

# 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. We find that mortgage lending pricing does not fully reflect the higher risk in non-recourse state because the emergence of the originate-to-distribute (OTD) model in the housing markets enables lenders to effectively shift the risks to other investors. The amplified housing cycle has a real effect leading to a higher volatility in households' consumption over the cycle.

**Keywords:** Non-recourse mortgage law, Limited liability, Housing Speculation, State border discontinuity, Originate-to-distribute

**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 the 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.<sup>1</sup> 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 an asset substitution problem whereby borrowers increase risky investments and bid up prices.

The primary goal of this paper is to analyze whether non-recourse law affects the magnitude of boom-bust cycles in the housing market. The question is important because higher housing price cycles may contribute to housing bubbles, and the feedback effects of subsequent crises significantly affect the real sector of the economy. Particularly, households portfolio choices are largely influenced by the housing price cycle and its volatility (e.g., Flavin and Yamashita (2002), Cocco (2005), and Yao and Zhang (2005)). 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))

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<sup>1</sup>Figure 1 identifies 11 states with non-recourse mortgage law.

and required extensive economic analysis to support housing system reform in many countries.<sup>2</sup>

The present 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 differs from previous literature that associates housing market collapse with a higher likelihood of strategic mortgage default by households in non-recourse states 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 Federal Housing Finance Agency (FHFA) 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

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<sup>2</sup>“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

the various characteristics, or hedonics, of houses. To mitigate this limitation, we use square footage housing price, and conduct 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 enables us to estimate the effect of non-recourse law on housing price cycles by controlling for unobserved spatial heterogeneity. By directly comparing county-pairs in the state-border sample after including 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. Our main results are also robust to consideration of state-level variation in bankruptcy laws, lending regulation and demographic heterogeneity.

We then document speculative investment behaviors of households in non-recourse states by showing a greater effect of non-recourse law in investment purpose housing purchase and households' higher leverage decisions than in recourse states. We expect that housing speculation is stronger among households with properties that are not primary residences and thus 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 the foreclosed home and 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 is more greatly affected by non-recourse law during the pre-crisis period. We further find that debt-to-income ratio, defined as the total mortgage amount divided by annual household income, is 2-7

percentage points higher in non-recourse than in recourse law states for both prime and subprime borrowers. These results support our main argument that speculative investment encouraged by non-recourse law amplifies booms and busts 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) document that the true quality of loans in the residential mortgage-backed security (RMBS) market has frequently been misreported to investors.

We further hypothesize that nationwide Government-sponsored Enterprise (GSE) loan policy drives underpricing of non-recourse loans, further fueling speculation in non-recourse states during boom periods. A large portion of mortgage loans are purchased by GSEs and, after being securitized, sold to the secondary market. Consequent to the anti-discretionary policy across states, however, originated loans are purchased by GSEs without state-specific pricing through higher guarantee fees. Hurst et al. (2015) show that regulatory guideline in pricing loans lead to understate a certain risk in the OTD market across states, and subsidizes borrowers in states with higher costs.

Households in non-recourse states can thus borrow at relatively cheaper costs. This GSE policy can drive greater speculation in non-recourse states.

To demonstrate the channel for housing speculation, we use 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. Our finding that, in non-recourse states, ZIP codes with high subprime loan ratios experienced particularly large housing price increases during the boom period is economically and statistically significant, and robust to different numbers of bedrooms, with the effect particularly strong for smaller homes.

Further supporting the hypothesis we find that the denial rate for loan applications, for both prime and subprime loans, is significantly lower in ZIP codes in non-recourse states. These results suggest that housing booms are likely to be larger in non-recourse law states because the OTD market dissuades lenders from controlling consequent risk and screening quality of loans.

Distinguishing between GSE, Non-GSE, and bank portfolio loans for purposes of examining which types of mortgage securitization are responsible for the mispricing of non-recourse law, we find that the ratios of Non-GSE and GSE, and sum of GSE and Non-GSE (securitized) loans to total mortgage loans to be associated with higher housing price growth in non-recourse states. These results are consistent with Keys et al. (2010) finding that weaker screening origination standards are applied to loans likely to be sold in the Non-GSE secondary market. The results further suggest that, despite relatively stricter quality requirements, securitized GSE loans are also potentially likely to promote further housing speculation due to regulatory limitations, supporting the second channel.

Lastly, we examine whether amplified housing price cycle in non-recourse states engender an increase in real household consumption volatility. We find that households in non-recourse states, particularly with higher age and lower income, tend to increase

consumption of non-durable goods during the pre-crisis period consequent to relaxation of borrowing constraints and a perceived increase in wealth. Consistent with that of Mian et al. (2015), who found foreclosures instrumented by state judicial requirements to lead to a real effect, we also find that the households in non-recourse states experience a steeper decline in consumption during the recession period, supporting our hypothesis on housing speculation and increased real consumption volatility by non-recourse law.

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 (e.g., Favara and Imbs (2015), Maggio and Kermani (2015), and Mian and Sufi (2009)). 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), Pence (2006), 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) show 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) propose 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 use state laws on judicial requirements for foreclosure to investigate housing prices and trends in foreclosure.<sup>3</sup> Our paper mainly differs from these studies in emphasizing the ex-ante impact of non-recourse law on the housing boom-bust cycle and households consumption, and its interaction with mortgage lenders taking into account the growth of the mortgage securitization market.

The present 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 suggested that subprime mortgage expansion promoted the unsustainable growth responsible for the market’s collapse.<sup>4</sup> This paper extends previous research by showing how subprime mortgage expansion and the secondary mortgage (GSE and Non-GSE) securitization market, by influencing both lending and households’ investment behavior, account for variations in housing speculation across states and the impact of the mortgage crisis.

The rest of this paper is organized as follows. The definition and origins of non-recourse law are explored in Section 2. Sample data is described in Section 3. In Section 4, an empirical strategy is developed and the impact of non-recourse law on housing prices and household investment behavior examined. The impact of non-

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<sup>3</sup>According to Mian et al. (2015), twenty states are classified as judicial foreclosure states. 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. Non-recourse law, which is not emphasized in this study, 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.

<sup>4</sup>e.g., Agarwal and Ben-David (2014), Berndt and Gupta (2009), Himmelberg et al. (2005), Demyanyk and Van Hemert (2011), Jiang et al. (2014), Keys et al. (2009,?, 2012), Mian and Sufi (2009) and Purnanandam (2011)



recourse law combining with mortgage securitization market analyzed in Section 5. Section 6 presents our results on the real effects. Section 7 concludes.

## 2 Background of Non-recourse Mortgage Law

### 2.1 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.

It is widely accepted among both academics and practitioners that 11 states have non-recourse mortgage laws.<sup>5</sup> Figure 1 illustrates the distribution of recourse and non-recourse law in the United States.<sup>6</sup>

### 2.2 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)).

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<sup>5</sup>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. A comprehensive description of state foreclosure laws in the United States is provided in <http://www.foreclosurelaw.org/>.

<sup>6</sup>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)).

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 finds no clear economic or legal reasons for states' development of different procedures in the event of mortgage default. In addition, that the differences have persisted little changed since the 1930s mitigates concerns about bias in our empirical results.

## 3 Data and Summary Statistics

### 3.1 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.<sup>7</sup> 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](http://www.zillow.com)). Widely used in related literatures (e.g., Huang and Tang (2012), Guerrieri et al. (2013), 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

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<sup>7</sup>Purchase-Only Indexes, Estimated using Sales Price Data

ratio. This ratio reflects the 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 2005-2009, and calculate the growth rate.

