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The Effects of Securitization on Consumer Mortgage Financing Costs

by

Steven Todd

A dissertation submitted in partial fulfillment
of the requirements for the degree of

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Chairperson of Supervisory Committee

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to Offer Degree Business Administration

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Abstract

The Effects of Securitization on Consumer Mortgage Financing Costs

by Steven Todd

Chairperson of the Supervisory Committee

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Although previous studies have found that securitization reduces primary mortgage rates by 30 basis points or more, I find these benefits disappear when fixed and adjustable rate spreads are unbundled and measured separately. I find no evidence that securitization lowers primary mortgage spreads. Nor do I find evidence that tax and regulatory changes over the last 15 years have affected primary mortgage spreads. I find that securitization reduces loan origination fees, resulting in substantial savings for consumers. In 1993 alone, securitization produced consumer savings of more than \$2.8 billion in loan origination fees. This is the first study to test for differences between the effects of passthrough and CMO creation on primary mortgage costs. I find that these activities have indistinguishable effects on loan rates and origination fees.

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1. Introduction

This paper studies the effects of securitization on consumer mortgage financing costs. I test whether the securitization activities of mortgage originators and other financial institutions have reduced consumer mortgage costs by reducing the liquidity premium on mortgage assets. I consider two types of costs: mortgage origination fees and mortgage coupon rates. I extend the literature in this area by distinguishing between fixed and adjustable-rate mortgages, and isolating the differential wealth effects of various securitization activities on both mortgage coupon rates and loan origination fees. Several previous studies [Hendershott and Shilling (1989), Sirmans and Benjamin (1990), and Jameson, Dewan and Sirmans (1992)] have estimated that securitization reduces primary mortgage rates by 30 to 50 basis points. These estimates suggest that the economic value of securitization to consumers could be as large as \$30 billion in 1993 alone.¹

The Federal housing agencies, investment and commercial banks, mortgage companies and savings institutions package illiquid mortgage loans into pools of assets which serve as collateral for various marketable securities. Securitization transforms individual mortgage loans into mortgage-backed securities (MBS). These include mortgage passthroughs (so named because the principal and interest payments from a pool of mortgage loans are "passed through" to an investor), multi-class securities known as collateralized mortgage obligations (CMOs), and interest only (IO) or principal only (PO) strips.

¹ In 1993, mortgage loan originations exceeded \$1 trillion. These loans had an average coupon rate of 7.24%. Assume securitization reduces mortgage coupon rates by 30 basis points. The present value of \$1 a month for 30 years at 7.54% is \$142.46. The present value of \$1 a month for 30 years at 7.24% is 146.74. This figure, compared to the original \$142.46 present value, represents a 3.00% increase in value. With more than \$1 trillion in mortgage originations, this translates into a net savings to consumers of \$30.04 billion. This gain accrues to home buyers and ignores possible welfare gains to mortgage investors, who benefit from lower secondary market yields. I assume the demand for mortgage loans is perfectly inelastic around the equilibrium rate and quantity. To the extent that demand is elastic around this equilibrium, the gains in consumer surplus are reduced.

Securitization merits study because the U. S. mortgage market is the largest debt market in the world. At the end of 1994, U.S. household mortgage debt exceeded \$3.6 trillion. This compares with U.S. Treasury debt of \$3.5 trillion and corporate debt of \$2.2 trillion. By way of contrast, corporate equity was valued at \$6.0 trillion. Of the \$3.6 trillion in household mortgage debt outstanding at the end of 1994, \$1.6 trillion had been securitized. Passthrough securities accounted for \$968 billion; CMOs and strips accounted for \$659 billion. Table A2 documents the growth in outstanding mortgage-backed securities. The Federal housing agencies have been the largest issuers of mortgage-backed securities.²

Financial intermediation in the mortgage market also merits study because the securitization technology developed here is increasingly being applied to other loan markets such as credit card receivables, car loans, lease receivables, home equity loans and commercial mortgage loans. The mortgage market provides an opportunity to question certain public policy issues. Agencies of the U.S. Government played an important role in developing a secondary mortgage market. Increasingly, however, investment and commercial banks are using credit enhancements to securitize non-conforming mortgages and other assets.³ At some point, we must question the value of public intervention in the market for mortgage loans.⁴

² Mortgage-backed securities issued or guaranteed by Ginnie Mae, Fannie Mae and Freddie Mac are known as agency MBS. Mortgage-backed securities guaranteed by commercial banks, investment banks, savings institutions and mortgage companies are known as private MBS. The Bank of America issued the first private passthrough security in 1977. From 1977 through 1990, private passthrough issuance totaled approximately \$100 billion, or less than ten percent of the passthrough market. Citicorp has been the largest issuer of private passthrough securities. Prior to 1990, private issuers dominated the market for multi-class securities. During this time, the five largest private issuers of CMOs and strips were Citicorp (a commercial bank), Salomon Brothers (an investment bank), Merrill Lynch (an investment bank), Home Savings (a savings institution) and Travelers (an insurance company). Most of these privately issued multi-class securities were collateralized by agency passthroughs. From 1990 through the present, Fannie Mae and Freddie Mac have been the largest issuers of CMOs and strips. Ginnie Mae did not receive the authority to issue multi-class securities until 1994.

³ The most common forms of credit enhancement are corporate guarantees, letters of credit, bond insurance and senior/subordinate structures in which the subordinate bond class absorbs defaults. Non-conforming mortgages do not meet the underwriting standards of the Federal housing agencies. These standards set limits on loan size and loan-to-value ratios. Mortgage loans that exceed the underwriting standard on loan size are known as jumbo loans.

The remainder of this paper is organized as follows. Section 2 discusses the theoretical benefits of securitization, and section 3 reviews the empirical evidence on securitization. Fixed-rate mortgages are examined in section 4, adjustable-rate mortgages are examined in section 5 and loan origination fees are examined in section 6. Section 7 concludes.

⁴ Congress recently created the Office of Federal Housing Enterprise Oversight (OFHEO) to insure the financial solvency of FNMA and FHLMC and evaluate the costs and benefits of privatizing these agencies. The 1992 legislation that created OFHEO takes a skeptical view of the consumer welfare benefits resulting from the securitization activities of FNMA and FHLMC. If securitization does not ultimately benefit consumers, then it makes little sense for tax payers to subsidize the activities of the Federal housing agencies. (Subsidies take the form of credit guarantees from the U.S. government.) I find that securitization lowers mortgage origination fees. Given these observed consumer benefits, it seems reasonable to ask whether we need the Federal housing agencies to produce securitization services. Recent growth in the secondary market for private securities backed by nonconforming (jumbo) mortgage loans suggests that private issuers will supply securitization services. And as I point out in footnote 3 above, private issuers dominated the market for CMOs up until 1990. So it seems clear that securitization services could be produced privately. Yet we need to be concerned about potential differences between the effects of private and public securitization activities. Unfortunately both activities have occurred simultaneously in the market for conventional mortgages, so it is not possible to test for different effects. (Monthly data on passthrough and CMO issuance by type of issuer are not available.) Private issuers have had near exclusive reign in the market for jumbo loans, but primary and secondary data on these loans is not available.

2. The benefits of securitization: theoretical arguments

Securitization creates value by reducing information costs and increasing risk sharing and risk diversification activities.⁵ As a result of securitization, mortgage assets are more liquid and mortgage risks are shared by a larger audience of investors. Several papers [Merton (JOF 1987); Amihud and Mendelson (JFE 1986); Kadlec and McConnell (JOF 1994)] have shown that there are gains associated with an increase in liquidity and the expansion of an investor base.⁶ These studies have focused on equity markets, but their findings may well apply to the fixed-income markets, especially mortgage assets, which are burdened by high information costs.

Mortgage investors incur non-negligible costs in assessing the risks of mortgage assets. These risks include interest rate risk (both price and reinvestment risk), default risk, liquidity risk and prepayment risk. The cash flows from mortgage assets are uncertain because most mortgage loans allow homeowners to prepay, often without penalty. Prepayments can be partial, as when principal in excess of the scheduled amount is paid, or complete, as when the mortgage is retired because of a refinancing, sale or default.

⁵ Lower information costs result from the standardization and aggregation of mortgage loans and the production of public information by security issuers and underwriters. Greater risk sharing occurs because mortgage originators are able to transfer loan default risks to the Federal housing agencies. Securitization increases risk diversification activities by expanding the audience for mortgage assets and improving the set of strategies to hedge risks. Pure private loan sales fail to increase risk diversification activities. They do not produce public information and they do not lower information costs by encouraging the standardization and aggregation of mortgage loans. Private loan sales may promote risk sharing if originators are able to transfer default risks to insurance companies or other non-originators.

⁶ Merton (1987) models capital market equilibrium under incomplete information. He finds that, all else equal, an increase in the size of a firm's investor base will lower investors' expected return and increase the market value of the firm's shares. Amihud and Mendelson (1986) develop a model of capital market equilibrium in which gross expected returns are an increasing and concave function of illiquidity, as measured by the relative bid-ask spread. According to their model, if bid-ask spreads decline following listing, then the lower expected returns required by investors should result in an increase in the market value of the firm's shares. Kadlec and McConnell (1994) empirically test these propositions and find that share value is increased and bid-ask spreads are reduced when firms list on the New York Stock Exchange.

Securitization reduces information costs at least three ways. First, it promotes the use of standardized lending agreements. Mortgage originators intent on securitizing their assets are motivated to offer home buyers a standard set of loans, with uniform loan documentation and qualification requirements. Mortgage investors avoid the costs of evaluating originator-specific documents. Issuers of mortgage-backed securities guarantee that loan documentation is accurate and complete, and the characteristics of the underlying mortgages (e.g., payment type, maturity, age, coupon, net interest spread, loan size, assumability, etc.) conform to a set of standards.

Second, securitization reduces information costs by aggregating mortgage loans. Most passthrough securities contain ten or more mortgage loans; most CMOs and strips contain several hundred passthroughs or several thousand mortgage loans. Investors need not evaluate the risks of each of these underlying mortgages. They can focus on the aggregate risk of the mortgage-backed security.⁷

Third, securitization reduces information costs by introducing monitoring and information services to the public domain. The Federal housing agencies report prepayment and default experiences and loan and security information (e.g., originations, trading volumes, institutional holdings, etc.). Wall Street securities firms, the largest underwriters of CMOs and strips, develop and offer expertise in evaluating and hedging risks. Mortgage investors have low cost access to pricing information, prepayment models, risk valuations and hedging strategies. Much of this information is new and was previously

⁷ In 1983 Freddie Mac issued the first CMO security as an interest only (IO) and principal only (PO) strip. Today, it is not uncommon for CMOs to contain 20 or 30 classes of bonds, each distinct in its coupon, maturity and principal paydown. When a CMO is issued, the underwriter purchases the underlying mortgage collateral from the issuer. If the average CMO issue size is \$500 million, and the average passthrough size is \$1 million, a typical CMO issue involves the trading of hundreds of mortgage passthroughs or thousands of individual mortgage loans. An increase in CMO issuance will likely be accompanied by an increase in the secondary trading volume of mortgage assets. This increase in secondary trading volume will likely increase the liquidity of mortgage assets, reducing the bid-ask spread and lowering the yields of mortgage assets in the secondary market.

unavailable.⁸ Some of this information was produced by mortgage originators or mortgage investors. In many instances, the costs of information production are quite substantial.

Securitization increases risk sharing and risk diversification activities at least three ways. First, securitization enables mortgage originators to transfer loan default risk to other financial intermediaries. Since Ginnie Mae passthroughs are guaranteed by the U.S. government, taxpayers essentially assume the default risk of loans securitized by Ginnie Mae. Fannie Mae, Freddie Mac and private issuers of mortgage-backed securities assume the default risk of loans they securitize. To the extent that these same financial intermediaries who issue mortgage-backed securities can diversify their mortgage portfolios more than loan originators who are constrained by interstate banking regulations, default risk is reduced.

Second, securitization increases risk sharing and risk diversification activities by expanding the audience for mortgage assets. All agency mortgage-backed securities (passthroughs, strips and CMOs) receive a triple-A credit rating from the national rating agencies (Moody's, S&P and Fitch).⁹ With this triple-A credit rating, mortgage-backed securities become a viable investment for credit-constrained portfolios. Competing with Treasuries and investment-grade corporate bonds, mortgage-backed securities find their way into the portfolios of pension funds (private and public), mutual funds, hedge funds, banks, thrifts and insurance companies.

⁸ For example, prepayment behavior continues to challenge researchers. Wall Street securities firms employ dozens of Ph.Ds. from the fields of statistics, economics and computer science. These researchers, who often command salaries exceeding \$500,000 per year, develop sophisticated mathematical models that forecast prepayments and price the option components of mortgage-backed securities. Over the last decade, securities firms have spent hundreds of millions of dollars on technology (e.g., supercomputers) and personnel in an effort to better understand prepayment behavior. Mortgage investors are the direct beneficiaries of much of this research.

⁹ Privately-issued multi-class securities backed by agency passthroughs also receive a triple-A credit rating. Privately-issued mortgage-backed securities backed by whole loans (i.e., mortgage loans that have not been securitized) usually earn a double-A credit rating. These securities typically employ some form of credit enhancement. As of September 1991, no single triple-A rated mortgage-backed security had been downgraded due to poor performance of the mortgage collateral. Only seven out of 645 double-A rated securities had been downgraded.

Securitization also expands the audience for mortgage assets by producing transaction services such as denomination and maturity intermediation. Passthrough securities can be purchased in increments of \$25,000. Retail investors who might have been locked out of the mortgage market because of high minimum purchase requirements can invest in mortgage assets. CMOs segment mortgage loan cash flows into several bond classes with differing maturities. Short-term investors who might have avoided the mortgage market because of a duration mismatch can invest in mortgage assets.

Finally, securitization increases risk diversification activities by improving and expanding the set of strategies to hedge risks. CMOs are multi-class securities which redistribute the principal and interest cash flows of underlying mortgage assets. In redistributing the cash flows, CMOs also redistribute the risks of mortgage assets. By redistributing these risks, CMOs allow investors to custom tailor risk management strategies. Without CMOs, it would not be possible to synthesize many of these risk management strategies.¹⁰

¹⁰ In the appendix, I discuss the risk management opportunities afforded by CMOs. At present, one example will illustrate the appeal of strips. Interest-only (IO) strips have negative duration. When rates rise, prepayments decrease, IOs extend in maturity and IO prices increase. This occurs because the increased value of a longer stream of interest payments more than offsets the decline in value associated with higher discount rates. The price behavior of IOs provides a natural hedge against the interest rate risk of most fixed-income securities. See, for example, Carron (1992).

3. The benefits of securitization: previous empirical evidence

Although several papers have examined the effect of securitization on primary loan rates or secondary market yields, none have examined the market for adjustable-rate mortgages, and none have considered the differential value added by CMO and strips markets. In addition, all the studies I've reviewed potentially mis-measure the value of securitization activities by omitting or mis-specifying the interest rate, prepayment, default and liquidity premia on mortgage assets.

Hendershott and Shilling (1989) and Sirmans and Benjamin (1990) examine primary mortgage rates on conforming and non-conforming loans. Although both papers find that conforming loans carry significantly lower rates than non-conforming loans, it is difficult to measure how much of the difference in rates can be attributed to securitization activity.¹¹ Furthermore, it is not obvious that the rate advantage that conforming loans enjoy persists through time. Hendershott and Shilling point out that as recently as 1985, yields on conforming loans exceeded yields on similar jumbo loans.

I wish to test the hypothesis that securitization lowers consumer mortgage financing costs by reducing the liquidity premium on primary loans. Neither Hendershott and Shilling nor Sirmans and Benjamin examine this question. Sirmans and Benjamin treat the liquidity premium as a constant throughout their sample, and Hendershott and Shilling treat securitization as a one-time event, focusing on two disjoint sample periods: May - June 1978 (a pre-securitization period) and June - July 1986 (a post-securitization period). Neither paper considers time-variation in the prepayment premium, and both papers ignore national origination data, focusing instead on regional mortgage markets.

¹¹ Hendershott and Shilling (1989) consider a sample of conventional fixed-rate mortgage loans closed in California during two periods: May - June 1978 (a pre-securitization period) and June - July 1986 (a post-securitization period). Regressing effective loan rates on a set of loan specific variables, they find that the coefficient on the conforming loan dummy increases from -5 basis points for the first sample period to -29 basis points for the second sample period. Sirmans and Benjamin (1990) consider weekly mortgage quotations from 54 different Baton Rouge, Louisiana mortgage lenders over a two-year period beginning in 1985. Regressing effective loan rates on FHLMC commitment rates and a set of lender and loan specific variables, they find that the coefficient on the jumbo loan dummy is statistically significant at 42 basis points.

Black, Garbade and Silber (1981) and Rothberg, Nothaft and Gabriel (1989) examine secondary market yields on mortgage passthrough securities. Black, Garbade and Silber find that securitization significantly reduces the yields of GNMA passthroughs, but does not significantly reduce the yields of FHA mortgage loans.¹² Rothberg, Nothaft and Gabriel find that securitization does not significantly reduce the yields of either GNMA or FHLMC passthroughs. These two papers test whether securitization benefits **mortgage investors** but say nothing about potential benefits to **home buyers**.

Jameson, Dewan and Sirmans (1992) examine primary mortgage yields over the period 1982 - 1986 and find that the CMO innovation results in a 31 basis point reduction in mortgage - Treasury spreads. I extend their work and separately consider the markets for fixed and adjustable-rate mortgages in an effort to measure the value of securitization activities more precisely. Since I am interested in the long-run effects of securitization, I augment their sample to cover the period 1980 - 1995. I consider two types of mortgage costs (loan origination fees and mortgage coupon rates), various new measures of securitization activity and several additional regressors that may affect mortgage spreads. I discuss these issues in sections 4-6.

Roth (1988) argues that growth in the secondary mortgage market has transformed mortgage funding into a national market and caused mortgage rates to move much more closely with capital market rates. Information from the Department of Housing and Urban Development supports his claim, reinforcing an argument from section 2 of this paper that securitization increases risk sharing and risk diversification activities. Tables A1 - A6 show that mortgage-backed security issuance has paralleled the shift of mortgage assets from loan originators to non-originators.

Mortgage originators have been net sellers of residential mortgage loans since 1983, the same year Freddie Mac initiated a CMO origination program (— see table A4).

¹² FHA mortgage loans are primary loans guaranteed by the Federal Housing Administration. These loans carry the full faith and credit of the U.S. government.

Mortgage companies, whose share of originations has increased dramatically over the last decade (— see table A3), have sold nearly all of the loans they have originated. Mortgage pools, issuers of mortgage-backed securities, have been the largest buyers of residential mortgage loans (— see table A5). The Federal housing agencies, commercial banks, savings and loans, insurance companies and pension funds currently dominate the market for mortgage assets (— see table A6). In 1980, the market for mortgage assets was far from segmented and non-originators held \$580 billion in mortgage assets, or nearly 40% of the mortgage market.¹³ By 1994, non-originators had increased their mortgage holdings to \$2,769 billion, or nearly 64% of the mortgage market. While commercial banks have increased their mortgage holdings, savings and loans have reduced their MBS holdings. Mortgage companies are conspicuously absent from Table A6. The largest loan originators are non-players in the market for mortgage assets.

¹³ Non-originators include the Federal housing agencies, other agencies of the U.S. government, state and local governments, insurance companies, pension funds, households, REITs, credit unions and finance companies.

4 The effects of securitization on fixed-rate mortgages

In this section I test whether securitization activities have reduced the costs of primary market, fixed-rate mortgage loans. This is the first study to test the effects of securitization on a sample of commitment rates for conventional, fixed-rate mortgages. It is also the first study to test for differences between the effects of passthrough and CMO creation.

