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Foreign Official Institutions and the Market for U.S. Federal Agency Debt

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March 2007

Abstract

As the market for U.S. Federal Agency debt has matured over the past decade, these instruments have become increasingly viewed by market participants as a substitute for U.S. Treasury debt. Consistent with this, foreign investors (both official and private) have markedly ramped-up their holdings of Federal Agency securities. We document this participation and find that it is negatively correlated with attendant yield spreads for long maturities – consistent with substitutability. Additional, but preliminary, analysis suggests that foreign official and private account holdings appear to be similarly related to these yield spread reductions. If robust, this result suggests that foreign official purchases of Federal Agency debt do not convey any additional information to investors about the implied guarantee of Federal Agency debt by the U.S. government.

*The views expressed do not necessarily reflect those of the Federal Reserve Bank of Atlanta, the Federal Reserve System, or their staffs. We thank Eric Leeper, Jim Nason, and Tao Zha for helpful conversations about the macroeconomic implications of these issues. We also thank Federal Reserve Board staff for sharing the yield curve series' used in the paper. Vanessa Mitchell provided valuable research assistance. Helpful comments have been received from seminar participants at Keio University, Yokohama National University, and the University of Tokyo.

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I. Introduction

Foreign official institutions, primarily foreign governments and foreign central banks, hold a large and increasing fraction of U.S. Treasury securities. As of mid-year 2006, "foreign official holdings" were $1.3 trillion, a figure that had more than doubled over the previous five years.[1] Perhaps less well-known is that these foreign official institutions have also markedly increased their holdings of so-called U.S. Federal Agency securities in recent years to a level of roughly $415 billion.[2] Describing some potential causes and consequences of this latter trend is the subject of this paper. Specifically, we investigate whether this increase in foreign official holdings has had a measurable effect on the yield differential between Federal Agency and Treasury securities of the same maturity.

The primary explanation for the recent run-up in foreign official holdings of U.S. dollar-denominated assets is the desire of emerging market central banks to increase their liquidity by adding substantial foreign currency-denominated reserves.[3] This policy was first advocated by Feldstein (1999) in the wake of the Asian financial crisis and is documented by Rodrik (2006). The initial increase in the demand for U.S. dollar-denominated assets was also concurrent with a material contraction in the supply of new U.S. Treasury securities resulting from the U.S. federal budget surpluses of 1998-2001. Because Treasury securities have historically accounted for the

[1] See Flow of Funds Accounts, Board of Governors of the Federal Reserve System, Table L.107 ("Rest of the World"), line 9 "Treasury Securities, Official".

[2] See Flow of Funds Accounts, Board of Governors of the Federal Reserve System, Table L.107 ("Rest of the World"), line 12 "Agency -and GSE-Backed Securities, Official". This amount primarily reflects debt securities, but does include some mortgage-backed securities.

[3] Bernanke, Reinhart, and Sack (2004) note that, in some cases, the increased holdings may also be related to foreign central banks seeking to maintain currency values.

preponderance of U.S. dollar-denominated foreign reserve assets, they were the assets initially in the greatest demand. Taken together, these demand and supply forces put upward pressure on Treasury prices (or equivalently downward pressure on their yields) and led investors to consider alternative low-risk U.S. dollar assets. Federal Agency debt securities were the obvious choice given their minimal credit risk due to an implied federal guarantee, similar structural characteristics, and ample liquidity. Fleming (2000) and Fleming and Fabozzi (2001) describe this substitution activity and how it was enabled by the primary issuers of Federal Agency debt and Ambrose and King (2002) present related empirical evidence.

Virtually all of the roughly $2.7 trillion in Federal Agency debt obligations outstanding as of mid-year 2006 were issued by three housing-related government-sponsored enterprises (GSEs): Fannie Mae, Freddie Mac, and the Federal Home Loan Bank System.[4] Notably, GSEs are privately owned financial institutions and <u>not government agencies</u>. However, GSE-issued securities are perceived by investors to bear an implicit federal guarantee because of each institution's unique Congressional charter, extraordinary ongoing interactions with government officials, and past government actions to assist financially troubled GSEs. As a result of the perceived implicit guarantee, GSE debt securities generally trade at yields below those of any AAA-rated corporation but still offer a yield premium over comparable U.S. Treasury securities.

The recent increase in foreign official activity in the U.S. fixed income market may have had an effect on the prices of these securities (see, for example, Bernanke, Reinhart, and Sack, 2004).[5] For the Federal Agency market particularly, increased foreign official purchases could

[4] These three institutions accounted for $2.58 trillion of the just over $2.72 trillion of Federal Agency debt outstanding at that time (about 95 percent). See < http://www.bondmarkets.com/assets/files/RsrchQrtly_SIFMA-6.pdf>

[5] This is one of many possible contributors to the unusual flattening of the yield curve in the face of substantial monetary tightening during the mid-2000s. See Greenspan (2005a) and Bernanke (2006) for discussion.

affect prices through both increased demand as well as by possibly altering investor perceptions of the implied guarantee. In particular, sizable purchases of housing GSE debt by foreign official sources could further solidify existing market expectations that a federal guarantee exists. For example, financial market participants may infer that the U.S. Congress would be unwilling to impose losses on foreign governments in that event of a housing GSE insolvency.[6] If true, all investors would perceive a higher probability of bailout in the event of financial distress and hence require a lower risk premium.

This paper investigates whether foreign official holdings of Federal Agency debt contribute toward our understanding of the evolution of the yield premium on these securities relative to comparable Treasury securities. This research contributes along several lines. First, to our knowledge, this is the first paper that documents the dramatic increase in foreign official activity in the Federal Agency market. Economists and policymakers may need to be aware of this when evaluating certain implications of foreign (official) investment activity on interest rates and exchange rates. Second, while a voluminous literature describes the existence of conjectural guarantees (especially for large financial firms), we attempt to uncover whether investment activity by a potentially important investor class -- foreign official institutions – independently influences the dynamics of the yield spread. Third, the three housing GSEs that dominate the Federal Agency market are increasingly controversial participants in the financial services landscape. Indeed, the housing GSE investment portfolios funded with Federal Agency debt are believed by the Treasury and Federal Reserve to pose a systemic risk to the economy.[7] Finally,

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[6] Under current law, only Congress can affect resolution of an insolvent GSE. See Carnell (2005) and Wall, Eisenbeis, and Frame (2005) for further discussion.

[7] See public statements by former Treasury Secretary Snow (2005) and former Federal Reserve Board Chairman Greenspan (2005b). See also Eisenbeis, Frame, and Wall (2006) for a detailed discussion of the systemic risk posed by Fannie Mae and Freddie Mac and an analysis of policy options to deal with it.

while the Federal Agency debt market is of substantial size and importance, there are fewer published research articles about it than about other facets of the U.S. fixed-income market.[8]

II. Housing GSEs and Federal Agency Debt: Recent Developments

As noted previously, three housing-related GSEs dominate the Federal Agency debt market. Fannie Mae and Freddie Mac, which are both publicly traded companies listed on the NYSE, use the proceeds from their debt issues to fund portfolios largely comprised of mortgages and mortgage-backed securities. (Fannie Mae's and Freddie Mac's other primary line of business is the issuance of off-balance-sheet credit guarantees on pools of residential mortgages – a form of securitization.) The FHLB System, which is a collection of 12 cooperatively-owned wholesale banks, use their funds to make (generally mortgage-) collateralized loans to members (known as "advances") as well as to purchase mortgage-related assets in the secondary market. Frame and White (2005) and Flannery and Frame (2006) provide detailed background information on Fannie Mae/Freddie Mac and the FHLB System, respectively.

The housing GSEs largely fund their balance sheets (about $2.7 trillion on a consolidated basis) using Federal Agency debt and roughly maintain a 25:1 leverage ratio. As outlined in U.S. Congressional Budget Office (1996, 2001) and elsewhere, the GSEs' federal charters include several important provisions that shape investor perceptions that their obligations are federally guaranteed. These include the authorization of the Secretary of the Treasury to purchase a limited about of each housing GSEs securities (the so-called federal line-of-credit), the treatment of these GSEs' obligations as "government securities" under the Securities Exchange Act of 1934, and the

[8] There are some exceptions. Fleming (2000) and Fabozzi and Fleming (2001) provide overviews of the Federal Agency market. Several other studies have attempted to estimate the value of the implied guarantee for Federal Agency securities (Ambrose and Warga (1996, 2002), Nothaft, Pearce, and Stovanovich (2002), and Passmore, Sherlund, and Burgess (2005)). Finally, Ambrose and King (2002) analyze how the declining volume of Treasury debt during the late 1990s affected Federal Agency yield spreads.

requirement that the President appoint some of the Directors of each institution. Other factors further serve to fuel investor perceptions of an implied federal guarantee. For example, Congress has had a long and historic commitment to housing and has previously intervened to assist troubled GSEs (e.g., U.S. General Accounting Office 1990). Congress has also established regulators to oversee each institution's compliance with statutory mission and safety-and-soundness provisions. Finally, there has been regular movement of personnel between the housing GSEs (especially Fannie Mae and Freddie Mac) and the executive and legislative branches of government.

The market's perception of an implied guarantee results in housing GSE obligations being rated AAA even though their stand-alone ratings would be lower.[9] This borrowing advantage has been estimated empirically to be about 40 basis points, although these estimates vary significantly over time and depending upon the maturity and credit rating of the comparison bonds that were used.[10] Another implication of the perceived implied guarantee is that the housing GSEs face little market discipline, or market-induced constraints on their size and risk. This, in turn, has given rise to policymakers' concerns about systemic risk emanating from the housing GSEs.

The Federal Agency market has grown substantially in size and importance in recent years with the growth of Fannie Mae, Freddie Mac, and the Federal Home Loan Bank System. As of year-end 1990, the Federal Agency market stood at about $420 billion, or less than 20

[9] Fannie Mae and Freddie Mac receive AA- ratings from Standard and Poor's in terms of their "risk to the government". However, such ratings incorporate whatever government support or intervention the entity typically enjoys during the normal course of business. See Frame and Wall (2002) for a discussion.

