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Signals from the Markets for Fannie Mae and Freddie Mac Subordinated Debt

by

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Abstract

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In the first quarter of 2001, Fannie Mae and Freddie Mac, the two largest government-sponsored enterprises (GSEs), began issuing subordinated debt as part of a set of voluntary initiatives announced in October 2000. However, both Enterprises suspended new issuance after public revelations of accounting irregularities and the accompanying upheavals in their senior managements. Last year, the Enterprises reaffirmed their commitment to issuing sub debt through an agreement with their regulator, the Office of Federal Housing Enterprise Oversight (OFHEO), which shifts their sub debt issuance from a voluntary initiative to an enforceable commitment. In that context, there has been growing interest in the usefulness of signals from the markets for the Enterprises' subordinated debt as a means of improving regulatory oversight.

While considerable research exists with respect to the subordinated debt of large banks, little research has been undertaken with respect to Fannie Mae and Freddie Mac. Because of the special status of GSEs, the special terms of the Enterprises' sub debt, and other differences relative to banks, market signals related to Enterprise sub debt may not be as strong. This paper explores that topic and how sub debt market signals have evolved as the perceptions of the risk of the two Enterprises has changed following recent revelations of accounting errors and earnings misstatements. To do so, we replicate for the Enterprises the work of Gonzalez-Rivera and Nickerson (forthcoming) developed in the context of large banks. They develop a model of a multivariate dynamic signal that combines fluctuations in equity prices, subordinated debt yields, and senior debt yields to monitor and assess in real time the risk profile of the issuing institution. The signal is a coincident indicator based on a time series model of idiosyncratic yield fluctuations and equity returns. Using this model Gonzalez-Rivera and Nickerson document high-risk events for the Bank of America and Banker's Trust. Our goals are to determine whether such a model for the Enterprises provides reliable indicators of high risk events and, if so, whether we can construct a reliable leading indicator based on spreads between the yields on the sub debt of the Enterprises and the yields on comparable Treasury securities. We also use econometric analysis to examine whether the market behavior of sub debt yields has changed over time.

Signals from the Markets for Fannie Mae and Freddie Mac Subordinated Debt

Fannie Mae and Freddie Mac (hereafter referred to as the Enterprises) began voluntarily issuing subordinated (sub) debt in the first quarter of 2001 as part of an initiative intended to, among other things, enhance market discipline of their activities. That intention was confirmed by Fannie Mae's former Chief Financial Officer, Timothy Howard (March 2001), in testimony before the House Subcommittee on Capital Markets, Insurance, and Government-Sponsored Enterprises. In that testimony, Mr. Howard asserted that the Enterprises' sub debt programs provide three benefits to the market and policymakers. First, sub debt holders have an incentive to monitor an Enterprise's risk. Second, prices of an Enterprise's sub debt signal to policymakers how investors view the Enterprise's financial condition. Finally, sub debt serves as an additional capital cushion.

This paper is part of a broader effort at OFHEO to better understand the usefulness and limits of the sub debt programs. In another OFHEO working paper, Smith (2007) concludes:

- The sub debt programs of Fannie Mae and Freddie Mac have a number of shortcomings. If an Enterprise missed interest payments on its sub debt, they would be deferred (with accrued interest) for up to five years; investors could incur credit losses only if the Enterprise defaulted. This deferral-not-default feature may lead investors to perceive an implicit federal guarantee of the sub debt, in which case the yields will provide little information about changes in market perceptions of Enterprise risk.

- The yields of Fannie Mae and Freddie Mac sub debt respond to new information about the financial condition and risk of the Enterprises in ways that make economic sense. However, statistical analysis suggests that, in the period from September 2002 through November 2005, changes in the sub debt yields conveyed little information about changes in investor perceptions of the risk of either Enterprise. That analysis also implies that investors perceived an implicit guarantee of Fannie Mae and Freddie Mac sub debt, and the debt contributed little to market discipline of the Enterprises, during that period. The stock market is currently the only significant source of market information about, and market discipline of, Fannie Mae and Freddie Mac.

This paper reports on further empirical work that supports those conclusions. Here we report findings from both regression and Kalman filter analysis that document the market behavior of GSE sub debt and its potential role in market discipline. In brief, we find that yields and yield changes on GSE sub debt are too closely linked to those of GSE senior debt and U.S. Treasury securities to provide strong market signals or to conclude that market participants are closely monitoring and effectively disciplining the GSEs through their pricing of GSE sub debt. Thus, the research demonstrates the limits of market signals and market discipline associated with the sub debt programs of the Enterprises as currently constituted.

The remainder of the paper is organized as follows. First, we provide an overview of the use of sub debt to enhance market discipline in the context of regulated financial institutions in the U.S., primarily commercial banks. Next, we review and analyze the voluntary sub debt programs of Fannie Mae and Freddie Mac and their strengths and weaknesses. We then present three types of empirical information on the degree to which the sub debt programs contribute to market discipline of the Enterprises: descriptive statistics and simple regression analysis, a dynamic signal model, and Chow breakpoint tests for changes in the market behavior of sub debt yields over time. The final section presents our conclusions.

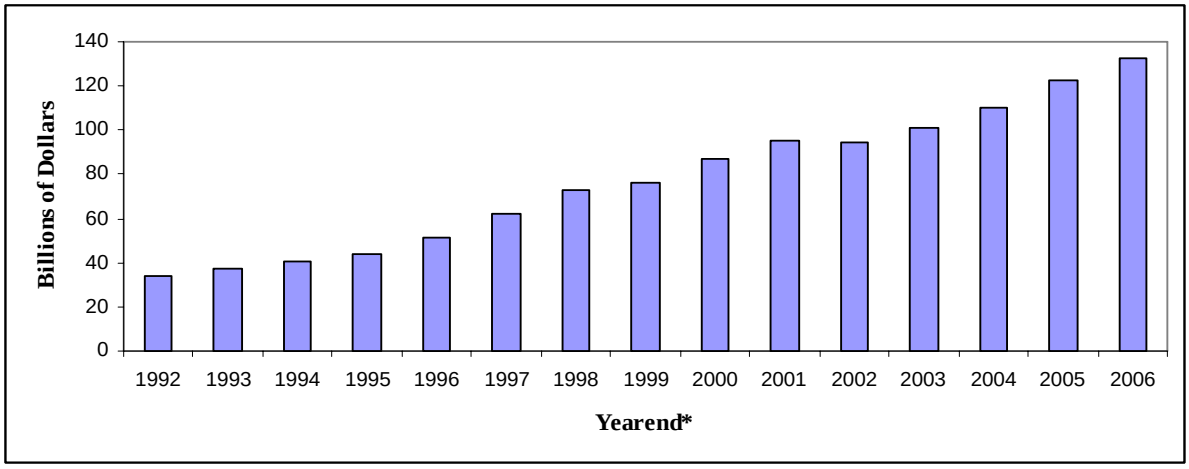
Market Discipline and Sub Debt

In recent years, researchers and financial regulators have focused on the potential of market information and incentives to improve the regulation of financial institutions. The premise is that market participants process information more efficiently than do government regulators and have strong incentives to gather and act upon that information. The actions of these market participants in turn provide rewards or exact penalties that provide incentives for managers to conduct business in a safe, sound, and efficient manner.

Research on ways to enhance market discipline of banking organizations has focused primarily on sub debt. To a large extent, the focus on sub debt was motivated by the FDIC's history of protecting both insured and uninsured deposits. That protection diminished the incentive for uninsured depositors to monitor and discipline banks. Sub debt is attractive to regulators because it is clearly subordinate to deposits and outside the deposit insurance safety net. Because of the lack of security, sub debt investors are likely to monitor risk-taking more vigilantly. Some analysts believe that changes in the yields on sub debt provide signals of investors' perception of the credit worthiness of the issuer. Sub debt is appealing as a potential source of enhanced market discipline because that debt explicitly falls outside the federal safety net for banks (Evanoff and Wall, 2000).

In the last decade or so, as U.S. banking organizations have become larger, more complex, and more diversified in their operations, bank regulators have become increasingly interested in the possibility of relying more heavily on financial markets to monitor and discipline the behavior of large banking organizations. The interest of bank regulators in sub debt was codified in the Financial Services Modernization Act of 1999 (the Gramm-Leach-Bliley Act), which required large, complex banks to issue "eligible debt" if they controlled a financial subsidiary. The Act defines "eligible debt" to be long-term, unsecured, and rated in one of the top three investment grades. In addition, regulations allow banks the flexibility to include sub debt as part of total required capital. Data compiled by the Federal Deposit Insurance Corporation (FDIC) indicate that outstanding sub debt at U.S. commercial banks alone (excluding amounts for bank holding companies) nearly quadrupled from $34 billion at the end of 1992 to $133 billion at midyear 2006 (Figure 1).

