Strategic Default Induced by Loan Modification Programs

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Abstract

We use the October 2008 Countrywide legal settlement as a natural experiment to investigate how borrowers may change their payment behavior to be eligible for loan modifications. We find that the Countrywide modification program induces strategic default among both borrowers current in their loan payments and those already in payment delinquency before the settlement. By January 2009, modification-induced strategic default is about nine percentage points, on a base default rate of 30 percent, and such strategic behavior is more severe among riskier loans. These findings have implications on designs of loan modification programs that are different from the existing literature.

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1. Introduction

Loan modification has long been adopted by banks as a loss prevention and recovery method, and it has become more commonly used since the latest financial crisis. It was also among the major tools by the federal governments to help homeowners during the housing market downturn (for example, the Home Affordable Modification Program, or HAMP). Since modifications are mainly targeted at troubled loans, financial hardship (delinquency or at least being in danger of falling behind on loan payments) is among the requirements of most loan modification programs. Such an eligibility requirement could, however, possibly induce strategic default behavior, i.e., borrowers intentionally missing payments to qualify for modifications with very favorable terms. It is a potential issue widely acknowledged among lenders, policy makers, and academics.[2] Furthermore, there is a general consensus that strategic default is costly, as it not only increases the cost of modification programs, but may also weaken the moral standard of society: if some debtors are perceived as being bailed out unjustly, more strategic default might follow (e.g., Guiso, Sapienza, and Zingales [2011]).

The scope of such behavior is difficult to assess because the true cause behind any default is largely unobservable. Further, government loan modification programs (such as HAMP) are often applied nationwide, so there is a lack of a counterfactual. On the other hand, proprietary modification programs by individual banks are rather sporadic, making it difficult to draw an informative inference. A good understanding of modification-induced strategic default is important, however, as it can help design effective loan modification programs so that strategic default can be minimized. Deep insight into such behavior also constitutes a major component of a full evaluation of the economic impact of any government-sponsored loan modification proposals (for example, Calomiris, Higgins, and Mason [2011]). Although the worst days of the housing market may be over, modification-induced strategic default is by no means confined to the mortgage sector and can happen in any segments with rising default risk. A thorough analysis of modification-induced default thus bears tremendous implications for banking practice and public policy decisions in general.

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[2] For example, "Four AGs Say Foreclosure Settlement Proposal Promotes Strategic Default" by Jon Prior, *HousingWire*, March 23, 2011. Also see the literature review in section 2.

We rely on the empirical evidence arising from the Countrywide legal settlement to assess the extent of modification-induced strategic default. Countrywide was among the largest mortgage lenders in the United States, if not the largest, during the booming years of the latest housing bubble.[3] Under a multi-state settlement on October 6, 2008, Countrywide committed to offer unsolicited loan modifications to borrowers who have difficulty making mortgage payments. The settlement, affecting Countrywide but not other lenders, has been applied nationally from the beginning, and it provides a valuable natural experiment for studying modification-induced strategic behavior.

The existing literature (for example, Mayer, Morrison, Piskorski, and Gupta [2014], hereafter MMPG) has exploited the exogenous shock of the Countrywide legal settlement and provided evidence supporting the existence of modification-induced strategic default. Our study contributes to the literature by adopting a broader view of modification-induced strategic default. Specifically, MMPG investigates modification-induced strategic default only among borrowers who were current in payments before the program announcement. They focus on the impact of the modification program on the transition rate from current to default. We argue that the modification program has a second form of impact, namely reducing the rate of transition from default back to current among borrowers who were already in payment delinquency before the settlement. Our evidence indicates that the second form of impact is as important as the first one. By investigating loans both current and delinquent upon modification announcement, we reveal new evidence on modification-induced behavior. Such evidence casts serious doubt on the effectiveness of the practice of incorporating rigorous audits into loan modification programs as a preventive measure to deter strategic behavior.

Our primary dataset is DataQuick, which is a monthly loan-level panel dataset covering over 95 percent of private-label mortgage-backed securities.[4] We include in our

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[3] For example, Countrywide's market share in the loans covered by our primary dataset, DataQuick, exceeds 17 percent, while the market share of the second largest lender is less than 6 percent.

[4] Private-label, or non-agency, mortgage-backed securities have as underling assets the mortgages that do not conform to the criteria set by the government-sponsored enterprises Freddie Mac, Fannie Mae, and Ginnie Mae. For example, many of the mortgages that made up private-label mortgage backed securities were "jumbo loans" with a loan amount exceeding the limit of $415,000 set by the three government agencies at that time.

study mortgages that are likely to qualify for the modification program.[5] We directly estimate the fraction of modification-induced default relying on mortgage fixed effect models. We find that the modification program induces significant strategic default among the likely eligible loans. By the fourth month since the modification announcement, the estimated induced default from our base sample is about nine percentage points among Countrywide loans, relative to the base default rate of 30 percent among loans by other lenders. There is clear evidence that the modification program induces strategic default not only among loans current in their payments, but also among borrowers who were already past due in their payments before the modification announcement. In general, we find that modification-induced strategic default is rather widespread, and this behavior seems to be more serious among more risky loans, such as those interest only loans, balloon loans, and those already delinquent in the mortgage payment at the time of the modification announcement.

Our evidence thus suggests that it is very difficult even for a program requiring rigorous audits, such as HAMP, to effectively address the problem of strategic default. HAMP requires borrowers to submit many documents, such as proof of their occupancy status, an affidavit of financial hardship, and income verification. The lengthy process of audit may be one of the reasons leading to its ineffectiveness, and HAMP has been heavily criticized for not doing much to mitigate the housing market problem.[6] In spite of being too slow, HAMP may be justified as a way to minimize strategic default, as argued in MMPG. Our evidence, however, casts much doubt on such an argument, as borrowers already delinquent on their mortgage payments before the modification announcement can most likely survive rigorous audits. In fact, our estimates suggest that roughly half of the loans defaulted strategically in the base sample are already in payment delinquency immediately before the announcement of the Countrywide settlement.

Besides adding to the literature on strategic default, our study connects to the stream of literature examining the strategic behavior resulting from government bailouts

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[5] There is some uncertainty on whether a borrower may qualify for the modification. For example, assessing fair market value of a residential property is by no means an easy task, so the eligibility criterion of 75 percent loan-to-value ratio (LTV) does not create a clear cutoff point.

[6] For example, the statement by the National Taxpayer Union at http://www.ntu.org/news-and-issues/government-reform/hamp-terminate.html.

and bank regulation,[7] the strategic behavior by lenders to take advantage of the securitization market,[8] loan modification,[9] and potential solutions to strategic default.[10]

The rest of the paper proceeds as follows. Section 2 reviews the existing studies on strategic default. The Countrywide legal settlement, the subprime market, and the market share of Countrywide are discussed in section 3. We elaborate on the data source, data construction, and graphical patterns in section 4, and describe our statistical models in section 5. Section 6 presents the empirical results, and finally, we draw conclusions in section 7.

2.   Existing Studies and Findings on Strategic Default

There is a broad range of literature on strategic default. One stream of studies focuses on how negative home equity is related to mortgage default (Quercia, Ding, and Ratcliffe [2009]; Foote, Gerardi, and Willen [2008]; Bajari, Chu, and Park [2008]; and Guiso, Sapienza, and Zingales [2011]). These papers document a strong link between negative home equity and default. Further, the link seems to be much stronger during the latest financial crisis than earlier periods. Another stream of research investigates the strategic choice of default among different types of debts by the same person (Cohen-Cole and Morse [2009]; Elul, Souleles, Chomsisengphet, Glennon, and Hunt [2010]; Jagtiani and Lang [2010]; and Anderson et al. [2013]). These papers generally suggest that borrowers who default on their mortgages are often current on their other debts. In addition, other studies use different approaches to show the existence of strategic default, for example, by linking default behavior with state recourse laws (Ghent and Kudlyak [2009]) or documenting borrower behavior prior to mortgage default (Jennings [2011][11]).

Therefore, there is quite extensive evidence on the existence of strategic default; that is, at least some default is driven more by choice than by economic hardship. None

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[7] For example, Agarwal et al. (2012), Farhi and Tirole (2009), and Poole (2009).

[8] For instance, Mian and Sufi (2009), Keys et al. (2010, 2012), Rajan et al. (2010), Berndt and Gupta (2009), and Purnanandam (2010).

[9] For example, Mason (2007); Thompson (2009); Mayer, Morrison, and Piskorski (2009); Piskorski et al. (2010); and Agarwal, Amromin, Ben-David, Chomsisengphet, and Evanoff (2011).

[10] For example, Edmans (2010).

[11] "When the Roof Fell In" by Andrew Jennings, *The Economist*, March 3, 2011.

of the above studies, however, particularly addresses the extent of this strategic behavior *induced by mortgage modification programs*. MMPG is the first and only study so far that specifically examines modification-induced strategic default, and it is also the first to explore this issue using the Countrywide legal settlement as a natural experiment. MMPG provides strong evidence suggesting that loan modification programs can induce strategic default. As discussed in the introduction, its research design does not, however, capture the full extent of strategic default. To better understand the empirical setting of strategic default and analyze the modeling approaches, we borrow a bathtub theory, which is often used in macroeconomics and labor economics to model unemployment (e.g. Shimer [2012]).

In a bathtub analogue, the fraction of the bathtub filled with water is dynamically determined by both the water inflow rate and outflow rate. In an unemployment study, the fraction of bathtub filled with water is the unemployment rate, and analogously, it is the fraction of loans being current in our case.[12] In an unemployment study, the water inflow consists of transitions from employment to unemployment and the outflow consists of transitions from unemployment back to employment. In our case, the water outflow consists of loans transiting from current to default, and the water inflow consists of loans transiting from default back to current, i.e., the cure of defaulted loans.

MMPG models the transitions from current to default, but completely ignores the transitions from default back to current. They essentially estimate a discrete time single-spell (being current) hazard model.[13] Its focus of interest, the "rollover rate" from current to 60 days past due (DPD), is the hazard rate of becoming default given that it is current in the previous period (that is, the water outflow rate in the bathtub analogue.)

