Prepayment Penalties in Residential Mortgage Contracts: A Cost-Benefit Analysis

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Abstract

Prepayment penalties are ubiquitous in the commercial mortgage market yet reviled and highly restricted by law and regulation in the residential mortgage market. Considering the perspectives of both the borrower and the lender, we attempt a balanced cost-benefit analysis of this controversial contract feature for residential mortgage loans.

We will address the following questions: What is the economic value of the prepayment penalty feature? Why is it more prevalent in the subprime than the prime market segment? Do borrowers obtain an offsetting economic benefit when they contract for a loan containing a prepayment penalty? What is the average cost of a prepayment penalty to borrowers, and how often is this cost actually incurred? In general, although we find a significant reduction in interest rates for loans containing a prepayment penalty, the expected costs outweigh the benefits by a considerable margin.

Keywords: Mortgage; Prepayment; Subprime and predatory lending

Introduction

Given the embedded options they contain, mortgages are among the most complex of financial contracts.[1] Prepayment, the right to call the debt at par value, has been a topic of interest for researchers for many years (see, for example, Dickinson and Heuson 1994 for a survey of the early literature

[1]Those options include prepayment of the loan (calling the debt before maturity) and default (putting the debt to the lender in return for forfeiture of the collateral property). For a review of the option-theoretic approach to valuing mortgage contracts, see Kau and Keenan (1995).

or LaCour-Little 2007c for a more recent review). Contract provisions limiting prepayment, however, have received relatively little rigorous analysis.

In this article, we attempt a balanced cost-benefit analysis from the perspective of both the borrower and the lender. To do this, we begin by using simulation to compute the economic value of prepayment penalties to lenders and investors in residential mortgage contracts. We then compare these theoretical predictions with the results found in the empirical research on actual mortgage contracts. Next, we consider the costs imposed on borrowers by prepayment penalties, using data on subprime home purchase loans originated during 2002 to calculate both the magnitude of the issue and the probability that these borrowers will experience a prepayment penalty.[2] To set the stage for the analysis, we begin with a brief overview of call protection in other segments of the bond market, including the corporate, government, and agency segments.

In the corporate bond market, a significant fraction of bonds are callable. The usual structure involves a call protection period during which the option may not be exercised, followed by a period during which the bond is callable at a premium that declines as the bond approaches maturity.[3] King (2002) reports that across a sample of corporate bonds originated from 1973 to 1994, the median call protection period was five years. Likewise, Gande et al. (1997) report that for a sample of 1993–95 corporate bond issues, the average call period was 5.27 years for issues underwritten by banks and 5.64 years for issues underwritten by investment houses. These same data indicate that the average call premium (the cost to prepay the bond early) was 4.00 percent for debt underwritten by banks and 3.70 percent for debt underwritten by investment houses. The yield boost[4] that a call premium of this type provides is on the order of 50 basis points,[5] assuming, for example, an 8.00 percent coupon issued at par and called at 104 in five years.

Prepayment penalties are a common feature in the commercial mortgage market as well. According to Citigroup, full-term lock-outs[6] are now standard contract features on virtually all mortgages contained in commercial

[2]While subprime lending surged between 2003 and 2006 before the market collapse of 2007, we have detailed data available for only 2002 loan originations.

[3]A call premium is, in effect, a prepayment penalty, since it requires the issuer of the bond to pay an additional amount to retire the debt early. That premium is expressed in terms of a percentage of outstanding debt: For example, 104 means 104 percent of the current debt outstanding (or a 4 percent prepayment penalty).

[4]A yield boost represents the increase in realized yield experienced by investors on a debt security called by its issuer before maturity and will depend both on the amount of the call premium (prepayment penalty) and on the timing of the call.

[5]A basis point is 1/100 of 1 percent, so 50 basis points equals 0.50 percent.

[6]A lock-out prohibits early prepayment in almost all circumstances.

mortgage-backed securities pools (Wheeler 2000). According to the Bank of America Commercial Mortgage Division term sheet, prepayment penalties are "Lock Out with Defeasance or Yield Maintenance" on all but the shortest maturities (two years or less).[7] The typical rationale for these restrictions is that large underwriting costs must be recouped for commercial mortgages to be profitable for the originator. So prevalent are prepayment penalty restrictions in the commercial mortgage market that much of the research on loan performance, reviewed in the next section, simply assumed away prepayment risk to focus exclusively on default risk.

In the government bond market, call protection is relatively less common since these contracts do not currently provide any option to retire the debt early. Before 1984, the U.S. Department of the Treasury often issued callable debt, but the additional yield required by investors offset the benefit of the call option to the government, so the practice was discontinued (Bliss and Ronn 1998). Agency securities—securities issued or guaranteed by government corporations or government-sponsored enterprises (GSEs)[8]—sometimes include call options, structured in the manner of corporate bonds or some variation thereof. For example, Freddie Mac offers medium-term notes with a wide range of call structures, noting that the yield on callable securities provides a premium over noncallable instruments of the same maturity (2008).[9]

By contrast, prepayment penalties in the residential segment of the U.S. mortgage market have been a matter of concern for regulatory and housing advocacy groups for decades, even though such penalties are common in

[7]The Bank of America Securities (2004): Standard Conduit—Fixed-Rate term sheet summary was provided to the lead author by a Bank of America commercial loan officer..

[8]Government corporations include the Government National Mortgage Association or the Tennessee Valley Authority. GSEs include Fannie Mae, Freddie Mac, and the Federal Home Loan Banks.

[9]According to Freddie Mac (2008):

> Callable debt is term debt within which the issuer has the right, but not an obligation, to call (or retire) the bonds prior to the final maturity of the issue. Freddie Mac can issue callable debt in a variety of forms, with final maturities typically ranging from one to thirty years, and call provisions effective as early as three months or as distant as ten years after the securities are issued. Our securities can be issued with either single or multiple call provisions, depending upon investors' and Freddie Mac's requirements. Popular types of call provisions include American (continuous call option on or after a certain date), European (single call on a certain date) or Bermudan (multiple discrete calls, e.g., on certain interest payment dates). To compensate for the maturity uncertainty that an investor is assuming by its purchase, callable debt is priced to yield a premium over the yield obtainable from bullet (or fixed maturity) debt with the same final maturity.

other countries. Canadian mortgages, for example, contain stringent penalties, and the incremental cost of obtaining an "open" mortgage—one allowing prepayment—is 45 to 80 basis points (Courchane and Giles 2002).

Prepayment penalties were originally restricted by the same state laws that prohibited high interest rates, but the Alternative Transaction Mortgage Parity Act of 1982[10] and regulatory interpretations in the 1990s allowed them to be used more widely. Concerned with alleged abuses in the home equity lending industry, however, Congress enacted the federal Home Owner's Equity Protection Act (HOEPA)[11] in 1994. HOEPA restricts prepayment penalties to five years on covered transactions[12] and prohibits them entirely if the borrower's debt-to-income ratio exceeds certain levels. Federal law also prohibits prepayment penalties on federally insured (Federal Housing Administration and U.S. Department of Veterans Affairs) residential mortgage loans, and the GSEs—Fannie Mae and Freddie Mac—have established guidelines for their purchase of loans containing prepayment penalty features.[13] Prepayment penalties have become a sensitive topic, particularly in the subprime market, where total originations increased from $134 billion in 2002 to over $600 billion in 2006 before there was a sharp decline to $191 billion in 2007, as high rates of mortgage default caused a sharp contraction in the market beginning that summer ("Non-Conforming Mortgage Market Was Hammered" 2008).

While differing sources report variation in the percentage of loans subject to prepayment penalties, all acknowledge that most subprime loans contain such a provision. According to Standard & Poor's (2004), about 80 percent of subprime mortgages contained prepayment penalties as of 2000. Chomsisengphet and Pennington-Cross (2006) report that for subprime loans in the First American/Loan Performance database, the percentage of those subject to prepayment penalties has varied over time, with a greater incidence

[10]This is Title VIII of the Garn–St Germain Depository Institutions Act (Pub. L. No. 97–320, 96 Stat. 1469).

[11]See Board of Governors of the Federal Reserve System (2006) for HOEPA's legislative history.

[12]A covered transaction under HOEPA is a home-secured loan meeting certain high cost triggers, today an annual percentage rate that exceeds comparable maturity Treasury rates by 8 percent or more.

[13]GSE rules generally require that borrowers be offered the choice of loans with and without prepayment penalties and that the contract containing the penalty provide an offsetting economic benefit, such as a lower rate. In addition, penalties may not be triggered by acceleration due to default. These limitations are consistent with the evolving standards of responsible lending practice.

for adjustable-rate, as opposed to fixed-rate, loans. Similarly, using a large database of subprime loans originated between 1995 and 2004, Elliehausen, Staten, and Steinbuks (2008) report that 60 percent of subprime loans contain prepayment penalties. We will discuss this important new article further in the next section.

Housing and consumer activists tend to condemn prepayment penalties on the grounds of consumer protection or economic justice, arguing that they are inherently unfair, unreasonably expensive, and/or inadequately disclosed to or poorly understood by borrowers. For example, the Woodstock Institute has recommended that prepayment penalties be strictly regulated (Smith 2006). Woodstock advocates banning prepayment penalties or, alternatively, limiting them to 1 percent of the loan amount. Similarly, the position of the National Consumers League (2005) is that "[u]nfair prepayment penalties should be prohibited." According to the Center for Responsible Lending (2004), "Each year prepayment penalties in subprime loans cause 850,000 families to lose $2.3 billion in home equity wealth." Other organizations that have taken strong positions on prepayment penalties in residential mortgage contracts include the Neighborhood Assistance Corporation and ACORN (Association of Community Organizations for Reform Now). However, lenders and many economists view prepayment penalties as a mechanism to increase the predictability of cash flow from mortgage loans, thereby enhancing their value to investors and reducing the cost of credit to borrowers.

Many state legislatures have taken up the cause of limiting allowable prepayment penalties. Ho and Pennington-Cross (2006a) provide a comprehensive survey of state and local regulation of mortgage loan terms, including prepayment penalties. For example, Colorado limits the duration of prepayment penalties to three years after the loan origination date and the amount to six months' interest. Georgia limits prepayment penalties to the first two years after loan origination and caps them at 2 percent of the loan amount during the first year and 1 percent during the second. Illinois restricts prepayment penalties to the first three years after loan origination and caps them at 3 percent of the loan amount during the first year, 2 percent during the second year, and 1 percent during the third year. Pennsylvania prohibits prepayment penalties on loans with an original balance of less than $50,000 but allows them for up to five years after origination, provided that the same product is also available without a prepayment penalty. North Carolina has one of the strongest state laws, prohibiting prepayment penalties entirely on loans with an original balance of $150,000 or less.