Figure 1. Subordinated Debt Outstanding at Commercial Banks, 1992-2006



*The figure for 2006 is as of June 30. Source: Federal Deposit Insurance Corporation

The Sub Debt Programs of Fannie Mae and Freddie Mac

In October 2000, Fannie Mae and Freddie Mac jointly announced a set of six initiatives. Those initiatives consisted of a series of financial, operating, and disclosure changes designed to enhance capital adequacy, transparency, and market discipline. Included among those initiatives was a commitment to voluntarily issue publicly traded and externally rated sub debt.[1] The Enterprises initially committed to sub debt programs with the following features (Fahey, 2001; Frame and Wall, 2002):

- semi-annual issuance beginning after the inaugural year (2001);
- the amount of outstanding sub debt was to grow to a range of between $8 to $10 billion for Freddie Mac and $12 to $15 billion for Fannie Mae, within three years;
- after the three-year phase-in period, each Enterprise would maintain a combined total of core capital[2] and outstanding sub debt that equals or exceeds the sum of 4 percent of on-balance sheet assets and 0.45 percent of off-balance sheet mortgage securities;

[1] Both Fannie Mae and Freddie Mac had issued subordinated debt prior to the announcement of the new program. Freddie Mac had $145 million and Fannie Mae had about $1.5 billion of such debt outstanding prior to commencement of the current sub debt program.

[2] Core capital is the sum of the par value of outstanding common stock, the par value of outstanding non-cumulative preferred stock, paid-in capital and retained earnings.

- at all times, the debt would be publicly rated by Moody's Investors Service and Standard and Poor's;

- the sub debt would be unsecured and subordinated and would rank junior in priority of payments to all senior liabilities, current and future;

- deferral of interest payments on the sub debt of an Enterprise would be triggered when: (1) core capital falls below 125 percent of critical capital[3] levels; or (2) the Enterprise's core capital falls below minimum capital levels, and, following a request from the Enterprise, the Secretary of the Treasury exercises his or her discretionary authority to purchase the obligations of an Enterprise (pursuant to Section 306(c) of the Freddie Mac Act or Section 304(c) of the Fannie Mae Act);

- interest deferral could extend for a period of up to five years but not beyond the maturity date of the issue. All deferred interest would accrue interest at the stated coupon on the securities, compounded semi-annually. All deferred interest, as well as interest on that deferred interest, on all sub debt securities would be paid as soon as the deferral of interest was no longer required, provided all debt obligations, if any, purchased by the U.S. Secretary of the Treasury had been repaid;

- upon the occurrence of a triggering event, an Enterprise would not redeem any outstanding sub debt or declare or pay dividends on, or redeem, purchase, or acquire, its outstanding common and preferred stock;

- maturity would not accelerate upon default or any other event; and

- sub debt would not convert to equity even when deferral of interest payments is triggered.

Fannie Mae and Freddie Mac issued a total of $12.5 billion and $5.5 billion of sub debt, respectively, under the voluntary initiative. While Fannie Mae's volume is within its commitment to issue between $12 and 15 billion, Freddie Mac's falls considerably short of its anticipated level of $8 to $10 billion. Both Enterprise's stopped issuing sub debt as their accounting came under scrutiny. Freddie Mac stopped issuing sub debt after November 2002, and Fannie Mae last issued sub debt in November 2003. For Fannie Mae, spreads over senior debt of comparable maturity at time of pricing ranged from 22 to 38 basis points, and averaged about 30 basis points. By the time the Enterprises had

[3] Critical capital is equal to the sum of 1.25 percent of aggregate on-balance sheet assets as measured under Generally Accepted Accounting Principles, and, 0.25 percent of other aggregate off-balance sheet obligations.

stopped issuing new sub debt, both had reached the goal of having total capital plus sub debt in excess the sum of 4 percent of on-balance sheet assets and 0.45 percent of off-balance sheet mortgage securities.

In September 2005, the sub debt programs of Fannie Mae and Freddie Mac were reaffirmed in agreements with their federal regulator, the Office of Federal Housing Enterprise Oversight (OFHEO). In those agreements, each Enterprise committed to issuing sub debt and to submitting an issuance plan for review by OFHEO every six months. Each Enterprise agreed to maintain a ratio of 4 percent or more of its qualifying sub debt plus core capital to the sum of its assets and .45 percent of its outstanding net MBS. Despite its suspension of sub debt issuance, Freddie Mac has remained in compliance with its agreement to maintain that minimum ratio of core capital plus sub debt to assets and outstanding MBS. Fannie Mae's restatement of its financial results for 2002, 2003, and 2004 revealed that Fannie Mae had failed to meet that commitment during 2003 but did so in subsequent years. In June 2006, Freddie Mac issued new sub debt; Fannie Mae has yet to do so.

Possible Limits to Market Discipline through Subordinated Debt

Despite the adoption of a sub debt requirement for large, complex banks and the sub debt programs of the Enterprises, the usefulness of sub debt to financial regulators remains a matter of debate. Important obstacles may exist to effective market discipline of large financial institutions, and studies on sub debt as a source of market discipline have resulted in mixed findings (Smith, 2007). Among the most important obstacles is that, to varying degrees, very large financial institutions may benefit from implicit government guarantees of their liabilities because they are perceived to be too big to fail. Because that perception limits market discipline, such institutions may choose a risk profile associated with a higher-than-socially-optimal probability of default (Nier and Baumann, 2006).

That issue is particularly relevant to the Enterprises. There is a widespread perception by investors that GSE obligations carry an implicit federal guarantee that limits market discipline. The U.S. Congressional Budget Office (1991) provides several reasons for that perception. First, GSEs were chartered by or pursuant to acts of Congress and are subject to varying degrees of federal oversight. Second, the federal government gives GSE securities the attributes of and the same preferred investment status as Treasury debt, and exempts the obligations of most of the enterprises from the protections for investors deemed necessary for all debt that is publicly issued by wholly private firms. In so doing, the government signals that investors should consider GSE securities to be safe investments. Investors infer that the government stands ready to provide financial assistance to a GSE if the enterprise gets into serious financial trouble and its ability to discharge its obligation is in doubt. Third, the volume of GSE outstanding obligations is substantial, totaling some $5 trillion. Since depository institutions hold a large proportion of these obligations, it is generally believed that the federal government could not tolerate a default by any GSE because it would reduce the market value of all GSE obligations, perhaps significantly, and could endanger the stability of the entire financial system. Finally, the Congress continues to support the public purposes that the GSEs serve, and the failure of any GSE could disrupt the achievement of its public purpose. The Congressional aid to the Farm Credit System in 1987 illustrates that point. Notwithstanding the apparent perceptions and the reasons for them, it should be noted that GSE obligations are *not* federally guaranteed and, in fact, their debt obligations by statute carry a disclaimer of any government backing.

The Shadow Financial Regulatory Committee (2001) expressed skepticism that investors in the Enterprises' sub debt would be any less protected from credit losses than investors in their senior debt. Consistent with this conclusion, the Committee viewed the yield differentials between the Enterprises' sub and senior debt as mainly reflective of liquidity differences in secondary markets rather than a difference in default risk. The Committee also observed that the Federal Financial Institutions Examination Council gave Enterprise sub debt a 20 percent risk weighting for purposes of bank capital regulation—the same risk weighting given senior GSE debt.

In addition to the issue of an implicit federal guarantee, specific features of the sub debt programs of Fannie Mae and Freddie Mac may also limit their usefulness with respect to market discipline. Frame and Wall (2002) viewed the interest deferral provision of the Enterprises' sub debt programs as problematic. In their view, a requirement that sub debt convert to equity in times of distress would be more effective in establishing that sub debt holders were at risk in the event of financial distress at one of the Enterprises. OFHEO's then-Director Armando Falcon (2000) had previously stated that, "as a general matter, sub debt is more effective if it is convertible to equity on a permanent basis rather than simply having interest payments suspended, especially when the investor is later made whole."

