Non-Recourse Mortgage Law and Housing Speculation*

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Abstract

In a state with non-recourse mortgage law, borrowers have limited liability on their mortgage loan. Examining price discontinuities at state borders, we show that non-recourse law causes larger swings in housing prices by encouraging speculative investments when housing markets are in a boom cycle. Non-recourse states experience 3 percentage points higher annual growth during the boom period and 3 percentage points steeper annual drop in housing price during the recession. We find that the emergence of the originate-to-distribute (OTD) model in the housing markets enables lenders to effectively shift the risks to other investors, mortgage lending pricing does not fully reflect the higher risk in non-recourse state.

Keywords: Recourse mortgage law, Limited liability, Housing Speculation, State border discontinuity, Originate-to-distribute, Subprime

JEL Classification: E44, G21, G28, K11, R20

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1 Introduction

The wide swing in U.S. home prices in the early years of the 21st century can hardly be understood by the standard economic explanation based on fundamentals. Understanding and identifying the mechanisms that determine boom-bust cycle in the housing market are thus central challenges that both financial economists and policymakers are facing. This paper builds on the previous literature to show that mortgage law plays an important role in the housing market. In particular, it sheds light on the effects of non-recourse mortgage law on the housing price cycle and mortgage lending by taking into account the growth of the mortgage securitization market.

U.S. mortgage law varies from state to state. Among many provisions included in mortgage law, non-recourse law governs lenders' right of deficiency judgment when borrowers default on mortgage loan payments.[1] Borrowers in recourse law states have full liability for their mortgage loans because lenders, in the event that foreclosure value is insufficient to meet the debt obligation, are able to claim other assets. Lenders in non-recourse law states are precluded from doing this and so bear some costs. Therefore, without proper pricing of the additional cost, the limited liability in non-recourse state gives rise to the asset substitution problem whereby borrowers increase risky investment and bid up prices. (Allen and Gale (2000))

The primary goal of this paper is to analyze whether recourse law affects the magnitude of boom-bust cycles in housing market. The question is important because the housing price cycle, or its volatility, is a major consideration of households portfolio choice. (Flavin and Yamashita (2002), Cocco (2005), and Yao and Zhang (2005)) Particularly, higher housing price cycle may contribute to housing bubbles, and subsequent crises can have significant feedback effects on the real sector of the economy. Reflecting the importance of recourse law, the debate over recourse law has become controversial between scholars and policymakers (Pavlov and Wachter (2004, 2006), Ghent and Kudlyak (2011), Solomon and Minnes (2011), and Mitman (2011)) and required ex-

[1]Figure 1 identifies 11 states with non-recourse mortgage law.

tensive economic analysis to support housing system reform in many countries.[2]

Our paper focuses on a by-product of non-recourse law, namely, the social cost incurred as a consequence of households exploiting it by shirking their contractual mortgage obligations. Our key hypothesis is that non-recourse law amplifies the housing price cycle by encouraging risk-shifting behavior. Mortgage borrowers in non-recourse states, because they can walk away when house values fall below remaining mortgage amount (i.e., are "underwater"), have speculative motives to increase their risky investments (or increase their leverage, debt-to-income) in housing market. Our paper is different from the previous literature which finds higher likelihood of strategic mortgage default by households in non-recourse states when housing market collapses, in a sense that we focus on the ex-ante households investment behaviors and identify the channel by linking with securitization market.

We first examine the housing price growth rates in pre- and post-mortgage crisis. Our main hypothesis is that non-recourse law causes housing speculation during the boom time driving the higher volatility in housing price. Using ZIP code-level housing prices from Zillow Real Estate Research between 2004 and 2009, we find evidence that housing prices in non-recourse states increased more during housing market booms, 2004-2006 and dropped more steeply during housing market recessions, 2007-2009. The economic impact of non-recourse law is large. Prior to the crisis, recourse states experienced 7% annual growth and the crisis reduced the housing price growth rate by 5%. But states with non-recourse law experienced 10% growth, and the corresponding drop in housing prices was 8%. Such stark differences in growth rates support the important impact of non-recourse law. We also calculate the growth rate using FHFAs state-level house price index and find consistent evidence that housing price cycle is amplified in non-recourse states during our entire sample period. Unlike repeat-sales housing price data, our data do not control for the various characteristics, or hedonics, of houses. To mitigate this limitation, we use square footage housing price, and conduct

[2] "Full Recourse Loans Won't Save Canada's Housing Market", 14 May 2013, CNBC, and "Heading to Non-Recourse Mortgage Financing? (Spain)", 2011, Banking Law News, Azofra and Peruyero

additional estimations by the number of bedrooms. This finding remains robust. We also consistently demonstrate that the price-to-rent ratio commonly used as a measure of housing valuation increases during expansion and declines during recession more sharply in non-recourse than in recourse law states.

Empirically, however, it is difficult to distinguish the effects of non-recourse law from the effects of other characteristics that are unrelated to this state law. To circumvent this identification problem, we examine the effect of non-recourse law on housing prices by employing a state-border discontinuity design with the contiguous border county-pair sample. This identification strategy allows us to estimate the effect of recourse law on housing price cycles by controlling for fundamental property value and unobserved spatial heterogeneity. By directly comparing the county-pair in state-border sample with the inclusion of county-pair fixed effects, we further find that housing prices during the pre-crisis period increase upon crossing from recourse into non-recourse states whereas during the crisis prices decrease.

We then document speculative investment behaviors of households in non-recourse states by showing a greater effect of non-recourse law in non-residential housing investments and households' higher leverage decisions than in recourse states. We expect that housing speculation is stronger for households with properties that are not primary residences and thus are subject to less non-monetary utility loss from strategic default. Non-monetary costs that provide a disincentive to default, even with limited liability, include lowering of a defaulting household's credit rating and the utility loss of a foreclosed home and the necessity to move. Consistent with this hypothesis, we find that the average housing price growth rate for borrowers with properties purchased either as second homes or for investment purposes show a greater effect by non-recourse law during the pre-crisis period. We also find that debt-to-income ratio, defined as the total amount of mortgage divided by households' annual income, is 2-7 percentage points higher in non-recourse than in recourse law states for both prime and subprime borrowers. These results suggest that non-recourse law precipitates larger housing boom and busts by encouraging speculative investment in housing markets.

If this households' investment incentive is well predicted, however, mortgage lenders may behave differently. The excessive risk-taking behavior in non-recourse states can be prevented if mortgage loans are properly priced. More specifically, lenders can control the risk of borrower's default by means of low loan-to-value (LTV) ratios, high interest rates, and strict screening processes. Used appropriately, such tools can preclude borrowers from shifting risk and bidding up prices above fundamental values. Therefore, after establishing the relation between nonrecourse mortgage law and housing price growth, we examine the channel through which non-recourse law can lead to more speculative households housing investments.

First, we hypothesize that the emergence of the originate-to-distribute (OTD) model, together with credit expansion, enables lenders to effectively pass along the risks and reduces the screening incentive ex-ante (e.g., Keys et al. (2010) and Purnanandam (2011)), thereby promoting excessive loan originations in non-recourse states and amplifying the housing price cycle. Specifically, it is likely that securitization in a complex structure of financial derivatives effectively conceals the origins of loans. Piskorski et al. (2013) argue that the true quality of loans in the residential mortgage-backed security (RMBS) market has frequently been misreported to investors.

An alternative hypothesis is that nationwide GSE (government-sponsored enterprise) loan policy drives underpricing of non-recourse loans and causes further housing speculation in non-recourse states during housing boom period. A large portion of mortgage loans are purchased by GSEs and sold to secondary market after being securitized. However, due to the anti-discretionary policy across states, originated loans are purchased by GSEs without proper pricing through higher guarantee fees. Hurst et al. (2015) show that regulatory limitation in pricing loans allows mispricing in OTD market across states and subsidizing borrowers in states with higher costs. Therefore, households in non-recourse states can borrow mortgage relatively cheaper interest rates. This mispricing, which is covered by taxpayers, can drive more speculation in non-recourse states.

We attempt to demonstrate the channel of the housing speculation using cross-

sectional variation in risk-shifting intensity from the OTD model. The two-stage risk-shifting hypothesis (from non-recourse households to lenders and from lenders to the securitization market) predicts that interaction with subprime mortgage expansion will promote greater housing speculation in non-recourse states during the pre-crisis period. We find that ZIP codes with high subprime loan ratios experienced particularly large housing price increases during the boom period in non-recourse states. The results are both economically and statistically significant and robust to the different number of bedrooms. The effect is particularly strong for small homes. Supporting the hypothesis, we find that the denial rate of loan application is significantly lower in ZIP codes located in non-recourse states for both prime and subprime loans. These results suggest that the housing boom is likely to be larger in non-recourse law states because the OTD market dissuade lenders from controlling the consequent risk and screening quality of loans. Consistent with the first hypothesis, we also find that ZIP code-level ratio of non-GSE (non-government sponsored enterprise) loans to total mortgage loans leads to a higher housing price growth in non-recourse states. The results suggest that non-GSE loans are likely to promote further housing speculation since GSE loans have been regulated to follow relatively stricter requirement of loan quality.

In this paper, we first propose the causal relation between mortgage foreclosure law and housing speculation. This paper has important implications for the housing price boom in the early 2000s. Previous literature attributes the boom to low, long-term real interest rates managed by monetary policy (e.g., Himmelberg et al. (2005) and Taylor (2007)). Other literature maintains that certain superstar cities experienced significant housing price appreciation due to an inelastic supply of land and growing number of high income households (e.g., Glaeser et al. (2008) and Gyourko et al. (2013)), and Shiller (2007) asserts that the real estate boom during this period was driven by a "social epidemic of optimism" that encouraged speculative investment. Additionally, the role of credit supply in housing price dynamics has been explored in the literature. Favara and Imbs (2015) focus on US branching deregulations between 1994 and 2005 to identify credit supply shock and show the casual relationship between the supply of

mortgage loans and house prices. Maggio and Kermani (2015) also examine the effect of credit supply on the boom and bust cycle in house prices and real economic activity by exploiting an enactment of a preemption rule which exempts national banks from state anti-predatory lending laws. Mian and Sufi (2009) show an effect of subprime mortgage expansion on house prices between 2002 and 2005. Our contribution to this literature, the suggestion that mortgage law has a significant impact on state variations in housing investment behavior and price patterns, enhances understanding of cross-sectional variation in housing prices across states.

In the literature, the effect of foreclosure and bankruptcy law on household economic behavior has been examined from various perspectives (Gropp et al. (1997), Fay et al. (2002), Li et al. (2011), Ghent and Kudlyak (2011), Dobbie and Song (2015), and Mian et al. (2015)). In particular, several papers reveal that mortgage foreclosure law affects household default decision when home values are underwater. Ghent and Kudlyak (2011) shows that mortgage defaults are more frequent in non-recourse law states and quantifies the effect of recourse law on default, and Pavlov and Wachter (2004, 2006) proposes a model for the underpricing equilibrium of the put option embedded in non-recourse mortgage lending. Other recent studies provide a theoretical framework for households mortgage default decisions related to mortgage foreclosure law (Mitman (2011), Campbell and Cocco (2015), and Corbae and Quintin (2015)). Findings in the present paper are also closely related to those of Mian et al. (2015), who uses state laws on judicial requirements for foreclosure to investigate housing prices and trends in foreclosure.[3] Our paper mainly differs from these studies in emphasizing the impact of non-recourse law on the housing boom-bust cycle and its interaction with mortgage lenders taking into account the growth of the mortgage securitization market.

