

Does Regulatory Capital Arbitrage or Asymmetric Information Drive Securitization?

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Abstract

Banks face the choice of keeping loans on their balance sheet as private debt or transforming them into public debt via asset securitization. Securitization transfers credit and interest rate risk, increases liquidity, augments fee income, and improves capital ratios. Yet many lenders still choose to retain a portion of their loans in portfolio. An open research question is whether lenders exploit asymmetric information to sell riskier loans into the public markets or retain riskier loans in response to regulatory capital incentives (regulatory capital arbitrage). We examine this question empirically using micro-level data and find that securitized mortgage loans have experienced lower ex-post defaults than those retained in portfolio, providing evidence consistent with the latter explanation for securitization.

Keywords: banks, debt, securitization, regulatory capital

1. Introduction

Securitization is one of the major financial innovations to have occurred over recent decades (Greenspan [2000]). In securitization, heterogeneous and illiquid individual loans are combined into relatively homogenous pools and transformed into highly liquid bonds traded in dealer markets and generically referred to as asset-backed securities. Such assets now permeate fixed income portfolios at both the institutional and individual investor level. While the largest and most well known example of securitization is the residential mortgage market, over the past decade securitization has spread rapidly into home equity loan markets, commercial loan markets, credit card receivables, auto loans, small business loans, corporate loans, and other loan types. Although better developed in the U.S. than in most other industrialized nations, securitization is expanding into foreign markets as well (see, for example, Taylor [1996] for a summary of securitization activity in European markets).

Asset securitization creates value by increasing liquidity, reducing or reallocating credit or interest rate risk, improving leverage ratios, and allowing recognition of accounting gains. Moreover, many of these securities provide the raw material for synthetic securities traded in derivatives markets, expanding the market for the underlying asset. In the process financial re-engineering can create entirely new cash flow patterns tailored to meet diverse clientele needs. Investors are attracted to the spread over government security rates on asset-backed securities and trade-off liquidity, interest rate, call, and credit risk for the higher yields available in the asset-backed market.¹

¹ See Bernardo and Cornell [1997] for an empirical analysis of Wall Street pricing of derivatives backed by mortgage-backed securities.

According to the Bond Market Association, as of the end of the third quarter of 2002, the asset-backed market comprised just under one-third of the total \$19 trillion bond market. Within this category, mortgage-related assets were the largest component, comprising approximately \$4.7 trillion, with other asset-backed securities totaling \$1.5 trillion. The combined category, and even the mortgage-related category alone, exceeds the size of the treasury market (\$3.2 trillion) or the corporate bond market (\$4.0 trillion). Yet banks and thrifts still hold approximately \$2.6 trillion in mortgage loans on their balance sheets, representing about one-third of all outstanding mortgage debt (including both public and private forms). How and why has this pattern developed?

Securitization first appeared in the residential mortgage market in the early 1980s and received a major boost when the Tax Reform Act of 1986 incorporated legislation authorizing Real Estate Mortgage Investment Conduits (REMICs), a tax and accounting favored structure under which assets to be securitized are transferred to a bankruptcy-remote trust, thereby insulating performance of securities issued from the financial position of the issuer.² As a result, by 1993, private issuers accounted for 15% of total mortgage-backed securities volume (Korrell [1996]).

Furthermore, in the US mortgage market, a well-developed institutional structure exists to facilitate securitization for the majority of loans. Freddie Mac and Fannie Mae

² Ranieri [1996] traces the origins of securitization in the United States to the late 1970s when the word itself first appeared in the *Wall Street Journal*. Kendall [1996] discusses the institutional requirements for securitization to develop. Furthermore, Thomas [2001] notes that securitization is a natural response to information asymmetries arising from project financing as well as comparative advantages in loan servicing. For example, the signaling model developed by Greenbaum and Thakor [1987] suggests that securitization allows financing of projects having significant information asymmetry between borrower and lender, while the risk allocation models of Benveniste and Berger [1987] and James [1988] indicate that securitization overcomes potential wealth transfers from shareholders to depositors, allowing lenders to fund project that otherwise would not be funded. As a result, securitization is a natural response to the underinvestment problem proposed by Myers [1977], which suggests that firms may forgo profitable

(together the government-sponsored enterprises, the agencies, or the GSEs) were chartered by Congress specifically to create a secondary market in mortgage debt to ensure the continued availability of funds for housing finance.³ Both agencies purchase loans under either cash or swap programs (Fabozzi and Dunlevy [2001]). In the swap program, large pools of loans are swapped with a single lender in return for a mortgage-backed security collateralized by the same pool of loans. Interest on the pool of loans covers servicing costs, typically paid to the originator, a guaranty fee paid to the agency, and the balance of the available interest payments are available for the coupon on the security. Under the cash program, the agencies purchase smaller pools of loans and combine them into larger multi-lender pools and issue securities backed by them. In either case, the originator can realize all loan fees collected in excess of costs as current period profits, and can continue to earn ongoing fees for loan servicing with limited balance sheet exposure and without any credit risk.⁴

After authorization of REMICs in 1986, a market in non-agency mortgage-backed securities also developed. Non-conforming loans may be securitized in these private label issues, though alternative credit enhancement structures are required, since guaranties are not available from the agencies. Non-conforming loans are either too large to meet conforming size limits (jumbos), or do not meet agency underwriting guidelines (Alt-A or subprime). Typically, multi-class securities are issued with subordinate tranches bearing most of the credit risk. In this case, credit risk may not be completely

investment opportunities if such investments result in possible wealth transfers from equity holders to debt holders.