4.1 *A model of fixed-rate mortgage spreads*

Black, Garbade and Silber (1981) examine the effects of passthrough creation on the secondary market yields of FHA loans. They argue that the spread between the yields on FHA mortgage loans and Treasury securities compensates investors for servicing costs and timing (prepayment), credit (default) and marketability (liquidity) risks. Rothberg, Nothaft and Gabriel (1989) examine the effects of pass-through creation on the secondary market yields of FHLMC pass-throughs. They argue that the spread between the yields on FHLMC pass-throughs and Treasury securities compensates investors for call (prepayment), credit (default) and marketability (liquidity) risks. Following Black, Garbade and Silber (1981) and Rothberg, Nothaft and Gabriel (1989), I start by assuming the rates on conventional fixed-rate mortgage loans compensate mortgage originators for prepayment, default and liquidity risks. An additional risk, however, arises in the primary mortgage market because of the implied forward contract on mortgage loans. In general, loan originators guarantee mortgage rate quotations for a period of 2 or 3 months following the loan application date. During the commitment period, mortgage originators are exposed to the risk that interest rates may rise. Thus, in addition to the prepayment, default and liquidity premia described in other studies, I assume primary mortgage rates compensate originators for interest-rate risk of short duration. Equation (4.1) describes a model of the primary market, fixed-rate mortgage loan spread.

$$R_f - R_{tf} = I_f + P_f + D_f + L_f \quad (4.1)$$

Here, R_f denotes the coupon rate (or yield) on fixed-rate whole loans issued at par, R_{tf} denotes the yield on a comparable benchmark Treasury security, and I_f , P_f , D_f and L_f represent interest-rate, prepayment, default and liquidity premia respectively. Note that equation (4.1) models the spread between the yields on primary mortgage loans and a benchmark Treasury security. This approach is consistent with Black, Garbade and Silber (1981) Rothberg, Nothaft and Gabriel (1989) and Jameson, Dewan and Sirmans (1992).

Looking at equation (4.1), it is not obvious which Treasury security represents an appropriate benchmark. For a typical 30-year fixed-rate mortgage loan, we might choose a 30-year Treasury bond, as Jameson, Dewan and Sirmans (1992) do, or we might choose a Treasury security with an equivalent duration or average life.¹⁴ Of course, if we choose to match on maturity, duration or average life, we must make some assumptions about the prepayment behavior of mortgage loans. Black, Garbade and Silber (1981) assume the prepayment premium, P_f , in equation (4.1) is constant through time, and they set their benchmark equal to a portfolio of Treasury securities whose "future cash payments, including both interest and principal payments, match the timing and amount of the expected future payments on an FHA mortgage, including interest, scheduled amortization of principal and accelerated prepayments of principal." They do not, however, specify how they predict these prepayments. Rothberg, Nothaft and Gabriel (1989) allow P_f to vary through time, and they set their benchmark equal to the 10 year constant-maturity Treasury, presumably under the assumption that a typical 30 year fixed-rate mortgage prepays in year 10. I allow P_f to vary through time and report all results using a Treasury benchmark whose average life equals that of the underlying mortgage loan under the assumption of no prepayment. Since my benchmark is computed under the assumption of no prepayment, I endeavor to capture all prepayment risks in the prepayment premium, P_f . Industry practitioners prefer to use average life measures when they evaluate mortgage

¹⁴ Average life expresses the average number of years a dollar of principal is outstanding. It is formally defined as the dollar-weighted average time to receive future payments of principal (P_k), where T_k is the time from settlement to the receipt of principal flow P_k .

$$\text{Average life} = (T_1P_1 + T_2P_2 + \dots)/(P_1+P_2+ \dots)$$

assets. Notwithstanding this convention, I recompute all results using duration and maturity matching Treasury benchmarks. These other benchmarks yield similar results.

4.2 *Economic proxies for the risk premia on fixed-rate mortgages*

Treasury bond futures prices provide a starting point in the search for an economic proxy of interest-rate risk. Mortgage originators frequently use Treasury bond futures contracts to hedge the interest-rate risk inherent in their forward loan commitments. Consider the price differential between the next two Treasury bond futures contracts. These contracts follow a quarterly cycle (March, June, September and December), so there is always a three month difference between the maturity of the current Treasury bond futures contract and the maturity of the subsequent Treasury bond futures contract. The price differential between the next two Treasury bond futures contracts provides an estimate of expected changes in future long-term rates. When investors expect long-term rates to remain stable or rise, this price differential is positive. When investors expect long-term rates to fall, this price differential can be negative, provided the decline in rates is sufficient to raise expected future spot prices of Treasury bonds by more than the coupon income forfeited on the later futures contract. Standard arbitrage arguments imply that the prices of adjacent-delivery futures contracts are related to forward rates and carrying costs. However, forward rates on 30 year securities are not directly observable from a Treasury yield curve that includes maturities of 30 years and less. Additionally, it is difficult to value the carrying costs on Treasury bond futures contracts because these contracts include a delivery option.

I expect a positive relation between interest-rate risk and the price differential between the next two Treasury bond futures contracts. The larger the price differential, the greater the expected increase in long-term rates. In the model below, I conduct a simple test to determine whether the futures price differential (denoted, FUT) explains actual changes in 30 year Treasury bond rates (denoted, R_{T30}). Results are summarized in the

table below.

$$R_{T30}^{t+k} - R_{T30}^t = a + bFUT^t + u^t$$

$$u^t = \rho u^{t-1} + \varepsilon^t$$

k =	1	2	3	4	5	6
b	0.25	0.15	0.29	0.34	0.15	0.32
pval(b)	.12	.40	.07*	.03**	.32	.03**

As postulated, FUT appears to predict future changes in Treasury bond rates over 3, 4 and 6 month periods. Equation (4.2) below describes a simple model of the interest-rate premium on fixed-rate mortgages. (Symbols above the equations indicate the expected signs of the coefficients.)

$$I_t^t = a_0 + a_1 \overset{+}{FUT}^t \quad (4.2)$$

Here, FUT^t denotes the difference between the prices of adjacent delivery Treasury bond futures.

For fixed-rate mortgage loans, the prepayment premium represents the sum of the premiums on a series of distinct, American-style call options. Homeowners can exercise these call options completely, by retiring the mortgage, or partially, by paying principal in excess of the scheduled amount. Complete exercise usually coincides with a refinancing or home sale. Partial exercise can occur at any time.¹⁵ Previous studies have argued that call options increase in value when interest rates become more volatile. Schwartz and Torous (1989) show that there is a positive relation between the prepayment premium and the volatility of refinancing rates. Hendershott and Van Order (1989) argue that a steepening yield curve reduces the value of call options because it increases the probability that interest rates will rise. Therefore, I expect a negative relation between the rates on fixed-rate mortgages and the slope of the yield curve, and a positive relation between the rates on

¹⁵ Hayre and Lauterbach (1991) show that partial prepayments occur with great frequency.

fixed-rate mortgages and the volatility of interest rates. Equation (4.3) describes a simple model of the prepayment premium on fixed-rate mortgages.

$$P_f^t = b_0 + b_1 \text{SLOPE}^t + b_2 \text{VOLRT30}^t \quad (4.3)$$

Here, SLOPE^t measures the slope of the yield curve and VOLRT30^t measures the volatility of 30 year Treasury bond rates.¹⁶

The default premium compensates mortgage originators for credit risk. Previous studies have argued that this default premium is highly correlated with credit risk in the market for corporate bonds. One measure of corporate bond credit risk is the spread between the yields of corporate bonds rated AAA and those rated BAA. Black, Garbade and Silber (1981) and Jameson, Dewan and Sirmans (1992) employ this measure of default risk in their studies.¹⁷ In a study of default behavior, Van Order (1990) examines the default experiences of 725,000 conventional mortgage loans originated between 1973 and 1983. He finds that loan-to-value (LTV) ratios and origination year are significant in explaining mortgage loan defaults.¹⁸ Equation (4.4) describes a simple model of the default premium on fixed-rate mortgages.

$$D_f^t = c_0 + c_1 \text{QUAL}^t + c_2 \text{DELNQ}^t \quad (4.4)$$

where $\text{QUAL}^t = R_{\text{BAA}}^t - R_{\text{AAA}}^t$

Here, QUAL^t denotes the corporate quality spread (— defined as the difference between the yields of corporate bonds rated AAA and those rated BAA) and DELNQ^t denotes the delinquency rate on conventional mortgage loans. The delinquency rate measures the

¹⁶ I compute the volatility measure as the annualized standard deviation of the log differences in daily yields on the 30 year Treasury bond. I choose the 30 year Treasury bond because it has the highest correlation with fixed-rate mortgage rates.

¹⁷ Rothberg, Nothaft and Gabriel (1989) use the spread between AAA and A corporate bonds.

¹⁸ The higher the loan-to-value ratio, or, equivalently, the lower the borrower's equity position in the property, the higher the probability of default.

percentage of outstanding conventional mortgage loans for which loan payments are more than 30 days late.

The liquidity premium compensates mortgage originators for liquidity risk. Previous studies have argued that this risk is constant [Hendershott and Van Order (1989)], binary (i.e., shifts with the commencement of securitization activities) [Rothberg, Nothaft and Gabriel (1989) and Hendershott and Shilling (1989)], related to the outstanding balance of mortgage originations [Jameson, Dewan and Sirmans (1992)], or a function of lender type [Sirmans and Benjamin (1990)]. As a proxy for liquidity risk, I consider the volume of new securities issued, relative to the volume of new mortgages originated. This measure of liquidity implicitly captures secondary trading activity relative to the primary mortgage market and is analogous to differential liquidity premium measures used by Garbade and Silber (1976) and Kamara (1988), who advance the frequency of market clearings as an important determinant of market liquidity. Equation (4.5a) describes a simple model of the liquidity premium.

$$L_f^t = d_0 + d_1 \text{SEC}^t \quad (4.5a)$$

$$\text{where } \text{SEC}^t = \text{PT}^t + \text{CMO}^t$$

Here, SEC^t measures the percentage of newly originated mortgage loans that are securitized. PT^t measures the percentage of newly originated mortgage loans that are securitized as passthroughs and CMO^t measures the percentage of newly originated mortgage loans that are securitized as CMOs. In general, mortgage originators securitize new loans within a year of their origination dates. Consequently, I compute these securitization measures as the ratio of the dollar volume of mortgage loans securitized in the current month to the dollar volume of mortgage loans originated over the previous 12 months.¹⁹

¹⁹ I find no evidence of seasonality in these measures of securitization activity. I experiment with other securitization measures based on monthly, quarterly and semi-annual mortgage loan issuance. The results are insensitive to these measures of securitization activity.

Securitization activity in the market for conventional mortgage loans lagged securitization activity in the market for government-backed mortgage loans by nearly a decade. The securitization of fixed-rate mortgage loans preceded the securitization of adjustable-rate mortgage loans by nearly four years. I use different securitization variables to distinguish between markets (conventional and government-backed) and loan type (fixed and adjustable-rate). While SEC denotes total securitization activity in the conventional and government-backed markets for both fixed and adjustable-rate mortgages, SECCF denotes securitization activity in the conventional loan market for fixed-rate mortgages only. A similar naming scheme is applied to the passthrough and CMO measures.

Two major tax and regulatory changes, and one major financial innovation occur during the sample period of my study. I model these three events with three dummy variables. The first of these, which I denote EVENT1, marks the commencement of CMO activities: this occurs in June, 1983. EVENT2 signals passage of the Tax Reform Act of 1986, which permitted financial institutions to sell mortgage assets through Real Estate Mortgage Investment Conduits (REMICs). EVENT3 signals passage of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) of 1989. This legislation established risk-based capital standards for Federally-insured mortgage lenders and assigned primary mortgage loans to the second highest allowable risk class, requiring a 50% capital allocation. Each of these events may produce an immediate change in the liquidity premium. Or, the value of securitization activities may change as a result of any of these events. That is to say, each of these events may affect the intercept or slope terms in equation (4.5a).²⁰ I model these structural changes in the mortgage market in Equation (4.5b).

$$\begin{aligned}
 L_f^t = & e_0 + e_1 \text{EVENT1}^t + e_2 \text{EVENT2}^t + e_3 \text{EVENT3}^t \\
 & + (f_0 + f_1 \text{EVENT1}^t + f_2 \text{EVENT2}^t + f_3 \text{EVENT3}^t) \text{PT}^t \\
 & + (f_4 + f_6 \text{EVENT2}^t + f_7 \text{EVENT3}^t) \text{CMO}^t
 \end{aligned} \tag{4.5b}$$

²⁰ I assume the tax and regulatory changes do not affect the other risk premia.

I expect EVENT1 and EVENT2 to reduce the liquidity premium of mortgage loans because bundling activities increase the demand for collateral. EVENT3 may increase the liquidity premium on mortgage loans if originators incur higher carrying costs due to increased capital requirements.

Substituting equations (4.2) - (4.5b) into equation (4.1), I obtain the following model of the conventional, fixed-rate whole loan mortgage spread.

$$\begin{aligned}
 \text{FSPRD}^t = & e_0 + e_1 \text{EVENT1}^t + e_2 \text{EVENT2}^t + e_3 \text{EVENT3}^t + a_1 \text{FUT}^t + b_1 \text{SLOPE}^t \\
 & + b_2 \text{VOLRT30}^t + c_1 \text{QUAL}^t + c_2 \text{DELNQ}^t \\
 & + (f_0 + f_1 \text{EVENT1}^t + f_2 \text{EVENT2}^t + f_3 \text{EVENT3}^t) \text{PT}^t \\
 & + (f_4 + f_6 \text{EVENT2}^t + f_7 \text{EVENT3}^t) \text{CMO}^t
 \end{aligned} \tag{4.6}$$

Here, FSPRD^t denotes the difference between R_f^t , the coupon rate (or yield) on conventional, fixed-rate mortgage loans, and R_{tf}^t , the yield on a comparable benchmark Treasury security. FUT^t measures the Treasury bond futures price differential, SLOPE^t measures the slope of the yield curve, VOLRT30^t measures the volatility of 30 year Treasury bond yields, QUAL^t denotes the corporate quality spread, DELNQ^t denotes the delinquency rate on conventional mortgage loans, EVENT1^t is a dummy variable that signals the introduction of CMO activities, EVENT2^t is a dummy variable signaling passage of the Tax Reform Act of 1986, EVENT3^t is a dummy variable signaling passage of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) of 1989, PT^t measures the percentage of newly originated mortgage loans that are securitized as passthroughs and CMO^t measures the percentage of newly originated mortgage loans that are securitized as CMOs.

In certain tests of equation (4.6), I replace R_f with an effective mortgage rate. This is the stated contract rate, plus all origination fees amortized over the term of the mortgage. Consumers pay these fees, or "points" to mortgage originators when loans close.

For conventional, fixed-rate whole loan mortgage spreads, I test the following hypotheses.

- | | |
|----------------|--|
| $e_1 < 0$ | The spread decreases with the introduction of CMOs. |
| $e_2 < 0$ | The spread decreases with the REMIC legislation of 1986. |
| $e_3 > 0$ | The spread increases with the FIRREA legislation of 1989. |
| $a_1 > 0$ | The spread increases with the Treasury bond futures price differential. |
| $b_1 < 0$ | The spread decreases with the slope of the yield curve. |
| $b_2 > 0$ | The spread increases with the volatility of Treasury bond rates. |
| $c_1 > 0$ | The spread increases with the corporate quality spread. |
| $c_2 > 0$ | The spread increases with mortgage delinquencies. |
| $f_0 < 0$ | The spread decreases with passthrough activities. |
| $f_1 < 0$ | The spread decreases with passthrough activities and the introduction of CMOs. |
| $f_2 < 0$ | The spread decreases with passthrough activities and the REMIC legislation of 1986. |
| $f_3 > 0$ | The spread increases with passthrough activities and the FIRREA legislation of 1989. |
| $f_4 < 0$ | The spread decreases with CMO activities. |
| $f_6 < 0$ | The spread decreases with CMO activities and the REMIC legislation of 1986. |
| $f_7 > 0$ | The spread increases with CMO activities and the FIRREA legislation of 1989. |
| $f_0 \neq f_4$ | Passthrough and CMO activities affect mortgage spreads unequally. |

4.3 *Data for fixed-rate mortgage regressions*

Data for my study come from many sources. Fixed-rate mortgage coupon rates come from the FHLMC weekly survey of mortgage lenders. These data represent commitment rates on new, 30 year conventional mortgage loans with loan-to-value ratios of 80%. My sample includes the survey rate for the first week of each month for the period January, 1980 through December, 1995. Mortgage origination fee and term data come from the *Federal Reserve Bulletin*. These data are averages for all loans (both fixed and

adjustable-rate mortgages) that close. Treasury and corporate yield data come from *Citibase*. Treasury bond futures prices come from the *Wall Street Journal*. Delinquency data come from the *Mortgage Bankers Association* survey of mortgage lenders. Whole loan origination data come from *Mortgage Banking* and the FHLBB. Passthrough and CMO origination data come from GNMA, FNMA, FHLMC and *Inside Mortgage Finance*.

4.4 Empirical results for fixed-rate mortgage spreads

Table 1 presents summary statistics for the data. Note that FEES is computed as the difference between the effective mortgage rate (i.e., the contract rate, plus origination fees amortized over the term of the mortgage) and the stated mortgage contract rate. FSPRD, FEES, FUT, SLOPE, QUAL, and DELNQ are in percent. All other variables are in decimal form. For most variables, the sample period is from 1980:1 through 1995:12 and consists of 192 observations. Both FSPRD and FEES have positive mean values which are statistically different from zero. The mean fixed-rate spread is 1.689%; spreads range from a low of 0.286% to a high of 4.079%. Mean loan origination fees are 0.331%; fees range from a low of 0.090% to a high of 0.840%. Plots of FSPRD and monthly changes in FSPRD appear in figures 1 and 2 respectively.

Many of the variables in Table 1 are highly autocorrelated. The column labeled $\rho_1(\text{Var})$ measures first-order autocorrelation. These statistics range from a low of .264 for the Treasury bond volatility measure (VOLT30) to a high of .976 for the mortgage delinquency variable (DELNQ). I first difference each variable and compute first-order autocorrelations for the differenced time series. These statistics, labeled $\rho_1(\Delta\text{Var})$, range from a low of -.493 for the Treasury bond volatility measure to a high of .298 for the yield curve slope variable (SLOPE). Such high autocorrelation measures might be symptomatic of non-stationarity in the time series.

Multivariate regressions of non-stationary time series can create spurious results. I test for stationarity in each of the variables in table 1 by performing an augmented Dicky-Fuller t test. For each variable I run the following regression and test whether ρ is unity.

$$y_t = \zeta_1 \Delta y_{t-1} + \zeta_2 \Delta y_{t-2} + \dots + \zeta_{p-1} \Delta y_{t-p+1} + \alpha + \rho y_{t-1} + \varepsilon_t$$

I choose p , the number of autoregressive lag terms, according to the procedure outlined in Hamilton (1994). Table 2 summarizes the results of these unit root tests. At a 5% level of significance, I fail to reject the null hypothesis that a unit root exists for all of the series except SLOPE, VOLT30 and PTCF. I repeat the test for each of the differenced time series. Here, I reject the null hypothesis of a unit root at a 1% level of significance for each of the differenced variables in table 2.

I endeavor to deal with the stationarity problems of the data by running all regressions on first differences, or monthly changes in the variables. As a check, I run a second set of regressions on levels, but I include lagged values of the dependent variable as additional regressors.²¹ In general, these levels regressions produce results that are similar to the results from the regressions on first differences. Where there are discrepancies, I report them.²²

Tables 3 and 4 report regressions of changes in fixed-rate mortgage contract spreads on changes in economic proxies for interest-rate, prepayment, default and liquidity risks. Table 3 examines nominal mortgage contract spreads, while table 4 examines effective mortgage spreads. Most of the estimates are quite similar across tables. I find a negative relation between mortgage spreads and the slope of the yield curve. This is consistent with Rothberg, Nothaft and Gabriel (1989) and Jameson, Dewan and Sirmans (1992). Recall the argument by Hendershott and Van Order (1989) that a steepening yield curve reduces the value of call (prepayment) options because it increases the probability

²¹ I choose the number of lag terms by running simple autoregressions on levels for each variable. Using an OLS t test, I choose those variables whose coefficients are significantly different from zero at a 5 percent level of significance. I also experiment with lagged values of the independent regressors, but these are rarely significant and they do not qualitatively alter my results.

