Finance and Economics Discussion Series
Divisions of Research & Statistics and Monetary Affairs
Federal Reserve Board, Washington, D.C.

The Past, Present, and Future of Subprime Mortgages

Shane M. Sherlund

2008-63

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November 2008

Abstract
This paper models the historical default and prepayment behavior for subprime mortgages using data on securitized mortgages originated from 2000 to 2007. I find that more recently originated subprime loans are more likely to default, well ahead of their first mortgage rate resets, and less likely to prepay (i.e., refinance). This rise in mortgage defaults stems largely from unprecedented declines in house prices, along with slack underwriting and tight credit market conditions. I estimate a competing hazards model to quantify the effects of (1) house price appreciation, (2) underwriting standards, (3) mortgage rate resets, and (4) household cash flow shocks, such as job loss and oil price increases, on the likelihood of borrowers with subprime mortgages to default or prepay. Ultimately, I find that borrower leverage is one of the most important factors explaining both default and prepayment for borrowers with subprime mortgages. Then, using several different assumptions about the future path of house prices, I simulate potential trajectories for subprime mortgage defaults between 2008 and 2010. Further, I explore the short-term sensitivities of default and prepayment to house prices and various mortgage characteristics.

Journal of Economic Literature classification numbers: G21, R21.

Keywords: Subprime mortgages, default, prepayment.

All comments welcome. Please contact author for latest version.

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* I thank Karen Dynan, Andreas Lehnert, Chris Mayer, and Karen Pence for helpful comments and discussions, and Amy Cunningham for excellent research assistance. The views and conclusions expressed herein do not necessarily reflect the views of the Board of Governors of the Federal Reserve System, its members, or its staff. This paper previously circulated as *An Outlook for Subprime Mortgages*.

† Economist, Household and Real Estate Finance, Federal Reserve Board, 20th and C Streets NW, Mailstop 93, Washington, DC, 20551. Phone: 202-452-3589. Email: Shane.M.Sherlund@frb.gov.

1. Introduction

The performance of mortgages has come under intense scrutiny recently. As shown in Figure 1, the serious delinquency rate on subprime variable-rate mortgages approached 30 percent by mid-2008—well above levels reached in 2001-2002. The serious delinquency rate on subprime hybrid 2/28 mortgages[1], which accounted for about 80 percent of outstanding subprime variable-rate loans at the end of 2007, was also close to 30 percent by mid-2008—well above the previous peak of about 10 percent reached in late 2001. In addition, the delinquency rate on subprime fixed-rate mortgages exceeded 9 percent by mid 2008, well on its way to exceeding its previous peak in late 2002.

Several factors have been cited as having led to increased delinquencies and defaults. First, macroeconomic factors have played a role. As noted by Gerardi, Shapiro, and Willen (2007), the house price experience of individual households has a large effect on delinquency status. Figure 2 shows house price appreciation for the nation, as well as formerly high-appreciation areas (California, Florida, Arizona, and Nevada) and areas experiencing specific economic stress due to unemployment (Ohio, Michigan, and Indiana). As house prices stagnate or decline, some homeowners are left with little or no equity, have less incentive to remain current on their mortgage payments, and have a more difficult time refinancing or selling their homes. Further, job loss and the rise in energy prices may have also lead to borrowers falling behind on their mortgage payments.

Second, as pointed out by Demyanyk and Van Hemert (2007), Keys et al. (2008), and Mian and Sufi (2008), underwriting standards have slackened gradually since at least 2000. As shown in Figure 3, average combined loan-to-value (CLTV) ratios on subprime variable-rate mortgages rose from less than 80 percent in 2000 to over 85 percent in 2005-2006, partly as a result of the more widespread use of piggyback mortgages. Further, the share of fully documented subprime variable-rate mortgages declined from around 75 percent in 2000 to around 60 percent in 2005-2006. By 2005-2006, nearly one in six subprime variable-rate mortgages was originated with "low quality" underwriting, meaning they had little or no documentation and LTV ratios in excess of 95 percent. Lending standards have improved

[1] Hybrid 2/28 mortgages carry a fixed mortgage rate for the first two years before resetting toward market-based rates every six months thereafter.

substantially in the last couple of years but only after the adverse consequences of the earlier lax standards became clear.

Third, policy concern, as highlighted by the streamlined modification plan of the HOPE NOW Alliance, has focused on the potential for mortgage rate resets and the associated change in mortgage payments to promote defaults. Figure 4 shows the estimated number of subprime loans scheduled to reset for the first time over the next several years (loans outstanding as of July 2008). 1.3 million subprime mortgages were scheduled to reset for the first time during 2008 (of which 0.6 had already reset during the first half of 2008). Another 0.6 million were schedule to reset for the first time in 2009 and another 0.1 million in 2010.[2] If delinquencies and defaults are driven by household cash flow problems, mortgage rate resets that result in higher mortgage payments could strain households to the point of mortgage delinquency or default. Bucks and Pence (2008) show that households often do not understand the terms of more complex mortgage contracts, and therefore might not understand how much their payment can increase when taking on a mortgage. The associated higher monthly payments, combined with tighter credit market conditions, which have limited the ability of many households to refinance or sell their homes to avoid the payment increases, also may have contributed to higher mortgage delinquency rates.

The generally favorable economic environment during 2004-2006, including above-average house price appreciation, relatively low interest rates, and low unemployment, may have masked potential performance problems associated with less stringent mortgage underwriting and mortgage rate resets. Homeowners having difficulty making mortgage payments or facing higher mortgage payments due to mortgage rate resets could easily refinance or sell their homes. Once house price appreciation slowed considerably (and turned negative in many locations) and underwriting subsequently tightened considerably, homeowners were less able to refinance or sell their homes, leading to increased risks of default.

Pennington-Cross and Ho (2006) examined the tendencies of subprime fixed-rate and hybrid mortgages to prepay (through refinancing or home sale) or default (termination after a notice of foreclosure is served) over the period 1998 to 2005.[3] Using a competing hazards model and data on securitized subprime mortgages from First American LoanPerformance, they show that hybrid mortgages tended to prepay quickly around the first mortgage reset date. Further,

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[2] 0.7 million of the subprime loans outstanding as of July 2008 reset for the first time during 2007.
[3] A third option is that the homeowner continues making mortgage payments on a reasonably timely basis.

conditional on having a large number of prepayments around the first mortgage rate reset date, default hazard *rates* tended to rise slightly after the first mortgage rate reset. Fixed-rate mortgages, however, exhibited no such pattern around the same loan age, as they do not face mortgage rate resets.

Gerardi, Shapiro, and Willen (2007) also studied the prepayment and default behavior of mortgages, using an extensive database of homeowners in Massachusetts. Because their data allow them to follow homeowners over time (rather than individual mortgages over time), they can see through refinancings and isolate the ultimate causes of default. They find that, at the homeowner level, mortgage rate resets have little effect on the default behavior of households. Because most households had the ability to refinance or sell their home, default rates did not increase as a result of mortgage rate resets. Instead, the authors argue, flat to falling house prices are the primary driver of recent mortgage defaults.

Demyanyk and Van Hemert (2007) focus on underwriting. Using a simple model of year-after-origination delinquencies, house prices, and loan-level attributes, they find a positive trend in their model's residuals. They attribute this trend to a decline in unobserved loan quality. Further, the authors provide evidence that mortgage originators increased the rate they charged to high-risk borrowers over time, consistent with the downward trend in unobserved loan quality. But, on average, subprime mortgage rates remained low in spite of this increased riskiness.

Mortgage borrowers can exercise various options relating to how they finish, or terminate, their mortgages. First, borrowers can make timely mortgage payments until they pay off the mortgage balance. Second, borrowers can pay down their mortgage balance early, through early payments, refinancing, or home sale. These borrowers are said to prepay their mortgages, thereby exercising their prepayment option. Prepayment is largely driven by borrowers refinancing into mortgage with different terms, sometimes to extract home equity. Third, borrowers can fall behind on their mortgage payments and enter the process of foreclosure. These borrowers are said to default on their mortgages, thereby exercising their default option. Defaults are presumed to be largely driven by the combination of home equity and life events at the household level (unemployment, illness, divorce, etc.). Borrowers can also exercise their default option more ruthlessly by defaulting as soon as their home equity falls below some threshold value. These options and how they are affected by house prices, underwriting, mortgage rate resets, and household shocks are the focus of this paper.

I model the historical default and prepayment behavior for subprime mortgages using data on securitized mortgages originated from 2000-2007 contained in the First American LoanPerformance ABS database. I find that more recently originated subprime loans are more likely to default, even ahead of their first mortgage rate resets, and less likely to prepay (i.e., refinance). I estimate a competing hazards model to identify the effects of (1) house price appreciation, (2) underwriting standards, (3) mortgage rate resets, and (4) household cash flow shocks, such as unemployment and oil prices, on the likelihood of borrowers with subprime mortgages to default or prepay. Then, using several different assumptions about the future path of house prices, I simulate potential trajectories for subprime defaults between 2008 and 2010. Further, I explore the short-term sensitivities of default and prepayment to house prices and various mortgage characteristics.

The remainder of the paper is organized as follows. Section 2 describes the competing hazards model, while Section 3 describes the First American LoanPerformance data. Section 4 contains a brief description of the variables used for estimation and the results. Section 5 describes the model simulation and the implied trajectories for subprime mortgage defaults, and Section 6 concludes.

