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What Moves the Mortgage-Backed Securities Market?

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Using a vector autoregressive model with monthly data from 1988 through 2001, this study investigates the factors that drive the excess returns on a widely followed mortgage-backed securities (MBS) index. We find that eight important economic variables (industrial productions, new home sales, bond horizon premium, bond quality premium, mortgage rate, refinancing proxy, general stock market index and world bond market index) appear to move the excess returns on MBS. Impulse response analysis and variance decomposition further indicate a strong dynamic relationship between MBS excess returns and changes in these economic variables. Additional analysis of Freddie Mac and Fannie Mae MBS also indicates that the risk of the MBS guarantor is an important determinant of the MBS return dynamics after the creation of the Office of Federal Housing Enterprise Oversight.

The mortgage debt market has become an increasingly important component of the U.S. capital market in the past two decades. Mortgage-backed securities (MBS) in particular, which are created through securitization of mortgage loans made by financial institutions such as commercial banks, savings and loans and mortgage companies, have come to dominate the mortgage debt markets in recent years.

The MBS market has grown at a much faster pace than the overall mortgage market because an increasing proportion of mortgage originations are now securitized. As of 2001, the value of U.S. MBS outstanding amounts to about \$3.7 trillion, about half the size of the total U.S. mortgage debt market and equivalent to 36% of U.S. gross domestic product. Advances in financial engineering and structured finance techniques, increased availability of consumer credit information and standardization and credit support from government agencies are credited for the success of the U.S. MBS market. Table 1 and Figures 1 and 2 illustrate the dramatic development of the MBS market over the past 25 years.

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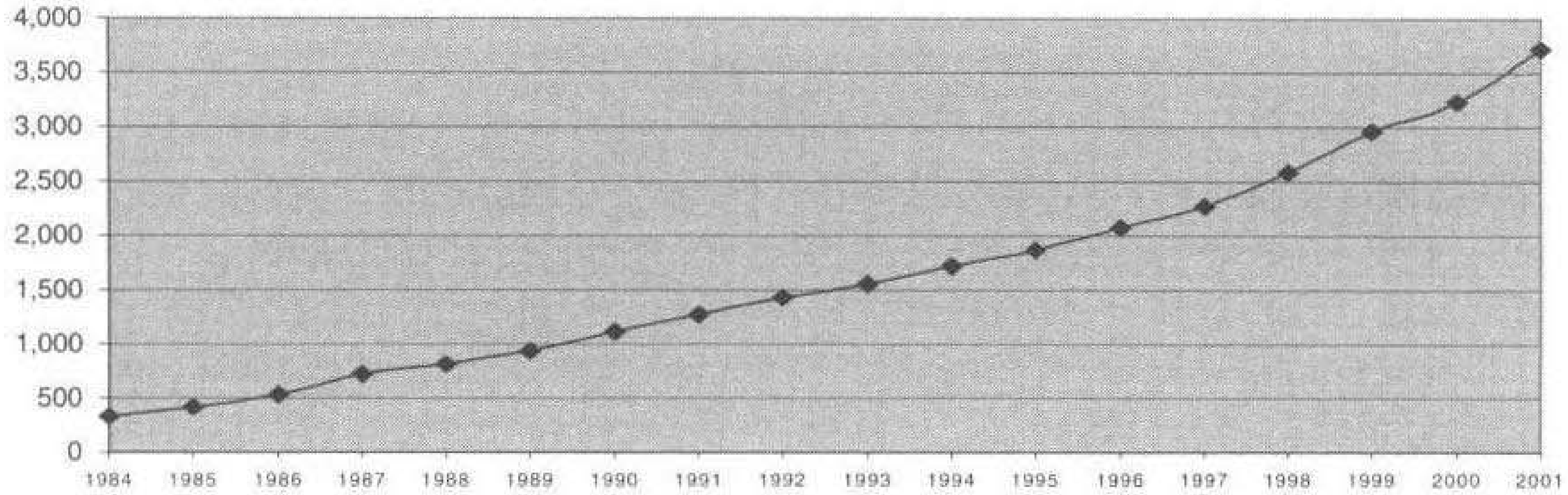
Table 1 ■ Size of the U.S. MBS market.

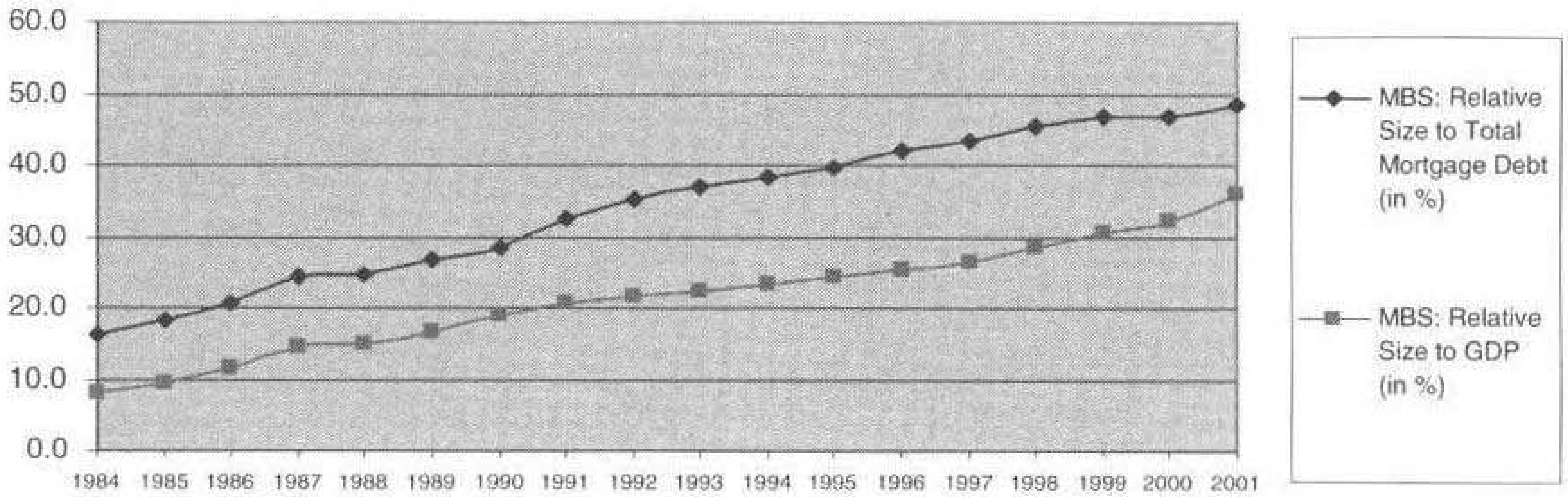
Year	U.S. MBS Outstanding (in Billions of Dollars)	U.S. Mortgage Debt Outstanding (in Billions of Dollars)	MBS: Relative Size to Total Mortgage Debt (in %)	GDP (in Billions of Dollars)	MBS: Relative Size to GDP (in %)
1984	332	2,023	16.4	4,109.7	8.1
1985	415	2,267	18.3	4,375.3	9.5
1986	530	2,567	20.6	4,612.3	11.5
1987	718	2,943	24.4	4,957.0	14.5
1988	811	3,268	24.8	5,379.0	15.1
1989	942	3,538	26.6	5,720.8	16.5
1990	1,111	3,912	28.4	5,886.3	18.9
1991	1,271	3,916	32.5	6,183.6	20.6
1992	1,426	4,043	35.3	6,521.6	21.9
1993	1,551	4,215	36.8	6,887.8	22.5
1994	1,716	4,475	38.3	7,297.5	23.5
1995	1,862	4,714	39.5	7,629.6	24.4
1996	2,070	4,929	42.0	8,124.2	25.5
1997	2,273	5,257	43.2	8,627.8	26.3
1998	2,588	5,683	45.5	9,092.7	28.5
1999	2,955	6,319	46.8	9,649.5	30.6
2000	3,232	6,914	46.7	10,028.1	32.2
2001	3,717	7,658	48.5	10,313.1	36.0

Figure 1 ■ U.S. MBS outstanding in billions of dollars.



This study uses a vector autoregressive (VAR) model to examine the economic factors that are important for the excess returns on a widely tracked and followed MBS index (*i.e.*, the total return on MBS index minus the 3-month risk-free Treasury bill rate). This is a new approach applied to the MBS research, although the VAR model has been used in the literature related to traditional financial and real estate market analysis (see, *e.g.*, Hasbrouck 1991, Lee 1992, Liu and Mei 1992, Campbell and Ammer 1993).

Figure 2 ■ Relative size of the U.S. MBS market.



Source: Federal Reserve Bulletin.