Fannie Mae and Freddie Mac also receive "bank financial strength" ratings from Moody's (on an A-E scale), which were B+ (Fannie Mae) and A- (Freddie Mac) as of November 2005. These ratings are intended to measure the likelihood that a financial institution will require financial assistance from third parties, such as the government or shareholders. Importantly, in the case of Fannie Mae and Freddie Mac, the bank financial strength ratings consider (among other things) the companies' GSE status.

[10] See Ambrose and Warga (1996, 2002), Nothaft, Pearce, and Stevanovic (2002), and Passmore, Sherlund, and Burgess (2005).

percent of the size of the publicly-held U.S. Treasury market.[11] By 2003, the Federal Agency market had grown to roughly its current size ($2.6 trillion), which was almost 84 percent of the Treasury market at that time. Figure 1 illustrates these trends using quarterly data from the Flow of Funds.

During the early 1990s, both the Treasury and Federal Agency markets experienced growth. For the Federal Agency market, this likely reflected changes in the housing GSEs operating environments and incentives following the passage of legislation spurred by the 1980s thrift crisis. For example, the Financial Institutions Recovery and Reform Act of 1989 both transformed Freddie Mac into a publicly traded company and imposed tariffs on the FHLB System that made it more profit-oriented. The passage of the Federal Housing Enterprises Financial Safety and Soundness Act of 1992 created a safety-and-soundness regulator for Fannie Mae and Freddie Mac, suggesting some financial interest on the part of the U.S. government. The establishment of the regulator, therefore, may have strengthened investor perceptions of an implied guarantee of housing GSE obligations. This law also set statutory minimum capital requirements at levels below those for depository institutions, which likely encouraged growth in Fannie Mae's and Freddie Mac's asset portfolios (again largely funded with Federal Agency debt) via a process of regulatory capital arbitrage.

The rate of growth in the Federal Agency debt market increased during the late-1990s for some related reasons. First, a robust housing market led to growth in the level mortgage debt outstanding – a trend which has continued. For example, between 1995 and 2000, residential

[11] See Flow of Funds Accounts, Board of Governors of the Federal Reserve System, Tables L.209 (Line 3: "Other Treasury issues" less Line 12: "Monetary authority") and L.210 (Line 2: "Budget Agencies" plus Line 3: "Government-sponsored enterprises" less Line 11: "Monetary authority").

mortgage debt outstanding increased from $3.9 trillion to $5.6 trillion, a 44 percent increase.[12] Residential mortgage debt outstanding since grew to $10.5 trillion as of mid-year 2006. Such growth, coupled with the earlier changes in their operating environments, resulted in the housing GSEs seeking to purchase an increasing share of a growing mortgage market.[13]

In order to fund this growth, each housing GSE began "benchmark programs" that involve the regular issuance of coupon securities in large sizes and across maturities to produce a yield curve of liquid Federal Agency securities.[14] The roll-out of these programs coincided with the contraction of the supply of U.S. Treasury debt arising from government budget surpluses. This decreased Treasury debt supply arose through a combination of smaller offerings, less frequent auctions, and even the discontinuation of some securities like the 30-year bond. Thus, investors began considering substitute assets for dollar-denominated investment and other assets/indices as risk-free benchmarks, including Federal Agency debt (Fleming, 2000). This allowed the housing GSEs to attract investors that typically only purchased Treasury securities, like foreign central banks (Fabozzi and Fleming, 2001). Today, foreign central banks purchase almost 30 percent of new debt issuance offered by Fannie Mae and Freddie Mac.[15]

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[12] See Flow of Funds Accounts, Board of Governors of the Federal Reserve System, Table L.217 (Line 10: "Home" plus Line 3: "Multifamily residential").

[13] By law, Fannie Mae and Freddie Mac may only deal in "conforming" mortgages (or securities backed by such mortgages). The conforming loan limit is $417,000 for 2006. FHLB System mortgage investments are similarly backed only by conforming loans.

[14] Fannie Mae's program is called *Benchmark Notes* and Freddie Mac's is *Reference Notes*. The FHLB System actually runs two different, but related, programs: *Tap Issue Program* and *Global Debt Program*. Specific information about each of the benchmark programs can be found in the investor relations sections of each institution's web-sites: <www.fanniemae.com>, <www.freddiemac.com>, and <www.fhlb-of.com>.

[15] Fannie Mae and Freddie Mac disclose this information in their on-line newsletters. See, for example, <http://www.freddiemac.com/debt/pdf/refpoint_feb06.pdf> (Freddie Mac's Reference Point) or < http://www.fanniemae.com/markets/debt/pdf/fundingnotes_3_06.pdf;jsessionid=XMUTQ4TQKQ0LPJ2FQSISFGI> (Fannie Mae's Funding Notes). The GSEs actually report the percentage purchased by central banks, but since the Federal Reserve does not purchase GSE securities the figure can be assigned to the foreign institutions.

Since the end of 2003, the stock of Federal Agency debt has remained relatively constant, while Treasury supply has increased to finance U.S. deficits. However, the lack of growth in the Federal Agency market masks important differences across institutions. Generally speaking, this period is one in which several significant financial and/or accounting problems were uncovered at housing GSEs. Freddie Mac, which was found in 2003 to have engaged in earnings management, has seen little net portfolio growth since. Fannie Mae has shrunk since it was discovered in 2004 that the GSE has inappropriately applied hedge accounting rules and misclassified assets, over-stating its equity by $10.8 billion (Kopecki 2005). Finally, the FHLB System continued to grow during this time, although some individual FHLBs faced similar hedge accounting problems. Figure 2 illustrates these trends by providing monthly debt outstanding for Fannie Mae, Freddie Mac, and the FHLB System between first quarter of 2001 and the second quarter of 2006.[16]

3. Foreign Holdings of Federal Agency Debt

The Federal Reserve reports, on a quarterly basis, information about U.S. financial assets held by the "rest of world" that includes a break-down of foreign holdings of U.S. Treasury and Federal Agency securities according to whether they were in "official" or "private" accounts.[17] Figure 3 plots this information both in nominal dollar terms and as proportions of the total of Treasury and Federal Agency debt outstanding quarterly from 1996 to 2005.[18]

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[16] These data were obtained from each housing GSE. We begin in 2001 because that was the earliest information available for Fannie Mae. Freddie Mac provided this data back to 1999 and the FHLB System to 2000.

[17] See Flow of Funds Accounts, Board of Governors of the Federal Reserve System, Table L.107. "Official holdings" are recorded in Lines 10 and 11, while "Private holdings" are found in Lines 13 and 14.

[18] Note that the Federal Agency holdings recorded in the Flow of Funds Table L.107 include both debt and mortgage-backed securities. This leads to an overstatement of the proportion (concentration) of foreign holdings of Federal Agency securities. Data provided by U.S. Department of the Treasury, Federal Reserve Bank of New York, and Board of Governors of the Federal Reserve System (2005) indicates that, as of mid-year 2005, foreign private investors held about $200 billion in mortgage-backed securities issued by Fannie Mae, Freddie Mac, and Ginnie Mae

A couple things stand out here. First, foreign official holdings of Federal Agency securities have escalated from as little as $11 billion in 1995 (less than 2 percent of total Federal Agency debt outstanding) to over $415 billion in mid-year 2006 (nearly 16 percent of the total).[19] The sharp rise in Federal Agency debt holdings by foreign official institutions over the last decade is consistent with the previous discussion about both supply-side and demand-side developments. In particular, the housing GSEs reshaped their debt funding programs to mimic those of the U.S. Treasury and many foreign central banks sought to substantially increase their holdings of U.S. dollar-denominated assets.

Second, among foreign investors, those from "private" institutions appeared to be the "first movers" with respect to substituting U.S. Treasury securities for Federal Agency securities. Notice that during 1998 foreign private holdings of Treasuries begins to decline, but similar holdings of Federal Agency's expands. The expansion of foreign private holdings of Federal Agency securities continued until 2003 when the Freddie Mac accounting scandal came to light. Interestingly, it does not appear that foreign official holdings of Federal Agency securities reacted to this news.

One interpretation of these trends is simply inertia in the investment behavior of foreign official institutions.[20] These institutions traditionally purchased Treasury securities as their U.S. dollar reserve assets and are arguably less sensitive to yield spreads. At some point, foreign official institutions may have made a policy decision to purchase Federal Agency securities –

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and foreign official accounts for another $63 billion. Hence, of the $415 billion of Federal Agency securities in foreign official accounts, about $63 billion (15 percent) of it is mortgage-backed securities.

[19] As noted previously, the foreign holdings of Federal Agency securities includes some amount of mortgage-backed securities, which will bias these figures upward. Nevertheless, the general inference should remain unchanged.

[20] An alternative interpretation may relate to foreign official institutions using private accounts to manage some of their investments.

most likely owing to the contraction in the supply of new Treasury issues, coupled with their own desire to ramp-up reserves. Once this policy was put into place, it does not appear that the foreign official institutions changed course in light of breaking news events regarding the individual housing GSEs.

The emergence of foreign official institutions as significant purchasers of Federal Agency debt may also have had implications for the yield spreads on these securities (over comparable Treasury securities). On one hand, these purchases reflect a new and significant source of demand, which would have put downward pressure on Federal Agency yields. At the same time, the substitution away from Treasury debt (to Federal Agency debt) reduces upward pressure on Treasury yields through reduced demand for these assets. The net effect on Federal Agency yield spreads is hence theoretically ambiguous. A secondary effect could result from changes in investor perceptions about the strength of an implied guarantee for Federal Agency securities. That is, market participants may infer that the U.S. government may be more likely to intervene in the event of GSE financial distress if there is a non-trivial proportion of GSE debt held by foreign official sources.[21] In this case, a net increase in the proportion of foreign official holdings of Federal Agency debt would be associated with a reduction in the Federal Agency – Treasury yield spread.

Figure 4 relates quarterly data on foreign holdings of Federal Agency debt (the sum of "private and "official") as a proportion of total Federal Agency debt outstanding to quarterly constant maturity yield spreads on 5-year and 10-year Fannie Mae debt relative to comparable

[21] Closely related to this is the notion of a "convenience yield" for Federal Agency securities as these instruments become increasingly accepted as Treasury surrogates (e.g., Krishnamurthy and Vissing-Jorgensen, 2006).

