Third Party Originators and Mortgage Prepayment Risk: An Agency Problem?

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Abstract. **We focus on an agency problem encountered by mortgage lenders and investors in mortgage-backed securities when the underlying collateral is originated by third parties. Third parties, such as mortgage brokers, have economic incentives to encourage borrowers to refinance and, accordingly, their actions may affect asset values. We sketch the principal-agent problem and examine two sets of data. Results support the argument: loans originated by third parties are significantly more likely to prepay after controlling for other known determinants of termination risk. Moreover, third party loans are about three times as sensitive to refinancing incentives, compared to retail loans.**

Introduction

A basic tenant of finance is that the value of an asset is the present value of its future cash flows. In the case of mortgages and mortgage-backed securities, prepayment estimation is essential in forecasting expected mortgage cash flow patterns. Accordingly, security prices are highly dependent on prepayment assumptions. With roughly 1.7 trillion dollars in mortgage loans securitized, many of which re-packaged into highly volatile derivative instruments, accurate forecasting of mortgage loan prepayments is of increasing importance to a wide variety of players in the capital markets.

In this article, we focus on an agency problem encountered by mortgage lenders and investors in mortgage-backed securities when the underlying collateral is originated by third parties (TPOs), such as mortgage brokers. We show how the contractual relationship between mortgage lender and third party originator may be cast in terms of the classic principal-agent problem. Since prepayment risk is not shared between lender and originator, TPOs can "churn" the customer, earning additional fees every time the mortgage is refinanced. Regression results using loan level data on mortgage terminations over the period 1992–1997 supports the argument. Results show that loans originated through third parties are significantly more likely to prepay, after controlling for re-financing incentive, loan type and size, and age. While it is difficult,

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if not impossible, to control for all borrower characteristics that may affect prepayment probabilities, the magnitude of these effects strongly supports the agency problem hypothesis developed. Additional market level data is consistent with loan level regression results, although the magnitude of the difference appears much smaller.

Institutional Background

The secondary mortgage market represents a large segment of the bond market. As of 1998, about 60% of single-family mortgage debt has been securitized, with the bulk of these loans pooled into mortgage pass-through securities issued by the Federal Home Loan Mortgage Corporation or the Federal National Mortgage Corporation (collectively called the government-sponsored enterprises or GSEs). Loans larger than the congressionally set loan limits, currently $240,000, are often securitized by major mortgage banking firms, these issues are known as ''non-agency'' or ''private label'' mortgage-backed securities (MBS). Agency guaranties protect investors from default risk; in the case of non-agency securities, subordinate bond structures provide this protection. But since, in general, borrowers may prepay their mortgage at any time without penalty, investors in MBS are exposed to prepayment risk, which increases as interest rates fall and refinancing becomes more attractive. Even in a stable interest rate environment, investors are exposed to prepayment risk, since borrowers who pay off their mortgage early to move to another house produce unscheduled cash flows to the mortgage pool. The rate at which these unscheduled cash flows arrive is known in the industry as the single-monthly-mortality rate (SMM) or, on an annualized basis, the conditional prepayment rate (CPR).[1] While investors in MBS bear this risk directly, firms that sell these mortgage pools to the GSEs, or to the capital markets directly in non-agency issues, retain exposure. Those firms typically service the loans they sell on behalf of the investor, retaining a servicing fee, usually 25 basis points for a conventional fixed rate product, that is a function of the principal balance of loan. This cash flow stream, known as the ''servicing asset'' in the industry, behaves much like an interest-only (IO) strip: when interest rates fall, principal balances runoff faster due to prepayments and servicing fee income is reduced. Since mortgage firms are required by GAAP rules to capitalize their servicing assets, unanticipated prepayments cause large accounting losses. For example, the FDIC recently reported that the 48 largest commercial banks saw the value of their servicing rights fall by $990 million during the third quarter of 1998, due to a surge of mortgage refinancing during that period.[2] Furthermore, those same institutions were able to successfully hedge only $746 million of that decline in value, producing net losses of $244 million due to unanticipated prepayments.

Those outside the industry may not appreciate that mortgage servicers typically acquire loans through multiple origination channels. These include networks of retail branches and loan production offices, corporate relationships, referrals from real estate brokers, telephone and internet-based sales units, as well as third party originators, such as mortgage brokers and loan correspondents. In addition, bulk packages of loans or loan servicing rights trade among lenders and investment bankers post-origination.