²² For the regressions on first differences, I exclude the raw event terms from equation 4.6. When these variables are first differenced, they contain zeroes for all months, except one.

that interest rates will rise. The coefficient estimates of SLOPE suggest that a 100 basis point increase in the slope of the yield curve reduces mortgage spreads by 34 to 44 basis points.²³ Across all models in tables 3 and 4, I find a positive relation between mortgage spreads and the volatility of long-term interest rates. This is consistent with Rothberg, Nothaft and Gabriel (1989) and Schwartz and Torous (1989) who show that the prepayment premium increases with the volatility of refinancing rates. The coefficient estimates of VOLT30 suggest that an increase in long-term rate volatility from an annual rate of, say, 12% (the mean value over my sample period) to a rate of, say, 22% increases mortgage spreads by 25 to 30 basis points. Taken together, the coefficient estimates of SLOPE and VOLT30 suggest that the prepayment premium on primary mortgage loans is economically significant. And contrary to the assumptions of Black, Garbade and Silber (1981), I find considerable time-variation in the prepayment premium.

I find a positive relation between mortgage spreads and the corporate quality spread. This is consistent with Black, Garbade and Silber (1981), Rothberg, Nothaft and Gabriel (1989) and Jameson, Dewan and Sirmans (1992). The coefficient estimates of QUAL suggest that a 100 basis point increase in the difference between AAA and BAA corporate yields increases mortgage spreads by about 50 basis points.²⁴

I find no relation between mortgage spreads and securitization activity, contrary to Hendershott and Shilling (1989), Sirmans and Benjamin (1990) and Jameson, Dewan and Sirmans (1992). This result is consistent with Black, Garbade and Silber (1981) who find no reduction in the secondary market spreads of government-guaranteed FHA loans due to GNMA passthrough creation. It is also consistent with Rothberg, Nothaft and Gabriel (1989) who find no reduction in the secondary market spreads of FHLMC passthroughs due to the CMO event. None of the measures of securitization activity in tables 3 and 4 are

²³ This compares with estimated spread reductions of 26 basis points (bp) [Rothberg, Nothaft and Gabriel (1989)] and 47 bp [Jameson, Dewan and Sirmans (1992)].

²⁴ This compares with estimated spread increases of 59 bp [Black, Garbade and Silber (1981)], 25 bp [Rothberg, Nothaft and Gabriel (1989)] and 72 bp [Jameson, Dewan and Sirmans (1992)].

statistically significant, even after controlling for the tax and regulatory changes of 1986 and 1989.

I use an F test to test for differences between the passthrough and CMO coefficients in model V. I find no differences between passthrough and CMO creation, at least in terms of their effects on mortgage spreads. This result, to the best of my knowledge, the first of its kind, has important public policy implications. Ginnie Mae lobbied for 3 years to receive CMO issuance authority. No doubt, it argued that CMOs are a true financial innovation that expands the audience for mortgage assets and enhances the liquidity of whole loans, ultimately reducing mortgage rates and benefiting consumers. These benefits are not completely realized from passthrough creation alone. Congress accepted Ginnie Mae's claims of positive consumer wealth effects resulting from CMO creation, and, in 1994 granted Ginnie Mae the authority to issue CMOs. Our tax dollars support Ginnie Mae's CMO efforts; our tax dollars also indirectly fund (via government-backed credit guarantees) the private housing agencies, Fannie Mae and Freddie Mac, the dominant issuers of CMOs. It appears these expenditures do not ultimately benefit home buyers.

Across all models in tables 3 and 4, the futures price differential has a positive effect on spreads. This is consistent with my hypothesis that the commitment risk of primary mortgages is related to Treasury bond futures prices. Coefficient estimates of FUT suggest that an increase in the futures price differential from, say, 0.52% (its mean value over the sample period) to 1.344% (its maximum value over the sample period) increases mortgage spreads by about 35 basis points. The commitment risk on primary mortgage loans is economically significant.

I find a positive relation between mortgage spreads and mortgage delinquencies. This is consistent with my hypothesis and the research of Van Order (1990). The corporate quality spread does not completely capture the default risks of mortgage loans. Coefficient estimates of DELNQ suggest that an increase in mortgage delinquencies from, say, 3%, to 4% of all loans, increases mortgage spreads by about 50 basis points, nearly the same increase that results from a 100 basis point increase in the corporate quality spread.

All estimates in tables 3 and 4 are based on the Cochrane-Orcutt adjustment for first-order serial correlation in the residuals. The Durbin-Watson statistics measure the first-order autocorrelation of the residuals of the quasi-differenced models. After this adjustment, I fail to reject the hypothesis that the residuals are serially uncorrelated at a 5-percent level of significance for all models.

I re-estimate all the models in tables 3 and 4 using the set of conventional fixed-rate securitization measures described in section 4.2 (i.e., SECCF, PTCF and CMOCF). These results are quite similar to those I report. I also re-estimate all the models in tables 3 and 4 using both maturity and duration matched Treasury benchmarks. Again, the results are similar to those I report.

4.5 *Summary and conclusions*

This is the first study to test the effects of securitization on a sample of commitment rates for conventional, fixed-rate mortgages. I find the spread between primary mortgage rates and Treasury securities contains premia for interest-rate, prepayment and default risks. Variations in these risk premia explain a significant portion of the time variation in primary mortgage spreads. Several previous studies have found that securitization reduces mortgage spreads. I find no evidence that securitization lowers primary fixed-rate mortgage spreads. Nor do I find evidence that tax and regulatory changes over the last 15 years have affected primary mortgage spreads.

This is the first study to test for differences between the effects of passthrough and CMO creation on primary mortgage spreads. I find that these activities have indistinguishable effects, and that neither reduces primary fixed-rate mortgage spreads. This result has important public policy implications.

5 The effects of securitization on adjustable-rate mortgages

In this section I test whether securitization activities have reduced the costs of primary market, adjustable-rate mortgage loans. This is the first study to test the effects of securitization on a sample of commitment rates for conventional, adjustable-rate mortgages. It is also the first study to test for differences between the effects of passthrough and CMO creation.

5.1 *A model of adjustable-rate mortgage spreads*

As with fixed-rate mortgages, I follow Black Garbade and Silber (1981) and Rothberg, Nothaft and Gabriel (1989) and assume the rates on conventional adjustable-rate mortgage loans compensate mortgage originators for prepayment, default and liquidity risks. These three terms would completely capture the risks of pure continuous-time floating-rate loans, but several features of adjustable-rate mortgage contracts introduce a variety of interest-rate risks. The coupon rate on an adjustable-rate mortgage changes at regular, discrete intervals (e.g., every year), designated reset dates. At each reset date, a new coupon rate is set by adding a fixed spread (margin) to the prevailing level of an underlying index (e.g., the yield on one-year Treasury bills). Most adjustable-rate mortgage contracts include periodic rate caps which prevent coupon rates from rising by more than a fixed percentage (e.g., 2%) between successive reset periods.²⁵ Lifetime rate caps constrain coupon rates from rising above the initial coupon rate (at loan origination) by more than a fixed percentage (e.g. 6%). Finally, it is common for the initial coupon rate to be lower than the fully indexed rate, computed by adding the margin to the initial level of the index. For this reason, the initial rate is often called a teaser rate.

In light of the foregoing discussion, it is reasonable to assume that originators of primary adjustable-rate mortgages seek compensation for the interest-rate risks imposed by discrete reset intervals, periodic and lifetime caps, and teaser rates. Thus, in addition to

²⁵ Some contracts provide for payment caps which prevent monthly mortgage payments from rising by more than a fixed percentage between successive reset periods.

the prepayment, default and liquidity risks considered in previous studies, I include a premium for interest-rate risk in equation (5.1) below, which models the primary market adjustable-rate mortgage loan spread.

$$R_a - R_{ta} = I_a + P_a + D_a + L_a \quad (5.1)$$

Here, R_a denotes the coupon rate (or yield) on adjustable-rate whole loans issued at par, R_{ta} denotes the yield on a comparable benchmark Treasury security, and I_a , P_a , D_a and L_a represent interest-rate, prepayment, default and liquidity premia respectively. Note that equation (5.1) models the spread between the yields on primary mortgage loans and a benchmark Treasury security. This approach is consistent with Black, Garbade and Silber (1981) Rothberg, Nothaft and Gabriel (1989) and Jameson, Dewan and Sirmans (1992).

Adjustable-rate mortgages come in a variety of styles. The choice of an appropriate benchmark Treasury security in equation (5.1) will depend on the terms of the loan contract, specifically, what the underlying index is and how often coupon rates reset. Loan data for my study represent rates on adjustable-rate mortgages that are indexed to one-year Treasury bills and that reset annually. These are the most common adjustable-rate mortgages. Given these parameters, it seems reasonable to use one-year Treasury bills as a comparable benchmark security.

5.2 *Economic proxies for the risk premia on adjustable-rate mortgages*

The interest-rate risk premium in equation (5.1) compensates mortgage originators for the risks imposed by discrete reset intervals, periodic and lifetime rate caps and teaser rates. The first two sets of risks represent the sum of the premiums on a series of distinct, European-style cap options. Originators of adjustable-rate mortgages are short these caps. Options theory tells us that cap options increase in value when interest rates become more volatile. Consistent with theory, Berk and Roll (1988) and Kau, Keenan, Muller and Epperson (1993) find an inverse relation between interest-rate volatility and the secondary market prices of adjustable-rate mortgages. Theory also suggests that a steepening yield

curve increases the value of cap options because it increases the probability that interest rates will rise and the caps will be in-the-money. In support of this, Berk and Roll (1988) find that upward trends in interest rates reduce the secondary market prices of adjustable-rate mortgages. In light of these observations, I expect the rates (or spreads) on adjustable-rate mortgages to be positively related to both the slope of the yield curve and the volatility of one-year Treasury bill yields.

The use of teaser rates by adjustable-rate mortgage originators serves to compress the spread between the initial mortgage coupon rate and the benchmark Treasury security. Originators are more inclined to use teaser rates when the short-maturity segment of the yield curve is steep and yields are expected to rise in the near term.²⁶ In such a scenario, at the first reset date, the coupon rate on an adjustable-rate mortgage will increase. It is also likely that a steep short-maturity segment of the yield curve coincides with lower deposit costs, relative to the returns available on longer-maturity assets. *Ceteris paribus*, when deposit costs are low, mortgage originators are more likely to settle for lower rates (or spreads) on adjustable-rate mortgages. Conversely, when the short-maturity segment of the yield curve is negatively sloped, yields are expected to fall in the near term, and adjustable-rate mortgage originators are unlikely to offer homebuyers additional financing incentives in the form of teaser rates. Doing so would result in lower coupon income after the first reset date. These arguments suggest that rates (or spreads) on adjustable-rate mortgages will be negatively related to short-term expected changes in interest rates. As a proxy for short-term expected changes in interest rates, I use the yield spread between three month and one-year Treasury bill rates. Based on arguments above, I expect a negative relation between the rates (or spreads) on adjustable-rate mortgages and the Treasury bill spread. Equation (5.2) models the interest-rate risk premium on adjustable-rate mortgage

²⁶ By "short-maturity segment of the yield curve", I mean that portion of the yield curve that comprises one complete coupon reset period.

loans. (Symbols above the equations indicate the expected signs of the coefficients.)

$$I_a^t = g_0 + g_1 \overset{-}{\text{TBLSPD}}^t + g_2 \overset{+}{\text{SLOPE}}^t + g_3 \overset{+}{\text{VOLRT1}}^t \quad (5.2)$$

Here, TBLSPD^t measures the difference between the yields on one-year and three month Treasury bills, SLOPE^t measures the difference between the yields on 30-year Treasury bonds and one-year Treasury bills, and VOLRT1^t measures the volatility of one-year Treasury bill rates. Note that g_2 , the SLOPE coefficient, has a positive sign. This differs from the fixed-rate mortgage case, where we saw a negative SLOPE coefficient. There, the SLOPE term proxied for prepayment risks, which are less pronounced when the yield curve is steep and interest rates are expected to rise. If changes in the slope of the yield curve have opposite and unequal effects on the risks of fixed and adjustable-rate mortgages, then it is important for securitization studies to consider fixed and adjustable-rate mortgages separately. Previous papers that have bundled these two loan types together have potentially mismeasured the prepayment and interest-rate risk premia.

As with fixed-rate mortgage loans, the prepayment premium on adjustable-rate mortgages represents the sum of the premiums on a series of distinct, American-style call options. Hendershott and Van Order (1989) argue that a steepening yield curve reduces the value of call options because it increases the probability that interest rates will rise. Schwartz and Torous (1989) show that there is a positive relation between the prepayment premium and the volatility of refinancing rates. I expect, therefore, a negative relation between the rates on adjustable-rate mortgages and the slope of the yield curve, and a positive relation between the rates on adjustable-rate mortgages and the volatility of interest rates. Equation (5.3) describes a simple model of the prepayment premium on adjustable-rate mortgages.

$$P_a^t = h_0 + h_1 \overset{-}{\text{SLOPE}}^t + h_2 \overset{+}{\text{VOLRT1}}^t \quad (5.3)$$

Here, SLOPE^t measures the slope of the yield curve and VOLRT1^t measures the volatility of one-year Treasury bill rates.

One reason adjustable-rate mortgages were developed was to insulate mortgage originators from the prepayment risks resulting from large unexpected changes in interest rates. Originators expect adjustable-rate mortgages to experience fewer prepayments than fixed-rate mortgages. Consistent with this, Kau et al (1988) and Cunningham and Capone (1990) find that adjustable-rate mortgages have lower prepayment probabilities than fixed-rate mortgages. If the prepayment risks of adjustable-rate mortgages are low, then we might expect coefficient h_1 in equation (5.3) to be small relative to coefficient g_2 in equation (5.2). In this case, we might expect an overall positive relation between the rates (or spreads) on adjustable-rate mortgages and the slope of the yield curve, reflecting the fact that the interest-rate risks imposed by rate caps overwhelm the prepayment risks.

The default premium compensates mortgage originators for credit risk. As with fixed-rate mortgages, I follow Black, Garbade and Silber (1981) and Jameson, Dewan and Sirmans (1992) and use the corporate bond quality spread as a proxy for default risk. I also test whether the default premium includes risks that are peculiar to the mortgage market by including a measure of mortgage delinquencies in the default premium model described by equation (5.4).

$$D_a^t = i_0 + i_1 \text{QUAL}^t + i_2 \text{DELNQ}^t \quad (5.4)$$

where $\text{QUAL}^t = \text{RBAA}^t - \text{RAAA}^t$

Here, QUAL^t denotes the corporate quality spread (— defined as the difference between the yields on AAA and BAA corporate bonds) and DELNQ^t denotes the delinquency rate on conventional mortgage loans. The delinquency rate measures the percentage of outstanding conventional mortgage loans for which loan payments are more than 30 days late.

The liquidity premium compensates mortgage originators for liquidity risk. As with fixed-rate mortgages, I use the ratio of new mortgage securities to new mortgage loans

as a proxy for liquidity risk. Equation (5.5a) describes a simple model of the liquidity premium.

$$L_a^t = j_0 + j_1 SECCA^t \quad (5.5a)$$

where $SECCA^t = PTCA^t + CMOCA^t$

Here, $SECCA^t$ measures the percentage of newly originated adjustable-rate mortgage loans that are securitized, $PTCA^t$ measures the percentage of newly originated adjustable-rate mortgage loans that are securitized as passthroughs and $CMOCA^t$ measures the percentage of newly originated adjustable-rate mortgage loans that are securitized as CMOs.

As with fixed-rate mortgages, I use dummy variables to model the tax and regulatory changes that occur during the sample period of my study. $EVENT2$ signals passage of the Tax Reform Act of 1986 and $EVENT3$ signals passage of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) of 1989. Each of these events may affect the intercept or slope terms in equation (5.5a). I model these structural changes in the mortgage market in Equation (5.5b).²⁷

$$L_a^t = k_0 + k_2 EVENT2^t + k_3 EVENT3^t + (l_0 + l_2 EVENT2^t + l_3 EVENT3^t) PTCA^t + l_4 CMOCA^t \quad (5.5b)$$

Substituting equations (5.2) - (5.5b) into equation (5.1), I obtain the following model of the conventional, adjustable-rate whole loan mortgage spread.

$$ASPRD^t = k_0 + k_2 EVENT2^t + k_3 EVENT3^t + g_1 TBLSPD^t + (g_2 + h_1) SLOPE^t + (g_3 + h_2) VOLRT1^t + i_1 QUAL^t + i_2 DELNQT + (l_0 + l_2 EVENT2^t + l_3 EVENT3^t) PTCA^t + l_4 CMOCA^t \quad (5.6)$$

²⁷ I exclude $EVENT1$ from equation (5.5b) because the introduction of CMOs begins before the start of the sample period for adjustable-rate mortgages. Equation (5.5b) does not include CMO and $EVENT$ interaction terms because CMOs backed exclusively by adjustable-rate mortgages were first issued in 1994, after the tax and regulatory changes described above.

Here, $ASPRD^t$ measures the difference between R_a^t , the coupon rate (or yield) on conventional, adjustable-rate mortgage loans, and R_{t1}^t , the yield on a one-year Treasury bill, $TBLSPD^t$ measures the spread between one-year and three-month Treasury bills, $SLOPE^t$ measures the slope of the yield curve, $VOLRT1^t$ measures the volatility of one-year Treasury bill rates, $QUAL^t$ denotes the corporate quality spread, $DELNQ^t$ denotes the delinquency rate on conventional mortgage loans, $EVENT2^t$ is a dummy variable signaling passage of the Tax Reform Act of 1986, $EVENT3^t$ is a dummy variable signaling passage of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) of 1989 and $PTCA^t$ measures the percentage of newly originated adjustable-rate mortgage loans that are securitized as passthroughs and $CMOCA^t$ measures the percentage of newly originated adjustable-rate mortgage loans that are securitized as CMOs.

In certain tests of equation (5.6), I replace R_a with an effective mortgage rate. This is the stated contract rate, plus all origination fees amortized over the term of the mortgage. Consumers pay these fees, or "points" to mortgage originators when loans close.

For conventional, adjustable-rate whole loan mortgage spreads, I test the following hypotheses.

- | | |
|-------------------|---|
| $k_2 < 0$ | The spread decreases with the REMIC legislation of 1986. |
| $k_3 > 0$ | The spread increases with the FIRREA legislation of 1989. |
| $g_1 < 0$ | The spread decreases with the Treasury bill spread. |
| $(g_2 + h_1) > 0$ | The spread increases with the slope of the yield curve. |
| $(g_3 + h_2) > 0$ | The spread increases with the volatility of Treasury bill rates. |
| $i_1 > 0$ | The spread increases with the corporate quality spread. |
| $i_2 > 0$ | The spread increases with mortgage delinquencies. |
| $l_0 < 0$ | The spread decreases with passthrough activities. |
| $l_2 < 0$ | The spread decreases with passthrough activities and the REMIC legislation of 1986. |

- $l_3 > 0$ The spread increases with passthrough activities and the FIRREA legislation of 1989.
- $l_4 < 0$ The spread decreases with CMO activities.
- $l_0 \neq l_4$ Passthrough and CMO activities affect mortgage spreads unequally.

5.3 *Data for adjustable-rate mortgage regressions*

Data for my study come from many sources. Adjustable-rate mortgage data come from the FHLMC weekly survey of mortgage lenders. These represent commitment rates on new, 30 year conventional mortgage loans indexed to the one-year Treasury bill, with loan-to-value ratios of 80%. My sample includes the survey rate for the first week of each month for the period July, 1984 through December, 1995. Mortgage origination fee and term data come from the *Federal Reserve Bulletin*. These data are averages for all loans (both fixed and adjustable-rate mortgages) that close. Treasury and corporate yield data come from *Citibase*. Delinquency data come from the *Mortgage Bankers Association* survey of mortgage lenders. Whole loan origination data come from *Mortgage Banking* and the FHLBB. Passthrough and CMO origination data come from GNMA, FNMA, FHLMC and *Inside Mortgage Finance*.