³ Initially Fannie Mae created a market a government-insured mortgage loans and Freddie Mac created an analogous market for conventional loans, at that time originated mainly by savings institutions.

⁴ This assumes the originator's credit quality is sufficient to sell loans on a non-recourse basis, which is not always the case. If lenders produce poor quality loans, the GSEs may condition future purchases on recourse.

transferred since issuers sometimes retain subordinate pieces of the security. Collateralized mortgage obligations (CMOs) further reallocate risk by prioritizing receipt of amortization, both scheduled and unscheduled prepayments, to allow expected maturities to be more precisely defined.⁵

Regardless of the mode or outlet, securitization increases liquidity for the originator. Under the agency swap program, the originator receives a liquid asset in the form of a mortgage-backed security; under the cash program, the lender has cash proceeds to reinvest, either in additional mortgage lending or in alternative liquid instruments, such as treasury securities. Under a non-agency REMIC structure, the lender will receive cash proceeds net of transaction costs from sale of the multi-class securities issued.

For banks, an additional benefit is that securitization reduces the level of regulatory capital required. Under current Basel capital rules, residential mortgage loans that have been prudently underwritten generally require a 50% risk-weighting; i.e. 2% capital (50% times the 4% standard tier one capital requirement), whereas agency securities require only a 20% risk weighting; i.e. 0.8% capital. For details on the bank capital rules and current proposals to make requirements better conform to actual risk levels, see Calem and LaCour-Little [2003]. They argue that, for most mortgage loans, existing regulatory capital levels are too high, creating an incentive to securitize the least risky loans. Furthermore, Passmore, Sparks and Ingpen [2002] demonstrate that the incentive to securitize loans declines as regulatory capital requirements increase. Consistent with some of the literature, we refer to the decision to hold an asset in

⁵ As of year-end 2002, almost \$1.0 trillion in agency CMOs were outstanding (Source: The Bond Market Association).

securitized form to minimize regulatory capital requirements as regulatory capital arbitrage.

In addition to regulatory capital rules favoring securitization, the presence of information asymmetries also encourages securitization. If we assume that the lender is better informed about the credit quality of the borrower than the purchasers of the securitized debt, then the purchasers of securitized debt may set credit standards that are higher than those of the lender in order to protect themselves against the possible “lemons market” outcome suggested by Akerlof [1970]. For example, DeMarzo and Duffie [1999], using a liquidity based model of securitization show that if asymmetric information results in the lender facing a downward sloping demand curve for its mortgage backed security, then an optimal strategy is to retain a portion of the asset in portfolio. Their model implies that if the issuer does not wish to retain any portion of the mortgage backed security, then she should sell only those loans having the lowest degree of asymmetric information into the pool and retain those loans with high degree of asymmetric information. Hence, the lender may retain loans that are higher risk (and have higher rate spreads) than those sold to the secondary loan market. As a result, we would predict that retained loans have a higher incidence of default than those sold to the secondary market.

If lenders wish to reduce regulatory capital requirements, transfer credit and interest rate risk, and increase liquidity, we would expect to see most loans securitized. On the other hand, if firms prefer diversification to specialization, they may retain some percentage of the loans in their portfolio (see Winton [1999] for a discussion of diversification versus specialization in lending). If existing risk-based capital rules

require too much capital for low risk loans and too little capital for higher risk loans, we would expect to see the lower risk loans securitized and the higher risk loans retained in portfolio. Furthermore, since banks typically have ongoing contracts to sell loans in the secondary market, they have an interest in maintaining their reputation for credit quality so as not to lose market access. This repeated game structure provides another reason to expect that securitized loans should be relatively safer than those retained by banks in portfolio.

In addition to the liquidity benefits of securitization, one must consider differences in default probability. For example, Carey [1998] found that default rates on corporate bond debt placed in private portfolios were less than the default rates on loans sold into the public debt market. The implication for the lending market is that firms should be able to offer lower rates relative to the loans sold in the public market on a risk-adjusted basis. Hence, the advantages of liquidity must be measured against the differentials in ex-ante default risk of loans that are securitized versus loans that are kept in the firm's investment portfolio.

In this paper, we empirically examine the *ex-post* performance of securitized and unsecuritized loans with the goal of determining whether securitization is a natural by-product of information asymmetries present in the loan market or whether securitization occurs in response to lender incentives resulting from bank capital regulations. Our analysis is based on approximately 14,000 mortgage loans originated between 1995 and 1997 and observed through the year 2000. These loans represent a broad spectrum of the mortgage market (both conventional and jumbo) with approximately 95 percent being ultimately securitized. To preview our empirical findings, we find that higher risk loans

are indeed retained in portfolio, while lower risk loans are securitized, confirming the implications of Calem and LaCour-Little [2002] and DeMarzo and Duffie [1999], and contrary to the results of Carey [1998], working with corporate bond debt data and private placements.

