Mortgage Delivery Options

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Abstract

The risk that a mortgage borrower whose loan is committed to the securitization process is tempted to switch lenders if market rates drop considerably during the loan origination period is a significant exposure for primary lenders in the single-family mortgage market. We propose a simple innovation, mortgage delivery options (MDOs), that shifts this exposure to securitizers or portfolio investors. Simulation results indicate that such an option would have been economically beneficial for representative originators, securitizers, and investors, (and, by extension, for primary borrowers), during our1992- 2005 sample period.

Mortgage Delivery Options

Overview

The single family residential mortgage market is one of the largest capital markets in the United States, if not the world. Most loans made in the primary market are subsequently transformed into mortgage-backed securities (MBSs) in a secondary market and then find their way into the portfolios of the ultimate investors. Recent defaults in the sub-prime mortgage sector have focused attention on the process by which residential loans are underwritten and securitized. It seems clear that efforts to resolve the current crisis of confidence in the global financial system will include changes in the way long-term investments in residential mortgage loans are originated and transferred to ultimate lenders. One aspect that has not been considered thus far is the interest rate risk that originators face during the time between the sale of an approved loan to the secondary market and the delivery of the closed mortgage to the investor via securitization.

In this paper, we model the mortgage origination and sale process as a profit opportunity that accrues to the primary market lender if and only if it is able to deliver a closed loan, (originators earn a significant mark-up when the loan is sold to a securitizer in return for a negotiable mortgage-backed security.[1]) Mortgages are not created instantaneously, however, and the possibility that market rates might move up or down during the 30- to 60-day origination process (known as the loan "pipeline") creates interest rate exposure that must be borne by one or more parties to the transaction. In most cases, originators protect borrowers from loan rate increases by writing explicit cancellation options paid for by non-refundable, up-front

[1] If the securities are then sold, (the normal outcome), the originator also retains a periodic revenue stream for servicing the mortgage or sells that right for the present value of the expected servicing annuity, (usually at least ¼% of the loan amount).

commitment fees. These fees which are typically charged as a percent of the loan amount, are part of the overall origination fees charged on the loan[2]. Exercise of these call options by borrowers forces primary mortgage originators to create below-market rate loans if interest rates rise during the pipeline period but a mandatory-delivery market allows the originator to transfer this risk to securitizers[3]. Funds generated from the sale of closed loans are used to support new borrowers so originators serve as temporary investors in long-term mortgage assets.

The loan origination process is inherently profitable in this form as long as the term structure is upward sloping *and* primary mortgage rates remain stable or trend upward, *but* borrowers cannot be forced to close loans at previously locked quotes if rates drop far enough to offset the loss of their non-refundable commitment fees while their loans are in the pipeline. In these instances primary mortgage originators must choose between two unattractive alternatives: 1) lowering loan rates to retain borrowers, or 2) giving up origination-and-sale profits and servicing revenues. In Section 3.1 we demonstrate that lowering the loan rate to keep the origination process intact is the always the optimal strategy, despite the fact that the primary mortgage originator suffers an origination loss based on the difference between the market rate that must be offered to the retain the borrower and the rate promised to the securitizer.

[2] The lender collects two types of fees as part of the mortgage origination process. The commitment fee is a true "origination" fee paid by the borrower and retained by the lender. Lenders also collect a variety of third-party charges, such as appraisal and title search fees. These are passed on to the supporting parties. Stanton and Wallace (1998) present a detailed theoretical analysis of the impact of the two types of fees collected at loan origination and show that true origination fees can serve as s signaling device where borrowers reveal private information about their future plans to lenders. We return to the issue of the importance of origination fees in Section 4.

[3] The Federal National Mortgage Association, (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac), are the most widely-quoted securitizers but a variety of private institutions also issue loan purchase commitments. Given the existence of instruments that protect originators against upside interest rate risk, it is somewhat surprising that the innovation we propose, which is a mirror image, has not yet evolved in the mortgage market.

Subsequent analysis indicates that mortgage delivery options (MDOs) that protect originators from these losses would have been economically viable during our 1992 – 2005 sample period, if they had been available, because:

1) the frequency and magnitude of interest rate declines was such that the exposure to pipeline risk was significant,
2) the spread between primary and secondary market loan rates led to significant origination profits which could have been used to pay mortgage delivery option premia to writers,
3) the correlation between primary market mortgage yields and Treasury security yields was both low and unstable, which indicates that traded interest rate contracts would not have served as effective hedging devices for mortgage originators, and
4) based on conservative assumptions, purchases of MDOs would have improved the risk/return distribution faced by primary mortgage originators without altering the risk/return distribution faced by securitizers or long-term mortgage investors.

The remainder of the paper is structured as follows: we present an overview of current academic thinking about the mortgage origination and investment market and a simple graphical model of the origination process with and without MDOs in section 1. Section 2 demonstrates that primary mortgage rate declines large enough create pipeline risk for originators occur with significant frequency and that the mortgage origination process is inherently profitable enough for an originator to compensate a securitizer or investor for the risk entailed in writing an MDO. Section 3 contains a more detailed analysis of the risks and incentives in the mortgage origination process and simulates the values of the proposed mortgage delivery options under a

variety of financial market conditions. Section 4 contains the risk/return comparisons for primary mortgage originators and for securitizer/investors with and without MDOs and describes the results of robustness checks. Section 5 concludes.

1. The Mortgage Origination and Investment Market

1.1 Related Research

The market for household mortgage debt is one of the largest non-financial credit markets in the United States. As of December 2008, residential mortgage debt outstanding totaled more than $11 trillion, (which is almost 1/3 of the volume in the entire non-financial credit market) and almost $5 trillion of this amount was held in mortgage-backed securities. By the end of 2008 MBS debt outstanding market was approaching the volume of Treasury debt issued (currently about $6.3 trillion).

Academics have long argued that securitizing individual mortgage loans adds liquidity to the market for residential debt and allows lenders to diversify their holdings geographically. For example, DeMarzo (2005) reviews the costs and benefits of pooling and selling assets for informed and uninformed intermediaries. He develops a model where pooling assets and then directing the cash flows from these assets to different tranches of security holders is the optimal strategy to maximize the benefits of an originator's private information.

DeMarzo's theoretical work is supported empirically by a recent paper by Downing, Stanton and Wallace (2008). These authors present an excellent overview of the institutional structure of the market for securitized residential mortgages and demonstrate that informed intermediaries place pools of loans they expect to have the least attractive long-term performance, (i.e. pools where underlying borrowers will exercise their termination options most efficiently) towards specific secondary market investment vehicles. In related work, Oldfield

(2000) demonstrates how a structured vehicle composed of an assortment of different mortgage cash flow derivatives, each of which is targeted towards a specific type of investor, has the ability to generate significant profits for an informed underwriter.

Recent developments in prime and sub-prime mortgage markets make it clear that the pooling and tranching strategy may have been overused by U.S. intermediaries in the early years of this decade. The most damning criticism of the securitization process is that it reduces an informed lender's incentive to screen the credit quality of loan applicants carefully because the risk of loan default is transferred to another party in the securitization process.[4] On this point, Purnanandam (2008) demonstrates that lenders who sold large volumes of loans into the secondary market prior to the sub-prime mortgage crisis that began in 2007 also experienced significant write-offs in their retained portfolios. In addition, he presents some evidence that pooled mortgage loans experienced higher foreclosure rates than retained loans.

In related work, Loutskina and Srahan (2008) compare the experience of two distinct classes of mortgage lenders, distinguishing between lenders that concentrate their activity in a few markets and those who diversify their holdings geographically[5]. Empirical results indicate that concentrated lenders retained more originated loans in their institutional portfolios, earned higher and more stable profits and suffered smaller declines in the market value of their equity during the 2001-2006 segment of their sample period.

Loutskina and Strahan couch their classification of lenders in terms of Grossman and Stiglitz's (1981) model of stable asset pricing equilibria, arguing that concentrated lenders function as informed investors who earn abnormal profits as a result of their ability to produce

[4] The securitizer bears the credit risk if the mortgages are prime loans packaged under the auspices of Fannie Mae or Freddie Mac's programs while the owner of the security or the writer of a credit default swap against it suffers the losses if sub-prime loans default.