### 3.2 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.

As HMDA data does 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 U.S. Department of Housing and Urban Development (HUD).<sup>8</sup> 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 fractions of GSE, Non-GSE and bank portfolio loans to total originated loans for each county level. HMDA data has limited loan-level information relative to LPS, but it covers a wider set of loans (across GSEs and Non-GSEs) being used in many previous literature to capture securitization (i.e., Han et al. (2015)). HMDA data includes agency and non-

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<sup>8</sup><http://www.huduser.org/portal/datasets/manu.html>

agency mortgage-backed securities, and it covers 93.3 percent of FHA loans and 81.6 percent of GSE acquisitions (Scheessele (1998)).

### 3.3 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 60, 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 and property tax rate. All variables are defined in Appendix A.

### 3.4 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 1.8% 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 -3.9% during the crisis period from 2007-2009. The standard deviation of growth rates across states is also large. During the pre-crisis period, 10 percentile states experienced 2.9% increase while 90 percentile states experienced 14.1% increase. During the crisis period, 10 and 90 percentile states experienced -10 to 1.1% price growth. The average nominal GDP growth rate is 4.0%, the population growth is 1.0%, and the income growth rate is 2.5%, on average, during our sample period. The average fraction of Subprime loan and Non-GSE loan are 17.3% and 39.1%, respectively.

## 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 Comparison between Non-recourse and Recourse States

Our first set of tests investigates whether non-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.<sup>9</sup> 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 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 during a housing market boom, and drop more steeply during a housing market re-

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<sup>9</sup>The housing price growth rate declined sharply in 2006 but remained positive, which indicates that housing prices peaked in 2006. Following the literature, we define 2004-2006 as the pre-crisis period or the boom period for the housing cycle, and 2007-2009 as the recession period (e.g., Gao et al. (2016)).

cession. 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% higher annual growth rates, respectively. Consistent with our hypothesis, the fraction of investment purpose transactions and debt-to-income ratio are also significantly higher in non-recourse states. 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 4.9% annually in recourse, and 8.3% in non-recourse states. It should be noted that control variables for economic conditions are not significantly different between non-recourse states and recourse states. This implies that samples are relatively similar except the difference in non-recourse mortgage law.

## 4.2 Regression Analysis

Multiple complementary approaches are employed to identify a causal relation between non-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,

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

where the dependent variable,  $\Delta \ln(P_{it})$ , is the growth rate of housing price per square foot in ZIP code  $i$  at time  $t$  from 2004-2009,  $\text{Recession}_t$  is a dummy variable equal to zero before and including 2006 and one after that year,  $\text{Non-recourse}_i$  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.

In this specification, the main coefficient of interest is the coefficient on non-recourse dummy,  $\beta_1$ , 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,  $\beta_2$ , 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  $\beta_1$  and negative sign on  $\beta_2$ .

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 such as age (proportion of the population aged 60 or above), female population ratio, 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 (e.g., 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. Lastly, we include year fixed effects,  $\theta_t$  to capture the national wide changes in housing market condition for each year. The standard errors are clustered county-year

level.

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 3.1% annually, in non-recourse than in recourse states during the pre-crisis period. The effect accounts for approximately 40.3% of the unconditional housing price growth rate (7.7%) in 2004-06. 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 5.6%, 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 percentage points 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 60 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 suggests 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 at the county-level. 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 4.5 and 4.3 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 set 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.<sup>10</sup> 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 growth (FHFA)) is larger in non-recourse states during the pre-crisis period by 2.8%, while the price index declines more sharply during the crisis by 6.0%. The coefficients are statistically significant at 1% level.

Our housing data has another limitation since we cannot control for the various property attributes, or hedonics, of houses. Our median-price measure for square-footage assumes 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 Model (4)-(7), 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.

There is another potential concern that some of the control variables are endogenously determined with housing price  $P_{it}$ . Housing price cycle may also lead credit and business cycles over the long term (Tamirisa et al. (2009)). In the unreported results, we address this possibility by performing the regression with lagged variables for time-varying controls like GDP, income, and population growth. We run the regression using the lagged variables for state-level time-varying controls. The results imply that

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<sup>10</sup>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/>)

our main results are robust to the endogeneity problem between housing price growth and the control variables.

### 4.3 State-Border Test

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.<sup>11</sup>

This concern can be mitigated because we observe no systematic difference in economic 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 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 non-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

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<sup>11</sup>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.

variation over time. We run the following regression,

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

where  $\Delta \ln(P_{it})$  is the average growth rate of housing price in ZIP code  $i$  at time  $t$  from 2004-2009 and  $\text{Non-recourse}_i$  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  $\phi_i$  to capture the variation between contiguous counties along a state border. Standard errors are heteroskedasty consistent and clustered at the county-year level. The coefficient on  $\text{Non-recourse}$  captures a sharp discontinuous change in housing price when a border is crossed into a recourse state.

In Table 4, we present results for the contiguous state border county-pair sample with the county-pair fixed effect. The coefficients on the  $\text{Non-recourse}$  dummy variable is consistent with the previous result. The economic magnitude of the estimate on  $\text{Non-recourse}$  dummy variable is 6-14% depending on the number of rooms. The results indicate that during the boom period, housing prices increase more in non-recourse than in recourse states, especially at state borders. We find negative and significant coefficients on the interaction term  $\text{Non-recourse} * \text{Recession}$  in these models as well.

## 4.4 Robustness Tests

We report here the results of robustness tests performed to address concerns that unobserved heterogeneity could drive our main results.

We consider, in particular, state-level variations in personal bankruptcy law and lending regulation that are potentially correlated with the non-recourse/recourse difference. Variations in bankruptcy homestead state laws that protect home equity from creditors up to a state-specified exemption amount in case of personal bankruptcy, for example, affect households' incentive to default (Dobbie and Goldsmith-Pinkham (2014)), and also to speculate during boom periods. We examine whether the effects

of non-recourse law are robust to consideration of the homestead exemption amount. We also control for state foreclosure timelines for completing uncontested foreclosures, and check whether our results are affected by state-level anti predatory lending laws. In 1994, the US Congress passed the Home Ownership and Equity Protection Act (HOEPA) to regulate interest rates for high-cost loans. We use the state index for HOEPA laws from Bostic et al. (2008), which capture the extent of the anti predatory lending laws coverage, restrictions, and enforcement. Table 5 shows that our main results are robust to inclusion of these state-level variations.

We also control for county-level housing supply elasticity from Glaeser et al. (2008), and the Herfindahl Hirschman Index for bank competition based on state-level total deposits to capture ex-ante differences in credit supply. The re-estimation results reported in Table 5 are similar to those reported in Table 3.

We address the concern that the effect of non-recourse mortgage provisions on housing speculation might vary with states understanding of the differences between recourse and non-recourse mortgage law by controlling for state-level financial literacy using indicators based on Lusardi and Mitchell (2014) and National Financial Capability Study data. Model (6) in Table 5 shows that our results are robust to controlling for state-level financial literacy.

We address a potential concern that some states may experience a higher influx of foreign investors (e.g., Vancouver experiences rapid housing price growth due to Chinese investors) and subsequent housing price increases by controlling for state-level variation in the influence of immigrants. Model (7) in Table 5 shows that the effect of non-recourse law on housing price growth is unchanged after controlling for the growth of immigrants in each state.<sup>12</sup>

Lastly, Models (8)-(9) in Table 5 show that the effect of non-recourse law on housing price growth remains consistent after controlling for states political characteristics (i.e., red states versus blue states) and industry composition.