2. Data

The data used for this research consist of event histories on 14,285 conventional fixed rate mortgages originated between January 1995 and December 1997. Both conforming and non-conforming loans are included, although super-jumbos (loans with initial balances in excess of \$650,000) are not. Loans were originated throughout the United States. Table 1 reports the distribution of the loans by origination year and Table 2 shows the geographic distribution of the sample. Since our data comes from a single lender, we compared the sample distribution to the MIRS and Home Mortgage Disclosure Act (HMDA) databases. The distribution of mortgage originations across years follows a similar pattern as observed in the broader market. However, the comparison indicates that our sample is somewhat over represented by loans in the New York/New Jersey region and under represented in the Northwest and Southwest regions.⁶

We have relatively complete micro-level data for each loan in the sample including geographic location, loan amount, note rate, and points paid at time of loan origination. We also observe major credit quality indicators, including loan-to-value ratio (*LTV*) and borrower credit score at time of origination (*FICO*).⁷ Borrower characteristics available include age (*BRWAGE*) and income (*INCOME*). Table 3 reports

⁶ Tables detailing the comparison of our sample with the broader market are available upon request.

the descriptive statistics for the sample, segmented by origination year and outcome. In general, we find that loans sold to the GSEs had lower loan-to-value ratios at origination than loans held in portfolio or sold as private label MBS. Across origination years, we see a general decline in LTV in the later years, which is consistent with greater refinancing activity in 1996 and 1997 than in 1995.

In general, credit quality appears to have increased year over year, with declining LTVs and increasing credit scores. However, we note that differences do exist across the three samples. In general, borrower credit quality is lower for loans held in portfolio and highest for loans sold to the GSEs. For example, in 1997 borrower credit scores averaged 693 for loans held in portfolio versus 719 for loans sold to the GSEs. We also find smaller differences in borrower age at origination (our proxy for wealth) with loans sold to the GSEs having a higher average borrower age. However, loans sold to the GSEs have lower average borrower income at origination. Consistent with housing market appreciation, loan amounts increased over time, and we find that loan amounts for loans sold as private label MBS are consistently greater than loans held in portfolio or sold to the GSEs. For example, loans sold as private label had an average balance in 1997 of \$264,900 while the average loan balance for loans held in portfolio was \$123,600.

Overall, we note that 72 percent (10,246) of the loans were sold to the GSEs, 23 percent (3,288) were sold as private label MBS, and 5 percent (751) were retained in the lender's portfolio. However, the breakdown by origination year indicates a subtle trend away from retaining loans in portfolio. For example, in 1995 we see that 8.5 percent of loans originated were retained in portfolio but by 1997 only 3.1 percent of the loans

⁷ Borrower credit quality is measured by the credit score obtained from the Fair, Isaac and Company (FICO). Higher scores indicate higher quality borrowers.

originated that year were retained. As a result, we see a corresponding increase in the percentage of loans that were sold into the secondary market.

We can identify at least two possible reasons for this shift in loan disposition. First, it could simply result from changes in average borrower characteristics over time, with more borrowers meeting secondary market standards seeking loans in 1997 than in 1995. This would be consistent with the observed increase in mortgage refinancing that occurred during 1997 as interest rates fell. On the other hand, the observed change in loan disposition may represent a shift in risk preferences by the lender.

3. Ex-post Defaults and Prepayments on Securitized and Portfolio Loans

In this section we estimate an empirical model of prepayment and default using borrower information available to the lender at the time of underwriting. The purpose of this model is to estimate *a priori* prepayment and default probabilities for each borrower. We use these estimated probabilities in the next section to examine the risk profile of loans that are securitized versus those that are retained in portfolio.

It is well known that a mortgage borrower has the option to prepay the mortgage, default, or continue the mortgage by making the payment due. In estimating a competing risks model, we denote mortgages that are still current at the end of the observation period as censored. Thus, we define T_j ($j=1,2,3$) as the latent duration for each loan to end by prepaying, defaulting, or being censored and the observed duration, τ is the minimum of the T_j .

Conditional on a set of explanatory variables, x_j , that include personal characteristics as well as market conditions at the time of origination, the probability density function (*pdf*) and cumulative density function (*cdf*) for T_j are

$$f_j(T_j | x_j; \theta_j) = h_j(T_j | x_j; \theta_j) \exp(-I_j(r_j | x_j; \theta_j)) \quad (1.)$$

$$F_j(T_j | x_j; \theta_j) = 1 - \exp(-I_j(r_j | x_j; \theta_j)) \quad (2.)$$

where I_j is the integrated hazard for outcome j :

$$I_j(T_j | x_j; \theta) = \int_0^{T_j} h_j(s | x_j; \theta_j) ds \quad (3.)$$

and h_j is the hazard function.