The paper also offers novel suggestion to a growing literature on housing bubbles. An extensive theoretical literature on bubbles notwithstanding, it remains empirically challenging to identify a credit bubble from estimates of fundamental economic value,

[3]A detailed discussion of how recourse law differs from the judicial foreclosure requirement can be found in Appendix A.

and to distinguish a particular channel among many theoretical bubble models. Our empirical setting affords the unique advantage of the state-border discontinuity test by means of which we control for changes in fundamental values and examine whether a credit bubble is driven by investors' limited liability. The paper's results, although mainly relevant to the housing market, are generalizable to the asset bubble literature that attributes bubbles to limited liability and the credit cycle. Since the U.S. mortgage market is one of the biggest consumer credit markets in the world and most households heavily rely on mortgage financing when they purchase home, the U.S. housing market provide us unique advantages to show credit bubble.

The paper also expands previous research on the recent mortgage crisis by providing some of the first evidence of the combined effect of mortgage law and the securitization market on housing markets. Together with significant credit expansion from low interest rate policies, the role of the housing market preceding the crisis is highlighted (e.g., Herring and Wachter (2003), Reinhart and Rogoff (2008, 2009), Mayer et al. (2009), and Makarov and Plantin (2013)). Many studies have shown that subprime mortgage expansion have promoted the unsustainable growth that led to the market's collapse.[4] This paper further extends pervious research by showing how subprime mortgage expansion, through its influence on lending behavior, accounts for variations in housing speculation across states and the impact of the mortgage crisis.

The rest of this paper is organized as follows. Sample data are described in Section 2. The definition and origins of recourse law are explored in Section 3. In Section 4, an empirical strategy is developed and the impact of recourse law on housing prices and household investment behavior examined. The impact of recourse law combining with mortgage securitization market analyzed in Section 5. Section 6 concludes.

[4]e.g., Agarwal and Ben-David (2014), Berndt and Gupta (2009), Himmelberg et al. (2005), Demyanyk and Van Hemert (2011), Jiang et al. (2010), Keys et al. (2009, 2012), Mian and Sufi (2009) and Purnanandam (2011)

2 Data and Summary Statistics

2.1 Housing Price Data

In this study, we use multiple sources of housing market data including Zillow Real Estate Research and Federal Housing Finance Agency (FHFA) house price index.[5] Using multiple sources of housing price data, we calculate annual housing price growth rate over the sample period of 2004-2009.

Particularly, our empirical works mainly rely on the housing market data from Zillow Real Estate Research (www.zillow.com). Widely used in related literatures (e.g., Huang and Tang (2012), Guerrieri et al. (2013), and Mian et al. (2015)) the Zillow database provides ZIP code-level housing price data at the monthly level from 1999-2013. The 36,577 ZIP codes in the Zillow.com data for 50 states represent 78% of U.S. ZIP codes. Using, for each ZIP code, as a measure of housing price the median home value scaled by a home's square footage reduces the total sample to around 11,000 major ZIP codes in 50 states. We calculate the rate of annual growth in housing price at time t based on the price in January in periods t and t+1.

We also employ as an alternative measure of the housing valuation the price-to-rent ratio. This ratio reflects the relative cost of owning a house relative to the fundamental value of the asset, present value of future rental value. A housing price overvaluation may generate an unsustainably high price-to-rent ratio. We acquire median rent value from American Community Survey data at the county level for the period of 2005-2010, and calculate the growth rate.

2.2 Subprime loan and Securitization

HMDA data provides comprehensive primary mortgage originations and secondary market loan purchases for individual one-to four family residential mortgages that a bank originated in each calendar year. Lenders are required to report origination information on borrower, lending institutions, and type of purchaser of mortgages.

[5]Purchase-Only Indexes, Estimated using Sales Price Data

As HMDA data do not include an indicator for whether a loan is subprime, various methodologies for identifying subprime borrowers are employed in the literature. We classify subprime loans based on lender identification and interest rate charged. We construct a subprime ratio measure specifically, the number of sub-prime mortgage loans out of the total number of mortgage loans originated, using a list of subprime lender specialists compiled annually by HUD (http://www.huduser.org/portal/datasets/manu.html). However, this subprime lender list is available until 2005. Therefore, we classify a loan as subprime after 2005 if the annual percentage rate (APR) is three percentage points above a comparable Treasury APR (i.e., if the mortgage spread is beyond three percentage points).

The "Type of Purchaser" includes whether the mortgage was sold in that calendar year and whether sold to a government-sponsored enterprise (GSE) or an affiliate institution for purchased loans. Using this data, we calculate the non-GSE loan ratio to total originated loans for each ZIP code-level. HMDA data has limited loan-level information relative to LPS, but it covers a wider set of loans (across GSEs and non-GSEs) and used in many previous literature to capture securitization. (i.e., Han et al. (2015)). HMDA data includes agency and non-agency mortgage-backed securities, and it covers 93.3 percent of FHA loans and 81.6 percent of GSE acquisitions.(Finance (1998))

2.3 Control Variables

To control characteristics of local housing market, we collect a variety of economic and demographic characteristics. The American Community Survey (ACS), Federal Housing Finance Agency (FHFA), and Federal Reserve Bank of New York provide county-level fraction of high education, population with age greater than 62, and married status. The ACS data include socioeconomic characteristics of households, such as population, income growth, and unemployment rate. We also collect other important state-level variation in mortgage foreclosure laws, judicial foreclosure.

2.4 Summary Statistics

Table 1 presents summary statistics of the state-level data used in our analysis. Table 1 shows that 11 states, or 22% of all state observations, have non-recourse mortgage law. The average housing price growth rate is around 1-2% during the sample period. It is noteworthy that annual housing price growth has a large variation during our sample period as a result of the collapse of housing prices during the mortgage crisis. The average housing price growth rate are 7.7% annually during the pre-crisis period from 2004 to 2006, and dropped by -4% during the crisis period from 2007-2010. The standard deviation of growth rates across states is also large. During the pre-crisis period, 10 percentile states experienced 3% increase while 90 percentile states experienced 14% increase. During the crisis period, 10 and 90 percentile states experienced -10 to 0% price growth. The average nominal GDP growth rate is 4%, the population growth is 1%, and the income growth rate is 2%, on average, during our sample period. The average fraction of NonGSE loan and Subprime loan are 51% and 15%, respectively.

3 Background of Non-recourse Mortgage Law

3.1 Definition of Non-recourse Mortgage Law

U.S. mortgage law varies across states in many important ways. State-level mortgage law can be classified as recourse and non-recourse, depending on lenders' right of deficiency judgment when borrowers default on residential mortgage loans. Recourse law permits lenders to claim, in other assets and salary, the difference between a remaining mortgage amount and the foreclosure value of a house. Non-recourse law allows lenders to seize only the collateralized house in the event of a mortgage default.

Although states are not strictly classified as recourse and non-recourse, it is widely accepted among both academics and practitioners that 11 states have non-recourse

mortgage laws.[6] Figure 1 illustrates the distribution of recourse and non-recourse law in the United States.[7]

3.2 Origins of Non-recourse Mortgage Law

State-level recourse law has changed little since its enactment during the Great Depression of the 1930s. During that economic recession, foreclosure sales were sufficiently intense and widespread to distort the housing market and caused houses to be sold below their fundamental value. However, mortgage lenders sold borrowers' properties at a deep discount and then claimed deficiency judgments for the full amount of the debt, which amplified the depression. This prompted the anti-deficiency judgment legislation enacted in many states (Solomon and Minnes (2011)).

How states with non-recourse mortgage laws were chosen is an important consideration, as selection on the basis of particular economic motives could imply an unobserved factor responsible for both the legislation and recent housing market dynamics. To mitigate concerns about reverse causality and omitted variable bias, we look to Ghent (2013), who provides historical perspective on how individual states enacted divergent foreclosure laws, in particular, the recourse provision, in the wake of the Great Depression. The paper's finding of no clear economic or legal reasons for states' development of different procedures in the event of mortgage default suggests that the differences relate mainly to judges' idiosyncratic interpretations of case law. In any case, that the differences have persisted little changed since the 1930s mitigates concerns about bias in our empirical results.

[6]There have been debates over the identification of non-recourse states between scholars. Zywicki and Adamson (2009) argue that 15-20 states have non-recourse laws while Ghent and Kudlyak (2011) estimate that eleven states have non-recourse laws. We mainly employ the classification of Ghent and Kudlyak (2011). But we also check the robustness with the other classifications. http://www.foreclosurelaw.org/ provides a comprehensive description of state foreclosure laws in the United States.

[7]In Appendix A, we also compare recourse law with the judicial foreclosure requirement, one of the major mortgage foreclosure laws investigated in the literature (Mian et al. (2015)).

4 Non-recourse Law Effects on Housing Price

We attempt to understand in this paper whether the magnitude of housing price cycle reflects differences between recourse and non-recourse laws. We hypothesize that non-recourse law states experience a larger price increase during a housing market boom and a larger burst during a housing market recession. The asset substitution model by Allen and Gale (2000) provides the theoretical rationale for borrowers with limited liability investing aggressively in risky assets and creating a bubble by bidding up asset prices above their fundamental value.

4.1 Univariate Test

Our first set of tests investigates whether recourse law has an effect on housing price growth. Figure 2 presents the time-series behavior of the aggregate growth rate of housing price (Panel A) and price-to-rent ratio growth (Panel B) in recourse and non-recourse states. Although these growth rates move in a similar fashion, greater swing is observed in non-recourse states in both Panel A and B. NBER classifies the periods from March 2001 to November 2001 and December 2007 to June 2009 as recessionary periods. As can be seen in Panel A of Figure 2, the housing price growth rate is higher during the pre-crisis period of 2002-2005, but falls below that of recourse states during the recent crisis period from 2007-2011.[8] It is also worth noting that the housing price growth rate from 1998-2000 is higher, and drops more steeply during the first recessionary period in 2001, in non-recourse than in recourse states. Panel B of Figure 2 shows the price-to-rent ratio growth during the pre-crisis period to be positive and higher, and during the crisis decrease more, in non-recourse than in recourse states. Figure 2 shows a repeating pattern of a larger housing price swing in non-recourse states.

Table 2 compares the main housing market variables between recourse and non-recourse states. We hypothesize that housing prices in non-recourse states rise more

[8]The housing price growth rate declined sharply in 2006 but remained positive, which indicates that housing prices peaked in 2006.

during a housing market boom, and drop more steeply during a housing market recession. In Panel A, which compares recourse and non-recourse states in the pre-crisis period from 2004-2006, non-recourse states are seen to have higher ZIP code-level housing price growth, on average, by 3 percentage points annually, at the 1% significance level. County-level Price-to-rent ratio and MSA-level FHFA housing price index also show 3.6% and 1.8% annual growth rates, respectively. This is consistent with our hypothesis. On the other hand, during the crisis period in our sample, housing prices show a larger drop in non-recourse states. As can be seen in Panel B of Table 2, during the crisis period from 2007-2009, the ZIP code-level housing price growth rate declined, on average, by 5% annually in recourse, and 8% in non-recourse states. It should be noted that most of control variables are not significantly different between non-recourse states and recourse states. This implies that samples are relatively similar except the difference in mortgage law.

