0.19	-0.85	-1.37
	0.35	-0.50	2.17	0.58	-0.09	1.55	-0.93	-0.74
4. D(Treasury_Fed_Bill) _t × $D^{Negative}$	-0.67	0.37	-0.45**	-1.00	0.00	-0.16	0.76	1.40
	-0.73	0.60	-2.66	-1.50	0.01	-1.27	0.78	0.72
5. D(Treasury_Fed_Coupon+TIPS) _t	-0.10	-0.05	-0.01	-0.07	0.01	0.00	-0.16**	-0.68**
	-0.95	-1.26	-1.13	-0.77	0.68	-0.11	-2.10	-4.50
6. D(Treasury_Outstanding) _t	0.38**	0.06**	0.01**	0.10	0.03**	-0.01	0.15**	0.24**
	6.92	2.39	3.06	1.31	3.66	-0.76	2.56	2.25
7. Adjusted R ²	0.57	0.12	0.53	0.20	0.45	-0.08	0.20	0.21
8. Number of Observations	47	47	47	47	47	47	47	47

t-statistics (based on Newey-West heteroskedasticity consistent standard errors) are below the coefficient estimates. */** indicates significance at 90%/95% level of significance

$D^{Negative}$ is a dummy variable that is one when D(Treasury_Fed_Bill)<0.

Table 4a: Holdings of MBS (1991.Q1-2012.Q3)

	I	II	III	IV	V	VI	VII	VIII
	D(Rest of the World)	D(DIs)	D(Insurance)	D(Investment)	D(Pension and Retirement)	D(State and Local Gov't)	D(Brokers and Dealers)	D(HH)
1. Constant	5698.49	18102.61**	1612.43**	5541.08	1643.02	289.53	-172.88	-4162.87
	1.60	3.89	2.11	1.07	1.33	0.23	-0.05	-0.47
2. Lagged Dependent Variable	0.53**	0.07	0.55**	0.44**	0.34**	0.37**	-0.04	-0.04
	3.84	0.54	4.51	4.75	2.75	2.99	-0.24	-0.37
3. D(MBS_Fed) _t	-0.08	0.02	0.00	-0.18**	-0.06**	-0.01	-0.08	-0.45**
	-1.31	0.35	0.45	-3.84	-3.96	-0.94	-1.41	-2.57
4. D(MBS_Outstanding) _t	0.01	-0.04	0.00	0.07	0.02**	0.02	0.04	0.11
	0.21	-0.88	0.01	1.36	2.04	1.32	0.64	1.23
5. Adjusted R ²	0.36	-0.01	0.28	0.34	0.32	0.19	0.04	0.19
6. Number of Observations	87	87	87	87	87	87	87	87
7. Memo: $\frac{\beta_3}{1-\beta_2}$	-0.18	0.03	0.00	-0.33	-0.08	-0.02	-0.08	-0.44

t-statistics (based on Newey-West heteroskedasticity consistent standard errors) are below the coefficient estimates. ** indicates significance at 90%/95% level of significance

Implications of Coefficient Estimates (in \$billions)

	D(MBS_Fed)	D(Investment)	D(Pension and Retirement)	D(HH)
		$\beta_3 \times D(\text{MBS_Fed})$	$\beta_3 \times D(\text{MBS_Fed})$	$\beta_3 \times D(\text{MBS_Fed})$
LSAP1	\$1,250	-\$230	-\$70	-\$568

Table 4b: Holdings of MBS (2001.Q1-2012.Q3)

	I	II	III	IV	V	VI	VII	VIII
	D(Rest of the World)	D(DIs)	D(Insurance)	D(Investment)	D(Pension and Retirement)	D(State and Local Gov't)	D(Brokers and Dealers)	D(HH)
1. Constant	8295.88 1.17	24057.31** 3.36	698.23 0.91	10938.19 1.36	1596.80 0.87	915.30 0.65	1225.53 0.27	-10729.56 -0.85
2. Lagged Dependent Variable	0.52**	0.03	0.68**	0.46**	0.46**	0.57**	-0.06	-0.06
3. D(MBS_Fed) _t	2.97 -0.09	0.25 0.01	4.87 0.01	4.62 -0.20**	3.56 -0.05**	4.24 -0.01	-0.34 -0.09	-0.53 -0.45**
4. D(MBS_Outstanding) _t	-1.16 0.01 0.21	0.14 -0.06 -1.01	1.27 0.00 0.51	-3.46 0.06 1.06	-3.13 0.01 1.60	-0.86 0.00 0.38	-1.46 0.04 0.67	-2.58 0.09 0.91
5. Adjusted R ²	0.34	-0.04	0.43	0.34	0.43	0.34	0.02	0.16
6. Number of Observations	47							
7. Memo: $\frac{\beta_3}{1-\beta_2}$	-0.19	0.01	0.02	-0.37	-0.10	-0.02	-0.08	-0.42

t-statistics (based on Newey-West heteroskedasticity consistent standard errors) are below the coefficient estimates. ** indicates significance at 90%/95% level of significance

Table 5: Panel Estimation of Treasury and MBS Holdings (Post-2001)