Most MBS are in the form of mortgage pass-through securities. A mortgage pass-through security is created when mortgages with similar loan types, coupons and maturities are pooled and when participations in the pool are sold.[1]

The great majority of mortgage pass-through securities have been issued or guaranteed by three government agencies created by the U.S. Congress to enhance liquidity in the secondary mortgage markets. The three agencies are commonly called Ginnie Mae (Government National Mortgage Association, GNMA), Fannie Mae (Federal National Mortgage Association, FNMA) and Freddie Mac (Federal Home Loan Mortgage Corporation, FHLMC). Ginnie Mae is a government agency within the Department of Housing and Urban Development (HUD), whose guarantee assumes the full faith and credit of the U.S. government. Fannie Mae and Freddie Mac are New York Stock Exchange-listed "government-sponsored enterprises" (GSEs), which do not represent the explicit guarantee of the U.S. government but are believed by market participants to convey the government's implicit guarantee. The explicit (for Ginnie Mae MBS) or implicit (for Fannie Mae or Freddie Mac MBS) guarantee of the three federal agencies has made investments in MBS more attractive, as credit risk is either eliminated (for Ginnie Mae MBS) or substantially reduced (for Fannie Mac or Freddie Mac MBS). The Office of Housing Enterprise Oversight (OFHEO) was established in 1992 to "promote the housing sector and a strong economy by ensuring the safety and soundness of Fannie Mae and Freddie Mac and fostering the vitality of the nation's housing finance system."[2] How the risk

[1] Since 1983, some mortgage pass-though securities have been further structured by redirecting the cash flows to multiple bond classes to create collateralized mortgage obligations (CMOs). CMOs are considered as derivatives of mortgage pass-throughs. We are concerned here only with mortgage pass-throughs (the major form of MBS), not CMOs.

[2] Mission stated at the Office of Housing Enterprise Oversight Web site: http://www.ofheo.gov/.

of the guarantor affects MBS return dynamics, especially after the creation of OFHEO, should be of interest to investors and policy makers.

A critical aspect of the MBS is the exposure of investors to prepayment risk—the premature or unscheduled payment of principal to investors when homeowners refinance, relocate or default. Refinancing typically occurs when the market mortgage rate falls far enough below the weighted average coupon rate (WAC) on the securitized mortgage pool and when homeowners can reduce their monthly mortgage payments significantly. Refinancing, triggered by a drop in mortgage rates, is an undesirable event for MBS investors who must reinvest the proceeds at lower market rates. The amount and the timing of cash flows received from a mortgage pass-through are largely affected by the prepayment of the mortgage pool. Because the timing and speed of repayment may vary, cash flows received by MBS investors are highly irregular.

A change in mortgage rate affects the MBS returns through both the discount-rate effect (*i.e.*, the prevailing mortgage rate and the present value of the mortgage cash flows are negatively related) and the prepayment effect. This study explicitly examines how mortgage rates affect the MBS returns to shed light on both the discount-rate effect and the prepayment effect. Consistent with expectations, our analysis documents negative discount-rate effect of mortgage interest rates and positive prepayment effect.

One strand of MBS research focuses primarily on the theoretical valuation and pricing issues of MBS that relate to prepayment risk resulting from interest rate movements (Dunn and McConnell 1981, Schwartz and Torous 1989, 1992 and Stanton 1995). Bennett, Peach and Peristiani (2001) analyze the impact of structural changes in the mortgage market on homeowners' prepayment patterns. Other studies examine the impact of MBS issuance on the yield or interest rate of the mortgage debt, demonstrating the relevance and contribution of MBS in the financial market (Black, Garbade and Silber 1981, Kolari, Fraser and Anari 1998).

We conduct an empirical analysis of the key factors that affect MBS returns, on which limited academic research is available. Although pricing and yield questions have been widely researched, investors often find yield-to-maturity (YTM) an unsatisfactory indicator of total return on the MBS investments. This is because YTM assumes that the security is held until maturity and that all the cash flows received prior to maturity are reinvested at the YTM.

We use total returns, instead of YTM, in our analysis to avoid the confounding problems of reinvestment and prepayment. Total return, also called the holding-period return, measures what investors can earn from a security over a specified holding period. It is the most commonly used measure of return for securities in general (*e.g.*, stocks, bonds). Total return on mortgage-backed securities includes price return, coupon return and paydown return.[3]

Our results are important for several reasons. First, despite the economic importance of the MBS market, very little attention has been paid to empirical economic factors underlying returns. Although fundamental economic variables have been identified for excess returns on stocks and bonds (Chen, Roll and Ross 1986, Campbell and Ammer 1993, Elton, Gruber and Blake 1995), little is known for the type of economic variables relevant for MBS excess returns.

Specific economic factors related to MBS are examined and included in our analysis as follows. The real activity has been shown to affect stock returns in the finance literature (Lee 1992). Similarly, it should also be expected to affect the MBS returns. We use two variables—industrial productions and new home sales—to proxy for the real activity.[4] That is, as the economy expands, these two variables will show signs of growth in real activity for the overall economy and the housing sector. The MBS returns are expected to be lower during economic expansion because higher economic growth often leads to a higher return in real sector investments and a higher real interest rate.

The MBS, which are risky debt-related instruments, are expected to be sensitive to credit, liquidity and call risk premiums in the fixed income market. Thus, the bond quality premium proxy (BQP, the difference in total returns between long-term AAA corporate bonds and long-term Treasury bonds) for credit, liquidity and call risk premiums should be positively related to MBS returns. Similarly, shifts in interest rate yield curve may affect MBS returns given that MBS are long-term fixed-income securities. As a result, we use the change in bond horizon premiums (BHP, difference in total returns between long-term Treasury bonds and 30-day Treasury bills) to capture the term structure risk.

As argued earlier, MBS returns are subject to the discount-rate effect and prepayment effect as a result of interest rate movements. To capture the discount-rate effects, we use the change in the 30-year mortgage rate. To capture the

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[3] See Dynkin *et al.* (1999, pp. 20–22) for a detailed explanation of the three components of the MBS index returns.

[4] We thank an anonymous referee for suggesting the use of the *new home sales* variable in the analysis.

prepayment effect, we use a variable that reflects the refinancing effect when the prevailing mortgage rate is lower than the weighted average coupon rate of the MBS mortgage pool. As a result, we are able to separate these two confounding effects caused by interest rate volatility.

Several studies on MBS have demonstrated that MBS are well integrated into the capital market (Hendershott and Van Order 1989, Devaney, Pickerill and Krause 1992, Goebel and Ma 1993), but the relationship of MBS with the stock market is still not well researched. We provide a useful piece of information on how investors select MBS over stocks as an alternative asset class in their investment portfolio. The analysis provides information helpful to government-sponsored agencies (such as FHLMC and FNMA) for improving the working of the secondary mortgage markets and the risk management of their mortgage security portfolios. To this end, we include stock market return in our model, whereby we view MBS as part of the investors' investment portfolio.

We also analyze the impact of the world bond market index on MBS returns. Barr and Priestley (2004) and Ilmanen (1995) indicate that the world bond market affects domestic bond market returns. As the MBS market is an important investment vehicle for both domestic and foreign investors, it is worthwhile to investigate to what extent the MBS returns are affected by the world bond market risk.

In our model, we identify eight economic (real and financial) variables that are shown to relate significantly with MBS excess returns. They are growth in *industrial productions* and *new home sales*, which are used to capture the real activity of the economy and the housing sector; changes in *bond quality premium* (differences in total returns between long-term AAA corporate bonds and long-term Treasury bonds) to capture credit, liquidity and call risks; *bond horizon premium* to capture the term structure risk; change in *mortgage rate* to shed light on the discount rate effect; *refinancing* variable to reflect the prepayment effect; *stock market excess returns* to analyze the substitution effect of the equity market on MBS; and *world bond market excess returns* to examine the impact of common world market risk factor.

In our analysis, we also try to analyze two other related issues. First, we investigate whether there is a seasonality pattern in the MBS excess returns by incorporating an exogenous variable for the summer period (*i.e.*, May, June and July) in the VAR model.[5]

[5] Naranjo and Toevs (2002) suggest possible seasonality in mortgage yields, particularly for the three largest mortgage origination months (May, June and July).

Second, we apply a similar VAR model to analyze mortgage REIT returns to see if the MBS and Mortgage REITs are subject to similar economic forces.[6] While little is known for the MBS return dynamics, the REITs have been extensively researched in the literature (see Liu and Mei 1992, Peterson and Hsieh 1997, Chen *et al.* 1998, Francis and Ibbotson 2001 and Arora, Heike and Mattu 2000). Although both MBS and mortgage REITs represent the debt side of the real estate market, they differ in two ways. MBS are pass-through securities of mortgage pools, while mortgage REITs are real estate investment funds with at least 75% of their holdings in mortgages or MBS. Moreover, MBS are purely debt instruments, while most mortgage REITs are publicly traded and their prices may deviate from the funds' net asset value. Our results help investors understand more about the return dynamics of the mortgage REITs and MBS because it is likely that these markets may have different drivers for their return behaviors.