As of this writing, a total of 28 states now restrict prepayment penalties. Many statutes are patterned on HOEPA, under which loans with rates above a certain threshold are subject to additional restrictions on contract terms. However, restrictions on prepayment penalties, in terms of both length and amount, generally apply whether the loan meets the applicable pricing threshold or not. Of course, the cost to lenders of complying with so many divergent statutes is significant, and there have been calls for federal legislation in the broader arena of responsible lending practices. To date, however, no laws have been enacted. Current legislation triggered by the recent surge in mortgage defaults and foreclosures, including the Homeownership Protection and Enhancement Act of 2007 (Senate Bill 1386) and the American Home Ownership Preservation Act of 2007 (Senate Bill 2114), would prohibit prepayment penalties. Action on these bills is pending. As of this writing, members of Congress are close to finalizing the American Housing Rescue and Foreclosure Prevention Act of 2008.

Clearly, there are a number of important questions with respect to prepayment penalties in residential mortgage contracts. Here are the ones we will address in this article:

1. What is the economic value of the prepayment penalty contract feature?
2. Why are prepayment penalties more prevalent in the subprime than in the prime market segment?
3. Do borrowers obtain an offsetting economic benefit when they have a loan containing a prepayment penalty?
4. What is the cost to borrowers of a prepayment penalty, and how often is this cost actually incurred?

In the next section, we review the literature on call protection in the bond and commercial mortgage markets and the more limited literature on prepayment penalties in the residential mortgage market. In the following section, we describe the theory of mortgage valuation and the Monte Carlo method typically used to value mortgage contracts in practice. Next, we describe the assumptions and inputs to the particular valuation simulation we undertake. The following two sections review the results from the simulations and the empirical analyses, including models estimating the effect of penalties on prepayment patterns and the expected cost of prepayment penalties to subprime borrowers. Finally, we offer conclusions, including summary answers to the four primary research questions we have posed, together with policy implications.

Literature review

We begin by briefly noting related research in other segments of the bond market. Callable debt has been a topic of considerable interest in the corporate finance literature, with topics addressing both pricing policy and optimal call option exercise policy. The actual prices of bonds traded can be studied, for example, to determine whether the theoretical value of the call option is reflected in market pricing. In addition, the timing of actual call option exercise by issuers of callable debt has been studied to determine whether call policy conforms to theoretically optimal behavior. For example, using callable Treasury securities, Longstaff (1992) examined implicit call option values, finding that callable bonds trade at prices higher than predicted in about one-third of all cases. Using somewhat different techniques, Jordan, Jordan, and Jorgensen (1995) estimated that only about 7 percent of Treasury bonds trade at prices too low for their call features. Bliss and Ronn (1998) examine the history of U.S. Treasury bonds over a longer period (1926 to 1995) and argue that when the four-month advance notice period required to call U.S. Treasury bonds is taken into account, prices and call policy appear rational.

In the corporate bond sector, King and Mauer (2000) found that the vast majority of issuers delay their calls by an average of 27 months from the date when the option can first be exercised. In terms of pricing the option, King (2000) reports a "general practice of setting the coupon rate on callable issues 20-70 basis points higher than a similar non-callable issue" (3).

In the commercial mortgage market, most early research on performance (Kau et al. 1990; Riddiough and Thompson 1993; Titman and Torous 1989; Vandell 1992; Vandell et al. 1993) focused on default risk and simply assumed away prepayment risk, believing that commercial mortgages contain prepayment penalties, lock-outs, or yield maintenance provisions[14] that essentially preclude prepayment or fully compensate the lender when it occurs. More recently, however, Abraham and Theobald (1997), Kelly and Slawson (2001), and Fu, LaCour-Little, and Vandell (2003) have shown that prepayments should not simply be assumed away in articles in the commercial mortgage context and that the penalty structure itself is important. We now briefly summarize these newer studies.

[14]Lock-outs prohibit prepayment; and yield maintenance agreements provide for a penalty equal to the present value of any savings from refinancing, thus eliminating any incentive to do so.

Abraham and Theobald (1997) used Freddie Mac data on loans originated from 1984 to 1990 to develop a simple prepayment model. Since their data set includes some variation in prepayment penalties (lock-outs, yield maintenance, and step-down structures), the effect of the prepayment penalty can be observed over time. They describe the function as a "hockey stick" pattern, in which prepayments are close to zero during the lock-out period, then inflect sharply (to roughly a 45-degree angle) once the prepayment penalty period has expired.

Kelly and Slawson (2001) used simulation to address the value of delay in the case of commercial mortgages containing prepayment penalties. They consider a full range of possible alternatives, including permanent, fixed, and step-down penalties; yield maintenance; and lock-outs. These authors find that time-varying prepayment penalties significantly affect optimal prepayment decisions, since the value of delay differs for static and declining prepayment penalty structures.

Fu, LaCour-Little, and Vandell (2003) present empirical work generally consistent with that of Kelly and Slawson (2001); namely, they find that time-varying penalty structure alters the value of delay and, hence, optimal refinancing. The most important factors are those implied by option theory: the value of the option to refinance net of prepayment penalty costs, the remaining loan term, upcoming changes in the magnitude of the penalty, and interest rate volatility. Other factors also played a role, including the region of the country, the size of the loan, and whether the borrower had experienced other opportunities to refinance and had failed to do so.[15] In general, Fu, LaCour-Little, and Vandell (2003) find that any penalty structure is effective in reducing prepayments compared with no penalty.

From our review of the literature, we can conclude that evidence from the commercial mortgage market confirms that prepayment penalties do affect borrower behavior and reduce prepayments as intended. Moreover, the structure of the penalty matters in terms of how patterns are altered. As a result, loans subject to prepayment penalties can be expected to exhibit different cash flow patterns, and hence different economic values, than those of otherwise similar loans without the call protection feature.

We expect a similar result in the residential market segment and will test this proposition in our later empirical analysis of subprime loans. Indeed,

[15] Pools of loans in which the most rate-sensitive borrowers have already refinanced, leaving behind relatively less rate-sensitive borrowers, are often referred to as "burned out." Hence, various "burnout" measures are often incorporated into prepayment models to account for this phenomenon. For more information, see Hall (2000).

the effects are likely to be greater in the subprime segment than in the prime segment since the benefits in terms of rate reduction will be larger. Subprime borrowers whose credit improves to the extent that they can refinance into a prime loan will have a large financial incentive to do so. As Federal Reserve researchers have noted, "The effect of even a small improvement in the credit history score is much larger for borrowers in the higher-priced segment of the home-loan market than for those in the prime segment" (Avery, Canner, and Cook 2005, 369).

In the residential context, the literature on loan performance, including prepayment determinants, is extensive (see, for example, Ambrose and LaCour-Little 2001; Chinloy 1991, 1995; Green and Shoven 1986; Hayre, Chaudhary, and Young 2000; or Schwartz and Torous 1989). The topic of prepayment penalties, however, has been neglected and, to the extent that it is mentioned at all, it tends to be confined to the small but rapidly growing body of research on the subprime mortgage sector.[16] Outside of the literature on the subprime segment, Chinloy (1991) comments in a footnote that some states restrict the ability to charge prepayment penalties, and Chinloy (1995) remarks that the typical prepayment penalty, when one exists, applies to the first five years of the contract, thus acting to depress prepayment rates during that initial period.

In the growing body of literature on the subprime market segment, Courchane, Surette, and Zorn (2004) used survey information to examine whether borrowers are inappropriately channeled into subprime loans, whether subprime borrowers can transition into the prime segment, and what the overall satisfaction level of borrowers in the subprime segment is, noting that having a prepayment penalty was more frequently associated with a bad outcome on the loan, as reported by the borrowers. Chomsisengphet and Pennington-Cross (2006) provide an excellent overview of the evolution of subprime lending over time; they note that prepayment penalties extend the duration of loans and that lower loan-to-value ratios (LTVs) tend to mitigate default risk. Danis and Pennington-Cross (2005) examine the role of previous delinquencies on loan performance, noting that many delinquent subprime loans terminate through prepayment, rather than default, presumably often triggering prepayment penalties; Danis and Pennington-Cross (2005) term these events "distressed prepayments."

We now turn to critics of subprime lending. Farris and Richardson (2003) find that prepayment penalties are more likely to be observed in low-

[16] Policy makers' concern over subprime lending notwithstanding, "[A]cademic scholarship on the topic seemed minimal" (Staten and Yezer 2004, 359).

er-income and minority neighborhoods, consistent with the relatively greater fraction of subprime lending concentrated there. This distributional issue—that the cost of more onerous terms such as prepayment penalties is more likely to be borne by relatively lower-income households—is at the heart of much of the criticism of subprime lending. For example, Squires (2004) characterizes prepayment penalties as just one of the many objectionable practices in which subprime lenders engage, and Goldstein and Son (2003) assert that prepayment penalties on home loans are inherently abusive and offer an abbreviated cost-benefit calculation. They argue that even if borrowers save, perhaps, 55 basis points in annual interest rate by accepting a prepayment penalty, they face a penalty of at least 4 percent of the loan amount (400 basis points), thus implying that costs substantially outweigh benefits over a two- to three-year period. Our analysis, while considerably more rigorous, reaches qualitatively similar conclusions.

Focusing on prepayment penalties in particular, Quercia, Stegman, and Davis (2007) argue that this contract feature increases default risk in subprime loans since it constrains borrowers' ability to refinance when they encounter financial difficulties. Using data on 1999 subprime refinancing loans, they estimate that loans containing prepayment penalties are 16 to 20 percent more likely to experience foreclosure. They arrive at this conclusion after controlling for a variety of risk factors, including borrower credit score, contract type, level of documentation, and changes in house price levels.

However, there is concern that regulations restricting economically rational contract terms for credit may reduce the supply. Accordingly, the effect of state laws restricting particular mortgage contract terms has been a topic of considerable interest with varying results. Elliehausen and Staten (2004) and Harvey and Nigro (2004) examine the effect of the North Carolina law[17] on lending volume. Although these researchers use different methods and data sets, both find that passage of the law restricted the flow of mortgage credit, particularly to low- and moderate-income borrowers. Quercia, Stegman, and Davis (2004) concede that loan volume declined as a result of the North Carolina law but argue that the reduction represented loans with predatory features curtailed by the law and, hence, that the law is working as intended.