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<sup>12</sup>In the unreported results, we also include the total number of immigrants in 2000 and proportion of Asian immigrants in 2004. Our main results remain unchanged.

## 4.5 Investment Purpose Housing Speculation

In this section, we present as evidence of speculative investment behavior of households in non-recourse states a greater effect of non-recourse law in investment purpose housing purchases. Housing plays a dual role as investment and residence. More critically considered for residential purpose housing purchases are such non-monetary factors as job location and neighborhood, and in the event of mortgage default, households may experience higher utility loss from the foreclosure and attendant necessity to move.

Those purchasing second homes or housing exclusively for investment purposes tend to take into account mainly financial gain, and may benefit from limited liability in non-recourse states. Such investors have a greater incentive to speculate in the housing market during boom times, being able to simply walk away in the event of default. Consistent with our hypothesis, a recent work by Gao et al. (2016) uses the fraction of non-owner-occupied home purchases as a measure of housing speculation. We conjecture that ZIP codes with a higher fraction of investment purpose housing transactions are likely to exhibit a greater effect of non-recourse law.

We test this hypothesis by first estimating the proportion of investment purpose (non-owner-occupied) relative to residential purpose transactions 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.

$$\begin{aligned} \Delta \ln(P_{it}) = & \beta_0 + \beta_1 \text{Non-recourse}_i * \text{High Invest}_{it} + \beta_2 \text{High Invest}_{it} \\ & + \beta_3 \text{Non-recourse}_i + \beta' X_{it} + \varepsilon_{it} \end{aligned}$$

where  $\text{High Invest}_{it}$  is the dummy that equals one if the proportion of housing investors in ZIP code  $i$  is greater than the sample median, zero otherwise, and  $\text{Non-recourse}_i$  an indicator for whether ZIP code  $i$  is located in a non-recourse state.

Table 6 reports the results of this regression. The coefficient  $\beta_1$  is positive and

statistically significant, implying that the effect of non-recourse law on house price is stronger if investment purpose transactions are more numerous than residential purpose transactions. The effect is particularly significant for houses with two and three bedrooms. The results suggest that the effect of non-recourse law on house price appreciation is amplified in areas with a higher proportion of housing investors than homeowners since housing investors have more chance to exploit the benefits 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 non-recourse law on household debt-to-income decisions. The housing price pattern in non-recourse states is likely to reflect household speculative behavior. Borrower’s limited 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 defined as the total mortgage amount divided by annual income at origination date.<sup>13</sup> 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,

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

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  $Non-recourse_i$  an indicator for whether ZIP code  $i$  is located in a non-recourse state.

We also include the year fixed effect  $\theta_t$ . Standard errors are robust to heteroskedasticity

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<sup>13</sup>A debt-to-income ratio is generally referred to as the ratio of borrower’s monthly loan payment to monthly gross income. Due to the data limitation, the variable we use in this paper is the annual ratio.

and clustered at the county-year level. In this specification, the coefficient  $\beta_1$  on the non-recourse indicator shows whether households' debt-to-income ratio is higher in non-recourse states.

Table 7 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 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%-5% level. The coefficient estimate of 0.063 in Model (1) indicates that households in non-recourse states borrow around 3 percentage points ( $0.063/2.117=0.030$ ) more debt on average given the same income. The highly-levered investment behavior is more significantly observed in prime loan. The coefficient estimate in Model (3) is 0.091, indicating that households in non-recourse states borrow 4.3 percentage points ( $0.091/2.117=0.043$ ) 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' speculative incentive is well predicted, mortgage lenders may try to 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 shift-

ing risk and bidding up prices above fundamental values. However, Ghent and Kudlyak (2011) document that the difference of interest rate between non-recourse and recourse states is insignificant. 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 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)).<sup>14</sup> It is likely that the multiple stages of securitization in a complex structure of financial derivatives effectively conceal the origins of loans. Furthermore, Piskorski et al. (2013) find that the true quality of loans in the residential mortgage-backed security (RMBS) market has frequently been misrepresented to investors. They show that for one 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

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<sup>14</sup>Rapid expansion of this market was accompanied by relaxation of the regulation of mortgage lending.



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,

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

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  $\text{Non-recourse}_i$  and  $\text{Subprime}_{it}$  is the main variables of interest. Our hypothesis predicts a positive coefficient, or  $\beta_1 > 0$ .

Table 8 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.<sup>15</sup> 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 in the most of models.

The economic magnitude of this effect can be interpreted as housing price growth 1 to 2.9 percentage points higher with a one standard deviation increase in the subprime

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<sup>15</sup>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.

loan ratio.<sup>16</sup> The effect accounts for approximately 13.0-37.7% of the unconditional housing price growth rate (7.7%) in 2004-06.

The interaction effect between non-recourse law and subprime ratio is larger for 1-bedroom and 2-bedroom homes. 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.

In Table 8, we also report estimation results for interactions between the fraction of Non-GSE mortgage and non-recourse law and the fraction of total securitized loans, sum of both GSE and Non-GSE, and non-recourse law. Our results are consistent with Keys et al. (2010) finding that weaker screening origination standards are applied to loans likely to be sold in the Non-GSE secondary market. In Model (6), the positive and significant coefficient on the interaction term between Non-GSE ratio and non-recourse law confirms the findings on the subprime channel, and further shows that the fraction of securitized loans in Model (7) also increases the housing price growth rate in non-recourse states.

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 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

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<sup>16</sup>The standard deviation of the ZIP code-level sub-prime loan ratio is 0.185 for the pre-crisis period. The economic magnitude is calculated as  $0.185 \times 0.159 = 0.029$  in Model (2).

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,

$$Denial Rate_{it} = \beta_0 + \beta_1 Non-recourse_i + \beta' X_{it} + \phi_i + \varepsilon_{it},$$

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

We test denial rates for prime loans and subprime loans separately, to control for basic loan quality.<sup>17</sup> We also test both total sample period and pre-crisis period. In Table 9 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 0.7% lower than in recourse states. The effect accounts for approximately 4.3% of the unconditional probability of loan denial (16.3%) for the prime loan in 2004-09. The effect is larger during the pre-crisis period, 2004-2006. The results remain significant for subprime loans.

## 5.2 Non-recourse Mortgage Law and GSE Anti-discretionary Policy

We next examine whether lenders in non-recourse states underprice mortgage loans because of cross-state anti-discretionary policy. The securitization market differs sharply between GSEs and Non-GSEs.<sup>18</sup> We calculate GSE, Non-GSE and portfolio loan ratios for each county using HMDA data. GSEs like Fannie Mae and Freddie Mac, which purchase, securitize, and sell to the secondary market a large portion of mortgage loans, offer guarantees that limit the risk of capital losses, enabling mortgage

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<sup>17</sup>We acknowledge some limitations in our analysis of denial rate. First, while the denial rate in HMDA is an outcome variable reflecting both credit supply and households mortgage demand, it is challenging to distinguish which mechanism actually drives the result. Second, our analysis is not conditioning households credit risk variables such as LTV and FICO score. To mitigate this concern, we analyze denial rates for prime and subprime loan separately.