The mortgage broker receives his or her compensation from the borrower in terms of origination fees and points; they may also receive an origination fee from the major

lender at the time the submitted loan application is funded. Correspondents, like brokers, receive origination fees and points from borrowers; moreover, they may re-sell the loan to the lender at a capital gain, in the event its note rate exceeds current market rates at the time of sale. These relationships promote efficiency in the national mortgage market, allowing capital to flow to those areas of the country where loan demand is greatest, even if suppliers of funds are located in other parts of the country. Mortgage brokers play an increasing role in mortgage origination, with an estimated market share of 52% of new loan production during 1997 (LaMalfa, 1998).[3] The increasing share of loan origination by mortgage brokers is due to their lower cost structure and incentive compensation, which attracts the most ambitious loan officers to brokerage, according to LaMalfa. Clearly mortgage brokers play an important role in decimating information on market conditions to relatively less informed consumers.

Contracts between lenders and TPOs typically include non-solicitation clauses;[4] the lender does not want the correspondent or the broker to encourage borrowers to re-finance when rates fall or it is otherwise advantageous[5] for the borrower to do so. Yet the broker and correspondent earn their living by transaction volume and, like other brokers, have an economic incentive to ''churn'' the customer. Moreover, since it is relatively easier[6] to complete transactions with existing customers than to locate new customers, brokers and correspondents have incentives to breach these non-solicitation provisions and encourage their customers to ''re-finance early and re-finance often,'' perhaps with a different lender to conceal their actions from the original mortgagee.

For the mortgage servicer, mortgage prepayments are inherently difficult to analyze. Payoff requests arrive but the borrower is under no obligation to explain *why* the loan is being prepaid. Reasons may relate to the personal circumstances of the owner: a desire to move to a new home because of change in household composition, wealth, or income; relocation for employment reasons; prepayment of the entire loan balance because of windfalls such as inheritances; or refinancing to take cash out of a property to finance college education, major consumer expenditures or debt consolidation.[7] Alternatively, prepayment may occur on sale of the property due to financial duress, perhaps in lieu of default and foreclosure, or to convert from one type of mortgage to another, for example, from an adjustable rate mortgage to a fixed rate one.[8] Finally, and perhaps most importantly, mortgage prepayment is more likely to occur when interest rates fall and the borrower's call option is in the money.[9] But disentangling these myriad reasons for prepayment is not easy. Accordingly, monitoring TPO behavior after a loan acquisition is costly to the lender.

Literature Review

The mortgage market has evolved considerably over the past twenty years, with the evolution of a wide array of alternative instruments and the expansion of the secondary market, including a variety of mortgage-based derivatives. Researchers have recognized that contingent claims methodologies can provide important insights into market workings. A mortgage loan may be viewed as a fixed income instrument combined with American put and call options held by the borrower and written by the lender. The right to prepay the mortgage at any time is a call option at par; the

ability to default on the mortgage at any time is a put option in which the mortgage is sold to the lender for the market value of the property. Prepayment options are more likely to be exercised when interest rates fall; default options are more likely to be exercised when house prices fall.[10] Hendershott and Van Order (1987) provide a survey of representative pricing model results. Kau, Keenan, Mueller and Epperson (1992) develop a formal treatment of the valuation problem for fixed rate mortgages.

Research into mortgage prepayment has taken a number of approaches. Theoretical work focuses on valuation and optimal exercise of the embedded call option to prepay as rates fluctuate over time (Kau and Kim, 1991; Follain, Scott and Yang, 1992; and McConnell and Singh 1994). Methodological issues and modeling techniques are summarized in Kang and Zenios (1992). Empirical research often uses mortgage pool data, where loan level information is largely limited to pool type, issuer, time and weighted average note rate. Peters, Pinkus and Askin (1984), Richard and Roll (1988), Schwartz and Torous (1989, 1992) and Foster and Van Order (1990-1991) address single family residential mortgage prepayments using pool data; and Elmer and Haidorfer (1997) examine prepayments on multi-family mortgage backed securities.