Extending the literature beyond the early North Carolina law, Ho and Pennington-Cross (2006a) examine the effect of local and state predatory lending laws on the flow of subprime mortgage credit, finding that the

[17]In mid-1999, North Carolina became the first state to enact legislation restricting loan terms (including prepayment penalties) on higher-cost mortgage loans.

strength of the law, measured by the extent of market coverage and prohibitions, can have a strong impact on both the flow of credit and the rejection of mortgage applications. As to the effect of state laws on the cost of credit, Ho and Pennington-Cross (2008) find that Home Mortgage Disclosure Act (HMDA) data, even with the new pricing measures available since 2004, is insufficient for the purpose of analysis. Using non-HMDA data, Ho and Pennington-Cross (2008) find that stronger laws tend to increase the cost of borrowing on fixed-rate loans while decreasing the cost of adjustable-rate or hybrid loans. Addressing similar questions, Li and Ernst (2007) examine the effect of state predatory lending laws, finding (1) no significant change in the overall flow of subprime residential mortgage credit, (2) a decrease in the proportion of loans with targeted terms (e.g., prepayment penalties), and (3) lower costs to consumers.

More directly relevant to the analysis presented here is DeMong and Burroughs (2005). Using a data set of almost a million subprime loans,[18] most of which contained prepayment penalties and were originated by multiple lenders, DeMong and Burroughs (2005) tested the hypothesis that loans containing such penalties would carry lower annual percentage rates (APRs) if other factors were held constant. Results were consistent with their hypothesis. The decrease in APR associated with a prepayment penalty was 38 basis points across all product types for 30-year first-lien subprime loans after borrower income, credit score, LTV, level of loan documentation, and loan type (fixed versus variable rate) were controlled for. By contrast, Ernst (2005), using 2000–2002 data from the Loan Performance Asset-Backed Securities Database, argues that prepayment penalties are not associated with lower interest rates to borrowers on subprime fixed-rate mortgage loans. These findings are not necessarily inconsistent, however, since DeMong and Burroughs (2005) analyzed APRs, while Ernst (2005) analyzed note rates. Our analysis focuses on note rates, since we do not have APR information and APR was not generally collected and retained by lenders until the HMDA amendments that took effect in 2004 began requiring the reporting of loans above certain thresholds (see LaCour-Little 2007a on the topic of these amendments).

The distinction between APR and note rate warrants some discussion. APR is a regulatory proxy required by the Truth in Lending Act of 1968 for the economic concept of the effective cost of debt and incorporating the effect of points and fees charged up-front by the lender. Points and fees are a

[18]This data set represents loans originated by a group of predominantly subprime lenders whose data are compiled at the direction of the American Financial Services Association.

contentious issue in subprime lending as well, particularly in the refinancing segment of the market, where borrowers can capitalize such costs into their refinanced loan balance. (This practice is sometimes characterized as equity-stripping.) But more important for our discussion here, APR is a rather poor proxy for the effective cost of debt, especially for adjustable-rate mortgages (ARMs), since it requires the assumption that interest rates will remain unchanged throughout the term of the loan contract. Moreover, for both fixed- and adjustable-rate instruments, the effective cost of debt is affected by the holding period of the loan, so loans that are prepaid more quickly (and contain points or fees) have higher actual effective costs than are disclosed by the APR, which assumes that loans are held until their contractual maturity. In summary, while some might argue that APR is a better measure than note rate alone, it also has many significant disadvantages as a measure of the cost of credit.

The most recent article to rigorously examine prepayment penalties is by Elliehausen, Staten, and Steinbuks (2008). It recognizes that mortgage pricing and prepayment penalties may be jointly determined, producing bias in single-equation estimates of the effect of a prepayment penalty on loan pricing.[19] These authors use a model that accounts for the endogeneity of price, LTV, and prepayment penalty, finding that penalties are associated with lower loan prices (as measured by APR), reducing "risk premiums by 38 basis points for fixed-rate loans, 13 basis points for variable-rate loans, and 19 basis points for hybrid loans"(2008, 25). We incorporate this important new methodology into our analysis.

As we have seen, call protection features differ greatly across sectors of the debt market. But no research has carefully addressed the economic value of call protection to lenders in the residential market; moreover, research on the extent to which presumed increases in asset values are passed on to borrowers in reduced note rates is limited. Although the literature has established that borrowers do not, in general, ruthlessly exercise prepayment options, the expected cost of prepayment penalty provisions to borrowers has not been rigorously analyzed. We hope the analyses presented here will move the policy debate in a more reasoned direction, considering both the costs and the benefits of prepayment penalties to all parties in the market for residential mortgage loans.

[19]Lender price sheets that specify interest rates for a given level of credit and loan type typically contain two sets of interest rates: one for loans that have prepayment penalties and the other for loans that do not.

Mortgage pricing in theory and practice

In this section, we review very briefly the theory of mortgage pricing, then turn to the way mortgages are actually priced. (See Kau and Keenan 1995 for an overview and Kau and Kim 1994 for an application focused on default risk.)

The theory is grounded in the idea that mortgages can be viewed as noncallable instruments with embedded put and call options. The put option corresponds to loan default and allows the borrower to "sell" the collateral property to the lender to extinguish the debt;[20] the call option allows the borrower to prepay the loan at any time before maturity (call the debt at par). Prepayment penalties, when included, alter the borrower's calculation of the optimal call strategy and increase the yield to the lender when paid.

Treating mortgages as contingent claims allows mortgage value (*V*) to depend on two underlying stochastic processes, the market interest rate, $r(t)$, and the house value, $H(t)$. The usual setup is to assume that the current (or spot) interest rate process follows the well-known CIR process:[21]

$$\mathrm{d}(r) = \gamma(\Theta - r)\mathrm{d}t + \sigma_r \sqrt{r}\, \mathrm{d}z_r \tag{1}$$

where Θ is the steady-state mean rate, γ is the speed of adjustment factor, and σ_r is the volatility of interest rates. In addition, the value of the mortgage depends on the value of the house, $H(t)$, the evolution of which can be described as follows:

$$\frac{\mathrm{d}H}{H} = (\alpha - s)\mathrm{d}t + \sigma_H \mathrm{d}z_H \tag{2}$$

where α is the instantaneous total return to housing, s is the service flow, and α_H is the volatility of housing returns. In equations (1) and (2), $\mathrm{d}z_r$ and $\mathrm{d}z_H$ are standard Wiener processes.[22] The intuition here is that the value of a mortgage loan is subject to two forms of uncertainty: the level of interest

[20] Whether the debt is actually extinguished depends on recourse provisions and state law. Practically speaking, however, since a large fraction of those defaulting are bankrupt, the prospect of a collectible deficiency judgment is quite slim.

[21] The CIR process, named after Cox, Ingersoll, and Ross (1985), is one of several classes of term structure models that use differential equations to represent the evolution of interest rates over time, thus allowing the derivation of formulas to value assets subject to interest rate uncertainty.

[22] In mathematics, the Wiener process is a continuous-time stochastic process named in honor of Norbert Wiener. It is often called Brownian motion and represents purely random movement.

rates and the level of house prices. By specifying a particular model of how interest rates and house prices change over time (both are subject to some degree of random variation), mortgage loans can be valued by simulation.

Research has shown that the value of the mortgage (*V*) satisfies the following partial differential equation:

$$\tfrac{1}{2}H^2\sigma_H^2\frac{\partial^2 V}{\partial H^2} + \rho H\sqrt{r}\,\bar{\sigma}_H\sigma_r\frac{\partial^2 V}{\partial H\partial r} + \tfrac{1}{2}r\sigma_r^2\frac{\partial^2 V}{\partial H^2}$$

$$+\,\gamma(\Theta - r)\frac{\partial V}{\partial r} + (r - s)\,H\frac{\partial V}{\partial H} + \frac{\partial V}{\partial t} - rV = 0 \qquad (3)$$

In equation (3), the correlation between the two state variables (dz_H and dz_r) is ρ.

A large literature describes the theoretical value of mortgage contracts using this approach (see, for example, Chinloy 1991; Dunn and McConnell 1981; Hilliard, Kau, and Slawson 1998; Kau et al. 1992; or Kau and Kim 1994). One problem with the theoretical approach, however, is that it does not fit the actual prices observed in the mortgage market particularly well because of an apparent irrationality on the part of mortgage borrowers who fail to default to the extent predicted when house prices fall and fail to prepay to the extent predicted when interest rates fall. Some part of this behavior may be due to rational delay, while other parts may be due to exogenous factors that prompt prepayments for other than financial reasons (e.g., borrower mobility).

In any event, actual pricing practice deviates from the theoretical paradigm across several dimensions. First, since prepayment risk is typically an order of magnitude greater than default risk, at least in the prime, and insured, residential mortgage market segments, the role of default risk is minimal. Moreover, because of path dependency and the computational burden of simulating two state variables simultaneously, mortgages are generally priced using a single state variable—interest rates—and default is treated as a nonstochastic time-invariant vector of expected rates. This is the approach used in most commercially available residential mortgage valuation tools, such as the program we use and describe next.

Simulation procedure

Here we explain the assumptions and inputs to the particular valuation simulations we undertake. We use the Mortgage Industry Advisory Company's WinOAS software to price hypothetical mortgage pools,[23] with and without specific prepayment penalties, on varying valuation dates. Compared with many other Wall Street valuation tools, WinOAS software has the advantage of an "open-box" versus a "black box" design, allowing the user a great deal of control over the term structure model simulation process, prepayment and default models, and other important features, with auditable cash flows available for every simulation. WinOAS takes as user inputs the valuation date (and entire term structure as of that date), the desired option-adjusted spread (OAS),[24] details on the collateral (whole loans, pass-through securities, or mortgage servicing rights), default and prepayment functions, prepayment penalty terms (if any), and parameters of the interest rate process (the mortgage/Treasury spread, which is assumed to be constant across simulations, volatility, and mean reversion).

We priced hypothetical pools of prime and subprime mortgages on three different valuation dates: June 30, 1997; June 30, 2000; and June 30, 2003. We selected these dates as good examples of particular term structure conditions. In June 1997, the yield curve was quite flat, implying that the difference between short- and long-term rates was very small. At that point, the 10-year Treasury rate stood at 6.50 percent, the 1-year Treasury rate was at 6.00 percent, and the one-month LIBOR (London Inter-Bank Offered Rate)[25] was at 5.6875 percent.

By contrast, in June 2000, the yield curve was inverted (short-term rates exceeded long-term rates, a pattern often thought to predict a recession), with the 10-year Treasury rate at 6.03 percent, the 1-year Treasury rate at 6.43 percent, and the three-month LIBOR at 6.77 percent.

In June 2003, the yield curve had shifted again and was very steep. Short-term rates were much lower than long-term rates, with the three-month LIBOR and the 1-year Treasury rate both at 1.11 percent and the 10-year

[23]A hypothetical mortgage pool is a set of identical loans of a particular type and coupon that can be priced as of a particular point in time, given certain assumptions and a simulation procedure.