4.2 Multivariate Test

The previous results can be driven by other potential factors affecting housing market. Multiple complementary approaches are employed to identify a causal relation between recourse law and amplified housing price cycle. To separately capture the effects of nonrecourse law before and after the crisis, we apply the difference-in-difference specifications that exploit the nationwide credit supply shock of the mortgage market collapse in 2007 that affected states differentially. The identification of ZIP codes disproportionately affected by the crisis enables us to estimate regressions as follows,

$$\Delta ln(P_{it}) = \beta_0 + \beta_1 \textit{Non-recourse}_i + \beta_2 \textit{Recession}_t * \textit{Non-recourse}_i + \beta^{'} X_{it} + \theta_t + \varepsilon_{it}$$

where the dependent variable, $ln(P_{it})$, is the growth rate of housing price per square foot in ZIP code i at time t from 2004-2010, $\textit{Recession}_t$ is a dummy variable equal to zero before and including 2006 and one after that year, $\textit{Non-recourse}_i$ is a dummy variable equal to one if ZIP code i is located in a non-recourse state, and zero otherwise.

The annual nationwide housing price growth rate was 8%-11% from 2002-2005, dropped to 2.3% in 2006, and in 2007 turned negative and remained so until 2011. We therefore define $Recession_t$ as a dummy variable equal to zero before and including, and one after, the year 2006.[9]

In this specification, the main coefficient of interest is the coefficient on non-recourse dummy, β_1, which captures the average difference in housing price growth by non-recourse law before crisis period. The coefficient on the interaction term between non-recourse dummy and Recession dummy, β_2, captures the differential impact of the crisis on housing price growth rates in recourse and non-recourse states. If non-recourse law causes a larger speculation in the housing market, the crisis may precipitate a disproportionately larger drop in housing price in non-recourse states. Our hypothesis predicts a positive sign on β_1 and negative sign on β_2.

This difference-in-difference estimator suggests a relation between non-recourse law and housing market speculation. However, this estimator can be confounded if housing prices are affected differently for reasons unrelated to recourse law. We address this problem by including the set of other state-level control variables, X_{it}, that potentially affect demand in the local housing market, such as annual GDP growth, per capita income growth, and population growth rate. We also include county-level demographic variables from Census data in 2000 such as age (propotion of the population aged 62 or above), education level, and marriage status of households, which are likely to be a source of omitted variables bias. Other state- and MSA-level controls increase precision.

We include a dummy variable for $Judicial\ Foreclosure$, another major state-level law that sets forth judicial requirements in the foreclosure process. Other literature (Pence (2006), and Mian et al. (2015)) indicates that state-to-state variation in judicial foreclosure law is an important determinant of mortgage credit and foreclosure rates.[10] Lastly, we include year fixed effects, θ_t to capture the national wide changes in housing market condition for each year. The standard errors are clustered county-year level.

[9]The stand-alone variable for recession, $Recession_t$, is dropped because we add year fixed effect.
[10]Figure 3 illustrates the classification of the judicial requirement.

In Table 3, the first model estimates the non-recourse law effect on housing price growth (HP growth) for the full sample with control variables. The estimates show that housing price growth in non-recourse states is higher than in recourse-states in the boom period but falls more after the mortgage market collapse. A positive and significant coefficient on the *Non-recourse* dummy variable indicates that housing prices have grown higher by 2.5% annually, in non-recourse than in recourse states during the pre-crisis period. In particular, the estimated coefficient on the interaction term shows that housing prices dropped more in non-recourse states during the crisis. The negative difference-in-differences produced by these changes is consistent with non-recourse states generating a larger speculation. The economic magnitude of the interaction effect is 5.5%, and the coefficient is significant at the 1% level. This indicates that housing prices declined more in non-recourse states than recourse states by 5%-6% annually during the crisis period. It is noted that all the control variables have intuitive signs of coefficients. Economic attributes such as the growth rates of GDP, population, income are positively associated with the housing price growth. The portion of age over 62 and the married status are negatively associated with the housing price growth.

We examine the effect of non-recourse law on the housing valuation directly using the price-to-rent growth rate. Since rent is a long-run indicator of a property's fundamental value, the price-to-rent ratio captures the effect of non-recourse law on speculative bubbles in the housing market. We employ an identification strategy identical to that of previous regressions for the sample period from 2006-2009. Table 3 presents the estimates for regression of the price-to-rent growth rate on non-recourse law. Consistent with the previous results on housing price growth, we show that, relative to the present value of future rental or "fundamental value," housing prices before and during the crisis appreciate and fall, respectively, by 3.8 and 4.4 percentage points more in non-recourse than in recourse states.

The ideal home price index would be repeated sales price for same house for every year. However, since house sales do not occur each period, we rely on the estimated value by Zillow which uses sales prices for the same et of houses in each time period.

For every ZIP code, we use the median values of homes located in each ZIP codes scaled by square footage of a home. Zillow database provides both median sales price and estimated home value using a time series tracking the monthly median home value in a particular geographical region. The detail estimation methodology is described in the following webpage (http://www.zillow.com/research/zhvi-methodology-6032/). For robustness, we employ an alternative source of housing price growth rate calculated based on the FHFA MSA-level housing price index for the sample period. Consistent with the results based on Zillow housing price, Table 3 shows that the growth rate of housing price index (HPI index (FHFA))is larger in non-recourse states during the pre-crisis period by 2.7%, while the price index declines more sharply during the crisis by 5.9%. The coefficients are statistically significant at 1% level.

Our housing data has a another limitation since we cannot control for the various property attributes, or hedonics, of houses. The median-price measure for square-footage we are using assume constant composition and quality of houses across sale dates. Hedonic regression pricing with a vector of property characteristics mitigates the constant quality limitation, however, it is challenging in dearth of data limitation. Thus, we use housing price growth rate by the number of bedrooms and conduct the same regressions, which mitigates the concern on potential unobserved characteristics of house. The results are robust to the different number of bedrooms. In Table 3, while the magnitudes of coefficients for non-recourse dummy and interaction term vary by the number of bedrooms, the results are consistent with the previous findings. The effect of non-recourse law on housing price during the expansion period increases with the number of bedrooms.

We also run the identical regression model to estimate coefficients for each year in our sample period. In the separate analysis in Table 4, the results show the positive coefficients in housing price growth rate in non-recourse states each year during the pre-crisis period, 2004-2006, and the negative coefficients in each year during the crisis period, 2007-2009. The magnitudes of relative increases are significantly higher in non recourse states. The economic magnitudes are 1.6% in 2004, 3.5% in 2005, and become

insignificant in 2006. Then, the effects turn into significantly negative from 2007 and later years in -1 to -3% annually.

There is another potential concern that some of the control variables are endogenously determined with housing price P_{it}. For example, households that expect increases in property price may increase consumption. We address this possibility by performing the regression with lagged variables for time-varying controls. In the unreported results, we run the regression using the lagged variable for state-level, time-varying controls like GDP, income, and population growth. The results imply that our main results are robust to the endogeneity problem between housing price growth and the control variables.

4.3 State-Border tests

The previous regression is still unable to control for unobserved spatial heterogeneity. Two randomly selected locations, identical except for recourse law status, provide an ideal empirical setting for our experiments. There are, however, a biggest challenges to examining the causal relation is in the absence of a randomized experiment, unobserved heterogeneity may lead to omitted variable bias. Many other characteristics, such as preference for home ownership, dwelling patterns, and state-specific laws and policies, may affect the return on housing assets. Also, substantial heterogeneity may be observed in housing and demography within large states.[11]

This concern can be mitigated because we observe no systematic difference in economic and social attributes across recourse and non-recourse states from our summary statistics. To suggest further evidence, we control for unobserved spatial heterogeneity by performing difference-in-difference regressions at the ZIP code-level using the same explanatory variables, but focused on counties close to a border between states with different recourse laws. We include county-pair fixed effects to capture county-pair specific characteristics. A number of studies have used the state border effects

[11]For example, New York's Erie County and Westchester County have similar populations of 0.75 million, but median household income levels of $47,533 and $77,006, respectively, whereas Connecticut's Fairfield County is contiguous with, and has socioeconomic characteristics similar to those of, Westchester county.

methodology to explore how differences in the socioeconomic environment affect various factors across counties and states (e.g., Holmes (1998), Pence (2006), Dube et al. (2010), and Mian et al. (2015)).

Our framework for examining the impact of recourse law by exploiting the discontinuity at state borders combines the strategy employed in Pence (2006) and Mian et al. (2015) with a difference-in-difference setting less susceptible to unobserved variation over time. We run the following regression,

$$\Delta ln(P_{it}) = \beta_0 + \beta_1 \textit{Non-recourse}_i + \beta_2 \textit{Non-recourse}_i * \textit{Recession}_t + \beta^{'} X_{it} + +\theta_t + \phi_i + \varepsilon_{it}$$

where $\Delta ln(P_{it})$ is the average growth rate of housing price in ZIP code i at time t from 2004-2009 and $\textit{Non-recourse}_i$ is an indicator that identifies whether ZIP code i is located in a non-recourse state. The county-pair sample regression captures the jump, or discontinuity, at the state border. We include the county-pair fixed effect ϕ_i to capture the variation between contiguous counties along a state border. Standard errors are heteroskedasty consistent and clustered at the county level. The coefficient on *Non-recourse* captures a sharp discontinuous change in housing price when a border is crossed into a recourse state.

In Table 5, we present results for the contiguous state border county-pair sample with the county-pair fixed effect. This specification enables us to control for unobserved spatial heterogeneity. The coefficients on the *Non-recourse* dummy variable is consistent with the previous result. We find negative and significant coefficients on the interaction term $\textit{Non-recourse} * \textit{Recession}$ in these models as well. The economic magnitude of the estimate on non-recourse is 2-4% depending on the number of rooms. The results indicate that during the crisis housing prices drop more in non-recourse than in recourse states, especially at state borders.

4.4 Robustness Tests

In this section, we provide an additional set of robustness tests that address the concerns of other potential heterogeneity and self-selection that can drive our main results.

First, one might be concerned that the effect of non-recourse mortgage provision on housing speculation is specific to a certain state with better understanding of the difference of recourse and nonrecourse mortgage law. We address this concern by controlling for state-level financial literacy. We construct the indicators of state-level financial literacy based on Lusardi and Mitchell (2014) and National Financial Capability Study data. Models (1)-(3) in Table 6 show that our results are robust even after controlling for state-level finical literacy.

Second, we also address a potential concern that some of states may experience higher influx of foreign investors (e.g. Vancouver experiences rapid housing price growth due to Chinese investors) and subsequent housing price increase by controlling for the state-level variation in influence of immigrants. As shown in Models (4)-(6) in Table 6, the effect of non-recourse law on housing price growth remains unchanged after controlling for the total number and growth of immigrants, and the proportion of Asian immigrants in each each state.