Another shortcoming of the sub debt programs of Fannie Mae and Freddie Mac is that they were initially voluntary and were later suspended as the accounting of the Enterprises came under scrutiny. A defining characteristic of a voluntary program is that it can be altered or terminated at any time, and both Enterprises deviated from their initial pledges. Fannie Mae and Freddie Mac committed to issue sub debt at least twice a year following the inaugural period, yet Freddie Mac did not issue sub debt between November 2002 and June 2006, and Fannie Mae has not issued any since November 2003. As the commitments to issue sub debt were voluntary, OFHEO had no authority to require the Enterprises to honor them. To maximize market discipline, sub debt must be issued at regularly scheduled intervals, regardless of market conditions or the potential financial consequences to the issuer. The joint report of the Board of Governors of the Federal Reserve System and the Secretary of the Treasury (2000) found a significant impact on market discipline at the time of debt issuance. That report indicates that required disclosures made at the time of issuance and the attention to those disclosures that issuance attracts substantially adds to market information. When issuance is suspended, so too is any disclosure of new information by the issuer or by third-parties such as credit ratings agencies. Although third-party rating agencies continue to monitor and can change their ratings of existing issues regardless of the suspension, such monitoring is an imperfect substitute for the lost information flow.

Another weakness involves the lack of a specific commitment that sub debt support a specified amount of Enterprise assets. Rather, Fannie Mae and Freddie Mac each promises to maintain a minimum ratio (approximately four percent) of capital and sub debt to its on- and off-balance sheet assets. Thus, as long as an Enterprise's capital growth keeps pace with its asset growth, it may not need to issue sub debt, or may only issue a minimum amount of such debt. Freddie Mac's experience has illustrated that point. Specifically, while the Enterprise issued no sub debt in 2003, its ratio test exceeded the threshold previously set, and even improved from the previous year.

Finally, and perhaps most important, the events that trigger the suspension of interest payments on the sub debt occur only after an Enterprise experiences a severe deterioration in its financial condition as measured by book-value capital ratios. Since the financial crises of the 1980s, researchers have criticized reliance on book-value measures. Benston et al. (1986, pp. 203ff), for example, emphasize the divergence between book and market values and the potentially adverse consequences of relying on book values. The Department of the Treasury (1991), among others, emphasized the desirability of early regulatory intervention or "prompt corrective action" (PCA). Advocates of PCA note that as the capital ratios of poorly capitalized savings and loan associations declined, thrift managers and owners responded to the one-sided incentives created by regulatory forbearance, deposit insurance, and bankruptcy laws by increasing the risk exposure of their institutions (White, 1991; Barth et al., 1989). The original proposals to require bank regulatory agencies to take prompt corrective action against ailing banks emphasized the advantage of market-value measures of capital in triggering regulatory intervention (e.g., Benston and Kaufman, 1988). Eisenbeis and Wall (2002) have recently suggested that bank regulators' implementation of PCA would be improved if they developed and implemented supplemental disclosures of the fair value of bank assets and liabilities.

Consistent with those views, an alternative to the trigger chosen by the Enterprises would be for triggering event(s) to occur well in advance of the potential insolvency of an Enterprise. Such triggers would encourage greater market scrutiny and

provide the Enterprises with additional incentives to maintain a significant capital cushion. Wall, Eisenbeis, and Frame (2004) suggest that the capital of Fannie Mae and Freddie Mac be measured in terms of economic value rather than historic cost, and that OFHEO set each Enterprise's minimum and critical capital requirements in terms of economic value as well. Doing so would increase the likelihood that the capital trigger levels for the deferral of interest on an Enterprise's sub debt would be crossed before the Enterprise was insolvent. Frame and Wall (2002) had previously observed that book-value capital ratios may not reflect an Enterprise's financial condition. As was the case with Fannie Mae for several years in the late 1970s and early 1980s, an Enterprise may report positive book-value capital but be insolvent on a market-value basis.

Empirical Performance of Fannie and Freddie Sub Debt

The existence and the criticisms of the Enterprises' sub debt program raise the question of whether or not the market for sub debt does indeed provide information that may be useful for monitoring safety and soundness. We explore this possibility in three ways. First, we provide a description of the historic behavior of sub debt relative to senior debt and Treasury securities of comparable maturities. We also relate the behavior of the debt issues to the behavior of the Enterprises' common stock. We then proceed by estimating a risk signal model a la Gonzalez-Rivera and Nickerson (2006). Finally, we explore the possibility of changes in the behavior of sub debt yields during the sample period (early 2002 through late 2005) and whether such changes are in the direction of greater information flowing from market prices for these instruments.

A Description of Enterprise Sub Debt Data and Behavior

We use daily data on each Enterprise's common stock price and on paired issues of senior and subordinated noncallable debt with initial maturities of 10 years. The data are from the Bloomberg database and cover the period from the initial trading in each Enterprise's subordinated debt through December 6, 2005. Without loss of generality since the daily yields movements are highly correlated and for ease of explication, we

focus on the behavior of the oldest outstanding 10-year subordinated issue of each Enterprise. In addition, we use data on a 10-year Treasury note of similar vintage and on the S&P 500 and the Citigroup Global Markets bond indexes for AAA- and A-rated U.S. corporate 7 to10 year bonds from the Haver Analytics database. Table 1 provides descriptive statistics for these data.

Figures 2 through 5 use data from Freddie Mac to provide representative examples of the behavior of Enterprise debt relative to Enterprise common stock and Treasury debt. As noted below, this behavior differs markedly from that documented by Gonzalez-Rivera and Nickerson for Bank of America sub debt. Figure 2 shows the levels of the price of Freddie Mac common stock and the yield on Freddie Mac sub debt due on March 21, 2011. For the entire sample period, the stock price and yield are positively correlated ($\rho = 0.33$), but for the subperiods preceding and following the public disclosure of Freddie Mac's accounting and earnings management issues in June 2003, the stock price and yield were first very positively correlated ($\rho = 0.77$) and then negatively correlated ($\rho = -0.18$). The negative correlation is the more usual relationship if default risk is a major driver of stock and debt security price changes because increases (decreases) in default risk would drive stock prices down (up) and debt yields up (down), all else being equal. Gonzalez-Rivera and Nickerson, for example, document a negative relationship between stock prices and yields for the Bank of America during their sample period of October 1998 through July 2001.

The anomalous correlation may be related to the negative convexity inherent in the asset portfolios of the Enterprises related to the prepayment risk associated with fixed-rate American mortgages (which unlike mortgages in many other countries have no prepayment penalty). It may also be related to the unusual behavior of interest rates following September 11, 2001, a period not covered by the Gonzalez-Rivera and Nickerson data. However, the correlation is also positive in the fall of 2005 ($\rho = 0.86$). Figure 3 graphs the price of Freddie Mac common stock against three yield spreads: that between the Freddie Mac sub debt due on March 21, 2011 and a ten-year Treasury bond due on February 15, 2011; that between the Freddie Mac sub debt and a ten-year Freddie

Mac reference note (senior debt) due on March 15, 2011; and that between the senior debt issue and the ten year Treasury bond. Those spreads are perhaps better indicators of investors' assessments of default risk. Two of the spreads in figure 3, those between the Freddie Mac debt issues and Treasuries, have correlations to the Freddie Mac stock price similar to that of the sub debt yield. That is, those spreads are first positive (0.42 and 0.63 for the sub debt and senior debt spreads, respectively) and then negative (-0.62 and -0.34). In contrast, the correlation of the sub debt-senior debt spread is always negative at -0.63 before June 2003 and -0.67 afterward. The negative correlation between the stock price and the sub debt-senior debt spread is consistent with a market default risk signal.

Table 2 shows the correlations of these spreads with the stock price for the full sample and for the periods before and after the revelation of accounting errors at Freddie Mac. For the full sample period, the correlation of the stock price with the senior-Treasury spread remains positive, but the stock price's correlation with the sub debt-Treasury spread and the sub debt-senior spread are both negative. The sub debt-senior spread correlation is negative for both subperiods as well, but the spreads of both sub debt and senior debt to Treasury debt switches signs from positive in the earlier period to negative in the latter. Thus, the anomaly remains, at least in some periods, in the spreads to Treasury. Figure 3 also shows that the volatility of those spreads dampened significantly after June 2003.

Figure 4 shows the unusually close relationship between the daily yield change for Freddie Mac senior debt and the daily yield change for a comparable Treasury security. A simple regression demonstrates this relationship: The yield on the Freddie Mac senior debt security moves .92 basis points for each basis point move in the yield on the Treasury security; and daily yield changes on the Treasury security explain 90 percent of the variation in the daily yield changes on the Freddie Mac senior debt security. Similarly, figure 5 shows a very tight relationship between the yields on Freddie Mac's senior and sub debt securities. Again, a simple regression shows that the yield on Freddie Mac sub debt security moves 1.01 basis points for each basis point move in the yield on its senior debt security, explaining 96 percent of the variation in the daily yield changes

on Freddie Mac's sub debt security. Taken together these relationships imply (and it is unnecessary to graph) a very tight relationship between the yields on Freddie Mac's sub debt security and the Treasury security as well.