[24]The OAS is the spread over the Treasury yield curve required to discount the uncertain cash flows from a mortgage or mortgage-backed security to match its market price. In a sense, it measures the increase in yield obtained from investing in mortgages that are subject to prepayment risk over the risk-free rate provided by treasuries; hence, choosing OAS is akin to choosing the discount rate for purposes of valuation.

[25]LIBOR is a popular international benchmark interest rate for pricing risky assets. It represents a wholesale rate that banks charge each other for unsecured borrowings. LIBOR is generally slightly higher than Treasury rates of comparable maturity.

Treasury rate at 3.52 percent. Prime mortgage rates (for 30-year fixed-rate mortgages) were approximately 8.0 percent in June 1997, 8.5 percent in June 2000, and 5.25 percent in June 2003. We assumed that the subprime/prime mortgage spread was 250 basis points at each date, so subprime rates were 10.5 percent, 11 percent, and 7.75 percent at each corresponding date.[26] There is some evidence that this spread has declined over time, but again, for consistency and simplicity, we assume a constant relationship.

All pricing simulations use a constant 100 OAS as the target level of relative return; that is, we are finding the loan prices implied by discounting simulated cash flows at risk-free rates plus 100 basis points. This may be a little high for conventional prime mortgages, where 70 to 85 OAS would be the norm (Arora, Heike, and Mattu 2000). Moreover, while it could be argued that subprime mortgages should command a higher OAS, given their greater default risk and servicing cost, our objective here is not to reproduce actual market prices, but rather to determine the relative effect of prepayment penalties, holding other factors constant, so a constant OAS seems appropriate. In other words, we will use consistent assumptions to value hypothetical mortgage pools with and without prepayment penalties to determine the impact of those penalties on asset values.

We use the default and prepayment functions built into WinOAS. These are standard functions that are used by the mortgage industry and that can be readily calibrated to market consensus values. For example, dealers in mortgage and mortgage-backed securities continuously update and publish their assumptions about likely prepayment speeds for various mortgage types, since these assumptions are a necessary input for pricing calculations. For default, we use the Bond Market Association's Standard Default Assumption (SDA) vector. Like the well-known Public Securities Administration vector, which provides a benchmark speed for prepayment rates, 100 percent SDA corresponds to a low initial default rate that increases rapidly to a maximum of 0.60 percent in month 30, stabilizes, and then declines to a level of 0.05 percent after month 60. The effective cumulative default rate is approximately 4 percent of the original loan balance at 100 percent SDA.

For prime mortgage prepayments, we use the 30-Year Fixed-Rate Conforming New (CONV30N) prepayment model (one of several built into WinOAS). This is a simple two-factor prepayment function that takes loan age and spread to current mortgage rates as inputs and predicts a prepayment

[26]LaCour-Little (2007b) reports a mean rate on subprime home purchase loans of 9.30 percent in 2002, compared with a conventional conforming rate of 6.59 percent (an overall difference of 271 basis points).

rate. For a mortgage that is 25 basis points "out-of-the-money" (e.g., a 6.0 percent mortgage when the current market rate is 6.25 percent), the implied conditional prepayment rate (CPR) is about 9 percent.[27] At 70 basis points "in-the-money" (e.g., a 6.95 percent mortgage when the current market rate is 6.25 percent), the CPR would be about 15 percent, increasing to 22 percent at 200 basis points, and 55 percent for mortgages more than 300 basis points in-the-money. For those familiar with the prepayment rates of mortgage pools, these values are intended simply to provide some comfort that the models we used are plausible.

There is considerable evidence that subprime loans are relatively less sensitive to rate movements, both because of penalties that raise the cost of prepayment and because credit improvement is the more important factor for subprime borrowers and that factor is not correlated with rate movements. (See, for example, Pennington-Cross 2003 or Ho and Pennington-Cross 2006b.) Accordingly, we use the MIAC 30-Year Fixed-Rate Conforming Seasoned (CONV30S) prepayment model for subprime loans. This model is much less sensitive to rate movements and hence more representative of actual subprime prepayment patterns, with maximum prepayment speeds on the order of 20 to 30 percent CPR, considerably lower than is the case for prime loans. Obviously, more sophisticated prepayment functions are possible and often used; our purpose here is not to best predict prepayments, but rather to use plausible and consistent assumptions to compare pricing effects with and without prepayment penalties.

Figures 1, 2, and 3 illustrate the relative responsiveness of prepayment speeds of the two models to interest rate movements, with a single realization of the interest rate simulation process starting at June 1997. Figure 1 depicts the interest rate scenario with rates dropping sharply over the first five years, followed by a period of generally increasing rates. This is not unlike the course of history to date. The model predicts prepayment spikes in excess of 50 percent CPR for prime loans (figure 2), while the subprime rates are relatively constant at slightly above 20 percent CPR (figure 3). This is, of course, only a single realization of interest rate movements. As one measure of the overall difference in prepayment rates, on a static basis the average life-equivalent speed for prime loans is about 18 percent CPR, while subprime loans prepay at 27 percent CPR—about 50 percent faster. This means that if interest rates were to remain constant over time, subprime loans would be assumed to prepay about 50 percent faster than prime loans.

[27]The CPR is a measure of the annual prepayment rate for a pool of loans or a mortgage-backed security and is expressed in percentage terms.

Figure1. Simulated Prime Mortgage Rate Starting June 30, 1997: 12 Percent Volatility (Single Realization)

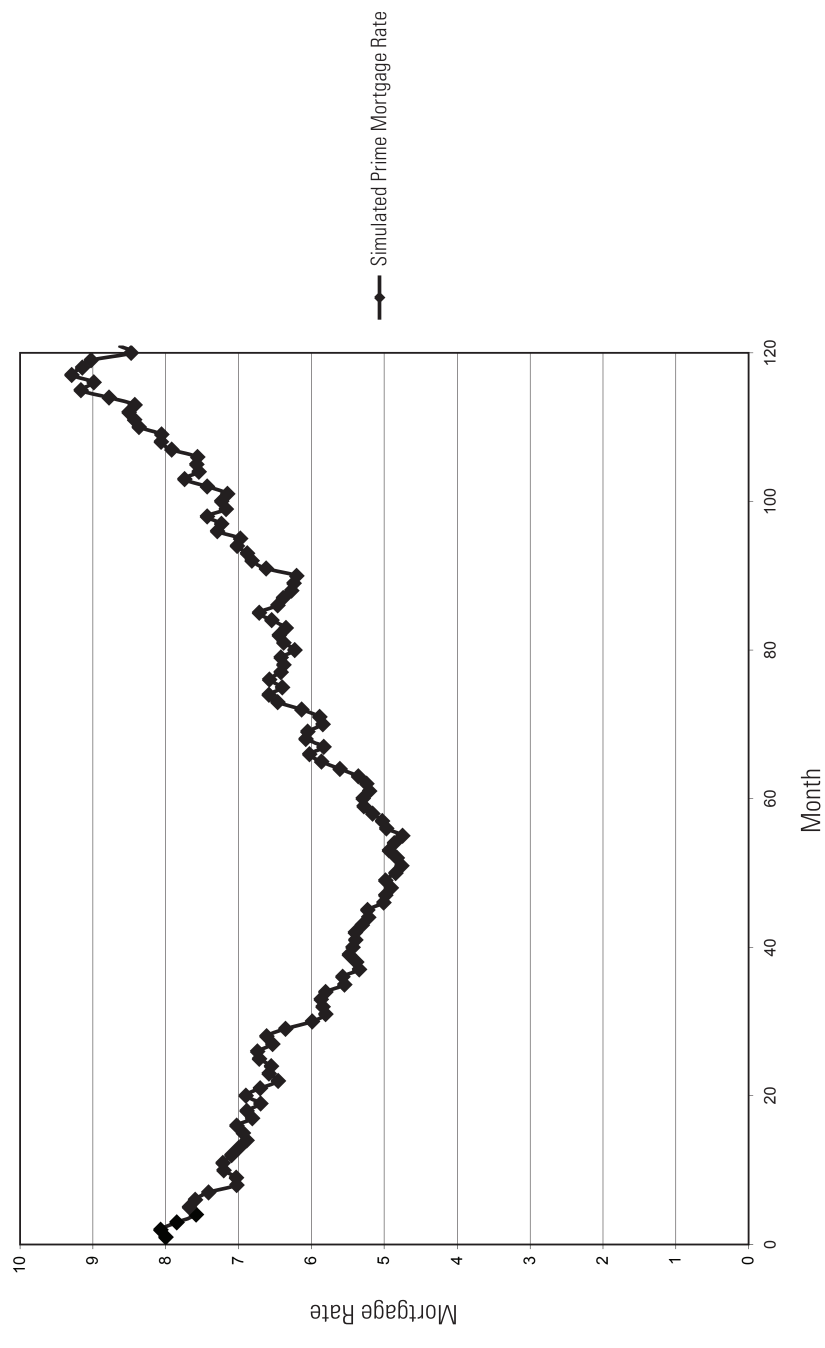


Figure 2. Prepayment Speed of Prime Mortgages Given the Single Rate Path Depicted in Figure 1