The joint distribution of the duration and outcome is

$$f(\tau, j | x; \theta) = h_j(\tau | x_j; \theta_j) \exp(-I_0(\tau | x; \theta)) \quad (4.)$$

where $x = (x_1, x_2, x_3)$, $\theta = (\theta_1, \theta_2, \theta_3)$ and $I_0 = \sum I_j$ is the aggregated integrated hazard. Thus the conditional probability of an outcome is

$$\Pr(j | \tau, x; \theta) = \frac{h_j(\tau | x_j; \theta)}{\sum_{j=1}^3 h_j(\tau | x; \theta)}. \quad (5.)$$

In order to simplify estimation, we specify a separate exponential hazard function for each mortgage outcome

$$h_j(\tau_j | x_j; \theta_j) = \exp(x_j' \beta_j). \quad (6.)$$

and estimate (5) in a multinomial logit framework.

Since the purpose of the competing risks model is to obtain an unbiased expectation of borrower prepayment and default risk, we divide our sample an estimation sample and a holdout sample. We estimate (5) using the estimation sample. Using the estimated coefficients, we then calculate the predicted prepayment and default

probabilities for the loans in the holdout sample. This scheme avoids introducing bias into the subsequent analysis by using *ex ante* outcome probabilities based on *ex post* realizations. In order to only use information (or statistical inferences) available at loan origination, we place all loans originated in 1995 or 1996 in the estimation sample and reserve the loans originated in 1997 as the holdout sample. Thus, we are using information about loans originated in 1995 and 1996 to develop empirical prepayment and default models that will be used to calculate predicted prepayment and default probabilities for loans originated in 1997.

Table 4 presents the parameter estimates of the competing risks model estimated from the estimation sub-sample. Again, our purpose here is to obtain forward looking prepayment and default probabilities and thus we only use information about the borrower that was available at origination. Therefore, the set of explanatory variables (x_j) includes the borrower's credit score (*FICO*) at origination, the borrower's age and income at origination (*BRWAGE* and *INCOME*), the mortgage loan-to-value ratio at origination (*LTV*), the discount points paid by the borrower at origination (*DISCPTS*), and a dummy variable indicating whether the loan was eligible for sale to the GSEs at origination (*CONFORM*).⁸ Following Ambrose and Pennington-Cross [2000], we also include a set of dummy variables that classify states based on judicial versus non-judicial foreclosure laws and deficiency versus non-deficiency judgment states in order to control for differences in state laws regarding mortgage default and foreclosure. q_1 indicates

⁸ Although we know the actual loan status at the time the dataset was created (i.e. whether sold to Fannie Mae or Freddie Mac, sold to a private label MBS, or retained in portfolio), we cannot precisely determine whether the mortgage was conforming at origination. Thus, we classify a mortgage as conforming if it was sold to the agencies, or the borrower FICO score is above 660 and the loan amount was below the conforming loan limit in place at time of origination and the LTV is either less than 80 percent, or the loan has private mortgage insurance if the LTV is greater than 80 percent.

states that have non-judicial foreclosure available and allow lenders to obtain deficiency judgments;⁹ q_2 indicates states that have non-judicial foreclosure available but do not allow deficiency judgments;¹⁰ q_3 indicates states that require judicial foreclosure and allow deficiency judgments;¹¹ and finally q_4 indicates states that require judicial foreclosure and do not allow deficiency judgments.

Consistent with theoretical predictions, we note that the probability of prepayment increases and the probability of default decreases with borrower credit quality. That is, borrowers with higher FICO scores at origination are more likely to prepay and less likely to default. The odds-ratio estimates indicate that every one point increase in borrower credit quality at origination reduces the probability of default by 0.1% and increases the probability of prepayment by a similar percentage. Furthermore, we note that younger borrowers with higher incomes at origination have higher prepayment probabilities. We also see that the loan-to-value ratio at origination also has the expected effect on prepayment and default, with the probability of prepayment declining and the probability of default rising as the loan-to-value ratio at origination increases. Furthermore, we see that discount points paid at origination have the expected impact on prepayment. That is, borrowers who pay points are less likely to prepay.¹² Not surprisingly, given the underwriting guidelines established by the Fannie Mae and Freddie Mac, the competing risk estimation shows that mortgages that fall into the ‘conforming loan’ category have lower probabilities of prepayment and default.

⁹ q_1 indicate AL, AR, DC, GA, HI, MO, IA, MA, MD, MI, MS, RI, NE, NH, NM, NV, NY, TN, UT, VA, WV, WY, CO.

¹⁰ q_2 indicate AK, AZ, CA, ID, OK, ME, MN, MT, NC, OR, SD, TX, WA.

¹¹ q_3 indicate CT, DE, FL, IL, IN, KS, KY, NJ, OH, PA, SC, VT.

¹² See Stanton and Wallace [1998] and Kau and Keenan [1987] for a discussion of the impact of mortgage points on borrower prepayment.