Third, our test might not be valid if, for example, households on either side of the border have chosen to be located on that particular side because of very different state policies. This is likely to be a concern when policies in the two states differ drastically, for instance, because they lie on the opposite sides of political or industry spectrums.

Furthermore, the effect of non recourse law on housing price growth remains consistent even after controlling for the political characteristics of states (i.e. either Red States or Blue States), industry composition and difference in property tax (Models (7)-(9) in Table 6).

For robustness, we also include other state-level variations in lending regulation and personal bankruptcy law. First, we consider the variation in bankruptcy homestead state laws, which protect households' home equity from creditors up to a state-specified

exemption amount in case of personal bankruptcy. Second, we check whether state-level anti-predatory lending laws affect our results. In 1994, US Congress enacted Home Ownership and Equity Protection Act (HOEPA) to regulate interest rates for high-cost loans. Bostic et al. (2008) construct the state index for HOEPA laws capturing the extents of coverage, restrictions and enforcement. Third, we control the state foreclosure timelines to complete an uncontested foreclosure. Our results are robust to the inclusion of other state-law variations.

4.5 Evidence of Housing Speculation

Housing plays a dual role as investment and residence. While the investment purpose of housing is important for homeowners as housing usually takes a great portion of their total asset, other factors such as job location and neighborhood are also critical for their decision on home purchase. On the other hand, *housing investors* (housing buyers solely with investment purpose) only take into account the gain from housing investment, and they are more likely to invest in housing market with speculative motive. In this regard, we conjecture that housing investors respond more sensitively to mortgage recourse law since the law can directly affect the gain on their investment, and therefore, the effect of non-recourse law on housing prices would be amplified in areas where housing investors abound.

To test this hypothesis, we first estimate the proportion of housing investors relative to real homeowners in a specific area using occupancy variables in HMDA data. We then examine how the effect of mortgage recourse law on house price varies with the proportion of housing investors. More specifically, we use the following regression specifications.

$$\Delta ln(P_{it}) = \beta_0 + \beta_1 \textit{Non-recourse}_i * \textit{Invest}_{it} + \beta_2 \textit{Invest}_{it} + \beta_3 \textit{Non-recourse}_i + \beta' X_{it} + \varepsilon_{it}$$

where $\textit{Invest}_{it}$ is the proportion of housing investors in ZIP code i, and $\textit{Non-recourse}_i$ an indicator for whether ZIP code i is located in a non-recourse state. In this equation,

the coefficient β_1 indicates how the effect of mortgage recourse law varies with the proportion of investors within ZIP code i. Our hypothesis predicts a positive coefficient of β_1.

Table 7 shows the result of this regression. The coefficient β_2 is positive and statistically significant, implying that areas where investors abound experience higher house price appreciation. More importantly, the coefficient β_1, which is also positive and statistically significant, shows that the effect of mortgage recourse on house price is stronger if the portion of housing investor is high relative to homeowners. In sum, the effect of non-recourse law on house price appreciation is amplified in areas with high portion of housing investors relative to homeowners since housing investors have more chance to exploit the benefit of non-recourse law to maximize the gain from their housing investment.

4.6 Household Leverage Decisions

We investigate the source of a larger housing price cycle in non-recourse states by examining the impact of recourse law on household debt-to-income decisions. The housing price pattern in non-recourse states is likely to reflect household speculative behavior. Limited borrower liability, because it may encourage highly leveraged investments that have the potential to increase returns without incurring additional downside risk, may lead households to invest with a higher debt-to-income ratio. To examine households' speculative investment motive, we construct average debt-to-income ratio at ZIP code-level using HMDA data as a proxy for the leverage decision of households investment in the housing market. The DTI ratio is the total mortgage amount divided by annual income at origination date. HMDA data includes borrowers' individual mortgage amount and income level at mortgage origination. We estimate the effect of non-recourse law on debt-to-income using the following specification,

$$DTI_{it} = \beta_0 + \beta_1 Non\text{-}recourse_i + \beta^{'} X_{it} + \theta_t + \varepsilon_{it},$$

where DTI_{it} is the debt-to-income ratio, or borrower's total mortgage lending divided by annual income from HMDA data, at loan origination in ZIP code i in year t, and $Non\text{-}recourse_i$ an indicator for whether ZIP code i is located in a non-recourse state. We also include the year fixed effect θ_t. Standard errors are robust to heteroskedasticity and clustered at the county-year level. In this specification, the coefficient β_1 on the non-recourse indicator shows whether households' debt-to-income ratio is higher in non-recourse states.

Table 8 shows that debt-to-income ratios associated with households' investments in housing assets tend to be higher in non-recourse states. We present the results for the full sample loans in Models (1) and (2), for the total sample period and the pre-crisis period, respectively. In Models (3)-(4), we present the results for the prime loan sample for the total sample period and the pre-crisis period, respectively. *Non-recourse* dummy in all Models (1)-(4) yields positive estimates statistically significant at the 1%-10% level. The coefficient estimate of 0.043 in Model (1) indicates that households in non-recourse states borrow around 2 percentage points (0.043/2.117 =2.03) more debt on average given the same income. The speculative behavior is more significantly observed in prime loan. The coefficient estimate in Model (3) is 0.148, indicating that households in non-recourse states borrow 7 percentage points (0.148/2.117=7.0) more debt given the same income for borrowing prime loans. The results support the evidence of speculative motives for investing in non-recourse states.

Taken together, these results suggest that, because the risk-shifting feature of non-recourse mortgage law promotes riskier investments in housing purchases, housing prices experience a larger boom in non-recourse than in recourse states.

5 Non-recourse Law and Mortgage Securitization Market

After establishing the relation between non-recourse mortgage law and speculation in housing market, we attempt to identify the channels. If this households' investment incentive is well predicted, mortgage lenders may behave differently. The excessive risk-taking behavior in non-recourse states can be prevented if mortgage loans are properly priced. More specifically, lenders can control the risk of borrower's default by means of low loan-to-value (LTV) ratios, high interest rates, and strict screening processes. Used appropriately, such tools can preclude borrowers from shifting risk and bidding up prices above fundamental values. In this section, therefore, we examine channel through which non-recourse law can lead to more speculative households housing investments.

5.1 Non-recourse Law and Mortgage Subprime Mortgages

First, we conjecture that the larger housing price cycle observed in non-recourse states notwithstanding lender efforts to control for the additional risk is attributable to the emergence of the originate-to-distribute (OTD) market that enables lenders to effectively shift the risk of those costs to other investors. In other words, mortgage lending behavior does not fully reflect the higher risk in non-recourse states. The literature suggests that the OTD market, by enabling mortgage lenders to securitize mortgage loans and resell them to third parties, mitigates constraints in credit supply and the ex-ante incentive to screen borrowers (Keys et al. (2009, 2010), Keys et al. (2012) and Purnanandam (2011)).[12] It is likely that securitization in a complex structure of financial derivatives effectively conceals the origins of loans. Furthermore, Piskorski et al. (2013) argue that the true quality of loans in the residential mortgage-backed security (RMBS) market has frequently been misreported to investors. They show that for one

[12]Rapid expansion of this market was accompanied by relaxation of the regulation of mortgage lending.

in ten loans in the RMBS market borrower occupancy status or second lien information is misrepresented and thus not priced in the securities at issuance.

To the extent that it does not reflect the embedded risk in non-recourse mortgage loans, the OTD market promotes a disproportionately large increase in speculative investments in non-recourse states. This is consistent with the argument that the OTD model induces excessively risky mortgage loan originations (Pennacchi (1988) and Gorton and Pennacchi (1995)). Particularly, subprime mortgage loan origination is likely to be associated with loans with poor quality and lax screening incentive. We test this relation by estimating the interaction effect of the *Non-recourse* dummy variable and ZIP code-level fraction of subprime mortgage loan origination ratio, defined as the number of subprime mortgage loans divided by the total number of mortgage loans originated, during the pre-crisis period. We use the following specification,

$$\Delta ln(P_{it}) = \beta_0 + \beta_1 \textit{Non-recourse}_i * \textit{Subprime}_{it} + \beta_2 \textit{Subprime}_{it} + \beta_3 \textit{Non-recourse}_i + \beta^{'} X_{it} + + \theta_t + \varepsilon_{it}$$

where the dependent variable is the growth rate of housing price per square foot in ZIP code i at year t in the pre-crisis period. Year fixed effects are included and all standard errors are robust to heteroskedasticity and clustered at the county-year level. The interaction term between $\textit{Non-recourse}_i$ and $\textit{Subprime}_{it}$ is the main variables of interest. Our hypothesis predicts a positive coefficient, or $\beta_1 > 0$.

Table 9 presents the results of the regression that tests whether non-recourse law interacting with OTD lending drives greater housing price increases in non-recourse states. This test emphasizes a channel through which sub-prime mortgage expansion disinclines lenders in non-recourse states to control for the excessive risk in loan origination.

In literature, subprime mortgage loan is positively associated with housing price growth rate. Consistent with previous literature, we find that housing price shows a larger increase during the pre-crisis period when the ratio of the subprime loan is

higher, an effect statistically significant at the 1% confidence level.[13] The positive and significant coefficients on the interaction between subprime and non-recourse states in Models (1)-(5) support our hypothesis. We employ the full sample for the pre-crisis period with control variables in Model (1), and separately estimate by the number of bedrooms using the same specification. The interaction effects remain positive and economically and statistically significant across models.

The economic magnitude of this effect can be interpreted as housing price growth 1 to 2.5 percentage points higher with a one standard deviation increase in the subprime loan ratio.[14] The interaction effect between non-recourse law and subprime ratio is largest for 1-bedroom homes and decreases over the bedroom number. Coefficients are significant at the 1-10 % level. Furthermore, it is interesting to note that the non-recourse dummy becomes insignificant when the interaction effect is included, which supports the importance of subprime channel we suggested in this paper.

Then, we examine the interaction effects between non-recourse law and subprime loan ratio on housing price growth by sample year. In Table 10, the results show that the subprime loan is positively interacting with non-recourse law and leads to a higher housing speculation during the pre-crisis period whereas it leads to steeper drop in housing price during the recession period. In 2004 and 2005, the interaction effects are positive and significant at the 1% level. For example, a one standard deviation increase in the sub-prime loan ratio lead to 4.2 and 7.5 percentage points higher housing price growth in non-recourse states in 2004 and 2005, respectively.[15]

To further suggest the underlying evidence of two-stage risk shifting hypothesis, we test whether denial rates for loan applications differs between recourse and non-recourse states. The null hypothesis predicts denial rate to be higher under non-recourse law because lenders are expected to require stricter screening to control the additional risk in non-recourse states. On the other hand, our alternative hypothesis

[13]The coefficient on subprime ratio is positive and significant in the regression estimates without employing non-recourse law or its interaction with the sub-prime ratio.

[14]The standard deviation of the ZIP code-level sub-prime loan ratio is 0.18 for the pre-crisis period. The economic magnitude is calculated as 0.18*0.141=0.025 in Model (2).