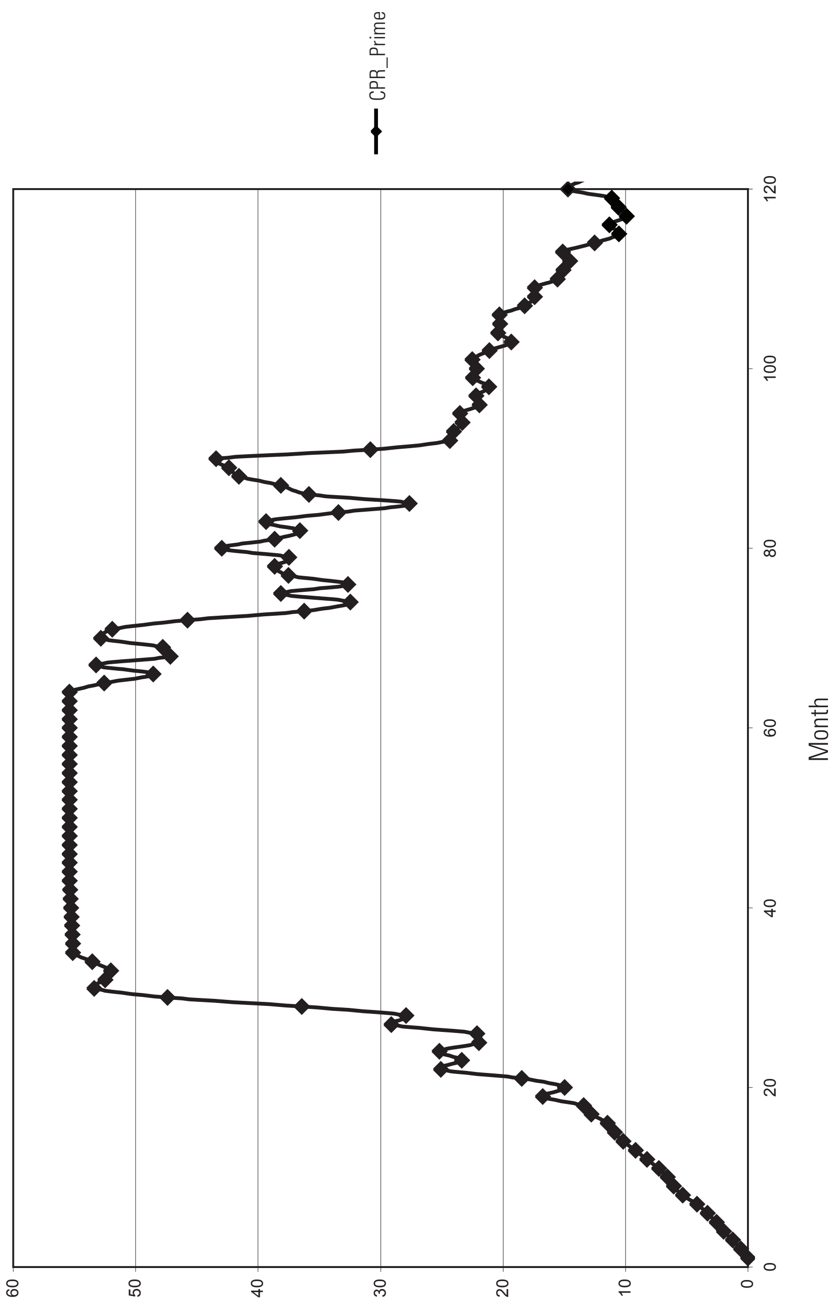
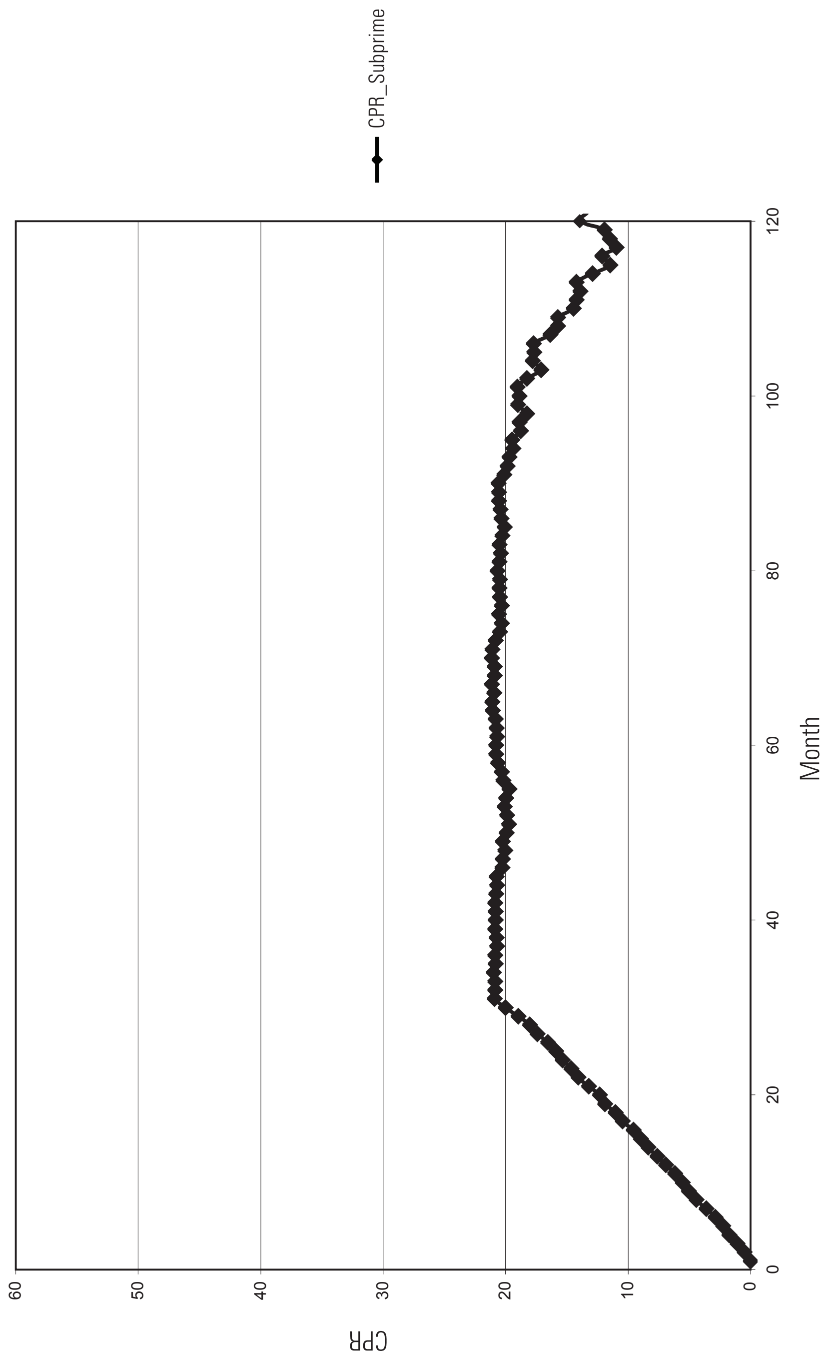


Figure 3. Prepayment Speed of Subprime Mortgages Given the Single Rate Path Depicted in Figure 1



We assume that prime mortgages default at 100 percent SDA and prepay at 100 percent CONV30N. This is, of course, too low for subprime loans, which bear considerably more credit risk. LoanPerformance.com, an industry-wide source, reported in 2007 that as of March of that year, 0.69 percent of prime mortgages were seriously delinquent, compared with 8.28 percent of subprime mortgages. Due to declines in house prices that began in early 2006, this differential is much higher than it has been historically over the recent past, so we set the default assumption on subprime mortgages at 300 percent (three times the rate for prime mortgages).

To benchmark our assumptions about prepayment differentials, we again rely on LoanPerformance.com (2007) data. As of the first quarter of 2007, aggregate subprime prepayments are reported at 28 percent CPR, compared with 15 percent CPR for prime mortgages. Since this pattern has been relatively more stable over time, we set the prepayment speed multiplier for subprime loans at 200 percent (they prepay at twice the rate of prime loans). In the simulations we present, prepayment penalties are assumed to be collected on only 80 percent of the outstanding loan balance and only on prepayments caused by home sale or refinancing, not default and foreclosure.[28]

Simulation results

This section describes and discusses the results of the simulations. Table 1 recaps the input assumptions discussed in the preceding section. Table 2 summarizes the simulation results. To briefly preview the overall results, the incremental value of prepayment penalties is significantly higher for the hypothetical subprime mortgage pool than it is for the prime mortgage pool across all three yield curve scenarios.

Beginning with the June 1997 valuations, we see that prime 8.0 percent coupon mortgages are worth 99.21 to 99.79 (depending on the assumption about future interest rate volatility) and that those values increase by 69 to 77 basis points with three-year prepayment penalties. By contrast, 10.5 percent subprime mortgages are worth 107.64 to 107.70 (again depending on the assumed volatility), and those values increase by at least 233 basis points with three-year prepayment penalties.

[28]State laws often afford borrowers the statutory right to prepay up to 20 percent of the loan balance each year without penalty; hence, prepayment penalties when incurred can be charged on only 80 percent of the balance then outstanding. Six months' interest on 80 percent of the loan balance has become the norm for prepayment penalty structure in the subprime market segment, and this is the calculation used in WinOAS.

Table 1. Assumptions for Simulation

	Pricing Dates	Yield Curve	Prime	Subprime
	June 30, 1997	Flat	8%	10.50%
	June 30, 2000	Inverted	8.50%	11%
	June 30, 2003	Steep	5.25%	7.75%
Prepayment function				
Prime	30-year conventional new		100%	
Subprime	30-year conventional seasoned			200%
Default function	SDA		100%	300%
Loss, given default	25%			
Subprime/prime spread	250 basis points			
Mortgage/Treasury spread	Actual, empirical at each pricing date, then constant			
OAS	100			
Mortgage contract	30-year fixed rate mortgage			
Prepayment penalty				
Amount	Six months' interest			
Term	3 years			
Term structure model				
Diffusion process	Lognormal			
Mean reversion	10%			
Volatility	12% and 16%			

For the June 2000 valuations, a similar pattern emerges: 8.5 percent prime mortgages are worth 99.24 to 99.94, and those values are 79 to 87 basis points higher in the case of prepayment penalties. However, 11 percent coupon subprime mortgages are valued at 107.20 to 107.24, and those values increase by 241 to 249 basis points with three-year prepayment penalties. As was the case with the June 1997 results, the decline in value associated with an increase in interest rate volatility is much lower for subprime loans than for prime loans because they are less sensitive to interest rates, underscoring the notion that it is credit improvement (rather than changes in interest rates) that drives subprime prepayments. Moreover, since prepayment rates for subprime loans are high even without declines in interest rates, the value of the prepayment penalty is greater. Intuitively, investors in prime loans need protection from prepayment less frequently (only when interest rates drop sharply); investors in subprime loans, however, need continual protection, even when interest rates are stable or rising. Accordingly, the implied value of the prepayment penalties is much greater for subprime loans.

Table 2. Simulation Results

	8% Prime		10.5% Subprime	
June 1997	12% Volatility	16% Volatility	12% Volatility	16% Volatility
No penalty	99.79	99.21	107.70	107.64
Three-year penalty	100.48	99.28	110.08	109.97
Implied value	0.69	0.77	2.38	2.33
	8.5% Prime		11% Subprime	
June 2000	12% Volatility	16% Volatility	12% Volatility	16% Volatility
No penalty	99.94	99.24	107.24	107.20
Three-year penalty	100.73	100.11	109.73	109.61
Implied value	0.79	0.87	2.49	2.41
	5.25% Prime		7.75% Subprime	
June 2003	12% Volatility	16% Volatility	12% Volatility	16% Volatility
No penalty	102.51	102.49	112.74	112.68
Three-year penalty	102.88	102.89	114.57	114.50
Implied value	0.37	0.40	1.83	1.82

Notes: This table shows simulated values of prime and subprime mortgages on three different pricing dates by level of interest rate volatility, with and without a three-year prepayment penalty. The difference in the two values is the implied value of the prepayment penalty. More information on input assumptions is shown in table 1. All calculations were performed using WinOAS.