Variable	2001-2012		2007-2012	
	Treasury	MBS	Treasury	MBS
1. Constant	15.78** (6.67)	6.60** (2.46)	32.65** (12.67)	5.22 (5.08)
2. Lag(Fed holdings)	0.17 (0.15)	0.14* (0.08)	0.08 (0.13)	0.11 (0.09)
3. Broker-dealers	-0.07** (0.03)	-0.07** (0.03)	-0.07** (0.03)	-0.08** (0.04)
4. Depository institutions	0.01 (0.03)	-0.05 (0.08)	-0.03 (0.05)	-0.08 (0.07)
5. GSEs	-0.02 (0.02)	-0.18** (0.06)	-0.05 (0.04)	-0.18** (0.06)
6. Households	-0.42** (0.01)	-0.38** (0.06)	-0.53** (0.01)	-0.38** (0.06)
7. Insurance companies	-0.01 (0.01)	-0.01 (0.01)	-0.02 (0.02)	-0.01 (0.02)
8. Investment funds	-0.12** (0.04)	-0.20** (0.02)	-0.14** (0.03)	-0.24** (0.02)
9. Pension funds	0.01 (0.02)	-0.08** (0.01)	-0.07 (0.07)	-0.07** (0.02)
10. Rest of world	0.08* (0.05)	-0.25** (0.05)	-0.08 (0.08)	-0.19** (0.06)
11. State and local governments	-0.01 (0.02)	-0.02** (0.01)	-0.06 (0.06)	0.00 (0.02)
12. Number of observations	405	405	189	189

Standard errors (based on clustered robust standard errors around each investor type) are below the coefficient estimates. **/** indicates significance at 90%/95% level of significance

Table 6: Portfolio Rebalancing Model (2001.Q1-2012.Q3)

HH

	Treasury	MBS	Corporate Equity	Corporate Bond	Open Market Paper or CP	Municipal Securities and Loans	Checkable Deposits and Currency
1.Constant	-36098.87**	-9022.58	-58570.02	-138045.80**	-1663.76	-36169.17**	-3778.59
	-1.94	-0.38	-1.62	-4.06	-1.10	-8.96	-0.29
2. Lagged Dependent variable	-0.06	-0.06	-0.03	-0.15*	0.66**	0.01	0.05
	-0.78	-0.44	-1.04	-1.76	7.48	0.42	0.51
3. D(Treasury_Fed) _t	-0.78**	0.04	0.36	0.51**	0.03**	0.12**	0.18**
	-6.02	0.23	1.49	3.14	2.57	4.26	1.97
4. D(MBS_Fed) _t	0.18	-0.40**	0.09	0.48**	0.06**	0.07**	0.03
	1.28	-2.40	0.38	2.84	5.50	2.42	0.35
5. D(Outstanding issuance) _t	0.28**	0.08	0.43**	0.74**	0.06	0.97**	0.19**
	5.07	1.00	22.08	9.12	5.60	59.57	3.04
6. (Tb10yr-Tb3m) _t	48.76	-10.29	45.43	169.65	0.66	54.21**	-3.54
	0.61	-0.11	0.30	1.50	0.10	3.13	-0.06
7. D(HY OAS) _t	-396.48**	31.32	195.07	492.22**	10.54	39.09**	135.37**
	-5.39	0.35	1.23	4.92	1.61	2.61	2.66
8. D(VIX) _t	70.60**	18.74	35.78	-41.87**	-0.98	0.01	-25.61**
	4.85	1.06	1.03	-2.26	-0.83	0.00	-2.49
Adjusted R ²	0.61	0.13	0.97	0.50	0.72	0.98	0.23

t-statistics (based on SUR estimation) are below the coefficient estimates. **/** indicates significance at 90%/95% level of significance

Pension Funds

	Treasury	MBS	Corporate Equity	Corporate Bond	Open Market Paper or CP	Fed Funds and Security Repos
1. Constant	5244.56**	3715.09	-21702.30*	6119.01	119.95	1130.23
	1.99	1.03	-1.65	1.12	0.09	1.19
2. Lagged Dependent variable	0.33**	0.46**	0.01	0.44**	0.02	-0.11
	3.29	4.02	0.39	3.85	0.20	-0.90
3. D(Treasury_Fed) _t	0.02	0.00	-0.23**	0.00	0.01	0.01*
	0.96	-0.07	-2.58	-0.13	0.69	1.74
4. D(MBS_Fed) _t	0.06**	-0.05**	-0.28**	0.02	0.01	0.02**
	2.88	-2.16	-3.23	0.88	1.04	2.59
5. D(Outstanding issuance) _t	0.03**	0.01	0.16**	0.00	0.03**	0.00
	3.29	1.00	23.65	-0.01	4.38	-0.31
6. (Tb10yr-Tb3m) _t	-21.31*	-9.06	105.94*	-17.08	-3.73	-8.24**
	-1.88	-0.64	1.91	-0.96	-0.66	-1.98
7. D(HY OAS) _t	-15.46	-2.06	-174.90**	6.91	6.64	13.67**
	-1.49	-0.17	-3.08	0.44	1.39	3.74
8. D(VIX) _t	3.34*	-0.20	-2.04	0.98	-0.97	-2.23**
	1.65	-0.08	-0.16	0.35	-0.99	-3.04
Adjusted R ²	0.61	0.38	0.98	0.28	0.25	0.15

t-statistics (based on SUR estimation) are below the coefficient estimates. */** indicates significance at 90%/95% level of significance

Figure 1: Holdings by sector