Treasury yields over the between 1997 and mid-year 2006.[22] These series are strongly negatively correlated**,** although notably different within sub-samples.[23] While this suggests an empirical relationship, there are a number of other potentially important related developments that occurred in financial markets generally and the Federal Agency market particularly during this time that bear consideration. First, as noted above the market for Federal Agency debt expanded rapidly during this time both in levels as well as a proportion of government-related debt (the sum of the Treasury and Federal Agency markets). Second, at least the latter part of this period was characterized by historically low interest rate levels, a flat yield curve, and low credit risk premia in the United States.

To study these relationships further, we specify a simple linear regression that relates the yield spread on Federal Agency debt securities to several financial market indicators. (We emphasize that the regression provides a motivating framework for our analysis, rather than any assumption about structure.) The dependent variable *SPREAD* is defined as the difference between the Fannie Mae and Treasury constant maturity yields for the 5- and 10-year maturities -- measured on the last day of each quarter between 1997:Q1 and 2006:Q1. Our primary independent variable of interest is the amount of Federal Agency securities held by foreign investors as a proportion of total Federal Agency debt outstanding (*FOREIGNRATIO*). We interpret this measure as an indicator of the marginal demand for Federal Agency debt. We also include total Federal Agency debt outstanding as a proportion of the sum of the aggregate quantities of Treasury and Federal Agency debt outstanding (*AGENCYRATIO*), and interpret this

[22] Quarterly constant maturity bond yield data are available through Fannie Mae's web-site for various maturities (3-month to 30-years) and on a daily frequency back to August 12, 1996. The Treasury constant maturity series are available from the Board of Governors of the Federal Reserve web-site.

[23] Between 1997 and 2002, the correlation between the proportion of Federal Agency debt held by foreigners and their yield spread is slightly positive (about 0.2 for the 10-year spread). However, this correlation becomes strongly negative (about -0.7 for the 10-year spread) over the 2002 to 2006 period.

proportion as a proximate measure of net Federal Agency debt supply. Both *FOREIGNRATIO* and *AGENCYRATIO* enter our regression specification (below) in logarithmic form to moderate the curvature of the ratios over this period. Results using the simple ratio are similar.

Consistent with the literature examining variation in bond yield spreads, we include variables that capture interest rate levels as well as the term structure of interest rates (e.g., Duffee 1998). These are the interest rate on the three-month constant maturity Treasury bill (*3MTBILL*) and the difference between the constant maturity 10-year Treasury bond and similar three-month Treasury bill (*TERMSPREAD*). These data come from the Board of Governors website. We also account for the general movement in credit risk premia for long-term bonds by including the difference between the composite yield on the Moody's BAA and AAA bond indices at the 10-year maturity (*RISKSPREAD*).

Equation (1) provides our general specification, which is estimated for both the 5-year and 10-year Fannie Mae constant maturity yield spreads using various specifications. Estimating (1) using all contemporaneous values may be problematic because some of the right-hand-side variables may be jointly determined with SPREAD. As a result, we estimate each regression using instrumental variables using the lagged values of the right-hand-side variables as instruments.

$$(1) \qquad SPREAD_t = ß_0 + ß_1\, ln(FOREIGNRATIO_t) + ß_2\, ln(AGENCYRATIO_t) + ß_3\, 3MTBILL_t + ß_4\, TERMSPREAD_t + ß_5\, RISKSPREAD_t + \varepsilon_t$$

Table 1 presents some descriptive evidence concerning the recent relationship between foreign investment in Federal Agency securities and the yield spreads on Federal Agency debt.

First, note that the coefficient on ln(FOREIGNRATIO) is negative and statistically significant for both the 5- and 10-year yield spread analysis. This suggests that increased foreign investment in Federal Agency securities (combined official and private) is associated with reduced Federal Agency yield spreads. Second, the coefficient on ln(AGENCYRATIO) is positive and statistically significant, which is consistent with the anticipated effect on the yield spread of an increase in the supply of Federal Agency relative to Treasury debt. Of the other regressors, only the 3MTBILL appears to be potentially important, suggesting a positive effect of level of the short term interest rate on the SPREAD. Figure 5a displays the fitted value from the estimation of the 10-year Fannie Mae yield spread to its actual value – i.e., SPREAD.

Instrumental variables estimates may suffer from a "weak instruments problem" in the event that the instruments are only weakly correlated with the variables of interest. In this case, estimated standard errors would be biased downward, thereby limiting the usefulness of t-statistics for inference. In order to make inferences that are robust irrespective of the presence of weak instruments, we calculate Anderson-Rubin test statistics to examine whether the two coefficients of interest are nonzero.[24] Table 2 presents the Anderson-Rubin statistics for the specifications in column 3 of Table 1. When the two coefficients are tested jointly, the instruments provide little additional information for isolating the precise coefficient value estimates when the two coefficients range within a specific range. The coefficient for ln(AGENCYRATIO) ranges from 0.9 to 1.5 and the coefficient for ln(FOREIGNRATIO) between -.6 and -1.1. These ranges are relatively tight and provide sufficient support for our contention that the supply proxy has a positive effect on the yield spread and the demand proxy has a negative effect on the yield spread.

[24] See Stock, Wright, and Yogo (2002) and Nason and Smith (2006) for recent applications of this test.

The results provided in Tables 1 and 2 support the idea that increased foreign holdings of Federal Agency securities is associated with tighter Federal Agency debt spreads. We would like to push further and examine whether we can isolate this effect as coming from foreign private or foreign official sources. While both are sources of demand, foreign official holdings of Federal Agency debt may also affect perceptions about the implied federal guarantee of these obligations. For this exercise we replace *ln(FOREIGNRATIO)* with two variables: the (log) ratio of foreign official Federal Agency security holdings to total Federal Agency debt outstanding – *ln(FOROFFRATIO)* -- and the (log) ratio of foreign private Federal Agency security holdings to total federal Agency debt outstanding – *ln(FORPRVRATIO)*. Equation (2) illustrates the recast empirical relationship. As before, we estimate a series of regressions -- each using instrumental variables using lagged values of the right-hand-side variables.

(2) $$SPREAD_t = ß_0 + ß_1\, ln(FOROFFRATIO_t) + ß_2\, ln(FORPRVRATIO_t) + ß_3\, ln(AGENCYRATIO_t) + ß_4\, 3MTBILL_t + ß_5\, TERMSPREAD_{t+} ß_6\, RISKSPREAD_t + \varepsilon_t$$

Table 3 presents these results. Foreign private and official holdings both appear to be negatively related to Federal Agency yield spreads. These results are generally statistically significant, with the exception of the foreign private holdings in the 10-year yield spread regression. The supply of Federal Agency debt (relative to the sum of the Treasury and Federal Agency debt markets) is found to be positively related to yield spreads. Of the other regressors, again only the 3MTBILL appears to be potentially important and is positively related to the Federal Agency yield spread. Figure 5b displays the fitted value from the estimation of the 10-year Fannie Mae yield spread to its actual value.

As above, we also conduct Anderson-Rubin tests, although this time focused exclusively on the two ratios for foreign holdings (FOROFFRATIO and FORPRVRATIO). The results are reported in Table 4. The coefficient estimates both carry the anticipated sign (negative) and appear to be significantly different from zero. However, in this case, the Anderson-Rubin statistics for the joint coefficient tests signal that there is a fairly wide range of values over which the instruments appear to have little additional information for the coefficient estimates. In other words, the instruments cannot help us distinguish precisely between values for the two coefficients that range from 0.3 to -0.9 for ln(FORPRVRATIO) and from -0.1 to -0.7 for ln(FOROFFRATIO). The ranges are bounded away from zero and the sum of the coefficients hovers between -0.6 and -0.8, which is (not surprisingly) the range of values for the aggregated variable examined previously – ln(FOREIGNRATIO).

The results in Table 4 suggest that we cannot distinguish whether foreign official holdings have an effect on Federal Agency debt yields – above and beyond that conveyed by foreign purchases generally. Overall, the estimates for our motivating single equation regressions (1) and (2) above provide some suggestive correlations between the "risk spread" on Federal Agency debt yields (relative to Treasury yields) and some quarterly quantity data that are unavailable on a higher frequency. In the next section, we examine a subset of these series in a vector autoregression framework in an attempt to capture the dynamics of the data using an alternative empirical approach. Again, the investigation concentrates on descriptive analysis and purposely avoids any structural interpretation.

IV. Evidence from Vector Autoregressions

We further investigate the relationship between foreign (official and private) holdings of Federal Agency securities and long-term (5- and 10-year) Federal Agency debt spreads using a

vector autoregression (VAR) that includes the same data series (and data transformations) as we used in the motivating regressions above**.** The VAR that will be the basis for our empirical analysis can be written as:

(3) $Y_t = ß_0 + ß_1 Y_{t-1} + \ldots + ß_p Y_{t-p} + u_t$

where Y_t denotes an $m\times1$ vector of current dated observations for period t on the m variables in the VAR; the $ß_i$ are $m\times m$ coefficient matrices; and $ß_0$ is an $m\times1$ vector of constant terms. The error term is defined as where ε_t is assumed to be a Normal and independently distributed $m\times1$ vector such that $E[\varepsilon_t | y_{t-s}, s>0] = 0$ and $E[\varepsilon_t \varepsilon_t' | y_{t-s}, s>0] = I$ for all t; and A is a non-singular $m\times m$ matrix so that the covariance of u_t is $\Sigma = A^{-1}A^{-1'}$. In our applications, we normalize A to be an upper triangular Choleski factorization of Σ, which implies no a priori restrictions on Σ (i.e, the VAR is exactly identified).