[5] The authors define a loan portfolio as "concentrated" if 75% or more of the retained loans are located in a single Metropolitan Statistical Area.

superior information. "Uninformed" lenders make up another valuable component of the market in that they serve as liquidity traders who hold well-diversified portfolios, are compensated fairly for the systematic risk they bear and economize on the production of costly information.

Gan and Riddiough (2007) develop a novel approach to the issue of credit screening in mortgage markets. In their model it is the mortgage securitizer, representing Fannie Mae and Freddie Mac, (the government-sponsored enterprises that support the creation of mortgage-backed securities), who commits funds towards a significant investment in credit screening facilities. This investment gives the securitizer a form of monopoly power to thwart the entry of competitors and has measurable and empirically supported impacts on the pricing of mortgage pools.

There is no doubt that there is room for more improvement in the mortgage origination/securitization/investment process given the impact the sub-prime crisis has had on the global financial system. A recent working paper by Duarte and McManus (2008) proposes the creation of a derivative product based upon the credit losses experienced by a representative mortgage pool that would allow originators to retain whole loans while hedging the credit risk of those loans in the financial markets. This innovation is designed to improve the flow of credit originated by Loutskina and Strahan's "concentrated" lenders. The contract we propose is targeted towards improving the flow of credit originated by liquidity traders instead. As we demonstrate graphically in the next section of the paper and analytically in Section 3, a mortgage delivery option fills an obvious gap in the risk/return continuum for mortgages that will become the loan inventory in the securitization process.

1.2 A Graphical Representation of Interest Rate Exposure in the Residential Mortgage Origination Market

From a pure options point of view, the upside rate lock sold by the mortgage originator to the primary borrower in return for a non-refundable commitment fee can be viewed as a written interest rate call option, or cap, with a strike at the current primary market mortgage yield, (Figure 1(a)). This cap costs the originator nothing if market rates fall (left hand side) but generates a loss if market rates rise because the borrower exercising a call option on the underlying mortgage interest rate can force the primary mortgage originator to create a below-market rate loan.

The loan-in-process becomes a long position in the underlying locked mortgage yield if the originator sells the loan that underlies a completed application to a securitizer as soon as the borrower is approved and the originator locks a mortgage rate for the borrower. This position gains value when the market rate moves above the rate at which the loan was sold (because an identical loan can be purchased at a discount in the market) and loses value when market rates drop, (see Figure 1(b)).

Combining Figures 1(a) and 1(b) into Figure 1(c) shows the typical mortgage originator's risk profile in U.S. residential mortgage markets. The sold loan-in-process and the written interest rate cap combine to create a covered call on the underlying mortgage yield. Note that this position is not risk-free, but is exposed to a decline in market interest rates. We can describe the combination of Figures 1(a) and 1(b) algebraically as $(S - C)$, where S is the long position in the underlying interest rate and $(-C)$ is the short position in a call option (interest rate cap) on S.

Figure 1(d) plots the payoff of a mortgage delivery option (MDO) of the sort proposed here--an interest rate floor that rewards the option buyer, (the mortgage originator), when market

rates drop below the option strike rate (the committed mortgage yield). Purchase of the put (mortgage delivery) option changes the risk profile of the mortgage originator to $(S - C + P)$, where P is the long position in the MDO (an interest rate floor).

Setting the term in parentheses equal to $PV(X)$, (the present value of the exercise prices of the put and call discounted at the risk-free rate), generates the well-known put/call parity relationship for European-style options first discussed by Stoll (1969). Note that $PV(X)$ is insensitive to underlying mortgage interest rate changes. Figure 1(e), which is the sum of Figures 1(c) and 1(d), shows this graphically in that the mortgage originator who adds a long position in a mortgage delivery option to its existing loan portfolio is immunized against risks from mortgage interest rate changes in either direction.

Mortgage delivery options could make sense in theory, but not in practice. For example, conditions in the secondary mortgage market need to allow for compensation to the MDO seller (the mortgage securitizer or the long-term investor) for the risk entailed in writing the option contracts at a price that is also attractive to the primary mortgage originator. Alternatively, the chance of such options finishing in-the-money may be so small that the present values of their expected payoffs do not exceed their costs or alternative hedging contracts may provide more efficient hedging vehicles. We address pricing, the prospects for alternative hedges and risk of loss considerations using data from 1992 – 2005, a sample that covers a variety of market conditions, in the next section of the paper.

Our results indicate that mortgage delivery options would have been economically feasible throughout the sample period. Specifically:

1) Interest rate declines in the primary mortgage market were frequently steep enough to tempt primary borrowers to threaten to forfeit their non-refundable

rate lock fees in exchange for lower mortgage rates at other mortgage originators,

2) Securitizers paid significantly higher prices to exchange primary loans for MBSs than the funds mortgage originators disbursed to primary borrowers, and

3) Primary mortgage market yields were not highly correlated with yields on Treasury securities that underlie alternative hedging vehicles.

In essence, point (1), above, highlights the need for protection from interest rate declines at the originator level, point (2) addresses the existence of underwriting profits that can be used to pay for the MDOs, and point (3) speaks to the notion of idiosyncratic risk in the primary mortgage market.

Simulation results presented in Sections 4 and 5 demonstrate that the protection supplied by mortgage delivery options such as those proposed here would have improved the risk/return tradeoff in the residential mortgage origination market during our sample period while offering option writers an investment with an improved risk-return tradeoff Sharpe ratio.

1. Empirical Tests for Mortgage Market Conditions Conducive to the Success of a Mortgage Delivery Option Contract

1.1 Primary Market Yield Declines

A mortgage borrower who has paid an originator an up-front, non-refundable commitment fee is protected against the adverse impact of mortgage rate increases during the 30- to 60-day period required to assemble the documentation needed to close a loan but does not

benefit from mortgage rate declines. If competing loan rates fall far enough the borrower will sacrifice the commitment fee in return for lower long-term loan payments at another lender.[6]

Figure 2(a) shows the results of simple Net Present Value analyses assuming a typical commitment fee of 1% of the loan amount and a range of committed loan yields that is representative of the 30-year fixed-rate primary mortgage market since the early 1990s. The borrower's expected holding period in the loan is clearly the most important ingredient in the decision to abandon a funded commitment.

Given these results, we assume that a primary market rate drop of 0.25% or more during the loan commitment period generates pipeline risk for the primary market originator, (the second line from the top in Figure 2(a), which measures the cash flows faced by a borrower with a five-year expected holding period, rests just below or just above 0.25% across the entire range of primary mortgage yields). The choice of 0.25% is conservative in that borrowers with expected holding periods of five years *or more* would be tempted to sacrifice their commitment fees if rates dropped by that amount, *or less*, during the pipeline period.

Figure 2(a) also highlights a related point that will be useful in later sections of this paper. A financial asset's duration (D) measures the relationship between a change in the interest rate used to discount its payment and the asset's price, which is the present value of those payments. Given the results in Figure 2 (a), we assume that 0.25% decrease in primary market loan rates will increase the present value of an approved 30-year mortgage loan by more than enough to offset the 1% non-refundable commitment fee and tempt the residential borrower to seek a new loan at the lower market rate.[7] Our empirical and simulation results use the value to

[6] A specific borrower's forfeit threshold depends upon his or her expected holding period in that a smaller decline is required for a longer expected loan life, and vice-versa.

[7] This is tantamount to assuming that the typical borrower has an expected holding period (duration) of at least four years, (D > 4) which is a conservative assumption for 30-year fixed rate debt.

yield change scale factor of (1% Δ Present Value ≈ 0.25% Δ Yield × 4) repeatedly, especially in sections where we assess the pipeline risk of the loan in process that has been sold to the secondary market to the primary originator. It is important to note that assumption *understates* the risk faced by the originator because borrowers will seek alternative financing at a lower market rate *sooner* if they have a longer expected loan horizon.

Figure 2 (b) plots a weekly nationwide primary mortgage market yield series derived from the Mortgage Bankers Association average rates and points on 30-year fixed-rate loans on the left-hand axis.[8] It also documents the number of times the series drops by more than 0.25% in the 3- or 7-weeks following the observation, and the amount of the decline in those cases, (right-hand axis)[9].

Rate declines large enough to tempt a borrower to abandon a committed loan occur in 13.6% of the 734 weeks in the 1992 – 2005 sample using a 30-day loan-in-process period and in 37.3% of the instances if it takes 60 days to close a loan. These results suggest that pipeline exposure is a significant risk for primary mortgage originators who sell loans forward to securitizers as soon as they have approved borrower applications.