Using the parameter estimates from Table 4, we compute the predicted prepayment and default probabilities for the borrowers in the holdout sub-sample. Table 5 reports the mean predicted cumulative prepayment and default probabilities for 12, 24, 36, 48, and 60 months after origination. Based on our estimated model, we find that the average probability of prepayment for the first twelve months is 1.3 percent and the average probability of default is 0.1 percent. As the mortgages season, the cumulative probability of prepayment rises to 61.6 percent by month 60 and the cumulative probability of default rises to 8.1 percent.

Table 5 also reports the predicted cumulative outcome probabilities based on the disposition of the loan after origination. In general, we find that the prepayment probabilities for mortgages retained in portfolio, sold to the GSEs, or sold as private label MBS are roughly the same. The prepayment probabilities for mortgages sold as private label MBS are slightly higher (66 percent by month 60 versus 60.8 percent for mortgages sold to the GSEs or 53 percent for mortgages retained in portfolio). However, we find that the probability of default is higher for mortgages retained in portfolio than for loans sold to the secondary market. The cumulative probability of default by month 60 is 12.5 percent for loans held in portfolio versus 7.4 percent for loans sold to the GSEs and 10.0 percent for loans sold to private label MBS. Again, this is consistent with the observed pattern of the GSEs imposing tighter underwriting standards on the mortgages that they will accept. In addition, the observed pattern is consistent with our expectations concerning the loans that the lender would sell to the GSEs given the GSE practice of requiring lenders to buy back defaulted mortgages if the default experience is outside acceptable limits.

4. The Decision to Securitize

We now turn to the question of whether the predicted prepayment and default probabilities have a systematic impact on the lender's decision to securitize the loan. In the introduction, we noted two possible theories for securitization. First, originators may wish to retain high risk loans and securitize low risk loans in response to bank capital regulations. Second, originators may take advantage of asymmetric information to securitize less profitable loans (based on risk/return). With respect to the first theory, if bank capital regulations do impact loan portfolio decisions, then we would expect to find a positive relationship between expected default probabilities and the probability of retaining the loan in portfolio. That is, higher risk loans as revealed by higher expected default probabilities are more likely to be retained in portfolio. The second theory suggests that originators will utilize inside information to selectively securitize loans – that is, originators will securitize loans with lower expected profitability. Here, the tradeoff between higher risk and securitization is not as clear. The originator may find it more profitable to keep higher risk loans if the corresponding yield spread justifies the risk. This suggests that we must examine the probability that a loan is retained in portfolio relative to expected prepayment and default potential as well as loan yield spread at origination.

In order to determine whether a particular loan is over or under priced relative to other loans originated by the lender, we follow Ambrose, LaCour-Little and Sanders [2003] and estimate an ordinary least squares regression of the mortgage yield spread at origination. We calculate the mortgage yield spread (*YLDSPD10*) as the effective

mortgage yield, including the effect of points calculated over a 10-year holding period, less the 10-year constant maturity Treasury rate. To control for characteristics that impact mortgage yields, we follow the standard yield spread models developed in the literature and include as independent variables the loan amount, the mortgage loan-to-value ratio, a dummy variable denoting whether the loan amount is above the conforming loan limit, a dummy variable denoting whether the loan meets the GSE conforming loan standards, the borrower's credit quality score, a set of dummy variables controlling for location, the current local house price and market interest rate volatilities, the market credit risk premium – defined as the difference between the 'AAA' bond index and the 'Baa' bond index, the yield curve slope – calculated as the difference between the 10-year and 1-year Treasury bond rates, and a set of dummy variables that categorize states based on judicial versus non-judicial foreclosure laws and deficiency versus non-deficiency judgment states in order to control for differences in legal environment.¹³ Table 6 reports the results of the OLS regression estimation for the loans originated in 1997 (the holdout sample). All coefficient estimates have the expected signs. From this estimation, we collect the residuals to provide an indication of which loans are over or under priced relative to the other loans originated in 1997. Based on the distribution of the residuals, we categorize loans as being under priced if the residual is negative and in the bottom quartile of the distribution (*low_spd* = 1). We categorize loans as being over priced if the residual is positive and the top quartile of the distribution (*high_spd* = 1).

In order to determine the probability that a loan will be held in portfolio, we estimate the following logit model:

¹³ McKenzie [2002] provides an extensive survey of empirical mortgage yield spread modeling efforts.

$$\begin{aligned} \Pr(\text{Portfolio} = 1) = & \beta_0 + \beta_1 \text{yldspd10} + \beta_2 \text{Jumbo} + \beta_3 \text{cred_spd} + \beta_4 \text{yldcurve} + \beta_5 \sigma_r \\ & + \beta_6 \text{prepay} + \beta_7 \text{default} + \beta_8 \text{prepay} * \text{low_spd} + \beta_9 \text{prepay} * \text{high_spd} \quad (7.) \\ & + \beta_{10} \text{default} * \text{low_spd} + \beta_{11} \text{default} * \text{high_spd} + \varepsilon \end{aligned}$$