2. Competing Hazards Framework

Let T_D, T_P, and T_A denote the number of months from loan origination to default, prepayment, and the end of the sample (the latter being the case for active mortgages—i.e., those that have neither defaulted nor prepaid), respectively. Then the age of mortgage i varies according to $T_i = \min\{T_D, T_P, T_A\}$. The propensity, or hazard function, for a surviving loan to default or prepay at loan age t takes the form

$$\lambda_i^j(t) = \lim_{\Delta t \to 0} \frac{\Pr\{t \le T_i \le t + \Delta t \mid T_i \ge t\}}{\Delta t},$$

where j denotes either default or prepayment. The hazard function is typically modeled by assuming that each household follows the same baseline hazard function, and that proportional deviations from the baseline can be explained proportionally by the explanatory variables. In other words,

$$\lambda_i^j(t) = \lambda_0^j(t) e^{\alpha_j + \beta_j X_i(t)},$$

where $\lambda_0^j(t)$ is the baseline hazard for termination type *j* (default or prepayment) at loan age *t*, $\alpha_j + \beta_j X_i(t)$ is a (linear) function of exponentially proportionate adjustments to the baseline hazard function, $X_i(t)$ is a vector of characteristics, and α_j and β_j are parameters to be estimated. *X* can include characteristics such as loan attributes at, or at any point after, origination, economic conditions, such as interest rates or unemployment, and regional variables, such as ZIP-code level average household income.

Several approaches have been implemented to model the baseline hazard function, $\lambda_0^j(t)$. One can use a parametric baseline function, such as polynomials in loan age (t). Pennington-Cross and Ho (2006) use a third-order polynomial of loan age, while Gerardi, Shapiro, and Willen (2007) use a fifth-order polynomial of loan age. Alternatively, one can use a nonparametric baseline hazard function, in which one essentially estimates an indicator variable for each loan age. While the nonparametric approach allows far greater flexibility, the resulting parameter estimates (α_j and β_j) can be more difficult to interpret. Further, for the simulation exercises presented toward the end of this paper, a parametric baseline function was conceptually more attractive. But rather than use polynomials of loan age, I take as baseline hazard functions the standard prepayment and default assumptions from the Public Securities Association (PSA). The PSA assumptions are standard in the mortgage industry, and form a reasonable basis on which to base my estimates of hazard functions. Figure 5 shows how the standard prepayment and default assumptions vary by loan age. Conditional on having not defaulted or prepaid, the probability of prepayment increases up to a loan age of 30 months, then holds constant for the life of the loan. The probability of default, however, increases up to a loan age of 30 months, holds constant up to 60 months, declines up to 120 months, then holds constant for the remaining life of the loan.

3. Data

The primary data source is the First American LoanPerformance ABS database. These loan-level data track securitized mortgages in mortgage pools marketed as alt-A and subprime at some point during the 1992-2007 period.[4] I restrict this analysis to first-lien, 30-year mortgages originated from 2000 to 2007 contained in "subprime" ABS pools. The data contain information

[4] The "subprime" pools run 1995-2007 and reportedly cover 75-90 percent of subprime pools.

such as combined LTVs, mortgage rates, credit scores, loan documentation, and occupancy status (all at origination), as well as any prepayment penalties, interest-only features, piggyback mortgages, loan purpose (refinance versus purchase), property type, and information on reset periods and rates.

The data also track the performance of these mortgages over time. Delinquency status (current, 30 days late, 60 days late, 90 days late, or in foreclosure) is recorded monthly for active loans. The data also differentiate between different types of mortgage termination: foreclosure or prepayment without a notice of foreclosure. Throughout this paper, *default* will describe any mortgage that terminates after a notice of foreclosure was served, whereas *prepayment* will describe any mortgage that terminates without such a notice (presumably through refinancing or home sale).

To model default and prepayment behavior, I augment the LoanPerformance data by including publicly available MSA-level house prices from S&P/Case-Shiller, where available, and state-level house prices from the Office of Federal Housing Enterprise Oversight (OFHEO). These data are used to construct mark-to-market combined LTV ratios and measures of house price volatility. Further, I augment the data with oil prices, various interest rates, and state-level unemployment rates. Finally, I include ZIP-code level data on average household income, share of minority households, share of high school (or less) educated households, and the child share of the population from the 2000 Census. Descriptions for each of the variables can be found in Table 1.

4. Estimation and Results

In this section, I present an overview of some of the main estimates from the competing hazards model. Note that because of the high correlations between many of the variables used in estimation, some of the effects of interest are difficult to isolate based on the coefficient estimates alone. I therefore direct the interested reader to the policy experiments contained in Section 5.

In estimating the competing hazards model, I include the following variables in X: Combined LTV and payment-to-income ratios, contract mortgage rate, state-level unemployment, oil prices, fully indexed rate (6-month LIBOR plus loan margin), credit score, loan documentation, and occupancy status, all at the time of loan origination. I also include whether the loan has prepayment penalties, interest-only features, piggyback mortgages, refinancing or purchase, and the type of property. Further, I include indicator variables to pick out low-quality loans (those with LTV ratios in excess of 95 percent and not fully documented), loans with low credit scores (less than 600), and an interaction term between occupancy status and cumulative house price appreciation over the life of the mortgage. As noted earlier, I include an estimate of the mark-to-market combined LTV ratio, the current contract mortgage rate, house price volatility, state-level unemployment rates, oil prices, and the fully indexed rate at each loan age, as well as a variable capturing a negative equity position. Indicator variables for mortgage rate resets are also included. The first captures the one-quarter window of the first mortgage rate reset (one month before, the month of, and the month after reset). The other captures whether the loan is in the post-reset period. Finally, I include an indicator variable for changes in mortgage payments of more than five percent from the original mortgage payment to capture potential payment shock effects.

Tables 2 through 4 present sample averages for these variables at origination and termination (default, prepay, or still active) for hybrid 2/28s, hybrid 3/27s, and fixed-rate mortgages, respectively. Some interesting patterns emerge: Borrowers with variable-rate loans have riskier characteristics than those with fixed-rate loans, and riskier loans are more likely to default than to prepay. First, loan-to-value ratios are lower, while documentation status is better for borrowers with fixed-rate mortgages. Further, borrowers with fixed-rate loans tend to have lower payment-to-income ratios, higher FICO scores, fewer piggyback mortgages, and smaller loan sizes. However, these borrowers are similar in terms of education, race, and owner occupancy status. Next, mortgages that defaulted have higher loan-to-value ratios (both at origination and marked to market), higher payment-to-income ratios, lower FICO scores, a higher incidence of negative equity and piggyback mortgages than mortgages that prepaid over the same period. This latter result holds across both variable-rate and fixed-rate subprime mortgages.

To allow additional flexibility in estimation, I estimate the competing hazards model over several different subsets of the data. First, I separate my sample into the three most predominant subprime product types: hybrid 2/28, hybrid 3/27, and fixed-rate mortgages. This enables the estimated parameters to reflect differences in how these different types of mortgages prepay and default. Next, I split each product type into refinancing versus purchase mortgages, again to allow for potential differences in how these types of mortgages prepay or default. In all, I estimate the model for six distinct product types. The results are presented in Tables 5 and 6.[5]

House Price Appreciation. House price appreciation is primarily captured through the mark-to-market CLTV (cltvnow) variable. Borrowers who experience a lot of house price appreciation can expect to have reduced their respective combined LTVs more than borrowers who have experienced less house price appreciation. As a result, those borrowers have more of an incentive to make timely payments (fewer defaults) and have more opportunities to refinance successfully (more prepayments). Thus, house price appreciation should strongly affect which mortgages have successful endings (active or prepay) versus those that have unsuccessful endings (default). CLTV at origination (cltvorig) does not affect default or prepayment rates to a statistically significant degree, perhaps because of the high rate of success for high-LTV loans during 2000-2004 and the relative importance of cumulative house price appreciation during the life of a mortgage. Additionally, the estimates provide some evidence that negative equity (negeq) leads to increased risk of default, especially for subprime variable-rate purchase loans. However, the magnitude of the effect is fairly small, and negative equity may be a necessary, but not sufficient, condition for default. Unless borrowers exercise their default option in a ruthless manner (i.e., they default as soon as their equity position reaches a certain trigger), the default decision may depend on life events, such as job loss, illness, and divorce—before the borrowers considers his or her equity position. Finally, the results provide only weak evidence, at best, that investors are more likely to default when house price appreciation is low (invhpa), thereby exercising their default option in a more ruthless manner.

Underwriting. Underwriting is captured through several variables, including: credit scores (ficoorig and lofico), loan documentation (doc and loqual), occupancy status (nonowner), simultaneous second liens (piggyback), payment-to-income ratio (pti), loan-to-value ratio (cltvorig), prepayment penalties (pporig and ppnow), interest-only features (ioorig and ionow), and mortgage rates (mrateorig). Credit scores predict default and prepayment well, with higher credit scores defaulting less and generally prepaying more often. This suggests that borrowers with higher FICO scores were generally lower default risks ex post. Fully documented loans default less often, but not to a statistically significant degree. For subprime 2/28s, low quality

[5] Given the complexity of interpreting these coefficient estimates, I also report one-, two-, and three-year ahead probabilities of default and prepayment for an arbitrary mortgage under the simulation assumptions described in Section 5. These results are shown in Tables 8-10 and described in more detail at the beginning of Section 5.

loans (i.e., those with high LTVs and little or no documentation) tend to default and prepay more frequently, perhaps because these borrowers are most sensitive to realized house price appreciation. In a high house price appreciation environment, low quality loans can be originated and refinanced into other terms once the borrower accumulates sufficient equity.