As of June 2003, overall rates were much lower and the yield curve was considerably steeper, yet the same qualitative pattern is apparent: On the one hand, 5.25 percent prime mortgages are worth 102.49 to 102.51, and those values increase by 37 to 40 basis points with prepayment penalties. On the other hand, 7.75 percent subprime mortgages are worth 112.68 to 112.74, with increments to value of 182 to 183 basis points with prepayment penalties. Across all simulations, the value of the mortgages, whether prime or subprime, is lower with more interest rate volatility but higher with prepayment penalties.

The overall pattern that emerges here is that the incremental value of prepayment penalties is roughly 3 to 5 times greater for subprime mortgages than it is for prime mortgages. This simple economic fact helps explain the prevalence of this contract feature in the subprime market sector. Averaging over our small set of simulated prepayment penalty values, we can calculate an overall average of 0.65 percent (of the loan amount) for prime loans and 2.21 percent for subprime loans.

In equilibrium, this increase in value for loans with prepayment penalties should translate into a reduction in required yields and, hence, borrower costs. As mentioned earlier in the literature review section, DeMong and Burroughs (2005) found that loans with prepayment penalties carry lower APRs than loans without penalties, and Elliehausen, Staten, and Steinbuks (2008) obtained similar results while controlling for the potential endogeneity of loan terms and pricing.

What is the reduction in coupon rate implied by our simulation results? A simple way to answer this question is to compute the decrease in static yield[29] necessary to produce the value premium over par that call protection provides. Focusing on the subprime results from table 2, we tabulate those values over a range of reasonable coupon values for two assumptions about loan life—36 months versus the full 360 months—in table 3. Values range from 22 to 87 basis points, so if other factors are held constant, loans without prepayment penalties should carry note rates 22 to 87 basis points higher to produce the same average asset value.

When table 3 is examined more closely, two main patterns are evident. First, the higher the coupon, the greater the required reduction in static yield to equalize values. Second, the shorter the life of the loan, the greater the required reduction in static yield to equalize values. Since subprime loans carry higher coupons and faster prepayment speeds, the reduction in coupon will be greater—that is, the benefit to the borrower will be larger—than would be the case for prime loans. This result again helps explain why prepayment penalties are relatively more common in subprime rather than prime loans. The relative reduction in note rates that subprime borrowers should (theoretically at least) obtain is greater than it would be for prime loans for two reasons: (1) Subprime loans carry higher interest rates than prime loans, and (2) subprime loans prepay relatively more quickly.

We must note that this analysis is based on 30-year fixed-rate mortgages. While this is the most common form of mortgage in general, many and perhaps most subprime loans are structured as hybrid adjustable-rate instruments and this form of contract is increasingly popular in the prime segment as well (see Ambrose, LaCour-Little, and Huszar 2005 on prime hybrids and Ho and Pennington-Cross 2006b on subprime ones). Such contracts are significantly more difficult to model and price, so for our purposes, we must be content with the results described for fixed-rate mortgages.

[29]Static yield, in contrast to OAS, measures the yield independent of possible changes in interest rates and associated changes in prepayment rates. That is, it is a calculation based on the assumption that the term structure of interest rates over time remains constant at today's level.

Table 3. Decrease in Yield to Obtain a Price of 102.21

Assuming the Full 360-Month Life	
Coupon	Basis Points
0.07	0.0022
0.08	0.0023
0.09	0.0024
0.1	0.0026
0.11	0.0027
0.12	0.0029

Assuming a 36-Month Loan Life	
Coupon	Basis Points
0.07	0.0082
0.08	0.0083
0.09	0.0084
0.1	0.0085
0.11	0.0086
0.12	0.0087

Notes: This table shows the decrease in static yield required to produce the average increase in value for subprime mortgages resulting from a prepayment penalty (the average of the six values shown in table 2), by coupon and the expected life of the loan. For example, a 7.00 percent mortgage fully amortized over 360 months will have a value of 102.21 if its cash flows are discounted at 0.07 - 0.0022 = 6.78 percent. If, however, we assume that the loan will pay off in full after 36 months, then the required discount rate to produce a 102.21 price is 0.07 – 0.0082 = 6.18 percent.

Empirical analyses

We now turn to an empirical analysis in which we have two objectives:

1. To assess whether the reductions in contract rate implied by the pricing simulations we have described can be shown to occur in actual loan contacts
2. To determine the expected cost to borrowers of the prepayment penalty provision

For the first objective, we begin by reviewing existing empirical work to set the stage for our own analysis.

After controlling for borrower income, credit score, LTV, level of loan documentation, and loan type (fixed versus variable rate), DeMong and Burroughs (2005) estimated an overall reduction in APR of 38 basis points across all product types for 30-year first-lien subprime loans carrying prepayment penalties. Elliehausen, Staten, and Steinbuks (2008) provide a more complete and rigorous analysis of the effect of prepayment penalties on loan pricing, taking into account the endogeneity of LTV, prepayment penalty, and loan pricing. They use the Financial Service Research Program's subprime mortgage database, a multilender, multiyear loan-level database that was estimated by the Federal Reserve to cover about one-quarter of all higher-priced loans as of 2004. Elliehausen, Staten, and Steinbuks (2008) find reductions in interest rate spreads of 38 basis points for fixed-rate mortgages, 13 basis points for variable-rate mortgages, and 19 basis points for hybrid mortgages. The estimate of 38 basis points for fixed-rate mortgages is consistent with the range of 22 to 87 basis points estimated by the simulation procedure we described in the previous section.

Accordingly, to corroborate the effect of prepayment penalties on actual contract note rates, we analyze empirical data on subprime loans from an individual lender that prefers to remain anonymous. Table 4 presents descriptive statistics for the data set. A total of 7,513 subprime loans, all of which were originated during 2002, are included. Overall, about 89 percent contained some prepayment penalty. The average note rate is 8.90 percent, and the average loan size is $133,600. Most (78 percent) of the loans are 2-year ARMs, although there are also 3-year ARMs and 30-year fixed-rate contracts. The average LTV is 83 percent, and the average FICO (Fair, Isaac & Company) credit score is 625, consistent with the subprime characteristics of the data set. We note that 26.5 percent of loans were originated by mortgage brokers.

Table 5 displays the models estimated to determine the magnitude of the reduction in the contract rate in the presence of a prepayment penalty. Following Elliehausen, Staten, and Steinbuks (2008), we use an instrumental variables technique to control for endogeneity. Panel A shows the result of the regression to produce the predicted values of the LTVs. We use standard ordinary least squares with LTV as the dependent variable. The independent variables include indicators for the mortgage type, the level of documentation, and the origination channel. The loan amount, FICO score, and borrower income are also included. The unique and exogenous variables in this estimation are those that measure the average house prices in the neighborhood and the prime lending rate. The results of the regression are used to predict LTVs. These will serve as the instrument for the LTV in the contract rate regression. This technique corrects for endogeneity.

A similar procedure is followed for the presence of the prepayment penalty as shown in panel B. A probit estimation is performed with the dependent variable set to 1 if there is a prepayment penalty and 0 otherwise. As in the LTV regression, independent variables include mortgage type, loan amount, documentation level, FICO score, borrower income, and origination channel. The unique and exogenous variables in this regression are indicators

Table 4. Descriptive Statistics for the Subprime Loan Database

	Mean	Standard Deviation	Minimum	Maximum
Proportion of loans with a prepayment penalty	0.890	0.313	0.000	1.000
LTV	83.213	9.631	20.000	100.000
Mortgage contract rate	8.900	1.492	5.375	14.500
Proportion of loans that are 2/28 ARMs	0.775	0.418	0.000	1.000
Proportion of loans that are 3/27 ARMs	0.107	0.309	0.000	1.000
Loan amount (in thousands of dollars)	133.6	66.3	11.9	372.0
Proportion of loans with no documentation	0.237	0.425	0.000	1.000
FICO score	625.3	62.0	485.0	819.0
Borrower's income (in thousands of dollars)	57.7	36.8	12.2	826.0
Proportion of loans that are originated by brokers	0.265	0.441	0.000	1.000
Percentage in the area moving in 1999	10.058	3.386	0.000	19.831
Percentage in the area moving from 1995 to 1998	25.527	7.368	0.000	49.180
Percentage in the area moving from 1990 to 1994	17.738	4.230	0.000	43.662
House value (in thousands of dollars)	170.7	132.0	15.5	3,750.0
Proportion of loans subject to a state restriction on prepayment	0.623	0.485	0.000	1.000
Proportion of loans with a borrower aged 35 to 44	0.319	0.466	0.000	1.000
Proportion of loans with a borrower aged 45 to 54	0.177	0.382	0.000	1.000
Proportion of loans with a borrower aged 55 to 64	0.068	0.251	0.000	1.000
Proportion of loans with a borrower aged 65 or older	0.018	0.134	0.000	1.000
Units in the area between $100,000 and $199,999 (%)	0.359	0.153	0.000	0.843
Units in the area between $200,000 and $299,999 (%)	0.105	0.080	0.000	0.520
Units in the area between $300,000 and $499,999 (%)	0.059	0.063	0.000	0.333
Units in the area valued at over $500,000 (%)	0.030	0.044	0.000	0.664
Prime lending rate	4.710	0.156	4.250	5.530

Note: N = 7,513.