where *prepay* and *default* are the cumulative 24 month prepayment and default probabilities estimated from (5), and *low_spd* and *high_spd* are the indicator variables calculated from the residuals of the yield spread regressions indicating whether the actual mortgage yield spread is low or high relative to the predicted yield spread. Thus, equation (7) controls for the lender's expectation of default and prepayment risk at the time of origination as well as the interaction of risk expectations and price. The variables *cred_spd*, *yldcurve*, and σ_r are macro economic variables that represent the market credit spread, slope of the yield curve, and interest rate volatility at loan origination. We calculate *cred_spd* as the yield difference between Moody's 'AAA' and 'Baa' bond indices. The yield curve slope is estimated as the difference between the 10-year and 1-year Treasury bond rates. We use the standard deviation in the 1-year Treasury bond rate over the 24 months prior to origination as a proxy for the expected volatility in the risk-free interest rate. Including these variables allows us to test for market conditions that may lead to increased probability for securitization. We also include the mortgage yield spread (*yldspd10*) and a dummy variable controlling for whether the loan amount is above the conforming loan limit (*jumbo*).

Table 7 reports the parameter coefficients for the generalized logit estimation of (7). The model estimates the probability that the loan will be retained in the lender's portfolio versus being sold into the secondary market (either to the GSEs or as private label MBS). Consistent with the expectations that secondary market players effectively bid away loans that meet their underwriting standards, the coefficient for the expected 24

month default probability is significantly positive. This indicates that loans with higher expected default probabilities are more likely to be retained in portfolio and less likely to be sold into the secondary market. The expected probability of prepayment is significantly negatively related to the decision to retain the loan. That is, loans with higher expected prepayment rates are less likely to be retained and more likely to be securitized. These results are consistent with the theory that lenders have an incentive to retain higher risk loans in portfolio.

Turning to the interaction of the default and prepayment probabilities with the indicator of over or under pricing, we find that the interaction of prepayment and low spread is highly significant. This suggests that for loans with actual yield spreads less than spreads predicted by our model, the probability of being retained in portfolio increases as the expected prepayment probability increases. In other words, loans with higher prepayment probabilities and yield spreads lower than expected are more likely to be held in portfolio. Interestingly, the interactions of expected default probabilities with the residual spread indicators are not significant. Thus, we do not find evidence that the originator is utilizing asymmetric information to selectively retain high yielding, low risk mortgages.¹⁴ However, we do find evidence that the originator is selectively retaining mortgages based on expected prepayment. Given that the mortgage yields were calculated assuming a constant 10-year holding period, early prepayment has the impact of increasing the lender's yield. Thus, the results indicate that the originator may be utilizing asymmetric information to retain mortgages that the market has undervalued (actual yield spreads are lower than predicted yield spreads), but have a higher probability of realizing a boost in yield through early prepayment.

Finally, we observe that loans originated during periods with increased credit spreads are less likely to be retained while loans originated in periods with steeper yield curves are more likely to be retained in portfolio. This is consistent with investor “flight to quality” during periods of economic uncertainty resulting in reduced demand for mortgages in secondary market. Together, the coefficients on expected default probability and economic conditions are consistent with the theory that lenders are retaining the higher risk mortgages in portfolio in response to bank capital regulations.

5. Summary and Conclusions

Banks have the choice of securitizing loans that they have originated or retaining them in portfolio. While there are many reasons to securitize loans into the secondary market, there are countervailing reasons for retaining them in the bank’s loan portfolio. Among the reasons for keeping loans in portfolio is the knowledge that the loans are superior performers (asymmetric information). Previous research by Carey [1998] indicates that loans sold in private placements have lower default rates than those sold into the secondary (or public) market, providing some support for the asymmetric information hypothesis.

On the other hand, secondary market participants such as Fannie Mae and Freddie Mac have strict underwriting criteria for purchasing loans from banks and in a repeated game framework it is difficult to justify the asymmetric information hypothesis. Rather, we would expect banks to retain loans that secondary market participants do not want to purchase (which includes loans with higher risk than secondary market participants are willing to purchase). Moreover, if Calem and LaCour-Little [2002] are correct that

¹⁴ This result is consistent with the theoretical predictions of Passmore and Sparks [1996].

existing risk-based capital requirements for most mortgage loans are too high, lenders would have an incentive to sell lower risk and retain higher risk assets in portfolio.

In the empirical work presented here, we find evidence that lenders do indeed retain higher risk loans for their portfolio while selling lower risk loans into the secondary market. Furthermore, we find that riskier loans (loans having higher expected prepayment and default probabilities) are more likely to be sold as private label MBS, which is contrary to the findings of Carey [1998], although his results relate to corporate bond debt sold through private placements, so the comparison is imperfect. Thus, our analysis supports the regulatory capital arbitrage explanation for asset securitization.

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Table 1
Distribution of Mortgage Loans by Origination Year

This table reports the frequency distribution by year for the sample of 14,285 conventional fixed rate mortgage loans originated between January 1995 and December 1997 by a national lender that prefers anonymity. Both conforming and non-conforming loans are included, although super-jumbos (loans with initial balances in excess of \$650,000) are not. Loans were originated throughout the United States.