From the structural VAR model, we are able to decompose the variance of MBS excess returns into components that can be explained by each of these variables. The structural VAR approach also enables us to investigate the extent to which an economic variable helps explain the MBS excess returns and to understand how excess returns of MBS respond to shocks in these eight economic variables over time. The empirical results help illuminate the dynamic relationships between the MBS excess returns and the economic variables. We can also shed light on both the driving forces behind MBS excess return variability and the relative importance of these economic variables.

We draw policy implications related to ensuring the soundness of the guarantors for the integrity of MBS markets. The risk of GSE guarantors such as Fannie Mae and Freddie Mac is an important determinant of the expected return on the MBS they issue or guarantee for two reasons. First, these agencies invest heavily in their MBS as a portfolio investment; second, highly leveraged strategies of these agency guarantors clearly affect the credit risk of MBS.[7]

Our study also complements the existing literature, particularly Gallo *et al.* (1997), which examines the performance of MBS mutual funds relative to the MBS indexes. Their empirical study concludes that the Lehman Brothers MBS index is the most appropriate benchmark for the MBS market.

The organization of this article is as follows. We next discuss briefly the data source. In the third section we explain the VAR methodology as well as the

[6] We thank an anonymous reviewer for suggesting the comparison between the MBS and mortgage REITs.

[7] See, *e.g.*, "Fannie's Risky Business" (2002).

results of the empirical analyses along with their implications. The final section concludes.

Data

Introduced in 1986, the Lehman Brothers MBS index covers the mortgage pass-throughs of GNMA, FHLMC and FNMA. Monthly data on the total return (including price return, coupon return and paydown return) and WAC of the MBS index and the three MBS subindices are obtained directly from the Lehman Brothers Fixed Income Research Department.[8] In addition, monthly data on industrial productions, inflation rate, money supply, mortgage rate and Treasury yields are obtained from the Federal Reserve Board. BQP and BHP are obtained from Ibbotson Associates. New home sales, S&P 500 total return and J.P. Morgan world bond index total return are obtained from the Global Insights (DRI) Database, while mortgage REIT index total return data are obtained from the National Association of Real Estate Investment Trusts (NAREIT).[9] To ensure the data availability for MBS index returns and related economic factors, we conduct the study based on monthly data for the sample period from January 1988 to December 2001.

Table 2 reports excess returns (*ER*) of the general index of MBS, along with excess returns of the GNMA, FHLMC and FNMA MBS subindices. Excess return is computed as the total return less the 3-month Treasury bill rate. Total returns on MBS are more complicated to compute than returns on stocks and traditional bonds. They comprise three components: price return, coupon return and paydown return.[10] Table 2 also reports the descriptive statistics of economic variables that are ostensibly related to MBS.[11] These variables are: growth in industrial productions (*IPG*) as an indicator of output and economic cycle; growth in new home sales (*NHSG*) as an indicator of economic activity in the housing sector; change in the bond horizon premium (*BHPD*) as a proxy for term structure risk premium; change in the bond quality premium (*BQPD*) as a proxy for credit, liquidity and call risk premiums; change in the 30-year mortgage rate (*MR30D*) to reflect the discount rate effect; a refinancing proxy

[8] See Appendix A for a detailed explanation of the Lehman Brothers MBS index construction methodology.

[9] The NAREIT's mortgage REIT index comprises those REITs with at least 75% debt or debt-related interest in real estate assets. On the other hand, REITs with at least 75% equity interest in real estate assets are included in the equity REIT index.

[10] See Dynkin *et al.* (1999) for a detailed conceptual and mathematical description of the MBS price, coupon and paydown return computation.

[11] We conduct unit root tests to check if these economic variables are stationary. Because none of them is stationary, we compute the first differencing of these variables to induce stationarity.

Table 2 ■ Descriptive statistics (monthly data 1988–2001).

Variables	Mean	Median	Maximum	Minimum	SD	Skewness	Kurtosis
ER_MBS	0.266	0.323	3.256	−2.896	1.003	−0.104	3.231
ER_GNMA	0.274	0.291	3.216	−2.991	1.008	−0.125	3.296
ER_FHLMC	0.261	0.310	3.336	−2.766	0.998	−0.069	3.259
ER_FNMA	0.263	0.315	3.246	−2.933	1.001	−0.118	3.237
ER_MREIT	0.164	0.377	13.741	−21.068	5.310	−0.683	5.335
IPG	0.218	0.263	1.759	−1.270	0.513	−0.135	2.952
NHSG	0.590	0.868	18.103	−20.975	6.999	−0.102	2.924
BHPD	−0.019	0.340	6.270	−9.370	3.098	−0.532	3.331
BQPD	0.003	−0.115	3.770	−4.160	1.186	0.056	4.641
MR30D	−0.021	−0.045	0.640	−0.570	0.212	0.357	3.138
WAC/MR30 (MBS)	0.968	0.961	1.185	0.804	0.084	0.339	2.502
WAC/MR30 (GNMA MBS)	1.008	0.997	1.258	0.839	0.091	0.500	2.671
WAC/MR30 (FHLMC MBS)	0.945	0.943	1.142	0.790	0.082	0.213	2.269
WAC/MR30 (FNMA MBS)	0.953	0.950	1.156	0.794	0.083	0.259	2.369
$MR30D * D$ (MBS)	−0.019	0.000	0.530	−0.380	0.100	0.551	10.721
$MR30D * D$ (GNMA MBS)	−0.029	0.000	0.540	−0.390	0.132	0.538	7.141
$MR30D * D$ (FHLMC MBS)	−0.018	0.000	0.330	−0.380	0.086	−0.373	8.595
$MR30D * D$ (FNMA MBS)	−0.019	0.000	0.330	−0.380	0.086	−0.354	8.502
ER_SP	0.570	0.800	10.820	−14.988	4.067	−0.454	3.754
ER_WB	0.224	0.272	2.958	−2.291	0.965	−0.131	2.951
IR_FRE	−6.6E−16	−0.937	33.194	−37.650	8.623	0.265	6.747
IR_FNM	2.1E−16	−0.807	36.781	−20.708	7.373	0.878	6.809

Note: ER_MBS: MBS Index excess return; *ER_GNMA*: GNMA MBS subindex excess return; *ER_FHLMC*: FHLMC MBS subindex excess return; *ER_FNMA*: FNMA MBS subindex excess return; *ER_MREIT*: Excess return on the mortgage REIT index; *IPG*: Growth in IP (industrial productions); *NHSG*: Growth in new home sales (seasonally adjusted); *BHPD*: Change in the bond horizon premium that is derived as the geometric difference between total returns on long-term Treasury bonds and U.S. 30-day Treasury bills; *BQPD*: Change in the bond quality premium that is derived as the geometric difference between total returns on long-term corporate bonds and long-term Treasury bonds; *MR30D*: Change in the 30-year mortgage rate; *WAC/MR30*: Ratio of *WAC* (weighted average coupon rate of the MBS mortgage pool) to the prevailing 30-year mortgage rate; $MR30D * D$: The interaction of *MR30D* with a dummy variable D that is equal to one if $WAC/MR30 > 1$, and 0 otherwise; *ER_SP*: S&P 500 excess return; *ER_WB*: Excess return on the J.P. Morgan World Bond Index; *IR_FNM*: Idiosyncratic risk premium on FNMA common stock (Ticker Symbol: FNM); *IR_FRE*: Idiosyncratic risk premium on FHLMC common stock (Ticker Symbol: FRE).

(*MR30D* ∗ *D*, the interaction of *MR30D* with a dummy variable *D*, which is equal to one if the weighted average coupon rate of the MBS mortgage pool is higher than the prevailing 30-year mortgage rate) to capture the prepayment effect; excess returns on the S&P 500 (*ER_SP*) as an indicator of the general stock market performance; and excess returns on the J.P. Morgan world bond index (*ER_WB*) as an indicator of the general world bond market risk.

Table 3 shows correlations of the excess returns of the different MBS indices with various expected economic variables and their own lags. All variables used are stationary. There is a consistent pattern across four MBS indices. These economic variables, which are growth in industrial productions (*IPG*), growth in new home sales (*NHSG*), change in term structure premium (*BHPD*), change

Table 3 ■ Correlation matrix (monthly data 1988–2001).