<sup>18</sup>Agarwal et al. (2012) analyze securitization strategy of lenders before and after the crisis using multiple loan-level data sets.

originators to increase loan volumes. Fannie Mae and Freddie Mac charge upfront and ongoing guarantee fees based on risk attributes of borrowers or loan type (such as LTV/credit-score grid, cash-out refinance, investor properties, secondary financing at origination, and jumbo conforming loan). Most lenders convert GSE guarantee fees into the interest rate on the mortgage, paid by borrowers over time.<sup>19</sup>

Because political influence prevents GSEs from pricing state-level variation in risk, mortgage rates for GSE loans do not differ significantly despite substantial differences in household bankruptcy provisions, foreclosure laws, and home exemptions across states (Hurst et al. (2015)).<sup>20</sup> The potential channel is thus that nationwide GSE loan policy that subsidizes borrowers in non-recourse states can drive taxpayer covered underpricing of non-recourse loans and engender further housing speculation during boom periods. This hypothesis predicts that a higher ratio of GSE loans can lead to state-level underpricing of non-recourse mortgage loans and increased housing speculation. We estimate the differential effects of GSE and Non-GSE loans by examining the interaction effects between types of securitization and non-recourse law.

Table 10 reports estimation results for interactions between types of securitization (Non-GSE and GSE) and non-recourse law. Including both interaction terms between the fractions of Non-GSE and GSE mortgages and non-recourse law, we find the interactions between GSE loan ratio and non-recourse law indicator, and Non-GSE loan ratio and non-recourse indicator, to exhibit positive and significant coefficients on the housing price growth rate. The interaction effects between the fraction of GSE mortgage and non-recourse law on housing price growth remain consistent with the different number of bedrooms. The results suggest that, despite relatively stricter loan quality requirements, securitized GSE loans are also likely to spur further housing speculation, likely due to regulatory limitations, supporting our second hypothesis.

In the aggregate, our results demonstrate an underlying mechanism in recent hous-

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<sup>19</sup>FHFA is directing GSEs to increase upfront fees by 25 basis points for loans for which the LTV ratio is greater than 80 percent or the credit score below 700.

<sup>20</sup>FHFA proposed in 2012 to impose an upfront fee on newly acquired single-family mortgages originated in states with laws likely to occasion for GSEs default-related losses much higher than the national average.

ing 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 greater risk shifting by lenders in non-recourse than in recourse states.

## 6 Non-recourse Mortgage Law and Households Consumption

Lastly, we examine the real effects of housing price change. Increases in housing price can relax households borrowing constraints and increase perceived wealth. How households increase consumption in response to housing price increases has been studied in the previous literature (i.e., Campbell and Cocco (2007)).

Because housing accounts for the largest portion of most homeowners total wealth, variation in housing value affects household consumption through either the wealth effect or borrowing constraint channel. During the most recent housing market boom and bust, households experienced a large fluctuation in housing value, which may have significantly influenced household consumption. Based on evidence provided above that housing prices in non-recourse states increased more rapidly during the housing market boom, we conjecture that the consumption growth rate was higher in non-recourse than in recourse states during this period. Furthermore, we expect that the consumption will decline more steeply during the subsequent crisis period.

Particularly, we expect the real effects to be stronger for households with higher age and lower income (Campbell and Cocco (2007)). Home ownership rate is increasing in age, and home equity shares of the elderly tend to be high, as they pay off a large proportion of their mortgages. The high home ownership rate and low loan-to-value ratio among the elderly predict a stronger relationship between non-recourse law and consumption growth in this group. For the low-income group, the housing asset may play an important role as collateral. An increase in housing price, by relaxing the borrowing constraint, can afford the low-income group an additional channel for

increasing consumption. Housing price increases can thus have a significant effect on consumption growth among the low-income group, and a relatively weaker effect in the high-income group, which already has another channel for borrowing.

We examine here, using state-level per capita consumption growth data provided by the Bureau of Economic Analysis, whether the difference in housing price growth is reflected in differences in the consumption growth rate between recourse and non-recourse states between 2004 and 2006. Following the existing empirical literature, we focus on non-durable consumption.<sup>21</sup>

Table 11 examines the effect of recourse law on consumption growth rates using a regression model. We regress state-level per capita consumption growth rates on non-recourse law indicator after controlling for state-level aggregate control variables including GDP and population growth rates. Although consumption growth rates exhibit no significant differences in the pooled sample, we find that consumption growth rates among the high age (Model (2)) and low-income (Model (5)) groups are substantially higher in non-recourse than in recourse states. In Models (2) and (5), non-durable consumptions in non-recourse states increase more by around 1 percentage point during boom period, and decrease more by 1.8 and 2.3 percentage points, respectively, during the crisis period.

## 7 Conclusion

In this paper, we investigate the role of state-level variation in non-recourse mortgage 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. Although the recent boom and bust in the US is characterized by unprecedented national-wide increase and decline, our results suggest that cross-sectional differences across states address a significant portion of housing price cycle and contribute our

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<sup>21</sup>Durable goods are not for immediate consumption and able to be used for several periods of time. Therefore, most of the consumption literature focus on non-durable consumption because it is difficult to translate durable goods expenditure into consumption.

understanding of housing markets in this period.

The effects are economically large and robust to property attributes, and state-level variations in economic and demographic conditions. Our evidence supports the asset substitution problem in housing market and households' speculative investment behaviors in non-recourse states. The combined effects of non-recourse law and securitization intensity on the housing speculation suggest that the OTD market constitutes a disincentive to lenders to control and properly price for that risk, by enabling them to effectively shift it to other investors.

The boom and bust 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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# APPENDICES

## A Variable Definitions

- *Non-recourse* is a dummy variable that equals one if the state does not allow lenders to claim deficiency judgments in the event of mortgage default, zero otherwise.
- *Recession* is a dummy variable that equals zero for 2004-2006 and one for 2007-2009.
- *HP growth (Zillow) in 2004-09* 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/after* is the ZIP-code level annual housing growth rate for 2004-2006, and for 2007-2009, respectively.
- *HPI growth (FHFA) in 2004-09* is the annual growth rate of the housing price index at the MSA-level from FHFA data.
- *Price/rent growth ratein2006 – 09* 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 2006-2009.
- *HP growth 1-bed, 2-bed, 3-bed, and 4-bed in 2004-09* are the annual growth rate of the ZIP code-level square footage housing price of home with a specific number of bedrooms from Zillow database.
- *DTI in 2004-09* is defined as the total mortgage amount divided by borrower's annual income at origination date for 2004-2009 at the ZIP-code level.
- *GDP growth in 2004-09* is the annual growth rate of nominal GDP at the county-level.
- *Income growth in 2004-09* is the growth rate of per capita income at the county-level.
- *Pop growth in 2004-09* is the annual population growth at the county-level.
- *Edu high in 2000* is the proportion of population with college education at the county-level in 2000.
- *Age over 60 in 2005-06* is the average proportion of population with age greater than 60 at the county-level for 2005-2006.
- *Female Ratio* is the proportion of female population at the county-level.
- *Married in 2000* is the proportion of population with married status at the county-level in 2000.
- *High Invest in 2004-06* is the dummy that is one if the proportion of investment purpose transactions at the county-level, non-owner-occupied home purchase, is greater than the sample median, and zero otherwise.
- *Subprime ratio in 2004-06* 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.
- *Fraction of GSE mortgage in 2004-06* is the aggregate ratio of the number of Government-sponsored enterprises (GSE) mortgage loans to the total number of mortgage loans originated at the county-level for 2004-2006.