[15]In 2004, 0.18*0.457 - 0.041 = 0.075. In 2005, 0.18*0.250 -0.003 = 0.042

predicts denial rate to be lower under non-recourse law because the subprime mortgage market enables lenders to pass-through the risk to the other investors in the economy. The mortgage application can be denied by the financial institution. The reasons for denial are variously related to (1) debt-to-income ratio; (2) employment history; (3) credit history; (4) collateral; (5) insufficient cash (downpayment, closing costs); (6) unverifiable information; (7) incomplete credit application; (8) denied mortgage insurance; and (9) other. Because we aim to calculate the denial rate consequent to a high risk of insolvency, we estimate the fraction of loan applications denied for reasons 1, 3, 4, or 5, listed above. The regression specifications for these tests are as follow,

$$\textit{Denial Rate}_{it} = \beta_0 + \beta_1 \textit{Non-recourse}_i + \beta' X_{it} + \phi_i + \varepsilon_{it},$$

where $\textit{Denial Rate}_{it}$ is the average denial rate in ZIP code i at year t. Our main hypothesis predicts a negative coefficient on $\textit{Non-recourse}_i$ dummy, which corresponds to $\beta_1 < 0$.

We test denial rates for prime loans and subprime loans separately, to control for basic loan quality. We also test both total sample period and pre-crisis period. In Table 11 Model (1), the dependent variable is the denial rate for prime loans for the period of 2004-2009. The result indicates that aggregate denial rate of mortgage application in non-recourse states is 1% lower than in recourse states. The effect is larger during the pre-crisis period, 2004-2006. The results remain significant for subprime loans.

Our overall results demonstrate an underlying mechanism in the recent housing speculation and explain why larger cycles are observed in non-recourse states. These results are consistent with our hypothesis, which states that the OTD market encourages more risk shifting by lenders in non-recourse than in recourse states.

5.2 Non-recourse Mortgage Law and GSE anti-discretionary policy

Lastly, we examine whether lenders underprice mortgage loans in non-recourse states because of anti-discretionary policy across states. Government-sponsored enterprises (GSE) such as Fannie Mae and Freddie Mac purchase a large portion of mortgage loans and sell to secondary market after securitizing those loans. In this securitization process, GSE provides guarantee to secondary market that limits the risk of capital losses which allows mortgage originators to increase loan volume. Fannie Mae and Freddie Mac charge upfront and ongoing guarantee fees based on certain risk attributes of the borrower or the loans such as LTV/credit-score grid, cash-out refinance, investor properties, secondary financing at origination, jumbo conforming loan. Most lenders convert GSEs' guarantee fees into the interest rate on the mortgage, which borrowers pay over time.[16]

However, there is political influence which prevents GSE from pricing state-level variation of risks. Despite the significant differences in household bankruptcy provision and foreclosure laws or home exemption across states, mortgage rates for GSE loans are not significantly different.(Hurst et al. (2015))[17] Therefore, the potential channel is that nationwide GSE loan policy can drive underpricing of non-recourse loans and causes further housing speculation in non-recourse states during housing boom period by subsidizing borrowers in non-recourse states. Households in non-recourse states can borrow mortgage relatively cheaper interest rates. This mispricing, which is covered by taxpayers, can drive more speculation in non-recourse states. This hypothesis predicts that higher ratio of GSE loans can lead to state-level underpricing of non-recourse mortgage loans and increases the housing speculation. We use the following

[16]For loans that have greater than 80 percent of LTV ratio or credit score below 700, FHFA is directing the GSE to increase the upfront fees by 25 basis points.

[17]In Sep 2012, FHFA proposes to impose an up-front fee on newly acquired single-family mortgages originated in specific states where GSEs are likely to incur default-related losses much higher than the national average because of the individual laws in those states.

specification to estimate the differential effects of non-GSE and GSE loans,

$$\Delta ln(P_{it}) = \beta_0 + \beta_1 Non\text{-}recourse_i * NonGSE_{it} + \beta_2 NonGSE_{it} + \beta_3 Non\text{-}recourse_i + \beta^{'} X_{it} + + \theta_t + \varepsilon_{it}$$

However, our finding do not support the hypothesis based on GSEs' anti-discretionary policy. Instead, we find that the interaction term between non-recourse and ZIPcode-level NonGSE loan ratio has positive coefficient at 1% significance level. The results suggest that non-GSE loans are more likely to promote further housing speculation because non-GSE loans which are purchased by private label securitizers induce the origination of mortgage loans with poor quality. In contrast, GSE loans are likely to be regulated to follow relatively stricter requirement of loan quality.

6 Conclusion

In this paper, we investigate the role of state-level variation in mortgage recourse law in generating a larger price cycle in the housing market. The results show that states with non-recourse law experience a larger expansion and burst in housing prices. The effects are economically large and robust to different property attributes, and state-level variations in economic and demographic conditions including financial literacy, immigrants, political status. Our evidence supports the bubble mechanism by the asset substitution problem, as proposed by Allen and Gale (2000) and households' speculative investment behaviors in non-recourse states. The combined effects of non-recourse law and subprime mortgage loan origination on the housing speculation suggests that the OTD market constitutes a disincentive to lenders to control for that risk by enabling them to effectively shift it to other investors.

The bubble and burst cycle in the housing market has been repeated and amplified in non-recourse states. Recourse mortgage law, although adopted by most European countries and Canada, China, and Japan, has become a subject of heated debate in relation to housing market reform. This paper identifies important implications

for the evaluation of non-recourse mortgage law with respect to preventing future housing market crises and collapse. Non-recourse law, while protecting households from premature foreclosure and lenders' deficiency judgments, causes larger swings in housing prices as a consequence of being exploited by households to make riskier investments when housing markets are in boom cycles.

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Figure 1: State-level Variation in Mortgage Recourse law

This figure illustrates the classification of mortgage recourse law. States shaded in dark are non-recourse states. These states with non-recourse law are Alaska, Arizona, California, Iowa, Minnesota, Montana, North Carolina, North Dakota, Oregon, Washington, and Wisconsin.

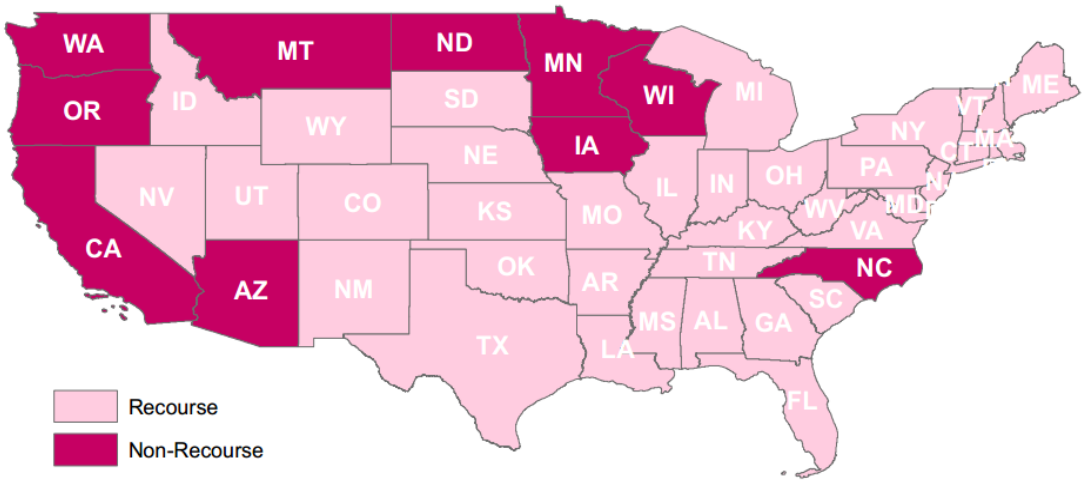

Figure 2: Recourse Law and Housing Price Growth Rate

This figure plots the aggregate housing price growth rates in recourse and non-recourse states. Panel A shows the housing price growth rate per square foot over recourse law from ZIP code-level data from 1998-2012. Panel B shows the median price-to-rent growth rate from 2006-2011. Housing Price Growth (Sq. Ft) is the annual growth rate of the median of estimated home value scaled by a homes square footage of a home. Price-to-Rent growth rate is the county-level median rent value divided by county-level median housing price from the American Community Survey Census data.