Subprime mortgages on non-owner occupied properties as well as those with simultaneous second liens have higher default rates, while borrowers with higher payment-to-income ratios default and prepay at higher rates. These types of loans have generally been perceived to be more risky than owner-occupied, single-lien, low payment-to-income ratio loans.

Prepayment penalties tend to hold down prepayments during the duration of the penalty period, which is what they are designed to do, but have little to no effect on defaults. Mayer, Piskorski, and Tchistyi (2008) attribute this to the lower cost of mortgages that contain prepayment penalty clauses. Mortgages that carry interest-only periods tend to have lower default rates during the teaser period, but slightly higher default rates afterward, likely because monthly payments typically adjust upward. Lastly, mortgages with higher mortgage rates tended to default and prepay at faster rates, reflecting the higher risk that induced the higher pricing, the higher cost of the mortgage to the borrower, or both. Additionally, some ZIP-code level demographic variables, such as the child population share, are correlated with default and prepayment, but these variables might act as proxies for other unobserved household variables.

Mortgage Rate Resets. The effect of mortgage rate resets is captured in a complex manner through the current mortgage interest rate (mratenow), the fully indexed rate (indnow), payment shock (pmt), and indicators for the reset (rstwind) and after reset (lngwind) periods. Because these variables all tend to move during the mortgage rate reset period, the partial effects for each of these variables is not particularly informative. But in results reported more fully in the next section, prepayments jump during reset periods, while defaults remain largely unaffected (default *rates* increase, however, due to the large number of prepaid mortgages dropping from the pool of outstanding mortgages). Note that although there is little evidence in the data to date to suggest that mortgage rate resets lead to higher mortgage delinquencies, this might not necessarily be the case going forward. In an environment of stagnant to falling house prices and stricter underwriting standards, households facing potentially higher mortgage payments due to a mortgage rate reset may find prepayment more difficult, thereby increasing the ultimate chances of default.

Other Factors. Other factors influencing defaults and prepayments include unemployment rates, the change in oil prices since loan origination, and house price volatility. Strikingly, higher unemployment rates tend to be associated with higher prepayments, but not necessarily with higher defaults. Because I use only state-level unemployment data, I could be missing much of the more local variation in unemployment and thus the underlying effect on default. Further, house prices could be capturing some of these more local effects.

Increased oil prices, however, tend to be associated with higher rates of default. As the price of oil increases, the ability of some households to make their monthly mortgage payments could be reduced, especially for higher payment-to-income households who may have stretched to afford their homes in the first place. Similarly, areas experiencing high house price volatility tend to have higher rates of prepayment and higher rates of default, the latter of which holds for refinanced mortgages only.

Summary. House price appreciation seems to be the primary determinant of default and prepayment behavior. Borrowers with subprime mortgages could more easily prepay when house price appreciation was high (almost regardless of the initial credit quality of the loan), but found it more difficult to prepay once house price appreciation slowed and turned negative. New, stricter underwriting further limited the ability of many borrowers with subprime mortgages unable to refinance or even sell. Many are then faced with the decision of default. With this in mind, mortgage rate resets could have an effect on defaults going forward, even though they have had only limited effects in the data to date. Prepayment is much more difficult for many borrowers, so their ability and willingness to face mortgage rate reset may now be an issue. Short-term interest rates have declined recently, so these borrowers are not currently facing drastically higher mortgage payments. Broader macroeconomic effects, such as oil prices, are also shown to affect default and prepayment behavior for these households with subprime mortgages.

5. Simulations

In this section, I simulate subprime mortgage defaults and prepayments during the 2008 to 2010 period and explore the effects of some policy option on those defaults and prepayments. Throughout this analysis, I draw house price, interest rate, and unemployment rate forecasts from Fannie Mae's and Freddie Mac's June 2008 monthly economic outlooks, and oil futures prices from NYMEX at the beginning of June 2008. Under my baseline simulations, aggregate house prices fall a total of 8.5 percent by the end of 2010. As shown in Figure 6, this implies house price appreciation of -7 to 0 percent at the national level over the simulation period. Moreover, MSA- and state-level house prices can fall by more or less (or possibly even rise), based on the historical relationships between regional house prices indexes and house price indexes at the national level. Interest rates are expected to fall a bit before increasing throughout the simulation period. The unemployment rate increases to 5.6 percent by the end of 2008 and falls to 5.4 percent by the end of 2010.[6] Lastly, oil prices continue to climb before moderating somewhat over the majority of the simulation.

Simulations, 2008-2010. Given X, $\hat{\alpha}$, and $\hat{\beta}$, the hazard functions can be estimated as

$$\hat{\lambda}_i^j(t) = \lambda_0^j(t)e^{\hat{\alpha}_j + \hat{\beta}_j X_i(t)}.$$

To determine the percent of loans defaulting and prepaying each month, I compute the average $\hat{\lambda}_i^j$ for various vintages (annual vintages for 2000-2002 and quarterly vintages for 2003-2007). I then assume that mortgages default and prepay based on the relative magnitudes of $\hat{\lambda}_i^j$ within each vintage (with the largest values of $\hat{\lambda}_i^j$ defaulting and prepaying first).

In an alternative "worse house price" simulation, I allow house prices to fall twice as much as under the baseline simulation, implying a 17 percent decline in aggregate house prices during 2008-2010. The unemployment rate, interest rates, and oil prices follow those of the baseline simulation. In each simulation, homeowners with variable-rate mortgages face mortgage rate resets as dictated by the terms of their mortgage contracts (index, margin, rate cap, periodic cap, etc.).

Additionally, I impose a little more structure on the simulations. In particular, I add a default trigger, which causes homeowners to default whenever their combined LTV ratio exceeds 125 percent.[7] Further, in addition to the effects of credit market tightness showing up implicitly through X (primarily through interest rates), I include explicit adjustments to the number of prepayments. When the simulation "wants" a prepayment, I check to see if prepayment makes sense, i.e., what is the combined LTV ratio when the homeowner wants to

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[6] As with house prices, state-level unemployment rates can rise or fall depending on the historical relationships between state-level unemployment rates and the national unemployment rate.

[7] I also conducted simulations without a default trigger as a check on robustness, with only minor differences (mainly in the timing of default).

prepay? When the combined CLTV exceeds 110 percent (and the mortgage is to be prepaid), I assume that the homeowner instead exercises his or her default option. And when the combined LTV ratio lies between 95 and 110 percent, I force the mortgage to remain active (no prepayment or default). Only when the simulation "wants" a prepayment and the combined LTV ratio is less than 95 percent is the mortgage allowed to prepay. Last, I assume that borrowers and loan servicers behave as they have historically, in that loans are not modified (the scope and scale of loan modification is difficult to pin down at this time), and that there are no new subprime mortgage originations going forward.[8]

Figure 7 shows the simulated trajectories for all subprime mortgage prepayments and defaults for the 2000-2007 vintages under the baseline assumptions. The solid lines depict realized data, whereas the dashed lines show the simulated data. As vintages become more recent, prepayments fall and defaults increase, reflecting the interaction of stagnant to lower house prices, looser underwriting, and tighter credit markets. For more recent vintages, therefore, mortgages are more likely to end in default than in prepayment relative to earlier vintages. Strikingly, nearly half of the subprime mortgages originated during 2006-2007 default under the baseline assumptions in these simulations by 2010—twice the proportion for subprime mortgages originated during 2005. Similarly, subprime mortgage prepayments fell by about half for 2006-2007 originations relative to 2005 originations.

Figure 8 shows the simulated cumulative prepayment and default curves under the scenario with worse house prices (the solid lines), where house prices fall twice relative to the baseline (the dashed lines). With lower house price appreciation (greater house price depreciation), more borrowers are unable to prepay their subprime mortgages and many more are subject to default, especially for more recent vintages. This latter result is likely attributable to the higher incidence of high loan-to-value ratios and negative equity. Over half of 2006-2007 originations in these data default under the worse house price assumptions.

So how might these translate into numbers of defaults going forward? Figure 9 shows the total number of subprime mortgage defaults, as well as figures for variable- and fixed-rate loans separately. Under the baseline simulation, the total number of subprime mortgage defaults was predicted to peak at around 135,000 per month (of which about 110,000 are variable-rate) in

[8] This last assumption really only applies to simulating default *rates*. Because we are primarily concerned with the effects on the 2005-2007 vintages, this assumption does not constrain the results. New subprime originations would tend to hold down default rates going forward.

April 2008, before declining throughout the remainder of the simulation.[9,10] Defaults on fixed-rate subprime mortgages may not peak until early- to mid-2009 at about 34,000 per month.

Under the alternative worse house price simulation the number of defaults is much higher. Total defaults exceed 140,000 per month from March through December 2008, with variable-rate loans contributing nearly 120,000 per month during much of that time. Defaults on subprime fixed-rate loans increase to over 50,000 per month from the latter half of 2008 well into 2009. Not only does a worse house price environment increase the total number of subprime mortgage defaults, it also increases the duration over which we could expect to see extraordinarily high default rates, likely owing to the inability to refinance because of little to no (or even negative) equity.

Table 7 summarizes these simulation results. The number of subprime mortgage foreclosure starts is projected to reach nearly 1.5 million during 2008, of which nearly 1.1 million are among variable-rate subprime loans. Foreclosure starts are expected to remain elevated at nearly 1.1 million during 2009, before returning to a more normal level of around 0.6 million during 2010. If aggregate house prices fall more than in the baseline, foreclosure starts would likely be higher and persist longer, as households find themselves with less equity in their homes than under the baseline.