Smith (2007) examines the response of the yields of Fannie Mae and Freddie Mac sub debt respond to specific discrete events and finds that, for the most part, the response is consistent in direction with market monitoring for default risk. In addition, figures 2 and 3 show a simultaneous rise in debt yields and fall in stock price on June 9 with announcement of accounting problems at Freddie Mac that is consistent with a joint market signal with respect to default risk. Those observations, however, are essentially anecdotal. In the next sections of this paper we apply a systematic method to determine whether such a joint signal from the debt and equity markets exists.

Table 1. Summary Statistics for Daily Prices and Yields of Selected Enterprise and Treasury Securities and Stock and Bond Indices, 2001-2005[4]

	Freddie Mac			Fannie Mae			Treasury	Indices		
	Share Price	Yield on 10 year Senior Debt dated 3/15/2011	Yield on 10 year Sub Debt Dated 3/21/2011	Share Price	Yield on 10 year Senior Debt dated 11/15/2010	Yield on 10 year Sub Debt Dated 2/01/2011	Yield on 10 year Treasury Note Dated 02/20/2011	AAA 10- year Bond Index	A 10-year Bond Index	S&P 500
Mean	61.79	4.63	4.93	70.30	4.63	4.94	4.19	972.35	1046.51	1086.64
Median	62.50	4.39	4.71	70.96	4.38	4.71	4.00	994.33	1079.58	1118.86
Maximum	73.70	6.23	6.49	87.49	6.22	6.47	5.52	1119.13	1227.58	1312.83
Minimum	47.35	3.14	3.56	41.62	3.02	3.54	2.78	791.32	826.27	776.76
Std. Dev.	4.84	0.72	0.71	9.28	0.75	0.71	0.62	97.08	120.78	120.03
Skewness	-0.41	0.63	0.64	-0.77	0.51	0.57	0.43	-0.30	-0.28	-0.65
Kurtosis	2.62	2.43	2.35	3.26	2.21	2.26	2.19	1.75	1.68	2.41
Number of Observations	1122	1122	1122	1216	1216	1162	1237	1225	1225	1183

Source: Computed from Bloomberg and Haver Analytics data. The number of observations varies by series because of differences in days with reported trades. For example, Treasuries have reported yields even on major holidays when U.S. stock markets are closed. In addition, U.S. stock markets were closed for several days during September 2001. Sub debt yields are often missing because of lack of trading, especially in 2001.

[4] Data for Freddie Mac securities is for the period from March 21, 2001 through December 6, 2005. Data for Fannie Mae and all other securities and indices is for the period form February 1, 2001 through December 6, 2005.

Figure 2. Freddie Mac Sub Debt Yields and Closing Stock Price, February 2001 to December 2005

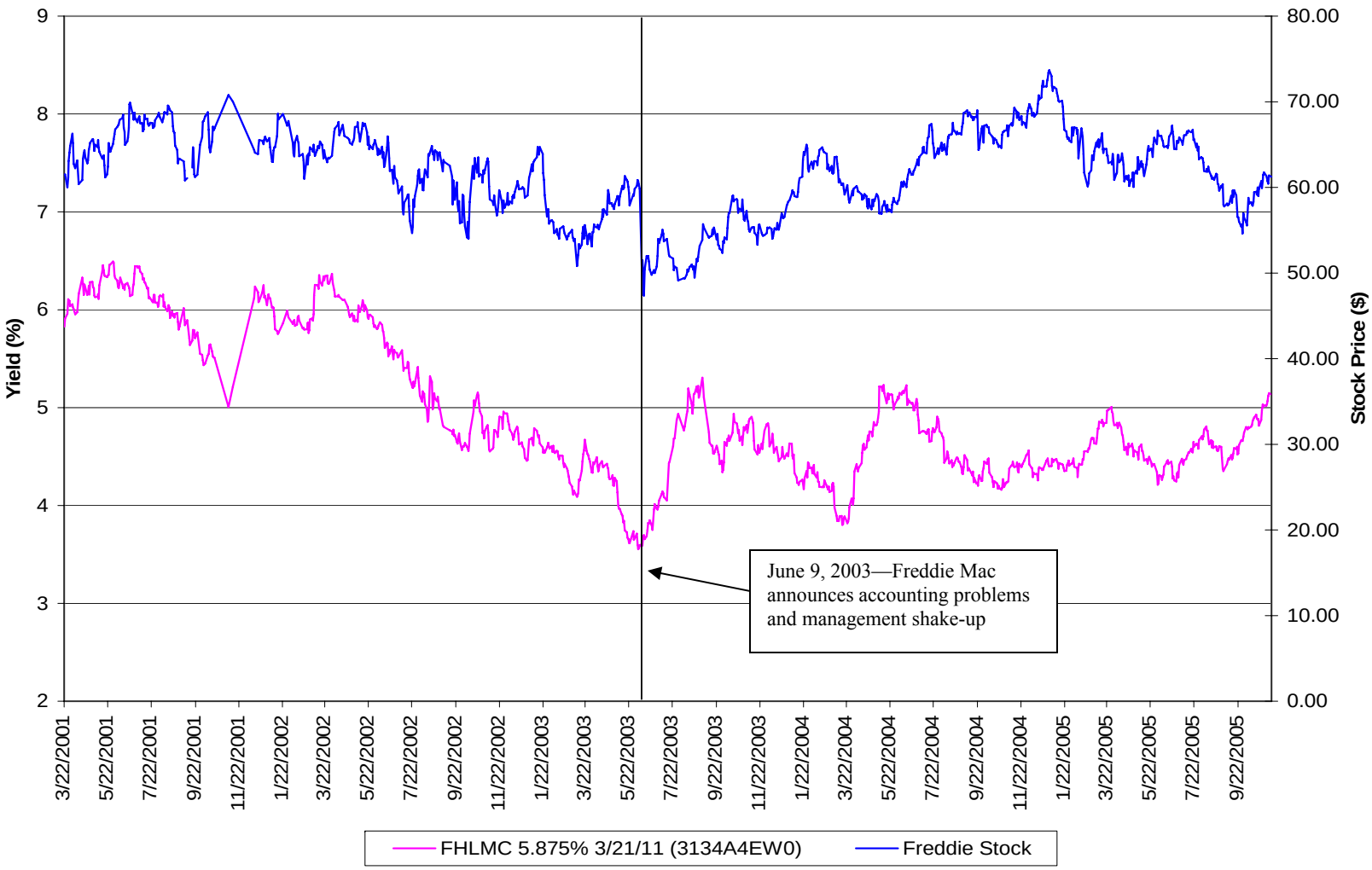


Figure 3. Freddie Mac Yield Spreads and Closing Stock Price, February 2001 to December 2005