5.4 *Empirical results for adjustable-rate mortgage spreads*

Table 5 presents summary statistics for the data. Note that FEES is computed as the difference between the effective mortgage rate (i.e., the contract rate, plus origination fees amortized over the term of the mortgage) and the stated mortgage contract rate. ASPRD, FEES, TBLSPD, SLOPE, QUAL, and DELNQ are in percent. All other variables are in decimal form. For most variables, the sample period is from 1980:1 through 1995:12 and consists of 192 observations. Both ASPRD and FEES have positive mean values which are statistically different from zero. The mean adjustable-rate spread is 0.863%; spreads range from a low of -0.630% to a high of 2.670%. Mean loan origination fees are 0.331%; fees range from a low of 0.090% to a high of 0.840%. Plots of ASPRD and monthly changes in ASPRD appear in figures 3 and 4 respectively.

Many of the variables in Table 5 are highly autocorrelated. The column labeled $\rho_1(\text{Var})$ measures first-order autocorrelation. These statistics range from a low of .306 for the Treasury bill volatility measure (VOLT1) to a high of .976 for the mortgage delinquency variable (DELNQ). I first difference each variable and compute first-order autocorrelations for the differenced time series. These statistics, labeled $\rho_1(\Delta\text{Var})$, range from a low of -.427 for the Treasury bill volatility measure to a high of .298 for the yield curve slope variable (SLOPE). Such high autocorrelation measures might be symptomatic of non-stationarity in the time series.

Multivariate regressions of non-stationary time series can create spurious results. As with fixed-rate mortgages, I test for stationarity in each of the variables in table 5 by performing an augmented Dicky-Fuller t test. Table 6 summarizes the results of these unit root tests. At a 5% level of significance, I fail to reject the null hypothesis that a unit root exists for all of the series except TBLSPD, SLOPE, and VOLT1. I repeat the test for each of the differenced time series. Here, I reject the null hypothesis of a unit root at a 1% level of significance for each of the differenced variables in table 5.

I endeavor to deal with the stationarity problems of the data by running all regressions on first differences, or monthly changes in the variables. As a check, I run a second set of regressions on levels, but I include lagged values of the dependent variable as additional regressors. In general, these levels regressions produce results that are similar to the results from the regressions on first differences. Where there are discrepancies, I report them.

Tables 7 and 8 report regressions of changes in adjustable-rate mortgage contract spreads on changes in economic proxies for interest-rate, prepayment, default and liquidity risks. Table 7 examines nominal mortgage contract spreads, while table 8 examines effective mortgage spreads. Most of the estimates are quite similar across tables. I find a positive relation between mortgage spreads and the slope of the yield curve. Recall the argument from section 5.2 that a steepening yield curve increases the value of rate caps because it increases the probability that interest rates will rise and the caps will be in-the-

money. Coefficient estimates of SLOPE suggest that a 100 basis point increase in the slope of the yield curve increases mortgage spreads by about 28 basis points. Note that changes in the slope of the yield curve produce opposite effects on fixed and adjustable-rate mortgages. Earlier, we saw that fixed-rate mortgage spreads decline as the yield curve steepens. There, the likelihood of prepayment is reduced by a steepening yield curve. Here, we see the opposite effect. A steepening yield curve increases adjustable-rate mortgage spreads. The interest-rate risk associated with a steepening yield curve overwhelms the reduced prepayment risk.

Across all models in tables 7 and 8, I find a positive relation between mortgage spreads and the volatility of short-term interest rates. This is consistent with Berk and Roll (1988) and Kau, et al (1993) who show that the prepayment premium increases with the volatility of refinancing rates. The coefficient estimates of VOLT1 suggest that an increase in short-term rate volatility from an annual rate of, say, 20% (the mean value over my sample period) to a rate of, say, 30% increases mortgage spreads by about 6 basis points. This is much smaller than the increase in spreads that accrues to fixed-rate mortgages when long-term rate volatility spikes higher. This is consistent with Berk and Roll (1988) who find that increased interest-rate volatility reduces the secondary market prices of adjustable-rate mortgages by less than the amount experienced by fixed-rate mortgages.

In all models, the Treasury bill spread coefficient is negative, consistent with my hypothesis that mortgage originators demand higher spreads when short-term interest rates are expected to decline in the immediate future. Recall the argument from section 5.2 that originators are more inclined to use teaser rates when the short-maturity segment of the yield curve is steep, yields are expected to rise in the near term and deposit costs are low, relative to the returns available on longer-term assets. The coefficient estimates of TBLSPD suggest that a reduction in the Treasury bill spread from, say, 0% to -0.94% (its minimum value over the sample period) increases mortgage spreads by about 70 basis points. Taken together, the coefficient estimates of SLOPE, VOLT1 and TBLSPD suggest that the interest-rate premium on primary, adjustable-rate mortgages is economically significant.

I find no relation between mortgage spreads and securitization activity. This is contrary to Hendershott and Shilling (1989), Sirmans and Benjamin (1990) and Jameson, Dewan and Sirmans (1992). It is consistent with Black, Garbade and Silber (1981) who find no reduction in the secondary market spreads of government-guaranteed FHA loans due to GNMA passthrough creation. It is also consistent with Rothberg, Nothaft and Gabriel (1989) who find no reduction in the secondary market spreads of FHLMC passthroughs due to the CMO event. None of the measures of securitization activity in tables 7 and 8 are statistically significant, even after controlling for the tax and regulatory changes of 1986 and 1989.

I use an F test to test for differences between the passthrough and CMO coefficients in model V. As with fixed-rate mortgages, I find no differences between passthrough and CMO creation, at least in terms of their effects on mortgage spreads.

I find no significant relation between mortgage spreads and the corporate quality spread, contrary to Black, Garbade and Silber (1981), Rothberg, Nothaft and Gabriel (1989) and Jameson, Dewan and Sirmans (1992). However, I do find a positive relation between mortgage spreads and mortgage delinquencies, consistent with Van Order (1989). Coefficient estimates of DELNQ suggest that an increase in mortgage delinquencies from, say, 3% to 4% of all loans, increases adjustable-rate mortgage spreads by about 50 basis points, nearly the same increase that accrues to fixed-rate mortgage spreads. This is consistent with Kau, et al (1993), who find that the default premium on adjustable-rate mortgages is roughly equal to that of fixed-rate mortgages; it is inconsistent with Cunningham and Capone (1990) who find that adjustable-rate mortgages have greater default risks than fixed-rate mortgages.

All estimates in table 7 and 8 are based on the Cochrane-Orcutt adjustment for first-order serial correlation in the residuals. The Durbin-Watson statistics measure the first-order autocorrelation of the residuals of the quasi-differenced models. After this adjustment, I fail to reject the hypothesis that the residuals are serially uncorrelated at a 5-percent level of significance for all models.

I re-estimate all the models in tables 7 and 8 using the most general set of securitization measures described in section 4.2 (i.e., SEC, PT and CMO). These results are quite similar to those I report.

5.5 *Summary and conclusions*

This is the first study to test the effects of securitization on a sample of commitment rates for conventional, adjustable-rate mortgages. I find the spread between primary, adjustable-rate mortgages and Treasury securities contains premia for interest-rate, prepayment and default risks. Variations in these risk premia explain a significant portion of the time variation in primary, adjustable-rate mortgage spreads. Several previous studies have found that securitization reduces mortgage spreads. I find no evidence that securitization lowers primary adjustable-rate mortgage spreads. Nor do I find evidence that tax and regulatory changes over the last 15 years have affected primary mortgage spreads.

This is the first study to test for differences between the effects of passthrough and CMO creation on primary mortgage spreads. I find that these activities have indistinguishable effects, and that neither reduces primary adjustable-rate mortgage spreads. This result has important public policy implications.

6 The effects of securitization on mortgage origination fees

In this section I test whether securitization activities have reduced loan origination fees. This is the first study that directly tests the effects of securitization on mortgage origination fees. It is also the first study to test for differences between the effects of passthrough and CMO creation.

6.1 *A model of mortgage origination fees*

Homebuyers incur two sets of costs when they obtain financing from mortgage originators. The coupon rate determines the annuity payment on the loan. The origination fee determines the upfront payment on the loan. Loan origination fees are quoted in "points," which are simply a percentage of the principal amount on the mortgage. Fees might reflect the administrative costs of making loans. Or, they may be related to the risks of mortgage loans, in much the same way that mortgage coupon rates reflect interest-rate, prepayment, default and liquidity risks. The fact that fees are directly related to the principal amount on the loan suggests the latter relation. In this section, I assume loan origination fees reflect the economic risks of mortgage loans. I also assume loan originators simultaneously set coupon rates and fees. This is analogous to a two-part tariff, where homebuyers are charged a one-time (loan origination) fee for the right to make annuity payments to a bank, in exchange for the capital necessary to purchase a home.

If the market for mortgage loans is competitive, then loan originators have no discretion about the coupon rates and loan origination fees they charge consumers. Both charges reflect the marginal costs of making mortgage loans. These costs are a function of the interest-rate, prepayment, default and liquidity risks of mortgage loans.

If the market for home financing services is not purely competitive, then the pricing strategy for a particular bank is non-trivial because different consumers have different demand curves for financing, it is difficult to distinguish one group of consumers from another, and, in general, all consumers who meet the underwriting standards of the bank must be charged the same loan rate and fee at a given time. Each bank simultaneously sets

its rates and fees in such a way as to maximize its surplus. For example, a bank facing above-average default risks because of sagging local home prices might impose higher loan origination fees and lower coupon rates, relative to other banks. Such a strategy might detract cash-poor and less credit-worthy homebuyers from seeking financing. Alternatively, a bank facing above-average prepayment risks resulting from a strong local economy might impose lower origination fees and higher coupon rates, relative to other banks. In a purely competitive market for mortgage loans, such differences among banks would not exist and loan origination fees and coupon rates would be equal across lenders.

It is common for mortgage lenders to offer homebuyers a menu of loan prices, with varying fees and coupon rates. At a given point in time, one bank might offer 30-year fixed-rate mortgages at a coupon rate of 8% with loan origination fees equal to 2 points, or at a coupon rate of 8.25% with loan origination fees equal to 1 point. The existence of multiple loan prices from a single lender supports the notion that the market for mortgage loans is not purely competitive. It also suggests that coupon rates and loan origination fees share an inverse relation. I test for this relation in sections 6.2 and 6.3, below.

6.2 *Simultaneous tests of loan origination fees and fixed-rate mortgage spreads*

In this section, I perform joint tests of the effects of securitization activities on fixed-rate mortgage spreads and loan origination fees. Modifying equation (4.6) to allow for interaction or feedback effects between coupon rates and fees, and extending the same methodology to loan origination fees, I obtain the following model of the costs of fixed-rate mortgages.

$$\begin{aligned} \text{FSPRD}^t = & e_0 + e_1 \text{EVENT1}^t + e_2 \text{EVENT2}^t + e_3 \text{EVENT3}^t + a_1 \text{FUT}^t \\ & + b_1 \text{SLOPE}^t + b_2 \text{VOLRT30}^t + c_1 \text{QUAL}^t + c_2 \text{DELNQT} \\ & + (f_0 + f_1 \text{EVENT1}^t + f_2 \text{EVENT2}^t + f_3 \text{EVENT3}^t) \text{SEC}^t + m_1 \text{FEES}^t \end{aligned} \quad (6.2.1)$$

$$\begin{aligned} \text{FEES}^t = & n_0 + n_1 \text{EVENT1}^t + n_2 \text{EVENT2}^t + n_3 \text{EVENT3}^t + o_1 \text{FUT}^t \\ & + p_1 \text{SLOPE}^t + p_2 \text{VOLRT30}^t + q_1 \text{QUAL}^t + q_2 \text{DELNQT} \\ & + (r_0 + r_1 \text{EVENT1}^t + r_2 \text{EVENT2}^t + r_3 \text{EVENT3}^t) \text{SEC}^t + s_1 \text{FSPRD}^t \end{aligned} \quad (6.2.2)$$

Here, $FSPRD^t$ denotes the fixed-rate mortgage spread (that is, the difference between R_f^t , the coupon rate on conventional, fixed-rate mortgage loans and R_{tf}^t , the yield on a comparable benchmark Treasury security), $FEES^t$ denotes loan origination costs (amortized over the life of the loan, and expressed as a spread), FUT^t measures the Treasury bond futures price differential, $SLOPE^t$ measures the slope of the yield curve, $VOLRT30^t$ measures the volatility of 30 year Treasury bond rates, $QUAL^t$ denotes the corporate quality spread, $DELNQ^t$ denotes the delinquency rate on conventional mortgage loans, $EVENT1^t$ is a dummy variable that signals the introduction of CMO activities, $EVENT2^t$ is a dummy variable signaling passage of the Tax Reform Act of 1986, $EVENT3^t$ is a dummy variable signaling passage of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) of 1989 and SEC^t measures the percentage of newly originated mortgage loans that are securitized.

Summary statistics for the data are presented in table 1. Plots of $FSPRD$ and monthly changes in $FSPRD$ appear in figures 1 and 2 respectively; plots of $FEES$ and monthly changes in $FEES$ appear in figures 5 and 6 respectively. Tests of equations (6.2.1) and (6.2.2) appear in table 9. These tests use a two-stage least squares estimation procedure. As in sections 4 and 5 of this paper, I endeavor to deal with the stationarity problems of the data by running all regressions on first differences, or monthly changes in the variables.

In none of the models in table 9 is there a statistically significant interaction effect between rates and fees. T statistics for the $FSPRD$ and $FEES$ regressors range from a low of -0.20 to a high of 0.11. It appears that time-series tests of aggregate fee and spread data (averaged across many mortgage lenders) fail to document a significant relation between these two mortgage costs. Perhaps cross-sectional tests (across different lenders) would confirm anecdotal evidence of an inverse relation between loan fees and mortgage spreads.

Given the insignificant t statistics of the feedback regressors, it is not surprising that the coefficient estimates for the spread equation (6.2.1) are extremely similar to the

estimates found in table 3 for the spread equation (4.6), which does not include fees as a regressor. Consistent with these earlier results, I find a negative relation between fixed-rate mortgage spreads and the slope of the yield curve, and a positive relation between spreads and the volatility of long-term interest rates. Mortgage spreads increase with delinquencies, the corporate quality spread and the Treasury bond futures price differential. I find no relation between fixed-rate mortgage spreads and securitization activity.

None of the economic proxies for interest-rate, prepayment and default risks are significant in the fee regression. However, I find a negative relation between securitization activity and loan origination fees. Coefficient estimates of SEC suggest that a 10 percent increase (in absolute terms) in the volume of monthly mortgage loans securitized reduces loan origination fees by 5.5 basis points, or nearly 17% of their mean value. This is economically significant. I use an F test to test for differences between the passthrough and CMO coefficients in the FEE equation for model IV. I find no differences between passthrough and CMO creation, at least in terms of their effects on loan origination fees.

I re-estimate all the models in table 9 using the set of conventional fixed-rate securitization measures described in section 4.2 (i.e., SECCF, PTCF and CMOCF). These results are similar to those I report, except the relation between fees and securitization activity is no longer significant. I also re-estimate all the models in table 9 using both maturity and duration matched Treasury benchmarks. The results do not differ from those I report.

6.3 Simultaneous tests of loan origination fees and adjustable-rate mortgage spreads

In this section, I perform joint tests of the effects of securitization activities on adjustable-rate mortgage spreads and loan origination fees. Modifying equation (5.6) to allow for interaction or feedback effects between coupon rates and fees, and extending the same methodology to loan origination fees, I obtain the following model of the costs of

adjustable-rate mortgages.

$$\begin{aligned} \text{ASPRD}^t = & k_0 + k_2 \text{EVENT2}^t + k_3 \text{EVENT3}^t + g_1 \text{TBLSPD}^t + (g_2 + h_1) \text{SLOPE}^t \\ & + (g_3 + h_2) \text{VOLRT1}^t + i_1 \text{QUAL}^t + i_2 \text{DELNQ}^t \\ & + (j_0 + l_2 \text{EVENT2}^t + l_3 \text{EVENT3}^t) \text{SECCA}^t + t_1 \text{FEES}^t \end{aligned} \quad (6.3.1)$$

$$\begin{aligned} \text{FEES}^t = & u_0 + u_2 \text{EVENT2}^t + u_3 \text{EVENT3}^t + v_1 \text{TBLSPD}^t + (v_2 + w_1) \text{SLOPE}^t \\ & + (v_3 + w_2) \text{VOLRT1}^t + x_1 \text{QUAL}^t + x_2 \text{DELNQ}^t \\ & + (y_0 + z_2 \text{EVENT2}^t + z_3 \text{EVENT3}^t) \text{SECCA}^t + \alpha_1 \text{ASPRD}^t \end{aligned} \quad (6.3.2)$$

Here, ASPRD^t denotes the adjustable-rate mortgage spread (that is, the difference between R_a^t , the coupon rate on conventional, adjustable-rate mortgage loans and R_{t1}^t , the yield on a one-year Treasury bill). FEES^t denotes loan origination costs (amortized over the life of the loan, and expressed as a spread), TBLSPD^t measures the spread between one-year and three-month Treasury bills. SLOPE^t measures the slope of the yield curve, VOLRT1^t measures the volatility of one-year Treasury bill rates. QUAL^t denotes the corporate quality spread. DELNQ^t denotes the delinquency rate on conventional mortgage loans, EVENT2^t is a dummy variable signaling passage of the Tax Reform Act of 1986, EVENT3^t is a dummy variable signaling passage of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) of 1989 and SECCA^t measures the percentage of newly originated adjustable-rate mortgage loans that are securitized.

Summary statistics for the data are presented in table 5. Plots of ASPRD and monthly changes in ASPRD appear in figures 3 and 4 respectively; plots of FEES and monthly changes in FEES appear in figures 5 and 6 respectively. Tests of equations (6.3.1) and (6.3.2) appear in table 10. These tests use a two-stage least squares estimation procedure. As in sections 4 and 5 of this paper, I endeavor to deal with the stationarity problems of the data by running all regressions on first differences, or monthly changes in the variables.

Consistent with earlier results, I find no statistically significant feedback relation between rates and fees. T statistics for the ASPRD and FEES regressors range from a low

of -0.82 to a high of -0.12. Given the insignificant t statistics of the feedback regressors, it is not surprising that the coefficient estimates for equation (6.3.1) are extremely similar to the estimates found in table 7 for equation (5.6). As before, I find a positive relation between adjustable-rate mortgage spreads and the slope of the yield curve, and a positive relation between spreads and the volatility of short-term interest rates. Spreads increase with mortgage delinquencies and decrease with the Treasury bill spread. I find no relation between adjustable-rate mortgage spreads and securitization activity.

None of the economic proxies for interest-rate, prepayment and liquidity risks are significant in equation (6.3.2). I find no relation between securitization activity and loan origination fees.²⁸ And I find no differences between passthrough and CMO creation, at least in terms of their effects on loan origination. I do find a negative relation between the corporate quality spread (QUAL) and loan origination fees. Coefficient estimates of QUAL suggest that a 100 basis point increase in the corporate quality spread reduces loan origination fees by 5 basis points.

I re-estimate all the models in table 10 using the most general set of securitization measures described in section 5.2 (i.e., SEC, PT and CMO). These results do not differ from those I report.

6.4 *Individual tests of the effects of securitization on mortgage loan origination fees*

Since the feedback regressors in tables 9 and 10 are not statistically significant, I eliminate them from my analysis. Combining all the other variables in equations (6.2.2)

²⁸ This may be related to the fact that many data points are lost in moving from table 9 to table 10. Note the significance of the intercept terms in table 10.

and (6.3.2). I test a simplified model of mortgage loan origination fees, given by equation (6.4.1).

$$\begin{aligned} \text{FEES}^t = & \beta_0 + \beta_1 \text{EVENT1}^t + \beta_2 \text{EVENT2}^t + \beta_3 \text{EVENT3}^t + \beta_4 \text{FUT}^t + \beta_5 \text{TBLSPD}^t \\ & + \beta_6 \text{SLOPE}^t + \beta_7 \text{VOLRT30}^t + \beta_8 \text{VOLRT1}^t + \beta_9 \text{QUAL}^t + \beta_{10} \text{DELNQ}^t \\ & + (\beta_{11} + \beta_{12} \text{EVENT1}^t + \beta_{13} \text{EVENT2}^t + \beta_{14} \text{EVENT3}^t) \text{SEC}^t \end{aligned} \quad (6.4.1)$$

Here, FEES^t denotes loan origination costs (average costs on all fixed and adjustable-rate loans that close, amortized over the life of the loan, and expressed as a spread), FUT^t measures the Treasury bond futures price differential, TBLSPD^t measures the spread between one-year and three-month Treasury bills, SLOPE^t measures the slope of the yield curve, VOLRT30^t measures the volatility of 30 year Treasury bond rates, VOLRT1^t measures the volatility of one-year Treasury bill rates, QUAL^t denotes the corporate quality spread, DELNQ^t denotes the delinquency rate on conventional mortgage loans, EVENT2^t is a dummy variable signaling passage of the Tax Reform Act of 1986, EVENT3^t is a dummy variable signaling passage of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) of 1989 and SEC^t measures the percentage of newly originated mortgage loans that are securitized.