Correlation	*ER_MBS*	*ER_GNMA*	*ER_FHLMC*	*ER_FNMA*
Own Lag	0.154**	0.142**	0.153**	0.165**
	(0.03)	(0.05)	(0.04)	(0.02)
IPG	−0.181**	−0.170**	−0.191**	−0.189**
	(0.01)	(0.02)	(0.01)	(0.01)
IPG (−1)	−0.106	−0.107	−0.103	−0.103
	(0.15)	(0.14)	(0.16)	(0.16)
NHSG	−0.014	−0.010	−0.022	−0.018
	(0.85)	(0.89)	(0.77)	(0.80)
NHSG (−1)	−0.143**	−0.135*	−0.147**	−0.150**
	(0.05)	(0.06)	(0.04)	(0.04)
BHPD	0.466**	0.465**	0.465**	0.453**
	(0.00)	(0.00)	(0.00)	(0.00)
BHPD (−1)	0.204**	0.201**	0.202**	0.207**
	(0.01)	(0.01)	(0.01)	(0.00)
BQPD	−0.153**	−0.147**	−0.162**	−0.142**
	(0.04)	(0.04)	(0.03)	(0.05)
BQPD (−1)	−0.167**	−0.167**	−0.166**	−0.162**
	(0.02)	(0.02)	(0.02)	(0.03)
MR30D	−0.532**	−0.524**	−0.525**	−0.543**
	(0.00)	(0.00)	(0.00)	(0.00)
MR30D (−1)	−0.003	0.008	−0.006	−0.015
	(0.97)	(0.92)	(0.93)	(0.83)
MR30D ∗ *D*	−0.294**	−0.371**	−0.167**	−0.221**
	(0.00)	(0.00)	(0.02)	(0.00)
MR30D ∗ *D* (−1)	−0.059	−0.049	−0.026	−0.017
	(0.42)	(0.51)	(0.73)	(0.82)
ER_SP	0.237**	0.242**	0.236**	0.245**
	(0.00)	(0.00)	(0.00)	(0.00)
ER_SP (−1)	−0.170**	−0.166**	−0.171**	−0.176**
	(0.02)	(0.02)	(0.02)	(0.02)

Table 3 ■ continued.

Correlation	*ER_MBS*	*ER_GNMA*	*ER_FHLMC*	*ER_FNMA*
ER_WB	0.798**	0.795	0.794**	0.796**
	(0.00)	(0.00)	(0.00)	(0.00)
ER_WB (−1)	0.181**	0.178**	0.178**	0.183**
	(0.02)	(0.02)	(0.02)	(0.02)
INFLATION	−0.002	−0.002	0.000	0.000
	(0.98)	(0.98)	(1.00)	(1.00)
INFLATION (−1)	0.032	0.042	0.025	0.016
	(0.66)	(0.57)	(0.73)	(0.82)
MSD	−0.055	−0.065	−0.048	−0.047
	(0.45)	(0.37)	(0.52)	(0.52)
MSD (−1)	−0.064	−0.069	−0.055	−0.057
	(0.38)	(0.34)	(0.45)	(0.43)
SUMMER	0.136*	0.136*	0.137*	0.139*
	(0.06)	(0.06)	(0.06)	(0.06)

Notes: ER_MBS: MBS Index excess return; *ER_GNMA*: GNMA MBS subindex excess return; *ER_FHLMC*: FHLMC MBS subindex excess return; *ER_FNMA*: FNMA MBS subindex excess return; *IPG*: Growth in industrial productions; *NHSG*: Growth in new home sales; *BHPD*: Change in bond horizon premium; *BQPD*: Change in bond quality premium; *MR30D*: Change in the 30-year mortgage rate; *WAC/MR30*: Ratio of *WAC* to the prevailing 30-year mortgage rate; $MR30D * D$: The interaction of *MR30D* with a dummy variable *D*, which is equal to one if $WAC/MR30 > 1$, and 0 otherwise; *ER_SP*: S&P 500 excess return; *ER_WB*: Excess return on the J.P. Morgan World Bond Index; *INFLATION*: Monthly inflation rate (percentage change in CPI); *MSD*: Change in money supply; *SUMMER* is a dummy variable that equals 1 if it is for the months of May, June and July, and 0 otherwise.
Level of significance of correlation coefficients in parentheses.
**Significant at 5%; *Significant at 10%.

in the quality premium (*BQPD*), change in the mortgage rates (*MR30D*), the refinancing variable ($MR30D * D$), excess returns on the S&P 500 (*ER_SP*) and excess returns of the world bond index (*ER_WP*) are significantly related to the MBS excess returns as expected.

We also include other variables: inflation and change in money supply for additional correlation analysis in Table 3. These variables are not significantly related to MBS returns, and thus they are not examined further later on.

Methodology and Empirical Results

We use a structural VAR model to examine the dynamics between the economic variables and the excess returns on MBS. In a reduced form of the VAR, the excess return on the MBS index (*ER_MBS*) is analyzed in the context of other eight endogenous variables, which are *IPG*, *NHSG*, *BHPD*, *BQPD*, *MR30D*, *MR30D* $*$ *D*, *ER_SP* and *ER_WB*. Each endogenous variable in the system is modeled as a function of the lag values of all the endogenous variables in the system, and the error terms may be correlated with one another.

In our structural form of the VAR, restrictions are placed on the contemporaneous relations among the nine endogenous variables to allow for the identification of uncorrelated/independent structural shocks. One general approach to structural VAR identification is the Cholesky decomposition proposed by Sims (1980), which restricts a variable higher in the ordering against having a contemporaneous effect on variables lower in the ordering.

Estimates from Structural VAR

Table 4 shows estimates of the structural VAR results for the general MBS index, GNMA, FHLMC, FNMA subindices and mortgage REIT index excess returns along with the eight economic variables with one lag (*IPG*, *NHSG*, *BHPD*, *BQPD*, *MR30D*, *MR30D* $*$ *D*, *ER_SP* and *ER_WB*).[12] As our goal is to investigate how the economic variables affect MBS returns, we order the variables from the real sector to the financial sector. We use the Schwarz information criterion (SIC) to select the optimal lag length. The VAR model with one lag has the lowest information criterion, and hence we use a lag length of one in our analysis.

It is apparent that *ER_MBS* does not interact strongly in terms of contemporaneous and lag effects with growth in industrial productions and new home sales. This pattern is similar for GNMA, FHLMC and FNMA. However, the mortgage REIT index appears to react strongly and contemporaneously with the industrial productions with a t value of -4.15, indicating a different return behavior between mortgage REITs and MBS.

The term structure risk premium variable (*BHPD*) is positive and significant at the 5% level for MBS, GNMA, FHLMC, FNMA and mortgage REITs. This result further demonstrates the importance of interest rate yield curve on the debt investments in real estate. The quality premium (*BQPD*) represents several components of risk premiums such as default risk, call risk and liquidity risk (Duca 1999). Although GNMA MBS are free of default risk, FHLMC and FNMA MBS are not considered credit risk-free. All MBS, however, are subject to liquidity risk and prepayment risk (a form of call risk). We find that the

[12] The empirical results are robust to alternative orderings of the eight economic variables in the structural VAR system.

Table 4 ■ Structural VAR parameter estimates (monthly data 1988–2001).