We begin by specifying a four variable VAR ordered as *3MTBILL*, *ln(FOREIGNRATIO)*, *ln(AGENCYRATIO)*, and *SPREAD* – each as defined previously. The choice of variable ordering determines the Choleski decomposition; and the given ordering implies that innovations associated with the short-term interest rate do not respond to movements in contemporaneous innovations associated with the other three variables. Similarly, innovations associated with FOREIGNRATIO respond contemporaneously to innovations associated with 3MTBILL, but not to innovations associated with the remaining two variables. Innovations associated with AGENCYRATIO respond to innovations associated with 3MTBILL and FOREIGNRATIO, but not to innovations associated with SPREAD. Finally, innovations associated with SPREAD respond to contemporaneous innovations associated with all other series in the VAR.

We offer only empirical justification for this ordering. We place the Federal Agency yield spread last in ordering to allow the other innovations to have the maximum explanatory

power for yield spread dynamics. Any financial variable is more likely to respond to innovations within the quarter than the quantity series, however, we did not want to put the hypothesized quantity measures as first in the ordering. That placement would likely maximize its explanatory power, so instead we put 3MTBILL first

We estimate the model for 1997:Q1 to 2006:Q2 (*T=38*) and using both the 5-year and 10-year Fannie Mae yield spreads. We exclude *TERMSPREAD* and *RISKSPREAD* from the VAR because these variables were found to be unimportant in the motivating regressions. In addition, we have relatively few quarterly observations so adding two more variables to the VAR would be extremely costly in terms of degrees of freedom.

Over-parameterization is a concern for multivariate models like VARs (e.g., Fair and Shiller 1990; Wallis 1989) – especially in small samples. To address this issue, we introduce a Bayesian prior that imposes inexact prior restrictions on the distribution of the VAR coefficients. Specifically, we use the prior and hyper-parameter values presented by Sims and Zha (1998).[25] The Bayesian estimation reduces the variability of the VAR coefficient estimates, which then has the observable effect of smoothing out the shape of the impulse response functions. In this empirical exercise, we focus attention on the impulse responses so the prior improves the interpretability of the graphical output. To assess statistical importance of the impulse response results, we generate 1000 random draws of a Monte Carlo experiment for each estimated VAR and use 68 percent error bands, that is, 2/3 probability bounds for assessing the impulse responses.

[25] Intuitively, the Sims-Zha prior is a restricted version of the standard Litterman (1986) prior and reflects the expectation that each series is a random walk, with the variance of the lag coefficients inversely related to the lag length. Thus, coefficients on distant lags are shrunk more sharply toward zero. Unlike the Litterman prior, the Sims-Zha prior makes no distinction between the prior variance of coefficients on the lags of the dependent variable and those of other variables in each equation. We use hyperparameter values as follows: $\lambda_0 = 1$; $\lambda_1 = 0.1$; $\lambda_2 = \lambda_3 = \lambda_4 = 1$; $\mu_5 = \mu_6 = 1$. These are the same as in Sims and Zha (1998) except for λ_1, which was 0.2 in that paper. In words, we tighten the random walk prior in this setting. For a discussion of the prior and of the hyperparameters, see Robertson and Tallman (1999) pages 8-10.

Preliminary results based on the aforementioned VARs are illustrated by the impulse response functions displayed in Figure 6 (using the Fannie Mae 10-year yield spread) and Figure 7 (using the Fannie Mae 5-year yield spread). The bottom row of each Figure presents impulse responses of the Fannie Mae yield spread to an "orthogonalized" innovation (unpredicted change) in the variable listed at the top of each column. In our investigation, we are most interested in the results for innovations in the amount of Federal Agency securities held by foreign investors as a proportion of total Federal Agency debt outstanding. In the second column of the bottom row of both Figures 6 and 7, we see that a one-standard deviation innovation to the ln(FOREIGNRATIO) measure generates a negative response in the Fannie Mae yield spread that lingers for several quarters. The point estimate of this effect suggests a reduction in the yield spread by as much as 2.5 basis points and the 0.68 probability error bounds are both below the zero line for several quarters, suggesting that this effect may be important statistically. Overall, it appears that an increase in foreign ownership proportion of Federal Agency debt results in a slightly smaller yield spread. One may view this as being consistent with foreign investors acting as the marginal source of demand for Federal Agency debt.

In the next stage, we focus on whether the Fannie Mae yield spread reduction reflects the effect of a change in the proportion of Federal Agency debt held by foreign official sources (FOROFFRATIO) and/or foreign private investors (FORPRVRATIO). This expands the VAR to five variables because we replace one measure (FOREIGNRATIO) with the two just listed.

Figures 8 and 9 present impulse response results for the augmented specification of the VAR model, again estimated with the Sims-Zha prior. The impulse response functions suggest that innovations to the FOROFFRATIO reduce the Fannie Mae yield spreads, but the 68 percent error bounds include zero. In contrast, the impulse responses show that innovations to

FORPRVRATIO affect the Fannie Mae yield spreads negatively, and the error bounds do not include zero. As a result, these results do not support the idea that a rising proportion of foreign official ownership of Federal Agency debt outstanding alters market perception of the implicit federal guarantee of the housing GSE debt.[26]

We caution that all of our results are preliminary at this point and that the short time series sample limits our ability to draw strong conclusions. We are exploring alternative data series and sources available, but each has its weaknesses. For one example, foreign official holdings of US Treasury debt and of US Federal Agency securities are available on a weekly frequency, although those data series do not begin until February 2000. However, neither weekly nor monthly series containing foreign private holdings of these same instruments is available. The ongoing accounting restatements at each housing GSE has also hampered our efforts to collect higher frequency data on total debt outstanding. Alternatively, we are considering approaching the problem by using quarterly data series that are interpolated into monthly series.

V. Conclusions

The market for U.S. Federal Agency debt has matured over the past 10-15 years and now stands at roughly $2.7 trillion outstanding. Virtually all of these securities have been issued by three financial institutions: Fannie Mae, Freddie Mac, and the Federal Home Loan Bank System. The obligations of these government-sponsored enterprises are perceived by investors to be

[26] We note that the impulse responses for the unrestricted OLS VAR are generally consistent with the results from the Bayesian VAR estimation. However, the unrestricted VAR suffers from imprecise parameter estimates, which is seen in jagged impulse response functions. We note that the results for the five variable VAR without the prior indicate some support for the foreign official agency ratio having a negative effect on the yield spread bounded away from zero. This is different from what is found when estimating the model using the prior.

implicitly guarantees by the U.S. government – and as such have increasingly become viewed as as a substitute for U.S. Treasury debt.

Foreign investors (both official and private) have markedly ramped-up their holdings of Federal Agency securities in recent years. We document this trend and find that the proportion of agency debt held by foreigners is negatively correlated with long dated Federal Agency yield spreads (to Treasuries) – consistent with substitutability. Additional analysis attempts to decipher whether the proportion of agency debt held by foreign official sources offers a distinct contribution to the decline in the agency treasury spread. Preliminary evidence suggests that foreign official account holdings and private account holdings have similar effects on these yield spreads. If robust, this result suggests that foreign official purchases of Federal Agency debt do not convey any additional information to investors that can be interpreted as related to the implied guarantee of Federal Agency debt by the U.S. government. We continue to explore alternative data and methodological approaches to better understand the relationship between foreign holdings of Federal Agency debt and the attendant yield spreads.

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Table 1
Yield Spread Regressions

Instrumental variables regressions for *SPREAD*, which is the daily quarter-end difference in the yield spread on constant maturity 5-year and 10-year Fannie Mae bonds with comparable U.S. Treasury bonds. One-period lagged values act as the instruments for each of the right-hand-side variables. *FOREIGNRATIO* is the dollar amount of Federal Agency securities held by foreign investors as a proportion of total Federal Agency debt outstanding. *AGENCYRATIO* equals total Federal Agency debt outstanding as a proportion of the sum of the aggregate quantities of Treasury and Federal Agency debt outstanding. *3MTBILL* is the three-month constant maturity Treasury bill; *TERMSPREAD* is the difference between the constant maturity 10-year Treasury bond and similar three-month Treasury bill; and *RISKSPREAD* is the difference between the composite yield on the Moody's BAA and AAA seasoned bond indices at the 10 year maturity. The sample covers 1997:Q1-2006:Q1, or 37 observations. T-Statistics in parentheses. Significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	5-Year Federal Agency Yield Spread			10-Year Federal Agency Yield Spread		
Constant	0.113	0.049	0.544**	0.028	-0.056	0.107
	(0.48)	(0.26)	(2.34)	(0.11)	(-0.28)	(0.40)
Log(FOREIGNRATIO)	-0.218	-0.693***	-0.587***	-0.380**	-1.015***	-0.690***
	(-1.33)	(-3.97)	(-4.12)	(-2.02)	(-5.56)	(-4.19)
Log(AGENCYRATIO)		0.612***	1.091***		0.817***	1.281***
		(4.29)	(8.78)		(5.48)	(8.94)
3MTBILL			0.075			0.107***
			(1.61)			(3.19)
TERMSPREAD			-0.032			0.083
			(-0.51)			(1.16)
RISKSPREAD			-0.097			0.041
			(-0.71)			(0.26)

Table 2
Anderson-Rubin Statistics

Anderson-Rubin test statistics of the joint hypothesis relating to the values of $ß_1$ and $ß_2$ from the following regression specification:

(1) $SPREAD_t = ß_0 + ß_1\, ln(FOREIGNRATIO_t) + ß_2\, ln(AGENCYRATIO_t) + ß_3\, 3MTBILL_t + ß_4\, TERMSPREAD_t + ß_5\, RISKSPREAD_t + \varepsilon_t$

Coefficient values for $ß_1$ are presented in the leftmost column and those for $ß_2$ along the top row. A * indicates instances where the joint hypothesis is rejected.