The implications of modification-induced strategic default are different among loans current or delinquent upon the modification announcement. For loans current

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[12] At the first glance, it seems to be more natural to link the bathtub water to defaulted loans as mortgage default is the focus of this study. Our choice of current loans, however, can give a natural interpretation to the central concept in MMPG, namely, the rollover rate. In our set-up, the rollover rate is equivalent to the water outflow speed (the hazard rate in duration analysis).

[13] Their baseline model defined by equation (1) is a single-spell hazard model with both left-censored spells (spells starting before the sample period) and fresh spells (spells starting within sample period). Their alternative model on page 2852 is a single-spell hazard model with left-censored spells only because in this setting once a loan becomes 60 days delinquent, it drops out of the sample.

before the modification announcement, modification-induced strategic default involves borrowers who intentionally stop payments (default) to become eligible for mortgage modification. On the other hand, among loans already delinquent upon announcement, modification-induced strategic default implies that some borrowers would continue missing the payments to remain eligible and take advantage of the modification program. These two types of strategic behavior have different policy implications. While the first type of strategic defaulters can probably be detected by a rigorous audit, identifying the second type of strategic defaulters might be difficult even with a rigorous audit. This is because efforts put in remedy activities, such as job searches, are unobservable. Over 30 percent of the loans in our base sample (as defined in section 4.2) have payments past due, with the overwhelming majority of them more than 60 DPD in the month right before the modification announcement. Sample cure rates, i.e., the rate of becoming current given that the loan is in default in the previous period, (that is, the water inflow in the bathtub analogue) are substantial both before and after the settlement, and our estimates indicate that the modification announcement indeed induces strategic default among borrowers who were already in payment delinquency before the modification announcement.

The substantial cure rates complicate the conversion of the key parameter in MMPG, *the effect of modification on "rollover rate,"* to *the fraction of loans induced into strategic default by the modification program*, the parameter of ultimate interest to banks and policy makers. We discuss this issue in greater detail in section 6 when we compare our estimates with those in MMPG.

3.   **Countrywide Legal Settlement**, **Subprime Markets, and Countrywide's Market Share**

3.1.   **Countrywide Legal Settlement**

Under the allegation that it "implemented a deceptive scheme through misleading marketing practices designed to sell risky and costly loans to homeowners," Countrywide entered a multi-state settlement on October 6, 2008. Following the settlement, Countrywide agreed to modify some loans it was servicing that were at risk of default,

namely mortgages that were 60+ DPD or otherwise likely to become delinquent. The terms of the settlement have been applied nationally from the beginning.

The settlement covers *subprime* hybrid adjustable-rate mortgages (including 2, 3, 5, 7, and 10 hybrid, ARM hereafter),[14] all pay option adjustable-rate mortgages, and subprime fixed-rate mortgages. Qualified loans under the settlement are eligible for several types of loan modifications, including elimination of the negative amortization feature; optional introduction of a 10-year interest-only period on the loan; interest rate reduction, with an annual increase subject to an interest rate cap of 7 percent;[15] and, for certain option ARM borrowers, the possibility of a permanent principal write-down. Obviously, the modification terms appear extremely favorable and the benefits last through the life time of the loan. How borrowers change their behavior to take advantage of these benefits is an empirical question.[16]

Countrywide agreed to implement the modification program starting December 1, 2008, by contacting eligible borrowers proactively. Countrywide was supposed to send a communication to borrowers whose mortgage payments were scheduled to change due to interest rate resets, inviting them to contact Countrywide if they could not afford the new payments. The foreclosure process for any potentially eligible borrowers was also expected to be suspended until modification eligibility had been determined.

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[14] A 2, 3, 5, 7, or 10 hybrid ARM's fixed-rate loan period is offered for a maximum of 2, 3, 5, 7, or 10 years. After this time is up, the loan reverts to an adjusted rate, which runs the remainder of the mortgage loan time.

[15] A reduction of interest rate to the introduction rate or lower (but no less than 3.5 percent) during the first five years, and a fixed-rate at the higher of 1) the Fannie rate and 2) the introductory rate for the remainder years. By the end of the fifth year, if the new payment is still not affordable, an extension of two more years of reduced interest rate is available.

[16] Aware of the possibility of borrowers strategically missing mortgage payments to be eligible for the modification program, Countywide included in its legal settlement a provision that, if it "detects material levels of intentional nonperformance by borrowers that appears to be attributable to the introduction of the loan modification program, it reserves the right to require objective prequalification of borrowers for loan modification under the program and to take other reasonable steps." Detecting "intentional nonperformance" is, however, not a trivial task, and it is not clear if this provision would deter homeowners from being strategically delinquent on their mortgage payments to qualify for modifications.

3.2   Subprime Mortgages and the Market Shares of Countrywide

Hybrid ARMs include a fixed interest rate for an initial period of time, which floats thereafter. The date that a hybrid ARM shifts from fixed-rate to floating-rate is known as the reset date. For example, ARMs 2/28 (ARMs 3/27) have fixed rates in the first two (three) years and floating rates for the remaining 28 (27) years (these ARMs are referred to as ARM2s and ARM3s hereafter). The introductory fixed interest rates for the first two to three years are typically below the market interest rates and the interest rates usually increase significantly upon reset. ARMs had been in existence for a long time before 2000, and the popularity of such mortgages increased dramatically after 2000. Since such mortgages enable borrowers to qualify for a much larger loan (i.e., by taking on more debt) than otherwise would be possible under the conventional fixed-rate mortgages, many subprime borrowers who could not afford conventional fixed-rate mortgages resorted to such loans, thus making these mortgages very risky.

We include in this study loans identified as subprime in DataQuick. Note that DataQuick covers only loans securitized by private label issuers, that is, neither loans on banks' books (non-securitized loans), nor loans securitized by the government-sponsored enterprises Freddie Mac, Fannie Mae, or Ginnie Mae. One concern is that our sample from DataQuick may not be representative of subprime loans. We have access to the Mortgage Metrics data, which include mortgages making up more than 60 percent of U.S. residential mortgages, covering both loans securitized and those on banks' books. We find from the Mortgage Metrics data that the degree of securitization among ARM2s and ARM3s by private labels is very high, above 90 percent before 2007. Therefore, the overwhelming majority of the ARM2s and ARM3s originated before 2007 is covered in DataQuick.

Countrywide was among the largest mortgage lenders, if not the largest, in the United States during the latest housing bubble, and a significant proportion of its loans were subprime.[17] Panel A of online appendix table A1 presents Countrywide's market share (i.e., new originations) in the subprime ARM2 and ARM3 markets based on DataQuick. This table suggests that Countrywide's operation in the subprime markets

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[17] See the information contained in http://www.justice.gov/crt/about/hce/documents/countrywidecomp.pdf.

was nationwide and not concentrated in any particular states. Panel B of online appendix table A1 shows Countrywide's market share over the 2005–2007 period among all loans in DataQuick. It is clear that there is some variation in Countrywide's market share, but the variation from one period to another is not large.

4. Data and Sample Construction

4.1. Data Source

DataQuick contains detailed loan and borrower information at origination, such as loan amount, initial interest rate (upon loan origination), interest rate type,[18] loan-to-value ratio (LTV), combined loan-to-value ratio (CLTV),[19] low/no documentation indicator, owner/investor indicator, primary mortgage insurance (PMI) information,[20] FICO credit score, property type,[21] property location, product type,[22] interest only indicator, balloon indicator,[23] loan purpose,[24] the existence of a prepayment penalty, etc. It also contains monthly updated information since origination, such as loan balance, current interest rate, monthly payment, delinquency status, date of last payment, date of next payment due, etc. DataQuick provides LTVs and CLTVs at origination only. To construct updated CLTVs, we assume that there is no pay-down on the second or higher liens from origination to the current month. We then estimate updated LTVs and CLTVs for each month based on 1) the current outstanding amount of the first lien, 2) the origination amount of the second and higher liens, and 3) changes in zip-level home price index

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[18] Interest rate types typically include fixed interest rate, floating interest rate, and combinations of them as in ARMs.

[19] When there is more than one lien on a residential property, the CLTV combines the outstanding debt from all liens, while the LTV reflects only the outstanding amount on the first lien.

[20] PMI is usually needed when down payments are less than 20 percent.

[21] Property types include single family house, one to four units, condominiums, planned unit development, etc.

[22] Product types include FRM, ARM, etc.

[23] Balloon loans do not fully amortize the term of the loans, thus leaving balances due at maturity; they are therefore more risky than the fully amortized loans but less risky than interest only loans.

[24] Loan purpose includes new purchase or refinancing, and whether there is cashout upon refinancing.

(HPI) from the origination month.[25] We further include zip-level unemployment rate among the explanatory variables in our model specification.[26]

4.2   Sample Construction

Our samples consist of Countrywide loans that are likely eligible for modifications and loans from other lenders that would likely be "eligible" had they been serviced by Countrywide.[27] Our *base sample* contains ARM2s originated in the second half of 2006. We chose ARM2 as it is the focus of most media discussions on subprime mortgages. This particular origination period is chosen as it is at the height of the housing bubble, thus naturally attracting more interest.[28]

To further shed light on a broad spectrum of subprime mortgages and other time periods, we investigate two alternative samples, including ARM3s originated in the second half of 2006 (alternative ARM3 sample hereafter) and ARM2s originated in the first half of 2005 (alternative ARM2 sample hereafter). During the four-month window after the settlement announcement, while the loans in the base sample are in the resetting period, the loans in the alternative ARM3 sample are not up for interest rate reset yet, and those in the alternative ARM2 sample have passed interest rate reset. So results from these samples would shed light on whether results from the base ARM2 sample are driven by the different reactions to interest rate reset between Countrywide and non-Countrywide loans.

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[25] The zip level HPI information is from Black Knight (formerly known as LPS). We have also used the zip level HPI information from CoreLogic, and those results are qualitatively similar to the results reported here.

[26] The zip-level unemployment rate variable used in our model was converted from county-level data. We obtain the county-level unemployment rate from Haver Analytics (http://www.haver.com). All zip code areas within the county share the unemployment rate at the county level. Some zip code areas span more than one county, and we calculate the population weighted averages using the 2010 census population available from the Missouri Census Data Center crosswalk (http://mcdc.missouri.edu/websas/geocorr12.html).