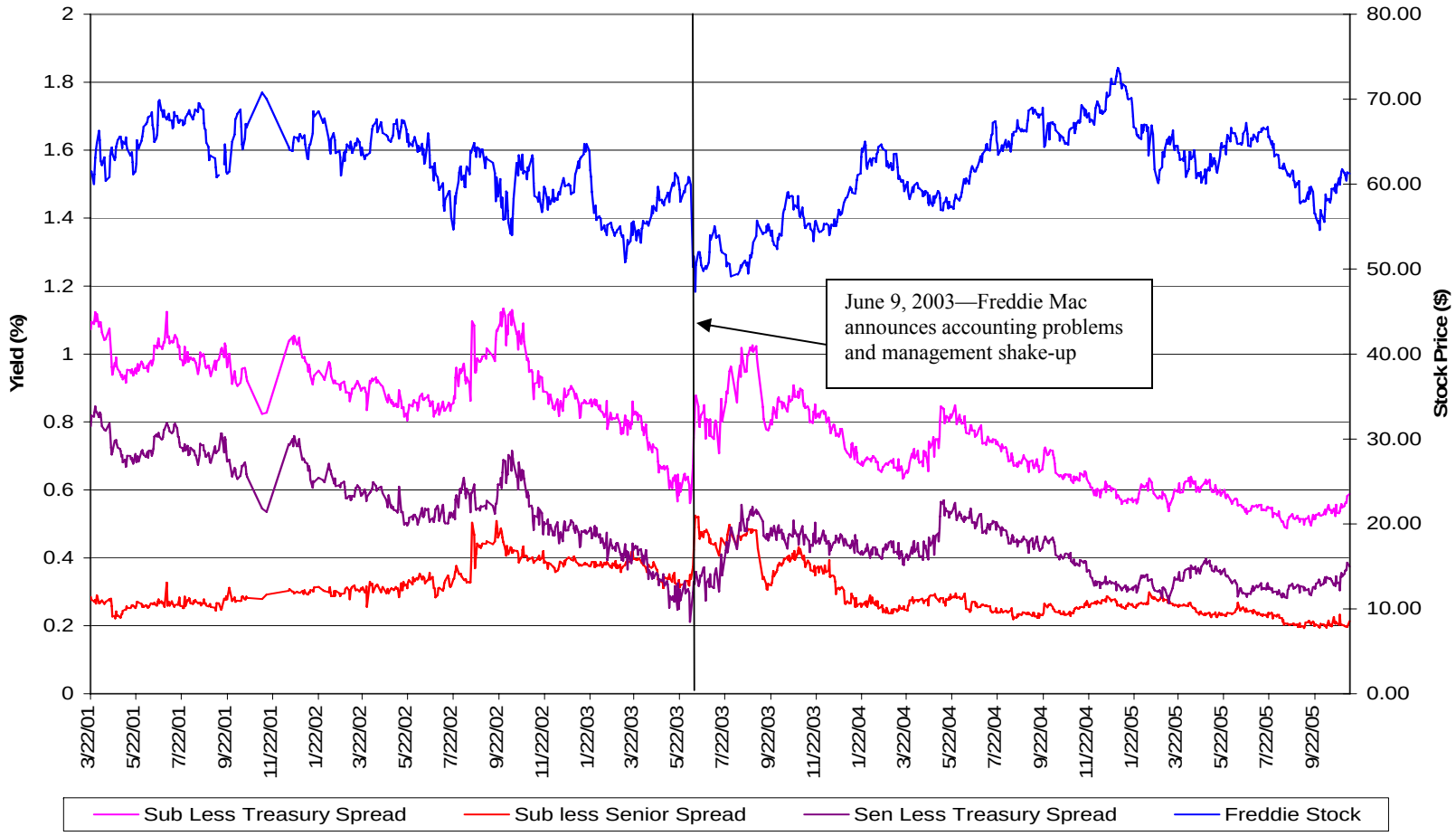


Table 2. Correlation of Freddie Mac Yield Spreads to Stock Prices, March 2001 to December 2005

	Correlation of stock price to:		
	Sub Debt- Senior Spread	Sub Debt- Treasury Spread	Senior- Treasury Spread
Full sample	-0.59	-0.11	0.18
March 2001 to June 6, 2003	-0.63	0.42	0.63
June 9, 2003 to Dec. 6, 2005	-0.67	-0.62	-0.34

Source: Computed from Bloomberg data.

Figure 4. Daily Changes in Freddie Mac Senior Debt and in Treasury Debt Yields, March 2001 to December 2005

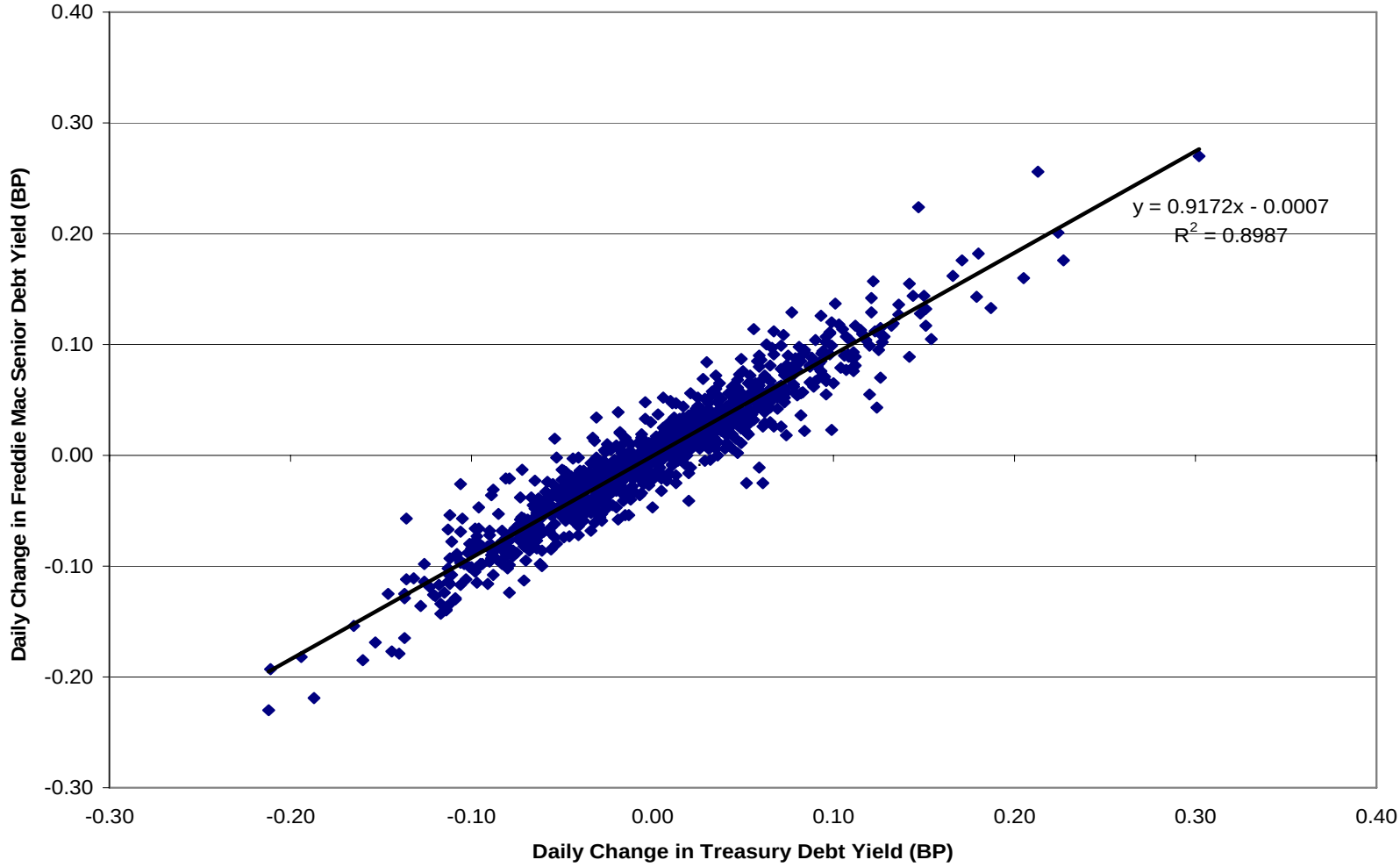
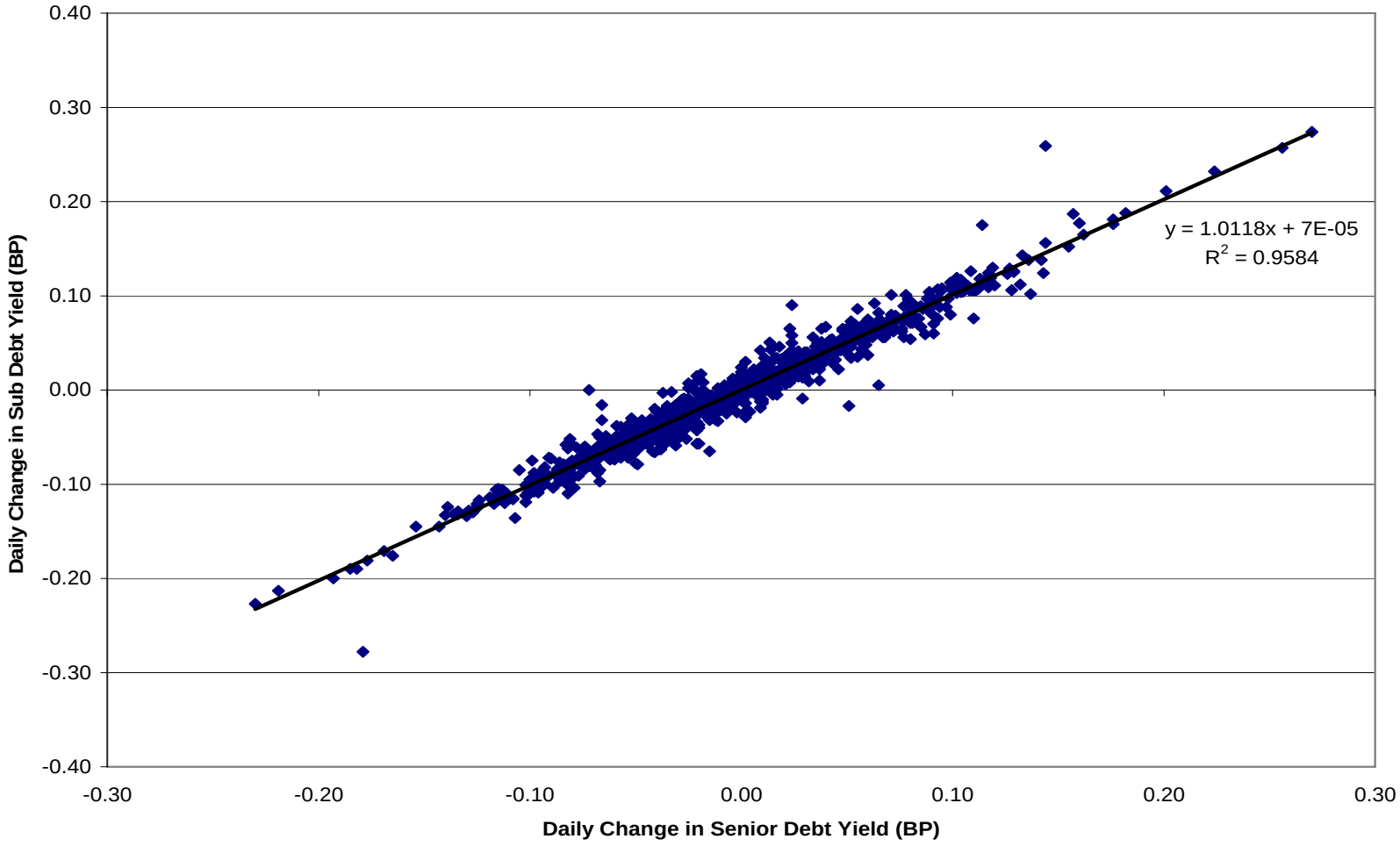