Independent\Dependent	*ER_MBS*	*ER_GNMA*	*ER_FHLMC*	*ER_FNMA*	*ER_MREIT*
Intercept	0.2039** (3.694)	0.2096** (3.856)	0.2027** (3.723)	0.2071** (3.777)	−0.1273 (−0.255)
IPG	−0.1245 (−1.473)	−0.1054 (−1.258)	−0.1106 (−1.317)	−0.1015 (−1.220)	−3.3751** (−4.154)
IPG (−1)	−0.0883 (−1.073)	−0.1113 (−1.365)	−0.0785 (−0.989)	−0.0837 (−1.058)	0.3789 (0.529)
NHSG	−0.0062 (−1.061)	−0.0057 (−0.947)	−0.0042 (−0.719)	−0.0057 (−0.975)	−0.0249 (−0.485)
NHSG (−1)	−0.0087 (−1.350)	−0.0091 (−1.376)	−0.0079 (−1.294)	−0.0083 (−1.364)	−0.0535 (−1.045)
BHPD	0.1839** (4.761)	0.1626** (4.202)	0.1840** (4.773)	0.1862** (4.862)	0.6986** (2.197)
BHPD (−1)	0.1004** (3.295)	0.0959** (3.054)	0.1022** (3.284)	0.1038** (3.332)	−0.6805** (−2.506)
BQPD	0.1794** (2.545)	0.1449** (2.074)	0.1856** (2.667)	0.1859** (2.674)	1.0735 (1.589)
BQPD (−1)	0.1362** (2.376)	0.1203** (2.047)	0.1491** (2.513)	0.1495** (2.539)	−1.0934 (−1.629)
MR30D	−1.8444** (−5.157)	−2.0647** (−4.850)	−1.9234** (−5.164)	−1.9466** (−5.224)	1.7850 (0.701)
MR30D (−1)	−0.5733* (−1.853)	−0.3568 (−1.005)	−0.6308** (−1.997)	−0.6744** (−2.113)	3.7726 (1.497)
MR30D ∗ *D*	1.0389* (1.823)	1.1613** (2.732)	1.4764** (3.071)	1.5711** (3.314)	
MR30D ∗ *D* (−1)	−0.2778 (−0.689)	−0.4750 (−1.444)	−0.3699 (−0.762)	−0.4097 (−0.848)	
ER_SP	0.0159* (1.778)	0.0276** (3.231)	0.0097 (1.051)	0.0113 (1.243)	0.2792** (2.132)
ER_SP (−1)	−0.0086 (−0.734)	−0.0074 (−0.606)	−0.0127 (−1.128)	−0.0134 (−1.176)	0.1642 (1.630)
ER_WB	0.3277** (3.872)	0.3505** (4.024)	0.3215** (3.796)	0.3210** (3.833)	−0.2122 (−0.345)
ER_WB (−1)	0.0390 (0.446)	0.0384 (0.432)	0.0313 (0.365)	0.0346 (0.400)	2.9839** (3.659)
Own Lag 1	−0.1379 (−1.475)	−0.1631* (−1.658)	−0.1515* (−1.632)	−0.1513* (−1.630)	0.1224 (1.405)
SUMMER	0.1083 (1.228)	0.1251 (1.355)	0.1153 (1.297)	0.1101 (1.278)	0.6795 (0.907)
R^2	77.3%	77.2%	77.0%	77.7%	35.9%
Adjusted R^2	74.5%	74.5%	74.2%	75.0%	29.0%
F-Statistics	27.95**	27.90**	27.54**	28.64**	5.24*

Notes: ER_MBS: MBS Index excess return; *ER_GNMA*: GNMA MBS subindex excess return; *ER_FHLMC*: FHLMC MBS subindex excess return; *ER_FNMA*: FNMA MBS subindex excess return; *ER_MREIT*: Excess return on the mortgage REIT index; *IPG*: Growth in industrial productions; *NHSG*: Growth in new home sales; *BHPD*: Change in bond horizon premium; *BQPD*: Change in bond quality premium; *MR30D*: Change in the 30-year mortgage rate; *WAC/MR30*: Ratio of *WAC* (weighted average coupon rate of the MBS mortgage pool) to the prevailing 30-year mortgage rate; *MR30D* ∗ *D*: The interaction of *MR30D* with a dummy variable *D*, which is equal to one if *WAC/MR30* > 1, and 0 otherwise; *ER_SP*: S&P 500 excess return; *ER_WB*: Excess return on the J.P. Morgan World Bond Index; *SUMMER* is an exogenous dummy variable that equals 1 it for the months of May, June and July, and 0 otherwise.
t ratios are in parentheses. **Significant at 5%; *Significant at 10%.

contemporaneous and lag changes in quality premium (*BQPD*) have a positive and significant effect on the excess returns of MBS, GNMA, FHLMC and FNMA, implying that higher MBS expected returns are associated with higher default risk, call risk and liquidity risk. Although contemporaneous *BQPD* also has a positive effect on the excess returns on mortgage REITs, the effect is not highly significant.

MR30D reflects the change in the prevailing 30-year mortgage rate, which embeds the interest cost of mortgage debt. A lower mortgage rate means a lower discount rate for investors and a higher present value of the mortgage cash flow, implying a higher return to investors. We call this the discount rate effect (*i.e.*, a negative interest rate effect on MBS returns). The empirical results confirm the negative discount effect of interest rate for all Lehman MBS index returns, but not mortgage REITs. This could be due to the fact that the Lehman MBS index only includes agency MBS that are pass-throughs of fixed-rate residential mortgages, while mortgage REITs may also invest in other mortgage loans or securities such as commercial mortgage-backed securities (CMBS), adjustable rate mortgages (ARMs), nonagency loans, jumbo loans, project loans, collateralized mortgage obligations (CMOs) or graduated payment mortgages (GPM).

At the same time, the refinancing variable, $MR30D * D$ (an interaction variable denoting the change in mortgage rates *MR30D*, with the condition that the prevailing mortgage rate falls far enough below the average mortgage pool coupon rate) implies that more investors can reduce their mortgage burden by prepaying their mortgage debts through refinancing. That is, drops in mortgage rate result in a lower return on MBS because increased cash flows from prepayments must be reinvested at lower yields. This result is called the prepayment effect (*i.e.*, a positive effect of interest rate on MBS returns). Our findings of positive and significant coefficient of $MR30D * D$ support the prepayment hypothesis.

Inclusion of *ER_SP* in the structural VAR model sheds light on how the stock market affects MBS returns. Contemporaneous stock market index returns appear to have a positive and significant impact on MBS returns and GNMA, suggesting a close linkage between the equity risk premium and MBS risk premium. A negative lag relation between stock excess returns and MBS excess returns, GNMA, FHLMC and FNMA, although insignificant, implies a reallocation effect for portfolio choices. Portfolio asset allocations will likely be shifted from MBS to the stock market after an upswing. That is, lower returns on MBS will be expected following an up market in stocks. Consistent with Peterson and Hsieh (1997) and Francis and Ibbotson (2001), our results indicate that excess returns on mortgage REITs are significantly linked to the equity market risk premium.

The world bond market appears to have a contemporaneous positive effect on MBS returns (GNMA, FHLMC and FNMA), which is significant at the 5% level. The lag effect is insignificant. Interestingly, only the lag world bond returns affect the mortgage REITs significantly. This pattern suggests the relationship of the world bond market risk factor with the closed-end real estate funds differs from its relationship with the MBS.

The impact of these economic variables on three different agencies (GNMA, FHLMC and FNMA) is quite similar with the exception of the stock market, although we find a slightly smaller coefficient of term structure and quality spread, a more negative coefficient of the mortgage rate variable as well as a larger coefficient of refinancing variable proxy in GNMA as compared to the other two (FHLMC and FNMA).

The seasonality factor does not appear to be significant on either the MBS or mortgage REIT returns in the VAR analysis. R^2 is much higher for the MBS markets (77%) than for mortgage REITs (36%), further suggesting that the driving forces of the MBS differ from that of the mortgage REITs.

Results of Impulse Response Analysis

Sims (1980) first introduced the impulse response analysis into VAR modeling as a descriptive device intended to represent the reaction of each variable to a shock (or innovation) in each equation of the VAR system over time. A meaningful impulse response analysis requires that shocks be uncorrelated. This orthogonal condition is fulfilled in the structural VAR framework that we have just estimated.

Table 5 reports the response of MBS excess returns to a shock in the growth in industrial productions and new home sales, change in the term structure premium, change in the quality premium, change in the mortgage rate, a refinancing variable proxy, excess returns of the S&P 500 as well as excess returns of the world bond index. Panels B–D report the impulse response for excess returns on GNMA, FHLMC and FNMA MBS indices. Results across all four panels are similar.

A shock in the growth in industrial productions appears to have an immediate significant negative effect on MBS excess returns while growth in new home sales has significant negative lag effect on MBS excess returns. Change in term structure has positive contemporaneous and lag effects on MBS returns, while change in quality spread has a positive contemporaneous but a negative lag effect (at the second period) on MBS returns. Contemporaneous negative discount rate effect and positive prepayment effect caused by changes in mortgage rate are both highly significant.

Table 5 ■ Impulse response of MBS return to 1 standard deviation innovations in variables (monthly data 1988–2001).