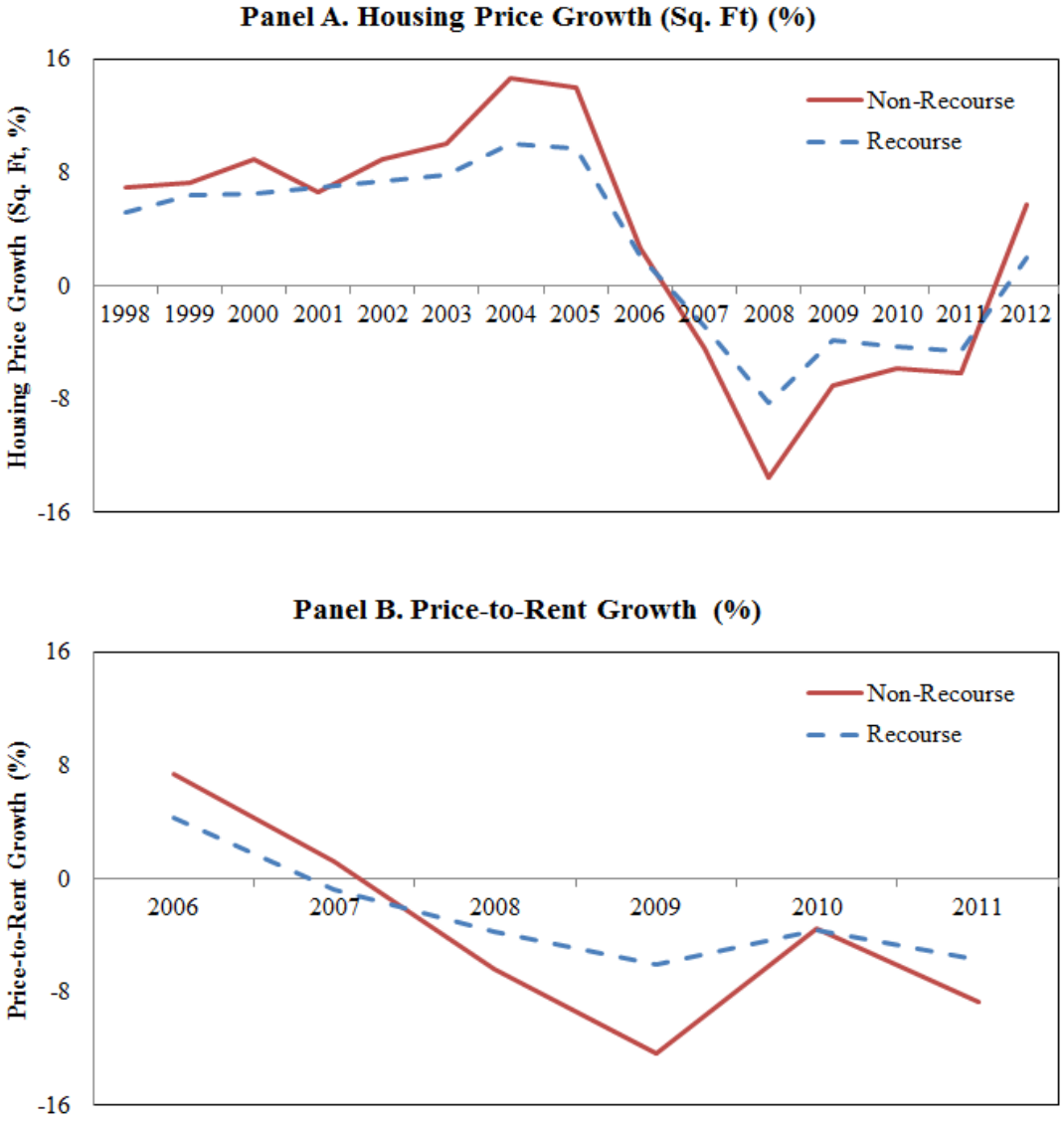

Table 1: Summary Statistics

This table presents summary statistics for the main variables used in the analysis for the period 2004-2010. HP Growth (Sq. Ft) is the annual growth rate of the ZIP code-level median of home value scaled by a homes square footage using Zillow database. HP Growth before is the annual housing growth rate for 2004-2006, and HP Growth after is for 2007-2009. HPI growth (FHFA) is the annual growth rate of the housing price index from FHFA data. Price/rent growth rate is the annual growth rate of the county-level median rent value divided by the county-level median housing price from the American Community Survey data from 2006-2010. HP growth 1bed, 2bed, 3bed, and 4bed are the annual growth rate of square footage housing price growth rate of home with a specific number of bedrooms. Debt-to-income ratio is defined as the total mortgage amount divided by borrower's annual income at origination date. Subprime loan ratio is the aggregate ratio of the number of sub-prime mortgage loans to the total number of mortgage loans originated at the ZIP code-level. NonGSE loan ratio is the aggregate ratio of the number of non-GSE mortgage loans to the total number of mortgage loans originated at the ZIP code-level. Denial rate is the rate of mortgage application denial due to a high risk of insolvency. The variables for economic conditions are state-level statistics. GDP growth rate is the annual growth rate of nominal GDP. Income growth is the growth rate of per capita income. The demographic variables are all county-level statistics. Census data in 2000 provides county-level age (propotion of the population aged 62 or above), race, education level, and marriage status of households.

	Mean	SD	10th	Median	90th	count
Non-recourse	0.220	0.418	0.000	0.000	1.000	50
HP growth	0.009	0.021	-0.015	0.012	0.032	50
HP growth before	0.077	0.045	0.029	0.067	0.141	50
HP growth after	-0.040	0.043	-0.100	-0.033	0.008	50
HPI growth (FHFA)	0.024	0.018	0.000	0.026	0.048	49
Price/Rent growth	-0.014	0.029	-0.047	-0.010	0.014	42
HP growth 1Bed	-0.011	0.042	-0.060	0.006	0.029	47
HP growth 2Bed	0.003	0.025	-0.026	0.007	0.030	49
HP growth 3Bed	0.006	0.022	-0.018	0.009	0.029	50
HP growth 4Bed	0.009	0.020	-0.016	0.014	0.032	49
Investment purpose	0.099	0.029	0.066	0.093	0.132	50
Debt-to-Income	2.117	0.134	1.976	2.114	2.280	50
Debt-to-Income prime	1.345	0.244	1.041	1.374	1.664	50
Subprime ratio	0.149	0.041	0.106	0.137	0.207	50
Denial rate prime	0.163	0.036	0.122	0.158	0.218	50
Denial rate subprime	0.015	0.005	0.009	0.015	0.022	50
NonGSE ratio	0.517	0.039	0.480	0.507	0.563	50
GDP growth	0.041	0.013	0.028	0.039	0.059	50
Pop growth	0.009	0.007	0.002	0.008	0.018	50
Income growth	0.020	0.008	0.011	0.020	0.028	50
Edu high	0.303	0.044	0.246	0.300	0.359	50
Age 62	0.149	0.022	0.128	0.151	0.169	50
Married	0.555	0.043	0.525	0.560	0.586	50
Judicial	0.440	0.501	0.000	0.000	1.000	50

Table 2: Univariate Analysis

This table presents the comparisons of the main variables between recourse state and non-recourse states. Panel A presents the statistics for the sample period 2004-2006 (Expansion). Panel B presents the statistics for the sample period 2007-2009 (Recession). A state is classified as a *Non-recourse* state if the state does not allow lenders to claim deficiency judgments in the event of mortgage default. We report the differences in average value in non-recourse states and in recourse states. ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	Non-Recourse			Recourse			Diff. Mean
Panel A. Expansion (2004-2006)	Mean	Median	SD	Mean	Median	SD	
HP growth	0.105	0.093	0.100	0.073	0.058	0.083	0.032***
HPI growth (FHFA)	0.087	0.077	0.054	0.070	0.054	0.045	0.018***
Price/Rent growth	0.077	0.068	0.091	0.041	0.039	0.074	0.036**
HP growth 1Bed	0.102	0.101	0.107	0.072	0.054	0.112	0.030***
HP growth 2Bed	0.100	0.091	0.104	0.070	0.054	0.094	0.030***
HP growth 3Bed	0.100	0.090	0.103	0.069	0.055	0.085	0.031***
HP growth 4Bed	0.100	0.090	0.099	0.069	0.055	0.083	0.031***
GDP growth	0.068	0.065	0.017	0.060	0.058	0.021	0.008
Pop growth	0.012	0.011	0.007	0.009	0.008	0.010	0.003
Income growth	0.033	0.032	0.011	0.035	0.031	0.012	-0.002
Edu high	0.283	0.281	0.043	0.307	0.303	0.044	-0.024
Age 62	0.143	0.146	0.026	0.150	0.150	0.021	-0.007
Married	0.562	0.562	0.014	0.552	0.559	0.047	0.010
Panel B. Recession (2007-2009)							
HP Growth	-0.077	-0.057	0.095	-0.048	-0.037	0.076	-0.029***
HPI growth (FHFA)	-0.027	-0.009	0.052	-0.016	-0.011	0.035	-0.011***
Price/Rent growth	-0.029	-0.010	0.052	-0.026	-0.026	0.033	-0.003
HP Growth 1Bed	-0.088	-0.078	0.102	-0.072	-0.053	0.104	-0.016***
HP Growth 2Bed	-0.084	-0.067	0.099	-0.061	-0.046	0.087	-0.023***
HP Growth 3Bed	-0.078	-0.059	0.096	-0.050	-0.039	0.075	-0.028***
HP Growth 4Bed	-0.076	-0.058	0.090	-0.048	-0.038	0.071	-0.029***
GDP growth	0.031	0.031	0.019	0.024	0.024	0.012	0.006
Pop growth	0.011	0.009	0.004	0.009	0.008	0.006	0.002
Income growth	0.011	0.006	0.009	0.010	0.010	0.010	0.002
Edu high	0.285	0.281	0.044	0.309	0.307	0.042	-0.024*
Age 62	0.144	0.149	0.027	0.151	0.152	0.020	-0.007
Married	0.563	0.562	0.014	0.554	0.560	0.047	0.009

Table 3: Non-recourse Law and Housing Price Growth

This table reports estimates and standard errors for regressions of housing price growth on non-recourse law indicators for the sample period 2004-2009. The dependent variable in Model (1) is Housing Price Growth (Sq. Ft), the annual growth rate of the median of home value scaled by the square footage of a home using Zillow Research. Price/Rent growth rate is the annual growth rate of the county-level median rent value divided by the county-level median housing price from the American Community Survey data. HPI growth (FHFA) is the annual growth rate of the housing price index from FHFA data. The dependent variables in Models (4)-(7) are the annual growth rate of housing price growth (Sq. Ft) from Zillow Research for a certain number of bedrooms. *Recession* is a dummy variable that equals zero before and including 2006, and one after that year. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lenders to claim deficiency judgments in the event of mortgage default. The other control variables are defined in Table 1. All standard errors are robust to heteroskedasticity and clustered at the county-year level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	(1) HP growth	(2) Price/Rent growth	(3) HPI growth (FHFA)	(4) 1-Bed	(5) 2-Bed	(6) 3-Bed	(7) 4-Bed
Non-recourse	0.025***	0.038***	0.027***	0.018**	0.023***	0.026***	0.027***
	(0.006)	(0.015)	(0.004)	(0.008)	(0.006)	(0.005)	(0.006)
Non-recourse X Recession	-0.055***	-0.044**	-0.059***	-0.036***	-0.047***	-0.056***	-0.055***
	(0.008)	(0.021)	(0.007)	(0.011)	(0.008)	(0.008)	(0.008)
GDP growth	0.979***	0.732***	0.710***	1.553***	1.176***	0.938***	0.930***
	(0.078)	(0.260)	(0.072)	(0.148)	(0.089)	(0.075)	(0.079)
Pop growth	1.668***	0.472	1.064***	1.932***	1.976***	1.673***	1.551***
	(0.247)	(0.538)	(0.221)	(0.414)	(0.269)	(0.250)	(0.261)
Income growth	0.264***	0.074	0.409***	0.431***	0.282***	0.230***	0.206***
	(0.031)	(0.079)	(0.049)	(0.059)	(0.037)	(0.032)	(0.033)
Edu high	0.183***	0.228***	0.130***	0.281***	0.230***	0.186***	0.162***
	(0.021)	(0.049)	(0.032)	(0.043)	(0.027)	(0.022)	(0.022)
Age 62	-0.090**	0.031	0.031	-0.213***	-0.152***	-0.096**	-0.078**
	(0.039)	(0.127)	(0.053)	(0.063)	(0.045)	(0.039)	(0.036)
Married	-0.057***	-0.129**	-0.089**	-0.047	-0.059**	-0.060***	-0.064***
	(0.021)	(0.054)	(0.037)	(0.029)	(0.024)	(0.021)	(0.021)
NonGSE ratio	0.042***	-0.025**	0.088***	0.055**	0.051***	0.041***	0.036***
	(0.013)	(0.010)	(0.028)	(0.024)	(0.016)	(0.013)	(0.013)
Judicial	0.010***	0.019***	0.002	0.010*	0.012***	0.010***	0.011***
	(0.003)	(0.007)	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	69473	14210	2076	13251	48515	63101	53467
Adjusted R^2	0.565	0.380	0.523	0.536	0.546	0.556	0.572