Given the obvious risks that declines in primary mortgage rates expose primary mortgage originators to, it is somewhat puzzling that mortgage delivery options of the sort proposed here have not evolved to transfer risk in the mortgage origination process. It may be the case that existing interest rate derivative contracts are adequate hedging vehicles for mortgage pipeline risk. We investigate this issue in Figure 2 (c), which plots the annual average correlations

[8] We convert the rates and points combinations to yields based on an assumption of a five-year mortgage life to generate Figure 2 (b), (a plot of the series we refer to as Yield5).

[9] Our primary yield decline analysis assumes an exposure period of 3 weeks for a 30-day loan commitment and 7 weeks for a 60-day loan commitment given that it would be difficult for a borrower who is purchasing a home to postpone closing while he or she negotiates new financing if the mortgage rate drop occurs in the last week of the loan-origination period.

between Treasury yields of various maturities and the primary mortgage market yield to five year life for a 30-year loan.[10]

The correlations range from some 20% to 70% and average 50% during the first part of the sample but only 40% or so during the latter part. The small size and the obvious volatility in the correlations over time indicate that interest rate derivative contracts based on Treasury yields or on other market yields that move closely with Treasury yields are unlikely to provide effective hedging vehicles for mortgage originators. The idiosyncratic nature of primary market mortgage yields evident in Figure 2 (c) suggests that an option tailored specifically to the residential mortgage sector has the ability to reduce the risk/return tradeoff faced by loan originators.

2.2 Mortgage Market Yield Spreads

Mortgage originators could not afford to purchase mortgage delivery options to protect themselves against the pipeline risk documented in Figures 2 (a) and 2 (b) unless there is a positive expected profit in the process of locking in loan rates for individual borrowers and then exchanging the loans for mortgage-backed securities (MBS). We investigate this question by collecting daily 30- and 60-day Federal National Mortgage Association (Fannie Mae) yields (NY30 and NY60, respectively) on commitments to exchange loans for MBSs from January 1992 through December 2005.[11] We then average these daily observations to create weekly values that match the weekly Mortgage Bankers Association (MBA) primary mortgage rate and points series. After converting the MBA rate and points pairs into yields-to-five-year life

[10] Correlations between the weekly values of each series are measured over calendar years.

[11] The Federal Home Loan Mortgage Corporation, (Freddie Mac), is another important participant in the mortgage securitization market. Results of the analysis is Sections 2.2 and 2.3 using Freddie Mac commitment data are nearly identical to those displayed here and are available from the authors.

(Yield5), we can compare the means and spreads in the three mortgage rate series (NY30, NY60, and Yield5) across the full sample and sub-periods that divide the sample into thirds.[12]

Results appear in Table 1, where the mean differences between the primary market yields (Yield5) and secondary market commitment rates (NY30 or NY60) are always positive and statistically significant at the 0.001 level. We also perform standard rank-sum tests on medians and report statistically significant differences at the 0.001 level. Spreads range from 25 to 50 basis points over the full 1992 – 2005 sample periods and the three subsets, indicating that mortgage originators could expect to sell loans in the secondary market for higher prices than the net amount disbursed to primary borrowers.[13] Therefore, significant funds were available to cover the primary lenders' origination expenses, including the purchase of mortgage delivery options.

2.3 Yield Change Variance Ratios

Results in Table 1 indicate that primary mortgage market yields exceeded the secondary market yields used to derive the value of loans sold to securitizers or investors by significant amounts during the 1992 – 2005 sample period so originators had a source of expected profit available to fund the purchase of a mortgage delivery option if desired. A market equilibrium cannot develop without a range of prices acceptable to buyers and to sellers, however.

Mortgage delivery option premia that loan-originating option buyers would have paid and that loan-purchasing option writers would have accepted depend on the premiums each entity attached to expected interest rate volatility. We assume that the historical variability in each

[12] Results in Tables 2 and 3, which are based on a five-year expected loan life, hold almost identically if we assume the primary market mortgage loan lasts for a full 30 years or for 12 years.

[13] The actual price received for a loan delivered to a securitizer or secondary market investor depends upon the expected life assumed for the mortgage. Using the duration factor of 4 assumed in the empirical work in this paper, 25 to 50 basis points in yield translates into 1% to 2% of a loan's face value as a mark-up on sale.

market participant's accepted yield series during the sample period reflects internal tolerance for expected interest rate risk *at that time* and compute two widely used volatility statistics for each of the three yield measures. Variance ratio F-test statistics then test whether the volatility in absolute changes and absolute percentage changes in the mortgage originator's yield series (Yield5) and the securitizer's yield series (NY30 and NY60) were equal during our sample period. If secondary market participants were equally-tolerant or less tolerant for interest rate risk than originating mortgage originators then there would have been no potential for option trading between the two parties to the securitization of a residential mortgage.

Table 2 reports variance measures and variance ratios for the full sample and each third of the series. All F-test statistics are statistically significant at the 0.005 level, suggesting that variances in absolute changes (Panel A) and absolute percentage changes (Panel B) in accepted yield were significantly greater for mortgage originators than for securitizers who represent long-term investors.

This difference in volatility may occur because the long-term investors who are the marginal investors in mortgage-backed securities hold large portfolios of MBS of differing rates and ages. Returns on these portfolios are inherently less correlated with each other than returns on portfolios of newly-originated loans so the incremental risk of additional current loans should be smaller at the long-term investor level than at the originator level. In addition, large portfolio investors have the asset volume and economies of scale necessary to employ sophisticated hedging programs to manage the interest rate exposure of their assets.[14] Finally, large long-term

[14] See Jaffee (2003) for a review of the risk management policies employed by Fannie Mae and Freddie Mac, two institutions that supported the market for securitizing individual residential loans and selling mortgage securities backed by these loans during our sample period. The two institutions were seized by Treasury officials in the summer of 2008 because they had made investments in sub-prime loans which lost significant value. The two entities continue to support the securitization of new residential mortgage loans after being seized by the US Treasury.

investors should be better able to create natural balance sheet hedges to support residential mortgage assets than small short-term originators.

For example, Table 3 summarizes the borrowing activity of five active Government Sponsored Enterprises (GSEs) and some 70 financial firms (SIC Code 6,000) from 1994 to 2004. Institutions of this sort are important investors in the MBS market and their incremental funding choices have clearly shifted towards variable rate and callable debt. These features reduce the potential duration of long-term liabilities and provide a better match to the expected duration of long-term but prepayable mortgage assets so it is not surprising that secondary mortgage market participants appear to be more tolerant of interest rate risk than primary mortgage originators.

2. Mortgage Delivery Option Simulations

Results in Tables 1 and 2 suggest that differences in yield spreads and volatilities between securitizer commitment and primary market yields may have been large enough to support a market for mortgage delivery options during the 1992-2005 sample period[15]. Empirical tests of this proposition require a detailed understanding of the risks and incentives faced by mortgage originators. We present an analytical version of the typical loan origination process in the first segment of the next section of the paper.

3. 1. A Generalized Representation of the Origination Process

We place the mortgage originator as an intermediary between a primary borrower and a securitizer who represents a long-term investor. The originator extracts an up-front commitment fee (λ) from the borrower to lock-in a mortgage loan yield of R_L at the beginning of the loan

[15] We limit our simulations to the 1992 – 2005 period to avoid contamination from the bursting of the housing market and mortgage market bubbles. Market data suggest that house prices reached their peak in early 2006.

origination period (t_k, t_{k+1}) and, at the same time, sells the borrower's loan to the securitizer at a secondary market yield of (R_L - π). Note that λ and π are both defined as yield equivalents to be consistent with our empirical work. Specifically, a loan that earns R_L and is priced at (R_L - π) sells at a premium which represents the originator's expected intermediation profit. Similarly, a borrower committed to paying R_L will be tempted to forfeit the commitment fee λ and acquire a loan from another originator if the present value of the promised loan payments based on R_L but discounted at (R_L - λ) or lower for the borrower's expected holding period exceeds the loan principal by the amount of the commitment fee λ. Note that R_L - λ defines the borrower's fee-forfeit threshold, at which the borrower is indifferent between (1) keeping the mortgage with the current originator and (2) forfeiting the commitment fee λ and seeking a different originator for a lower current mortgage rate.