	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
-0.2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-0.3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-0.4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-0.5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-0.6	*	*	*	*	*	*	*	0.05	0.11	0.14	0.10	*	*	*	*	*	*
-0.7	*	*	*	*	*	*	*	0.06	0.17	0.27	0.26	0.14	*	*	*	*	*
-0.8	*	*	*	*	*	*	*	*	0.15	0.31	0.38	0.28	0.12	*	*	*	*
-0.9	*	*	*	*	*	*	*	*	0.08	0.21	0.34	0.31	0.17	0.05	*	*	*
-1.0	*	*	*	*	*	*	*	*	*	0.08	0.17	0.20	0.14	0.06	*	*	*
-1.1	*	*	*	*	*	*	*	*	*	*	*	0.08	0.07	*	*	*	*
-1.2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-1.3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-1.4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-1.5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-1.6	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-1.7	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-1.8	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Table 3
Yield Spread Regressions

Instrumental variables regressions for *SPREAD*, which is the daily quarter-end difference in the yield spread on constant maturity 5-year and 10-year Fannie Mae bonds with comparable U.S. Treasury bonds. One-period lagged values act as the instruments for each of the right-hand-side variables. *FOREIGNRATIO* is the dollar amount of Federal Agency securities held by foreign investors as a proportion of total Federal Agency debt outstanding. *AGENCYRATIO* equals total Federal Agency debt outstanding as a proportion of the sum of the aggregate quantities of Treasury and Federal Agency debt outstanding. *3MTBILL* is the three-month constant maturity Treasury bill; *TERMSPREAD* is the difference between the constant maturity 10-year Treasury bond and similar three-month Treasury bill; and *RISKSPREAD* is the difference between the composite yield on the Moody's BAA and AAA seasoned bond indices at the 10 year maturity. The sample covers 1997:Q1-2006:Q1, or 37 observations. T-Statistics in parentheses. Significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	5-Year Federal Agency Yield Spread			10-Year Federal Agency Yield Spread		
Constant	-0.920***	-0.897***	0.342	-1.108**	-1.053***	0.254
	(-2.58)	(-2.62)	(0.78)	(-2.48)	(-2.73)	(0.55)
Log(FOROFFRATIO)	0.327***	0.200	-0.241*	0.306***	0.000	-0.447***
	(3.99)	(1.59)	(-1.89)	(2.98)	(0.00)	(-3.32)
Log(FORPRVRATIO)	-1.322***	-1.244***	-0.380*	-1.482***	-1.294***	-0.250
	(-4.73)	(-4.47)	(-1.73)	(-4.24)	(-4.14)	(-1.08)
Log(AGENCYRATIO)		0.248	1.252***		0.600***	1.699***
		(1.32)	(5.15)		(2.83)	(6.62)
3MTBILL			0.057			0.117**
			(1.22)			(2.37)
TERMSPREAD			-0.059			0.004
			(-0.91)			(0.05)
RISKSPREAD			-0.141			-0.120
			(-0.77)			(-0.62)

Table 4
Anderson-Rubin Statistics

Anderson-Rubin test statistics of the joint hypothesis relating to the values of $ß_1$ and $ß_2$ from the following regression specification:

(2) $SPREAD_t = ß_0 + ß_1\, ln(FOROFFRATIO_t) + ß_2\, ln(FORPRVRATIO_t) + ß_3\, ln(AGENCYRATIO_t) + ß_4\, 3MTBILL_t + ß_5\, TERMSPREAD_{t+} ß_6\, RISKSPREAD_t + \varepsilon_t$

Coefficient values for $ß_1$ are presented in the leftmost column and those for $ß_2$ along the top row. A * indicates instances where the joint hypothesis is rejected.

	0.2	0.1	0.001	-0.1	-0.2	-0.3	-0.4	-0.5	-0.6	-0.7	-0.8	-0.9	-1.0	-1.1	-1.2	-1.3	-1.4
0.4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
0.3	*	*	*	*	*	*	*	0.05	0.09	0.06	*	*	*	*	*	*	*
0.2	*	*	*	*	*	*	*	0.13	0.16	0.08	*	*	*	*	*	*	*
0.1	*	*	*	*	*	*	0.13	0.27	0.24	0.09	*	*	*	*	*	*	*
0.001	*	*	*	*	*	0.08	0.29	0.43	0.28	0.08	*	*	*	*	*	*	*
-0.1	*	*	*	*	*	0.19	0.50	0.55	0.26	*	*	*	*	*	*	*	*
-0.2	*	*	*	*	0.08	0.38	0.67	0.56	0.19	*	*	*	*	*	*	*	*
-0.3	*	*	*	*	0.17	0.56	0.73	0.45	0.11	*	*	*	*	*	*	*	*
-0.4	*	*	*	*	0.29	0.66	0.65	0.29	*	*	*	*	*	*	*	*	*
-0.5	*	*	*	0.09	0.38	0.63	0.47	0.14	*	*	*	*	*	*	*	*	*
-0.6	*	*	*	0.13	0.39	0.48	0.26	*	*	*	*	*	*	*	*	*	*
-0.7	*	*	*	0.15	0.32	0.29	0.11	*	*	*	*	*	*	*	*	*	*
-0.8	*	*	*	0.14	0.20	0.13	*	*	*	*	*	*	*	*	*	*	*
-0.9	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-1.0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-1.1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
-1.2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Figure 1: Debt Outstanding: US Treasury and Federal Agency