[27] We find that all ARM2s and ARM3s serviced by Countrywide as of June 2008 or September 2008 were originated by Countrywide. Therefore, in the rest of the paper, we do not differentiate between servicers and lenders.

[28] We do not lump loans from different origination periods together as there is ample evidence in the literature that loans originated in different periods differ substantially in their default behavior even after controlling for loan characteristics (Demyanyk and Van Hemert [2011]).

To construct our base sample, we apply several screening criteria to ARM2s originated in the second half of 2006. We include only first lien loans on owner-occupied properties, and exclude loans with missing values on the key variables used in the paper. We require the loans to have an updated LTV at or above 75 percent as of September 2008 to meet the modification requirement, and exclude any loans with origination or updated LTVs below 0.55 at any time during the period from January 2007 to January 2009 because these loans are unlikely to be subprime. Further, since mortgages with different terms have different payment structures, we constrain our sample to 30-year mortgages only.[29] We exclude loans with an interest rate below 3 percent in September 2008, as these loans have little room for rate reduction.

For loans passing the screening criteria we exclude loan-month observations once a loan enters the foreclosure procedure, as the probability of cure is virtually zero by the time of foreclosure. In addition, if a loan received a modification either from Countrywide or other lenders, we exclude its post modification observations. Typically modifications brought defaulted loans back to current status immediately, but these loans might be soon back to default. Including the post modification observations generates excessive artificial transitions between default and current. This is particularly problematic because of the overtime shift in the modification practice: mortgage modifications become more common over the sample period and especially towards the second half of 2008. Less than 0.2 percent of loans were modified before January 2008; this proportion goes up to 1.06 percent in August 2008, and further increases to 2.43 percent in January 2009. Finally, we delete the month when a loan is paid off to avoid classifying delinquency to paid off as cure, since a significant proportion of the paid-offs are driven by short sales.[30]

For each loan, given the monthly observations passing the screening process, we construct a panel beginning in January 2007 and ending in January 2009. A loan may drop out of our sample before January 2009 due to foreclosure, modification, or being

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[29] Countrywide has many mortgages with over 30-year amortization, whereas such types of mortgages are rare in other banks. To maintain comparability, we include only mortgages with 30-year amortization.
[30] Some borrowers falling behind their mortgage payments sell their residential properties and pay off the mortgages to avoid foreclosure.

paid off. Loans falling out of the sample before September 2008 are not eligible for the modification, and we exclude these loans.

Our panel stops in January 2009 because the American Recovery and Reinvestment Act of 2009, from which the nation-wide federal mortgage modification program HAMP derives authorization, was signed into law in February 2009.[31] Non-Countrywide borrowers may default strategically in anticipation of possible modifications under the new law, which can induce potential contamination on our estimations.

Our panel thus consists of the pre-event window from January 2007 to September 2008, and the post-event window from October 2008 to January 2009. At the end, we have 166,616 mortgages containing 3,885,002 monthly observations in the base ARM2 sample. Following the same procedure, we end up with 48,619 loans (1,183,678 monthly observations) in the alternative ARM2 sample and 35,160 loans (819,470 monthly observations) in the alternative ARM3 sample.

4.3   Default Rate

This section examines the monthly default rates of our samples, with the goal of contrasting the Countrywide loans with loans by other lenders and providing the overall picture of the housing market during our sample period from January 2007 to January

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[31] The details of HAMP were announced in March 2009. HAMP aims to modify first liens for eligible homeowners to achieve more affordable payments. This program ended on December 31, 2012. The eligibility criteria for homeowners are 1) the borrower has financial hardship and is delinquent or in imminent default; 2) the property is occupied as the borrower's primary residence; and 3) the borrower has sufficient, documented income to support the modified payment. The criteria for loans are 1) the amount owed on the first mortgage is equal to or less than $729,750; 2) the mortgage originated on or before January 1, 2009; and 3) the first mortgage payment (principal, interest, tax, insurance, and homeowner association/condo fees) is greater than 31 percent of the homeowner's monthly gross income. This modification program affects all servicers, not just Countrywide. HAMP requires participating loan servicers to reduce monthly payments to no more than 38 percent of the borrower's gross monthly income. The government would then chip in to bring payments down further to no more than 31 percent of the borrower's monthly income. In lowering the payment, the servicer would first reduce the interest rate to as low as 2 percent. If that's not enough to hit the 31 percent threshold, the servicer would then extend the terms of the loan to up to 40 years. If that is still not enough, the servicer would forebear loan principal at no interest.

2009. A mortgage is considered to be in default if it becomes 60+ DPD.[32] Note that the payment status is defined at the end of the month.

Figure 1 plots the default rates of our base sample. The vertical line marks October 2008, the time of the Countrywide settlement announcement. Throughout the sample period, the overall default rates display the well-known upward trend. The Countrywide default line is always above that of the other lenders throughout the sample period. The spread between Countrywide and other lenders is largely negligible in the beginning of the period, and it slightly widens as the loans age. The spread between the two lines suddenly enlarges drastically after October 2008, reaching nearly 16 percentage points by January 2009.

Figure 2 plots the default rates for our alternative ARM2 sample, consisting of loans originated in the first half of 2005. Note that loans in this sample are more than 18 months old by January 2007 and have passed interest rate reset in the post-announcement window. The default rates of Countrywide loans are largely comparable to those of other lenders before October 2007, and the spread between the two lines starts to emerge afterwards. As in figure 1, a clear rise in the Countrywide default line quickly widens the gap after October 2008, with the gap increasing from less than 10 percentage points in September 2008 to over 20 percentage points in January 2009.

Figure 3 plots the default rates for the alternative ARM3 sample, consisting of loans originated in the second half of 2006. The default rates between Countrywide and other lenders are comparable before June 2007. The two lines begin to diverge in July 2007, and the gap widens as the loans age. The abrupt increase in the spread of default rates between Countrywide and other lenders is again obvious around October 2008, with the gap enlarging from seven percentage points in September 2008 to roughly 17 percentage points in January 2009.

Therefore, figures 1–3 all depict a sudden increase in the default rate in Countrywide loans after October 2008, regardless of the reset status during the post-event window. The abrupt increase in the spread between Countrywide and other lenders after October 2008 is also evident in other alternative samples that we have investigated (but

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[32] We choose 60+DPD as the cutoff for mortgage default classification because 60+DPD is part of the criteria in the Countrywide settlement used to determine modification eligibility. MMPG uses the same 60+DPD definition for mortgage default.

not reported in the paper due to space limitations). This shared pattern across various samples is unlikely to be driven by idiosyncratic risks, and it lends directional support to the existence of strategic default induced by the settlement. Causal interpretation of these graphs is unreliable, however, because of the selection bias, i.e., these loans result from the two-way selection processes between the homeowners and mortgage lenders. In the next section, we present our econometric models to correct for the selection bias and estimate the scope of the strategic behavior induced by the modification program.

We next investigate graphically the *observed* transition rates from current to delinquent (the focal concept of *rollover rates* in MMPG) and the rates from delinquent back to current (*cure rates*). Both transition rates are referred to as empirical hazard rates in the duration model literature (see Kalbfleish and Prentice [1980]). In our setting, the first type of empirical hazard rate (rollover rate hereafter to match the terminology of MMPG) in month t is defined as the ratio of the number of loans becoming 60+DPD in month t to the number of loans being current in month $t-2$. The rollover rates of our base sample are plotted in figure 4. It is clear that the trends are very similar between this figure and figure 4 in MMPG, although our rollover rates are a couple of percentage points higher especially after July 2008 because of sample differences. The jump in Countrywide rollover rates after November 2008 is apparent.

The second type of empirical hazard rates, cure rates, are defined symmetrically, namely, the ratio of the number of defaulted loans becoming current again in month t to the number of loans being 60+DPD in month $t-1$. The cure rates of our base sample are presented in figure 5. The cure rates for both groups are high in the beginning and decline afterwards.[33] There is an exception to the overall declining pattern: the cure rates show a brief rise among Countrywide loans in June and July of 2008 - exceeding eight percentage points - and then fall drastically after August 2008. In the meanwhile, the cure rate of other lenders cuts from below in November 2008 when the cure rate among defaulted Countrywide loans approaches zero. Note that, because of the way we construct our data, the transitions from default to current are not contaminated by unnatural cures, such as loan modifications. Therefore, around modification announcement, we not only

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[33] Note that the high cure rates in the first few months are based on a small pool of default loans. For example, in February 2007, the total number of defaults is 189 among Countrywide loans and 508 among loans by the other lenders.

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observe changes in the rollover rates among loans that were current in payments, but also adjustments in the cure rates among loans already in default before the announcement.

We further depict the default rates for the subsamples based on their delinquency status as of September 2008 in figure 6: loans current as of September 2008 in panel A, loans 30–59 DPD as of September 2008 in panel B, and loans 60+ DPD as of September 2008 in panel C. We first examine panel A of figure 6. By sample construction, both default lines are at zero in September and October 2008. Before September, the overall default rates are very low, with the Countrywide's rates being higher. Both lines are, however, obviously above zero before the settlement, suggesting that the transition from default to current is far from rare and non-negligible. As the Countrywide line lies above that of other lenders before October 2008, this panel indicates that the cure rates are higher among Countrywide loans than among other lenders before October 2008, a finding consistent with that from figure 5. Both lines of default rates climb up sharply starting from November 2008. This pattern is intuitive as we define default as 60+ DPD, and it therefore takes two months to go from current to 60+ DPD. The overall default rates rise to around 20 percent, and the spread between Countrywide and other lenders increases to more than nine percentage points at the end of the sample period.

In panel B of figure 6, the two default lines are again at zero in September 2008 by construction. Not surprisingly, panel B shows that the default rates before September are higher than those in panel A, and this pattern again suggests substantial cure rates among the defaulted loans. The sharp rise in default rates for all loans starts in October. The default rates among Countrywide loans are higher than those of other lenders before October 2008, but the gap is rarely in double digits. The positive gap between Countrywide and other lenders enlarges in October, widens further in November and December, and finally reaches over 18 percentage points in January 2009.