Panel A: Impulse Response for MBS Index Excess Return									
Period	*IPG*	*NHSG*	*BHPD*	*BQPD*	*MR30D*	*MR30D* ∗ *D*	*ER_SP*	*ER_WB*	*ER_MBS*
0	***−0.130 (−1.9)***	−0.055 (−0.8)	**0.645 (11.1)**	**0.223 (5.0)**	**−0.235 (−5.8)**	**0.086 (2.2)**	***0.069 (1.8)***	**0.144 (3.9)**	**0.465 (18.3)**
1	−0.101 (−1.4)	**−0.145 (−2.1)**	**0.163 (2.5)**	−0.055 (−0.9)	−0.030 (−0.6)	−0.028 (−0.4)	**−0.224 (−3.4)**	0.075 (1.3)	0.014 (0.2)
2	−0.031 (−0.8)	−0.020 (−0.7)	−0.003 (−0.1)	***−0.063 (−1.7)***	−0.015 (−0.6)	0.000 (0.0)	***−0.054 (−1.8)***	−0.029 (−0.9)	0.027 (0.7)
3	−0.021 (−1.3)	−0.002 (−0.2)	−0.009 (−0.3)	0.026 (1.5)	−0.006 (−0.5)	0.006 (0.4)	−0.001 (0.0)	−0.020 (−1.3)	0.018 (1.2)
4	−2.E−03 (−0.3)	−2.E−04 (0.0)	−6.E−04 (0.0)	−7.E−03 (−0.8)	3.E−03 (0.5)	1.E−03 (0.2)	−2.E−03 (−0.2)	−3.E−03 (−0.5)	2.E−03 (0.4)
5	−2.E−03 (−0.5)	4.E−04 (0.2)	−6.E−03 (−1.4)	3.E−03 (0.7)	9.E−04 (0.5)	9.E−04 (0.4)	6.E−05 (0.0)	−3.E−03 (−1.3)	−8.E−04 (−0.3)
6	6.E−04 (0.4)	1.E−03 (0.8)	−3.E−04 (−0.2)	−8.E−04 (−0.4)	4.E−04 (0.5)	5.E−04 (0.6)	1.E−03 (0.9)	−5.E−04 (−0.4)	2.E−04 (0.2)
7	−9.E−05 (−0.2)	8.E−05 (0.2)	−8.E−04 (−0.8)	9.E−04 (0.9)	2.E−04 (0.6)	1.E−04 (0.4)	2.E−04 (0.3)	−1.E−04 (−0.2)	−3.E−04 (−0.5)
8	2.E−04 (0.9)	1.E−04 (0.6)	1.E−04 (0.3)	−4.E−04 (−0.7)	5.E−05 (0.3)	2.E−05 (0.2)	2.E−04 (0.6)	8.E−05 (0.3)	−6.E−05 (−0.2)
9	−3.E−05 (−0.2)	−4.E−06 (0.0)	−1.E−04 (−0.5)	2.E−04 (0.7)	6.E−06 (0.1)	8.E−06 (0.2)	1.E−05 (0.1)	−1.E−06 (0.0)	−4.E−05 (−0.4)
10	4.E−05 (0.7)	1.E−05 (0.3)	8.E−05 (0.7)	−1.E−04 (−0.6)	−1.E−06 (0.0)	−3.E−06 (−0.1)	2.E−05 (0.3)	3.E−05 (0.7)	3.E−06 (0.0)
Panel B: Impulse Response for Excess Return on GNMA MBS Subindex									
Period	*IPG*	*NHSG*	*BHPD*	*BQPD*	*MR30D*	*MR30D* ∗ *D*	*ER_SP*	*ER_WB*	*ER_GNMA*
0	***−0.127 (−1.8)***	−0.055 (−0.8)	**0.641 (10.9)**	**0.227 (5.0)**	**−0.230 (−5.5)**	**0.111 (2.8)**	**0.110 (2.8)**	**0.154 (4.1)**	**0.469 (18.3)**
1	−0.101 (−1.4)	**−0.137 (−2.0)**	**0.161 (2.5)**	−0.054 (−0.9)	−0.025 (−0.5)	−0.013 (−0.2)	**−0.224 (−3.4)**	0.078 (1.4)	0.030 (0.5)
2	−0.034 (−0.9)	−0.024 (−0.8)	−0.007 (−0.1)	***−0.067 (−1.8)***	−0.017 (−0.6)	−0.018 (−0.6)	***−0.055 (−1.8)***	−0.033 (−1.0)	0.023 (0.6)
3	−0.020 (−1.2)	−0.001 (−0.1)	−0.010 (−0.4)	0.023 (1.3)	−0.007 (−0.6)	−0.010 (−0.9)	0.000 (0.0)	−0.022 (−1.4)	0.012 (0.7)
4	−3.E−04 (0.0)	−3.E−04 (−0.1)	−1.E−03 (−0.1)	−8.E−03 (−1.0)	2.E−03 (0.5)	−3.E−03 (−0.7)	−2.E−03 (−0.2)	−3.E−03 (−0.5)	−1.E−03 (−0.2)
5	−5.E−04 (−0.2)	8.E−04 (0.3)	−6.E−03 (−1.4)	3.E−03 (0.7)	9.E−04 (0.5)	−6.E−04 (−0.4)	6.E−04 (0.2)	−3.E−03 (−1.0)	−1.E−03 (−0.5)
6	9.E−04 (0.7)	9.E−04 (0.8)	1.E−04 (0.1)	−7.E−04 (−0.4)	3.E−04 (0.3)	1.E−06 (0.0)	2.E−03 (1.0)	−2.E−04 (−0.1)	−2.E−04 (−0.2)
7	8.E−05 (0.2)	7.E−05 (0.2)	−6.E−04 (−0.6)	8.E−04 (0.8)	2.E−04 (0.6)	1.E−04 (0.4)	1.E−04 (0.2)	8.E−05 (0.1)	−3.E−04 (−0.6)
8	2.E−04 (0.9)	1.E−04 (0.4)	2.E−04 (0.5)	−3.E−04 (−0.7)	2.E−05 (0.1)	6.E−05 (0.5)	2.E−04 (0.5)	1.E−04 (0.5)	−4.E−05 (−0.2)
9	−3.E−05 (−0.3)	−1.E−05 (−0.1)	−8.E−05 (−0.3)	2.E−04 (0.7)	1.E−07 (0.0)	3.E−05 (0.5)	−1.E−05 (−0.1)	2.E−05 (0.2)	−6.E−06 (−0.1)
10	3.E−05 (0.5)	3.E−06 (0.1)	8.E−05 (0.7)	−9.E−05 (−0.6)	−6.E−06 (−0.2)	5.E−06 (0.2)	8.E−06 (0.1)	3.E−05 (0.7)	7.E−06 (0.2)

Panel C: Impulse Response for Excess Return on FHLMC MBS Subindex

Period	*IPG*	*NHSG*	*BHPD*	*BQPD*	*MR30D*	*MR30D ∗ D*	*ER_SP*	*ER_WB*	*ER_FHLMC*
0	***−0.132 (−1.9)***	−0.041 (−0.6)	**0.637 (11.0)**	**0.223 (5.0)**	**−0.241 (−5.9)**	**0.104 (2.7)**	0.047 (1.3)	**0.142 (3.9)**	**0.465 (18.3)**
1	−0.098 (−1.4)	**−0.145 (−2.1)**	**0.159 (2.5)**	−0.052 (−0.8)	−0.033 (−0.7)	0.014 (0.2)	**−0.219 (−3.4)**	0.080 (1.4)	−0.008 (−0.1)
2	−0.035 (−1.0)	−0.013 (−0.5)	−0.003 (−0.1)	−0.061 (−1.6)	−0.010 (−0.3)	0.033 (0.8)	−0.048 (−1.5)	−0.024 (−0.7)	0.034 (0.9)
3	−0.026 (−1.6)	−0.004 (−0.3)	−0.009 (−0.3)	***0.030 (1.7)***	−0.004 (−0.4)	0.015 (0.9)	0.002 (0.1)	−0.018 (−1.2)	0.017 (1.1)
4	−0.003 (−0.3)	0.000 (0.0)	0.000 (0.0)	−0.008 (−0.9)	0.003 (0.6)	0.004 (0.5)	−0.002 (−0.2)	−0.003 (−0.4)	0.002 (0.3)
5	−0.002 (−0.6)	0.000 (0.1)	−0.007 (−1.4)	0.004 (0.8)	0.001 (0.5)	0.001 (0.4)	0.000 (0.1)	−0.003 (−1.3)	−0.001 (−0.3)
6	0.001 (0.4)	0.001 (0.8)	0.000 (0.0)	−0.001 (−0.4)	0.000 (0.4)	0.000 (0.1)	0.002 (0.9)	0.000 (−0.4)	0.000 (0.2)
7	0.000 (−0.1)	0.000 (0.0)	−0.001 (−0.8)	0.001 (0.8)	0.000 (0.5)	0.000 (−0.2)	0.000 (0.2)	0.000 (−0.2)	0.000 (−0.6)
8	0.000 (0.9)	0.000 (0.5)	0.000 (0.4)	0.000 (−0.7)	0.000 (0.2)	0.000 (−0.4)	0.000 (0.6)	0.000 (0.3)	0.000 (−0.1)
9	0.000 (−0.2)	0.000 (−0.1)	0.000 (−0.5)	0.000 (0.7)	0.000 (0.0)	0.000 (−0.3)	0.000 (0.0)	0.000 (−0.1)	0.000 (−0.4)
10	0.000 (0.7)	0.000 (0.2)	0.000 (0.7)	0.000 (−0.6)	0.000 (−0.1)	0.000 (−0.5)	0.000 (0.3)	0.000 (0.7)	0.000 (0.1)