Plots of FEES and monthly changes in FEES appear in figures 5 and 6 respectively. Estimates of equation (6.4.1) appear in table 11. As in sections 4 and 5 of this paper, I endeavor to deal with the stationarity problems of the data by running all regressions on first differences, or monthly changes in the variables. As a check, I run a second set of regressions on levels, but I include lagged values of the dependent variable as additional regressors. In general, these levels regressions produce results that are similar to the results from the regressions on first differences. Where there are discrepancies, I report them.

I find a negative relation between loan origination fees and securitization activity. The coefficient estimates of SEC suggest that a 10 percent increase (in absolute terms) in the monthly volume of mortgage loans securitized reduces loan origination fees by nearly 5

basis points, approximately 15% of the mean fee value over the sample period. Using results from the levels regressions, which are not reported here, I compute a rough estimate of the fee savings that accrues to consumers in 1993. I find that securitization produces consumer savings of more than \$2.8 billion in loan origination fees in 1993 alone.²⁹

It seems reasonable to ask why loan origination fees decline as a result of securitization activities. One source of savings might be increased competition among mortgage lenders. Table A3 shows a steady increase in the market share of loan originations attributed to mortgage companies. These lenders securitize nearly all their loans. (See table A4.) By securitizing standardized loans and selling risky mortgage assets to other financial intermediaries who can repackage those risks (and perhaps sell the repackaged securities to a wider audience of investors seeking risk reduction strategies), mortgage companies reduce the costs of lending. Consumers are the direct beneficiaries of their activities.

Of course this reduction in loan origination fees may carry with it increased risks for mortgage investors. Lower origination fees exacerbate the negative convexity problems associated with most mortgage assets. One consequence of these lower fees is an increased level of refinancing activity. With lower origination fees, it takes a smaller decline in interest rates to trigger a loan refinancing. In general, the prepayments that result from refinancing activities reduce the value of most mortgage assets.³⁰ So, it is possible that

²⁹ On average, consumers paid loan origination fees of 1.30 points on the \$1 trillion of mortgage loans issued in 1993. Using the mean contract rate of 7.03% and the mean loan maturity of 26.1 years, I compute a net fee spread of .1418%. (I amortize the points over the life of the loan, obtaining an effective rate of 7.1718%.) I multiply .350 (the coefficient on SEC in the unreported levels regression corresponding to model I in table 11) by .0903 (the mean rate of monthly security issuance), and add the result to .1418%, obtaining a new net fee spread of .1734%. Using the loan attribute data above, I compute mean origination fees of 1.586 points that would have prevailed without securitization activity. The fee savings that accrues to consumers is $(1.586-1.30)*.01*\$1 \text{ trillion} = \2.86 billion .

³⁰ PAC bonds are an important exception. (See the Appendix for a discussion of these bonds.) Recent experience in the PAC bond market suggests that investors are finding greater value in the prepayment risk reduction opportunities afforded by PAC bonds. Over the last few years, PAC spreads over Treasury securities have narrowed a substantial amount.

securitization encourages financial innovation by compounding the risks of mortgage assets and forcing mortgage investors to find more effective risk reduction strategies.

I test for differences between the wealth effects of passthrough and CMO issuance in model II of table 11. The passthrough securitization measure (PT) is negative and statistically significant, but the CMO securitization measure (CMO) is not statistically significant. An F test reveals that passthrough and CMO issuance do not affect mortgage loan origination fees at statistically different rates.³¹

6.5 *Summary and conclusions*

This is the first study to directly test the effects of securitization on a sample of mortgage loan origination fees. I find that securitization reduces loan origination fees, resulting in substantial savings for consumers. In 1993 alone, securitization produced consumer savings of more than \$2.8 billion in loan origination fees.

This is the first study to test for differences between the effects of passthrough and CMO creation on loan origination fees. I find that these activities have indistinguishable effects on loan origination fees. This result has important public policy implications.

In time-series tests of aggregate fee and spread data, I find no significant relation between loan origination fees and mortgage spreads. I find that loan origination fees are weakly related to several economic proxies for interest-rate, prepayment and default risks.

³¹ In light of the previous discussion, it would be interesting to test for differences between the wealth effects of PAC bonds and other CMO classes. Unfortunately, these data are not available.

7. Conclusion

The spread between mortgage contract rates and rates on various benchmark Treasury securities is significantly positive and fluctuates substantially through time. The spread contains premia for three different risks: interest-rate, prepayment and default. I find that variations in these three risk premia explain a significant portion of the time variation in both fixed-rate and adjustable-rate conventional mortgage spreads.

Although previous studies have found that securitization reduces primary mortgage rates by 30 basis points or more, I find these benefits disappear when fixed and adjustable rate spreads are unbundled and measured separately. I find no evidence that securitization lowers primary mortgage spreads. Nor do I find evidence that tax and regulatory changes over the last 15 years have affected primary mortgage spreads.

I find that securitization reduces loan origination fees, resulting in substantial savings for consumers. In 1993 alone, securitization produced consumer savings of more than \$2.8 billion in loan origination fees.

This is the first study to test for differences between the effects of passthrough and CMO creation on primary mortgage costs. I find that these activities have indistinguishable effects on loan rates and origination fees. This result has important public policy implications.

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Appendix A: CMO Securities

Exhibit A1 highlights key developments in the CMO market. I describe these financial innovations below.

Exhibit A1

Financial innovation in the CMO market

Year	Financial Innovations
1983	IOs, POs, sequential bonds, Z bonds, residuals
1986	PACs, companion bonds, floating-rate bonds
1987	TACs, super POs
1988	PAC POs
1989	VADMs, PAC IOs, PAC Zs, super IOs

The first CMO securities were structured as a series of sequential-pay tranches (from the French word for "slice"), or "vanilla" bonds. Here, a sequence of bonds retires in strict maturity order. The second tranche receives no principal until the first tranche retires. The third tranche receives no principal until the second tranche retires, and so on, until all the classes retire.

In an effort to speed up the retirement of early tranches and create short-term securities for financial intermediaries with short-term liabilities, CMO issuers introduced Z bonds. These bonds accrue interest as principal until they begin to pay down. Since they are usually the last class to retire, Z bonds make cash flows available to all preceding classes, thus reducing the maturities of these classes.

By far, the most important innovation in the CMO market has been the development of prepayment protected bonds known as planned amortization classes, or PACs. These bonds pay principal according to a fixed sinking fund schedule. The schedule is guaranteed for a range of prepayment speeds, denoted by PAC bands, or collars. When principal prepayments are fast, excess principal is diverted to a support or

companion bond which pays down simultaneously with the PAC. When principal prepayments are slow, principal is borrowed from the simultaneous-pay support bond. The net effect is to redistribute some of the prepayment risk away from the PAC and toward the support bond.

When a CMO security includes a series of PACs with similar average lives, the PACs earn priorities commensurate with their degree of prepayment protection. The cash flow and average life characteristics of Type-I PACs are more stable than those of Type-II PACs, which are more stable than those of Type-III PACs, and so on. Given the prepayment protection offered by PACs, it is not surprising they are the most common CMO bond type. Nearly one-third of all outstanding mortgage derivatives are PACs. It is not unusual for new issue CMOs to have a 50% PAC composition. PACs may be combined with a variety of interest payment schemes. Fixed-rate, floating-rate and accrual PACs (PAC Zs) exist, as do zero-coupon (PAC POs) and interest-only PACs (PAC IOs). I discuss these in more detail below.

Targeted amortization classes (TACs) and Very Accurately Defined Maturities (VADMs) are variations on the PAC theme. TACs are weak-form PACs, and VADMs are strong-form PACs. The sinking fund schedule for a TAC is satisfied at only one prepayment speed. Thus, TACs offer far less prepayment protection than ordinary PACs. VADMs are PACs that are created from Z bonds. The accretion flows from a Z bond are fairly stable under a wide range of prepayment speeds. Thus, VADMs offer greater prepayment protection than ordinary PACs.

Companion or support bonds exist as a by-product of PAC creation. These bonds have increased prepayment risk relative to the underlying passthrough collateral. The average lives of companion bonds are extremely variable; they will extend when rates rise and shorten when rates fall. Companion bonds comprise about 11% of all outstanding mortgage derivatives.

Zero-coupon or principal-only (PO) bonds resemble pure PO strips. They are sold at a deep discount to face value and their average lives are extremely sensitive to changes in prepayment rates. When prepayments increase, principal is returned sooner and PO investors earn higher returns. PO bonds which are also companion bonds are called super POs.

Interest-only (IO) bonds resemble pure IO strips. They are sold at a deep discount to face value, they are priced with a notional principal amount, and their average lives are extremely sensitive to changes in prepayment rates. IOs have negative durations. When rates rise, prepayments decrease, IOs extend and IO prices increase. This occurs because the increased value of a longer stream of interest payments more than offsets the decline in value associated with higher discount rates. The price behavior of IOs provides a natural hedge against the interest rate risk of most fixed-income securities.

CMO floating rate bonds first appeared in 1986. Since most CMOs are collateralized by fixed-rate collateral, floating bonds are capped to ensure that sufficient interest exists to meet the coupon requirements of all classes. The coupon rate on a floating rate tranche is usually quoted as an index rate plus a spread. Most floaters are tied to LIBOR, although, recently, many have used a constant-maturity Treasury index. Floating rate bonds are usually sequential-pay bonds, but they can also be PAC, TAC, VADM or support bonds.

Super floaters are leveraged floating rate bonds. When the index rate increases one basis point, the coupon on a super floater increases by more than one basis point. The more leveraged the bond, the greater the change in price associated with a change in interest rates. For this reason, super floaters can be used to hedge interest rate risk, although, in practice, one must be careful with the caps. Rates on super floaters are usually expressed as a function of an index (e.g., $3 * \text{LIBOR} - 20 \text{ bp}$). Super floaters can be structured as PAC, TAC, companion, or sequential tranches.

Floating rate bonds are usually paired with inverse floaters. These bonds have coupon rates that move in the opposite direction of an index. If the movement is greater than one for one, the inverse floater is leveraged. Rates on inverse floaters are usually expressed as a function of an index (e.g., $30\% - 4 * \text{LIBOR}$). Inverse floaters appeal to investors seeking higher yields in declining rate environments.

Before CMOs became available, mortgage investors attempted to hedge interest rate and prepayment risks by (i) selling forward contracts on passthrough securities, (ii) purchasing put options on passthroughs, (iii) selling Treasury futures contracts, and (iv) purchasing put options on Treasury futures. The first two strategies imposed very high transaction costs; the last two strategies introduced basis risk. When CMOs became available, mortgage investors found cheaper and more effective ways to manage risks. CMO securities provide a range of maturity, duration and convexity matching strategies that cannot be replicated in the Treasury futures market. By allowing financial intermediaries to customize risk reduction strategies, CMOs lower the costs of hedging. Investors end up paying for only the risk reduction they desire. Exhibit A2 summarizes some of the risk reduction opportunities that CMO bonds provide. I describe these strategies below.

Exhibit A2

CMO bond risk reduction opportunities

Bond type	Duration	Convexity	Use
Sequential	+	-	target asset duration
Z	+	+	hedge short put liabilities
PAC, TAC, VADM	+	+	hedge prepayment risk
IOs	-	+	shorten asset duration
POs	+	+	hedge short put liabilities
floaters, superfloaters	+	-	hedge interest rate risk
PAC POs	+	+	increase asset duration; hedge prepayment risk
PAC IOs	-	+	shorten asset duration; hedge prepayment risk
PAC floaters	+	+	hedge prepayment risk; hedge interest rate risk

CMOs redistribute the risk characteristics of mortgages and passthroughs in useful ways. Positively convex bonds such as Z bonds and POs enable financial intermediaries to hedge the risks of liability portfolios containing embedded options. Negative duration securities such as IOs and PAC IOs enable short-funded financial intermediaries to lower the duration of their asset portfolios, thus reducing the gap between assets and liabilities.

PAC, TAC and VADM bonds segment the prepayment and interest rate risks of mortgage assets, providing call protection over a range of prepayment speeds, but exposing investors to all the risks and rewards of changes in interest rates. Banks and mortgage lenders can use PACs to duration match their assets and liabilities. Provided prepayments stay within the PAC bands, the assets will not shorten or lengthen. If the put options owned by depositors are equally insensitive to small shifts in interest rates, then the liabilities will stay duration matched to the assets, and the increase in asset value associated with lower rates will offset the increase in liability costs. Within a range of interest rate changes, the market value of the financial intermediary is hedged.

PAC IOs offer the prepayment protection of PACs, but enable short-funded financial intermediaries to lower the duration of their assets.. Like IOs, PAC IOs have negative duration. When interest rates rise, IOs and PAC IOs increase in value, offsetting the added expense of deposits that have been put back to banks at higher rates.

POs and PAC POs enable long-funded financial intermediaries, such as life insurers and pension funds, to increase the duration of their assets. Like POs, PAC POs have positive duration and positive convexity. When interest rates fall, POs and PAC POs increase in value, offsetting the increased cost of a liability stream discounted at lower rates.

Floating rate bonds protect financial intermediaries from an increase in interest rates. In exchange for this interest rate protection, investors forego the upside price appreciation that coincides with lower rates. PAC floaters offer prepayment and interest rate protection. Financial intermediaries with short liabilities can invest in PAC floaters that are indexed to short rates such as 3 month LIBOR or 1 year Treasury bills. A fall in rates will not coincide with an increase in prepayments, provided the PAC bands hold. Property and casualty insurers with short assets and short liabilities can hedge against a range of interest rate changes.

Table A1

Mortgage security issuance by type
(dollars in billions)

Year	GNMA MBS	FHLMC MBS	FNMA MBS	Private MBS	Total MBS	CMOs/ REMICs	Total Issuance
1972	2.7	na	0	0	2.7	0	2.7
1973	3.0	na	0	0	3.0	0	3.0
1974	4.6	na	0	0	4.6	0	4.6
1975	7.4	na	0	0	7.4	0	7.4
1976	13.8	na	0	0	13.8	0	13.8
1977	17.4	na	0	0.2	17.7	0	17.7
1978	15.4	na	0	0.7	16.1	0	16.1
1979	24.9	3.8	0	0.4	29.1	0	29.1
1980	20.6	2.5	0	0.2	23.3	0	23.3
1981	14.3	3.5	0.7	0.1	18.6	0	18.6
1982	16.0	24.2	14.0	0.3	54.5	0	54.5
1983	50.5	19.7	13.3	1.6	85.1	4.7	89.8
1984	27.9	18.7	13.5	0.2	60.3	10.8	71.1
1985	46.0	38.8	23.6	2.0	110.4	16.0	126.4
1986	101.4	100.2	60.6	7.0	269.2	48.3	317.5
1987	94.9	75.0	62.2	11.1	243.2	59.9	303.2
1988	55.2	39.8	54.9	15.4	165.3	78.8	244.0
1989	57.1	73.5	69.8	14.2	214.6	97.8	312.4
1990	64.3	73.8	96.7	24.4	259.3	111.7	371.0
1991	62.6	107.4	112.9	49.3	332.3	195.0	527.3
1992	81.9	178.4	194.0	89.5	543.8	279.2	823.0
1993	138.0	208.7	221.4	98.5	666.7	323.8	990.5
1994	111.3	117.1	130.6	63.2	422.2	119.2	541.4

Sources: GNMA, FHLMC, FNMA, Inside Mortgage Securities

Table A2

Outstanding mortgage securities by type
(dollars in billions)

Year End	GNMA MBS	FHLMC MBS	FNMA MBS	Private MBS	Total MBS	Agency- backed CMOs	Mortgage Debt (1 - 4 family)
1980	93.9	17.0	0	na	110.8	0	965.0
1981	105.8	19.9	0.7	na	126.4	0	1,039.8
1982	118.9	43.0	14.5	na	176.3	0	1,081.5
1983	160.0	57.7	25.1	na	242.8	4.7	1,199.0
1984	180.0	70.0	36.2	na	286.2	10.8	1,334.5
1985	212.1	99.9	55.0	na	367.0	29.3	1,503.8
1986	262.7	169.2	97.2	na	529.0	69.8	1,707.9
1987	315.8	212.6	140.0	27.8	696.2	112.7	1,940.8
1988	340.5	226.4	178.3	34.9	780.0	181.2	2,171.0
1989	369.7	272.9	228.2	43.3	914.1	256.4	2,407.8
1990	401.3	316.4	299.8	53.3	1,070.8	335.2	2,616.3
1991	425.2	359.2	372.0	84.0	1,240.4	433.6	2,780.0
1992	419.5	407.5	445.0	132.0	1,404.0	564.4 ^a	2,959.6
1993	414.0	439.0	495.5	164.0	1,512.6	667.0 ^a	3,144.9
1994	452.6	460.7	530.3	183.6	1,627.2	659.3 ^a	3,347.5 ^a

^a Inside Mortgage Securities estimate

Sources: GNMA, FNMA, FHLMC, Federal Reserve Board, Inside Mortgage Securities

Table A3

Residential mortgage originations*
(dollars in billions)

Year	Commercial Banks	Savings Banks	Savings & Loans	Mortgage Companies	Other	Total
1983	44.8 (22.2)	10.8 (5.4)	81.5 (40.4)	59.8 (29.6)	5.0 (2.5)	201.9
1984	41.9 (20.6)	12.7 (6.2)	96.2 (47.2)	47.6 (23.4)	5.3 (2.6)	203.7
1985	57.0 (19.7)	7.5 (2.6)	109.3 (37.7)	110.0 (38.0)	6.0 (2.1)	289.8
1986	108.6 (21.8)	31.1 (6.2)	176.1 (35.3)	176.0 (35.2)	7.5 (1.5)	499.4
1987	124.6 (24.6)	34.2 (6.7)	174.5 (34.4)	167.1 (33.0)	6.8 (1.3)	507.2
1988	101.9 (22.8)	28.4 (6.4)	160.4 (35.9)	148.0 (33.2)	7.5 (1.7)	446.3
1989	123.2 (27.2)	23.2 (5.1)	134.5 (29.7)	166.5 (36.8)	5.3 (1.2)	452.9
1990	153.3 (33.4)	18.0 (3.9)	121.0 (26.4)	161.2 (35.2)	4.9 (1.1)	458.4
1991	153.3 (27.3)	18.5 (3.3)	121.9 (21.7)	263.9 (47.0)	4.4 (0.8)	562.1
1992	232.1 (26.0)	34.2 (3.8)	184.5 (20.6)	437.6 (49.0)	4.7 (0.5)	893.7
1993	258.4 (25.6)	39.5 (3.9)	179.1 (17.7)	526.5 (52.2)	5.4 (0.5)	1,009.3

* Percent of total originations in parentheses.