Once the commitment fee λ is collected and the loan is sold forward, the eventual outcome depends upon the path taken by the primary market yield series, R_k, during the time interval (t_k, t_{k+1}). Consider first the simplest case, where $R_k \in [(R_L - \lambda), \infty)$. Here the primary market yield remains at or above the borrower's fee-forfeit threshold, R_L - λ. The primary mortgage originator sells a loan that earns R_L at a yield of (R_L - π) and captures an origination profit of,:

$$Profit = R_L - (R_L - \pi) = \pi \qquad (1)$$

The situation is somewhat more complex if the primary market yield drops substantially during the origination period, i.e. if $R_k \in [0, (R_L - \lambda)]$ holds. In this case the originator is confronted by a borrower who threatens to forfeit the commitment fee. If the originator allows the borrower to escape, it must cover the loan sold to the securitizer by purchasing the same loan in the secondary market at (R_k - π). Buying back this loan from the securitizer generates a loss

because ($R_L > R_k$) but the mortgage originator retains the commitment fee, which is measured by (λ) in yield equivalent terms. The net origination profit including the forfeited fee becomes:

$$Profit = (R_k - \pi) - (R_L - \pi) + \lambda = R_k - (R_L - \lambda) < 0 \quad (2)$$

Evaluating the profit at the extreme values of the relevant range for R_k:

If $R_k = 0$,

$$Profit = -R_L + \lambda \quad (2a)$$

If $R_k = (R_L - \lambda)$,

$$Profit = 0 \quad (2b)$$

Alternatively, the primary mortgage originator could voluntarily lower the primary borrower's loan rate to ($R_k + \lambda$). Note that the rate does not have to drop all the way to R_k because the borrower would have to pay another rate-lock fee λ to a different mortgage originator. In this case the primary mortgage originator's net origination profit with the lower loan rate, becomes:

$$Profit = (R_k + \lambda) - (R_L - \pi) = R_k - (R_L - \lambda) + \pi < \pi \quad (3)$$

Evaluating the profit at the extreme values of the relevant range for R_k:

If $R_k = 0$,

$$Profit = -R_L + \lambda + \pi \quad (3a)$$

If $R_k = (R_L - \lambda)$,

$$Profit = \pi \quad (3b)$$

Comparing (2) to (3) makes the originator's strategic position clear when primary market yield R_k drops significantly, i.e., $R_k \in [0, (R_L - \lambda)]$. It is always better off by lowering the loan rate to ($R_k + \lambda$) to retain the borrower. Comparing (3) to (1) exposes the risk in the originator's position, however. Note that the originator's profit will be less than π whenever $R_k < (R_L - \lambda)$.

Now consider the situation where the originator is able to purchase a mortgage delivery option for an option premium p, where p is measured in yield equivalent terms. The mortgage delivery option is a put option on the primary market yield R_k. Given that the borrower's commitment fee is safely in hand before the loan is promised to a securitizer, the appropriate option strike rate is $R_X = R_L - \lambda$ and the option at expiration will pay the originator:

$$max\,[\{(R_L - \lambda) - R_k\}, 0] \qquad (4)$$

Assuming the originator will always lower the loan rate to retain the borrower when primary market yield R_k drops significantly, and adding the mortgage delivery option would generate a payoff to the originator as follows:

If $R_k \in [(R_L - \lambda), \infty)$

$$Profit^* = R_L - (R_L - \pi) + max\,[\{(R_L - \lambda) - R_k\}, 0] - p = \pi - p \qquad (5a)$$

If $R_k \in [0, (R_L - \lambda)]$:

$$Profit^* = (R_k + \lambda) - (R_L - \pi) + max\,[\{(R_L - \lambda) - R_k\}, 0] - p = \pi - p \qquad (5b)$$

Thus, with purchase of the MDO, the mortgage originator locks in the origination profit of $\pi - p$ regardless of the values attained by R_k during the origination period.

3.2 Valuing the Mortgage Delivery Option

An interest rate option of the sort described in (4) is not costless and an assessment of its impact on the risk/return profile faced by a primary mortgage originator is an analytical exercise that requires estimates of the value of the option to the originator and to the securitizer or the long term investor. In a general interest rate option pricing framework of the sort proposed by Black (1976), an interest rate floor has a total life T with reset dates of $t_1, t_2, \ldots, t_n$, and $t_{n+1} = T$. Let

R_k be the interest rate for the period between time t_k and t_{k+1} observed at time t_k ($1 \le k \le n$). The floor produces a payoff at time t_{k+1} ($1 \le k \le n$) of:

$$L\delta_k \max\left(R_X - R_k, 0\right),$$

where R_k is assumed to follow a lognormal distribution with volatility of σ_k; L is the notional principal of the loan; $\delta_k = t_{k+1} - t_k$ is the amount of time between floor reset dates; and R_X is the exercise rate. We assume the exercise rate will be equal to $R_X = R_L - \lambda$, where λ is the amount of the decrease in primary market yield needed to tempt the primary borrower to give up its commitment fee in return for a mortgage loan at the new, lower market yield.

An interest rate floor can be viewed as a portfolio of *floorlets*. Each $floorlet_k$ is an interest rate put option at time t_{k+1} ($1 \le k \le n$) with a payoff $L\delta_k \max\left(R_X - R_k, 0\right)$. The value of the floor is the sum of the individual values of each floorlet. We adopt the version of the Black (1976) interest rate option model, as detailed by Hull (2000), to price a floorlet:

$$floorlet = L\delta_k P\left(0, t_{k+1}\right)\left[R_X N\left(-d_2\right) - F_k N\left(-d_1\right)\right]$$

Where $$d_1 = \frac{\ln\left(F_k / R_X\right) + \sigma_k^2 t_k / 2}{\sigma_k \sqrt{t_k}},\ d_2 = d_1 - \sigma_k \sqrt{t_k}$$

F_k is the forward rate for the period between time t_k and t_{k+1}; and $P\left(0, t_{k+1}\right)$ is the risk-free discount factor based on spot risk-free rate over time 0 to t_{k+1}.

4. Simulated Mortgage Delivery Option Values

4.1 Estimated Option Premia

We show in Figure 1 and in Equation (5) above that a properly structured MDO removes the originator's exposure to pipeline interest rate risk during the loan origination period, allowing

it to lock in an underwriting spread[16]. The option is not costless, however, and an MDO market cannot develop unless securitizers or long term investors are willing to write "floorlets" at prices mortgage originators are willing to pay. MDO option values and their impact on the risk/return profiles faced by mortgage originators and securitizers are empirical questions we address via simulations using historical data from the 1992 – 2005 sample period.

Our simulations define the forward rate, F_K, as the primary market mortgage rate at the closing of the loan, (Yield5$_{k+1}$); R_L as the primary market mortgage rate at the time of rate lock (Yield5$_k$); λ as 25 basis points[17]; L as the loan amount, which we assume to be $300,000; and T as the time between mortgage rate lock (t_k) and loan closing (t_{k+1}), which we take as either 30 or 60 days. Additionally, we use 90-day Treasury Bill rates taken from the FRED database compiled by the Federal Reserve Bank of St. Louis to compute risk-free discount factor $P\left(0, t_{k+1}\right)$.

For every week in our 1992 – 2005 sample period, we assume that the then-current primary market commitment yield less the yield decline needed to spur the borrower to forfeit its commitment fee (Yield5$_k$ - λ) is the floor (exercise) rate. The primary yield 30 or 60 days after the rate lock (Yield5$_{k+1}$) is the forward rate. We compute the interest rate floor option premiums using the sub-sample interest rate volatilities of Yield5. Option premiums are recorded and presented in basis points as a yield spread.

Results appear in Table 4 where the left and right panels represent 30-day and 60-day origination horizons, respectively. We translate dollar value differences to yield differences to

[16] Given that the duration of the exposed period is quite short (typically 60 days at most), we ignore the possibility the borrower will want to back out of his or her loan for non-interest dependent reasons such as a change in family size or employment. We also assume that the lender has screened the borrower's credit and assessed the value of the collateral prior to offering the option to lock the loan rate.