- *Fraction of Non-GSE mortgage in 2004-06* is the aggregate ratio of the number of non-GSE mortgage loans to the total number of mortgage loans originated at the county-level for 2004-2006.
- *Fraction securitized mortgages in 2004-06* is the aggregate ratio of the sum of number of GSE and non-GSE mortgage loans to the total number of mortgage loans originated at the county-level for 2004-2006.
- *Fraction portfolio mortgages in 2004-06* is the aggregate ratio of the number of loans in bank portfolio to the total number of mortgage loans originated at the county-level for 2004-2006.
- *Denial rate (prime loan) in 2004-09* is the ZIP code-level average denial rate of prime loan for 2004-2009.
- *Denial rate (subprime loan) in 2004-09* is the ZIP code-level average denial rate of subprime loan for 2004-2009.
- *Judicial* is the dummy variable that is one if the lenders in the state are required to go through the courts for a foreclosed sale.
- *Property tax in 2004-09* is the state-level property tax.
- *Homestead exemption in 2007* is the state-specified households' home equity exemption amount in case of personal bankruptcy by homestead state laws in 2007.
- *Foreclosure timeline* is the state-level foreclosure time lines to complete an uncontested foreclosure.
- *HOEPA index in 2004-05* is the state-level index for anti-predatory lending laws (Home Ownership and Equity Protection Act) during 2004-2005.
- *Housing supply in 2004-09* is the MSA-level housing supply elasticity.
- *HHI Bank in 2004-09* is the state-level Herfindahl Hirschman Index for banking competition based on total deposit for 2004-2009.
- *Financial Literacy in 2009* is the state-level financial literacy index related to compound interest, inflation, and stock risk.
- *Immigrant increase in 2000-14* is the growth rate of immigrant between 2000 and 2014.
- *Red states in 2004* is a dummy variable that equals one if the state predominantly vote for the Republican Party in 2004.
- *Industry composition in 2005-07* is the average GDP share of manufacturing sector in each state during 2005-2007.
- *Non-durable goods consumption in 2004-09* is per capita personal consumption expenditures for non-durable goods by state from Bureau of economic analysis.

Figure 1: State-level Variation in Non-recourse Mortgage 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.

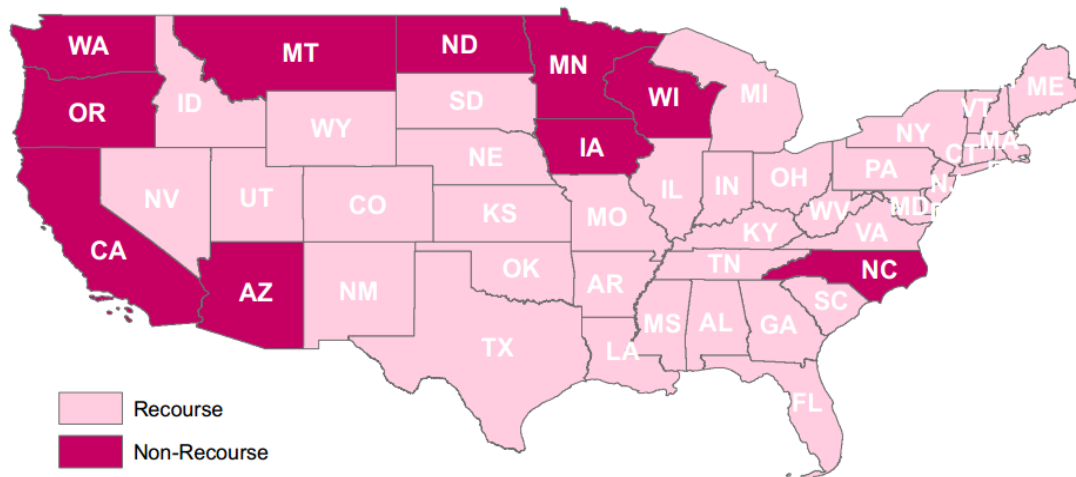


Figure 2: Non-recourse Law and Housing Price Growth Rate

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.

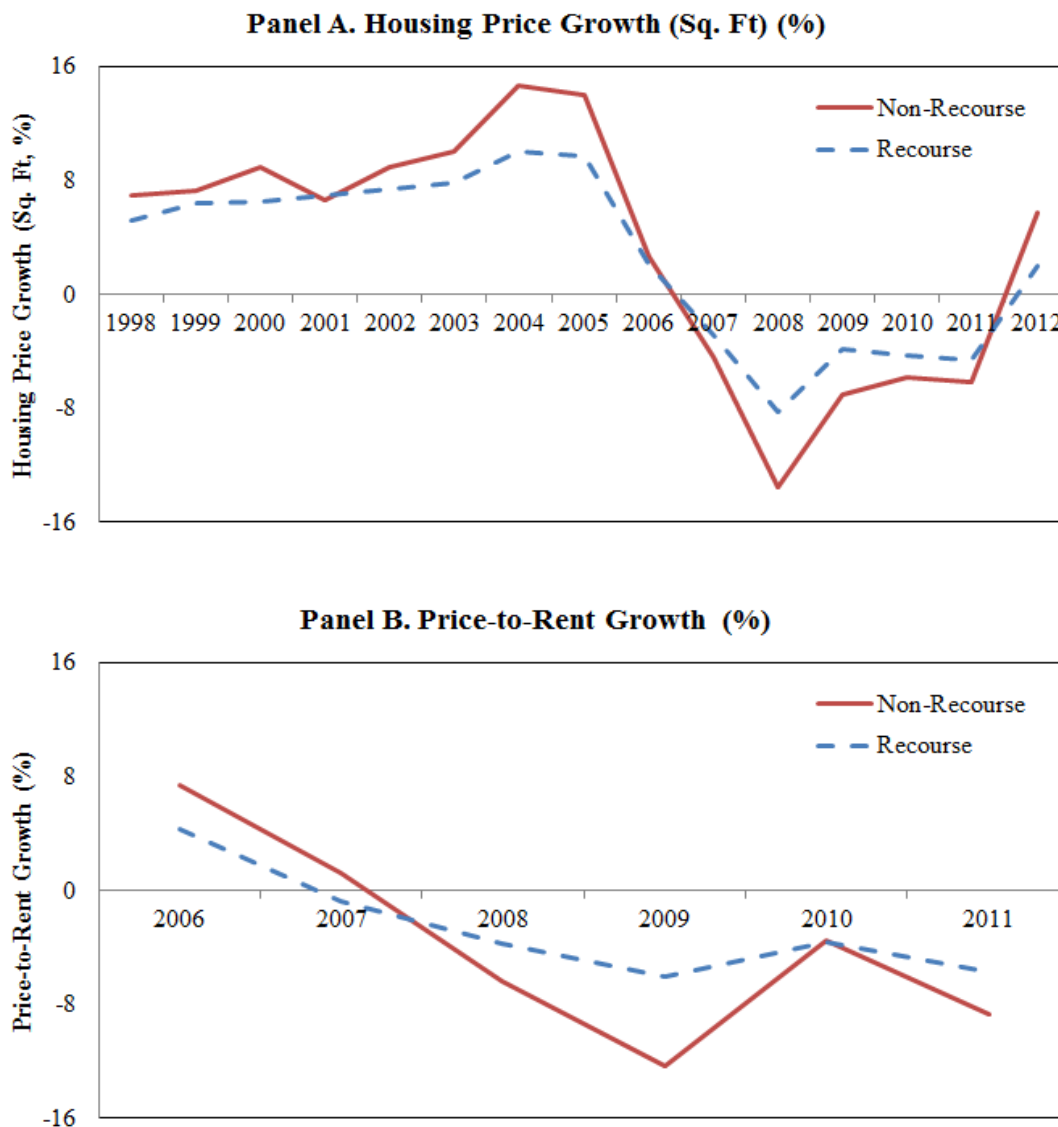


Table 1: Summary Statistics

This table presents summary statistics for the main variables used in the analysis for the period 2004-2009. The variables are defined in Appendix A.