One important note is that each of these simulations depends heavily upon assumptions regarding the path of house prices, interest rates, unemployment, and oil prices. Inasmuch as these paths deviate from what actually occurs, the simulated paths for defaults may also differ from those actually experienced.

Year-Ahead Cumulative Default and Prepayment Rates. Because of the aforementioned difficulty associated with isolating the effects of certain loan characteristics on mortgage prepayment and default, such as prepayment penalties and mortgage rate resets, I conduct some policy experiments to analyze the economic impact of various variables.
I do so by simulating the 1-, 2-, and 3-year ahead cumulative default and prepayment probabilities for a representative subprime mortgage under several different scenarios (the results

[9] The total number of defaults is adjusted to represent an estimate of the total number of subprime mortgages outstanding as of the end of 2007.
[10] The actual number of defaults during April 2008 was 105,000. 84,000 of there were among variable-rate loans, the remaining 21,000 were among fixed-rate loans. Note that the realized paths for house prices, interest rates, and oil prices have been somewhat better than assumed in the simulations, likely pushing down defaults somewhat.

are contained in Table 8) beginning in 2008.[11,12] Under the baseline assumptions described above, a representative subprime 2/28 has about a 6 percent chance of default by the end of 2008, a 22 percent chance of default through 2009, and a 51 percent chance of default through 2010. This same mortgage has a 7 percent chance of prepayment after one year (through 2008), a 19 percent chance of prepayment after two years (through 2009), and about a 26 percent chance of prepayment after three years (through 2010). This pattern is generally the same irrespective of mortgage type (albeit at different levels): A subprime 3/27 would experience a 5 percent default rate after one year and a 37 percent default rate after three years, whereas a subprime FRM would experience a default rate of 4 percent after one year and 35 percent after 3 years. The three-year cumulative prepayment rates drop to 24 percent for subprime 3/27s and 20 percent for subprime FRMs. Recall some of the patterns from Tables 2 through 4: Borrowers with subprime variable-rate mortgages are generally riskier than those with subprime fixed-rate mortgages. Thus, although subprime 2/28s tend to have much higher default rates, it is difficult to attribute the difference to the product itself (i.e., the subprime 2/28) versus riskier observed or unobserved borrower characteristics.

Worse House Prices. If house prices were to fall 50 percent more than under the baseline (house prices decline a total of 13 percent through the end of 2010), all three types of mortgages could expect to see higher default rates (and lower prepayment rates) at each horizon, with the subprime 2/28 exhibiting more than a 60 percent chance of default and a 21 percent chance of prepayment after three years. Cumulative default and prepayment rates are again lower for subprime 3/27s and FRMs. House price appreciation increases a borrower's equity, making prepayment more affordable and default less likely.

Prepayment Penalties. Next, I remove the two-year prepayment penalty. Here, default and prepayment rates on the subprime 2/28 would be slightly higher during the first two years, but the default rate would be slightly lower by the third year. The former result could be a consequence of higher (unobserved) fees charged to borrowers who do not take a mortgage with a prepayment penalty (or other unobserved characteristics of these borrowers). This result holds across product types.

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[11] This $150,000 purchase-money mortgage was originated in December 2007 and has a 2-year prepayment penalty, 95 percent CLTV (no simultaneous second lien), 8 percent mortgage rate, FICO score of 620, full documentation, and is for an owner-occupied property.

[12] Paths for house prices, interest rates, and unemployment are again taken from Fannie Mae's and Freddie Mac's June forecasts. Oil prices are drawn from futures prices listed on NYMEX.

Loan-to-Value Ratio; Mortgage Rates. Assuming the mortgage had a higher loan-to-value ratio (100 percent CLTV) or a higher mortgage rate (9 percent) at origination, default rates would be higher. Prepayment rates would be lower for borrowers with higher CLTV ratios at origination. The CLTV result is due to lower borrower equity; the mortgage rate result is likely due to increased monthly mortgage payments (or the associated higher risk of borrowers with higher mortgage rates). These results also hold across loan types.

Loan Documentation. Loans with no- or low-documentation also have higher probabilities of default, but tend to prepay slightly more quickly. This result suggests that these loans are more risky in terms of both credit and prepayment.

Interest-Only Loans. Next, I introduce a 2-year interest-only period on the two types of variable-rate mortgages. Having two years of interest-only payments lowers the probability of default slightly during the duration of the interest-only period for the subprime 3/27, but has essentially no effect on the default rate for subprime 2/28s. However, the probability of default increases due to the mortgage recasting to a 28-year amortization schedule for the subprime 2/28, leaving the cumulative default rate nearly 6 percentage points higher after three years. For both types of loans, cumulative prepayments decline.

Mortgage Rate Resets. Finally, I consider a policy in which the mortgage is allowed to skip its scheduled mortgage rate reset dates, thereby holding the initial rate constant for a longer period of time than originally specified in the mortgage contract. Here, the probability of prepayment declines at and after the scheduled mortgage rate reset date as borrowers no longer have an incentive to prepay ahead of that reset date. The cumulative default rate after three years falls slightly for the subprime 2/28, as it is not required to make higher monthly mortgage payments during 2010. The same result also holds for subprime 3/27s (not shown).

Summary. These simulations have shown the sensitivity of cumulative default and prepayment rates to house prices, prepayment penalties, combined loan-to-value ratios, mortgage rates, loan documentation, interest-only loan terms, and mortgage rate resets for three types of subprime mortgages. The results suggest that cumulative default and prepayment rates are perhaps most sensitive to the path of house prices during 2008-2010. That is not to say that these other factors are not important and will not matter going forward. Rather, the largest effects are likely to come from the path for house prices themselves. If house prices fall more than assumed in the baseline, the sensitivities of cumulative default and prepayment rates to these other factors could, and likely would, change as well.

6. Conclusions

This paper models the historical default and prepayment behavior for subprime mortgages using data on securitized mortgages originated from 2000 to 2007 contained in the First American LoanPerformance ABS database. I find that more recently originated subprime loans are more likely to default, even ahead of their first mortgage rate resets, and less likely to prepay (i.e., to refinance). This rise in mortgage defaults stems largely from unprecedented declines in house prices, along with slack underwriting and tight credit market conditions. I estimate a competing hazards model to identify the effects of (1) house price appreciation, (2) underwriting standards, (3) mortgage rate resets, and (4) household cash flow shocks, such as unemployment and oil prices, on the likelihood of borrowers with subprime mortgages to default or prepay. Ultimately, I find that borrower leverage is one of the most important factors explaining both default and prepayment for borrowers with subprime mortgages. Then, using several different assumptions about the future path of house prices, I simulate potential trajectories for subprime mortgage defaults during 2008-2010. Further, I explore the short-term sensitivities of default and prepayment to house prices and various mortgage characteristics. The results suggest that cumulative default and prepayment rates are perhaps most sensitive to the path of house prices during 2008-2010. That is not to say that these other factors are not important and will not matter going forward. Rather, the largest effects are likely to come from the path for house prices themselves.

Of course, these projections rely heavily upon the assumed paths for house prices, interest rates, unemployment, and oil prices. Subprime mortgage defaults could be higher or lower depending upon these paths and their interactions. Further, policies designed to stem foreclosures by skipping mortgage resets, lowering monthly payments, or the like, could be more or less effective than suggested here, again depending on the actual paths taken by house prices, interest rates, unemployment, and oil prices.

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Table 1: Variable Descriptions

This table defines each of the variables used to estimate the competing hazard models of subprime mortgage prepayment and default. Variables include borrower and mortgage characteristics and economic conditions at origination, as well as mortgage characteristics and economic conditions over the life of the mortgage.

Variable	Description
cash	Cash-out refinancing indicator
cltvnow	Current mark-to-market combined LTV (percent)
cltvorig	Combined LTV at origination (percent)
doc	Full loan documentation indicator
educ	ZIP-level share of high-school (or less) educated persons
ficoorig	Credit (FICO) score at origination
frmnow	Current 30-year FRM rate (percent)
frmorig	30-year FRM rate at origination (percent)
hhincome	ZIP-level average household income (dollars)
hpvol	House price volatility (percent, 2-year standard deviation HPA)
indnow	Current fully indexed rate (6-month LIBOR plus margin, percent)
indorig	Fully indexed rate at origination (percent)
invhpa	Cumulative house price appreciation if nonowner=1 (percent)
ionow	Interest-only period still in effect indicator
ioorig	Interest-only feature at origination indicator
kids	ZIP-level child share of population
lngwind	Mortgage past rate reset period indicator
lofico	Credit score < 600 indicator
loqual	CLTV>95 and doc=0 at origination indicator
mratenow	Current mortgage interest rate (percent)
mrateorig	Contract rate at origination (percent)
negeq	CLTV if current mark-to-market CLTV>100
nonowner	Not owner-occupied indicator
oil	Change in oil prices since loan origination (percent)
origamt	Loan amount at origination (dollars)
piggyback	Second liens recorded at origination indicator
pmi	Primary mortgage insurance indicator
pmt	Current monthly payment >5% larger than original indicator
ppnow	Prepayment penalty still in effect indicator
pporig	Prepayment penalty at origination indicator
proptype	Single-family home indicator
pti	Payment-to-income ratio at origination (percent)
race	ZIP-level minority population share
refi	Refinanacing (including cash-out) indicator
rstwind	Mortgages in reset period indicator
unempnow	Change in unemployment rate since origination (percent)
unorig	State-level unemployment rate at origination (percent)

Table 2: Sample Averages: Subprime 2/28s

This table provides sample averages for the variables used in estimation for subprime 2/28s. The table breaks these averages down to those observed at origination, those observed for active loans at the end of the sample period, those observed at the time of mortgage default, and those observed at the time of mortgage prepayment.