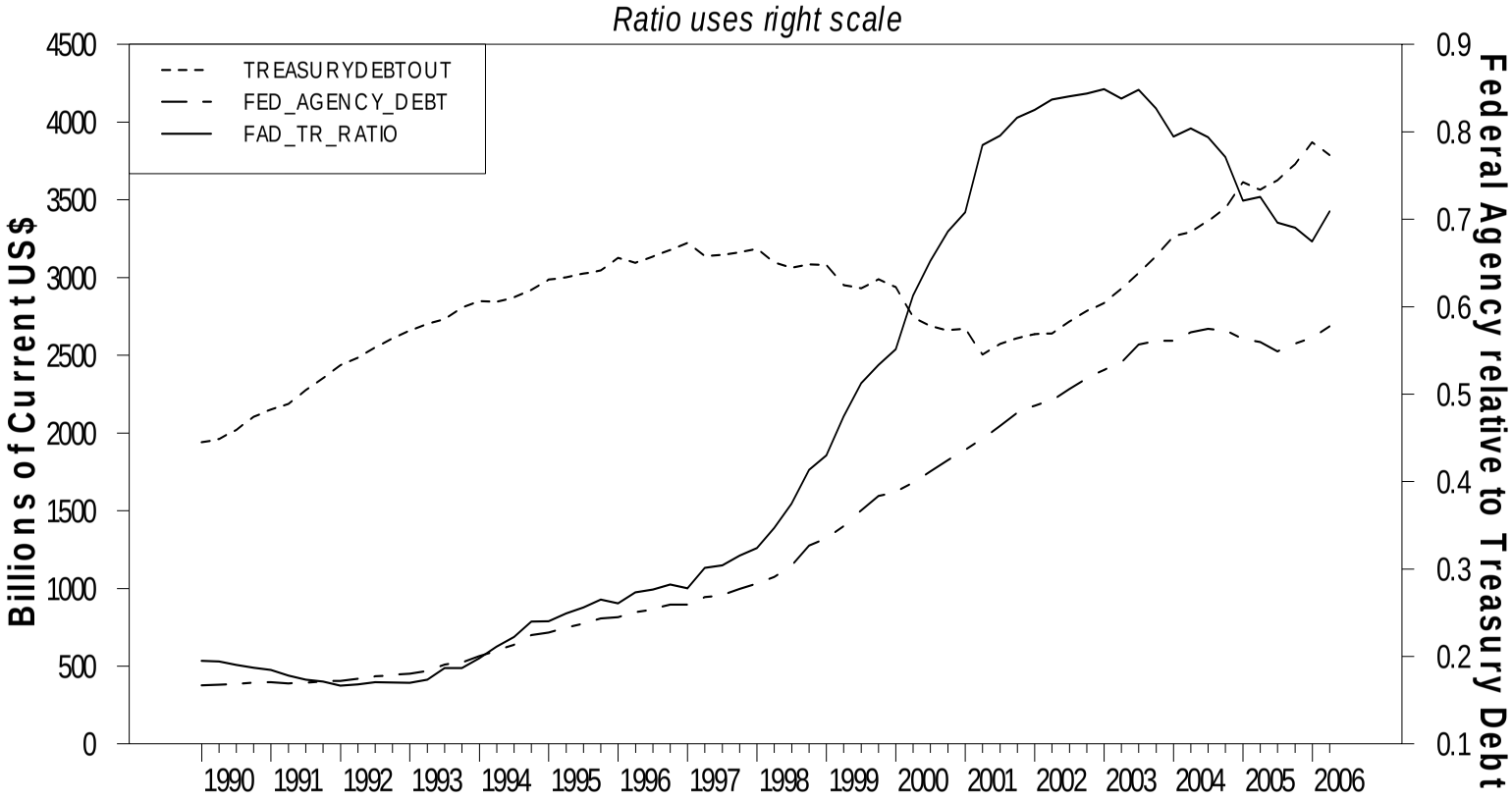

Figure 2: Federal Agency Debt: Debt Outstanding for Each GSE

Source: Balance Sheets of Each GSE

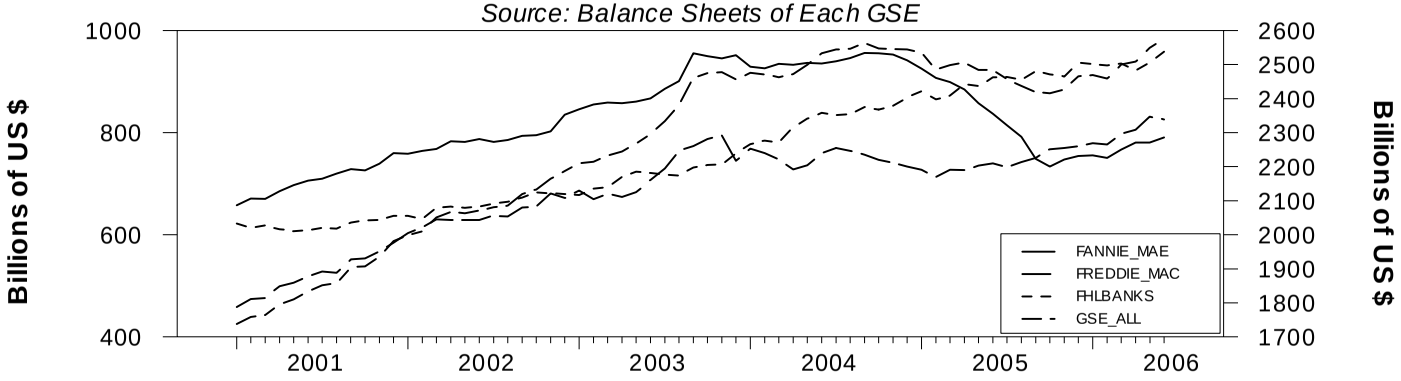

Figure 2: Proportion of Total Federal Agency Debt Outstanding

Source: Above

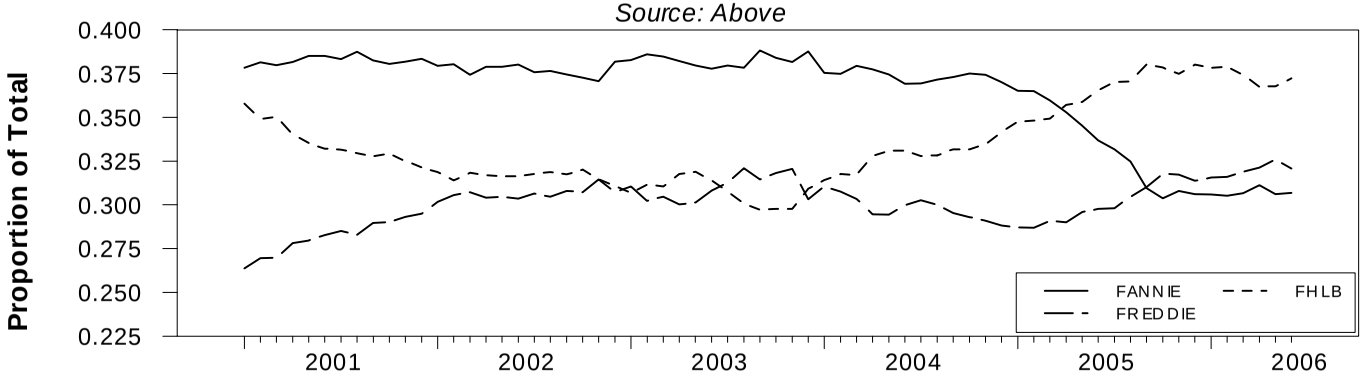

Figure 3A: Foreign Holdings of Federal Agency Debt and Treasury Debt

Source: Flow of Funds Accounts

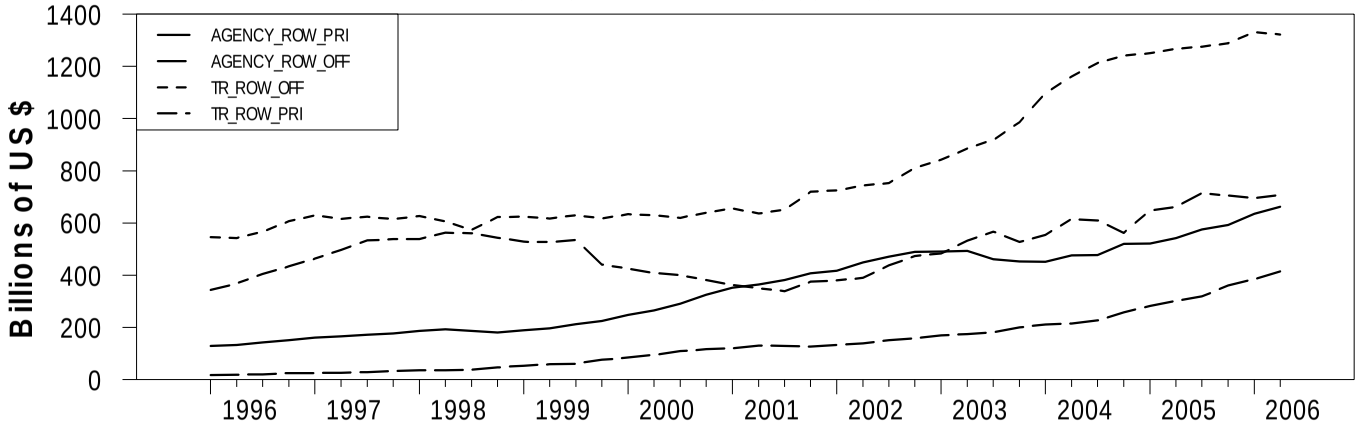

Figure 3B: Proportional Holdings of Federal Agency and Treasury Debt Outstanding

Source: Flow of Funds Accounts

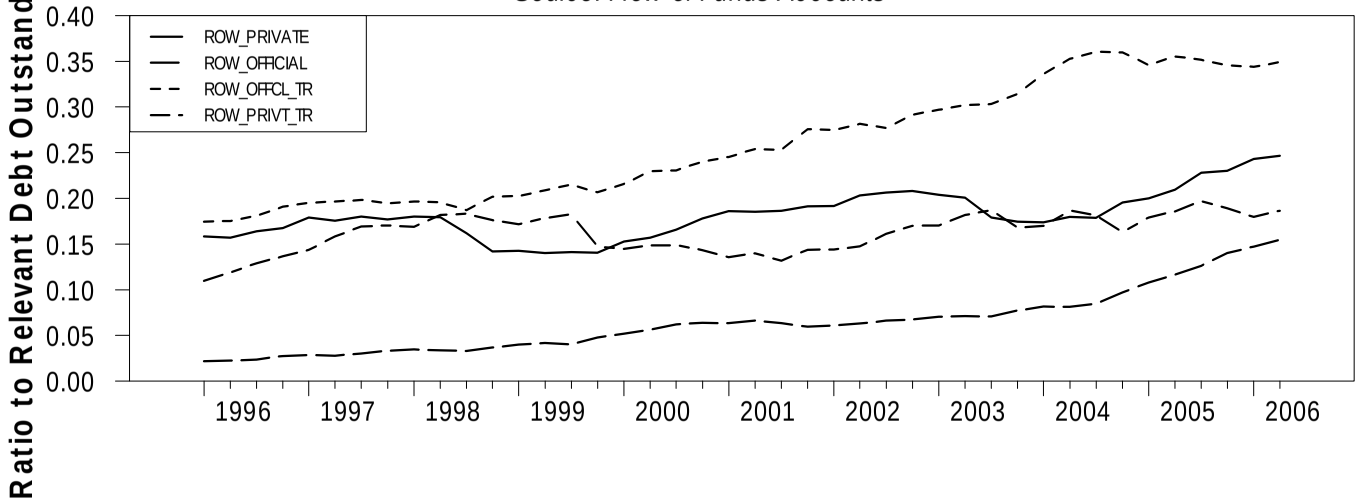

Figure 4a: ROW Proportion of Federal Agency Debt Outstanding (Left Scale)

Source: Flow of Funds Accounts, Board of Governors of the Federal Reserve System

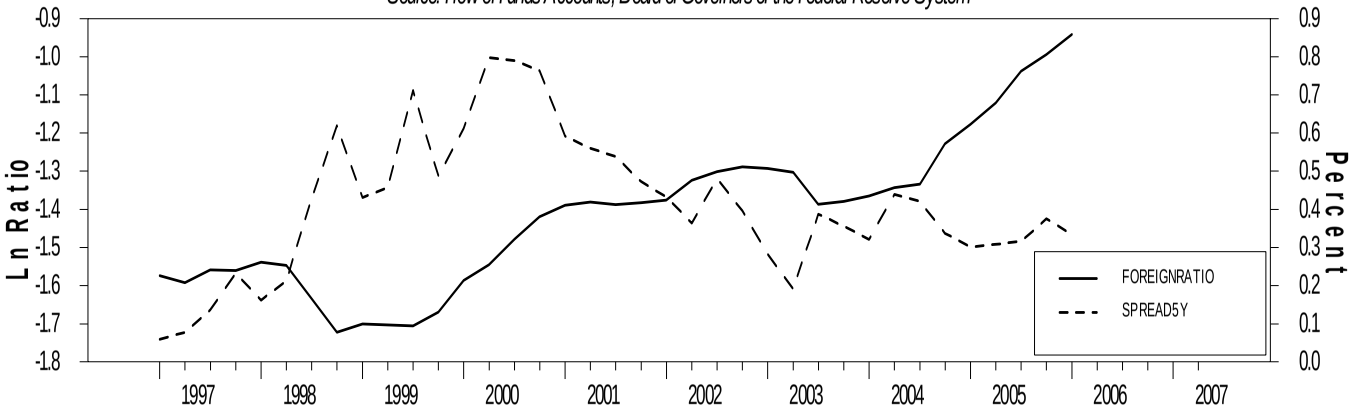

Figure 4b: ROW Proportion of Federal Agency Debt Outstanding (Left Scale)