Table 5. Contract Rate Estimations to Evaluate the Impact of a Prepayment Penalty

	Panel A			Panel B			Panel C			Panel D		
	LTV Regression			Prepayment Penalty (Probit)			Contract Rate (with Correction for Endogeneity)			Contract Rate (no Correction for Endogeneity)		
	Coefficient	Std. Error	*P*-value	Coefficient	Std. Error	*P*-value	Coefficient	Std. Error	*P*-value	Coefficient	Std. Error	*P*-value
Januray							0.948	0.061	0.00	0.942	0.056	0.00
February							0.898	0.061	0.00	0.907	0.056	0.00
March							0.836	0.055	0.00	0.851	0.051	0.00
April							0.920	0.054	0.00	0.926	0.050	0.00
May							0.891	0.052	0.00	0.905	0.048	0.00
June							0.849	0.052	0.00	0.879	0.048	0.00
July							0.433	0.050	0.00	0.443	0.046	0.00
August							0.203	0.048	0.00	0.197	0.045	0.00
September							0.165	0.049	0.00	0.131	0.045	0.00
October							0.103	0.048	0.03	0.094	0.044	0.03
November							0.130	0.049	0.01	0.091	0.046	0.05
2/28 ARM	2.872	0.328	0.00	0.023	0.060	0.70	–0.259	0.045	0.00	–0.212	0.032	0.00
3/27 ARM	1.640	0.436	0.00	0.441	0.092	0.00	–0.347	0.050	0.00	–0.329	0.043	0.00
Loan amount	0.019	0.002	0.00	–0.001	0.000	0.01	–0.006	0.000	0.00	–0.005	0.000	0.00
No documentation	–8.094	0.267	0.00	–0.149	0.049	0.00	0.208	0.085	0.02	0.105	0.028	0.00
FICO score	0.016	0.002	0.00	–0.000	0.000	0.61	–0.015	0.000	0.00	–0.015	0.000	0.00
Borrower's income	–0.017	0.003	0.00	–0.000	0.001	0.91	0.000	0.000	0.37	0.000	0.000	0.79
Originated by a broker	1.441	0.236	0.00	0.012	0.045	0.78	–0.357	0.029	0.00	–0.330	0.023	0.00
Percentage in the area moving in 1999				0.0002	0.0061	0.98						
Percentage in the area moving from 1995 to 1998				0.013	0.003	0.00						
Percentage in the area moving from 1990 to 1994				0.007	0.005	0.15						
Value of the house				0.000	0.000	0.91						
State restrictions on prepayment				–0.004	0.040	0.91						
Borrower aged 35 to 44				0.028	0.047	0.55						
Borrower aged 45 to 54				–0.045	0.055	0.42						
Borrower aged 55 to 64				–0.204	0.076	0.01						
Borrower aged 65 or older				–0.059	0.144	0.68						

Table 5. Contract Rate Estimations to Evaluate the Impact of a Prepayment Penalty *continued*

	Panel A			Panel B			Panel C			Panel D		
	LTV Regression			Prepayment Penalty (Probit)			Contract Rate (with Correction for Endogeneity)			Contract Rate (no Correction for Endogeneity)		
	Coefficient	Std. Error	*P*-value	Coefficient	Std. Error	*P*-value	Coefficient	Std. Error	*P*-value	Coefficient	Std. Error	*P*-value
Units in the area between $100,000 and $199,999 (%)	–1.826	0.763	0.02									
Units in the area between $200,000 and $299,999 (%)	4.953	2.740	0.07									
Units in the area between $300,000 and $499,999 (%)	–23.940	4.968	0.00									
Units in the area valued at $500,000 or more (%)	1.693	4.685	0.72									
Prime lending rate	–0.479	0.662	0.47									
Predicted prepayment penalty							–0.153	0.041	0.00			
Predicted LTV							0.060	0.010	0.00			
Prepayment penalty										–0.140	0.033	0.00
LTV										0.042	0.001	0.00
Constant	74.537	3.422	0.00	1.035	0.266	0.00	14.213	0.726	0.00	15.493	0.152	0.00

Notes: N = 7,513 for all estimations. Panel A is a regression with the LTV as the dependent variable. Results from the estimation are used to create the "Predicted LTV." The adjusted R^2 is 15.28 percent. Panel B is a probit estimation with the dependent variable set to 1 if there is a prepayment penalty and 0 otherwise. Results from this estimation are used to create the "Predicted prepayment penalty" variable. Chi^2 is 87.42, and *P*-value is 0. Panel C is a regression with the contract rate as the dependent variable. The "Predicted LTV" and the "Predicted prepayment penalty" from panels A and B are used as independent variables. The adjusted R^2 is 59.78 percent. Panel D is a regression with the contract rate as the dependent variable. The observed LTV and prepayment penalty are used as independent variables. The adjusted R^2 is 65.75 percent.

for the proportion of the neighborhood population that moved recently, the value of the house, whether the loan was subject to a state law restricting prepayment, and the age of the borrower. The results of this estimation are used to produce the predicted probability of a prepayment penalty. These probabilities are then transformed to a value of 0 or 1. The 89 percent of the observations with the highest probabilities are assigned a value of 1. That percentage was chosen because it reflects the true proportion of loans with a prepayment penalty.

The predicted LTV from panel A and the predicted prepayment penalty from panel B are used as independent variables in the regression in panel C. This method corrects for endogeneity, and we follow the methods and exogenous variables from Elliehausen, Staten, and Steinbuks (2008). Panel C shows the result of the key contract rate estimation. We use ordinary least squares regression, and the dependent variable is the contract rate. We control for the month of origination, the loan amount, the FICO score, the income of the borrower, and the origination channel. We include indicator variables for 2/28 ARMs and 3/27 ARMs, so the fixed-rate mortgage is the excluded outcome. We note that the coefficient for both ARM indicator variables is negative and significant, reflecting the lower contract rates for ARMs relative to fixed-rate loans. The variable of interest in the contract rate regression in panel C is the predicted prepayment penalty. We find a highly significant negative coefficient of –0.153. Therefore, we find a reduction of 15.3 basis points in the contract rate associated with the presence of a prepayment penalty.

Panel D reports the same estimation but uses the observed instead of the predicted values of the LTV and the prepayment penalty. The result is similar at a reduction of 14.0 basis points.

In table 6 we present an analysis of how the reduction in contract rate differs across subsets of the data. We find an overall reduction of 15.3 basis points for all loans, but 8.5 basis points for retail loans and 23.8 basis points for broker-originated loans. There is also variation across loan types, with observed reductions of 9.7 basis points for 3/27 ARMs, 17.8 for 2/28 ARMs, and 19.0 for fixed-rate mortgages. However, the coefficient for 3/27 ARMs was not statistically significant, perhaps because this is the smallest category of loan type.

An objection could be raised at this point that it is inappropriate to combine fixed- and adjustable-rate mortgages as we have done for some of the regressions. ARMs bear interest rate risk that fixed-rate instruments do not, and their initial teaser rates do not represent the true cost of credit. We have already noted the difficulty in measuring the effective cost of debt and the

Table 6. Breakdown by Channel and Product

	Method: With Correction for Endogeneity		Method: Without Correction for Endogeneity	
Sample	Coefficient	Significance Level	Coefficient	Significance Level
All loans	−0.153	0%	−0.140	0%
Broker-originated loans only	−0.238	0%	−0.113	7%
Retail loans only	−0.085	6%	−0.149	0%
2/28 ARMs	−0.178	0%	−0.101	0%
3/27 ARMs	−0.097	56%	−0.237	10%
Fixed-rate mortgages	−0.190	8%	−0.360	0%

Notes: This table reports the coefficient on the prepayment penalty variable in a contract rate estimation. The top row is taken directly from table 5, and the remaining rows are from estimations on subsamples of the loans.

deficiencies of using APR as a measure, especially for ARMs. Another possible cost measure is the margin, the amount added to the index to compute the fully indexed rate to which the loan will reset periodically (subject to whatever caps might be contained in the contract). Much of the original research on ARMs, mostly written well before the advent of subprime lending, focused on the margin (Brueckner 1986; Sa-Aadu and Sirmans 1989; Sprecher and Willman 1998). Unfortunately, we do not have enough data on the index and the margins for ARMs, so we cannot explore this dimension of the question further. We would note, however, that our analysis is primarily a comparison of the cost of credit, as measured by the note rate, over the initial period of the loan up to the expiration of the prepayment penalty. Since those penalty periods typically coincide with the length of the initial teaser rate, the effect of variation in margins, if any, should be minimal.

To recap, the values we have reported represent the benefit to the borrower of accepting a prepayment penalty. The cost is based on the likelihood of prepayment during the penalty period and, of course, the amount. To compute the likelihood of prepayment, we employ two distinct control data sets, originated at different times and hence exposing borrowers to distinct interest rate environments. What these data sets have in common, however, is that they represent subprime loans without prepayment penalties. The first data set (hereafter control group 1) was originated from 1995 to 1997 by CitiMortgage, a major lender active in both the prime and the subprime market segments. This is an extract from a proprietary database developed by the lead author. The second data set (hereafter control group 2) was originated in 2002, the same year as the data set we have used so far to assess the benefits in rate reduction accruing to borrowers with prepayment penalties. But control group 2 is drawn from the First American LoanPerformance Securities database and, hence, represents multiple loan originators (LoanPerformance, Inc. 2007). Borrowers in this sample had a great deal of incentive to profitably refinance through prepayment during the 2003–2005 period. In fact, 63 percent had prepaid within 24 months of origination, 85 percent within 36 months, and 100 percent within 60 months. Our strategy is to use these two control groups to estimate the probability that a borrower will exercise his or her prepayment option within two, three, or five years (the applicable periods during which prepayment penalties apply). We will then use predicted probabilities to calculate the expected cost of prepayment penalties imposed at those times. By using two control groups, we will get results across distinct phases of the interest rate cycle. Intuitively, loan contracts containing prepayment penalties may be a good or a bad deal for borrowers, depending on the subsequent movement of interest rates.

Descriptive statistics for these two databases appear in table 7, with estimation results in table 8. The dependent variable in the first estimation is the probability that prepayment will occur within two years. Consistent with the literature, we find that higher mortgage contract rates, loan amounts, and FICO scores are associated with a higher likelihood of prepayment. Lower LTVs and retail-originated loans also increase the probability of prepayment. These relationships hold when the time frame for prepayment is extended to three or five years and across both control data sets. We note that the absolute level of the coefficients differs across our two data sets. The control group 2 loans that originated in 2002 prepaid at a much faster rate, and, in fact, 100 percent of these loans had prepaid within five years. Of course, these borrowers experienced falling rates during 2003 and 2004, whereas borrowers in control group 1 experienced generally higher rates during 1999 and 2000.

Finally, in table 9 we present our cost-benefit calculations in dollar terms. Cost is calculated as the probability of prepayment times the dollar value of the penalty. For loans with a two-year penalty period (panel A), we use the coefficients from the regression with the corresponding duration in table 8 to calculate the probability of prepayment. The average probability is 30.7 percent if we use the control group 1 data set and 80.6 percent if we use control group 2 data. The penalty is estimated as 6 months' interest on 80 percent of the outstanding balance of the loan incurred 12 months before the expiration of the penalty period. The expected penalty equals this amount multiplied by the probability of prepayment. Across all the loans in the subprime database with a two-year penalty, the expected value of the penalty is $3,923 if we use the experience of the 2002 origination cohort (control group 2). This rather large cost should be compared with an interest savings of $418 over the time frame in question.