	Mean	SD	10th	Median	90th	count
Non-recourse	0.220	0.418	0.000	0.000	1.000	50
HP growth (Zillow) in 2004-09	0.018	0.023	-0.011	0.020	0.047	50
HP growth (Zillow) in 2004-06	0.077	0.045	0.029	0.067	0.141	50
HP growth (Zillow) in 2007-09	-0.039	0.050	-0.097	-0.036	0.011	50
Price/Rent growth in 2006-09	-0.012	0.032	-0.044	-0.007	0.020	41
HPI growth (FHFA) in 2004-09	0.042	0.019	0.019	0.043	0.070	49
HP growth 1Bed in 2004-09	0.011	0.030	-0.032	0.018	0.045	43
HP growth 2Bed in 2004-09	0.015	0.027	-0.016	0.018	0.041	49
HP growth 3Bed in 2004-09	0.015	0.023	-0.011	0.019	0.041	50
HP growth 4Bed in 2004-09	0.018	0.023	-0.008	0.020	0.045	49
Investment purpose in 2004-09	0.099	0.029	0.066	0.093	0.132	50
DTI in 2004-09	2.117	0.134	1.976	2.114	2.280	50
DTI prime loan in 2004-09	1.345	0.244	1.041	1.374	1.664	50
Subprime ratio in 2004-08	0.173	0.035	0.130	0.167	0.221	50
Subprime ratio in 2004-06	0.185	0.031	0.149	0.182	0.223	50
Denial rate (prime loan) in 2004-09	0.163	0.036	0.122	0.158	0.218	50
Denial rate (subprime loan) in 2004-09	0.015	0.005	0.009	0.015	0.022	50
Fraction of GSE mortgages in 2004-08	0.256	0.032	0.218	0.254	0.307	50
Fraction of NonGSE mortgages in 2004-08	0.391	0.068	0.305	0.387	0.477	50
Fraction of securitized mortgages in 2004-08	0.647	0.074	0.568	0.644	0.747	50
Fraction of portfolio mortgages in 2004-08	0.353	0.074	0.253	0.356	0.432	50
GDP growth in 2004-09	0.040	0.013	0.028	0.040	0.055	50
Pop growth in 2004-09	0.010	0.007	0.002	0.008	0.019	50
Income growth in 2004-09	0.025	0.009	0.015	0.024	0.035	50
Edu high in 2000	0.302	0.044	0.245	0.298	0.358	50
Age over 60 in 2005-06	0.163	0.022	0.135	0.163	0.186	50
Female ratio in 2005-06	0.509	0.007	0.500	0.510	0.516	50
Married in 2000	0.554	0.042	0.524	0.559	0.584	50
Judicial	0.440	0.501	0.000	0.000	1.000	50
Property tax in 2004-09	1.436	0.502	0.775	1.400	2.135	50
HOEPA index in 2004-05	6.120	4.131	0.000	6.140	11.165	50
Homestead exemption in 2007	10.940	2.124	9.210	10.820	13.816	49
Foreclosure timeline	4.976	0.598	4.045	5.049	5.699	50
Housing supply in 2004-09	2.300	0.917	1.358	2.144	3.500	46
HHI Bank in 2004-09	0.157	0.148	0.025	0.108	0.389	50
Financial Literacy in 2009	0.658	0.026	0.620	0.656	0.693	50
Immigrant increase in 2000-14	0.545	0.250	0.185	0.518	0.936	50
Red states in 2004	0.600	0.495	0.000	1.000	1.000	50
Industry composition in 2005-07	0.126	0.059	0.054	0.118	0.199	50
Non-durable goods consumption in 2004-2009	0.034	0.008	0.024	0.033	0.044	50



Table 2: Comparison between Non-recourse and Recourse States

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. The variables are defined in Appendix A. 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 (Zillow)	0.105	0.093	0.100	0.073	0.058	0.083	0.032***
Price/Rent growth in 2006	0.077	0.068	0.091	0.041	0.039	0.074	0.036**
HPI growth (FHFA)	0.087	0.077	0.054	0.070	0.054	0.045	0.018***
HP growth 1-Bed	0.102	0.101	0.107	0.072	0.054	0.112	0.030***
HP growth 2-Bed	0.100	0.091	0.104	0.070	0.054	0.094	0.030***
HP growth 3-Bed	0.100	0.090	0.103	0.069	0.055	0.085	0.031***
HP growth 4-Bed	0.100	0.090	0.099	0.069	0.055	0.083	0.031***
Investment purpose	0.108	0.083	0.085	0.093	0.067	0.081	0.015***
DTI	2.045	2.069	0.580	2.026	2.043	0.398	0.019***
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
<hr/>							
Panel B. Recession (2007-2009)							
HP growth (Zillow)	-0.083	-0.061	0.104	-0.049	-0.037	0.081	-0.034***
Price/Rent growth	-0.031	-0.018	0.060	-0.026	-0.024	0.039	-0.005
HPI growth (FHFA)	-0.011	0.007	0.062	0.006	0.013	0.034	-0.018***
HP growth 1-Bed	-0.089	-0.075	0.110	-0.072	-0.050	0.109	-0.017***
HP growth 2-Bed	-0.088	-0.069	0.108	-0.061	-0.044	0.093	-0.027***
HP growth 3-Bed	-0.085	-0.063	0.104	-0.052	-0.039	0.080	-0.034***
HP growth 4-Bed	-0.083	-0.064	0.098	-0.050	-0.039	0.075	-0.033***
Investment purpose	0.111	0.083	0.094	0.090	0.064	0.085	0.021***
DTI	2.259	2.274	0.687	2.225	2.226	0.795	0.034***
GDP growth	0.024	0.024	0.018	0.016	0.017	0.013	0.007
Pop growth	0.011	0.011	0.005	0.009	0.008	0.007	0.002
Income growth	0.016	0.013	0.009	0.015	0.016	0.010	0.001