Source: Flow of Funds Accounts, Board of Governors of the Federal Reserve System

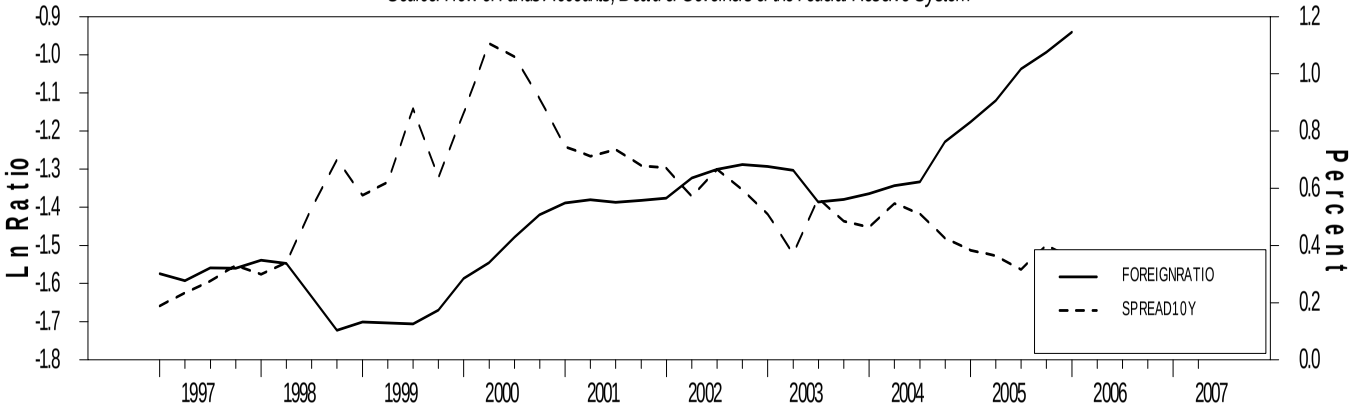

Figure 5a: Federal Agency Yield Spread (10 Year) Versus Fitted Value

Source: Federal National Mortgage Association

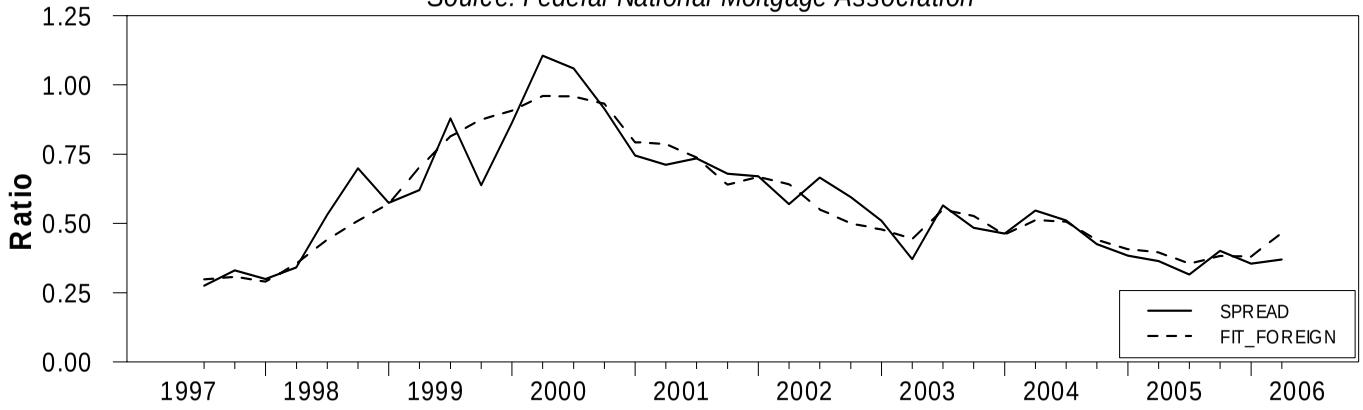

Figure 5b: Federal Agency Yield Spread (10 Year) Versus Fitted Value

Source: Federal National Mortgage Association

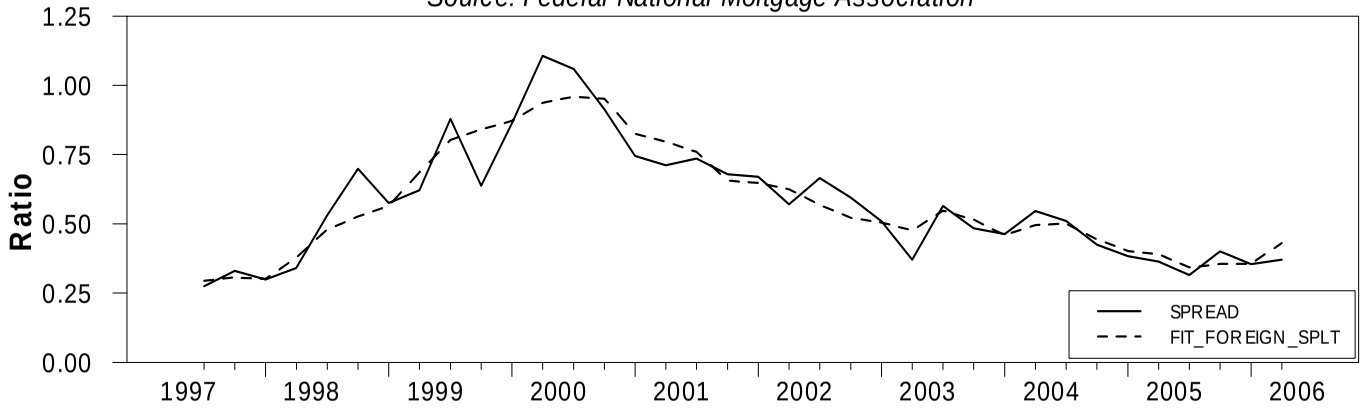

Figure 6: Impulse Response Functions for the 4 Variable VAR Using Sims-Zha Prior 10 Year Spread

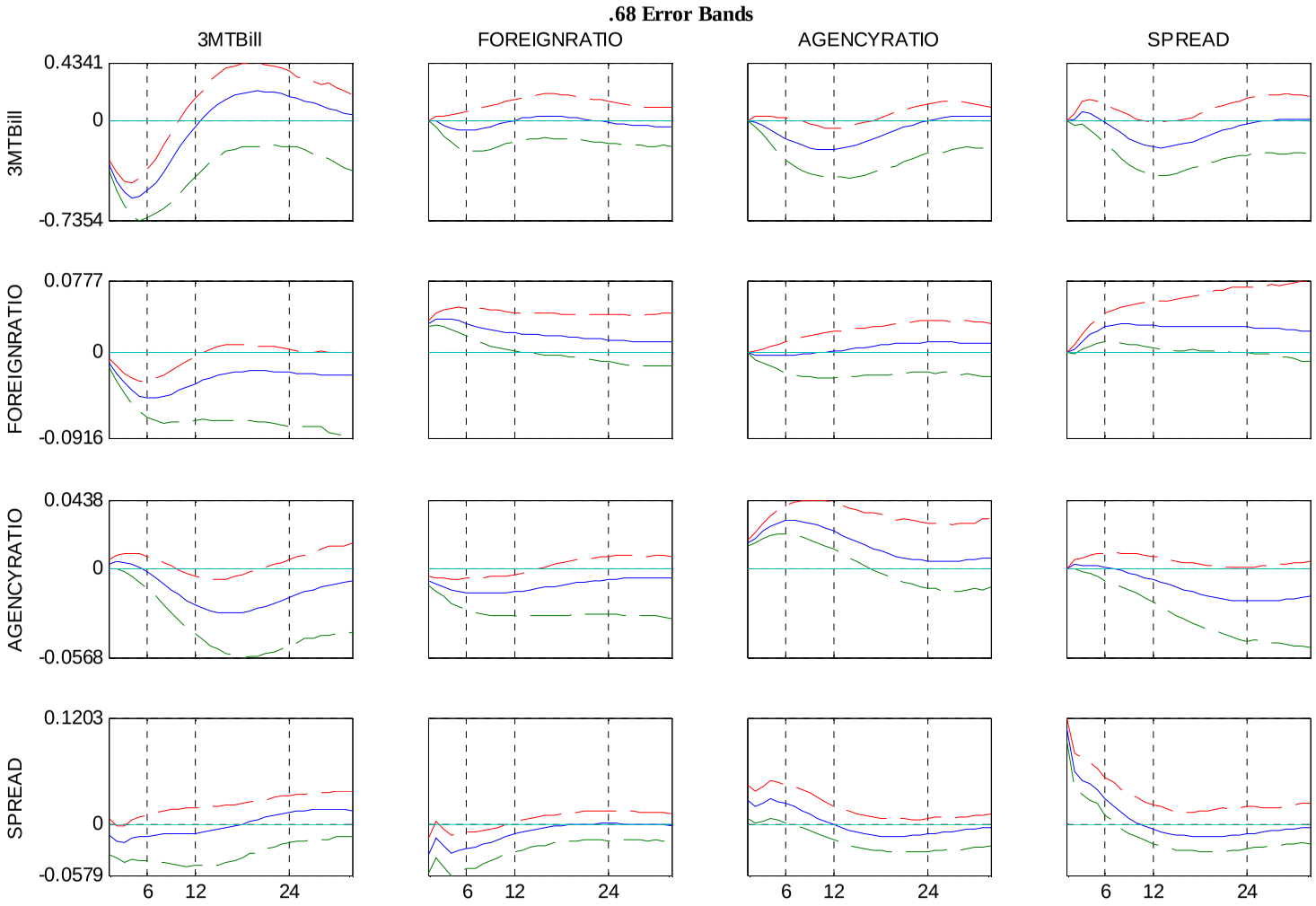

Figure 7: Impulse Response Functions for the 4 Variable VAR Using Sims-Zha Prior 5 Year Spread