Source: U.S. Department of Housing and Urban Development

Table A4

Residential mortgage purchases less sales by originator type*
(dollars in billions)

Year	Commercial Banks	Savings Banks	Savings & Loans	Mortgage Companies	Total
1983	-11.4 (-25.5)	-0.2 (-1.9)	-17.3 (-21.2)	-57.0 (-95.3)	-85.8 (-42.5)
1984	-7.6 (-18.1)	+0.4 (+3.2)	-9.5 (-9.9)	-44.3 (-93.1)	-61.0 (-30.0)
1985	-15.5 (-27.2)	-7.1 (-94.7)	-44.9 (-41.1)	-107.2 (-97.5)	-174.7 (-60.3)
1986	-28.2 (-26.0)	-9.4 (-30.2)	-94.9 (-53.9)	-165.0 (-93.8)	-297.4 (-60.0)
1987	-29.0 (-23.3)	-9.2 (-26.9)	-59.3 (-34.0)	-178.9 (-107.1)	-276.5 (-54.5)
1988	-15.2 (-14.9)	-6.3 (-22.2)	-48.4 (-30.2)	-143.1 (-96.7)	-212.9 (-47.7)
1989	-19.6 (-15.9)	-11.1 (-47.8)	-62.5 (-46.5)	-146.3 (-87.9)	-239.5 (-52.9)
1990	-35.5 (-23.2)	-8.5 (-47.2)	-71.1 (-58.8)	-162.1 (-100.6)	-277.3 (-60.5)
1991	-40.7 (-26.6)	-6.5 (-35.1)	-70.3 (-57.7)	-252.7 (-95.8)	-370.2 (-65.9)
1992	-59.6 (-25.7)	-12.3 (-36.0)	-112.6 (-61.0)	-436.4 (-99.7)	-621.1 (-69.5)
1993	-79.2 (-30.7)	-15.7 (-39.8)	-89.0 (-49.7)	-527.0 (-100.1)	-710.9 (-70.4)

* Purchases less sales as a percent of individual and total originations in parentheses.
Source: U.S. Department of Housing and Urban Development

Table A5

Residential mortgage purchases less sales by investor type*
(dollars in billions)

Year	MBS Conduits/ REITs	Federal Housing Agencies	Mortgage Pools	Total Purchases	MBS Issued
1983	5.5	15.7	81.4	102.6 (50.8)	85.1
1984	7.7	16.0	59.9	83.5 (41.0)	60.3
1985	7.9	22.4	107.4	137.7 (47.5)	110.4
1986	16.2	22.1	252.5	290.8 (58.2)	269.2
1987	21.2	17.6	225.0	263.7 (52.0)	243.2
1988	23.4	22.8	142.5	188.7 (42.3)	165.3
1989	16.4	23.1	192.1	231.6 (51.1)	214.6
1990	20.1	35.9	229.7	285.8 (62.4)	259.3
1991	38.8	41.9	271.7	352.4 (62.7)	332.3
1992	78.2	72.8	463.2	614.2 (68.7)	543.8
1993	90.6	103.4	561.8	755.7 (74.9)	666.7

* Purchases less sales as a percent of total originations in parentheses.

Source: U.S. Department of Housing and Urban Development

Table A6

Mortgage asset holdings by investor type
(dollars in billions)

Investor Group	1980	1985	1990	1994
Savings & Loans	602.1	765.4	778.9	586.8
Commercial banks	264.9	430.1	850.4	991.0
Insurers / Pension Funds	146.2	203.5	316.1	273.8
Households	123.0	124.9	176.9	186.9
Mortgage pools, govt agencies	114.3	370.0	1,019.7	1,438.7
Government agencies	99.9	136.4	154.3	256.4
U.S Government	42.0	53.2	82.8	69.5
State and local governments	33.3	74.0	109.1	108.7
Mortgage pools, private	0	13.9	60.2	182.6
Other	21.7	141.1	214.5	252.1
Total	\$1,447.4	\$2,312.3	\$3,762.9	\$4,346.6

Source: Federal Reserve Board, *Federal Reserve Bulletin*, various issues.

Table 1

Summary statistics of primary, fixed-rate mortgage spread and fee measures, and economic proxies of interest-rate, prepayment, default and liquidity premia

Variable	Name	Mean	Std.	Min.	Max.	ρ_1 (Var)	ρ_1 (Δ Var)
fixed-rate mtg. spread	FSPRD	1.689	0.780	0.286	4.079	.832	-.257
origination fees	FEES	0.331	0.194	0.090	0.840	.974	-.314
Tbond futures price diff.	FUT	0.520	0.580	-1.219	1.344	.938	-.248
yield curve slope	SLOPE	1.324	1.447	-3.480	4.230	.945	.298
volatility - Tbond	VOLT30	0.119	0.046	0.042	0.312	.264	-.493
corporate quality spread	QUAL	1.235	0.493	0.550	2.690	.956	.175
mortgage delinquencies	DELNQ	3.238	0.480	2.470	4.160	.976	.001
passthrough issuance	PT	0.041	0.018	0.007	0.091	.896	-.264
CMO issuance	CMO	0.012	0.012	0	0.050	.866	-.383
security issuance	SEC	0.053	0.026	0.007	0.112	.926	-.270
pt. issuance - conv. FRM	PTCF	0.049	0.018	0.007	0.090	.812	-.319
cmo issuance - conv. FRM	CMOCF	0.023	0.017	0	0.068	.758	-.408
sec. issuance - conv. FRM	SECCF	0.072	0.029	0.013	0.125	.861	-.231

FSPRD is the difference between the mortgage contract rate and a benchmark Treasury security matched on average life under the assumption of no prepayment. FEES is the difference between the effective mortgage rate (i.e., the contract rate, plus mortgage origination fees amortized over the term of the mortgage) and the nominal mortgage contract rate. FUT is the difference between the prices of adjacent delivery Treasury bond futures contracts. SLOPE is the difference between the yields on the 30 year Treasury bond and the 1 year Treasury bill. VOLT30 is the (annualized) volatility of daily yields on 30 year Treasury bonds. QUAL is the difference between the yields on corporate bonds rated AAA and those rated BAA. DELNQ is the percentage of conventional mortgage loans that are delinquent. SEC (PT) [CMO] is the dollar volume of mortgage loans securitized (as passthroughs) [as CMOs] during the month, expressed as a percentage of the dollar volume of mortgage loans originated over the last 12 months. SECCF (PTCF) [CMOCF] is the dollar volume of conventional, fixed-rate mortgage loans securitized (as passthroughs) [as CMOs] during the month, expressed as a percentage of the dollar volume of conventional, fixed-rate mortgage loans originated over the last 12 months. FSPRD, FEES, SLOPE, QUAL, DELNQ and FUT are in percent. All other variables are in decimal form. For most variables, the sample period is from 1980:1 through 1995:12 and consists of 192 observations. For SECCF, PTCF and CMOCF, the sample period is from 1983:12 through 1995:12.

Table 2

Stationarity tests of primary, fixed-rate mortgage spread and fee measures, and economic proxies of interest-rate, prepayment, default and liquidity premia

Variable	Name	# of AR terms	pval: levels	reject unit root levels	pval: 1st diff.	reject unit root 1st diff.
fixed-rate spread	FSPRD	3	.196	N	.000	Y
origination fees	FEES	3	.830	N	.000	Y
Tbond futures price diff.	FUT	2	.157	N	.000	Y
yield curve slope	SLOPE	2	.004	Y	.000	Y
volatility - Tbond	VOLT30	1	.000	Y	.000	Y
corporate quality spread	QUAL	3	.501	N	.000	Y
mortgage delinquencies	DELNQ	1	.681	N	.000	Y
passthrough issuance	PT	2	.129	N	.000	Y
CMO issuance	CMO	3	.374	N	.000	Y
security issuance	SEC	2	.250	N	.000	Y
pt. issuance - conv. fixed	PTCF	1	.039	Y	.000	Y
cmo issuance - conv. fixed	CMOCF	2	.167	N	.000	Y
sec. issuance - conv. fixed	SECCF	2	.128	N	.000	Y

Pvals indicate results of augmented Dicky-Fuller t tests of unit roots. FSPRD is the difference between the mortgage contract rate and a benchmark Treasury security matched on average life under the assumption of no prepayment. FEES is the difference between the effective mortgage rate (i.e., the contract rate, plus mortgage origination fees amortized over the term of the mortgage) and the nominal mortgage contract rate. FUT is the difference between the prices of adjacent delivery Treasury bond futures contracts. SLOPE is the difference between the yields on the 30 year Treasury bond and the 1 year Treasury bill. VOLT30 is the (annualized) volatility of daily yields on 30 year Treasury bonds. QUAL is the difference between the yields on corporate bonds rated AAA and those rated BAA. DELNQ is the percentage of conventional mortgage loans that are delinquent. SEC (PT) [CMO] is the dollar volume of mortgage loans securitized (as passthroughs) [as CMOs] during the month, expressed as a percentage of the dollar volume of mortgage loans originated over the last 12 months. SECCF (PTCF) [CMOCF] is the dollar volume of conventional, fixed-rate mortgage loans securitized (as passthroughs) [as CMOs] during the month, expressed as a percentage of the dollar volume of conventional, fixed-rate mortgage loans originated over the last 12 months. FSPRD, FEES, SLOPE, QUAL, DELNQ and FUT are in percent. All other variables are in decimal form. For most variables, the sample period is from 1980:1 through 1995:12 and consists of 192 observations. For SECCF, PTCF and CMOCF, the sample period is from 1983:12 through 1995:12.

Table 3

Regressions of changes in nominal contract spreads of conventional fixed-rate mortgages on changes in economic proxies for interest-rate, prepayment, default and liquidity risks.

Model:	I	II	III	IV	V
Intercept	0.003 (0.163)	0.004 (0.173)	0.004 (0.171)	0.003 (0.155)	0.002 (0.079)
Δ FUT		0.443** (2.464)	0.442** (2.453)	0.423** (2.331)	0.450** (2.460)
Δ SLOPE	-0.341*** (-6.061)	-0.433*** (-6.547)	-0.433*** (-6.529)	-0.428*** (-6.423)	-0.431*** (-6.409)
Δ VOLT30	2.946*** (5.595)	2.588*** (4.876)	2.587*** (4.857)	2.609*** (4.896)	2.520*** (4.573)
Δ QUAL	0.523*** (2.919)	0.497*** (2.837)	0.497*** (2.828)	0.489*** (2.775)	0.475*** (2.662)
Δ DELNQ		0.532** (2.047)	0.531** (2.037)	0.524** (2.009)	0.506* (1.896)
Δ SEC			0.137 (0.049)		
Δ PT				2.129 (0.617)	2.213 (0.369)
Δ CMO				-3.215 (-0.729)	16.139 (1.146)
Δ PT*EVENT1					8.327 (0.810)
Δ PT*EVENT2					-3.867 (-0.317)
Δ PT*EVENT3					-9.738 (-0.876)
Δ CMO*EVENT2					-18.096 (-0.970)
Δ CMO*EVENT3					-4.087 (-0.310)
ρ	-0.262	-0.268	-0.267	-0.266	-0.261
DW	2.130	2.128	2.129	2.123	2.139
R ²	.336	.369	.369	.372	.386

The sample period is from 1980:3 through 1995:12 and consists of 190 observations. T statistics are in parentheses. All estimates use the Cochrane-Orcutt adjustment for first-order serial correlation in the residuals. After this adjustment, I fail to reject the hypothesis that the residuals are serially uncorrelated at a 5-percent level for each regression. Asterisks denote pvalues less than 10 percent (*), 5 percent (**), and 1 percent (***).

Table 4

Regressions of changes in effective contract spreads of conventional fixed-rate mortgages on changes in economic proxies for interest-rate, prepayment, default and liquidity risks.

Model:	I	II	III	IV	V
Intercept	0.002 (0.084)	0.002 (0.095)	0.002 (0.099)	0.002 (0.085)	0.000 (0.015)
Δ FUT		0.457** (2.538)	0.458** (2.535)	0.440** (2.420)	0.466** (2.538)
Δ SLOPE	-0.347*** (-6.107)	-0.442*** (-6.643)	-0.442*** (-6.626)	-0.437*** (-6.524)	-0.440*** (-6.509)
Δ VOLT30	2.959*** (5.596)	2.585*** (4.857)	2.587*** (4.845)	2.608*** (4.878)	2.499*** (4.525)
Δ QUAL	0.520*** (2.880)	0.493*** (2.798)	0.493*** (2.785)	0.485*** (2.737)	0.472*** (2.634)
Δ DELNQ		0.566** (2.170)	0.568** (2.168)	0.562** (2.141)	0.542** (2.022)
Δ SEC			-0.414 (-0.148)		
Δ PT				1.392 (0.401)	0.181 (0.030)
Δ CMO				-3.447 (-0.779)	15.797 (1.119)
Δ PT*EVENT1					11.193 (1.085)
Δ PT*EVENT2					-5.696 (-0.465)
Δ PT*EVENT3					-8.937 (-0.800)
Δ CMO*EVENT2					-18.165 (-0.971)
Δ CMO*EVENT3					-3.796 (-0.287)
ρ	-0.257	-0.263	-0.262	-0.261	-0.255
DW	2.132	2.130	2.131	2.126	2.142
R ²	.332	.368	.368	.371	.385

The sample period is from 1980:3 through 1995:12 and consists of 190 observations. T statistics are in parentheses. All estimates use the Cochrane-Orcutt adjustment for first-order serial correlation in the residuals. After this adjustment, I fail to reject the hypothesis that the residuals are serially uncorrelated at a 5-percent level for each regression. Asterisks denote pvalues less than 10 percent (*), 5 percent (**), and 1 percent (***).

Table 5

Summary statistics of primary, adjustable-rate mortgage spread and fee measures, and economic proxies of interest-rate, prepayment, default and liquidity premia

Variable	Name	Mean	Std.	Min.	Max.	ρ_1 (Var)	ρ_1 (Δ Var)
adjustable-rate spread	ASPRD	0.863	0.733	-0.630	2.670	.918	-.091
origination fees	FEES	0.331	0.194	0.090	0.840	.974	-.314
Tbill spread	TBLSPD	0.780	0.523	-0.940	2.930	.852	.199
yield curve slope	SLOPE	1.324	1.447	-3.480	4.230	.945	.298
volatility - Tbill	VOLT1	0.196	0.105	0.041	0.600	.306	-.427
corporate quality spread:	QUAL	1.235	0.493	0.550	2.690	.956	.175
mortgage delinquencies	DELNQ	3.238	0.480	2.470	4.160	.976	.001
passthrough issuance	PT	0.041	0.018	0.007	0.091	.896	-.264
CMO issuance	CMO	0.012	0.012	0	0.050	.866	-.383
security issuance	SEC	0.053	0.026	0.007	0.112	.926	-.270
pt. issuance - conv. ARM	PTCA	0.017	0.014	0	0.082	.592	-.472
cmo issuance - conv. ARM	CMOCA	0.001	0.004	0	0.034	.414	-.403
sec. issuance - conv. ARM	SECCA	0.018	0.015	0	0.082	.556	-.465

ASPRD is the difference between the adjustable-rate mortgage contract rate and the yield on a one-year Treasury bill. FEES is the difference between the effective mortgage rate (i.e., the contract rate, plus mortgage origination fees amortized over the term of the mortgage) and the nominal mortgage contract rate. TBLSPD is the difference between the yields on one-year Treasury bills and three-month Treasury bills. SLOPE is the difference between the yields on the 30 year Treasury bond and the 1 year Treasury bill. VOLT1 is the (annualized) volatility of daily yields on one-year Treasury bills. QUAL is the difference between the yields on corporate bonds rated AAA and those rated BAA. DELNQ is the percentage of conventional mortgage loans that are delinquent. SEC (PT) [CMO] is the dollar volume of mortgage loans securitized (as passthroughs) [as CMOs] during the month, expressed as a percentage of the dollar volume of mortgage loans originated over the last 12 months. SECCA (PTCA) [CMOCA] is the dollar volume of conventional, adjustable-rate mortgage loans securitized (as passthroughs) [as CMOs] during the month, expressed as a percentage of the dollar volume of conventional, adjustable-rate mortgage loans originated over the last 12 months. ASPRD, FEES, TBLSPD, SLOPE, QUAL and DELNQ are in percent. All other variables are in decimal form. For ASPRD, the sample period is from 1984:7 through 1995:12. For VOLT1, the sample period is from 1982:1 through 1995:12. For SECCA, PTCA and CMOCA, the sample period is from 1983:12 through 1995:12. For all other variables, the sample period is from 1980:1 through 1995:12 and consists of 192 observations.

Table 6

Stationarity tests of primary, adjustable-rate mortgage spread and fee measures, and economic proxies of interest-rate, prepayment, default and liquidity premia

Variable	Name	# of AR terms	pval: levels	reject unit root levels	pval: 1st diff.	reject unit root 1st. diff
adjustable-rate spread	ASPRD	1	.296	N	.000	Y
origination fees	FEES	3	.830	N	.000	Y
Tbill spread	TBLSPD	6	.029	N	.000	Y
yield curve slope	SLOPE	2	.004	Y	.000	Y
volatility - Tbill	VOLT1	1	.000	Y	.000	Y
corporate quality spread:	QUAL	3	.501	N	.000	Y
mortgage delinquencies	DELNQ	1	.681	N	.000	Y
passthrough issuance	PT	2	.129	N	.000	Y
CMO issuance	CMO	3	.374	N	.000	Y
security issuance	SEC	2	.250	N	.000	Y
pt. issuance - conv. ARM	PTCA	3	.164	N	.000	Y
cmo issuance - conv. ARM	CMOCA	10	.993	N	.001	Y
sec. issuance - conv. ARM	SECCA	7	.507	N	.000	Y

Pvals indicate results of augmented Dicky-Fuller t tests of unit roots. ASPRD is the difference between the adjustable-rate mortgage contract rate and the yield on a one-year Treasury bill. FEES is the difference between the effective mortgage rate (i.e., the contract rate, plus mortgage origination fees amortized over the term of the mortgage) and the nominal mortgage contract rate. TBLSPD is the difference between the yields on one-year Treasury bills and three-month Treasury bills. SLOPE is the difference between the yields on the 30 year Treasury bond and the 1 year Treasury bill. VOLT1 is the (annualized) volatility of daily yields on one-year Treasury bills. QUAL is the difference between the yields on corporate bonds rated AAA and those rated BAA. DELNQ is the percentage of conventional mortgage loans that are delinquent. SEC (PT) [CMO] is the dollar volume of mortgage loans securitized (as passthroughs) [as CMOs] during the month, expressed as a percentage of the dollar volume of mortgage loans originated over the last 12 months. SECCA (PTCA) [CMOCA] is the dollar volume of conventional, adjustable-rate mortgage loans securitized (as passthroughs) [as CMOs] during the month, expressed as a percentage of the dollar volume of conventional, adjustable-rate mortgage loans originated over the last 12 months. ASPRD, FEES, TBLSPD, SLOPE, QUAL and DELNQ are in percent. All other variables are in decimal form. For ASPRD, the sample period is from 1984:7 through 1995:12. For VOLT1, the sample period is from 1982:1 through 1995:12. For SECCA, PTCA and CMOCA, the sample period is from 1983:12 through 1995:12. For all other variables, the sample period is from 1980:1 through 1995:12 and consists of 192 observations.

Table 7

Regressions of changes in nominal contract spreads of conventional adjustable-rate mortgages on changes in economic proxies for interest-rate, prepayment, default and liquidity risks.

Model:	I	II	III	IV	V
Intercept	0.004 (0.189)	-0.004 (-0.207)	-0.004 (-0.210)	-0.004 (-0.215)	-0.004 (-0.227)
Δ TBLSPD		-0.769*** (-5.906)	-0.769*** (-5.885)	-0.779*** (-5.931)	-0.778*** (-5.859)
Δ SLOPE	0.200* (1.973)	0.269*** (3.064)	0.273*** (3.079)	0.277*** (3.127)	0.274*** (3.046)
Δ VOLT1	0.509** (2.453)	0.581*** (3.120)	0.584*** (3.124)	0.584*** (3.117)	0.587*** (3.111)
Δ QUAL	0.163 (0.551)	-0.140 (-0.534)	-0.141 (-0.537)	-0.162 (-0.616)	-0.166 (-0.621)
Δ DELNQ		0.473** (2.290)	0.477** (2.298)	0.486** (2.335)	0.492** (2.329)
Δ SECCA			0.665 (0.425)		
Δ PTCA				1.325 (0.741)	5.779 (0.266)
Δ CMOCA				-3.851 (-0.641)	-3.514 (-0.580)
Δ PTCA*EVENT2					-2.820 (-0.127)
Δ PTCA*EVENT3					-1.963 (-0.390)
ρ	-0.116	-0.165	-0.164	-0.169	-0.158
DW	1.984	2.069	2.069	2.075	2.114
R ²	.082	.297	.298	.301	.302

The sample period is from 1984:8 through 1995:12 and consists of 137 observations. T statistics are in parentheses. All estimates use the Cochrane-Orcutt adjustment for first-order serial correlation in the residuals. After this adjustment, I fail to reject the hypothesis that the residuals are serially uncorrelated at a 5-percent level for each regression. Asterisks denote pvalues less than 10 percent (*), 5 percent (**), and 1 percent (***).