Variable	Origination	Active	Default	Prepay
cash	0.51	0.46	0.42	0.55
cltvnow	84.66	85.55	81.43	30.85
cltvorig	84.66	87.24	87.70	83.08
doc	0.65	0.65	0.62	0.65
pti	39.90	40.02	40.34	39.77
educ	0.37	0.38	0.38	0.36
ficoorig	609	612	602	609
frmnow	6.14	6.10	6.25	6.15
frmorig	6.14	6.16	6.19	6.12
hhincome	44,365	42,666	42,180	45,446
hpvol	4.29	6.04	5.04	5.53
indnow	9.33	10.67	10.79	10.08
indorig	9.33	10.35	9.77	8.85
invhpa	0.00	0.18	0.65	1.22
ionow	0.14	0.17	0.13	0.11
ioorig	0.14	0.19	0.15	0.11
kids	0.27	0.27	0.27	0.27
lngwind	0.00	0.38	0.29	0.16
lofico	0.45	0.41	0.48	0.45
loqual	0.10	0.13	0.15	0.08
mratenow	8.05	9.48	9.35	8.88
mrateorig	8.05	8.16	8.49	7.92
negeq	2.01	20.61	10.36	6.26
nonowner	0.08	0.09	0.11	0.07
oil	0.00	67.22	43.01	41.94
origamt	177,560	174,815	170,416	180,028
piggyback	0.18	0.28	0.25	0.14
pmi	0.23	0.19	0.24	0.25
pmt	0.00	0.48	0.31	0.15
ppnow	0.75	0.43	0.52	0.58
pporig	0.75	0.77	0.77	0.73
proptype	0.87	0.87	0.87	0.86
race	0.31	0.30	0.33	0.31
refi	0.59	0.53	0.50	0.63
rstwind	0.00	0.11	0.08	0.16
unempnow	0.00	0.56	-0.79	-5.45
unorig	5.28	4.93	5.23	5.41
No. obs.	4,438,912	1,067,592	560,680	2,810,640

Table 3: Sample Averages: Subprime 3/27s

This table provides sample averages for the variables used in estimation for subprime 3/27s. The table breaks these averages down to those observed at origination, those observed for active loans at the end of the sample period, those observed at the time of mortgage default, and those observed at the time of mortgage prepayment.

Variable	Origination	Active	Default	Prepay
cash	0.54	0.52	0.46	0.57
cltvnow	84.02	82.32	78.32	32.22
cltvorig	84.02	86.42	86.37	82.44
doc	0.68	0.68	0.67	0.68
pti	39.49	39.85	39.71	39.23
educ	0.37	0.37	0.38	0.36
ficoorig	612	619	601	610
frmnow	6.20	6.10	6.23	6.15
frmorig	6.20	6.08	6.33	6.24
hhincome	44,563	44,178	41,730	45,257
hpvol	3.82	5.78	4.18	5.07
indnow	9.51	10.68	10.78	10.27
indorig	9.51	10.02	10.01	9.18
invhpa	0.00	0.39	0.80	1.20
ionow	0.15	0.22	0.11	0.11
ioorig	0.15	0.24	0.12	0.11
kids	0.27	0.27	0.27	0.27
lngwind	0.00	0.16	0.13	0.09
lofico	0.43	0.37	0.49	0.44
loqual	0.09	0.11	0.12	0.07
mratenow	7.98	8.36	9.03	8.40
mrateorig	7.98	7.78	8.63	7.96
negeq	1.90	14.05	5.81	4.68
nonowner	0.08	0.09	0.10	0.07
oil	0.00	75.74	47.02	46.15
origamt	168,102	175,008	148,354	168,364
piggyback	0.15	0.22	0.19	0.11
pmi	0.23	0.20	0.27	0.24
pmt	0.00	0.23	0.13	0.08
ppnow	0.64	0.47	0.54	0.54
pporig	0.64	0.63	0.68	0.63
proptype	0.87	0.86	0.88	0.86
race	0.30	0.28	0.32	0.30
refi	0.62	0.60	0.54	0.65
rstwind	0.00	0.06	0.04	0.07
unempnow	0.00	-2.11	1.39	-3.85
unorig	5.23	5.04	5.18	5.34
No. obs.	966,746	278,465	105,110	583,171

Table 4: Sample Averages: Subprime FRMs

This table provides sample averages for the variables used in estimation for subprime FRMs. The table breaks these averages down to those observed at origination, those observed for active loans at the end of the sample period, those observed at the time of mortgage default, and those observed at the time of mortgage prepayment.

Variable	Origination	Active	Default	Prepay
cash	0.67	0.67	0.59	0.68
cltvnow	79.39	72.41	74.57	39.11
cltvorig	79.39	79.93	83.76	78.19
doc	0.73	0.75	0.72	0.71
pti	38.67	38.50	39.02	38.81
educ	0.38	0.38	0.40	0.37
ficoorig	627	632	603	625
frmnow	6.23	6.10	6.21	6.10
frmorig	6.23	6.13	6.45	6.30
hhincome	43,066	42,818	38,674	43,973
hpvol	3.87	5.70	3.78	5.11
invhpa	0.00	1.08	1.54	2.13
kids	0.27	0.27	0.27	0.27
lofico	0.34	0.31	0.49	0.36
loqual	0.04	0.04	0.06	0.03
mratenow	8.05	7.78	9.19	8.06
mrateorig	8.05	7.78	9.17	8.16
negeq	0.69	4.89	2.83	2.48
nonowner	0.10	0.09	0.14	0.09
oil	0.00	96.04	52.96	49.55
origamt	154,196	158,981	118,620	154,656
piggyback	0.06	0.09	0.08	0.04
pmi	0.23	0.20	0.27	0.26
pmt	0.00	0.03	0.03	0.02
ppnow	0.70	0.46	0.53	0.56
pporig	0.70	0.73	0.67	0.67
proptype	0.88	0.90	0.89	0.86
race	0.31	0.29	0.33	0.32
refi	0.78	0.79	0.69	0.79
unempnow	0.00	-4.58	3.12	-3.13
unorig	5.25	5.12	5.13	5.39
No. obs.	1,762,996	826,724	121,734	814,538

Table 5: Default Hazard Coefficient Estimates

This table provides coefficient estimates for the default hazard functions in the competing hazards models.

	Subprime 2/28		Subprime 3/27		Subprime FRM	
	Purchase	Refinance	Purchase	Refinance	Purchase	Refinance
constant	3.666 *	0.284	3.510 *	-0.632	2.598 *	2.029 *
cltvorig	-0.040	-0.033	-0.027	-0.028	-0.029	-0.038
mrateorig	0.082 *	0.091 *	0.142 *	0.178 *	0.045	0.128 *
pporig	0.053 *	0.076 *	-0.049	-0.009	0.049	0.186 *
unorig	-0.076	-0.091	-0.068	-0.084	-0.076	-0.165
indorig	0.067 *	0.034 *	0.061 *	0.034	-----	-----
ficoorig	-3.539	-3.053	-4.575	-3.455	-5.359	-5.377
doc	-0.201	-0.306	-0.340	-0.362	-0.313	-0.291
nonowner	0.416 *	0.416 *	0.665 *	0.575 *	0.736 *	0.439 *
ioorig	0.168 *	0.413 *	-0.432	0.343	-----	-----
piggyback	0.232 *	0.293 *	0.150 *	0.248 *	0.083 *	0.083
cash	-----	0.019	-----	0.013	-----	-0.018
proptype	0.092 *	-0.001	0.098 *	-0.060	-0.009	-0.028
loqual	0.075 *	0.061 *	-0.017	-0.090	0.084	0.221 *
invhpa	-0.012	-0.012	-0.021	-0.016	-0.021	-0.006
origamt	0.297 *	0.279 *	0.338 *	0.223 *	0.208 *	0.168 *
kids	0.569 *	0.666 *	0.689 *	0.608	0.207	-0.673
race	0.427 *	-0.209	0.463 *	-0.218	0.639 *	-0.145
educ	-0.255	0.149	-0.380	0.256	0.403	0.539 *
cltvnow	0.050 *	0.056 *	0.047 *	0.058 *	0.062 *	0.069 *
mratenow	0.123 *	0.150 *	0.080 *	0.065 *	0.166	0.145 *
ppnow	-0.193	-0.139	-0.060	-0.089	-0.134	-0.185
rstwind	-0.916	-0.345	-0.412	-0.426	-----	-----
lngwind	-0.554	-0.113	-0.268	-0.129	-----	-----
hpvol	-0.003	0.010 *	-0.006	0.010 *	-0.006	0.015 *
unempnow	0.001	-0.001	0.001	-0.001	-0.001	-0.002
indnow	0.013	0.018 *	0.017	0.015	-----	-----
ionow	-0.215	-0.297	0.243	-0.354	-----	-----
hhincome	-0.413	-0.288	-0.463	-0.204	-0.369	-0.202
oil	0.002 *	0.002 *	0.003 *	0.002 *	0.003 *	0.004 *
pmt	0.748 *	0.267 *	0.566 *	0.542 *	0.742 *	0.542 *
pmi	-0.063	0.020	0.043	0.068	0.041	0.028
negeq	0.001 *	0.000	0.002 *	0.000	0.001	0.000
frmorig	-0.091	-0.041	-0.219	-0.080	-0.082	-0.127
frmnow	0.101 *	0.107 *	0.134 *	0.188 *	0.200 *	0.136 *
pti	0.005 *	0.009 *	0.007 *	0.009 *	0.006 *	0.007 *
lofico	-0.137	-0.019	-0.218	0.020	0.042	-0.036
Log-likelihood	-832,949	-1,158,936	-117,936	-176,145	-127,965	-529,849
No. obs.	5,179,682	6,494,241	829,820	1,166,872	1,194,106	5,002,573

* Statistically significant at the 95-percent confidence level.