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 ZIP-code level 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 at the MSA-level. The dependent variables in Models (4)-(7) are the ZIP-code level annual growth rate of housing price (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. The variables are defined in Appendix A. 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) in 2004-09	(2) Price/Rent growth in 2006-09	(3) HPI growth (FHFA) in 2004-09	(4) 1-Bed in 2004-09	(5) 2-Bed in 2004-09	(6) 3-Bed in 2004-09	(7) 4-Bed in 2004-09
Non-recourse	0.031*** (0.006)	0.045*** (0.017)	0.028*** (0.004)	0.028*** (0.009)	0.031*** (0.007)	0.033*** (0.006)	0.034*** (0.006)
Non-recourse X Recession	-0.056*** (0.009)	-0.043* (0.022)	-0.060*** (0.007)	-0.038*** (0.011)	-0.049*** (0.009)	-0.058*** (0.009)	-0.058*** (0.008)
GDP growth in 2004-09	1.027*** (0.090)	0.713*** (0.219)	0.714*** (0.075)	1.560*** (0.154)	1.242*** (0.100)	0.984*** (0.085)	0.947*** (0.086)
Pop growth in 2004-09	1.691*** (0.264)	1.236*** (0.445)	1.025*** (0.218)	2.248*** (0.422)	2.009*** (0.280)	1.708*** (0.264)	1.631*** (0.265)
Income growth in 2004-09	0.307*** (0.038)	0.088 (0.078)	0.438*** (0.052)	0.500*** (0.067)	0.329*** (0.043)	0.267*** (0.038)	0.240*** (0.038)
Edu high in 2000	0.151*** (0.025)	0.231*** (0.049)	0.113*** (0.031)	0.168*** (0.047)	0.174*** (0.030)	0.152*** (0.025)	0.123*** (0.025)
Age over 60 in 2005-06	-0.120** (0.048)	-0.084 (0.132)	0.050 (0.057)	-0.202*** (0.078)	-0.171*** (0.055)	-0.121** (0.048)	-0.101** (0.044)
Female Ratio in 2005-06	0.823*** (0.195)	1.886*** (0.579)	-0.071 (0.162)	1.302*** (0.318)	0.961*** (0.215)	0.861*** (0.200)	0.853*** (0.209)
Married in 2000	-0.012 (0.026)	0.003 (0.068)	-0.100** (0.042)	0.009 (0.036)	-0.004 (0.029)	-0.012 (0.026)	-0.018 (0.026)
Judicial	0.008** (0.003)	0.008 (0.006)	0.003 (0.003)	-0.000 (0.006)	0.008* (0.004)	0.007** (0.003)	0.008** (0.003)
Property Tax	0.004 (0.004)	0.030*** (0.008)	-0.003 (0.003)	0.023*** (0.006)	0.011** (0.005)	0.005 (0.004)	0.005 (0.004)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	60942	14224	1986	12645	44493	56559	49402
Adjusted $R^2$	0.587	0.416	0.522	0.548	0.560	0.574	0.589

Table 4: 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 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 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. *Recession* is a dummy variable that equals zero before and including 2006, and one after that year. The variables are defined in Appendix A. 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) in 2004-09	(2) 1-Bed in 2004-09	(3) 2-Bed in 2004-09	(4) 3-Bed in 2004-09	(5) 4-Bed in 2004-09
Non-recourse	0.067*** (0.025)	0.147** (0.058)	0.062** (0.025)	0.065** (0.026)	0.063** (0.026)
Non-recourse X Recession	-0.049** (0.020)	-0.058** (0.023)	-0.039** (0.018)	-0.047** (0.019)	-0.049** (0.019)
GDP growth in 2004-09	0.972*** (0.177)	0.944*** (0.208)	0.965*** (0.151)	0.900*** (0.166)	0.906*** (0.159)
Pop growth in 2004-09	4.832*** (1.172)	7.618*** (1.130)	5.545*** (0.887)	4.760*** (1.146)	4.792*** (1.001)
Income growth in 2004-09	0.178*** (0.068)	0.331*** (0.106)	0.165** (0.067)	0.144** (0.065)	0.121* (0.065)
Edu high in 2000	0.019 (0.104)	-0.689* (0.374)	-0.107 (0.123)	0.019 (0.104)	0.004 (0.102)
Age over 60 in 2005-06	-0.183 (0.216)	-1.168* (0.611)	-0.231 (0.248)	-0.122 (0.209)	-0.017 (0.208)
Female Ratio in 2005-06	1.828* (1.016)	5.464 (3.882)	2.554** (1.226)	1.326 (0.922)	1.520 (0.942)
Married in 2000	0.207** (0.105)	-0.047 (0.188)	0.220** (0.108)	0.168 (0.103)	0.136 (0.103)
Judicial	0.014* (0.008)	-0.023 (0.018)	0.009 (0.008)	0.015* (0.008)	0.014* (0.008)
Property Tax	0.010 (0.009)	0.005 (0.024)	0.015 (0.010)	0.000 (0.008)	0.011 (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	16417	3897	13115	16215	14410
Adjusted $R^2$	0.676	0.564	0.618	0.648	0.649

Table 5: 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 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. *Homestead exemption* is the state-specified households' home equity exemption amount in case of personal bankruptcy by homestead state laws. *Foreclosure timeline* is the state-level foreclosure time lines to complete an uncontested foreclosure. *HOEPA index* is the state-level index for anti-predatory lending laws during 2004-2005 from Bostic et al. (2008). *Housing supply* is the MSA-level housing supply elasticity provided by Glaeser et al. (2008). *HHI Bank* is the state-level Herfindahl Hirschman Index for banking competition based on total deposit. *Financial Literacy* is the state-level average financial literacy index related to compound interest, inflation, and stock risk. *Immigrant increase* is the growth rate of immigrant between 2000 and 2014. *Red states* is a dummy variable that equals one if the state predominantly vote for the Republican Party in 2004. *Industry composition* is the average GDP share of manufacturing sector in each state during 2005-2007. Other economic- and demographic controls are unreported due to the limited space. 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.

	HP growth (Zillow) in 2004-09								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Non-recourse	0.032*** (0.006)	0.027*** (0.007)	0.031*** (0.006)	0.035*** (0.009)	0.031*** (0.006)	0.032*** (0.007)	0.030*** (0.006)	0.020*** (0.006)	0.026*** (0.007)
Non-recourse X Recession	-0.057*** (0.009)	-0.057*** (0.009)	-0.057*** (0.009)	-0.066*** (0.011)	-0.057*** (0.009)	-0.056*** (0.009)	-0.057*** (0.009)	-0.058*** (0.009)	-0.056*** (0.009)
Homestead exemption in 2007	-0.003*** (0.001)								
Foreclosure timeline		0.014*** (0.002)							
HOEPA index in 2004-05			-0.000 (0.000)						
Housing supply in 2004-09				0.002 (0.002)					
HHI Bank in 2004-2009					-0.020 (0.018)				
Financial Literacy in 2009						-0.097* (0.056)			
Immigrant increase in 2000-14							-0.012 (0.008)		
Red states in 2004								-0.032*** (0.004)	
Industry composition in 2005-07									0.112*** (0.035)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	60816	60942	60942	32319	60942	60942	60942	60942	60942
Adjusted $R^2$	0.591	0.591	0.587	0.546	0.588	0.588	0.588	0.597	0.589