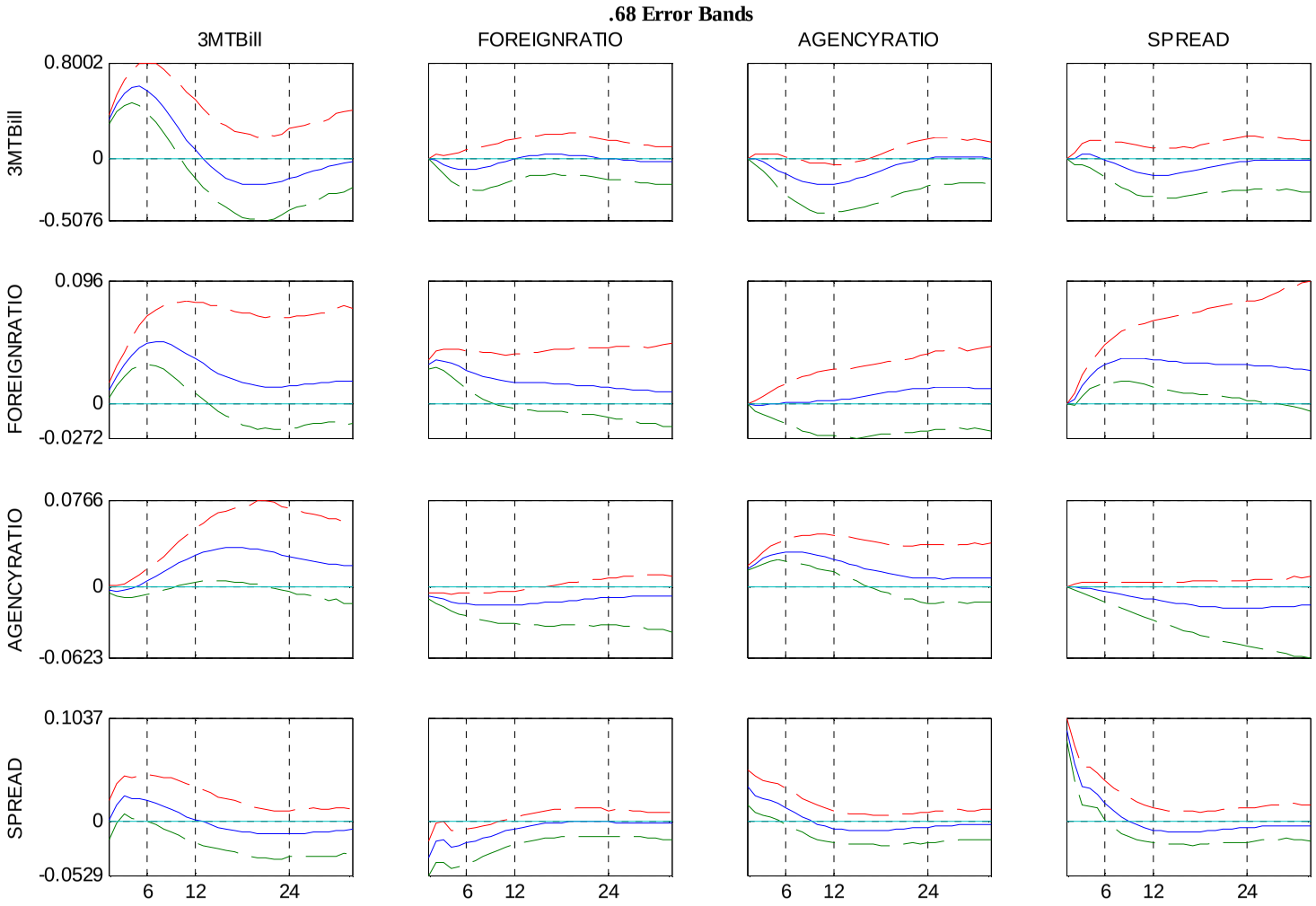

Figure 8: Impulse Response Functions for the 5 Variable VAR Using Sims-Zha Prior 10 Year Spread

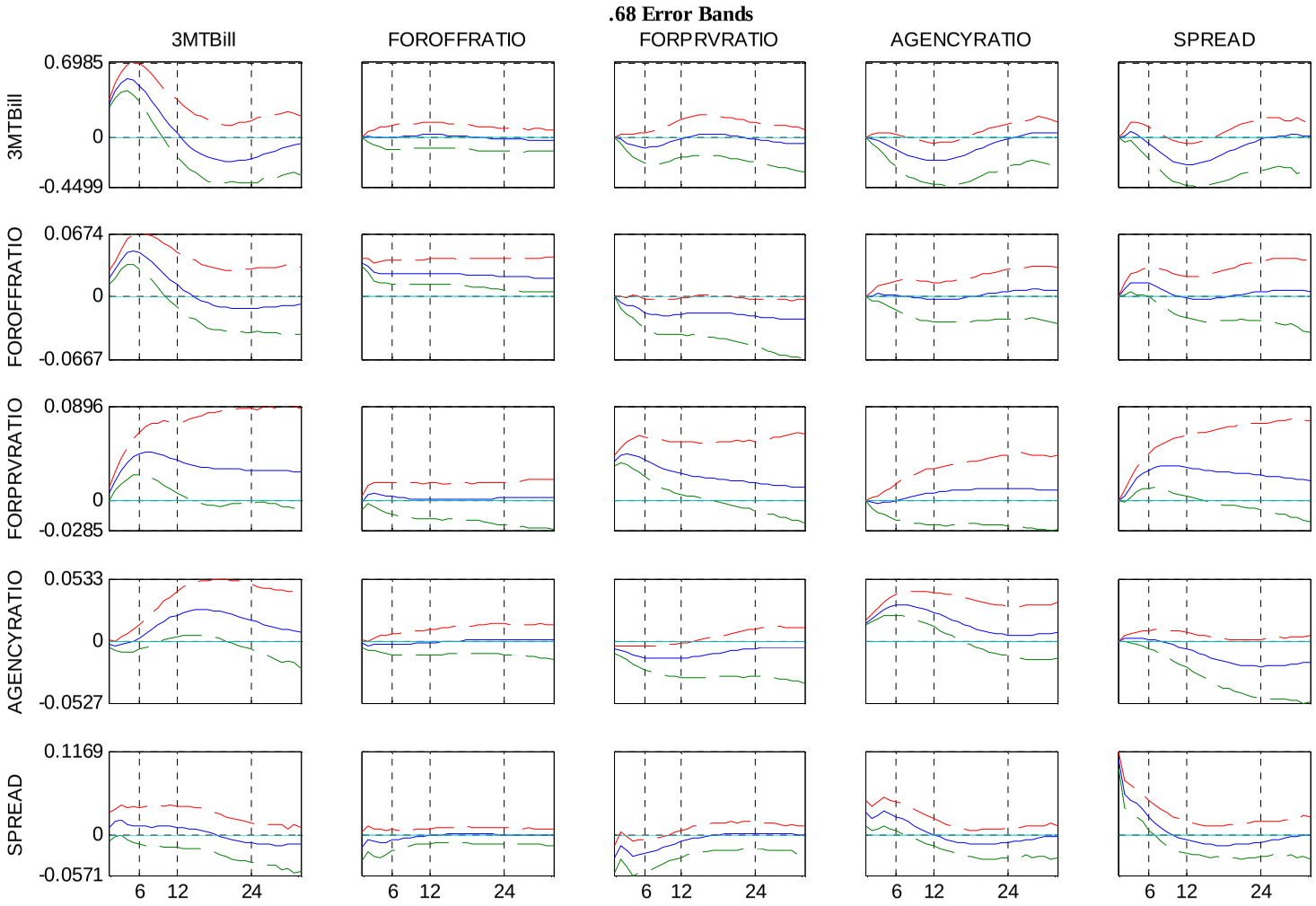
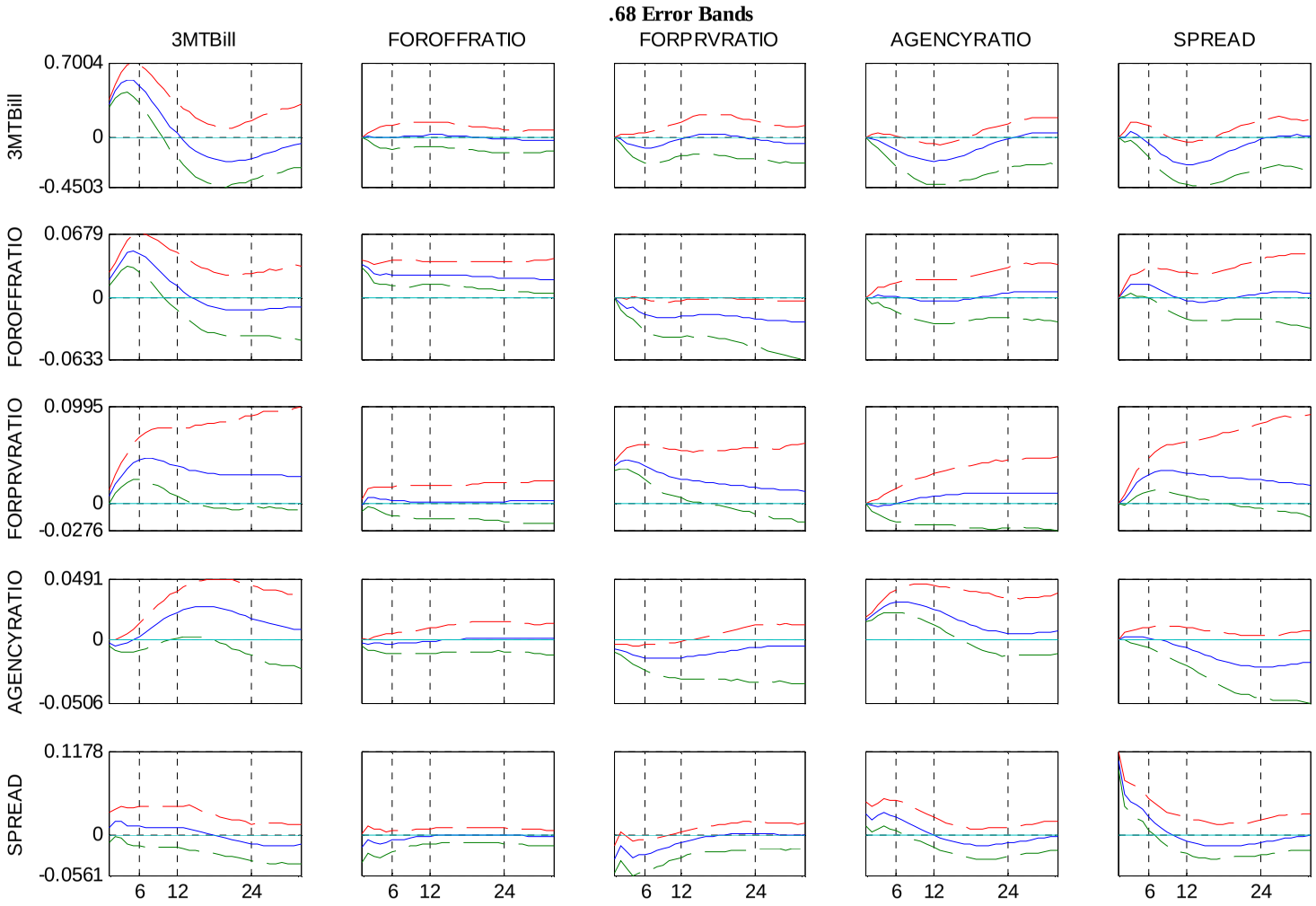
Figure 9: Impulse Response Functions for the 5 Variable VAR Using Sims-Zha Prior 5 Year Spread