Panel C of figure 6 plots default rates of loans 60+DPD as of September 2008, and consequently both default lines are at one for that month. Default rates during the pre-event window in this panel are much higher than those shown in the previous two panels. They start from low single digits in early 2007 to more than 40 percent in February 2008 and to 100 percent in September 2008. Different from the patterns in panels A and B, the default rate line of other lenders is above the Countrywide line in

every month from February to September 2008. The default rates are less than one in October, suggesting that some default has been cured, but the cure rate is slightly higher among Countrywide loans, as the Countrywide line is below the line for other banks in October 2008. Starting from November 2008, however, the line for other lenders drifts sharply downward, while the Countrywide line falls more slowly, and the Countrywide line cuts from below. By the end of the sample period, the default rate of Countrywide loans is almost 10 percentage points higher than the rate of other lenders, suggesting that the cure rate among loans of other lenders is actually 10 percentage points higher during the post-announcement period.

We have also investigated the graphs in figures 4 to 6 among the alternative samples and observe very similar patterns. In summary, there is directional evidence that 1) strategic default may take place not only among loans in better conditions, but also among loans already in delinquency before the legal settlement is announced, and 2) the modification program not only increases the transition rates from current to default but also decreases the transition from default to current.

4.4   Summary Statistics

Table 1 presents characteristics of our ARM2 base sample with a comparison between the Countrywide loans and those from other lenders. Roughly 18 percent of the loans in the ARM2 base sample are serviced by Countrywide. Since the panel is unbalanced, we also present the total number of observations. [34] During the sample period, the Countrywide default rate was 16.70 percent, which was 3.89 percentage points higher than that of the other lenders.

Next we present the loan and borrower summary statistics. On average, both the origination and the current outstanding loan amounts are lower among Countrywide loans, and both origination and current interest rates are slightly higher for Countrywide loans. The origination CLTVs are largely comparable between Countrywide loans and those from other lenders. The average updated CLTV is roughly 100 percent for both Countrywide and other lenders. Sample statistics (not included in the table) indicate that

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[34] All summary statistics presented in table 1 are based on the total number of observations.

38 percent of Countrywide loans and 39 percent of other lenders in the base sample are underwater (the outstanding loan amount is greater than the house value).

Countrywide has a slightly higher proportion of loans with full documentation than other lenders. The average FICO scores are below 620 among both groups, consistent with the subprime status of these loans. The average FICO score of Countrywide borrowers is even lower. The proportion of Countrywide loans with PMI is 10 times that of other lenders, and there is a significantly larger proportion of Countrywide ARM2s paying interest only. More loans from other lenders are balloon loans. The proportions of loans for refinancing purposes or with a prepayment penalty are largely balanced between the two groups, and there is little difference in the zip-level unemployment rates between the two groups. Overall, the lower loan amounts, higher interest rates, lower FICO scores, higher PMI, and more interest only loans suggest that the Countrywide borrowers are, in general, more risky than borrowers from other lenders, consistent with the default rate patterns in figure 1.

The next panel of table 1 presents the distributions by origination month. More Countrywide ARM2s are originated from September 2006 to November 2006, when the housing market largely plateaued. This could be another reason that Countrywide loans may be more risky. Further, this finding suggests that more Countrywide ARM2s are up for interest rate reset during the post-settlement window in 2008.

Online appendixes tables A2–A3 present summary statistics for the alternative samples. The proportion of Countrywide loans is 14.2 percent in the alternative ARM2 sample and 12.6 percent in the alternative ARM3 sample, both lower than the Countrywide market share of 17.9 percent reported in table 1 for the base sample. In both alternative samples, Countrywide borrowers tend to have lower FICO scores, a higher proportion of interest only loans, and a higher proportion of PMIs. Overall, between Countrywide and other lenders, there seems to be more similarity in ARM2s originated in the first half of 2005 than in ARM3s originated in the second half of 2006.

5. Econometric Approach

5.1 Target Parameter and Identification Issues

The target parameter of this study is *the population fraction of strategic default induced by the modification program.* The concept of the modification-induced default is as follows: for loans current upon modification announcement, the borrower chooses to miss payments if serviced by Countrywide (to become eligible for the settlement) and does not if serviced by other lenders; for loans delinquent upon modification announcement, the borrower chooses not to resume payments if serviced by Countywide (to stay eligible for the settlement), but resume payment if serviced by other lenders. In the bathtub analogue, our target parameter is the difference between 1) the fraction of bathtub filled with water without modification, and 2) the fraction after exogenously imposing the modification program. However, each borrower is serviced by either Countrywide or other lenders, but not both, and we thus face a typical missing data problem. The Countrywide legal settlement, unlike a nationwide government program such as HAMP, provides an exogenous variation on eligibility of the modification program, which allows us to construct a plausible counterfactual and overcome the missing data problem. We next discuss a few identification issues.

First, although it is reasonable to assume no anticipation of the Countrywide legal settlement when the mortgages in our samples were formed in 2005 or 2006, there is still no grounds to believe that the two loan populations, Countrywide and other lenders, are completely comparable before the settlement. These loans resulted from the two-way selection processes between the homeowners and mortgage lenders, and sections 4.3 and 4.4 indeed show notable differences between the Countrywide and other loans. Therefore, we need to control for loan and borrower characteristics to address the selection bias.

Second, although containing a relatively rich set of variables, DataQuick still misses some important borrower characteristics. For example, borrower occupation, updated FICO scores, and job and family income are unavailable in mortgage data in general, which is also the case with DataQuick. Therefore, an identification strategy solely relying on selection on observables is compromised. Fortunately, our panel data structure allows us to control for mortgage and borrower specific fixed effects to mitigate this potential bias. Since each mortgage is attached to a particular house, including

mortgage fixed effects in these models not only controls for time-invariant borrower/mortgage specific unobserved heterogeneity, but also controls for time-invariant local market specific factors.

Finally, an additional threat to the inference may still exist if there are unobserved factors whose effect may be triggered by the introduction of the modification program. Our fixed effect models do not have a safeguard against such time-varying influences due to unobservables. We follow the literature and take a proxy variable approach.[35] We consider a few loan characteristics at origination as proxies for those unobservable. For instance, riskier borrowers with less stable income may choose loans paying interest only, and these borrowers may be more likely to respond to loan modification programs and default strategically. We include interaction terms between the proxy variables and the post-settlement calendar month dummy variables in our richer models described below in section 5.3.

5.2 Basic Specification

Our basic specification is a mortgage fixed effect model. As described in section 4.2, our panel window is from January 2007 to January 2009. The basic specification takes the following form:

$$
Y_{ilm} = \alpha_1 X_{ilm} + \alpha_2 W_{lm} + \gamma_{oct} CW_i \cdot Oct_{2008} + \gamma_{nov} CW_i \cdot Nov_{2008} + \gamma_{dec} CW_i \cdot Dec_{2008}
$$
$$
+ \gamma_{jan} CW_i \cdot Jan_{2009} + \sum_{m=Feb\,2007}^{Jan\,2009} \delta_m D_m + \sum_{\tau=4}^{31} \theta_\tau D_{t\tau} + \sum_{\tau=1}^{31} \psi_\tau CW_i \cdot D_{t\tau} + \lambda_i + \varepsilon_{ilm}
$$
(5.1)

where Y_{ilm} is default status, $Y_{ilm} = 1$ if mortgage i located in local market l in calendar month m is 60+DPD ; $Y_{im} = 0$ otherwise. X_{ilm} denotes a vector of time-varying mortgage characteristics, and W_{lm} is a vector of local market (at the zip code level) conditions. $\alpha's$ are coefficients. The next four variables are the interaction terms between the Countrywide dummy variable and the post-settlement calendar month dummy variables, and their coefficients are $\gamma's$ with the corresponding subscript. The calendar month effects are captured by the summation term with δ coefficients, and January 2007 is the base calendar month. The loan age effects, separately for other lenders and Countrywide,

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[35] Such nonlinear specification is often used with panel data in labor economics. For example, Jakubson (1991) uses a similar model allowing the effects of other regressors to vary with union status.

are represented by the next two summation terms with θ and ψ coefficients respectively. In the loan age step function for other lenders, t represents loan age (measured by month) since origination, $D_{t\tau}$ is a dummy variable that takes on the value 1 if $t = \tau$ and 0 otherwise, and θ_τ are coefficients. Due to the relatively smaller number of defaults during the first 15 months, the coefficients θ_τ are constrained to be equal over age intervals of three given by $\tau = 4-6, 7-9, 10-12, 13-15$ and unrestricted for $\tau = 16,...,31$. The loan age step function of Countrywide assumes the same specification with a different set of parameters: ψ_τ. λ_i is the mortgage fixed effects and ε_{ilm} is the *iid* error term. Although the form of our dependent variable naturally leads to a nonlinear model, such as Probit or Logit, we choose a linear probability model due to the well-known incidental parameters problem and additional assumptions required to incorporate fixed effects in such nonlinear models.[36]

The coefficients of interest are $\gamma_{oct} - \gamma_{jan}$, the fraction of the modification-induced default measured in each month during the post-settlement window. This specification allows the measured size of strategic default to vary by month after the settlement. We interpret these four parameters using the potential outcome framework. In particular, let Y_m^1 denote the potential default status in month m if a representative loan were serviced by Countrywide and Y_m^0 denote the potential default status in month m if that loan were serviced by other lenders. Then, our target parameter, the size of induced strategic default in, for example October 2008, is measured by $E\left(Y_m^1 - Y_m^0 \middle| m = Oct_{2008}\right) = \gamma_{oct}$.[37] The measures for the other three months are analogous. Note that γ parameters are stock measure of population fraction as of particular post-settlement calendar month.

To provide the usual comparison to fixed effect models, we also estimate an ordinary least squares model by pooling all observations. In this OLS specification, we

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[36] MMPG chooses a pooled Probit model, which ignores the panel structure of observing each mortgage for multiple periods but has the advantage of including time-invariant borrower specific variables.

[37] Given the model setup, the γ parameters represent the average treatment effects, i.e., the increased default (measured in fractions) induced by exogenously imposing the settlement to all loans in the relevant population versus not imposing such a settlement.

add time-constant loan characteristics at origination, a Countrywide dummy variable, as well as state dummy variables to our basic specification in equation (5.1).