Year	Frequency	Percent
1995	4,695	32.9
1996	3,265	22.9
1997	6,325	44.3
Total	14,285	100.0

Table 2
Distribution of Mortgages Across Origination Year, Geographic Region and by Outcome
(Percent of Total Loans Originated in Each Year by Region and Outcome)

	Held in Portfolio			Sold to GSE			Sold to Private Label		
	1995	1996	1997	1995	1996	1997	1995	1996	1997
HUD Region	2.8%	1.2%	1.6%	3.5%	3.4%	4.2%	1.8%	4.8%	6.8%
1: New England	35.0%	65.2%	65.8%	34.0%	37.5%	35.7%	24.0%	29.2%	28.7%
2: New York/New Jersey	6.5%	9.9%	11.9%	7.2%	7.4%	9.9%	11.4%	14.7%	12.5%
3: Mid-Atlantic	3.5%	4.3%	6.2%	10.9%	11.9%	11.3%	6.0%	6.0%	5.7%
4: Southeast	17.6%	6.8%	2.6%	19.0%	19.8%	16.7%	12.1%	13.9%	12.7%
5: Midwest	0.0%	0.6%	0.0%	6.4%	3.5%	4.0%	0.9%	1.5%	1.3%
6: Southwest	7.8%	1.2%	0.5%	6.4%	3.5%	2.6%	2.0%	0.2%	1.0%
7: Great Plains	0.0%	0.6%	1.0%	1.9%	1.2%	1.4%	0.1%	1.1%	1.1%
8: Rocky Mountain	26.7%	9.9%	10.4%	9.7%	11.2%	13.3%	41.7%	28.3%	29.9%
9: Pacific	0.0%	0.0%	0.0%	0.9%	0.6%	0.9%	0.0%	0.3%	0.4%
10: Northwest	397	161	193	2930	2485	4831	1368	619	1301
Total Loans									

Table 4
Competing risks model of mortgage outcome.

$$\Pr(j | \tau, x; \theta) = \frac{h_j(\tau | x_j; \theta)}{\sum_{j=1}^3 h_j(\tau | x; \theta)}$$

The competing risks model is estimated as a multinomial logit model. The odds ratio estimates are calculated as e^β and provide an indication of the sensitivity of the estimated probabilities to a change in that variable.

Variable	Label	Coefficients		Odds Ratio Estimates	
		Prepay	Default	Prepay	Default
Intercept		-8.521*** (814.93)	-7.011*** (84.39)		
FICO	Fair Isaac Credit Score	0.002*** (26.90)	-0.008*** (117.11)	1.00	0.99
BRWAGE	Borrower Age	-0.014*** (63.07)	0.002 (0.24)	0.99	1.00
Income	Borrower Income	0.001*** (35.36)	-0.002** (3.89)	1.00	1.00
LTV	Loan-to-value Ratio	-0.631*** (29.93)	1.178*** (10.25)	0.53	3.25
Discpt	Discount Points Paid at Origination	-0.184*** (70.38)	0.014 (0.08)	0.83	1.01
q2	Non-judicial, No Deficiency	0.212*** (20.14)	0.130 (1.29)	1.24	1.14
q3	Judicial & Deficiency	0.182*** (20.75)	0.011 (0.01)	1.20	1.01
q4	Judicial, No Deficiency	0.538*** (5.59)	-9.291 (0.01)	1.71	<0.001
Conform	1=conforming loan	-0.037 (0.68)	-0.264*** (5.92)	0.96	0.77
Time	Number of months since origination	0.232*** (1150.42)	0.271*** (178.28)	1.26	1.31
Time ²	Time*Time	-0.003*** (981.62)	-0.003*** (146.18)	1.00	1.00
Likelihood Ratio Statistic		2964.5***			

(Chi-square statistics reported in parentheses)

- *** - significant at the 1% level.
- ** - significant at the 5% level.
- * - significant at the 10% level.

Table 5

Predicted Cumulative Prepayment and Default Probabilities

Predicted prepayment and default probabilities are calculated for each borrower in the hold-out sample using the estimated coefficients reported in Table 4. Sample means reflect the expected cumulative prepayment and default probabilities at 12, 24 36, 48 and 60 months since mortgage origination.

	Full Sample N=6,325		Held in Portfolio N=193		Sold to GSEs N=4,831		Sold as Private Label N=1,301	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A: Cumulative Prepayment Probabilities								
Month 12	0.013	0.003	0.011	0.003	0.013	0.003	0.014	0.004
Month 24	0.090	0.023	0.078	0.021	0.089	0.022	0.096	0.027
Month 36	0.285	0.074	0.247	0.067	0.281	0.070	0.306	0.087
Month 48	0.506	0.132	0.437	0.118	0.499	0.123	0.543	0.155
Month 60	0.616	0.161	0.533	0.144	0.608	0.150	0.661	0.188
Panel B: Cumulative Default Probabilities								
Month 12	0.001	0.000	0.001	0.001	0.001	0.000	0.001	0.001
Month 24	0.006	0.004	0.009	0.007	0.005	0.004	0.007	0.006
Month 36	0.026	0.019	0.040	0.029	0.024	0.015	0.032	0.025
Month 48	0.058	0.042	0.090	0.064	0.053	0.034	0.072	0.055
Month 60	0.081	0.058	0.125	0.089	0.074	0.048	0.100	0.077
ydspdmi	1.548	0.283	1.790	0.572	1.533	0.265	1.566	0.269