Empirical research initially focused on the role of borrower demographic characteristics affecting mobility, in addition to the effect of interest rate movements (Green and Shoven, 1986; and Quigley, 1988). More recently, interest has focused on borrower characteristics that might impede refinancing, even when it may be optimal for the borrower to do so given prevailing mortgage rate levels (Peristiani, Bennett, Monsen, Peach and Raiff, 1997; Archer and Ling 1997; Archer, Ling and McGill, 1996; Green and LaCour-Little, 1998; and Crawford and Wu, 1998). Another recent trend in the literature is to explicitly model the competing risks of default and prepayment (Deng, Quigley and Van Order, 1996; and Abrahams, 1997).

While most mortgage bankers and Wall Street participants[11] in the mortgage bond market generally agree that wholesale, or TPO, loans exhibit greater prepayment speed than do retail loans, this article is the first known academic research on the topic. In the next section, we sketch out the basic economic argument for why we might expect to observe such a pattern. Chun and LaCour-Little (1998) develop a more complete formal treatment of the agency problem as it applies to contracts between lenders and third party originators and mortgage prepayment risk.

The Agency Problem with TPO

The relationship between the third party loan originator and the subsequent loan purchaser may be viewed in the context of the classic principal-agent problem.[12] For a review of this literature, see Hart and Holmstrom (1987) and Mas-Colell, Whinston and Green (1995). Since lenders incur origination costs to obtain mortgage loan assets, profitability depends, in part, on the duration of the stream of borrower payments. The duration of loan payments depends, in part, on the hidden actions of the agent, who may encourage the customer to refinance or not, as well as states of nature (the movement of interest rates), and the personal situation of the borrower. These hidden

actions of the agent are unobservable by the principal, the loan purchaser, who only observes whether the loan prepays and cannot determine whether the agent has induced or encouraged the borrower's behavior.[13] If the agent's behavior were observable, the sole issue is how the principal and agent are to share the unsystematic risk of profitability. The optimal contract will specify a certain payment contingent on a specified level of the agent's effort,[14] and this level of effort will be guaranteed as long as the contract is in force. The risk preferences of the principal and the agent will determine how to share other risks associated with states of nature and borrower characteristics. For example, in the case of the risk neutral principal and the risk adverse agent, a fixed fee structure paid by the principal to the agent would represent the optimal contract.[15] As a result, the agent will be fully insured against any unsystematic risk. On the other hand, if the agent is risk neutral, a contingent contract based on the outcome will be optimal, and consequently the agent will absorb all the unsystematic risk.

The optimal contract when the agent's actions are unobservable involves a risk-incentive tradeoff. In other words, there exists a tradeoff between gains from the provision of extra incentives and losses from inefficient risk sharing. Suppose that the agent is risk averse and is paid a fixed amount that is independent of outcome. (This is the case, we argue, when TPOs are paid an up front fee by the lender, regardless of future loan performance.) Knowing that there is no reward for extra costly effort, the agent will exert no effort. Therefore, the principal has to offer the agent more compensation that depends upon observable outcome. As a result, the agent gains from the extra incentives but shares part of the risk. In the mortgage case at hand, the lender might compensate the TPO over the time (to the extent the loan does not prematurely prepay) and the present value of those payments would exceed what the TPO would receive if paid at the time of loan origination. But these are not the contractual arrangements currently in place. Accordingly, with no incentives to discourage refinancing, the agent chooses to encourage it. Given these adverse incentives, we expect to observe higher rates of prepayment among TPO loans.

Methodology

Prepayment research using loan level data is typically based on techniques of survival analysis, which originated in biological studies of mortality and has also found frequent application in industrial engineering failure time studies. Loans ''die'' prior to scheduled maturity from either default or prepayment. Kalbfleisch and Prentice (1980) and Cox and Oakes (1985) provide classic statistical treatments of the topic; Allison (1995) may be consulted for many practical examples using a wide range of examples, drawn from both medicine and sociology; Kiefer (1988) provides an economics literature review of duration modeling.[16] Data censoring is the principal econometric problem encountered, since loans that have not prepaid as of the end of the study period have their prepayment time censored; that is, we cannot observe the time-to-prepayment for loans that have not yet prepaid. Techniques to accommodate data censoring are needed, with the proportional and non-proportional hazard partial likelihood approaches most popular.