5.3   Specification Test and Richer Models

Using the base sample, we conduct a conventional specification test, i.e., applying the basic specification in equation (5.1) to a before-treatment, non-event window, namely June 2008 to September 2008. We do not expect the settlement to induce any strategic default in this pre-announcement window. Systematic factors specific to Countrywide loans beyond the settlement might be detected by this test. As with all specification tests in this spirit, however, passing the test does not provide a complete assurance of our model.

   We also explore a spectrum of richer models allowing the settlement-induced default behavior to differ among loans with various characteristics at origination. We consider loan characteristics at origination, including interest rate, LTV, status of loan documentation, balloon loans, and indicator of paying interest only. Our analysis is conducted by adding one variable at a time to the basic specification. The richer models are defined as

$$Y_{ilm} = \alpha_1 X_{ilm} + \alpha_2 W_{lm} + \gamma_{oct} CW_i \cdot Oct_{2008} + \gamma_{nov} CW_i \cdot Nov_{2008} + \gamma_{dec} CW_i \cdot Dec_{2008}$$
$$+ \gamma_{jan} CW_i \cdot Jan_{2009} + \beta_{oct} CW_i \cdot Oct_{2008} \cdot Z_i + \beta_{nov} CW_i \cdot Nov_{2008} \cdot Z_i + \beta_{dec} CW_i \cdot Dec_{2008} \cdot Z_i$$
$$+ \beta_{jan} CW_i \cdot Jan_{2009} \cdot Z_i + \eta_{oct} Oct_{2008} \cdot Z_i + \eta_{nov} Nov_{2008} \cdot Z_i + \eta_{dec} Dec_{2008} \cdot Z_i \qquad (5.2)$$
$$+ \eta_{jan} Jan_{2009} \cdot Z_i + \sum_{m=Feb\,2007}^{Jan\,2009} \delta_m D_m + \sum_{\tau=4}^{31} \theta_\tau D_{t\tau} + \sum_{\tau=1}^{31} \psi_\tau CW_i \cdot D_{t\tau} + \lambda_i + \varepsilon_{ilm}$$

where Z_i represents one of the loan characteristics at origination. The four terms with the β coefficients allow strategic behavior to differ among loans with characteristics at origination, and the four terms with η coefficients capture the effects that such strategic behavior may vary with the general macro conditions in the post-settlement window. With the additional interaction terms, our target parameter, i.e., the fraction of strategic default, becomes a function of γ, β, and Z_i: $E(Y^1 - Y^0 | Z = z) = \gamma + \beta \cdot z$. For example, if Z takes two values, 0 and 1, γ represents the population fraction of settlement induced default among loans with $Z = 0$, and $\gamma + \beta$ represents such fraction among loans with

$Z = 1$. Note that β is the difference between the two groups of loans in terms of such strategic reaction to the settlement.

6.   Empirical Results

6.1   Base Sample

Table 2 provides estimates from the base sample, i.e., ARM2s originated from the second half of 2006. Column (1) presents results from the basic specification (equation 5.1). The first four rows report the key parameter γ estimates. As discussed in section 5.2, these estimates measure the fractions of the modification-induced default in each month during the post-settlement window: 0.8 percentage points in October, 3.8 percentage points in November, 7.5 percentage points in December, and 8.9 percentage points in January. All four estimates are significant at the 1 percent significance level, and these estimates retain much of the pattern shown in figure 1. Note that throughout the four-month performance window, the average default rate among loans of other lenders is 29.85 percent for the base samples. Therefore, the peak estimate of January 2009 in the first column of table 2 suggests a 30 percent relative increase in default rate because of the modification program; this magnitude of modification-induced default is substantial.

As noted in section 2, the measure of induced default in MMPG, namely the increased rollover rate (a flow measure) given the settlement compared with no settlement, is the difference in water outflow *speed* (in a bathtub analogue) under the two counterfactual scenarios. In terms of the same bathtub analogue, our induced default measure, as discussed in section 5.1, is the difference in water *level* (a stock measure) under the two counterfactual scenarios. Although the increase in rollover rate due to modification as documented in MMPG provides directional evidence of induced strategic default, it is not an easy-to-interpret parameter for banking industry and policy makers because it is not trivial to convert a water outflow speed into a water level measure. This conversion can only be achieved by estimating a full structural model, namely a multi-state multi-spell duration model considering transitions both from current to delinquent

and from delinquent back to current (for example, see Ham, Li, and Shore-Sheppard [2016]).[38]

We facilitate a rough comparison, however, by a simple "back-of-the-envelope" calculation using the MMPG estimates. Their preferred estimate in column 4 of their table 2 indicates that the Countrywide loan "rollover rate" (monthly hazard rate) rises by 0.0054 during the October to December period as compared with an overall sample mean rollover rate of 0.048. Using their implicit assumptions of no chance for a defaulted loan to cure, no duration dependence, and no unobserved heterogeneity, we calculate the fraction of induced default to be about 1.5 percentage points ending in December 2008. This number is much lower than our corresponding estimate of 7.5 percentage points in table 2. This difference could be explained by 1) induced default in the form of a drop in cure rates among the Countrywide loans, which is not considered in MMPG, and 2) the difference in sample. A comparison between MMPG figure 4 and our figure 4 indicates that our base sample is riskier than the ARM2 sample in MMPG.[39] Our results below from subsamples and richer models suggest the modification program induced default is more severe among risky loans.

The remaining rows of table 2 show the coefficient estimates of the other control variables. We find that the default probabilities are positively associated with current interest rate, CLTV, and the zip-level unemployment rates. The calendar time coefficient estimates (not reported in the table to save space) indicate a monotonically upward trend in default during the sample period. The coefficient estimates of the loan age step functions (not reported to save space) show a general increase in default risk as these loans age.

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[38] The fixed-effect approach we use in this study is more practical than a multi-state multi-spell duration model approach. First, it estimates the fraction of induced default directly, while a fully structural duration model approach needs simulation to obtain our estimates. Second, our fixed-effect models are reduced-form models, relying on fewer structural assumptions.

[39] We can think of two major possible reasons leading to this difference in sample. First, MMPG's ARM2 sample (corresponding summary statistics reported in their table 1 and model estimates presented in their table 2) consists of loans originated during 2005, 2006 and first half of 2007, while our base sample consists of ARM2 loans originated in the second half of 2006 only. The second half of 2006 is the peak of the housing market, and subprime mortgages originated during this period are riskier than those originated in 2005 (for example, as shown in Demyanyk and Hemert (2011)). Second, MMPG sample imposes a matching constraint between BlackBox and Equifax. Loans not satisfying this constraint tend to have no record in the credit bureau files and are thus more risky.

As discussed in section 5.2, we also estimate an OLS model as a comparison to our fixed effect model, and the results are reported in column (2) of table 2. In addition to the time varying variables in the fixed effect model, the OLS specification also allows us to control for the time-constant loan characteristics at origination, including loan amount, initial interest rate, CLTV, FICO, dummy variables indicating full documentation, having PMI, paying interest only, balloon payments, refinancing loans, whether there is cashout upon refinancing, and property types.[40] Further, we control for the calendar time effects, a Countrywide dummy variable, state fixed effects, and loan age step functions. The OLS estimate of induced default in January 2009 is one percentage point larger than that from the basic specification in column (1), while the estimates of the other three months are rather comparable between the two columns.

6.2 Specification Test and Subsample Results

To reassure the evidence we present in the previous section, we conduct a specification test on the base sample using a non-event window from June 2008 to September 2008. The results from this test are presented in column (3) of table 2. The estimated fractions of induced default are negative and statistically significant in June and July, but the magnitude is small, about one percentage point or less. The estimates are not statistically significant in August and September. These results provide some reassurance for our model specification by suggesting that, after controlling for other factors, the default rates were comparable between Countrywide and other lenders before the modification program was announced.

Next we investigate whether strategic defaulters are concentrated in a particular segment of loans by breaking down the base sample into three subsamples: loans current, 30–59 DPD, and 60+ DPD as of September 2008. They represent 66.5 percent, 8.6 percent, and 24.9 percent of the base sample. The subsample results are reported in columns (1), (2), and (3) of table 3, respectively. For the loans current as of September 2008, the earliest time to become 60+ DPD (our definition of default) is November 2008, and thus we suppress the parameter measuring fraction of induced default in October

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[40] The OLS model has fewer observations because we have to require the availability of the time-constant variables. The time-constant variable coefficient estimates are not reported to save space, but are available upon request.

2008 in column (1). The estimated fraction increases from three percentage points in November 2008 to eight percentage points in January 2009. By contrast, the fraction estimates in column (2) are in double digits throughout the event window, suggesting that the program-induced strategic default shows up immediately among those 30–59 days behind their payments, and the effect is strong. Among loans 60+ DPD, the fraction estimate is 1.8 percentage points in October 2008, which rises quickly and reaches almost 16 percentage points by January 2009. Overall, table 3 suggests that strategic default occurs not only among borrowers who were current immediately before the modification program was announced, but also among those borrowers who were already in delinquency at that time. Overall, the estimated fraction of induced default is higher in columns (2) and (3) than in column (1), implying that the strategic behavior in general is more serious among riskier loans in this ARM2 sample. Further, to have a rough idea of the distribution of strategic defaulters among the three subsamples, we can multiply the fraction estimate in January 2009 with the corresponding number of loans for each subsample. We find that slightly over half of the default induced by the modification program is already in delinquency in September 2009. This finding confirms the importance of also investigating the transitions from delinquent to current, a notion discussed in the introduction of the paper.

The evidence in table 3 thus suggests that the extent of modification-induced strategic default is more severe among more risky loans, which seemingly contradicts the conclusion in MMPG that the estimated increase in rollover rates is largest among the least risky borrowers. The MMPG sample is closest to our first subsample in column (1) consisting of loans current in September 2008. To reconcile the differences between our results and those in MMPG, we further investigate loans in the column (1) sample with origination CLTVs below 80 percent (i.e., less risky loans in this group). We find that in this subgroup the estimated induced default is 10 percentage points in January 2009, which is two percentage points higher than the corresponding estimate for the overall group in column (1) of table 3. This result is consistent with the evidence in MMPG. This fraction estimate of 10 percentage points is still lower, however, than the corresponding estimates in columns (2) and (3) of table 3 for more risky loans: 30–59 and 60+ DPD as of September 2008.