[17] As shown in Figure 2a, 25 basis points is a large enough rate drop to tempt a primary borrower with an expected holding period of five years or more to give up a non-refundable 1% lock fee.

be consistent with our previous analytical results. Our assumption regarding tolerances for interest rate volatility means that our simulated primary lender is willing to give up more of its origination profit to pay the securitizer or the eventual investor for a mortgage delivery option than that entity will demand to write the option. It is also important to note that both the minimum option premia the writer will accept and the maximum the loan originator will pay are quite small-- less than 4 basis points for 30-day originations and less than 14 basis points for 60-day originations. Figure 4, below, indicates that the average loan origination fee on a 30-year fixed rate loan had declined from a high of 3% or more during the early part of the sample period to a long-run average of just above 1% by the second half of the decade of the 1990's. An insurance premium of only 4 or 14 basis points can easily be financed out of originations fees in excess of 100 basis points.

Furthermore, we examine the correlation between the MDO option premiums and the differences in the primary market and secondary market mortgage rate yields. Our empirical data over the 1992 – 2005 time period indicate that the correlation coefficient is 0.32, which statistically significantly positive at the 0.01 level. When yield spreads between the primary and secondary markets are large, MDO option premiums tend to be large, and vice versa.

4.2 The Impact of the Proposed Options on the Risk/Return Profile of the Originator and Option Writer

Mortgage delivery options of the sort we propose here will alter the risk/return trade-off faced by the primary mortgage market loan originator and the securitizer. Specifically, the cost of the option reduces the originator's profits during each week in the sample while the exercise of the option erases the originator's loss only when market rates fall by a large enough amount to

move the option into the money. A correctly-structured option position can immunize the originator in theory but the cost of the option, combined with the frequency with which it is exercised, may serve to reduce the originator's profit by more than is warranted given that risk reduction benefit conveyed by option exercise occurs infrequently. We investigate this possbility in Table 5 (A) and 5 (B). Because the mortgage originator generally cannot diversify his business risk of holding a portfolio of committed mortgage loans, Sharpe ratio is the appropriate measure of his risk/return trade-off. A series of Sharpe ratio calculations assesses the combined effect of the reductions in return and risk that a mortgage delivery option provides for the loan originator that purchases it in the left Panel (A). The right-side Panel (B) measures the joint impact of receiving the option premium each week and fulfilling option exercise sporadically on the risk/return distribution faced by the writer of the option, (either a loan securitizer or an end-stage investor in secondary mortgage market securities).

In the left-side panel of the Table 5 we see that the addition of a mortgage delivery option to the originator's portfolio serves to decrease the standard deviation of the returns to underwriting dramatically, but that the cost of the option is so small that paying for it has no appreciable impact on the size of the returns. Therefore, the purchase of a mortgage delivery option for each loan commitment allows the originator to lock in its underwriting profit with statistically significant decline in risk, as is suggested by the analysis in Figure 1 and Section 3.1.

Contrasting results appear in the right-side panel of Table 5, where the receipt of the periodic payment for the mortgage delivery option accumulates to cover the investor's loss when the underwriter exercises the options to such an extent that neither underwriting return, nor the standard deviation of that return, is compromised. Taken together the options we propose make the loan originator better off without harming the ultimate investor in the closed loan. As such,

these contracts should lower the risk of the mortgage origination process, generating benefits that can be transferred to individual borrowers via a competitive market for mortgage loans.

4.3 Robustness Check

We consider alternative assumptions of mortgage loan duration. So far, we assume that the average holding period of a 30-year mortgage loan is five years, which implies a duration of around 4. Our statistical analyis thus far is based on a duration of 4 and consequently, a break-even threshold rate of 0.25% below the originally locked mortgage rate below which the original borrower would walk away from the rate-locked mortgage loan and give up the prepaid 1% rate lock fee.

However, what if the original borrower intends to keep the mortgage loan for a longer (than the average of five years we assume previously) period of time? We consider the case where the average mortgage holding period is assumed to be 20 years, which implies a mortgage loan duration of about 8. Consequently, we reach a break-even threshold rate of 0.125% below the locked mortgage rate below which the original borrower would walk away from the rate-locked mortgage loan and give up the 1% rate lock fee.

We recompute all MDO premiums and report the results in the Panel B of Table 4. Because the threshold exercise rate is higher (increased to locked-rate – 0.125% from locked-rate – 0.25%), MDOs, which are the interest rate floors, carry higher option premiums, making it more costly to the mortgage originator to purchase these MDOs. However, because of higher exercise rates on these interest rate floors, these MDOs are more likely to finish in the money and more likely to generate a positive payoff to offset the increased option premium. Furthermore, we conduct Sharpe ratio analysis as we do in the previous section. The results are

quantatively the same, consistent with our previous conclusion the MDOs improves risk/return tradeoff for both mortgage originators and mortgage securitizers.

The underlying economic interpretation is clear. Long-term mortgage holders are more sensitive to mortgage rate changes. They are more likely to bargin with the mortgage originator even for small decreases in mortgage rates and are more likely to threaten to walk away from the loan. The mortgage originator needs more insuarance protection against even small mortgage rate decreases and consequently choose to purchase MDOs with higher exercise rates. Our empirical results in Table 4 show that even the increased MDO premiums are no more than five basis points for a 30-day rate lock and no more than 15 basis points for a 60-day rate lock. The MDO premiums are totally economically affordable. Sharpe ratio analysis shows that the MDOs with higher exercise rates quantitatively equally enhance the risk/return tradeoff for both the mortgage originator and mortgage securitizer.

5. Conclusions

In this paper, we model the mortgage origination and sale process as a risk-reduction opportunity that accrues to the primary market lender if and only if it is able to deliver a closed loan on which it earns a mark-up in price terms, or a "mark-down" in yield terms. The rise and fall of market mortgage rates during the 30-day to 60-day origination process creates interest rate exposure that must be borne by one or more parties to the transaction. In most cases, originators protect borrowers from loan rate increases by writing explicit cancellation options via non-refundable, up-front commitment fees, which are typically charged as a percent of the loan amount. Exercise of these call options given to the borrower forces primary mortgage originators

to create below-market rate loans if interest rates rise during the pipeline period but a mandatory-delivery market allows the originator to transfer this risk to securitizers.

Borrowers cannot be forced to close loans at previously locked quotes if rates drop far enough to offset the loss of their non-refundable commitment fees while their loans are in process so in these instances primary mortgage originators must choose between lowering loan rates to retain borrowers or giving up origination-and-sale profits and servicing revenues. We demonstrate that lowering the loan rate to keep the origination process intact is the optimal strategy, despite the fact that the primary mortgage originator suffers an origination loss based on the difference between the market rate that must be offered to the retain the borrower and the rate promised to the securitizer.

Subsequent analysis indicates that mortgage delivery options (MDOs) written by investors or securitizers to protect originators from these losses would have been economically viable during our 1992 – 2005 sample period, if they had been available, because:

1) the frequency and magnitude of interest rate declines was such that the exposure to pipeline risk was significant,
2) the spread between primary and secondary market loan rates led to significant origination profits which could have been used to pay mortgage delivery option premia to writers,
3) the correlation between primary market mortgage yields and Treasury security yields was both low and unstable so exchange-traded interest rate contracts would not have served as effective hedging devices for mortgage originators, and
4) purchases of MDOs would have significantly improved the risk/return distribution faced by primary mortgage originators without altering the risk/return distribution faced by securitizers or long-term mortgage investors.

We propose wide usage of mortgage delivery options in the retail and wholesale mortgage industry. Our study has demonstrated that such financial products enhance the risk-return tradeoff of mortgage originators and securitizers and that they improve risk taking and risk sharing efficiency in mortgage markets. Our empirical evidence further supports the feasibility of mortgage delivery options. Mortgage delivery options are particular valuable to mortgage originators in current financial markets where presence of significant volatility produces non-diversifiable business risk in the mortgage industry.

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Table 1
Summary Statistics for Primary Market and Securitizer (Fannie Mae) Commitment Yields, and Primary to Securitizer Yield Spreads

We convert Mortgage Bankers Association (MBA) primary mortgage rate and point pairs into yields-to-five-year mortgage life (Yield5) to proxy for primary mortgage market yields and report summary statistics on Yield5, Fannie Mae commitment net yields for 30- and 60-day agreements (NY30 and NY60) and spreads between Yield5 and each secondary market yield. The full weekly sample, which covers from January 1992 through December 2005, is partitioned into three approximately equal sub-samples. All rates are reported as a percent. *** indicates that the securitizer's sample mean is significantly less than the mean of Yield5 at the 0.001 level based on a two-sample Z-test, (or that the primary/securitizer yield spread is significantly positive), and +++ indicates that the securitizer's sample median is significantly less than the median of Yield5 at the 0.001 level based on a two-sample non-parametric rank-sum test.