Proportional hazards models were developed by Cox (1972), hence, the frequent reference in the literature to Cox regression, which really refers both to the model and the estimation method. In its simplest form, without time-dependent covariates, the model for prepayment is:

$$h_i(t) = \lambda_0(t)*\exp(\beta_1 x_{i1} + ... \beta_k x_{ik}), \tag{1}$$

where $h_i(t)$ is the hazard of prepayment as a function of time and a vector of explanatory variables, X, and $\lambda_0(t)$ is the baseline hazard for an individual whose covariates all have values of zero. Taking logs of both sides we have:

$$\log h_i(t) = \alpha(t) + \beta_1 x_{i1} + ... \beta_k x_{ik}. \tag{2}$$

To modify the basic model to allow for time varying covariates (such as interest rates), simply add a subscript t to those that vary over time. For example, if x_2 varies with time, then a two-factor model could be written:

$$\log h_i(t) = \alpha(t) + \beta_1 x_{i1} + \beta_2 x_{i2}(t). \tag{3}$$

The model is estimated by the method of partial likelihood. While there are advantages to the Cox regression approach for comparative statics, a principle disadvantage is the necessity of specifying a baseline hazard function. Actual predicted prepayment rates (the values of the hazard function over time) are highly dependent on the assumed underlying baseline function.

An alternative to the proportional hazards methodology is the discrete-time approach described by Allison (1995) in which the unit of observation, in the mortgage termination case, is transformed from loans, to loan-months. Loans are observed during each month of their life; in any month, a loan either prepays or it does not. We observe these loan-months and the characteristics, some time-invariant (such as property location) and some time-dependent (such as the spread between contract and market rate). Each loan contributes as many observations to the data set as the number of periods between its origination and its termination, by prepayment or censoring. Since resulting data sets tend to be unmanageably large, it is customary to over-sample the event of interest, in this case, months in which loan prepayment occurs. A roughly equal number of non-event months are randomly drawn to complete the data set. This technique accommodates the censored data problem, since observations are each month and hence are conditional on the loan having survived up until that point. Moreover, a simple binary logistic regression may be employed once the data have been suitably transformed. The familiar logit model is specified as:

$$\mathrm{Prob}(P_{it} = 1 | X_{it}) = \exp(B_{it} X_{it})/(1 + \exp(B_{it} X_{it})), \tag{4}$$

where $X = X_{1t}, X_{2t},...X_{Kt}$, representing k explanatory variables indexed by month t, and B_i is the estimated effect[17] of characteristic X_i on the probability that $P = 1$; here, $P = 1$ if the loan prepaid in month t, $P = 0$, if not. Note that some of the variables, X, are time-varying, such as the difference between the note rate and the current

market rate, and some are not, such as whether the loan was originated by a third party (TPO). In the empirical analysis presented, a relatively simple specification is used, since our focus here is on the effect of origination channel (the sign of the indicator variable *THIRDPTY*). Explanatory variables are discussed next.

Since the dollar savings on refinancing depend both on rate reduction and loan amount, original loan balance (*ORIBAL*) is included as an explanatory variable. We expect larger loans to be more likely to prepay, given the same refinancing incentive. The variable *MONTH* measures loan age and a squared version (*MONTHSQ*) is also included, to capture possible non-linearity in the effect of time on refinancing probability. The borrower's incentive to refinance (a rough proxy for the value of the borrower's call option) is measured as the spread between contract rate and the ten-year constant maturity Treasury rate (*INCENTIVE*). To compute refinancing incentive, we considered using matched maturity mortgage rates, such as the FHLMC's survey report of fifteen- and thirty-year mortgage rates. But to choose any particular rate is, in effect, to assume that borrowers only refinance into the same product. This is clearly an unrealistic assumption because, for example, when rates drop a borrower might elect to shift to a fifteen-year term to pay off their mortgage more quickly, while leaving monthly payment costs relatively unchanged. Likewise, when the slope of yield curve increases, a borrower might choose to refinance into an adjustable rate product even if the spread between note rate and current market rate for the same product is minimal. In contrast, the ten-year Treasury rate provides a general proxy for the level of interest rates. As a proxy for unmeasured borrower characteristics that may affect prepayment risk, we also include the variable *INCOME*, representing borrower annual income at time of loan origination. Finally, we include the variable *THIRDPTY*, an indicator variable set equal to one, if a mortgage broker or other third party originated the loan, and zero otherwise.