Table 8

Regressions of changes in effective contract spreads of conventional adjustable-rate mortgages on changes in economic proxies for interest-rate, prepayment, default and liquidity risks.

Model:	I	II	III	IV	V
Intercept	0.000 (0.014)	-0.007 (-0.400)	-0.007 (-0.401)	-0.007 (-0.407)	-0.008 (-0.431)
Δ TBLSPD		-0.752*** (-5.768)	-0.751*** (-5.745)	-0.761*** (-5.793)	-0.759*** (-5.715)
Δ SLOPE	0.208** (2.072)	0.276*** (3.148)	0.279*** (3.153)	0.284*** (3.199)	0.282*** (3.139)
Δ VOLT1	0.497** (2.392)	0.568*** (3.030)	0.571*** (3.032)	0.571*** (3.025)	0.573*** (3.012)
Δ QUAL	0.104 (0.351)	-0.196 (-0.749)	-0.197 (-0.750)	-0.218 (-0.828)	-0.221 (-0.827)
Δ DELNQ		0.474** (2.286)	0.477** (2.290)	0.486** (2.328)	0.497** (2.345)
Δ SECCA			0.559 (0.354)		
Δ PTCA				1.223 (0.679)	10.202 (0.467)
Δ CMOCA				-3.981 (-0.657)	-3.734 (-0.611)
Δ PTCA*EVENT2					-7.980 (-0.358)
Δ PTCA*EVENT3					-1.247 (-0.246)
ρ	-0.125	-0.175	-0.174	-0.179	-0.172
DW	1.988	2.072	2.071	2.078	2.120
R ²	.083	.291	.291	.295	.296

The sample period is from 1984:8 through 1995:12 and consists of 137 observations. T statistics are in parentheses. All estimates use the Cochrane-Orcutt adjustment for first-order serial correlation in the residuals. After this adjustment, I fail to reject the hypothesis that the residuals are serially uncorrelated at a 5-percent level for each regression. Asterisks denote pvalues less than 10 percent (*), 5 percent (**) and 1 percent (***).

Table 9

Simultaneous regressions of changes in loan origination fees and nominal contract spreads of conventional fixed-rate mortgages on changes in economic proxies for interest-rate, prepayment, default and liquidity risks.

Model:	I		II		III	
Dep. Var:	Δ FSPRD	Δ FEES	Δ FSPRD	Δ FEES	Δ FSPRD	Δ FEES
Intercept	0.003 (0.17)	-0.002 (-0.78)	0.003 (0.16)	-0.002 (-0.75)	0.003 (0.16)	-0.001 (-0.69)
Δ FUT			0.447** (2.36)	0.016 (0.80)	0.446** (2.34)	0.018 (0.90)
Δ SLOPE	-0.336*** (-5.76)	-0.005 (-0.79)	-0.430*** (-6.23)	-0.009 (-1.19)	-0.430*** (-6.22)	-0.009 (-1.21)
Δ VOLT30	2.969*** (5.32)	0.018 (0.29)	2.622*** (4.64)	0.009 (0.15)	2.621*** (4.62)	0.012 (0.19)
Δ QUAL	0.534*** (2.79)	-0.001 (-0.06)	0.508*** (2.72)	-0.001 (-0.07)	0.508*** (2.71)	-0.002 (-0.10)
Δ DELNQ			0.537*** (1.99)	0.035 (1.24)	0.536** (1.98)	0.038 (1.35)
Δ SEC					0.158 (0.05)	-0.546* (-1.81)
Δ PT						
Δ CMO						
Δ PT*EVENT1						
Δ PT*EVENT2						
Δ PT*EVENT3						
Δ CMO*EVENT2						
Δ CMO*EVENT3						
Δ FSPRD		0.001 (0.11)		-0.002 (-0.20)		-0.001 (-0.19)
Δ FEES	0.074 (0.10)		-0.146 (-0.20)		-0.140 (-0.19)	
ρ	-0.295	-0.305	-0.301	-0.306	-0.301	-0.310
DW	2.083	2.050	2.078	2.053	2.078	2.045
R ²	.336	.091	.369	.102	.369	.119

Table 9 (continued)

Model:	IV		V	
Dep. Var:	Δ FSPRD	Δ FEES	Δ FSPRD	Δ FEES
Intercept	0.003 (0.14)	-0.001 (-0.68)	0.001 (0.07)	-0.001 (-0.62)
Δ FUT	0.427** (2.23)	0.019 (0.96)	0.457** (2.36)	0.017 (0.86)
Δ SLOPE	-0.424*** (-6.11)	-0.010 (-1.24)	-0.428*** (-6.11)	-0.009 (-1.18)
Δ VOLT30	2.641*** (4.66)	0.009 (0.14)	2.551*** (4.36)	-0.010 (-0.16)
Δ QUAL	0.499*** (2.66)	-0.001 (-0.07)	0.488** (2.57)	0.001 (0.04)
Δ DELNQ	0.529* (1.95)	0.038 (1.36)	0.514* (1.86)	0.038 (1.35)
Δ SEC				
Δ PT	2.139 (0.58)	-0.729* (-1.95)	2.144 (0.33)	-2.019*** (-3.18)
Δ CMO	-3.140 (-0.68)	-0.236 (-0.49)	15.798 (1.06)	-0.389 (-0.26)
Δ PT*EVENT1			8.662 (0.79)	2.870*** (2.62)
Δ PT*EVENT2			-4.062 (-0.32)	-1.794 (-1.39)
Δ PT*EVENT3			-9.839 (-0.85)	0.739 (0.63)
Δ CMO*EVENT2			-17.617 (-0.90)	0.021 (0.01)
Δ CMO*EVENT3			-4.110 (-0.30)	0.252 (0.18)
Δ FSPRD		-0.001 (-0.13)		-0.002 (-0.20)
Δ FEES	-0.095 (-0.13)		-0.123 (-0.16)	
ρ	-0.300	-0.307	-0.298	-0.270
DW	2.072	2.042	2.085	2.023
R ²	.372	.123	.386	.164

The sample period is from 1980:3 through 1995:12 and consists of 190 observations. T statistics are in parentheses. All estimates use the Cochrane-Orcutt adjustment for first-order serial correlation in the residuals. After this adjustment, I fail to reject the hypothesis that the residuals are serially uncorrelated at a 5-percent level for each regression. Asterisks denote p-values less than 10 percent (*), 5 percent (**) and 1 percent (***).

Table 10

Simultaneous regressions of changes in loan origination fees and nominal contract spreads of conventional adjustable-rate mortgages on changes in economic proxies for interest-rate, prepayment, default and liquidity risks.

Model:	I		II		III	
Dep. Var:	Δ ASPRD	Δ FEES	Δ ASPRD	Δ FEES	Δ ASPRD	Δ FEES
Intercept	0.002 (0.08)	-0.004** (-2.28)	-0.004 (-0.23)	-0.003** (-2.12)	-0.004 (-0.23)	-0.003** (-2.11)
Δ TBLSPD			-0.768*** (-5.67)	0.015 (0.99)	-0.768** (-5.65)	0.015 (0.98)
Δ SLOPE	0.205* (1.95)	0.007 (0.84)	0.271*** (2.97)	(0.005) (0.60)	0.275*** (2.99)	0.005 (0.53)
Δ VOLT1	0.501*** (2.38)	-0.014 (-0.65)	0.581*** (3.04)	-0.018 (-0.81)	0.584*** (3.05)	-0.019 (-0.84)
Δ QUAL	0.128 (0.42)	-0.058** (-2.22)	-0.149 (-0.55)	-0.053** (-2.00)	-0.149 (-0.55)	-0.053* (-1.98)
Δ DELNQ			0.474** (2.23)	0.001 (0.07)	0.477** (2.24)	0.001 (0.04)
Δ SECCA					0.649 (0.40)	-0.108 (-0.61)
Δ PTCA						
Δ CMOCA						
Δ PTCA*EVENT2						
Δ PTCA*EVENT3						
Δ ASPRD		-0.006 (-0.82)		-0.002 (-0.27)		-0.002 (-0.25)
Δ FEES	-0.627 (-0.64)		-0.129 (-0.15)		-0.109 (-0.12)	
ρ	-0.125	-0.329	-0.176	-0.329	-0.174	-0.330
DW	1.980	2.125	2.054	2.130	2.054	2.130
R ²	.084	.143	.297	.150	.298	.153

Table 10 (continued)

Model:	IV		V	
Dep. Var:	Δ ASPRD	Δ FEES	Δ ASPRD	Δ FEES
Intercept	-0.004 (-0.23)	-0.003** (-2.10)	-0.005 (-0.27)	-0.004** (-2.19)
Δ TBLSPD	-0.778*** (-5.71)	0.015 (1.00)	-0.776*** (-5.66)	0.016 (1.10)
Δ SLOPE	0.280*** (3.04)	0.005 (0.51)	0.280*** (3.05)	0.006 (0.62)
Δ VOLT1	0.586*** (3.04)	-0.019 (-0.85)	0.598*** (3.03)	-0.020 (-0.92)
Δ QUAL	-0.172 (-0.63)	-0.052* (-1.93)	-0.188 (-0.69)	-0.050* (-1.88)
Δ DELNQ	0.487** (2.27)	0.000 (0.02)	0.497** (2.28)	0.000 (0.21)
Δ SECCA				
Δ PTCA	1.327 (0.72)	-0.130 (-0.64)	10.232 (0.45)	2.985 (1.28)
Δ CMOCA	-4.001 (-0.65)	0.042 (0.06)	-3.911 (-0.62)	-0.034 (-0.05)
Δ PTCA*EVENT2			-7.080 (-0.30)	-3.785 (-1.58)
Δ PTCA*EVENT3			-2.193 (-0.42)	0.772 (1.39)
Δ ASPRD		-0.002 (-0.22)		-0.002 (-0.25)
Δ FEES	-0.108 (-0.12)		-0.116 (-0.13)	
ρ	-0.183	-0.331	-0.202	-0.318
DW	2.055	2.130	2.063	2.108
R ²	.301	.153	.303	.180

The sample period is from 1984:8 through 1995:12 and consists of 137 observations. T statistics are in parentheses. All estimates use the Cochrane-Orcutt adjustment for first-order serial correlation in the residuals. After this adjustment, I fail to reject the hypothesis that the residuals are serially uncorrelated at a 5-percent level for each regression. Asterisks denote pvalues less than 10 percent (*), 5 percent (**), and 1 percent (***).

Table 11

Regressions of changes in loan origination fees on changes in economic proxies for interest-rate, prepayment, default and liquidity risks.

Model:	I	II	III	IV
Intercept	-0.002 (-0.903)	-0.002 (-0.887)	-0.002 (-0.898)	-0.003 (-1.560)
Δ TBLSPD			0.013 (1.487)	0.020* (1.723)
Δ FUT			-0.002 (-0.144)	
Δ SLOPE				-0.010 (-1.028)
Δ VOLT30				0.016 (0.244)
Δ VOLT1				-0.025 (-0.979)
Δ QUAL				
Δ DELNQ				
Δ SEC	-0.517* (-1.806)		-0.492* (-1.715)	-0.539** (-2.038)
Δ PT		-0.678* (-1.920)		
Δ CMO		-0.242 (-0.532)		
Δ PT*EVENT1				
Δ PT*EVENT2				
Δ PT*EVENT3				
Δ CMO*EVENT2				
Δ CMO*EVENT3				
ρ	-.313	-.310	-.317	-.267
DW	2.034	2.032	2.027	2.123
R ²	.117	.120	.128	.131

Table 11 (continued)

Model:	V	VI	VII	VIII
Intercept	-0.001 (-0.629)	-0.001 (-0.633)	-0.001 (-0.569)	-0.001 (-0.521)
Δ TBLSPD	0.022** (2.369)	0.022** (2.381)	0.023** (2.503)	0.023** (2.473)
Δ FUT				
Δ SLOPE	-0.009 (-1.626)	-0.009* (-1.685)	-0.010* (-1.720)	-0.010* (-1.709)
Δ VOLT30				
Δ VOLT1				
Δ QUAL	0.000 (0.004)			
Δ DELNQ	0.037 (1.429)	0.037 (1.435)	0.039 (1.480)	0.036 (1.393)
Δ SEC	-0.485* (-1.717)	-0.485* (-1.721)	-1.723*** (-3.147)	-1.719*** (-3.146)
Δ PT				
Δ CMO				
Δ PT*EVENT1			2.600*** (2.694)	2.618*** (2.721)
Δ PT*EVENT2			-2.005* (-1.655)	-1.278 (-1.369)
Δ PT*EVENT3			1.020 (0.935)	
Δ CMO*EVENT2			1.454 (1.106)	1.620** (2.264)
Δ CMO*EVENT3			0.211 (0.163)	
ρ	-0.303	-0.305	-0.267	-0.274
DW	2.061	2.057	2.044	2.049
R ²	.143	.143	.186	.182

Except for model IV, the sample period is from 1980:3 through 1995:12 and consists of 190 observations. For model IV, the sample period is from 1982:2 through 1995:12 and consists of 167 observations. All estimates use the Cochrane-Orcutt adjustment for first-order serial correlation in the residuals. After this adjustment, I fail to reject the hypothesis that the residuals are serially uncorrelated at a 5-percent level for each regression. Asterisks denote pvalues less than 10 percent (*), 5 percent (**) and 1 percent (***).