Full sample: 1/3/1992-12/31/2005	Yield5	NY30	NY60
Mean	7.5350	**7.1198*****	**7.1898*****
Yield spread		**0.4152*****	**0.3452*****
Median	7.5151	**7.1525**$^{+++}$	**7.2220**$^{+++}$
Minimum	5.3650	4.6900	4.7860
Maximum	9.7550	9.3000	9.3800
St. Dev.	1.0222	1.0557	1.0545

Sub-sample A: 1/3/1992-12/31/1995	Yield5	NY30	NY60
Mean	8.4099	**7.9178*****	**8.0035*****
Yield spread		**0.4921*****	**0.4064*****
Median	8.3659	**7.9080**$^{+++}$	**7.9880**$^{+++}$
Minimum	7.0029	6.5500	6.6500
Maximum	9.7548	9.3000	9.3800
St. Dev.	0.7109	0.7161	0.7122

Sub-sample B: 1/5/1996-12/31/2000	Yield5	NY30	NY60
Mean	7.9117	**7.6073*****	**7.6579*****
Yield spread		**0.3044*****	**0.2538*****
Median	8.0237	**7.7280**$^{+++}$	**7.7820**$^{+++}$
Minimum	6.6731	6.4160	6.4460
Maximum	8.9592	8.7180	8.7680
St. Dev.	0.5373	0.5515	0.5587

Sub-sample C: 1/5/2001-12/30/2005	Yield5	NY30	NY60
Mean	6.4577	**5.9932*****	**6.0702*****
Yield spread		**0.4644*****	**0.3875*****
Median	6.2795	**5.7720**$^{+++}$	**5.8380**$^{+++}$
Minimum	5.3647	4.6900	4.7860
Maximum	7.6161	7.2280	7.2880
St. Dev.	0.5636	0.6248	0.6275

Table 2
Variance Ratio F-Test Statistics for the Equality of Absolute Changes and Absolute Percentage Changes in Primary Market and Securitizer (Fannie Mae) Commitment Yields

This table reports variance ratio F-test statistics for absolute changes and absolute percentage changes in Fannie Mae commitment net yields for 30- and 60-day agreements (NY30 and NY60) and Mortgage Bankers Association (MBA) primary mortgage yields-to-five-year mortgage life (Yield5). Changes in yields are measured by differences and percentage changes are measured in log yield differences. We report the variances and variance ratio statistics during the full sample and each one of the three one-third sub-samples. ***, **, and * represent statistical significance at the 0.05, 0.01, and 0.005 levels, respectively.

Panel A: Variances in absolute changes in yields

	|ΔYield5|	|ΔNY30|	|ΔNY60|
Full sample: 1/3/1992-12/31/2005			
Variance ($\times 10^{-6}$)	33.5879	21.0951	21.2857
Variance Ratio	n/a	**1.5922*****	**1.5780*****
Sub-sample A: 1/3/1992-12/31/1995			
Variance ($\times 10^{-6}$)	35.1366	24.4214	24.4300
Variance Ratio	n/a	**1.4388*****	**1.4383*****
Sub-sample B: 1/5/1996-12/31/2000			
Variance ($\times 10^{-6}$)	31.5317	18.6341	18.7836
Variance Ratio	n/a	**1.6922*****	**1.6787*****
Sub-sample C: 1/5/2001-12/30/2005			
Variance ($\times 10^{-6}$)	34.4305	20.5526	20.9966
Variance Ratio	n/a	**1.6752*****	**1.6398*****

Panel B: Variances in absolute percentage changes in yields

	|%ΔYield5|	|%ΔNY30|	|%ΔNY60|
Full sample: 1/3/1992-12/31/2005			
Variance ($\times 10^{-4}$)	62.6882	45.6262	45.0832
Variance Ratio	n/a	**1.3740*****	**1.3905*****
Sub-sample A: 1/3/1992-12/31/1995			
Variance ($\times 10^{-4}$)	48.0791	39.0565	38.2233
Variance Ratio	n/a	1.2310	**1.2578***
Sub-sample B: 1/5/1996-12/31/2000			
Variance ($\times 10^{-4}$)	53.1646	31.4284	31.1103
Variance Ratio	n/a	**1.6916*****	**1.7089*****
Sub-sample C: 1/5/2001-12/30/2005			
Variance ($\times 10^{-4}$)	81.8054	61.6633	61.4000
Variance Ratio	n/a	**1.3266***	**1.3323***

Table 3
Descriptive Statistics for Non-Convertible Debt Issued by
Five GSEs and 70 Frequent Issuer Financial Firms during 1994-2004

This table reports yearly summary statistics for non-convertible debt issued by five GSEs and 70 frequent issuer (non-GSE) financial firms during 1994-2004. Amounts are ascaled to millions of January 2005 dollars using the Producer Price Index. Proportion variable rate is the percent of teh dollar value of total debt issued by the GSEs and Financial Firms that does not have fixed coupon rates, and proportion callable is the percent of dollar value that is callable. The five GSEs are FNMA (Federal National Mortgage Association, or Fannie Mae), FHLB (Federal Home Loan Bank Board), FHLMC (Federal Home Loan Mortgage Corporation, or Freddie Mac), FARM (Federal Farm Credit Banks and Federal Farm Credit Banks Funding), and SLMA (Student Loan Marketing Association, or Sallie Mae).

	FNMA	FHLB	FHLMC	FARM	SLMA	Non-GSE Financials	Grand Total	% Variable	% Callable
1994	41733	78107	25692	9898	20887	107916	284233	52.98%	37.84%
1995	92874	122169	36468	22565	17788	134378	426241	24.42%	45.83%
1996	116962	125219	40302	32564	16225	153272	484544	23.54%	48.81%
1997	131097	173003	38941	29066	15817	201420	589343	22.15%	46.81%
1998	169752	317250	63501	39595	21358	273264	884720	22.08%	56.87%
1999	138886	272635	79237	30013	30515	320729	872016	28.18%	52.23%
2000	87050	207697	53029	18680	28956	345117	740529	41.82%	38.70%
2001	199247	432130	126262	39549	21151	263641	1081979	23.31%	68.33%
2002	165590	459364	158314	55403	21025	274240	1133937	30.84%	69.87%
2003	295702	598773	205683	57853	5301	265511	1428824	33.14%	77.69%
2004	232351	394335	143996	41945	0	260687	1073314	41.64%	71.46%

Table 4: Mortgage Delivery Option Premiums Measured in Yield Equivalents

This table reports summary statistics for mortgage delivery option (MDO) premiums in basis points for a mortgage originator. Option premia are computed using the Black (1976) model for interest rate options. We assume that the loan amount is $300,000, the time lag between loan commitment to loan closing is either 30 or 60 days and variances of yields in the primary market (Δ Yield5) are taken directly from Table 2. Panel A reports MDO premiums with an exercise rate of 1/4% below the previously locked mortgage rate. Panel B reports MDO premiums with an exercise rate of 1/8% below the previously locked mortgage rate.