Table 6: Prepayment Hazard Coefficient Estimates

This table provides coefficient estimates for the prepayment hazard functions in the competing hazards models.

	Subprime 2/28		Subprime 3/27		Subprime FRM	
	Purchase	Refinance	Purchase	Refinance	Purchase	Refinance
constant	-0.385	-0.549	0.796	1.128 *	-0.438	-0.798
cltvorig	0.012 *	0.005 *	0.012 *	0.001	0.009 *	0.009 *
mrateorig	0.243 *	0.116 *	0.346 *	0.159 *	0.138 *	0.046
pporig	-0.656	-0.377	-0.657	-0.488	-0.562	-0.329
unorig	0.066 *	0.021 *	0.069 *	0.026 *	0.112 *	0.066 *
indorig	-0.121	-0.052	-0.054	0.015 *	-----	-----
ficoorig	1.380 *	0.478 *	0.517 *	0.007	-0.741	-1.459
doc	-0.027	0.032 *	-0.092	-0.003	-0.113	-0.015
nonowner	0.132 *	-0.370	0.076 *	-0.257	0.131 *	-0.315
ioorig	0.031	0.017	0.146	0.037	-----	-----
piggyback	-0.023	-0.067	0.028	-0.062	0.003	-0.029
cash	-----	0.092 *	-----	0.067 *	-----	0.097 *
proptype	-0.028	-0.114	-0.066	-0.135	-0.119	-0.172
loqual	0.051 *	0.038 *	0.081 *	0.046	0.112 *	-0.056
invhpa	-0.007	0.004 *	-0.006	0.001	-0.004	0.004 *
origamt	0.129 *	0.229 *	0.187 *	0.167 *	0.273 *	0.357 *
kids	0.199 *	0.921 *	-0.045	0.471 *	-0.028	0.902 *
race	-0.028	0.211 *	0.065	0.278 *	0.084 *	0.228 *
educ	0.206 *	0.313 *	0.383 *	0.467 *	0.629 *	0.517 *
cltvnow	-0.021	-0.017	-0.020	-0.011	-0.020	-0.018
mratenow	-0.219	-0.102	-0.246	-0.125	0.013	0.085 *
ppnow	0.281 *	0.196 *	0.254 *	0.242 *	0.209 *	0.365 *
rstwind	1.604 *	0.957 *	1.252 *	1.075 *	-----	-----
lngwind	0.648 *	0.148 *	0.535 *	0.568 *	-----	-----
hpvol	0.023 *	0.024 *	0.019 *	0.031 *	0.025 *	0.017 *
unempnow	-0.002	-0.004	-0.003	-0.005	-0.002	-0.001
indnow	0.080 *	0.003	-0.042	-0.081	-----	-----
ionow	-0.169	-0.175	-0.316	-0.243	-----	-----
hhincome	0.230 *	0.260 *	0.253 *	0.348 *	0.329 *	0.306 *
oil	-0.003	-0.005	-0.005	-0.006	-0.007	-0.008
pmt	-0.411	-0.366	0.230 *	0.012	0.903 *	1.375 *
pmi	-0.024	0.029 *	0.014	0.068 *	0.073 *	0.075 *
negeq	-0.006	-0.009	-0.006	-0.010	-0.004	-0.010
frmorig	-0.047	-0.148	-0.146	-0.212	-0.082	-0.139
frmnow	-0.199	-0.138	-0.379	-0.378	-0.682	-0.684
pti	0.003 *	0.004 *	0.002 *	0.004 *	0.003 *	0.006 *
lofico	-0.076	-0.001	-0.094	-0.035	-0.248	-0.101
Log-likelihood	-832,949	-1,158,936	-117,936	-176,145	-127,965	-529,849
No. obs.	5,179,682	6,494,241	829,820	1,166,872	1,194,106	5,002,573

* Statistically significant at the 95-percent confidence level.

Table 7: Simulated Foreclosure Starts

This table provides estimates of the number of subprime foreclosure starts expected to occur annually during 2007-2010. Under the baseline assumptions for house prices, interest rates, unemployment, and oil prices, foreclosure starts on variable-rate subprime mortgages are expected to peak during 2008, while foreclosure starts on fixed-rate subprime mortgages are expected to peak during 2009. If house price were to fall twice as much as under the baseline, foreclosure starts on subprime mortgages could increase as much as 25 percent. The baseline assumptions for house prices, interest rates, and unemployment are drawn from Fannie Mae and Freddie Mac's June economic outlooks, while oil prices are drawn from futures prices listed on NYMEX.

(millions of loans)		2007	2008	2009	2010
Baseline	Variable-rate	0.66	1.07	0.60	0.27
	Fixed-rate	0.17	0.39	0.47	0.28
	TOTAL	0.85	1.46	1.07	0.56
		2007	2008	2009	2010
Worse HP	Variable-rate	0.66	1.26	0.62	0.26
	Fixed-rate	0.17	0.57	0.68	0.32
	TOTAL	0.85	1.83	1.30	0.58

Table 8: Year-Ahead Cumulative Default and Prepayment Rates

This table provides estimates of the one-, two-, and three-year ahead default and prepayment rates for a representative subprime mortgage (this $150,000 purchase-money mortgage was originated in December 2007 and has a 2-year prepayment penalty, 95 percent CLTV (no simultaneous second lien), 8 percent mortgage rate, FICO score of 620, full documentation, and is for an owner-occupied property). The baseline assumptions for house prices, interest rates, and unemployment are drawn from Fannie Mae and Freddie Mac's June economic outlooks, while oil prices are drawn from futures prices listed on NYMEX. Defaults and prepayments are simulated under eight different scenarios: (1) the baseline, (2) house prices fall 50 percent more than under the baseline, (3) the prepayment penalty is waived at origination, (4) the mortgage is instead originated with a 100% combined LTV ratio, (5) the mortgage is instead originated with a 9 percent mortgage rate, (6) the mortgage is originated with little or no documentation, (7) the mortgage carries a two-year interest only period, and (8) the mortgage is allowed to "skip" its mortgage rate resets (i.e., the mortgage rate remains fixed at the initial contract rate).

	Subprime 2/28		Subprime 3/27		Subprime FRM	
	Default	Prepay	Default	Prepay	Default	Prepay
Baseline						
1-year	6.0%	6.9%	4.9%	8.0%	3.9%	6.4%
2-year	22.3%	19.2%	19.8%	16.7%	16.8%	13.5%
3-year	51.5%	25.7%	37.5%	23.9%	35.1%	20.0%
House Prices Fall 50% More						
1-year	6.9%	5.0%	5.8%	5.6%	4.7%	4.6%
2-year	26.6%	16.0%	23.8%	13.6%	21.0%	11.1%
3-year	60.5%	21.4%	45.1%	19.6%	43.9%	16.6%
No Prepayment Penalty						
1-year	6.8%	9.7%	5.4%	11.5%	4.2%	9.2%
2-year	24.0%	25.8%	20.8%	23.3%	17.5%	19.0%
3-year	46.2%	36.2%	36.8%	34.2%	33.4%	28.1%
100% CLTV at Origination						
1-year	6.7%	4.1%	6.0%	4.5%	5.0%	3.6%
2-year	24.7%	15.7%	23.2%	12.7%	20.6%	10.2%
3-year	56.4%	21.8%	43.1%	19.2%	41.8%	15.9%
9% Mortgage Rate						
1-year	7.2%	6.9%	6.0%	8.6%	4.9%	7.3%
2-year	26.2%	18.8%	23.6%	17.7%	20.7%	15.1%
3-year	54.2%	26.4%	43.1%	24.6%	41.2%	21.7%
No or Low Documentation						
1-year	8.0%	7.3%	6.7%	9.4%	5.9%	8.4%
2-year	28.4%	19.6%	25.8%	19.0%	24.2%	17.1%
3-year	59.5%	25.5%	45.9%	25.8%	46.1%	23.8%
2-Year Interest-Only Period						
1-year	6.0%	6.1%	4.1%	6.8%	-----	-----
2-year	22.4%	17.3%	17.1%	14.5%	-----	-----
3-year	57.0%	23.8%	35.3%	22.6%	-----	-----
Skip Mortgage Rate Resets						
1-year	6.0%	6.9%	4.9%	8.0%	-----	-----
2-year	23.3%	15.8%	19.8%	16.7%	-----	-----
3-year	46.0%	22.6%	38.0%	22.8%	-----	-----

Figure 1: Subprime Mortgage Delinquency Rates

This figure shows the serious delinquency rate (loans 90 days or more past due or in the process of foreclosure) for subprime variable-rate and subprime fixed-rate mortgages, separately, from January 2000 through July 2008. Rates are derived from First American LoanPerformance data.