Figure 5. Daily Changes in Freddie Mac Sub Debt and Senior Debt Yields, March 2001 to December 2005.



Modeling a Dynamic Risk Signal

Regulatory sub debt requirements are predicated on information flowing from market signals. Such signals may induce management or regulators to reduce the moral hazard that stems from informational asymmetries and incentives associated with unpriced risk-shifting inherent in deposit insurance, too-big-to-fail (TBTF) policies, or GSE status. Seiler (2003) shows that the share prices of Fannie Mae and Freddie Mac and the spreads between the yields of each Enterprise's 10-year senior debt and comparable-maturity Treasury debt respond predictably to new information about an Enterprise's financial risks and other factors. Smith (2007) extends these results to show that the spreads between the yields of each Enterprise's 10-year subordinated debt and comparable-maturity Treasury debt respond predictably to new information about an Enterprise's financial risks as well. These studies focus on a few events. The model applied here, in essence, tests whether such responsiveness is characteristic of the daily behavior of these markets.

Gonzalez-Rivera and Nickerson suggest that the practical value of sub debt has been limited by two factors. First, pricing data has been difficult to access and is likely to reflect factors besides default risk. Second, it is unclear how responsive sub debt prices are to default risk. To overcome these limitations, Gonzalez-Rivera and Nickerson develop a multivariate dynamic signal that combines information from equity prices and senior and sub debt yields. All three types of securities have some exposure to the default risk of the issuing firm, but differ in that exposure because of the priority in which they are paid. They combine this information to construct a "coincident indicator." That indicator is stochastic, extracted from price data using a Kalman filter algorithm, and monitors idiosyncratic risks because that data is first filtered from market conditions. For the examples in their paper (Bank of America and Banker's Trust), the indicator also turns out to be predictable because of its dependence on spreads to Treasury. Here we apply their technology to the case of the Enterprises.

Briefly stated, the Gonzalez-Rivera and Nickerson technology is as follows. If prices are informative, a common denominator must run through the prices of senior debt, subordinated debt, and equity related to the state of default risk of the corporation. Complicating this

observation is the fact that securities prices contain other information as well. The challenge is to isolate the component of the price that provides information on default risk, which is implicit in the price and not directly observable to the regulator or others. To extract the default signal, Gonzalez-Rivera and Nickerson proceed in two stages. In the first stage, they linearly filter the systematic component in equity and debt using information on the state of the stock and bond markets. The filtered series are proxies for the idiosyncratic components of each security. In the second stage, the idiosyncratic component of each security is split between two unobservable components. One is common to all securities and represents the default signal; the other is particular to each security and represents its individual characteristics.

Let $Dsub_t$, $Dsen_t$, and R_t be the time series of changes in subordinated debt yields, senior debt yields, and return on equity (defined as the daily percent change in the market price of common equity), respectively; and let f_t be a vector of factors. In the first stage of our approach, we remove the systematic component by running the following regressions

$$\left.\begin{aligned} Dsub_t &= \phi_{01} + \phi_1' f_t + \eta_{1t} \\ Dsen_t &= \phi_{02} + \phi_2' f_t + \eta_{2t} \\ R_t &= \phi_{03} + \phi_3' f_t + \eta_{3t} \end{aligned}\right\} \quad (1)$$

Gonzalez-Rivera and Nickerson use the S&P 500 index to filter bank equity returns. They filter bank senior and sub debt yields using the yields on 10-year Treasury notes, yields on an index of 10-year AAA bonds issued by banks and financial firms, and yields on indices of 10-year financial sector bonds. Those latter indices are of rated bonds which Gonzalez-Rivera and Nickerson use to capture more specific market conditions such as liquidity that correspond to particular risk ratings. That is, they use yields on an index of 10-year A or A+ rated bonds issued by financial firms to filter sub debt or senior debt, respectively.

In the second stage, Gonzalez-Rivera and Nickerson redesignate the residuals from (1) as the filtered series: $\eta_{1t} \equiv Dsubf_t$, $\eta_{2t} \equiv Dsenf_t$, $\eta_{3t} \equiv Rf_t$, representing the idiosyncratic component for each security. Within these series, Gonzalez-Rivera and Nickerson hypothesize a non-observable common denominator conveying the state of default of the corporation. Their model consists of the following equations

$$\left.\begin{aligned} Dsubf_t &= \beta_{01} + \beta_1 S_t + u_{1t} \\ Dsenf_t &= \beta_{02} + \beta_2 S_t + u_{2t} \\ Rf_t &= \beta_{03} + \beta_3 S_t + u_{3t} \end{aligned}\right\} \quad (2)$$

$$\Phi(L) S_t = c + \nu_t \quad (3)$$

$$\left.\begin{aligned} \Psi_1(L) u_{1t} &= \varepsilon_{1t} \\ \Psi_2(L) u_{2t} &= \varepsilon_{2t} \\ \Psi_3(L) u_{3t} &= \varepsilon_{3t} \end{aligned}\right\} \quad (4)$$

In equations (2), each series has two stochastic components, one is the unobserved default risk signal S_t that is common to the three series, and the other is an error component u_{it} that represents idiosyncrasies of each type of securities and measurement error. Equations (3) and (4) capture dynamic aspects of the model. Equation (3) allows the signal itself to have a general autoregressive structure. Equations (4) also allow for autocorrelation in the idiosyncratic term u_{it}, again written as general autoregressive structures. The lag polynomials $\Phi(L)$, $\Psi_1(L)$, $\Psi_2(L)$, $\Psi_3(L)$ are all assumed to be of finite order. Since S_t and u_{it} are both unobservable, they are assumed, for identification purposes, to be uncorrelated at all leads and lags. The main task is to retrieve the coincident indicator, S_t, through maximum likelihood estimation. If a common component to the three series exists as hypothesized in equations (2), then the estimates β_1, β_2, and β_3 should be statistically significant and β_1, β_2 have opposite signs to that of β_3 because, when the corporation's default risk increases, debt yields should increase and the return to equity should fall.

Results for Fannie Mae and Freddie Mac

Following Gonzalez-Rivera and Nickerson, we test for stationarity and cointegration, filter out market factors, and use the Kalman filter algorithm to test for the presence of a market signal related to default risk. The Kalman filter models a dynamic, linear relationship between series. To make valid inferences from classical statistical theory, the series must be stationary—that is,

the underlying statistical process generating the observations must not change over time. In addition, our application of the Kalman filter requires that the series not be cointegrated[5] because cointegrated series would indicate that prices do not fully reflect all information contained in past price movements—a violation of weak form market efficiency.

Table 3 shows results for the augmented Dickey-Fuller (ADF) tests for stationarity and Johannsen tests for cointegration. The ADF tests show that most of the data series are not stationary when measured in levels, but all are stationary when measured in first differences or percent returns. That result supports using first differences and percent returns in the analysis that follows. In addition, the Johansen test for cointegrating vectors indicates that the series are not cointegrated and, thus, that weak form market efficiency holds.