6.3 Results From Richer Models

In this section, we report results from the richer models specified in section 5.3. We explore two origination characteristic variables: interest only indicator and balloon indicator. We choose these two variables because interest only loans or balloon loans are generally deemed to be more risky, and we examine whether these characteristics are associated with more strategic default.

Table 4 presents the two richer models, estimates from the model involving interest only indicator in the first column and those from the model involving balloon indicator in the second column. Panel A presents the key parameter estimates as specified in equation (5.2), with γ estimates in the first four rows and β estimates in the next four rows for both models. Recall that γ captures the fraction of induced default among loans with the origination variable equal to 0, and β captures the difference in reaction to the settlement between the two groups of loans (indicator equal to 1 group minus indicator equal to 0 group). In this model, the fraction of induced default among loans with the origination variable equal to 1 is represented by $\gamma + \beta$, and we present these estimates in panel B. Our discussion focuses on the difference in strategic behavior captured by the two origination variables.

The β estimates in the first column suggest that, compared with loans with normal amortization, interest only loans have significantly higher tendency to default strategically in the third and fourth months. For example, the estimated fraction of induced strategic default in January 2009 is 1.6 percentage points higher among interest only loans than among those with normal amortization. Similarly, the β estimates in the second column suggest that the modification program induces more strategic default among balloon loans by 2.0 percentage points in the fourth month after the announcement. Since interest only loans or balloon loans are riskier, these results add to our earlier finding that strategic default is more pervasive among more risky loans.

We have also investigated other loan characteristics at origination, such as interest rate, LTV, documentation, FICO scores, and primary mortgage insurance. We do not find significant differences in strategic behavior captured by these variables at origination.

6.5   Alternative Samples

Table 5 reports the results from ARM2s originated from the first half of 2005 (column 1) and ARM3s originated from the second half of 2006 (column 2). We use the basic specification of equation (5.1). The fraction of induced default estimates in the first four rows of table 5 show an upward trend, reaching six percentage points for the alternative ARM2 sample and nine percentage points for the alternative ARM3 sample in January 2009. Again, these estimates confirm the directional evidence shown in figures 2–3.

Throughout the four-month performance window, the average default rates are about 19.89 percent and 16.27 percent for the alternative ARM2 and ARM3 samples, respectively. Therefore, the peak estimates of January 2009 in table 5 suggest that around 30 percent and 60 percent relative increases in default rate are due to the modification program, respectively for the two alternative samples.

7.   Conclusions

We conduct a comprehensive study to examine the extent of strategic default induced by a loan modification program, the Countrywide settlement. Adopting a broader view on modification-induced strategic default than the existing literature, we find that the extent of modification-induced default reaches six to nine percentage points four months after the modification announcement. Depending on the sample, we find that the induced default represent 30 to 60 percent increases in mortgage default relative to comparable loans by other lenders. Our fraction estimates are multiple times larger than the roughly converted fraction estimates from MMPG.

More importantly, we find substantial modification-induced default not only among borrowers who were current in their loan payments, but also among those who were already in delinquency before the announcement of the modification program. Among delinquent borrowers, the modification-induced strategic default is reflected as a lower cure rate for otherwise comparable loans. This evidence, not documented in the prior literature, suggests that it would be very difficult for even a rigorous audit to identify strategic defaulters among delinquent borrowers, since the efforts put in job searching and/or cost cutting are unobservable. As a result, designing a mortgage modification program can be more challenging than was understood before. In general,

we find that induced strategic behavior is widespread and tends to be more severe among more risky loans.

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Figure 1: Default Rates of Base Sample
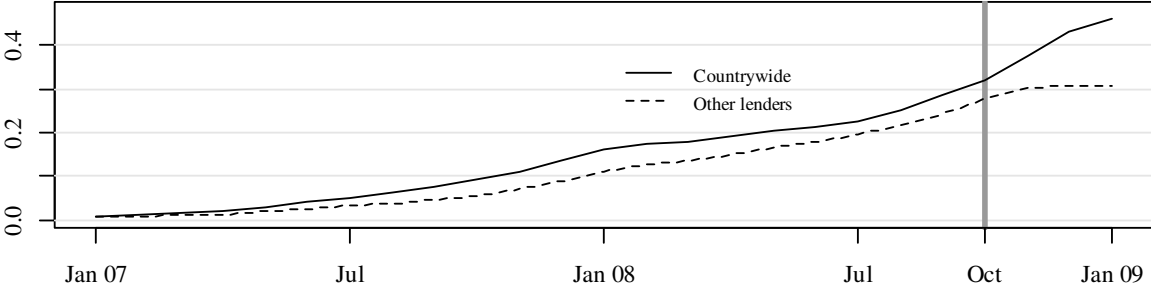
Figure 2: Default Rates of Alternative ARM2 Sample
Originated in 200501-200506
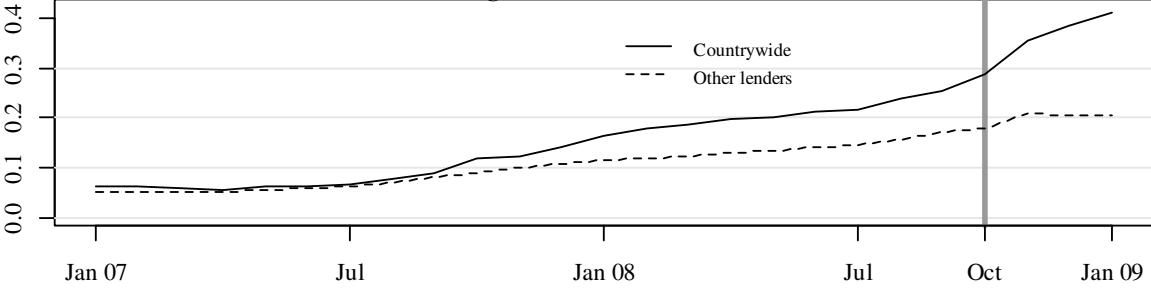
Figure 3: Default Rates of Alternative ARM3 Sample
Originated in 200607-200612
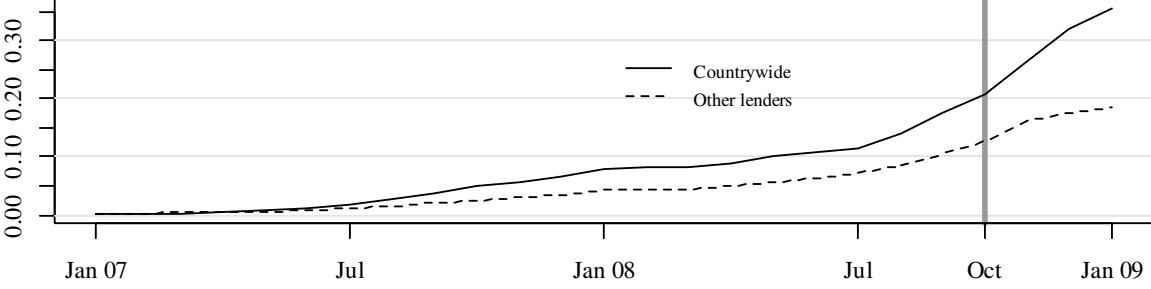
Figure 4: Base Sample Rollover Rates
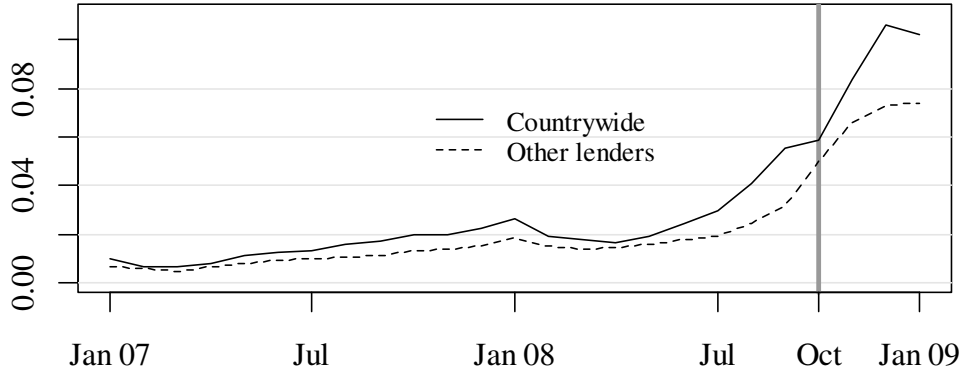
Figure 5: Base Sample Cure Rates
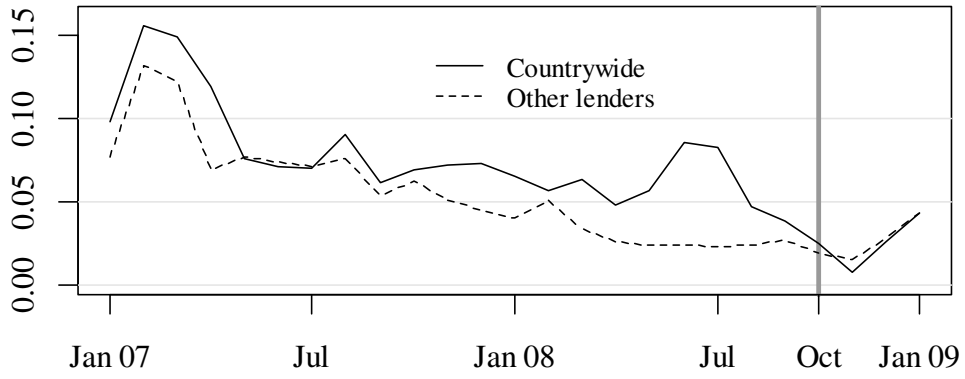
Figure 6: Three Subsamples of the Base Sample