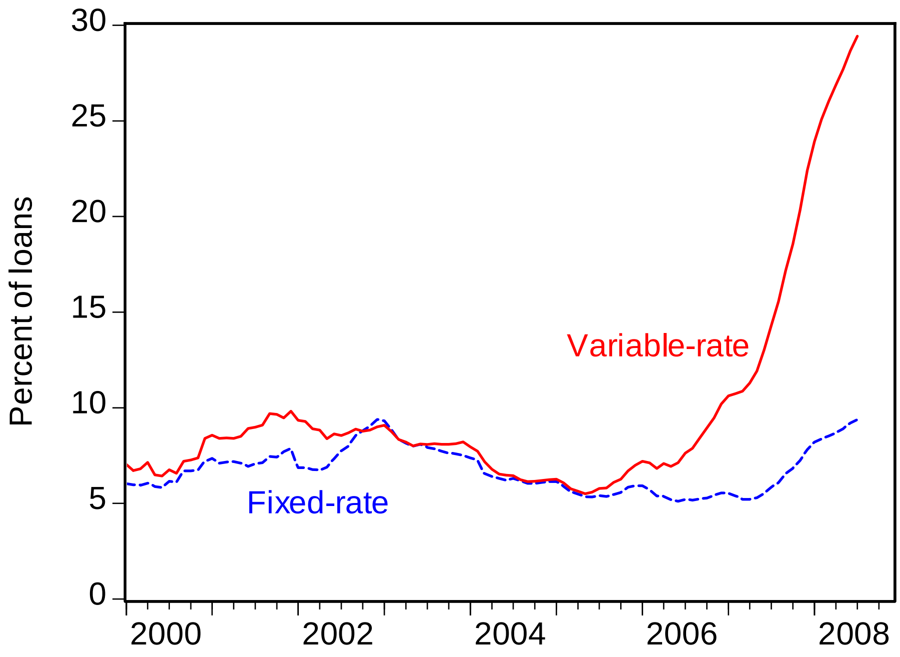


Figure 2: House Price Appreciation

This figure shows house price appreciation for the nation as a whole, for Ohio, Michigan, and Indiana, and for California, Florida, Arizona, and Nevada, from the first quarter of 2000 through the second quarter of 2008. Data are based on the OFHEO purchase-only house price indexes.

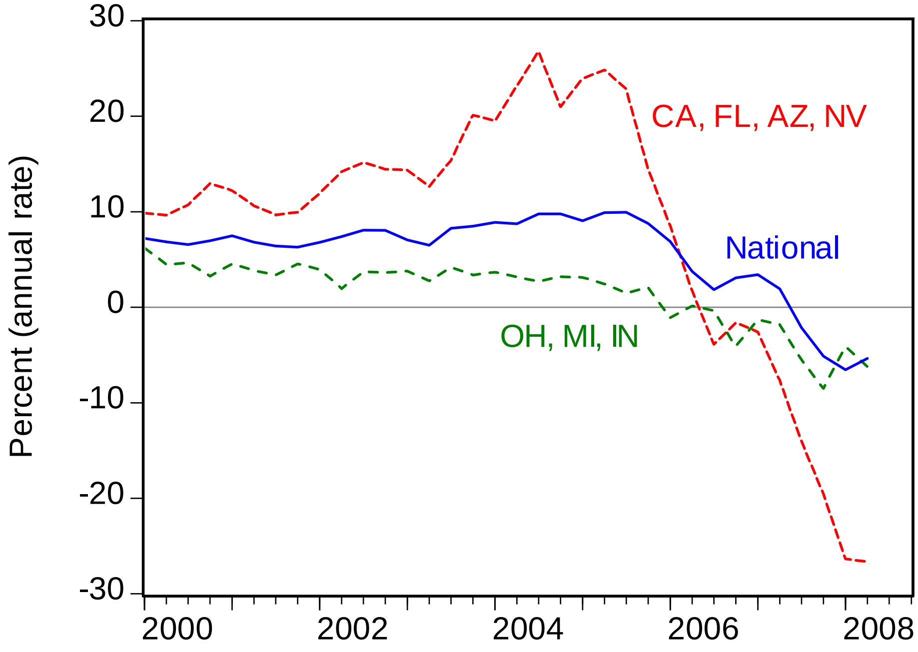
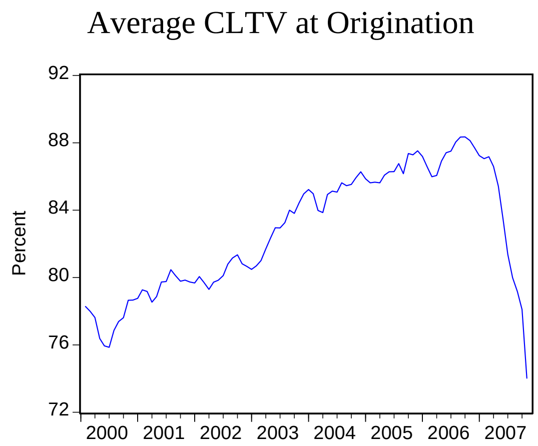


Figure 3: Subprime Underwriting

This figure shows how some observable underwriting standards slackened from 2000 to 2007. The average combined loan-to-value ratio rose throughout the 2000 to 2007 period, while the proportion of loans originated with full documentation declined. The proportion of low quality loans (combined LTV ratio in excess of 95 percent and not fully documented), the dotted line, rose over this period. Derived from First American LoanPerformance data.



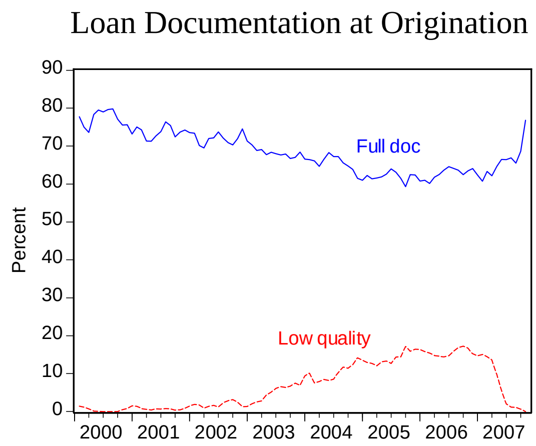


Figure 4: Subprime First Mortgage Rate Resets

This figure shows the schedule for first mortgage rate resets on subprime variable-rate mortgages as of July 2008. Many loans have already experienced their first mortgage rate resets (shaded region); many more are on the verge of resetting. By mid-2009, mortgage rate resets will decline substantially (as new mortgage originations dropped off beginning mid-2007). Resets occurring before 2007 or after 2012 are not shown. Derived from First American LoanPerformance data.

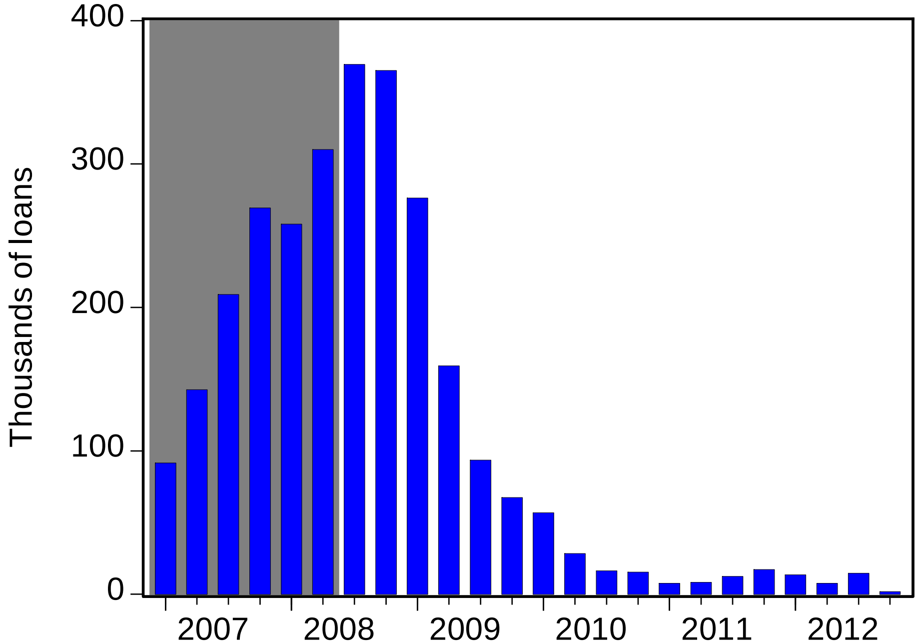


Figure 5: PSA Assumptions

This figure illustrates the PSA assumptions. The standard prepayment assumption has the conditional prepayment rate increasing until month 30; likewise, the standard default assumption has the conditional default rate increasing until month 30. After month 30, the standard prepayment assumption holds the conditional prepayment rate constant, whereas the standard default assumption holds the conditional default rate constant until loan age 60 months before dropping off until loan age 120 months.