Table 7. Descriptive Statistics for the Prepayment Database

Panel A: Loans Originated from 1995 to 1997

	All Loans (N = 958)				Prepaid within Two Years (N = 146)				Prepaid within Three Years (N = 236)			
	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
Interest rate	8.034	0.569	4.875	10.250	8.107	0.580	6.500	9.625	8.138	0.593	6.500	9.625
Loan amount (log)	11.582	0.573	9.793	13.394	11.797	0.614	10.181	13.394	11.735	0.598	9.966	13.394
LTV	87.997	12.004	17.000	99.900	83.015	14.969	24.800	99.900	83.954	14.475	24.800	99.900
FICO score	589.27	27.49	454.00	620.00	595.05	20.29	538.00	620.00	591.81	24.89	454.00	620.00
Originated by a broker	0.311	0.463	0.000	1.000	0.507	0.502	0.000	1.000	0.445	0.498	0.000	1.000

Panel B: Loans Originated in 2002

	All Loans (N = 3,225)				Prepaid within Two Years (N = 2,029)				Prepaid within Three Years (N = 2,755)			
	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation.	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
Interest rate	9.430	1.408	5.000	15.875	9.342	1.369	5.000	15.125	9.364	1.373	5.000	15.125
Loan amount (log)	11.729	0.661	9.453	13.816	11.826	0.651	9.693	13.515	11.784	0.653	9.693	13.816
LTV	83.129	10.479	20.000	107.100	82.972	10.513	21.280	100.000	83.244	10.358	21.280	106.000
FICO score	571.97	35.05	400.00	620.00	574.51	33.70	421.00	620.00	573.35	33.83	421.00	620.00
Originated by a broker	0.162	0.368	0.000	1.000	0.177	0.382	0.000	1.000	0.166	0.372	0.000	1.000

Table 8. Logit Models for Prepayment within a Certain Time Frame

Panel A: Loans Originated in 1995, 1996, and 1997

	Prepaid within Two Years			Prepaid within Three Years			Prepaid within Five Years			
	Coefficient	Standard Error	*P*-value	Coefficient	Standard Error	*P*-value	Coefficient	Standard Error	*Z*-score	*P*-value
Contract rate	0.585	0.179	0.00	0.734	0.150	0.00	1.036	0.139	7.46	0.00
Loan amount (log)	0.730	0.170	0.00	0.653	0.145	0.00	0.547	0.131	4.17	0.00
LTV	–0.031	0.007	0.00	–0.033	0.006	0.00	–0.023	0.006	–3.89	0.00
FICO score	0.009	0.004	0.02	0.004	0.003	0.22	0.002	0.003	0.63	0.53
Originated by a broker	0.620	0.196	0.00	0.460	0.168	0.01	0.112	0.156	0.72	0.47
Constant	–18.145	3.739	0.00	–14.137	3.007	0.00	–14.250	2.678	–5.32	0.00

Panel B: Loans Originated in 2002

	Prepaid within Two Years			Prepaid within Three Years			Prepaid within Five Years*			
	Coefficient	Standard Error	*P*-value	Coefficient	Standard Error	*P*-value	Coefficient	Standard Error	*Z*-score	*P*-value
Contract rate	0.053	0.032	0.10	0.003	0.042	0.95				
Loan amount (log)	0.644	0.065	0.00	0.862	0.091	0.00				
LTV	–0.009	0.004	0.01	–0.002	0.005	0.68				
FICO score	0.005	0.001	0.00	0.005	0.002	0.00				
Originated by a broker	0.332	0.105	0.00	0.264	0.148	0.07				
Constant	–9.641	1.237	0.00	–10.944	1.678	0.00				

*All of the loans in this sample were prepaid within five years.

Notes: Estimations are logit models where the dependent variable is an indicator variable set to 1 if the loan was prepaid within the given time frame and 0 otherwise. N is 958 for the estimations in panel A and 3,225 in for those in panel B. For all estimations, the *P*-value for the Chi^2 statistic is 0.0000, indicating significance.

Table 9. Costs and Benefits of Prepayment Penalties

	Costs				Benefits	
	Using 1995 to 1997 Data		Using 2002 Data			
	Probability	Expected Penalty	Probability	Expected Penalty	Rate Reduction Due to a Penalty (Basis Points)	Interest Savings over the Period
Panel A: Loans with a Prepayment Penalty Period of 24 Months or Less						
All loans	30.7%	$1,559	80.6%	$3,923	15.3	$418
Broker only	36.4%	$1,721	82.4%	$3,711	23.8	$378
Retail only	28.6%	$1,502	80.0%	$3,998	8.5	$431
2/28 ARM	30.5%	$1,558	80.6%	$3,933	17.8	$419
3/27 ARM	34.6%	$1,735	80.2%	$3,937	9.7	$418
Fixed 30 year	36.4%	$1,517	81.0%	$3,263	19.0	$279
Panel B: Loans with a Prepayment Penalty Period of 36 Months						
All loans	42.1%	$1,828	88.1%	$3,782	15.3	$579
Broker only	49.1%	$1,973	88.4%	$3,534	23.8	$526
Retail only	39.5%	$1,772	88.0%	$3,877	8.5	$599
2/28 ARM	46.2%	$2,324	87.7%	$4,310	17.8	$619
3/27 ARM	40.8%	$1,773	87.9%	$3,756	9.7	$579
Fixed 30 year	42.8%	$1,719	88.6%	$3,613	19.0	$563
Panel C: Loans with a Prepayment Penalty Period of 60 Months						
All loans	52.2%	$1,995	100.0%	$3,719	15.3	$878
Broker only	55.7%	$2,032	100.0%	$3,630	23.8	$854
Retail only	50.9%	$1,981	100.0%	$3,754	8.5	$888
2/28 ARM	60.5%	$2,337	100.0%	$3,674	17.8	$798
3/27 ARM	50.3%	$1,455	100.0%	$2,833	9.7	$673
Fixed 30 year	42.0%	$1,588	100.0%	$3,808	19.0	$986

Notes: This table compares the costs and benefits of a prepayment penalty. The costs are based on the probability of prepayment during the duration of the penalty. The probability of prepayment is based on the estimations in table 8. The expected penalty is equal to this probability times the penalty amount, which is set at six months' interest on the balance one year before the expiration of the penalty period. The benefits of a prepayment penalty are the interest savings during the penalty period, which is approximated as the reduction in the rate times the loan amount times the years that the penalty is in effect.

In different interest rate environments, the probability of prepayment will be lower and so will the expected penalty. Using the 1995 to 1997 origination cohort (control group 1), we find an expected penalty of $1,559. However, this is still more than three times the amount of the interest rate reduction.

We observe different prepayment likelihoods and different rate reductions between broker- and retail-originated loans and across different property types. These breakdowns are also reported in table 9. In addition, we repeat the analysis for the loans with three- and five-year penalty periods. Borrowers receive higher interest savings simply because they hold the loan for a longer period. Expected penalties change to reflect the higher probability of prepayment over a longer time frame and a slightly lower penalty value as the loan balance slowly amortizes.

It is important to note, however, that across all the mortgage types, penalty durations, origination channels, and interest rate environments we studied, we did not find a situation where the benefit of a prepayment penalty outweighed the expected cost.

Conclusion

Let us begin this section by summarizing the answers to the four primary research questions we posed earlier.

1. What is the economic value of the prepayment penalty contract feature?

The economic value is significant to lenders and investors, increasing asset values by 1 to 2 percentage points for prime and subprime loans, respectively.

2. Why are prepayment penalties more prevalent in the subprime than in the prime market segment?

Subprime loans carry higher note rates and prepay, without penalties, at higher rates than prime loans do. Therefore, the value of restricting prepayment is greater for lenders and investors, leading to greater use of the feature.

3. Do borrowers obtain an offsetting economic benefit when they have a loan containing a prepayment penalty?

Yes, borrowers receive a reduction in their cost of credit, as measured by their initial note rate, in return for taking a loan containing a prepayment penalty. We find that the magnitude of the benefit is on the order of 15 basis points overall. This value is somewhat lower than other estimates found in the literature.

4. What is the cost to borrowers of a prepayment penalty, and how often is this cost actually incurred?

The cost of a prepayment penalty can be substantial. In our analysis, expected cost, a measure that incorporates penalty size and the probability that it will occur, ranges from a low of about $1,500 to a high of almost $4,000. These values are based on probabilities of prepayment ranging from a low of about 30 percent to a high of 100 percent. Whether borrowers actually wish to prepay in any particular situation will depend on their own financial circumstances and the credit market conditions prevailing at the time.

We have seen that the availability and mechanisms to provide call protection to lenders and investors vary widely across the bond, commercial mortgage, and residential mortgage market sectors. Consumer protection and distributional concerns have led to a wide array of restrictions on call protection in the residential mortgage segment. This article has quantified these restrictions and helped explain why prepayment penalties are much more frequently seen in the subprime rather than the prime market. Our simulation indicated that for fixed-rate mortgages, a reduction of 22 to 87 basis points is required to produce the same average asset value; this range is generally consistent with the literature.

In addition to analyzing the benefits of prepayment penalties from the perspective of the lender and the investor, we have also assessed both the benefits and the costs to borrowers. Benefits arise for subprime borrowers since contract note rates are, on average, 15 basis points lower than they would be otherwise. We determine the expected cost of the penalty by modeling the probability of prepayment and multiplying it by the penalty amount. We found that this cost was larger than the benefit from interest savings. For example, for a loan originated in 2002 with a two-year penalty period, we determined that the average interest savings was $418, compared with an expected penalty cost of $3,923—an almost 10-fold difference.

In terms of policy implications, measures to ensure that borrowers originating loans containing prepayment penalties actually obtain rates that are lower than would otherwise apply without those penalties is the major challenge. This is particularly true in broker channels, where pricing is relatively opaque to consumers and largely unregulated third-party originators control pricing. Indeed, secondary market participants face perhaps an even greater challenge in verifying that loans originated with prepayment penalties actually provided an economic benefit to borrowers over what they could have obtained without those penalties, given their greater distance from the transaction and the limited information on available alternatives.

In summary, we have shown that the economic value of prepayment penalties to lenders and investors is substantial, increasing asset values by more than 2 percentage points for subprime loans and close to 1 percentage point for prime loans. Moreover, borrowers receive a measurable economic benefit in terms of a reduction in note rate. In addition, and perhaps counterintuitively, longer penalties actually produce relatively larger aggregate benefits for borrowers because they generate reduced note rates for a longer period. Finally, we conclude that the expected cost of prepayment penalties to borrowers is larger than the benefit, although this cost varies depending on the interest rate environment. In some sense, then, borrowers accepting prepayment penalties are making a bet on future interest rate movements; if that bet turns out badly, their cost can be quite high.

Should prepayment penalties be banned in residential mortgage contracts? On the basis of our analysis, we argue that they should not, although regulating them is certainly appropriate, given the high cost they can impose on borrowers. A reasonable position, currently under consideration by federal bank regulators, is to limit their term to five years or the fixed-rate period of any ARM, whichever is shorter, and to place a strong emphasis on adequate disclosure and informed consent. A complete prohibition might have undesirable and unintended consequences, such as a reduction in the availability of credit, an increase in the cost of credit, or a substitution of points charged up-front in lieu of prepayment penalties. Any of these would seem to leave borrowers unambiguously worse off.

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