Table 4: Non-recourse Law and Housing Price Growth by Year

This table reports estimates and standard errors for regressions of housing price growth on non-recourse law indicators for each year during our sample period 2004-2009. The dependent variable is Housing Price Growth (Sq. Ft), the annual growth rate of the median of home value scaled by the square footage of a home. This measure is aggregated at the ZIP code-level. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lenders to claim deficiency judgments in the event of mortgage default. The other control variables are defined in Table 1. All standard errors are robust to heteroskedasticity and clustered at the county-year level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	Year					
	2004	2005	2006	2007	2008	2009
Non-recourse	0.016*	0.035***	-0.001	-0.012*	-0.028**	-0.024***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.011)	(0.009)
GDP growth	0.768***	1.105***	0.867***	1.013***	1.567***	0.477***
	(0.159)	(0.188)	(0.104)	(0.156)	(0.183)	(0.160)
Pop growth	2.026***	2.843***	0.944***	0.339	-1.173	3.260***
	(0.481)	(0.625)	(0.279)	(0.473)	(0.768)	(0.523)
Income growth	1.295***	0.386***	0.080	0.046	0.387***	0.167***
	(0.250)	(0.057)	(0.049)	(0.055)	(0.087)	(0.054)
Edu high	-0.280***	-0.009	0.244***	0.286***	0.473***	0.315***
	(0.049)	(0.052)	(0.032)	(0.040)	(0.050)	(0.045)
Age 62	0.356***	0.426***	-0.343***	-0.434***	-0.325***	-0.287***
	(0.068)	(0.073)	(0.049)	(0.080)	(0.082)	(0.065)
Married	-0.058	-0.027	-0.122***	-0.114***	-0.054	0.029
	(0.052)	(0.045)	(0.031)	(0.039)	(0.050)	(0.045)
NonGSE ratio	0.128***	0.029	-0.059***	-0.058***	0.045**	-0.035
	(0.021)	(0.026)	(0.019)	(0.018)	(0.019)	(0.023)
Judicial	0.014**	0.021***	-0.001	-0.003	0.016**	0.010
	(0.006)	(0.006)	(0.004)	(0.006)	(0.007)	(0.007)
Observations	11423	11527	11590	11616	11637	11680
Adjusted R^2	0.347	0.415	0.186	0.170	0.291	0.135

Table 5: Non-recourse Law and Housing Price Growth: State Border Test

This table reports estimates and standard errors for regressions of housing price growth on non-recourse law indicators for the contiguous border county-pair sample in the pre-crisis period 2004-2006. The dependent variable in Model (1) is Housing Price Growth (Sq. Ft), the annual growth rate of the median of home value scaled by the square footage of a home aggregated at the ZIP code-level. The dependent variables in Models (2)-(5) are Housing Price Growth (Sq. Ft) for 1-bed, 2-bed, 3-bed and 4-bedrooms. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lenders to claim deficiency judgments in the event of mortgage default. *Recession* is a dummy variable that equals zero before and including 2006, and one after that year. The other control variables are defined in Table 1. All standard errors are robust to heteroskedasticity and clustered at the county-year level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	(1) HP growth (Zillow)	(2) 1-Bed	(3) 2-Bed	(4) 3-Bed	(5) 4-Bed
Non-recourse	0.029	0.225***	0.038*	0.040*	0.043**
	(0.019)	(0.066)	(0.022)	(0.021)	(0.022)
Non-recourse X Recession	-0.044**	-0.056**	-0.035**	-0.044**	-0.046**
	(0.019)	(0.023)	(0.018)	(0.018)	(0.018)
GDP growth	0.945***	0.936***	0.930***	0.879***	0.893***
	(0.175)	(0.206)	(0.151)	(0.163)	(0.158)
Pop growth	4.297***	7.408***	5.237***	4.498***	4.518***
	(1.080)	(1.120)	(0.876)	(1.099)	(0.966)
Income growth	0.172**	0.329***	0.163**	0.141**	0.117*
	(0.067)	(0.107)	(0.066)	(0.064)	(0.064)
Edu high	0.062	-0.892***	-0.143	0.016	0.011
	(0.096)	(0.233)	(0.107)	(0.096)	(0.097)
Age 62	0.170	-1.599**	0.071	0.128	0.160
	(0.168)	(0.633)	(0.186)	(0.163)	(0.170)
Married	0.159**	-0.295	0.164*	0.128	0.099
	(0.080)	(0.216)	(0.085)	(0.081)	(0.081)
NonGSE ratio	0.059***	0.076***	0.062***	0.065***	0.063***
	(0.012)	(0.026)	(0.014)	(0.013)	(0.013)
Judicial	0.015*	0.005	0.012	0.016*	0.015*
	(0.008)	(0.013)	(0.008)	(0.008)	(0.008)
County-pair sample	Yes	Yes	Yes	Yes	Yes
County-pair FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	17949	3909	13265	16417	14558
Adjusted R^2	0.665	0.564	0.613	0.644	0.647

Table 6: Non-recourse Law and Housing Price Growth: Robustness Tests

This table reports estimates and standard errors for regressions of housing price growth on non-recourse law indicators with various control variables for the sample period 2004-2009. The dependent variable in Models (1)-(9) is Housing Price Growth (Sq. Ft), the annual growth rate of the median of home value scaled by the square footage of a home using Zillow Research. *Recession* is a dummy variable that equals zero before and including 2006, and one after that year. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lenders to claim deficiency judgments in the event of mortgage default. $FinLiteracy1-3$ are the state-level financial literacy indices related to compound interest, inflation, and stock risk, respectively. $Immigrant2000$ is the proportion of immigrants for each state in 2000. *Immigrantincrease* is the growth rate of immigrant between 2000 and 2014. *ImmigrantAsian* is the proportion of Asian immigrants for each state in 2014. *Redstates* is a dummy variable that equals one if the state predominantly vote for the Republican Party in 2004. *Industrycomposition* is the average GDP share of manufacturing sector in each state during 2005-2007. All standard errors are robust to heteroskedasticity and clustered at the county-year level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	Housing Price growth (Zillow)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Non-recourse	0.023***	0.027***	0.026***	0.029***	0.025***	0.019***	0.015***	0.021***	0.025***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Non-recourse X Recession	-0.054***	-0.055***	-0.055***	-0.054***	-0.055***	-0.056***	-0.057***	-0.054***	-0.055***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Fin Literacy1	-0.041**								
	(0.019)								
Fin Literacy2		-0.093**							
		(0.039)							
Fin Literacy3			-0.053						
			(0.040)						
Immigrant 2000				-0.084***					
				(0.026)					
Immigrant increase					-0.003				
					(0.007)				
Immigrant Asian						0.143***			
						(0.022)			
Red states							-0.029***		
							(0.004)		
Industry composition								0.107***	
								(0.034)	
PropertyTax									0.002
									(0.003)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	69473	69473	69473	69473	69473	69473	69473	69473	69473
Adjusted R^2	0.566	0.565	0.565	0.567	0.565	0.572	0.573	0.567	0.565

Table 7: Non-recourse Law and Housing Speculation: Investment-purpose

This table reports estimates and standard errors for regressions of housing price growth on non-recourse law indicators and investment-purpose in the pre-crisis period 2004-2006. The dependent variable in Model (1) is Housing Price Growth (Sq. Ft), the annual growth rate of the median of home value scaled by the square footage of a home aggregated at the ZIP code-level. The dependent variables in Models (2)-(5) are Housing Price Growth (Sq. Ft) for 1-bed, 2-bed, 3-bed and 4-bedrooms. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lenders to claim deficiency judgments in the event of mortgage default. The other control variables are defined in Table 1. All standard errors are robust to heteroskedasticity and clustered at the county-year level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	(1) HP growth	(2) 1-Bed	(3) 2-Bed	(4) 3-Bed	(5) 4-Bed
Non-recourse X Invest	0.063**	0.052	0.060*	0.075**	0.048
	(0.032)	(0.050)	(0.033)	(0.036)	(0.038)
Investment-purpose	0.066***	0.022	0.043**	0.054***	0.064***
	(0.015)	(0.030)	(0.017)	(0.015)	(0.016)
Non-recourse	0.013**	0.021*	0.012*	0.013**	0.018***
	(0.006)	(0.012)	(0.007)	(0.006)	(0.006)
GDP growth	0.905***	1.082***	0.950***	0.824***	0.848***
	(0.092)	(0.167)	(0.101)	(0.092)	(0.100)
Pop growth	1.766***	3.163***	2.331***	1.915***	1.858***
	(0.305)	(0.481)	(0.310)	(0.317)	(0.329)
Income growth	0.239***	0.305***	0.238***	0.193***	0.177***
	(0.045)	(0.080)	(0.053)	(0.047)	(0.049)
Edu high	0.001	0.086	0.006	0.020	0.036
	(0.029)	(0.059)	(0.034)	(0.030)	(0.032)
Age 62	0.147***	0.117	0.150**	0.137***	0.100**
	(0.050)	(0.088)	(0.061)	(0.053)	(0.050)
Married	-0.048*	-0.045	-0.037	-0.056*	-0.065**
	(0.029)	(0.045)	(0.033)	(0.030)	(0.030)
NonGSE ratio	0.052***	0.068*	0.050**	0.050**	0.040**
	(0.019)	(0.037)	(0.023)	(0.020)	(0.020)
Judicial	0.012***	0.021***	0.013***	0.010***	0.010**
	(0.004)	(0.007)	(0.004)	(0.004)	(0.004)
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	34540	6500	24068	31373	26612
Adjusted R^2	0.405	0.394	0.403	0.407	0.421

Table 8: Non-recourse Law and Household Leverage Decision

This table reports estimates and standard errors for regressions of household investment behaviors for the sample period from 2004-2009. The dependent variable is the average debt-to-income ratio (DTI) at the ZIP code-level, defined as the total mortgage amount divided by borrower's annual income at origination date. DTI ratio for the entire mortgage loans are used in models (1)-(2), and only prime loans are used in models (3)-(4), respectively. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lender to claim deficiency judgments in the event of mortgage default. The other control variables are defined in Table 1. All standard errors are robust to heteroskedasticity and clustered at the county level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	DTI		DTI Prime Loan	
	(1) 2004-2009	(2) 2004-2006	(3) 2004-2009	(4) 2004-2006
Non-recourse	0.043***	0.032*	0.148***	0.142***
	(0.014)	(0.018)	(0.016)	(0.019)
GDP growth	-0.035	-0.900***	0.160	-3.092***
	(0.230)	(0.272)	(0.415)	(0.426)
Pop growth	-6.479***	-5.098***	-11.065***	-6.791***
	(0.786)	(0.900)	(1.033)	(1.095)
Income growth	0.620***	0.739***	0.564***	0.860***
	(0.128)	(0.200)	(0.153)	(0.211)
Edu high	-2.160***	-2.042***	-2.799***	-2.907***
	(0.087)	(0.116)	(0.111)	(0.144)
Age 62	-0.906***	-0.553***	-0.612***	-0.076
	(0.098)	(0.143)	(0.156)	(0.201)
Married	0.061	0.007	1.264***	1.276***
	(0.092)	(0.116)	(0.116)	(0.139)
NonGSE ratio	-2.080***	-1.441***	-1.516***	-1.433***
	(0.062)	(0.104)	(0.060)	(0.062)
Judicial	0.073***	0.058***	0.108***	0.143***
	(0.009)	(0.012)	(0.015)	(0.017)
Year FE	Yes	Yes	Yes	Yes
Observations	100134	50070	100134	50070
Adjusted R^2	0.213	0.182	0.052	0.091