Data

Two sets of data are used. A national mortgage loan-servicing firm who prefers anonymity provided the first data set, consisting of loan level information on 16,974 fixed-rate mortgage loans originated during calendar year 1992 at an average note rate of 8.45%. Collateral is highly diversified geographically, with the largest concentrations of loans from New York, California and Illinois. About half are thirty-year and half fifteen-year term. Both conforming and nonconforming loans are included. Loan payoff behavior is tracked through 1997 and defaulting loans are excluded. By year-end 1997, about 80% of these loans had prepaid. While additional data on adjustable rate mortgages (ARMs) was available, defining the borrower's incentive to refinance in the case of ARMs is much more difficult given annual rate adjustments. Accordingly, ARM loans were dropped from the final analysis and will be the topic of later research. Exhibit 1 gives summary statistics on the loan level data set including geographic distribution and payoff experience by year.

Since loan level data was from a single servicing firm, the question arises whether results may be generalized to the broader mortgage market. To test for similarities to the overall mortgage market, a second data set from the commercial provider

Exhibit 1
Descriptive Statistics: Entire Data Set

Variable	Mean	Std Dev	Minimum	Maximum
ORIBAL ($ 000)	138.90	106.10	10.8	1,945
INTRATE	8.45	0.58	5.5	10.375
PREPAY	0.79	0.40	0	1
15YEAR	0.53	0.50	0	1
JUMBO	0.16	0.37	0	1
THIRDPTY	0.48	0.50	0	1

Payoff Pattern: Total originated in 1992 = 16,974; Prepaid in 1993 = 5,758; Prepaid in 1994 = 2,977; Prepaid in 1995 = 1,277; Prepaid in 1996 = 1,830; Prepaid in 1997 = 1,593; and Not Prepaid as of 12/31/97 = 3,539. Geographic Distribution: California = 16.9%; Florida = 6.6%; Illinois = 11.4%; New York = 27.3%; and All Other States = 37.8%.

Mortgage Information Corporation (MIC) was examined. MIC compiles delinquency, default and prepayment data in cross-tabular format based on a population of some twenty-four million loans nationwide. Since loan level information is not available in this data set, we confine our analysis to a comparison of mean prepayment speeds by loan product and origination year stratified by TPO versus retail origination channel.

Results

Initially, separate analyses were performed on the thirty-year and fifteen-year, conforming and non-conforming, loan types. Each exhibit first shows the descriptive statistics for that particular product type, at the loan level, and then the results of the logistic regression. Exhibits 2–9 show results for thirty-year conforming FRM, the fifteen-year conforming FRM, the thirty-year jumbo FRM and the fifteen-year jumbo FRM, respectively. Exhibits 10–11 show the results for all loan types, but separately estimated for TPO versus retail loan types (controlling for loan term and conforming loan status through additional indicator variables, *JUMBO* and *15YEAR*). The

Exhibit 2
Thirty-Year Conforming FRM: Descriptive Statistics

Variable	Mean	Std Dev	Minimum	Maximum
ORIBAL ($)	112.70	45.5	10.8	202.3
INTRATE	8.67	0.50	6.50	10.38
PREPAY	0.82	0.38	0	1
INCOME ($)	70.5	47.6	0	941
THIRDPTY	0.54	0.50	0	1

Note: *N* = 6,836 loans.

Exhibit 3
Thirty-Year Conforming FRM: Logistic Regression Results

Variable	Estimate	Standard Error	Wald Chi-Sq	Odds Ratio
Intercept	−7.06	0.17	1,694	na
MONTH	0.22	0.01	883	1.25
MONTHSQ	<−0.01	<0.01	509	1.00
INCENTIVE	0.55	0.03	281	1.75
ORIBAL	<0.01	<0.01	9.10	1.00
INCOME	<0.01	<0.01	1.86	1.00
THIRDPTY	3.35	0.09	1,430	28.60

Note: The dependent variable is *PREPAY*; −2 LOG L = 4,566; Pseudo R^2 = .33; and N = 11,195 loan months.

Exhibit 4
Fifteen-Year Conforming FRM: Descriptive Statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
ORIBAL ($)	95.3	45.80	15.0	202.3
INTRATE	8.25	0.57	6.63	10.38
PREPAY	0.77	0.42	0	1
INCOME ($)	80.20	63.7	0	1,180
THIRDPTY	0.42	0.49	0	1

Note: N = 7,892 loans.