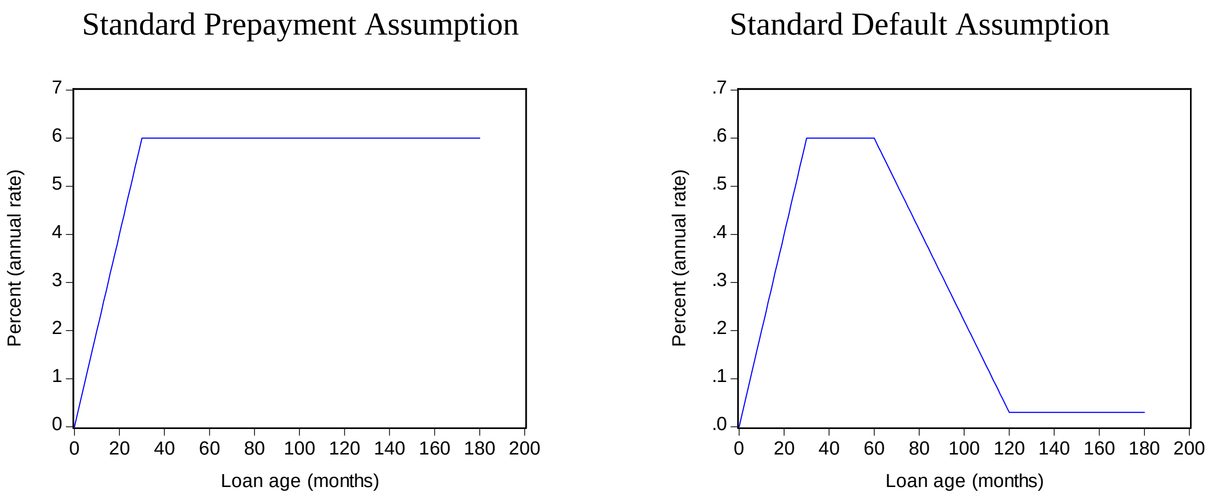


Figure 6: Simulation Assumptions

This figure illustrates the baseline assumptions for house prices, interest rates, unemployment, and oil prices. The path for national house prices is drawn from Freddie Mac's June economic outlook. State-level house prices are based on the historical correlations between state-level house prices and national house prices. Fixed-rate mortgage (FRM) rates are also drawn from Freddie Mac's June economic outlook. The path for the fed funds rate and the national unemployment rate are based on Fannie Mae's June economic outlook. As with state-level house prices, state-level unemployment rates are based on the historical correlations between state-level unemployment rates and the national unemployment rate. The path for oil prices is based on futures quotes from NYMEX in June.

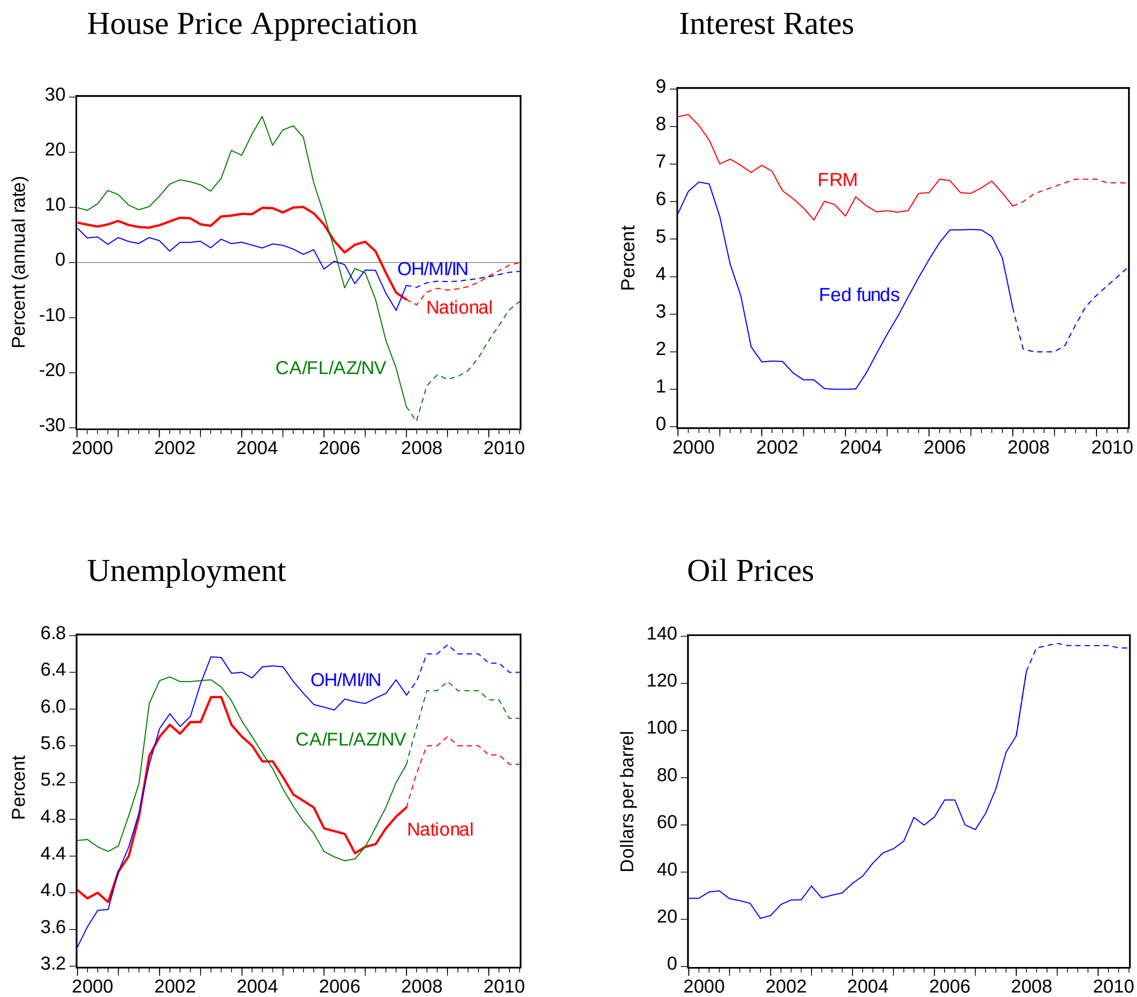
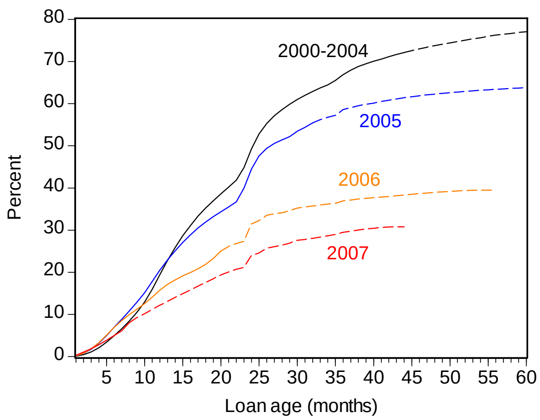


Figure 7: Baseline Simulation

This figure shows the simulated paths for cumulative prepayments and defaults under the baseline assumptions shown in Figure 6. Solid lines depict data through 2007; dashed lines represent simulated data through 2010. More recent vintages are more prone to default and less likely to prepay.

Cumulative Prepayments



Cumulative Defaults

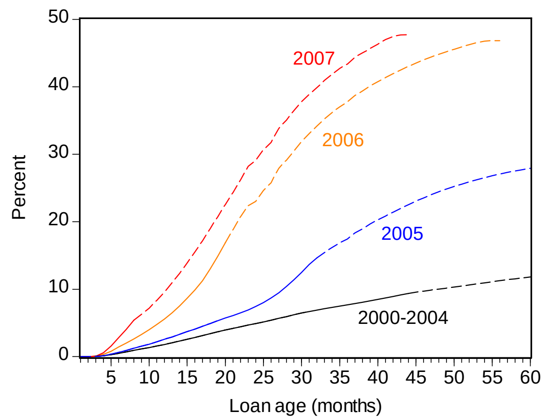
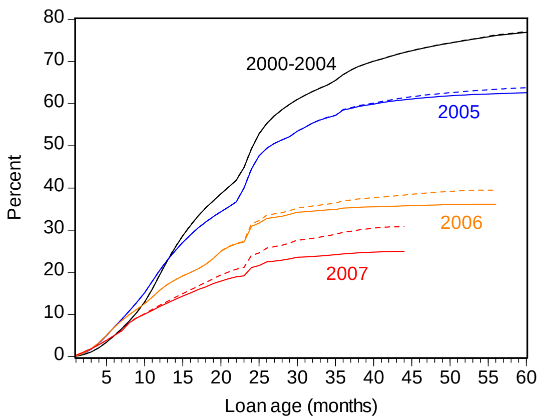


Figure 8: Worse House Price Simulation

This figure shows the simulated paths for cumulative prepayments and defaults under a scenario in which house prices fall twice as much as in the baseline. Solid lines depict these simulations; dashed lines represent the baseline simulations. A worse assumed path for house prices pushes prepayments lower and defaults higher.

Cumulative Prepayments



Cumulative Defaults

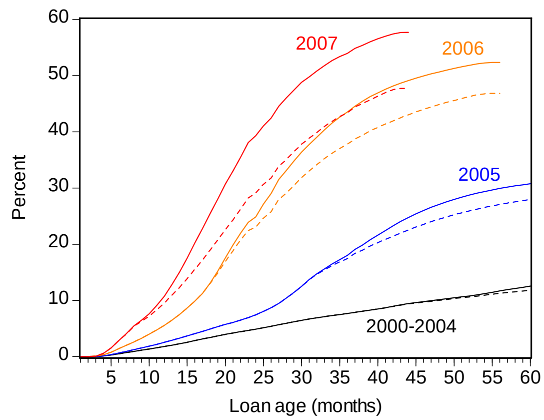


Figure 9: Subprime Mortgage Default Simulations

This figure shows the simulated paths for the total number of subprime mortgage defaults under the baseline and worse house price scenarios through 2010. Solid lines depict simulated data pertaining to that simulation; the dashed lines show the baseline simulation relative to the worse house price scenario. Under the baseline, total subprime defaults are expected to peak during mid-2008, but a worse path for house prices could push the peak higher and later into 2008 (2009 for subprime fixed-rate mortgages).

Baseline | Worse House Price Scenario