A: Default Rates - Mortgages Current As of September 2008
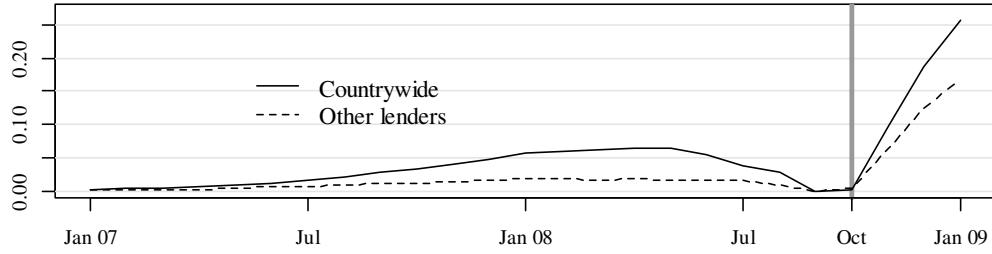
B: Default Rates - Mortgages 30-59 DPD As of September 2008
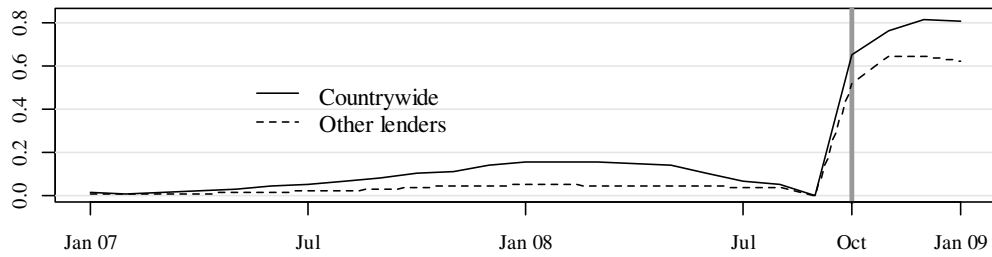
C: Default Rates - Mortgages 60+ DPD As of September 2008
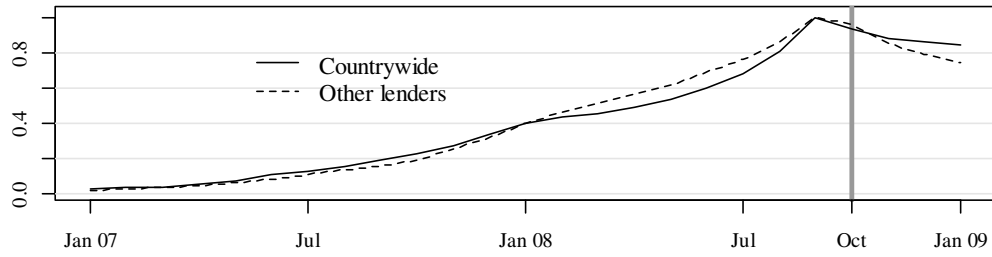
Table 1: Base ARM2s—Originated in the Second Half of 2006

	All lenders	Countrywide	Other lenders	Difference
Total number of loans	166,616	29,857	136,759	
Sample proportion		17.92%	82.08%	
Total number of observations	3,885,002	721,446	3,163,556	
Default rate	13.54%	16.70%	12.82%	**3.89%**
	(34.21%)	(37.30%)	(33.43%)	(0.05%)
Loan & borrower characteristics				
Loan amount at origination	231,060	211,909	235,427	**-23,519**
	(140,148)	(123,728)	(143,272)	(166)
Current balance outstanding	228,833	210,977	232,905	**-21,928**
	(134,269)	(121,411)	(136,706)	(162)
Interest rate at origination (%)	8.37	8.49	8.34	**0.15**
	(1.15)	(1.21)	(1.14)	(0.002)
Current interest rate (%)	8.45	8.58	8.42	**0.16**
	(1.17)	(1.23)	(1.15)	(0.002)
CLTV at origination (%)	89.08	89.09	89.08	0.004
	(9.91)	(9.86)	(9.92)	(0.013)
Updated CLTV(%)	100.05	99.79	100.11	**-0.318**
	(20.82)	(20.46)	(20.90)	(0.027)
Having full documentation	59.15%	62.12%	58.48%	**3.64%**
	(49.15%)	(48.51%)	(49.28%)	(0.06%)
Origination FICO	616	609	617	**-8.83**
	(53)	(51)	(54)	(0.07)
Having PMI	9.44%	36.53%	3.26%	**33.27%**
	(29.23%)	(48.15%)	(17.76%)	(0.06%)
Paying interest only	17.83%	27.34%	15.66%	**11.68%**
	(38.28%)	(44.57%)	(36.35%)	(0.06%)
Having balloon payments	34.27%	11.95%	39.36%	**-27.41%**
	(47.46%)	(32.44%)	(48.86%)	(0.05%)
Having prepayment penalty	77.71%	79.39%	77.33%	**2.05%**
	(41.62%)	(40.45%)	(41.87%)	(0.05%)
Refinancing loans	48.94%	47.44%	49.28%	**-1.84%**
	(49.99%)	(49.93%)	(49.99%)	0.07%

Table 1 Continued

	All lenders	Countrywide	Other lenders	Difference
Zip-level unemployment rate	5.58%	5.56%	5.59%	**-0.02%**
	(2.04%)	(2.03%)	(2.04%)	(0.003%)
Percentage of loans originated in				
200607	16.23	14.24	16.68	-2.44
200608	17.76	12.59	18.94	-6.35
200609	16.78	17.07	16.71	0.36
200610	16.85	22.17	15.63	6.54
200611	15.58	18.29	14.96	3.33
200612	16.81	15.64	17.08	-1.44

Notes:
1. All summary statistics presented are based on the total number of observations.
2. The columns under "All lenders," "Countrywide," and "Other lenders" report sample averages based on the total number of observations, and the standard deviations are in parentheses below the averages.
3. The "Difference" column reports the differences in means between Countrywide and other lenders and the standard errors of these differences are in parentheses below. Differences that are statistically significant at the 5% level are bolded.

Table 2: ARM2—Base Sample

Sample period	(1) Base model (fixed effect) Jan. 2007– Jan. 2009	(2) OLS Jan. 2007– Jan. 2009	(3) Specification test (fixed effect) Jan. 2007– Sept. 2008
Fraction of settlement induced default			
Countrywide x Oct. 2008	0.008***	0.008**	
	[0.003]	[0.003]	
Countrywide x Nov. 2008	0.038***	0.036***	
	[0.004]	[0.005]	
Countrywide x Dec. 2008	0.075***	0.077***	
	[0.005]	[0.006]	
Countrywide x Jan. 2009	0.089***	0.099***	
	[0.007]	[0.008]	
Countrywide x Jun. 2008			-0.008***
			[0.002]
Countrywide x Jul. 2008			-0.011***
			[0.003]
Countrywide x Aug. 2008			-0.001
			[0.005]
Countrywide x Sept. 2008			0.008
			[0.006]
Control variables			
Current interest rate	0.045***	0.044***	0.056***
	[0.001]	[0.001]	[0.001]
Current CLTV	0.390***	0.258***	0.395***
	[0.005]	[0.004]	[0.006]
Zip-level unemployment rate	0.387***	0.145***	0.207***
	[0.045]	[0.037]	[0.047]
Countrywide		0.032***	
		[0.001]	
Loan characteristics at origination	No	Yes	No
Mortgage fixed effects	Yes	No	Yes
State dummy variable	No	Yes	No
Calendar month dummy variable	Yes	Yes	Yes
Age function	Yes	Yes	Yes
Number of observations	3,885,002	3,829,082	3,274,919
Number of loans	166,616	164,203	166,616

Notes:
1. The fixed effect estimates are from the specification of equation (5.1), and the OLS estimates are from a pooled regression of the panel data.
2. Coefficient estimates of intercept, characteristics at origination, state, and month dummy variables are omitted to save space.
3. Robust standard errors in brackets
4.* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: ARM2 Base Subsample Results

	(1) **Current** **in Sept. 2008**	(2) **30–59 DPD** **in Sept. 2008**	(3) **60+ DPD** **in Sept. 2008**
Fraction of settlement induced default			
Countrywide x Oct. 2008	--	0.120***	0.018***
		[0.012]	[0.005]
Countrywide x Nov. 2008	0.030***	0.118***	0.080***
	[0.003]	[0.013]	[0.007]
Countrywide x Dec. 2008	0.059***	0.165***	0.138***
	[0.004]	[0.016]	[0.009]
Countrywide x Jan. 2009	0.080***	0.175***	0.159***
	[0.005]	[0.019]	[0.012]
Control variables			
Current interest rate	0.030***	0.089***	0.062***
	[0.001]	[0.003]	[0.002]
Current CLTV	0.122***	0.145***	0.034***
	[0.003]	[0.010]	[0.006]
Zip-level unemployment rate	0.123***	0.819***	0.256***
	[0.026]	[0.120]	[0.082]
Mortgage fixed effects	Yes	Yes	Yes
State dummies	No	No	No
Calendar month dummies	Yes	Yes	Yes
Age function	Yes	Yes	Yes
Observations	2,603,562	332,694	948,746
Number of loans	110,825	14,317	41,474

Notes:
1. All estimates are from the fixed effect specification of equation (5.1).
2. Coefficient estimates of intercept and month dummy variables are omitted to save space.
3. Robust standard errors are in brackets.
4.* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Richer Models—ARM2 Base Sample

Panel A: Key parameter estimates	Origination variable	
	Paying interest only indicator	**Balloon payments indicator**
γ estimates		
Countrywide x Oct. 2008	0.005*	0.014***
	[0.003]	[0.003]
Countrywide x Nov. 2008	0.035***	0.044***
	[0.004]	[0.004]
Countrywide x Dec. 2008	0.069***	0.081***
	[0.006]	[0.005]
Countrywide x Jan. 2009	0.082***	0.092***
	[0.007]	[0.007]
β estimates		
Countrywide x Oct. 2008 x origination variable	0.001	-0.007
	[0.006]	[0.007]
Countrywide x Nov. 2008 x origination variable	0.004	-0.008
	[0.006]	[0.008]
Countrywide x Dec. 2008 x origination variable	0.013*	-0.005
	[0.007]	[0.009]
Countrywide x Jan. 2009 x origination variable	0.016**	0.020**
	[0.007]	[0.009]