Panel A	**MDO premium in basis points with 30-day lock**					**MDO premium in basis points with 60-day lock**				
	Mean	Median	Maximum	Minimum	St. Dev.	Mean	Median	Maximum	Minimum	St.Dev.
Full sample: 1/3/1992-12/31/2005										
1/4% MDO premium (bps)	3.371	3.356	5.376	1.166	0.639	12.625	12.615	20.016	4.867	2.365
Sub-sample 1: 1/3/1992-12/31/1995										
1/4% MDO premium (bps)	3.487	3.532	5.376	1.730	0.701	13.138	13.035	20.016	5.991	2.701
Sub-sample2: 1/5/1996-12/31/2000										
1/4% MDO premium (bps)	3.457	3.434	5.202	1.771	0.618	12.859	12.661	18.819	7.115	2.197
Sub-sample3: 1/5/2001-12/30/2005										
1/4% MDO premium (bps)	3.188	3.223	4.543	1.166	0.562	11.961	12.228	16.507	4.867	2.075

Panel B	**MDO premium in basis points with 30-day lock**					**MDO premium in basis points with 60-day lock**				
	Mean	Median	Maximum	Minimum	St. Dev.	Mean	Median	Maximum	Minimum	St.Dev.
Full sample: 1/3/1992-12/31/2005										
1/8% MDO premium (bps)	3.764	3.765	5.849	1.373	0.674	13.600	13.601	21.174	5.455	2.450
Sub-sample 1: 1/3/1992-12/31/1995										
1/8% MDO premium (bps)	3.880	3.934	5.849	2.011	0.739	14.111	14.086	21.174	6.607	2.798
Sub-sample2: 1/5/1996-12/31/2000										
1/8% MDO premium (bps)	3.848	3.836	5.657	2.040	0.652	13.824	13.628	20.012	7.828	2.274
Sub-sample3: 1/5/2001-12/30/2005										
1/8% MDO premium (bps)	3.584	3.629	5.017	1.373	0.601	12.948	13.243	17.654	5.455	2.169

Table 5. Originator and Securitizer Sharpe Ratios

This table reports statistics on Sharpe ratios, defined as the difference between an underwriting return and the risk free rate divided by the standard deviation of the underwriting returns over time. We consider the returns to a mortgage originator who underwrites mortgage loans and a securitizer who purchases them. Returns are further partitioned into 30-day and 60-day rate-lock horizons and computed with and without use of mortgage delivery options. The sample period is between 1/3/1992 and 12/31/2005. *** indicates that the use of mortgage delivery options produces statistically higher Sharpe ratios at the 0.001 level.

Panel A: The Originator's Position

Without the mortgage delivery option the underwriting return is defined as the yield equivalent of the profit from successfully underwriting and closing a mortgage loan less any losses incurred when the mortgage rate drops. With a mortgage delivery option, the underwriting return includes two additional terms specified in yield equivalents: costs of the mortgage delivery options and any payoffs from the options if they finish in-the-money. We report the average underwriting returns, average 30-day or 60-day risk-free rates, standard deviations of underwriting returns, and average, minimum, and maximum of Sharpe ratios over the sample period.

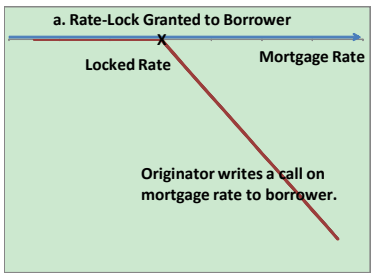
Panel B: The Securitizer's Position

We consider the returns to a mortgage securitizer who buys mortgage loans from mortgage originators. Without a mortgage delivery option, the mortgage securitizer's return is defined as 30-day or 60-day commitment rate, NY30 and NY60, respectively. With a mortgage delivery option, the mortgage securitizer's return is the commitment rate (either 30-day or 60-day) plus mortgage delivery option premium as a yield measure paid by the mortgage originator less the yield equivalent of the payout of the mortgage delivery option to the mortgage originator if the mortgage delivery option finishes in-the-money.

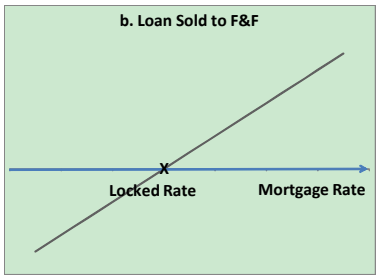
	Panel A: The Originator's Position				**Panel B: The Securitizer's Position**			
	30-Day Rate Lock		**60-Day Rate Lock**		**30-Day Rate Lock**		**60-Day Rate Lock**	
	Without Options	With Options	Without Options	With Options	Without Options	With Options	Without Options	With Options
Average underwriting return	2.4183%	2.4163%	2.3045%	2.3237%	7.5406%	7.5426%	7.5460%	7.5267%
Average risk free rate	0.2340%	0.2340%	0.5390%	0.5390%	0.2340%	0.2340%	0.5390%	0.5390%
St. Dev. of underwriting returns	0.1235%	0.0064%	0.3474%	0.0236%	1.0222%	1.0171 %	1.0224%	1.0183%
Average Sharpe ratio	**17.69**	**341.77*** **	**5.08**	**75.46*** **	3.74	3.77	3.75	3.75
Min Sharpe ratio	9.50	314.95	-2.30	57.69	1.51	0.87	1.51	-0.53
Max Sharpe ratio	19.42	373.18	6.70	95.89	5.73	5.79	5.73	5.83

Figure 1
Mortgage Originator's Risk Profile with and without MDOs

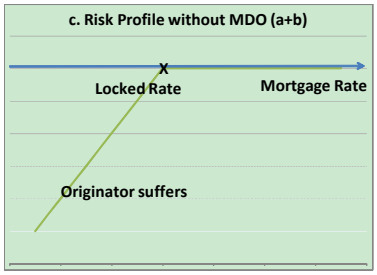
This set of figures presents the mortgage originator's risk profile with and without the use of mortgage delivery options (MDOs).



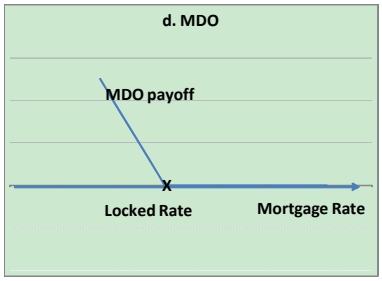
(a) The mortgage originator offers a rate-lock option to the borrower at a fixed exercise rate. The option calls away any benefits from the mortgage originator when mortgage rate exceeds the exercise rate because the borrower is allowed to borrow at no higher than the exercise rate.



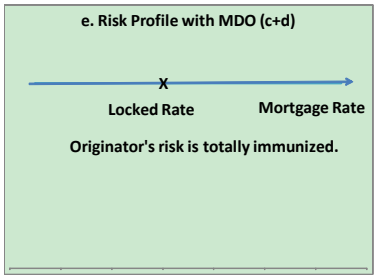
(b) After the mortgage originator approves a loan, it is sold at a fixed yield in the secondary market. This delivers the loan in the future. As mortgage rates increase, the profits to the mortgage originator increase, and vice versa, because a market rate loan that satisfies the secondary market commitment can always be purchased in the cash market.



(c) The mortgage originator is not affected by mortgage rate increases. However, without a mortgage delivery option (MDO), the mortgage originator loses when the mortgage rate decreases because the borrower will demand a lower rate.



(d) A mortgage delivery option (MDO) is an interest rate floor (put option), which generates a positive payoff when interest rate decreases.



(e) With a mortgage delivery option, the risk to the mortgage originator when mortgage interest rates drop is removed by the payoff of the MDO. Now the mortgage originator's position is immunized against risks associated with mortgage interest rate increases and decreases.

Figure 2(a): Committed Borrower's Analysis in the Face of Primary Market Yield Declines

This figure presents a simple Net Present Value analysis from the perspective of the residential mortgage borrower who has surrendered an up-front, non-refundable commitment fee of 1% of the loan amount in order to lock a mortgage yield against interest rate increases. The amount of the rate drop needed to tempt the borrower to sacrifice the 1% fee in return for a lower loan rate is slightly positively related to the committed loan yield and significantly positively related to the borrower's expected holding period.

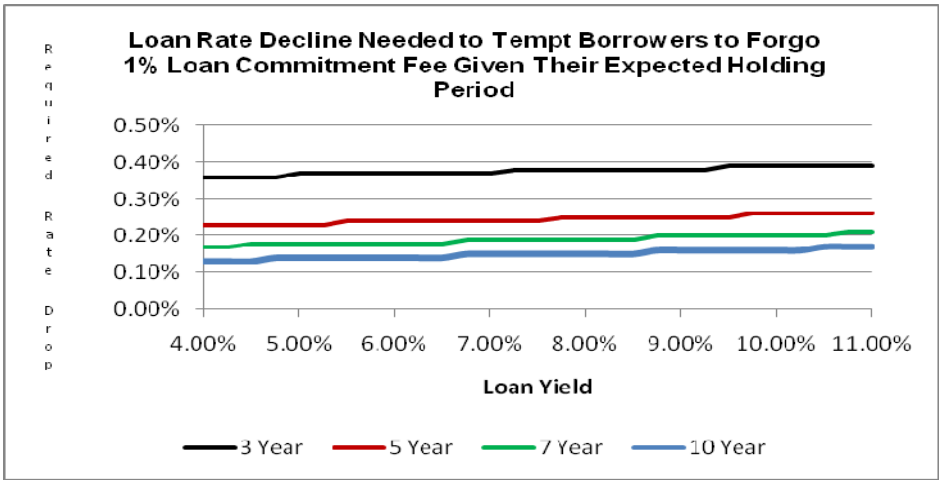


Figure 2(b): Primary Market Yields and Yield Declines in Excess of 0.25% Over the Next 3 or 7 Weeks, 1992–2005.