Table 6
Yield Spread Regression

Ordinary Least Squares (OLS) regression of mortgage yield spread at origination. The mortgage yield spread (*YLDSPD10*) is the effective mortgage yield, including the effect of points calculated over a 10-year holding period, less the 10-year constant maturity Treasury rate. Independent variables are the loan amount (*logbal*), the mortgage loan-to-value ratio (*logltv*), a dummy variable denoting whether the loan amount is above the conforming loan limit (*jumbo*), a dummy variable denoting whether the loan meets the GSE conforming loan standards (*conform*), the borrower's credit quality score (*logfico*), a set of dummy variables controlling for location (*midwest*, *south*, *west*), the current local house price (*loghpistd*) and market interest rate (*logsiggs10*) volatilities, the market credit risk premium (*logcredit*) – defined as the difference between the 'AAA' bond index and the 'Baa' bond index, the yield curve slope (*logyldcurve*) – calculated as the difference between the 10-year and 1-year Treasury bond rates, and a set of dummy variables that categorize states based on judicial versus non-judicial foreclosure laws and deficiency versus non-deficiency judgment states in order to control for differences in legal environment (*q2,q3,q4*).

Variable	Parameter		
	Estimate	t Value	Pr > t
Intercept	9.165***	22.51	<.0001
Conform	-0.036***	-3.29	0.001
Jumbo	0.112***	8.12	<.0001
Logltv	-0.020**	-2.38	0.017
Logcredit	-0.533***	-4.81	<.0001
Logfico	-0.165***	-5.95	<.0001
Logbal	-0.109***	-20.10	<.0001
Loghpistd	0.006	0.75	0.452
logsiggs10	16.604***	16.43	<.0001
Logyldcurve	-0.537***	-22.97	<.0001
q2	-0.010	-1.00	0.318
q3	0.025***	3.88	0.000
q4	-0.015	-0.46	0.644
South	-0.039***	-4.71	<.0001
Midwest	-0.002	-0.20	0.839
West	0.010	0.91	0.364

F-statistic: 88.7***

Adjusted R²: 0.1722

*** - significant at the 1% level.

** - significant at the 5% level.

* - significant at the 10% level

Table 7

Impact of Expected Prepayment and Default Probabilities on Securitization

Estimated coefficients of the following logit model of the probability that a loan is securitized:

$$\Pr(\text{Portfolio} = 1) = \beta_0 + \beta_1 \text{yldspd10} + \beta_2 \text{Jumbo} + \beta_3 \text{cred_spd} + \beta_4 \text{yldcurve} + \beta_5 \sigma_r + \beta_6 \text{prepay} + \beta_7 \text{default} + \beta_8 \text{prepay} * \text{low_spd} + \beta_9 \text{prepay} * \text{high_spd} + \beta_{10} \text{default} * \text{low_spd} + \beta_{11} \text{default} * \text{high_spd} + \varepsilon$$

prepay and *default* are the estimated cumulative 24 month prepayment and default probabilities, *low_spd* and *high_spd* are dummy variables calculated from the residuals of the yield spread regression indicating whether the actual mortgage yield spread is low or high relative to the predicted yield spread, *cred_spd* is the yield difference between Moody’s ‘AAA’ and ‘Baa’ bond indices, *yldcurve* is estimated as the difference between the 10-year and 1-year Treasury bond rates, σ_r is the standard deviation in the 1-year Treasury bond rate over the 24 months prior to origination, *yldspd10* is the mortgage yield spread at origination, *jumbo* is a dummy variable controlling for whether the loan amount is above the conforming loan limit.

Variable	Label	Parameter	Chi-Sq	Odds Ratio
Intercept		-6.485 ^{***}	9.46	
Yldspd10	Effective yield – 10-yr Treasury Rate	3.055 ^{***}	93.90	21.22
Jumbo		-0.018	0.01	0.98
cred_spd	Credit Spread (BBB-AAA)	-7.148 [*]	2.64	<0.001
yldcurve	Yield Curve	2.046 ^{***}	9.58	7.74
sig_gs1	Interest Rate Volatility	7.378 ^{***}	7.92	>999
cum_prepay24	Predicted Prepayment	-24.495 ^{***}	23.79	<0.001
cum_default24	Predicted Default	87.532 ^{***}	22.54	>999
cum_prepay24*low_spread		20.855 ^{***}	34.36	>999
cum_prepay24*high_spread		2.314	0.38	10.11
cum_default24*low_spread		-30.986	1.86	<0.001
cum_default24*high_spread		-12.248	0.21	<0.001
Likelihood Ratio Statistic		286.6 ^{***}		

- *** - significant at the 1% level.
- ** - significant at the 5% level.
- * - significant at the 10% level.