Panel B: Fraction of induced default among loans with origination variable taking value of 1	**Paying interest only**	**With balloon payments**
Oct. 2008	0.007	0.007
	[0.005]	[0.007]
Nov. 2008	0.039***	0.036***
	[0.006]	[0.008]
Dec. 2008	0.082***	0.076***
	[0.007]	[0.009]
Jan. 2009	0.097***	0.112***
	[0.009]	[0.010]

Notes:
1. Coefficient estimates are from the richer model specification of equation (5.2).
2. Only key parameter estimates are reported to save space. The same control variables are included as column 1 of table 2.
3. Robust standard errors in brackets
4.* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Alternative Samples

	ARM2s originated from first half of 2005	ARM3s originated from second half of 2006
Settlement induced default measure		
Countrywide x Oct. 2008	0.005	0.016**
	[0.006]	[0.006]
Countrywide x Nov. 2008	0.033***	0.035***
	[0.009]	[0.010]
Countrywide x Dec. 2008	0.049***	0.074***
	[0.012]	[0.013]
Countrywide x Jan. 2009	0.062***	0.094***
	[0.015]	[0.017]
Control variables		
Current interest rate	0.024***	0.071***
	[0.001]	[0.004]
Current CLTV	0.121***	0.159***
	[0.008]	[0.009]
Zip-level unemployment rate	0.730***	0.018
	[0.078]	[0.082]
Mortgage fixed effects	Yes	Yes
State dummies	No	No
Calendar month dummies	Yes	Yes
Age function	Yes	Yes
Number of observations	1,183,678	819,470
Number of loans	48,619	35,160

Notes:
1. All estimates are from the fixed effect specification of equation (5.1).
2. Coefficient estimates of intercept and month dummy variables are omitted to save space.
3. Robust standard errors in brackets.
4.* significant at 10%; ** significant at 5%; *** significant at 1%

Online Appendix Table A1: Countrywide's Share Among the Subprime Market

Panel A: State breakdown of Countrywide loans originated in 2006 with origination LTV above 0.55 (in percentages)

	ARM2	ARM3		ARM2	ARM3
AK	24.48	11.34	MT	30.66	39.57
AL	26.86	15.30	NC	21.23	7.98
AR	15.82	10.66	ND	25.86	0.00
AZ	20.16	16.23	NE	13.10	9.38
CA	15.39	14.49	NH	19.17	7.47
CO	14.86	12.17	NJ	16.27	9.62
CT	19.06	18.04	NM	14.54	14.13
DC	13.13	10.55	NV	21.08	18,43
DE	16.35	11.42	NY	14.88	10.67
FL	21.31	15.22	OH	16.80	13.29
GA	24.79	7.86	OK	22.44	18.31
HI	14.37	19.65	OR	17.06	12.82
IA	23.71	12.07	PA	17.77	12.05
ID	19.01	13.83	RI	10.03	13.05
IL	18.20	11.88	SC	16.17	7.11
IN	19.01	17.47	SD	11.11	0.00
KS	20.73	14.66	TN	20.04	10.75
KY	23.31	16.58	TX	20.44	13.27
LA	21.98	11.48	UT	17.79	23.93
MA	12.64	12.89	VA	15.48	11.67
MD	13.63	8.14	VT	18.80	6.60
ME	6.92	7.17	WA	18.32	14.70
MI	18.75	14.54	WI	14.15	8.75
MN	15.64	8.55	WV	29.57	11.19
MO	19.57	15.87	WY	25.29	9.13
MS	28.63	22.12			

Panel B: Countrywide market share of all subprime mortgages

Period	All loans	ARM2	ARM3
2005 1st half	0.20	0.14	0.46
2005 2nd half	0.13	0.07	0.33
2006 1st half	0.15	0.14	0.10
2006 2nd half	0.17	0.15	0.11
2007 1st half	0.25	0.19	0.19
2007 2nd half	0.26	0.11	0.14

Online Appendix Table A2: ARM2s Originated in First Half of 2005

	All lenders	Countrywide	Other lenders	Difference
Total number of loans	48,619	6,905	41,714	
Sample proportion		14.20%	85.80%	
Total number of observations	1,183,678	171,367	1,012,311	
Default rate	12.15%	16.97%	11.33%	**5.64%**
	(32.67%)	(37.54%)	(31.70%)	(0.10%)
Loan & borrower characteristics				
Loan amount at origination	191,712	204,204	189,597	**14,607**
	(122,010)	(123,496)	(121,629)	(322)
Current balance outstanding	188,226	201,466	185,985	**15,482**
	(116,884)	(119,254)	(116,329)	(310)
Interest rate at origination (%)	7.37	7.27	7.38	**-0.11**
	(1.11)	(1.07)	(1.11)	(0.003)
Current interest rate (%)	9.10	8.77	9.16	**-0.38**
	(1.68)	(1.73)	(1.67)	(0.004)
CLTV at origination (%)	88.43	87.65	88.57	**-0.92**
	(8.65)	(8.68)	(8.63)	(0.02)
Current CLTV (%)	92.03	92.78	91.90	**0.88**
	(19.57)	(21.08)	(19.30)	(0.05)
Having full documentation	48.71%	58.96%	46.97%	**11.99%**
	(49.98%)	(49.19%)	(49.91%)	(0.13%)
Origination FICO	619	617	619	**-1.52**
	(54)	(56)	(54)	(0.15)
Having PMI	15.91%	21.02%	15.04%	**5.98%**
	(36.57%)	(40.74%)	(35.75%)	(0.10%)
Paying interest only	26.29%	32.15%	25.30%	**6.86%**
	(44.02%)	(46.71%)	(43.47%)	(0.12%)
Having balloon payments	1.04%	0.81%	1.07%	**-0.26%**
	(10.12%)	(8.99%)	(10.30%)	(0.02%)
Having prepayment penalty	76.00%	76.36%	75.94%	**0.42%**
	(42.71%)	(42.49%)	(42.75%)	(0.11%)
Refinancing loans	48.09%	40.33%	49.40%	**-9.07%**
	(49.96%)	(49.06%)	(50.00%)	(0.13%)

Online Appendix Table A2: Continued

	All lenders	Countrywide	Other lenders	Difference
Zip-level unemployment rate	5.76%	5.81%	5.76%	**0.05%**
	(2.04%)	(2.12%)	(2.03%)	(0.01%)
Percentage of loans originated in				
200501	7.80	7.41	7.87	-0.46
200502	9.78	6.74	10.29	-3.55
200503	16.47	22.54	15.44	7.10
200504	17.75	24.48	16.62	7.86
200505	22.08	19.35	22.54	-3.19
200506	26.12	19.48	27.24	-7.76

Notes:
1. All summary statistics presented are based on the total number of observations.
2. The columns under "All lenders," "Countrywide," and "Other lenders" report sample averages based on the total number of observations, and the standard deviations are in parentheses below the averages.
3. The "Difference" column reports the differences in means between Countrywide and other lenders, and the standard errors of these differences are in parentheses below. Differences that are statistically significant at the 5% level are bolded.

Online Appendix Table A3: ARM3s Originated in the Second Half of 2006

	All lenders	Countrywide	Other lenders	Difference
Total number of loans	35,160	4,427	30,733	
Sample proportion		12.59%	87.41%	
Total number of observations	819,470	102,632	716,838	
Default rate	6.21%	10.24%	5.64%	**4.60%**
	(24.14%)	(30.32%)	(23.06%)	(0.10%)
Loan & borrower characteristics				
Loan amount at origination	227,849	226,178	228,090	**-1,912**
	(136,124)	(127,229)	(228,088)	(480)
Current balance outstanding	225,346	224,466	225,472	**-1,006**
	(129,549)	(123,087)	(130,447)	(414)
Interest rate at origination (%)	8.16	8.27	8.14	**0.13**
	(1.11)	(1.14)	(1.11)	(0.004)
Current interest rate (%)	8.14	8.26	8.12	**0.13**
	(1.10)	(1.12)	(1.10)	(0.004)
CLTV at origination (%)	88.56	87.87	88.66	**-0.79**
	(9.69)	(9.44)	(9.72)	(0.03)
Current CLTV (%)	96.67	97.29	96.58	**0.70**
	(17.41)	(18.54)	(17.24)	(0.06)
Having full documentation	63.64%	54.52%	64.94%	**-10.42%**
	(48.10%)	(49.80%)	(47.72%)	(0.17%)
Origination FICO	623	616	624	**-8.24**
	(55)	(56)	(55)	(0.19)
Having PMI	7.09%	14.51%	6.03%	**8.48%**
	(25.67%)	(35.23%)	(23.81%)	(0.11%)
Paying interest only	18.23%	21.26%	17.79%	**3.47%**
	(38.61%)	(40.92%)	(38.24%)	(0.14%)
Having balloon payments	37.25%	27.28%	38.68%	**-11.40%**
	(48.35%)	(44.54%)	(48.70%)	(0.15%)
Having prepayment penalty	61.19%	70.36%	59.88%	**10.48%**
	(48.73%)	(45.67%)	(49.01%)	(0.15%)
Refinancing loans	59.84%	61.59%	59.59%	**2.00%**
	(49.02%)	(48.64%)	(49.07%)	(0.16%)

Online Appendix Table A3: Continued

	All lenders	Countrywide	Other lenders	Difference
Zip-level unemployment rate	5.49%	5.65%	5.47%	**0.18%**
	(1.90%)	(2.14%)	(1.86%)	(0.01%)
Percentage of loans originated in				
200607	16.55	8.84	17.65	-8.81
200608	18.66	5.36	20.56	-15.20
200609	16.11	20.99	15.41	5.58
200610	16.57	29.71	14.69	15.02
200611	16.32	20.82	15.68	5.14
200612	15.79	14.28	16.00	-1.72

Notes:
1. All summary statistics presented are based on the total number of observations.
2. The columns under "All lenders," "Countrywide," and "Other lenders" report sample averages based on the total number of observations, and the standard deviations are in parentheses below the averages.
3. The "Difference" column reports the differences in means between Countrywide and other lenders and the standard errors of these differences are in parentheses below. Differences that are statistically significant at the 5% level are bolded.