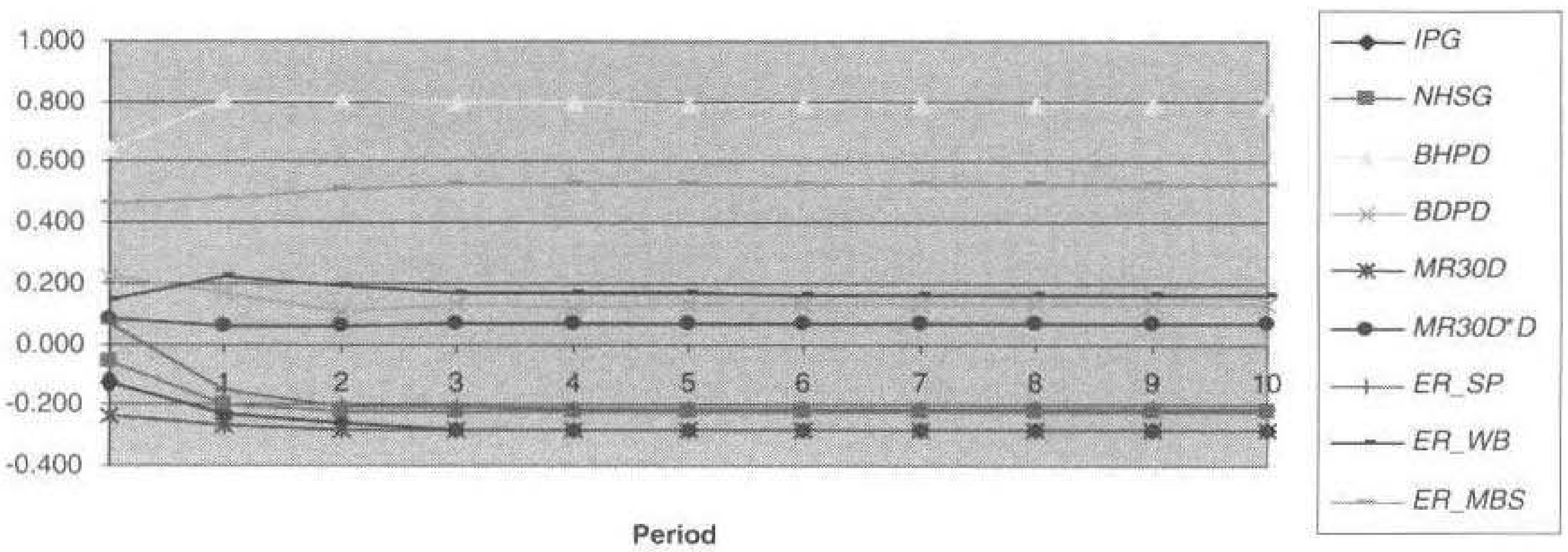
Panel D: Impulse Response for Excess Return on FNMA MBS Subindex

Period	*IPG*	*NHSG*	*BHPD*	*BQPD*	*MR30D*	*MR30D ∗ D*	*ER_SP*	*ER_WB*	*ER_FNMA*
0	***−0.128 (−1.9)***	−0.050 (−0.7)	**0.643 (11.1)**	**0.225 (5.1)**	**−0.242 (−6.0)**	**0.108 (2.9)**	0.053 (1.4)	**0.141 (3.9)**	**0.460 (18.3)**
1	−0.099 (−1.4)	−0.146 (−2.1)	**0.163 (2.5)**	−0.051 (−0.8)	−0.034 (−0.7)	0.013 (0.2)	**−0.223 (−3.4)**	0.082 (1.5)	−0.008 (−0.1)
2	−0.035 (−0.9)	−0.014 (−0.5)	−0.001 (0.0)	***−0.062 (−1.7)***	−0.011 (−0.4)	0.033 (0.8)	−0.049 (−1.5)	−0.023 (−0.7)	0.037 (1.0)
3	−0.026 (−1.6)	−0.005 (−0.3)	−0.008 (−0.3)	***0.031 (1.7)***	−0.005 (−0.4)	0.015 (0.9)	0.001 (0.1)	−0.018 (−1.2)	0.017 (1.1)
4	−3.E−03 (−0.3)	−3.E−05 (0.0)	1.E−04 (0.0)	−9.E−03 (−1.0)	3.E−03 (0.6)	4.E−03 (0.5)	−2.E−03 (−0.2)	−3.E−03 (−0.4)	2.E−03 (0.4)
5	−2.E−03 (−0.7)	2.E−04 (0.1)	−7.E−03 (−1.4)	4.E−03 (0.9)	1.E−03 (0.5)	1.E−03 (0.4)	3.E−04 (0.1)	−3.E−03 (−1.3)	−8.E−04 (−0.3)
6	6.E−04 (0.4)	1.E−03 (0.7)	2.E−05 (0.0)	−1.E−03 (−0.5)	4.E−04 (0.5)	3.E−04 (0.2)	2.E−03 (0.9)	−5.E−04 (−0.4)	3.E−04 (0.2)
7	−1.E−04 (−0.2)	2.E−05 (0.0)	−9.E−04 (−0.8)	1.E−03 (0.9)	2.E−04 (0.5)	−6.E−05 (−0.1)	1.E−04 (0.2)	−2.E−04 (−0.3)	−4.E−04 (−0.7)
8	3.E−04 (0.9)	2.E−04 (0.6)	2.E−04 (0.4)	−5.E−04 (−0.7)	5.E−05 (0.3)	−6.E−05 (−0.3)	2.E−04 (0.6)	8.E−05 (0.3)	−2.E−05 (−0.1)
9	−3.E−05 (−0.2)	−1.E−05 (−0.1)	−1.E−04 (−0.5)	3.E−04 (0.7)	2.E−06 (0.0)	−2.E−05 (−0.3)	−2.E−06 (0.0)	−9.E−06 (−0.1)	−6.E−05 (−0.5)
10	6.E−05 (0.7)	2.E−05 (0.3)	9.E−05 (0.7)	−1.E−04 (−0.6)	−6.E−07 (0.0)	−2.E−05 (−0.4)	3.E−05 (0.4)	4.E−05 (0.7)	9.E−06 (0.1)

Note: *IPG*: Growth in industrial productions; *NHSG*: Growth in new home sales; *BHPD*: Change in bond horizon premium; *BQPD*: Change in bond quality premium; *MR30D*: Change in the 30-year mortgage rate; *WAC/MR30*: Ratio of *WAC* (weighted average coupon rate of the MBS mortgage pool) to the prevailing 30-year mortgage rate; *MR30D ∗ D*: The interaction of *MR30D* with a dummy variable *D*, which is equal to one if *WAC/MR30* > 1, and 0 otherwise; *ER_SP*: S&P 500 excess return; *ER_WB*: Excess return on the J.P. Morgan World Bond Index; *ER_MBS*: MBS Index excess return; *ER_GNMA*: GNMA MBS subindex excess return; *ER_FHLMC*: FHLMC MBS subindex excess return; *ER_FNMA*: FNMA MBS subindex excess return.

t ratios are in parentheses. Bold = Significant at 5%; ***Bold and Italic*** = Significant at 10%.

Figure 3 ■ Cumulative impulse response of MBS excess return to 1 standard deviation of shocks in *IPG*, *NHSG*, *BHPD*, *BDPD*, *MGT30D*, *MGT30D* $*$ *D*, *ER_SP* and *ER_WB*.



It is interesting to see that a stock market return shock does have a longer-term effect on the MBS market. The impact of a shock is statistically significant for 2 months. In the contemporaneous month, the impact of the stock market shock to MBS excess returns is positive; it turns negative in the next 2 months. This result further confirms the idea of portfolio reallocation explained earlier. Figure 3 displays the pattern of the impulse response of MBS excess returns to the shocks in these variables.

The world bond returns affect MBS returns only contemporaneously, implying that world bond market information is incorporated into the MBS returns quickly. This is perhaps due the common underlying fundamentals and risk factors driving all the bond markets around the world.

Because impulse responses of MBS excess returns may have conflicting signs, the cumulative impulse response determines the length of time it takes for the cumulative effects of a shock to be stabilized. Panels A through D of Table 6 show the cumulative impulse response of MBS excess returns for one standard deviation of shocks in *IPG*, *NHSG*, *BHPD*, *BQPD*, *MR30D*, *MR30D* $*$ *D*, *ER_SP*, *ER_WD* and lag MBS excess returns. Again, the pattern is quite similar across the different types of MBS.