Table 4 contains results from the filtering regressions of the first-differenced series. We filter out the influence of market factors on the three series that represent changes in senior debt, sub debt, and equity values and retain only that variation that is due to 1) firm-specific risk and 2) risk that is idiosyncratic to each particular instrument. Our goal is to see if there is a signal—an indicator of a change in the market's perception of risk at the firm that is shared by all three instruments. To do this, we regressed each differenced series on relevant market indicators. Thus for first-differenced sub debt (*Dsub*) and senior debt series (*Dsen*), the regressors are the daily yield change in the 10-year Treasury bond and the return on the appropriate bond index, A rated for sub debt and AAA rated for senior debt, for both Enterprises. The return on the S&P 500 was also a statistically significant regressor for Freddie Mac senior debt, but was not for Freddie Mac sub debt or Fannie Mae senior debt or sub debt. For the returns on common stock series (*R*), the regressors are the return on the S&P 500 index and the daily yield change on the 10-year Treasury bond. The filters for the senior and sub debt series remove 84 to 90 percent of their variation, whereas the filters for the common stock series remove 21 percent of their variation. The high effectiveness of the debt filtering means that relatively little idiosyncratic information was contained in these series.

[5] Cointegration is a measure of the correlation between time series variables.

Table 3. Stationarity and Cointegration Tests

Augmented Dickey-Fuller Stationarity Tests				
	Fannie Mae		Freddie Mac	
Levels	**Statistic**	**Probability**	**Statistic**	**Probability**
Sub debt yield	-2.03	0.28	-2.02	0.28
Senior debt yield	-2.08	0.25	-2.04	0.27
Treasury debt yield	-2.03	0.28	-1.87	0.06
S&P500	-1.83	0.37	-1.07	0.73
Sub debt-Treasury spread	-2.98	0.04	-2.38	0.15
Senior debt-Treasury spread	-2.60	0.09	-3.02	0.03
AAA bond index	-1.48	0.55	-1.19	0.68
A bond index	-1.41	0.58	-1.17	0.69
Stock price	-1.52	0.52	-3.07	0.03
First differences				
Sub debt yield	-31.32	0.00	-22.81	0.00
Senior debt yield	-31.02	0.00	-30.38	0.00
Treasury debt yield	-35.79	0.00	-35.10	0.00
S&P500	-34.48	0.00	-34.11	0.00
Sub debt-Treasury spread	-42.57	0.00	-23.27	0.00
Senior debt-Treasury spread	-25.95	0.00	-23.35	0.00
Percent returns				
AAA bond index	-33.33	0.00	-32.82	0.00
A bond index	-33.35	0.00	-32.82	0.00
Stock price	-35.67	0.00	-33.30	0.00

Johansen Unrestricted Cointegration Rank Tests for No Cointegrating Vectors				
	Fannie Mae		Freddie Mac	
Series considered	**Statistic**	**Critical Value (1%)**	**Statistic**	**Critical Value (1%)**
Sub debt yield, Senior debt yield	12.42	24.60	4.99	20.04
Sub debt yield, Treasury yield	9.56	24.60	8.41	20.04
Sub debt yield, Stock Price	7.74	24.60	14.39	20.04
Sub debt yield, Senior debt yield, Stock Price	23.21	41.07	20.71	35.65
Sub debt yield, Senior debt yield, Stock Price, Treasury yield	41.54	60.16	38.32	54.16

Notably, the residuals from the sub debt and senior debt regressions are very small and very similar. Since the OLS estimated regressions above had adjusted R-squared greater than 80%, little unexplained variation is left in those residuals from which a signal might be detected. In contrast, the adjusted R-squared for the return on equity equations is one-fourth that level,

leaving much more unexplained variation in the residuals. The summary statistics for the residuals, which we now rename per the signal model as *Dsenf*, *Dsubf*, and *Rf,* are presented in table 5.

Table 4. Filtering Regressions

	Fannie Mae			**Freddie Mac**		
	Dsub	***Dsen***	***R***	***Dsub***	***Dsen***	***R***
Ret_S&P500			0.0068 (17.12)		-0.0014 (-2.44)	.0068 (16.56)
Dtryld	0.57 (20.44)	0.57 (27.43)	-0.020 (-2.87)	0.56 (20.75)	0.63 (29.49)	-.020 (-2.82)
RetAAA		-0.063 (-18.74)			-0.054 (-15.77)	
RetA	-0.059 (-12.72)			-0.060 (-13.05)		
Adjusted R-squared	0.84	0.90	0.21	0.86	0.91	0.21

T-statistics are in parentheses.
Independent variables: *Dsub* = the daily change in the yield of the 10 year sub debt. *Dsen* = the daily change in the yield of the 10-year senior debt. *R* = the daily return on equity.
Regressors: Ret_S&P500 = the daily return to the S&P500. Dtryld = the daily change in the yield of the 10-year Treasury bond. RetAAA = the daily return on an index of 10-year AAA-rated bonds. RetA = the daily return on an index of 10-year A-rated bonds.

Table 5. Summary Statistics for Residuals from Filtering Regressions

	Fannie Mae			**Freddie Mac**		
	Dsubf	***Dsenf***	***Rf***	***Dsubf***	***Dsenf***	***Rf***
Mean	0.0012	0.0010	-0.0285	0.0013	0.0008	0.0083
Median	0.0004	0.0015	-0.0345	0.0008	0.0009	-0.0182
Maximum	0.1753	0.1756	7.1153	0.1838	0.1120	7.1750
Minimum	-0.1753	-0.1440	-10.7619	-0.1419	-0.0815	-15.3954
Standard deviation	0.0255	0.0202	1.4590	0.0238	0.0191	1.4138
Skewness	0.2591	0.1786	-0.2640	0.6398	0.1941	-1.1171
Kurtosis	11.3247	11.9743	7.4789	11.7384	6.9531	17.6968
Jarque-Bera	3133.48	3633.31	916.13	3412.35	690.29	9668.19
Probability	0	0	0	0	0	0
Sum	1.3037	1.0372	-30.8408	1.4018	0.8246	8.7361
Sum of squared deviations	0.7001	0.4405	2298.86	0.5951	0.3817	2096.66
Observations	1081	1081	1081	1050	1050	1050

Table 6 shows the correlation matrix of the three sets of residuals. The sub debt and senior debt residuals are quite highly correlated and both are weakly negatively correlated with the residuals from the equity regression. The correlations of sub debt, senior debt, and equity are similar for the two Enterprises.

Table 6. Correlations Matrices

	Fannie Mae			**Freddie Mac**		
	Dsubf	***Dsenf***	***Rf***	***Dsubf***	***Dsenf***	***Rf***
Dsubf	1.00	0.55	-0.10	1.00	0.50	-0.08
Dsenf	0.55	1.00	-0.07	0.50	1.00	-0.07
Rf	-0.10	-0.07	1.00	-0.08	-0.07	1.00

The Kalman filter is used to identify and estimate the unobserved, but hypothetically existent shared risk signal (S) that explains part of the variation in each of these residual series. In theory, *Rf* should respond inversely to S as compared to *Dsenf* and *Dsubf*.

First, we tried using all three residual series to identify an underlying, unobserved signal. Thus, the three signal equations have the residuals as functions of the hypothetical signal variable (S) and an autoregressive error structure (idiosyncratic variation). The State variables represent the idiosyncratic variation in each series and in S. The results were not sensitive to specification differences and we assumed all state variables follow an AR(1) structure.

Table 7 contains results for the regressions using the Kalman filter algorithm to identify the unobserved default risk signal. As shown in panel 7a, the results for the full model show insignificant coefficients for the risk signal in the signal equations (the β's) and highly significant coefficient estimates for the autoregressive components (the ψ's) of the subordinated and senior debt residuals in the state equations. The result is a signal that is totally explained by past observations rather than innovations in debt yields or equity returns. In panel 7b we present results from an alternative specification that drops senior debt. We tested several alternative specifications, including dropping one of the debt series from the model (since the residuals are highly correlated) and altering starting values and error structures with no significant qualitative change in the nature of results presented in the table. Those results show no meaningful

relationship between the signal and the innovations in sub debt yield or equity returns for either Enterprise.

To confirm the relative dearth of information entering the signaling model, we also computed principal components for the three residual series for each Enterprise. Once again, those confirm that relatively little information remains in common across the three series after the filtering. The Principal Component Analysis presented in table 8 demonstrates that there is one principal component with an eigenvalue greater than one for each Enterprise.[6] That principal component explains 53 percent of correlation for Fannie Mae and 51 percent for Freddie Mac, and the residuals from senior and subordinated debt regressions load into this component positively while the residuals from equity regression load into it negatively. That result supports the idea that there is potentially a shared signal but given the similar loadings for the *Dsenf* and *Dsubf*, we are unlikely to be able to distinguish idiosyncratic variation in the residuals from the two debt series. Our interpretation: *Dsenf* and *Dsubf* are very similar and have a very similar relationship to *Rf*. Thus, we are unable to detect a market signal of default risk. That result is unexpected for large, well-known financial institutions with actively traded securities, especially during a period when significant operating and accounting problems were revealed to the market. Thus, although Seiler (2003) and Smith (2007) show that markets appear to respond reasonably to information announcements, we fail to find evidence that markets consistently evaluate changes in the default risk of these firms.