Exhibit 5
Fifteen-Year Conforming FRM: Logistic Regression Results

Variable	Estimate	Standard Error	Wald Chi-Sq	Odds Ratio
Intercept	−7.06	0.16	1,874	na
MONTH	0.26	<0.01	1,241	1.30
MONTHSQ	<−0.01	<0.01	820	1.00
INCENTIVE	0.25	0.03	80	1.28
ORIBAL	<0.01	<0.01	11	1.00
INCOME	<−0.01	<0.01	0.03	1.00
THIRDPTY	3.98	0.09	1,848	53.5

Note: The dependent variable is *PREPAY*; −2 LOG L = 5,622; Pseudo R^2 = .34; and N = 13,558 loan months.

Exhibit 6
Thirty-Year Non-Conforming FRM: Descriptive Statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
ORIBAL ($)	301.9	95	202.4	1,425
INTRATE	8.78	0.49	7.00	10.38
PREPAY	0.90	0.29	0	1
INCOME ($)	154	99	46	1,183
THIRDPTY	0.63	0.48	0	1

Note: N = 1,307 loans.

Exhibit 7
Thirty-Year Non-Conforming FRM: Logistic Regression Results

Variable	Estimate	Standard Error	Wald Chi-Sq	Odds Ratio
Intercept	−4.10	0.29	193.70	NA
MONTH	0.07	0.01	33.60	1.08
MONTHSQ	<−0.01	<0.01	18.90	1.00
INCENTIVE	1.35	0.08	289	3.86
ORIBAL	<−0.01	<0.01	1.03	1.00
INCOME	<−0.01	<0.01	4.28	1.00
THIRDPTY	0.46	0.11	18.30	1.56

Note: The dependent variable is *PREPAY*; −2 LOG L = 518; Pseudo R^2 = .22; and N = 2,072 loan months.

Exhibit 8
Fifteen-Year Non-Conforming FRM: Descriptive Statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
ORIBAL ($)	315.70	108	203	1,575
INTRATE	8.42	0.58	6.63	10.0
PREPAY	0.88	0.33	0	1
INCOME ($)	229	150	67.8	1,096
THIRDPTY	0.62	0.48	0	1

Note: N = 697 loans.

Exhibit 9
Fifteen-Year Non-Conforming FRM: Logistic Regression Results

Variable	Estimate	Standard Error	Wald Chi-Sq	Odds Ratio
Intercept	−5.35	0.45	143	na
MONTH	0.14	0.02	55	1.15
MONTHSQ	<−0.01	<0.01	29	1.00
INCENTIVE	1.08	0.10	114	2.97
ORIBAL	<0.01	<0.01	3.10	1.00
INCOME	<−0.01	<0.01	0.84	1.00
THIRDPTY	1.69	0.18	86.80	5.42

Note: The dependent variable is *PREPAY*; −2 LOG L = 385; Pseudo R^2 = .29; and *N* = 1,110 loan months.

difference in the magnitude of the coefficient on the variable *INCENTIVE* between TPO and retail loans provides some indication of the relative sensitivity of each borrower type to refinancing opportunities. We expect TPO loans to be more responsive to refinancing incentives relative to retail loans.

While there are differences among product types, regression results are remarkably consistent, with most parameter estimates significant at the 99% level. *MONTH* is consistently positive, ranging in value from 0.07–0.26. *MONTHSQ* is consistently negative, indicating the time has a non-linear effect on refinancing probability. As expected, *INCENTIVE* is consistently positive, ranging in values from a low of 0.25 (for the fifteen-year conforming product) to a high of 1.35 (for thirty-year non-conforming FRM). These results confirm the usual finding that prepayment probability

Exhibit 10
Retail Loans Only: Logistic Regression Results

Variable	Estimate	Standard Error	Wald Chi-Sq	Odds Ratio
Intercept	−4.33	0.12	1,325	NA
MONTH	0.14	0.01	653	1.15
MONTHSQ	<−0.01	<0.01	263	1.00
INCENTIVE	0.19	0.02	79	1.21
ORIBAL	<−0.01	<0.01	0.41	1.00
JUMBO	0.80	0.08	98	2.20
INCOME	<−0.01	<0.01	37.7	1.00
15YEAR	0.07	0.04	3.2	1.07

Note: The dependent variable is *PREPAY*; −2 LOG L = 3,646; Pseudo R^2 = .19; and *N* = 17,396 loan months.