The effect of the shock on MBS excess returns is typically absorbed within a 3-month period. It takes about 3 months for the shock in stock market excess returns (*ER_SP*) to be fully absorbed; 2 months for a shock in *IPG* (growth in industrial productions), *NHSG* (growth in new home sales), *BQPD* (change in quality premium), the discount rate (*MR30D*), the prepayment effect (*MR30D* $*$ *D*), or in world bond excess returns (*ER_WD*) to be fully absorbed; and 1 month for a shock in *BHPD* (changes in horizon premium) or the lag MBS excess returns (*ER_MBS*) to be fully absorbed.

Results of Variance Decomposition

While impulse response analysis is performed to illustrate how variables in the VAR system react over time to innovations or shocks in other variables, a variance decomposition technique allows us to compare the role that different variables play in causing such responses. Table 7 reports four panels of results showing variance decomposition of the excess returns for the MBS index as

Table 6 ■ Cumulative impulse response for MBS return to 1 standard deviation innovations in variables (monthly data 1988–2001).

Panel A: Cumulative Impulse Response for MBS Index Excess Return

Period	*IPG*	*NHSG*	*BHPD*	*BQPD*	*MR30D*	*MR30D * D*	*ER_SP*	*ER_WB*	*ER_MBS*
0	−0.130	−0.055	0.645	0.223	−0.235	0.086	0.069	0.144	0.465
1	−0.230	−0.200	0.808	0.168	−0.265	0.058	−0.154	0.219	0.480
2	−0.261	−0.220	0.805	0.104	−0.280	0.058	−0.209	0.190	0.506
3	−0.283	−0.222	0.796	0.130	−0.286	0.064	−0.209	0.170	0.524
4	−0.285	−0.222	0.795	0.123	−0.283	0.065	−0.212	0.167	0.527
5	−0.287	−0.222	0.789	0.126	−0.282	0.066	−0.212	0.164	0.526
6	−0.286	−0.221	0.788	0.126	−0.282	0.066	−0.210	0.163	0.526
7	−0.286	−0.221	0.788	0.127	−0.282	0.066	−0.210	0.163	0.526
8	−0.286	−0.221	0.788	0.126	−0.281	0.066	−0.210	0.163	0.526
9	−0.286	−0.221	0.788	0.126	−0.281	0.066	−0.210	0.163	0.526
10	−0.286	−0.221	0.788	0.126	−0.281	0.066	−0.210	0.163	0.526

Panel B: Cumulative Impulse Response for Return on GNMA MBS Subindex Excess Return

Period	*IPG*	*NHSG*	*BHPD*	*BQPD*	*MR30D*	*MR30D * D*	*ER_SP*	*ER_WB*	*ER_GNMA*
0	−0.127	−0.055	0.641	0.227	−0.230	0.111	0.110	0.154	0.469
1	−0.228	−0.193	0.802	0.173	−0.255	0.098	−0.114	0.232	0.498
2	−0.262	−0.217	0.794	0.106	−0.272	0.080	−0.169	0.200	0.521
3	−0.282	−0.218	0.784	0.128	−0.279	0.070	−0.169	0.178	0.534
4	−0.282	−0.219	0.783	0.120	−0.277	0.067	−0.171	0.175	0.532
5	−0.283	−0.218	0.777	0.123	−0.276	0.067	−0.171	0.172	0.531
6	−0.282	−0.217	0.777	0.122	−0.276	0.067	−0.169	0.172	0.531
7	−0.282	−0.217	0.776	0.123	−0.275	0.067	−0.169	0.172	0.530
8	−0.282	−0.217	0.776	0.123	−0.275	0.067	−0.169	0.172	0.530
9	−0.282	−0.217	0.776	0.123	−0.275	0.067	−0.169	0.172	0.530
10	−0.282	−0.217	0.776	0.123	−0.275	0.067	−0.169	0.172	0.530

Panel C: Cumulative Impulse Response for Return on FHLMC MBS Subindex Excess Return

Period	*IPG*	*NHSG*	*BHPD*	*BQPD*	*MR30D*	*MR30D * D*	*ER_SP*	*ER_WB*	*ER-FHLMC*
0	−0.132	−0.041	0.637	0.223	−0.241	0.104	0.047	0.142	0.465
1	−0.231	−0.187	0.795	0.171	−0.274	0.118	−0.172	0.222	0.457
2	−0.265	−0.199	0.792	0.110	−0.284	0.151	−0.220	0.198	0.491
3	−0.291	−0.203	0.783	0.141	−0.288	0.167	−0.218	0.180	0.508
4	−0.294	−0.203	0.783	0.133	−0.285	0.170	−0.220	0.178	0.510
5	−0.296	−0.203	0.776	0.136	−0.284	0.172	−0.219	0.174	0.509
6	−0.295	−0.202	0.776	0.135	−0.284	0.172	−0.218	0.174	0.509
7	−0.296	−0.202	0.776	0.136	−0.284	0.172	−0.218	0.174	0.509
8	−0.295	−0.202	0.776	0.136	−0.284	0.172	−0.217	0.174	0.509
9	−0.295	−0.202	0.776	0.136	−0.284	0.172	−0.217	0.174	0.509
10	−0.295	−0.202	0.776	0.136	−0.284	0.172	−0.217	0.174	0.509

Table 6 ■ continued.

Panel D: Cumulative Impulse Response for Return on FNMA MBS Subindex Excess Return									
Period	*IPG*	*NHSG*	*BHPD*	*BQPD*	*MR30D*	*MR30D* ∗ *D*	*ER_SP*	*ER_WB*	*ER_FNMA*
0	−0.128	−0.050	0.643	0.225	−0.242	0.108	0.053	0.141	0.460
1	−0.227	−0.196	0.805	0.173	−0.276	0.121	−0.170	0.224	0.452
2	−0.262	−0.210	0.805	0.111	−0.286	0.154	−0.219	0.201	0.489
3	−0.288	−0.214	0.797	0.142	−0.291	0.170	−0.218	0.183	0.506
4	−0.291	−0.214	0.797	0.134	−0.289	0.173	−0.220	0.180	0.508
5	−0.293	−0.214	0.790	0.137	−0.288	0.175	−0.220	0.177	0.507
6	−0.292	−0.213	0.790	0.136	−0.287	0.175	−0.218	0.176	0.508
7	−0.293	−0.213	0.789	0.137	−0.287	0.175	−0.218	0.176	0.507
8	−0.292	−0.213	0.789	0.137	−0.287	0.175	−0.218	0.176	0.507
9	−0.292	−0.213	0.789	0.137	−0.287	0.175	−0.218	0.176	0.507
10	−0.292	−0.213	0.789	0.137	−0.287	0.175	−0.218	0.176	0.507

Note: IPG: Growth in industrial productions; *NHSG*: Growth in new home sales; *BHPD*: Change in bond horizon premium; *BQPD*: Change in bond quality premium; *MR30D*: Change in the 30-year mortgage rate; *WAC/MR30*: Ratio of *WAC* (weighted average coupon rate of the MBS mortgage pool) to the prevailing 30-year mortgage rate; *MR30D* ∗ *D*: The interaction of *MR30D* with a dummy variable *D*, which is equal to one if *WAC/MR30* > 1, and 0 otherwise; *ER_SP*: S&P 500 excess return; *ER_WB*: Excess return on the J.P. Morgan World Bond Index; *ER_MBS*: MBS Index excess return; *ER_GNMA*: GNMA MBS subindex excess return; *ER_FHLMC*: FHLMC MBS subindex excess return; *ER_FNMA*: FNMA MBS subindex excess return.

well as the three subindices. A consistent pattern emerges across all four MBS indices, so we focus for the purpose of discussion on the results of Panel A.

Several results are worth noting. First, shocks to excess returns of MBS consistently explain about 24% of the variation of their own movement. Second, the bond horizon premium variable explains a sizable portion of the variation in MBS excess returns (about 48%). This result implies that the change in term structure risk premium is the critical driving force for the MBS excess returns. The bond quality premium variable (*BQPD*) explains about 6% of the MBS returns. Fourth, the negative discount effect (6%) appears to have a greater impact on MBS returns than the prepayment effect, *MR30D* ∗ *D* (less than 1%). Fifth, excess returns on the stock market (*ER_SP*) explain about 6% of the variation in MBS excess returns, while the world bond market explains about 3% of the MBS returns. Finally, the growth in new home sales (*NHSG*) explains about 2–3% and growth in industrial productions (*IPG*) explains about 3%. The financial market variables such as term structure risk premium, quality premium, mortgage rate and stock market return explain the variation of the excess return of MBS much more than real economy sector variables such as industrial productions and new home sales. This is perhaps due to the fact that financial variables may have incorporated the information content of the real variables.

Impact of Freddie Mac/Fannie Mae Equity Risk Premium

Among the three government agencies created to facilitate the development of the secondary mortgage market, GNMA carries the full faith and credit of the