This figure plots the primary mortgage market yield to five-year life given the national average 30-year fixed rate loan rate and points collected by the Mortgage Bankers Association, (left-scale). In addition, the series on the bottom, (right-scale) indicate the number of times the primary market yield drops by 0.25% or more during the next 3 weeks or the next7 weeks,and the amount of the yield decline in those cases.

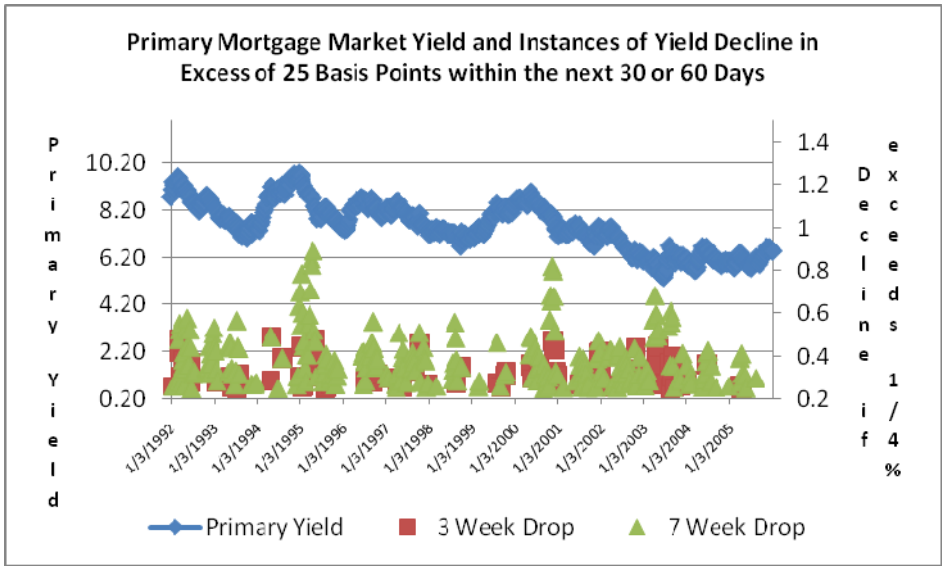


Figure 2 (c): Correlations between 30-Year Mortgage Yields and Treasury Yields

This figure plots the annual average correlations between mortgage and Treasury yields, measured on a weekly basis, across the sample period. National average primary market rates are taken from the Mortgage Bankers Association Weekly Survey and Treasury Yields are taken from the Federal Reserve Bank of St. Louis FRED database (www.stlouisfed.org/fred/index/html).

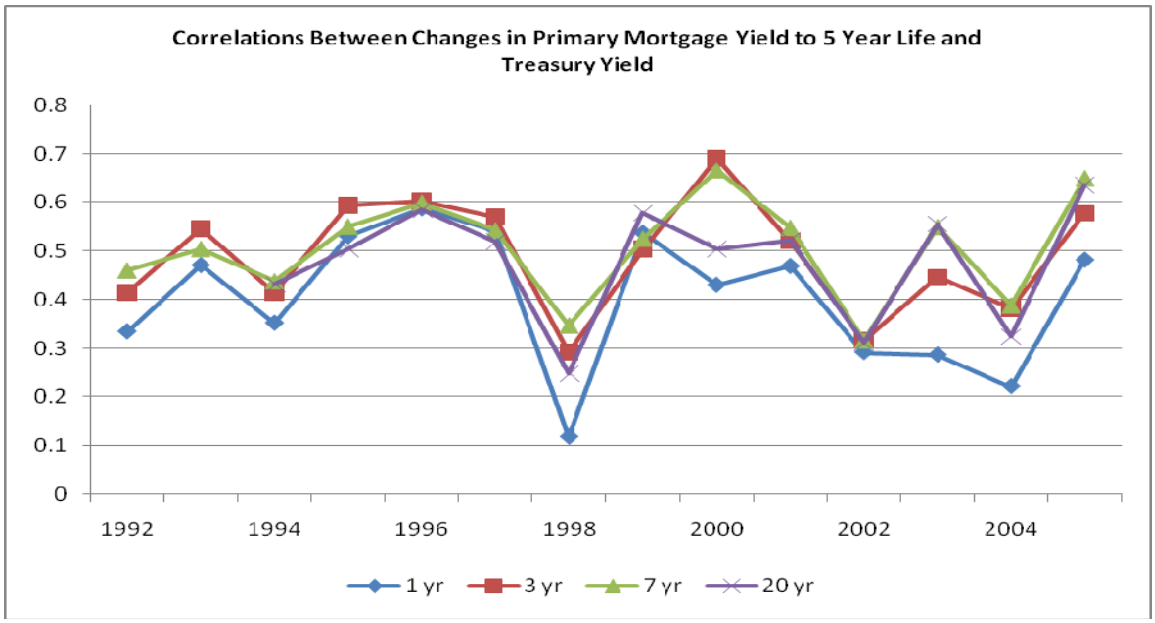


Figure 3. Total Point of 30-Year Fixed Rate Loan Originations

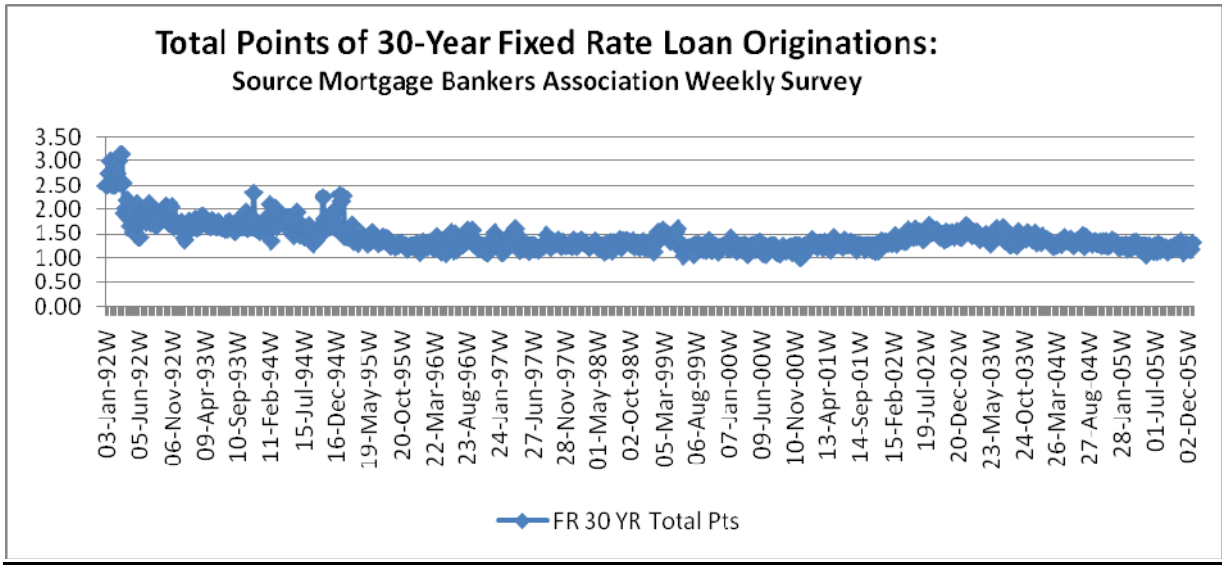


Figure 4. 30-Day and 60-Day Mortgage Delivery Option Premiums in Basis Points

This figure presents 30-day and 60-day mortgage delivery option premiums in basis points valued to a mortgage originator. Option premiums are computed using the Black (1976) model for interest rate options. Dollar option premium is the loan size ($300,000 in our example) multiplied by the option premium in basis points reported in this figure and in Table 4. The data points in top portion of the figure represent option premium of 60-day options while the data points in the bottom portion represent option premium of 30-day options. The figure further partitions the full sample period into three sub-samples: 1992-1995, 1996-2000, and 2001-2005.