Table 7a. Signal Regressions with Sub Debt, Senior Debt, and Equity

Fannie Mae	***Dsubf***	***Dsenf***	***Rf***
β_1	0.53 (0.52)		
β_2		0.09 (0.17)	
β_3			-0.15 (-0.55)
ψ_1	-0.25 (-9.56)		
ψ_2		-0.18 (-3.25)	
ψ_3			-0.04 (-0.33)
$\log \sigma_i^2$	-0.13 (-0.00)	0.20 (0.00)	0.37 (0.00)
$S_t = 1.00S_{t-1} + \nu_t$			

[6] Principal component analysis identifies orthogonal directions of maximum variance in the original data. The Kaiser criterion emphasizes eigenvalues greater than one because they indicate that the associated principal component accounts for more variance in the dependent variable than does an average original variable.

(181933) log *l* = 8189.12			
Freddie Mac	***Dsubf***	***Dsenf***	***Rf***
β_1	0.016 (0.05)		
β_2		0.01 (0.05)	
β_3			-0.14 (-0.05)
ψ_1	-0.32 (-2.93)		
ψ_2		-0.39 (-5.56)	
ψ_3			-0.05 (-1.94)
log σ_i^2	3.42 (0.02)	-10.26 (-0.04)	0.11 (0.00)
$S_t = -0.003S_{t-1} + \nu_t$ (-0.02) log *l* = 3485.34			

Z-statistics are in parentheses. *Dsubf, Dsenf,* and *Rf* are the filtered series (residuals) from the regressions in table 4.

Table 7b. Signal Regressions with Sub Debt and Equity

Fannie Mae	*Dsubf*	*Rf*
β_1	0.0022 (0.26)	
β_2		-0.0002 (-0.27)
ψ_1	-0.87 (-8.97)	
ψ_2		-0. 04 (-2.10)
log σ_i^2	-11.37 (-8.98)	4.74 (0.63)
$S_t = -0.19S_{t-1} + \nu_t$ (-6.50) log *l* = 5509.22		
Freddie Mac	*Dsubf*	*Rf*
β_1	-0.0052 (0.00)	
β_2		0.55 (0.00)
ψ_1	-0.12 (-2.87)	
ψ_2		-0.079 (-0.66)
log σ_i^2	-11.37 (-8.98)	4.74 (0.63)
$S_t = 0.15S_{t-1} + \nu_t$ (0.83) log *l* = 591.21		

Z-statistics are in parentheses. *Dsubf* and *Rf* are the filtered series (residuals) from the regressions in table 4.

Table 8. Principal Components and Eigenvectors of Residual Series

	Fannie Mae			Freddie Mac		
	Principal Components					
	Comp 1	Comp 2	Comp 3	Compensation 1	Comp 2	Comp 3
Eigenvalue	1.58	0.97	0.44	1.52	0.98	0.50
Variance Prop.	0.53	0.32	0.15	0.51	0.33	0.17
Cumulative Prop.	0.53	0.85	1	0.51	0.83	1
	Eigenvectors					
Variable	Vector 1	Vector 2	Vector 3	Vector 1	Vector 2	Vector 3
Dsubf	-0.69	-0.12	0.71	0.69	0.13	0.71
Dsenf	-0.69	-0.18	-0.70	0.69	0.15	-0.71
Rf	0.21	-0.98	0.04	-0.19	0.98	0.01

Chow Breakpoint Tests for Changes in Market Behavior of Sub Debt Yield

The negative results of the Gonzalez-Rivera and Nickerson approach are not entirely surprising given the lack of variability remaining in the filtered residuals associated with senior and subordinated debt and the high correlation between those two series. However, the possibility remains that the market's assessment of sub debt may be changing over time. If so, running the Gonzalez-Rivera and Nickerson model on subsets of the data may yield more positive results. The initial regressions that were used to filter the market signals from the firm-specific signals assumed that the underlying process is constant over the sample period. To test this assumption, we divided the samples into two time periods and repeated the filter regressions using these different samples. A tool that is particularly useful in this regard is the Chow test, a simple but effective test for structural change in all or some of the parameters in a model. Chow tests with a break point between May 31 and July 1, 2003 (recall the Freddie Mac announcement of accounting problems and the shakeup in senior management occurred in June 2003), are significant for all filter regressions for both GSEs, indicating that there was a significant event that changed the underlying relationships and one or several of the estimated parameters are significantly different in the two periods.

We present results related to the sub debt series because they are the primary focus of this paper—other results are available from the authors on request. As shown in table 9, the market assessment of sub debt changed markedly in the course of 2003, after the revelations of accounting problems at Freddie Mac. However, the market assessment of sub debt (for both Freddie Mac and Fannie Mae) is *more* closely linked to the Treasury debt after mid-2003 than it was in the period before, both in terms of the magnitude of the coefficient moving significantly closer to unity and in terms of the reduction in unexplained, idiosyncratic variation of the sub debt yield as shown by the improvement in the adjusted R-squared. Those results indicate that any signal will be weaker in the post-2003 period than in the overall data. Therefore, we did not rerun the signal regressions.

The results are consistent with at least three possible explanations. First, investors may have taken the news of problems at Freddie Mac as a signal that regulation or internal governance would become more effective and therefore that the default risk of the firm was decreasing. Second, the results are also consistent with increased liquidity in the sub debt market. Unfortunately, we have been unable to find trading volume data to test the latter possibility. Third, investors may have found some indication that caused them to revalue the implicit federal guarantee associated with the Enterprises' debt securities.

Table 9. OLS Regressions for Different Time Periods and Chow Breakpoint Test for Changes in the Market Behavior of Sub Debt Yields

	Fannie Mae			**Freddie Mac**		
	Time period			*Time period*		
	3/2001-12/2005	3/2001-5/2003	8/2003-11/2005	3/2001-12/2005	3/2001-5/2003	8/2003-12/2005
Dtryld (t-statistic)	0.56 (20.76)	0.55 (14.55)	.66 (17.40)	0.57 (20.44)	0.55 (13.77)	.64 (21.64)
RetA (t-statistic)	-0.06 (-13.05)	-0.06 (-9.09)	-.05 (-8.77)	-0.06 (-12.72)	-0.05 (-7.84)	-.06 (-12.46)
Adjusted R-squared	0.86	0.83	.91	0.84	0.78	.95
N	1060	466	570	1117	503	553
Chow breakpoint test--July 1, 2003 (probability)		19.28 (0.00)			7.10 (0.00)	

Conclusion

This paper provides empirical evidence on the usefulness of signals from the markets for sub debt of Fannie Mae and Freddie Mac since those Enterprises voluntarily started issuing such debt in early 2001. That evidence takes three forms. First, we have shown graphically and through simple regression analysis that the behavior of the sub debt of the Enterprises differs significantly from that of the sub debt of other large, regulated financial firms. In particular, both the sub debt and the senior debt of the Enterprises are much more tightly linked to Treasury debt than are the debt issues of large commercial banks. In addition, the yields on senior and sub debt of the Enterprises are much more highly correlated than is true for commercial banks. Finally, the debt yields, including sub debt yields, have tended to be positively rather than negatively correlated with the Enterprise's stock price, although the difference in time periods covered by our data on Fannie Mae and Freddie Mac and Gonzalez-Rivera and Nickerson's data on commercial banks should be noted.

The second form of evidence is from a dynamic signal model that sought to use the Kalman filter algorithm to extract unobserved information about default risks from the markets for Enterprise debt and common stock. Those models revealed no dynamic signal related to innovations in the yields on Enterprise debt or the returns to Enterprise common stock. That is, we find no evidence of a firm specific signal for either Enterprise that is shared by the sub debt, senior debt, and equity markets.

The final form of evidence was from Chow breakpoint tests to assess whether the market behavior of sub debt yields has changed over time. Those tests show that the market behavior of sub debt yields has changed as negative information has emerged about the Enterprises' management and risks. However, the nature of the change has been to link sub debt yields more closely to Treasuries. That paradoxical development is consistent with investors having greater confidence that Fannie Mae and Freddie Mac or their federal regulator would reduce the Enterprises' default risks, with greater liquidity in the Enterprise sub debt market in recent years, or with greater confidence in the value of the implicit federal guarantee associated with Enterprise debt.

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