Table 9: Non-recourse Law and Subprime Loan Ratio

This table reports estimates and standard errors for regressions of housing price growth on the interaction term of non-recourse law indicators and *Subprime* loan ratio for the pre-crisis period. The subprime loan ratio is the aggregate ratio of the number of subprime mortgage loans to the total number of mortgage loans originated at the ZIP code-level. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lender to claim deficiency judgments in the event of mortgage default. The other variables are defined in Table 1. All standard errors are robust to heteroskedasticity and clustered at the county-year level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	(1) HP growth (Zillow)	(2) 1-Bed	(3) 2-Bed	(4) 3-Bed	(5) 4-Bed
Subprime X Non-recourse	0.064**	0.141***	0.089***	0.048*	0.052*
	(0.027)	(0.031)	(0.027)	(0.028)	(0.029)
Subprime	0.031***	0.011	0.022*	0.032***	0.027**
	(0.011)	(0.021)	(0.013)	(0.012)	(0.012)
Non-recourse	0.008	0.004	0.003	0.012**	0.013**
	(0.006)	(0.010)	(0.006)	(0.006)	(0.006)
GDP growth	0.897***	1.087***	0.934***	0.820***	0.838***
	(0.093)	(0.167)	(0.101)	(0.093)	(0.101)
Pop growth	1.951***	3.254***	2.512***	2.058***	2.053***
	(0.307)	(0.460)	(0.306)	(0.316)	(0.326)
Income growth	0.230***	0.286***	0.227***	0.187***	0.169***
	(0.045)	(0.080)	(0.052)	(0.046)	(0.049)
Edu high	-0.036	0.038	-0.025	-0.014	0.007
	(0.029)	(0.059)	(0.035)	(0.030)	(0.031)
Age 62	0.189***	0.139	0.182***	0.175***	0.145***
	(0.050)	(0.085)	(0.061)	(0.053)	(0.050)
Married	-0.054*	-0.046	-0.040	-0.060**	-0.069**
	(0.028)	(0.044)	(0.033)	(0.029)	(0.030)
Judicial	0.013***	0.022***	0.014***	0.010***	0.010***
	(0.004)	(0.007)	(0.004)	(0.004)	(0.004)
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	34365	6464	23959	31226	26489
Adjusted R^2	0.403	0.402	0.405	0.405	0.420

Table 10: Non-recourse Law and Subprime Loan Ratio

This table reports estimates and standard errors for regressions of housing price growth on the interaction term of non-recourse law indicators and Sub-prime loan ratio for the pre-crisis period. The dependent variable is Housing Price Growth (Sq. Ft), the annual growth rate of the median of home value scaled by the square footage of a home aggregated at the ZIP code-level in a certain year. The Subprime loan ratio is the aggregate ratio of the number of Sub-prime mortgage loans to the total number of mortgage loans originated at the ZIP code-level. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lender to claim deficiency judgments in the event of mortgage default. The other variables are defined in Table 1. All standard errors are robust to heteroskedasticity and clustered at the county-year level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	Year					
	2004	2005	2006	2007	2008	2009
Subprime X Non-recourse	0.457 ***	0.250 ***	-0.039	-0.227 ***	-0.162 *	-0.329 ***
	(0.050)	(0.036)	(0.034)	(0.037)	(0.096)	(0.091)
Subprime	-0.041 **	-0.008	0.021 *	-0.048 ***	-0.061 ***	0.085 ***
	(0.019)	(0.021)	(0.011)	(0.014)	(0.023)	(0.021)
Non-recourse	-0.041 ***	-0.003	0.010	0.022 ***	-0.016	-0.003
	(0.008)	(0.008)	(0.010)	(0.007)	(0.010)	(0.009)
GDP growth	0.758 ***	1.006 ***	0.856 ***	0.938 ***	1.591 ***	0.547 ***
	(0.156)	(0.180)	(0.107)	(0.150)	(0.190)	(0.164)
Pop growth	2.233 ***	3.160 ***	0.925 ***	0.572	-1.026	2.827 ***
	(0.500)	(0.611)	(0.283)	(0.458)	(0.807)	(0.507)
Income growth	1.190 ***	0.355 ***	0.071	0.043	0.371 ***	0.159 ***
	(0.229)	(0.055)	(0.048)	(0.051)	(0.083)	(0.052)
Edu high	-0.317 ***	-0.016	0.264 ***	0.335 ***	0.518 ***	0.296 ***
	(0.048)	(0.047)	(0.032)	(0.037)	(0.057)	(0.051)
Age 62	0.333 ***	0.431 ***	-0.336 ***	-0.436 ***	-0.344 ***	-0.289 ***
	(0.069)	(0.074)	(0.050)	(0.078)	(0.081)	(0.064)
Married	-0.067	-0.022	-0.103 ***	-0.137 ***	-0.063	0.035
	(0.050)	(0.044)	(0.031)	(0.038)	(0.051)	(0.044)
Judicial	0.018 ***	0.025 ***	-0.002	-0.005	0.015 **	0.012 *
	(0.006)	(0.006)	(0.004)	(0.005)	(0.007)	(0.007)
Observations	11374	11464	11527	11551	11501	11437
Adjusted R^2	0.387	0.440	0.181	0.207	0.298	0.145

Table 11: Non-recourse Law and Subprime Loan Ratio: Denial Rate

This table reports estimates and standard errors for regressions of mortgage denial rate on the interaction term of non-recourse law indicators and Subprime loan ratio. *Denial Rate*$_{it}$ is the average denial rate in ZIP code-level. We estimate the fraction of loan applications denied for high risk of insolvency. The sample period is 2004-2009 in models (1) and (3). In models (2) and (4), the sample period is the pre-crisis period, 2004-2006. The subprime loan ratio is the aggregate ratio of the number of subprime mortgage loans to the total number of mortgage loans originated at the ZIP code-level. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lender to claim deficiency judgments in the event of mortgage default. The other variables are defined in Table 1. All standard errors are robust to heteroskedasticity and clustered at the county-year level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	Denial rate for prime loans		Denial rate for subprime loans	
	(1)	(2)	(3)	(4)
Non-recourse	-0.010***	-0.014***	-0.002**	-0.003**
	(0.002)	(0.003)	(0.001)	(0.001)
GDP growth	-0.056	0.595***	-0.002	-0.002
	(0.046)	(0.058)	(0.013)	(0.030)
Pop growth	0.940***	0.120	0.076*	0.135**
	(0.142)	(0.163)	(0.041)	(0.066)
Income growth	-0.002	0.058**	0.012	0.024
	(0.021)	(0.026)	(0.007)	(0.016)
Edu high	0.141***	0.213***	0.013***	0.027***
	(0.014)	(0.016)	(0.004)	(0.009)
Age 62	0.049**	-0.032	-0.026***	-0.056***
	(0.020)	(0.023)	(0.007)	(0.014)
Married	-0.245***	-0.177***	-0.043***	-0.086***
	(0.017)	(0.019)	(0.006)	(0.011)
NonGSE ratio	-0.190***	-0.153***	0.002	0.001
	(0.007)	(0.011)	(0.002)	(0.005)
Judicial	-0.023***	-0.030***	-0.003***	-0.005***
	(0.002)	(0.002)	(0.001)	(0.001)
Year FE	Yes	Yes	Yes	Yes
Observations	100134	50070	100134	50070
Adjusted R^2	0.137	0.152	0.167	0.096

Table 12: Interaction of Non-recourse Law and GSE Loan Ratio

This table reports estimates and standard errors for regressions of housing price growth on the interaction term of non-recourse law indicators and NonGSE loan ratio for the pre-crisis period, 2004-2006. The NonGSE loan ratio is the aggregate ratio of the number of NonGSE mortgage loans to the total number of mortgage loans originated at the ZIP code-level. The Sub-prime loan ratio is the aggregate ratio of the number of Sub-prime mortgage loans to the total number of mortgage loans originated at the ZIP code-level. A state is classified as a *Non-recourse* state (*Non-recourse*=1) if the state does not allow lender to claim deficiency judgments in the event of mortgage default. The other variables are defined in Table 1. All standard errors are robust to heteroskedasticity and clustered at the county-year level. Coefficients marked ***, ** and * are significant at the 1%, 5% and 10% level, respectively.

	(1) HP growth (Zillow)	(2) 1-Bed	(3) 2-Bed	(4) 3-Bed	(5) 4-Bed
NonGSE X Non-recourse	0.089**	0.183***	0.111***	0.082**	0.086**
	(0.036)	(0.045)	(0.035)	(0.037)	(0.037)
NonGSE ratio	0.020	-0.029	0.004	0.017	0.005
	(0.017)	(0.038)	(0.022)	(0.019)	(0.020)
Non-recourse	-0.038*	-0.092***	-0.054**	-0.033	-0.034
	(0.021)	(0.029)	(0.021)	(0.022)	(0.023)
GDP growth	0.888***	1.044***	0.921***	0.810***	0.827***
	(0.092)	(0.160)	(0.099)	(0.092)	(0.100)
Pop growth	2.038***	3.475***	2.627***	2.160***	2.154***
	(0.308)	(0.451)	(0.300)	(0.321)	(0.329)
Income growth	0.235***	0.285***	0.227***	0.188***	0.171***
	(0.044)	(0.075)	(0.051)	(0.046)	(0.048)
Edu high	-0.007	0.089	0.005	0.014	0.032
	(0.029)	(0.057)	(0.034)	(0.030)	(0.031)
Age 62	0.185***	0.121	0.173***	0.170***	0.134***
	(0.050)	(0.085)	(0.061)	(0.052)	(0.049)
Married	-0.064**	-0.052	-0.048	-0.069**	-0.078***
	(0.028)	(0.043)	(0.032)	(0.029)	(0.029)
Judicial	0.013***	0.022***	0.014***	0.010***	0.010***
	(0.004)	(0.007)	(0.004)	(0.004)	(0.004)
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	34540	6500	24068	31373	26612
Adjusted R^2	0.402	0.401	0.404	0.405	0.419

APPENDICES

A Comparison with Judicial Requirement

U.S. states have different laws regarding mortgage foreclosure. One of related provisions in mortgage foreclosure laws is judicial foreclosure requirement. In judicial foreclosure states lenders are required to go through the courts for a foreclosed sale whereas in non-judicial foreclosure states lenders have the own right to sell the property when borrowers are behind schedule on mortgage payments. According to Mian et al. (2015), twenty states are classified as judicial foreclosure states. The distribution of judicial foreclosure requirement is illustrated in Panel B of Figure 3. It shows that non-recourse states are mostly located in West coast and upper Midwest while the judicial foreclosure laws are mostly enacted in East coast. Among eleven non-recourse states, three states (Iowa, North Dakota and Wisconsin) have the judicial foreclosure requirement. Ghent (2013) and Mian et al. (2015) argue that the joint distribution of the mortgage laws were not caused by a certain economic reason or state-level policy differences.

Impacts of the judicial foreclosure requirement on the supply of mortgage loans and house prices have been examined by Pence (2006) and Mian et al. (2015). Pence (2006) finds that the judicial foreclosure requirement reduces mortgage credit supply by imposing greater costs on lenders seeking foreclosures on houses. Mian et al. (2015), on the other hand, highlight that non-judicial foreclosure requirements have a significant negative impact on house prices by increasing the supply of houses through the foreclosure process. Recourse law, which is not emphasized in these studies, clearly differs from the judicial foreclosure requirement. Although the judicial requirement has an effect on the foreclosure decision of homeowners, the liability of borrowers is distinct from this judicial process. The judicial requirement does not protect borrowers from unlimited liability.

Figure 3: State-level Variation in Judicial Foreclosure Requirement

This figure illustrates the classification of judicial requirement. States shaded in dark mandate a judicial process when lenders foreclose on property. Among eleven non-recourse states, three states (Iowa, North Dakota and Wisconsin) have the judicial foreclosure requirement.