Exhibit 11
TPO Loans Only: Logistic Regression Results

Variable	Estimate	Standard Error	Wald Chi-Sq	Odds Ratio
Intercept	−6.17	0.15	1,761	NA
MONTH	0.32	0.01	1,202	1.38
MONTHSQ	−0.01	<0.01	901	1.00
INCENTIVE	1.22	0.04	816	3.39
ORIBAL	<0.01	<0.01	19	1.00
JUMBO	−0.45	0.11	18	0.63
INCOME	<0.01	<0.01	1.0	1.00
15YEAR	0.62	0.05	130	1.87

Note: The dependent variable is *PREPAY*; −2 LOG L = 5,054; Pseudo R^2 = .33; and *N* = 12,472 loan months.

increases with loan age and, of course, increases dramatically as the spread to market rate increases (as the option to prepay is in-the-money). Moreover, the magnitude of the coefficient on *INCENTIVE* is larger in the case of the thirty-year loans, compared to the fifteen-year loans, consistent with the notion that borrowers obtain greater benefits from refinancing as remaining loan term increases. The effect of loan size (*ORIBAL*) is not consistent, and is negative (but not statistically significant) in the case of thirty-year non-conforming FRM. Likewise, the effect of income is not statistically significant in three out of the four regressions and, in the case in which it is statistically significant, the magnitude is too small to be of any economic significance. The indicator variable for a third party originator (*THIRDPTY*), however, is large, positive and highly statistically significant across all regressions, ranging in value from 0.45–3.98.

In Exhibits 10 and 11, separate regressions for all loans stratified by TPO status are presented. The coefficient on *INCENTIVE* is 0.19 for retail loans and 1.21 for TPO loans. By taking the exponent of these values, we have a summary measure of the increase in the odds of prepayment, holding other factors constant. Results suggest that TPO loans are about three times more sensitive to refinancing incentives compared to retail loans.

Market level data tell a similar story, though differences are less dramatic. In Exhibit 12, TPO loans exhibit consistently higher average prepayment speeds across all products going back to 1994 loan cohorts. The pattern appears to reverse with 1993 and earlier cohorts, however. This result could occur if third parties focus their attention mainly on recent customers or if, over time, third party effects dissipate as those borrowers inclined to refinance do so, leaving behind a pool of relatively less rate sensitive, or relatively more constrained, borrowers. While these differences in mean prepayment rates are much smaller than implied by the logit coefficient

Exhibit 12
Aggregate Market Totals: July 1998 National Prepayment Speeds (in SMM)

	30-Year FRM		15-Year FRM		T-Bill ARMs	
Orig. Year	Retail	TPO	Retail	TPO	Retail	TPO
1998	0.25	0.66	0.15	0.31	0.61	1.44
1997	1.43	1.92	0.90	1.04	3.37	4.34
1996	2.31	2.74	1.31	1.47	4.21	5.16
1995	2.53	2.66	1.51	1.69	4.51	5.56
1994	2.09	2.34	1.21	1.36	3.86	3.54
1993	1.45	1.38	1.03	1.15	3.57	3.11
1992	2.73	2.56	1.51	1.59	2.99	3.11
Pre-1992	2.81	2.74	1.94	1.76	2.53	2.49

Source: Mortgage Information Corporation. Mean values use approximately 24 million loan records.

estimates, our interest here is the direction of the relationship, not precise predicted values.

Conclusion

Empirical results are consistent with the arguments advanced. Loan purchasers can monitor credit risk in the loans purchased from third parties, but prepayment risk differences are much more difficult to observe, due to the array of reasons that may cause borrowers to prepay, or fail to prepay. But third parties have economic incentives to re-finance existing loan customers at the expense of the current loan owners who bear all the prepayment risk. Both parties might benefit from more efficient risk-sharing contracts. Loan level results show that loans originated through third parties are significantly more likely to prepay, after controlling for re-financing incentive, loan size and type, loan age and borrower income. Moreover, third party loans appear about three times as sensitive to refinancing incentives, compared to retail loans.