Figure 1
FRM spreads

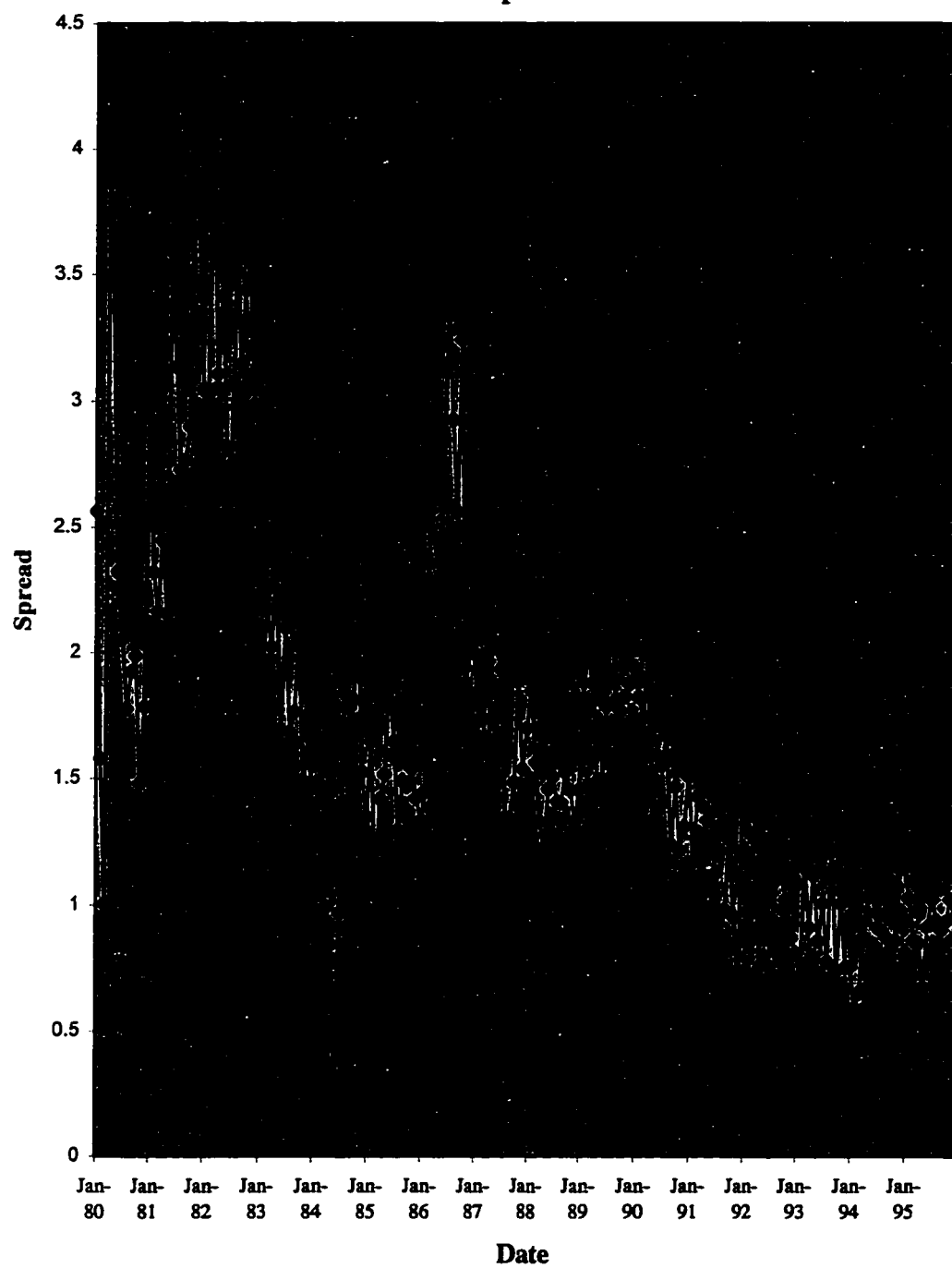


Figure 2
Monthly changes in FRM spreads

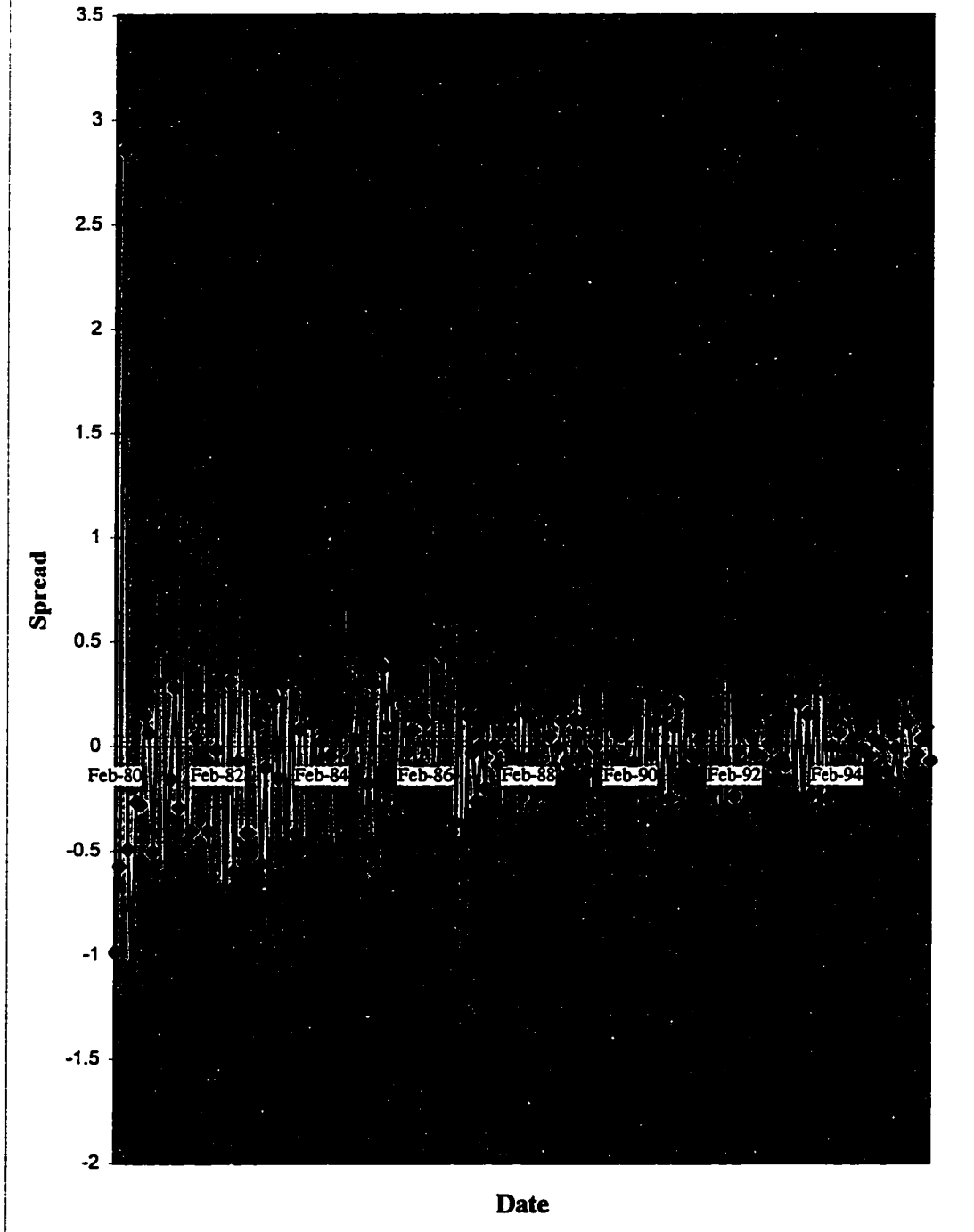


Figure 3
ARM spreads

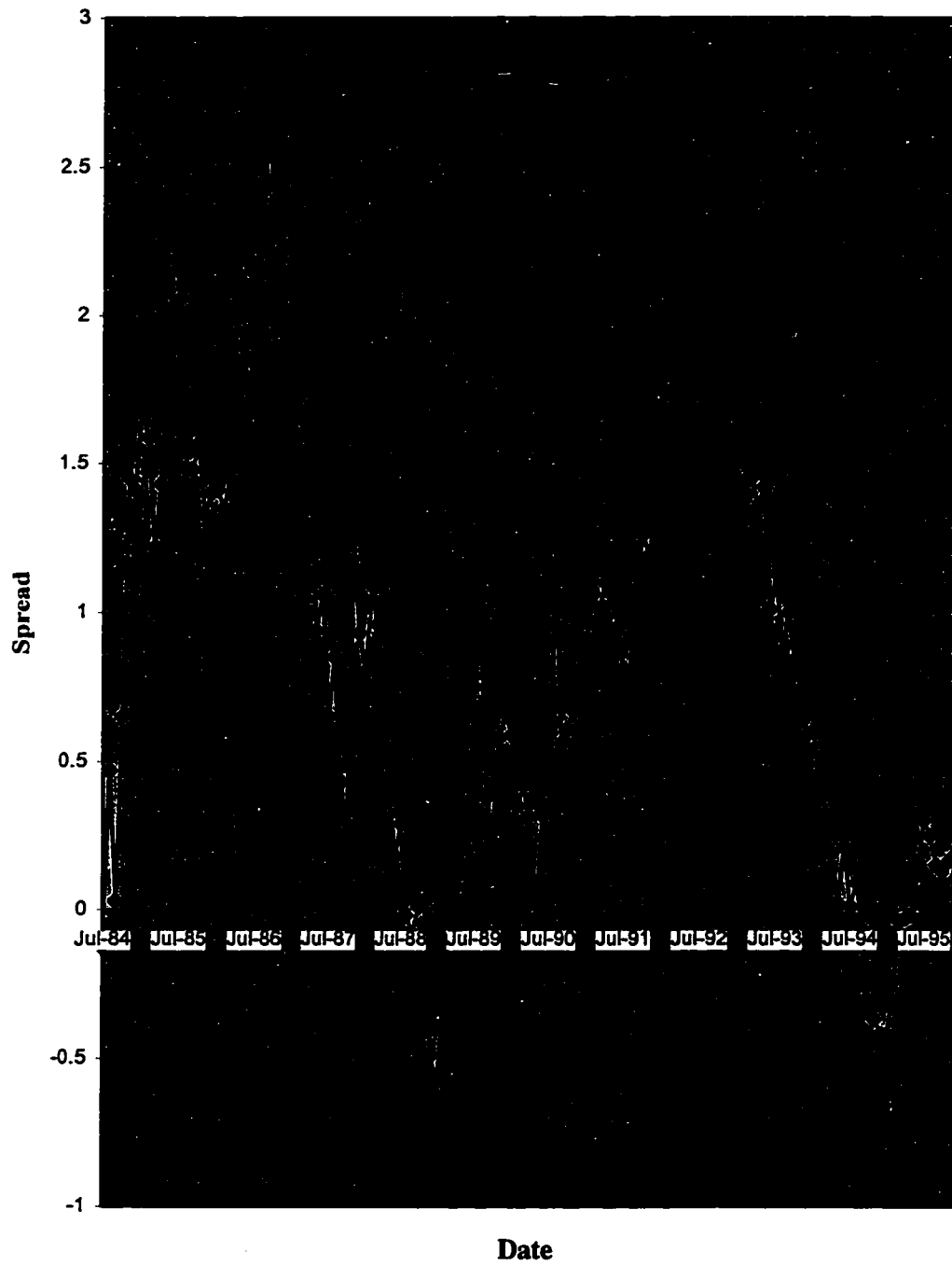


Figure 4
Monthly changes in ARM spreads

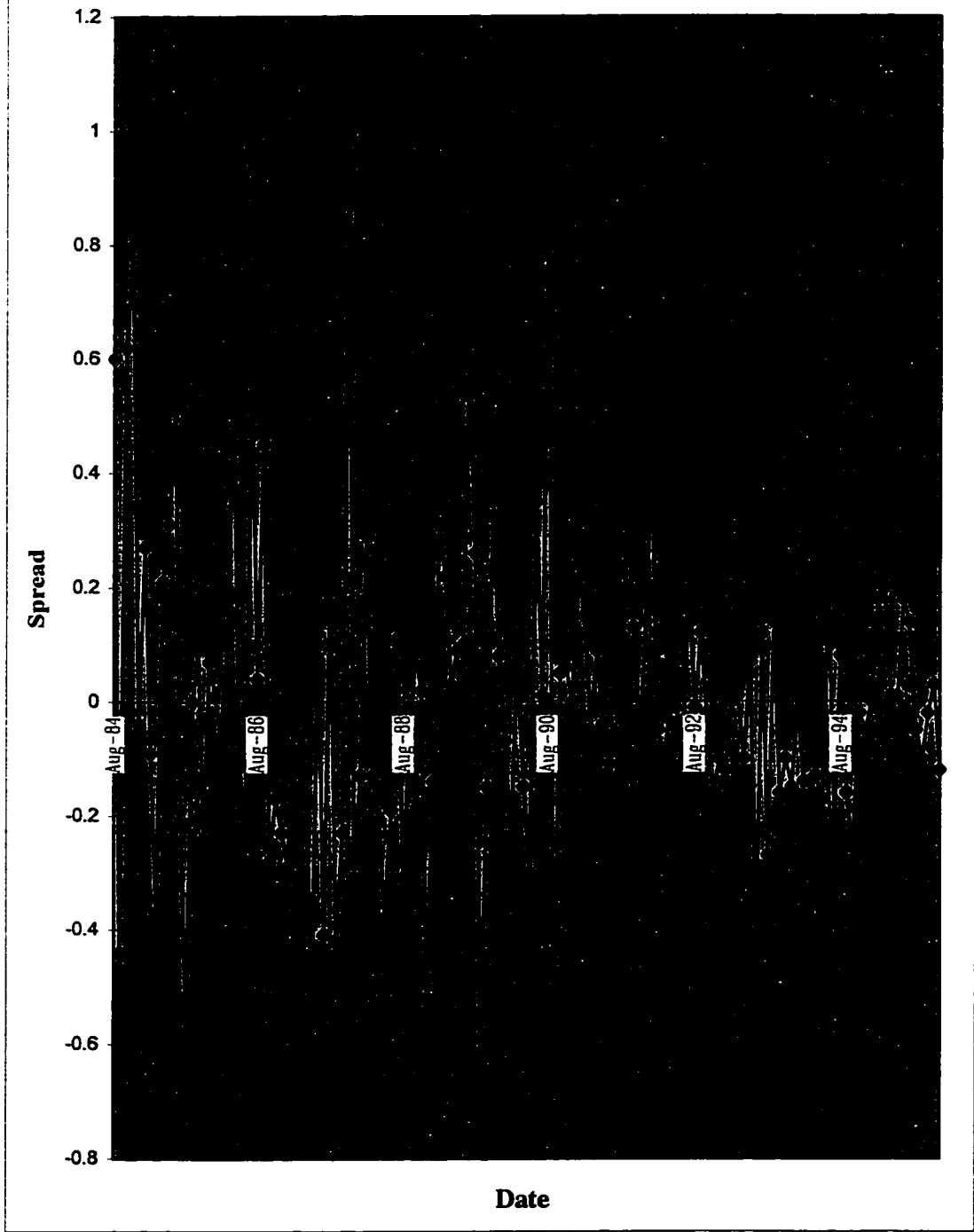


Figure 5
Loan origination fees

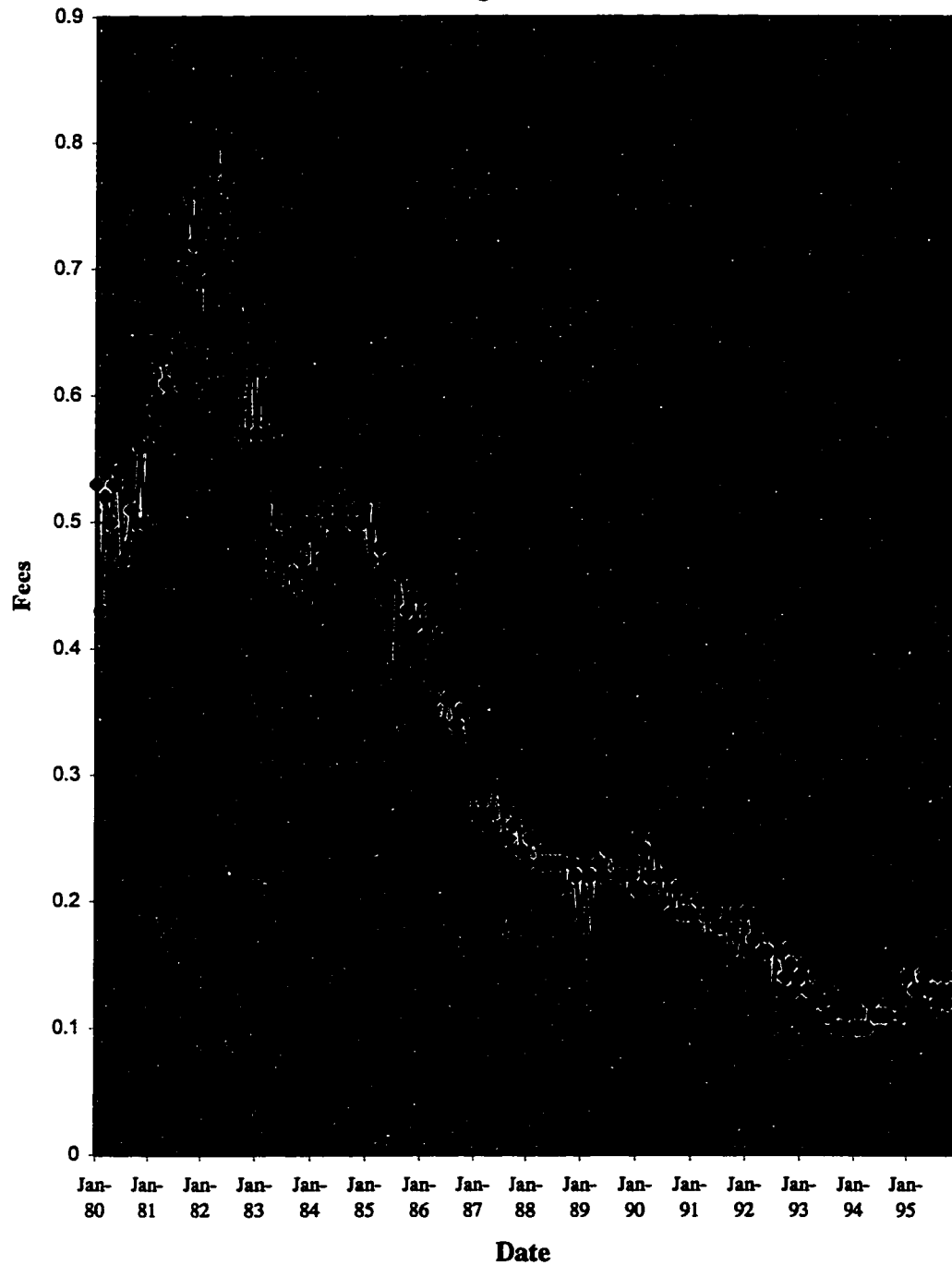
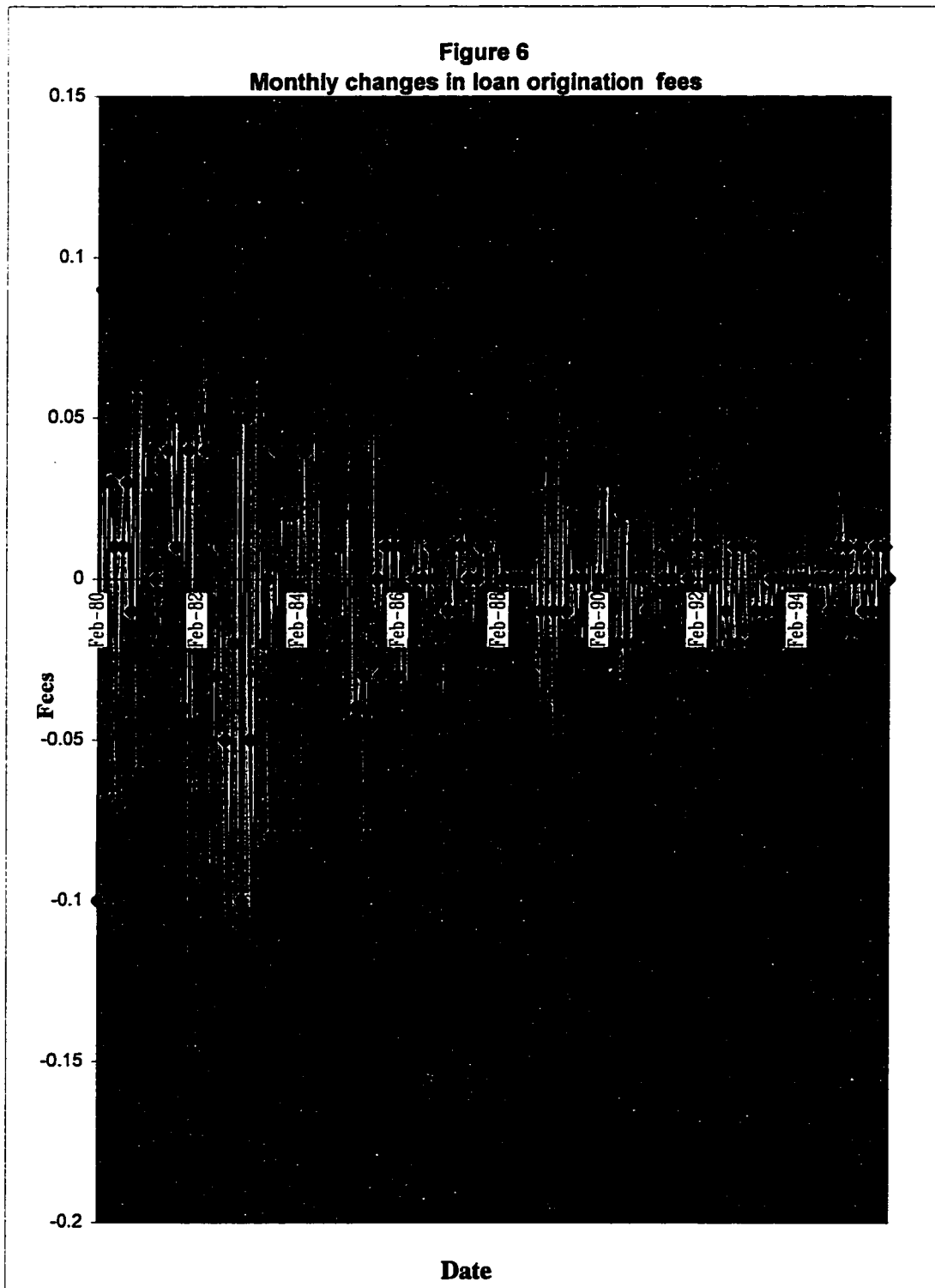


Figure 6
Monthly changes in loan origination fees



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Education

- 1992 - Ph.D. Finance, (expected 1997) University of Washington.
- 1978 - 82 B.S. Operations Research and Industrial Engineering, Cornell University.

Dissertation

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Chairman: Alan Hess

Academic Experience

- 1997 - Assistant Professor of Finance, *Loyola University*, Chicago, IL.
Courses taught: investments (undergraduate), corporate finance (MBA).
- 1995 - 97 Instructor. *University of Puget Sound*, Tacoma, WA.
Courses taught: financial markets, corporate finance.
- 1992 - 97 Instructor, *University of Washington*, Seattle, WA.
Courses taught: corporate finance, business economics.

Work Experience

- 1991 - 92 Portfolio Manager, *Home Insurance*, NY.
Managed an \$800 million portfolio of mortgage-backed securities (MBS) and collateralized mortgage obligations (CMOs). Initiated a trading program for asset-backed securities. Assisted in the development of asset/liability duration management strategies.

- 1988 - 91 Asst. Vice President, Derivative Products Group, *UBS Securities*, NY. Working with mortgage finance and trading areas, assisted in the structuring, sale and risk management of 15 CMO issues totaling over \$4 billion. Coordinated all analytical support activities for the fixed-income sales force. Assisted in the design, marketing and pricing of several equity warrant issues distributed in Zurich, Switzerland.
- 1985 - 88 Vice President, Financial Strategies Group, *Security Pacific*, NY. Responsible for the design of analytical models to optimally structure portfolios, structure and value CMO issues, monitor the MBS market for arbitrage opportunities, manage assets and liabilities, hedge a mortgage pipeline and value fixed and adjustable-rate mortgages.
- 1984 - 85 Senior Programmer/Analyst, Debt Strategy Group, *Merrill Lynch*, NY. Designed and programmed mathematical models to optimally structure portfolios.
- 1982 - 84 Programmer/Analyst, Pension Finance Group, *Equitable Life*, NY. Developed computer systems to analyze the profitability of pension products and portfolios.

Working Papers

- "The effects of securitization on consumer mortgage financing costs."
- "Conditional performance evaluation," with Heber Farnsworth, Wayne Ferson and David Jackson.
- "Securitization, prepayments and convexity."
- "Ownership structure and firm performance," with Tim Kruse.

Publications and Presentations

- 1997 *The Impact of Financial Intermediation on Consumer Mortgage Financing Costs*. Presented at Loyola University Chicago.
- 1995 - Farnsworth, H., W. Ferson, D. Jackson and S. Todd. *Conditional Performance Evaluation*. Presented by Ferson at the 1995 annual meeting of the American Finance Association, the 1995 NBER summer research institute, and at seven other conferences and universities.

- 1994 Mutual Fund Performance.
Presented at the University of Washington, Seattle, WA.
- 1994 Initial Public Offerings.
Presented at the University of Washington, Seattle, WA.
- 1993 Prepayments and the Valuation of Mortgage-Backed Securities.
Presented at the University of Washington, Seattle, WA.
- 1989 Valuing Derivative Securities using Monte Carlo Simulation.
Presented at the Wharton Financial Optimization Conference,
Philadelphia, PA.
- 1988 with N. De Liban. CMO Arbitrages. Security Pacific report.
- 1988 with N. De Liban. An Introduction to Collateralized Mortgage
Obligations. Security Pacific report.
- 1985 Portfolio Structuring Techniques. Merrill Lynch report.

Honors and Awards

- 1996 - 1997 Albert O. Foster Fellowship, University of Washington.
- 1995 Doctoral Program Teaching Award, University of Washington.
- 1994 Graduate and Professional Student Senate.
- 1993 School of Business, Ph.D. Student Council.
- 1978 Cornell University Merit Scholarship.
- 1975 U.S. Champion, Yamaha National Jazz Competition.