Aggregate market level results appear generally consistent with the effects described at the loan level. Informal conversations with investment houses and mortgage traders indicate that this risk is widely appreciated, if imperfectly quantified. Future research might explore the extent to which these differences are priced in the mortgage-backed securities market, develop more precise estimates of the magnitude of the difference in prepayment speeds and formally develop optimal contracts between mortgage lenders and third party originators, given prepayment risk.

Business implications of this research are clear. Buyers of mortgages, MBS and mortgage derivatives should consider with care the source of the collateral behind the

financial assets they are purchasing. Securities issuers could provide valuable information to the bond market through additional disclosures about the extent of TPO origination in mortgage pools. Finally, mortgage banking firms may wish to re-structure contracts with TPOs to reduce the agency problem documented here.

Notes

[1] Technically, prepayments are all non-scheduled payments of principal, including full and partial prepayments, calculated as a percentage of beginning of period outstanding loan balance. Partial prepayments, sometimes called curtailments since they shorten loan term but not contractual payments, are assumed here to be de minimus. For a complete treatment of the topic of curtailment, see Fu (1998).

[2] Ross Waldrop of the FDIC quote in the *National Mortgage News*, Dec 21, 1998, p. 1.

[3] Tom Lamalfa in a speech at the annual convention of the National Association of Mortgage Brokers, as reported in *Inside Mortgage Finance*, June 26, 1998.

[4] A representative contract provision reads, "After the sale of any mortgage loan to Purchaser, TPO shall not solicit the customer or borrower for any purpose, including refinancing." These provisions are construed narrowly, so as not to preclude broad-based advertising by brokers or correspondents, which might reach existing mortgage customers.

[5] Brokers, in particular, are sales people and they may promote a switch in mortgage products even when rates are relatively stable. For example, a broker might encourage a thirty-year FRM borrower to switch to the newly available hybrid 5/1 ARM product which, priced off the short end of the yield curve, would typically carry rates 50–75 basis points below the conventional thirty-year rate.

[6] Lenders have more information about existing loan customers who, after all, have already successfully obtained mortgage loans so, absent recent financial problems, they are more likely to be approved for new loans. This statement holds if the re-financing sought is only rate and term, not cash-out refinancing, which typically involves somewhat tighter underwriting standards.

[7] Refinancing to take cash out and pay off consumer debt is particularly attractive since 1986 changes to the tax law made most consumer interest non-deductible.

[8] This is a relatively under-explored area: when and why do mortgage borrowers switch from ARM to FRM or vice-versa? Existing research on mortgage choice considers the decision as a one-time event, not a decision the borrower may revisit from time to time, as market conditions change.

[9] This is referred to as "rate-term" refinancing in the industry.

[10] Though in empirical work, both of these options appear to be highly under-exercised relative to formal option model predictions.

[11] For instance, comments of participants in a presentation of this research at SolomonSmithBarney's mortgage research department, January 6, 1998.

[12] The principal-agent problem is most often formulated as that of a owner employing a manager whose unobservable effort affects ultimate profitability. The question then is what is the optimal contract between the principal and the agent.

[13] It is this difficulty in establishing the connection between the agent's behavior and the borrower's actions that makes monitoring so difficult. By way of contrast, consider the simplicity of recourse provisions against the agent in the event of default: if the borrower is late in making

payments for some specified number of days, the principal simply demands that the loan originator repurchase the loan.

[14] We define *effort* as follows: the agent encourages the borrower to stay with the current lender or at least does not interfere with the borrower's decision to prepay or not to prepay.

[15] Mas-Colell, Whinston and Green prove this point in Proposition 14.B.1. The optimal contract specifies that the agent chooses the action e^* that maximizes $[\int \pi f(\pi|e)d\pi - \nu^{-1}(u + g(e))]$ and the principal pays the agent a fixed amount.

[16] Broadly, one may study the duration of time until an event occurs with the accelerated failure time model, the rate at which the event occurs per unit of time with hazard models, or the conditional probability of the event's occurrence at a particular point in time with discrete models. Although not equivalent, all approaches are concerned with explaining the same sort of phenomenon.

[17] Interpretation of the coefficients varies, depending on whether the explanatory variable is continuous or binary. The convenient transformation, $\exp(B_i)$, gives a simple measure of the strength of the covariate's effect on the probability of the dependent's variable's occurrence. See, for example, DeMaris (1992) for a detailed review of logistic regression.

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