Table 6: 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. *High Invest* is the dummy that is one if the proportion of non-residential purpose transactions is greater than the sample median, and zero otherwise. All other variables are defined in Appendix A. 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) (Zillow) in 2004-06	(2) 1-Bed in 2004-06	(3) 2-Bed in 2004-06	(4) 3-Bed in 2004-06	(5) 4-Bed in 2004-06
Non-recourse X High Invest	0.014** (0.007)	0.011 (0.008)	0.013** (0.006)	0.013* (0.007)	0.011 (0.007)
High Invest in 2004-06	0.004 (0.003)	0.000 (0.004)	0.002 (0.003)	0.003 (0.003)	0.003 (0.003)
Non-recourse	0.008 (0.006)	0.021* (0.011)	0.007 (0.007)	0.009 (0.006)	0.012* (0.006)
GDP growth in 2004-06	0.781*** (0.107)	1.112*** (0.184)	0.840*** (0.114)	0.705*** (0.104)	0.715*** (0.110)
Pop growth in 2004-06	2.096*** (0.344)	3.458*** (0.491)	2.501*** (0.329)	2.150*** (0.341)	2.183*** (0.345)
Income growth in 2004-06	0.205*** (0.054)	0.335*** (0.086)	0.208*** (0.058)	0.168*** (0.053)	0.141*** (0.053)
Edu high in 2000	0.045 (0.036)	0.093 (0.064)	0.045 (0.039)	0.059* (0.035)	0.071** (0.035)
Age over 60 in 2005-06	0.066 (0.062)	-0.044 (0.106)	0.068 (0.073)	0.046 (0.063)	0.001 (0.058)
Female Ratio in 2005-06	-0.250 (0.246)	1.173*** (0.442)	-0.201 (0.275)	-0.258 (0.240)	-0.124 (0.248)
Married in 2000	-0.048 (0.036)	0.021 (0.050)	-0.039 (0.039)	-0.056 (0.035)	-0.057 (0.035)
Judicial	0.028*** (0.004)	0.026*** (0.007)	0.027*** (0.005)	0.027*** (0.004)	0.027*** (0.004)
Property Tax in 2004-06	-0.036*** (0.005)	-0.020** (0.008)	-0.032*** (0.006)	-0.034*** (0.005)	-0.033*** (0.005)
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	28276	6211	22098	28146	24600
Adjusted $R^2$	0.458	0.412	0.433	0.444	0.455

Table 7: 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. All other variables are defined in Appendix A. 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.

	DTI		DTI Prime Loan	
	(1) 2004-2009	(2) 2004-2006	(3) 2004-2009	(4) 2004-2006
Non-recourse	0.063*** (0.014)	0.048*** (0.014)	0.091*** (0.023)	0.056** (0.027)
GDP growth in 2004-09	-0.121 (0.284)	-1.057*** (0.265)	0.899** (0.449)	-2.732*** (0.544)
Pop growth in 2004-09	-6.846*** (0.646)	-5.890*** (0.748)	-13.070*** (1.142)	-9.628*** (1.319)
Income growth in 2004-09	0.695*** (0.146)	0.561*** (0.173)	0.674*** (0.215)	0.333 (0.260)
Edu high in 2000	-1.010*** (0.090)	-0.980*** (0.104)	-2.030*** (0.146)	-2.138*** (0.186)
Age over 60 in 2005-06	-0.784*** (0.112)	-0.316** (0.134)	-0.004 (0.232)	1.012*** (0.281)
Female Ratio in 2005-06	1.936*** (0.504)	1.211* (0.657)	0.859 (0.950)	-0.558 (1.138)
Married in 2000	0.516*** (0.089)	0.482*** (0.095)	1.628*** (0.152)	1.692*** (0.184)
Judicial	0.112*** (0.011)	0.097*** (0.011)	0.100*** (0.020)	0.110*** (0.024)
Property Tax in 2004-09	-0.183*** (0.012)	-0.176*** (0.014)	-0.168*** (0.021)	-0.150*** (0.026)
Year FE	Yes	Yes	Yes	Yes
Observations	58574	29183	58574	29183
Adjusted $R^2$	0.116	0.192	0.064	0.082

Table 8: 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 2004-06. 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. *Fraction of GSE (Non-GSE) mortgage in 2004-06* is the aggregate ratio of the number of GSE (non-GSE) mortgage loans to the total number of mortgage loans originated at the county-level for 2004-2006. *Fraction securitized mortgages in 2004-06* is the aggregate ratio of the sum of number of GSE and non-GSE mortgage loans to the total number of mortgage loans originated at the county-level for 2004-2006. Other economic- and demographic controls are unreported due to the limited space. All other variables are defined in Appendix A. 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) in 2004-06						
	(1)	(2) 1-Bed	(3) 2-Bed	(4) 3-Bed	(5) 4-Bed	(6)	(7)
Non-recourse X Subprime in 2004-06	0.083** (0.038)	0.159*** (0.039)	0.113*** (0.038)	0.064 (0.039)	0.072* (0.041)		
Subprime ratio in 2004-06	0.079*** (0.014)	0.045* (0.023)	0.067*** (0.015)	0.080*** (0.014)	0.068*** (0.014)		
Non-recourse X Fraction of Non-GSE mortgages in 2004-06						0.154** (0.060)	
Fraction of Non-GSE mortgages in 2004-06						0.073*** (0.027)	
Non-recourse X Fraction of securitized mortgages in 2004-06							0.332*** (0.072)
Fraction of securitized mortgages in 2004-06							0.047 (0.029)
Non-recourse	0.001 (0.008)	0.002 (0.011)	-0.004 (0.008)	0.006 (0.008)	0.006 (0.008)	-0.056** (0.026)	-0.213*** (0.047)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28276	30332	30332	6211	22096	28146	24600
Adjusted $R^2$	0.468	0.457	0.461	0.422	0.442	0.452	0.463

Table 9: Non-recourse Law and Subprime Loan Ratio: Denial Rate

This table reports estimates and standard errors for regressions of mortgage denial rate on the non-recourse law indicators.  $Denial Rate_{it}$  is the average denial rate at the 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. All other variables are defined in Appendix A. 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) 2004-09	(2) 2004-06	(3) 2004-09	(4) 2004-06
Non-recourse	-0.007** (0.003)	-0.007** (0.003)	-0.002** (0.001)	-0.004** (0.002)
GDP growth in 2004-09	-0.178*** (0.055)	0.465*** (0.068)	0.007 (0.015)	0.032 (0.033)
Pop growth in 2004-09	0.916*** (0.153)	0.177 (0.173)	0.090** (0.045)	0.144** (0.071)
Income growth in 2004-09	-0.046* (0.026)	0.046 (0.028)	0.017* (0.010)	0.036* (0.019)
Edu high in 2000	0.115*** (0.018)	0.180*** (0.020)	0.010* (0.005)	0.023** (0.011)
Age over 60 in 2005-06	0.019 (0.027)	-0.043 (0.030)	-0.031*** (0.009)	-0.071*** (0.018)
Female Ratio in 2005-06	-0.217* (0.129)	0.215 (0.150)	0.022 (0.039)	0.075 (0.078)
Married in 2000	-0.263*** (0.020)	-0.159*** (0.022)	-0.048*** (0.007)	-0.093*** (0.012)
Judicial	-0.008*** (0.003)	-0.018*** (0.003)	-0.004*** (0.001)	-0.007*** (0.002)
Property Tax in 2004-09	-0.008*** (0.003)	0.001 (0.003)	0.001 (0.001)	0.003* (0.002)
Year FE	Yes	Yes	Yes	Yes
Observations	78420	39210	78420	39210
Adjusted $R^2$	0.114	0.134	0.196	0.117



Table 10: Interaction of Non-recourse Law and Securitization

This table reports estimates and standard errors for regressions of housing price growth on the interaction term of non-recourse law indicators and securitized loan ratio for the pre-crisis period, 2004-2006. The *Fraction of GSE mortgages in 2004-06* and *Fraction of Non-GSE mortgages in 2004-06* are the aggregate ratio of the number of GSE and Non-GSE mortgage loans to the total number of mortgage loans originated at the county-level for 2004-06, respectively. All other variables are defined in Appendix A. 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) in 2004-06	(2) 1-Bed in 2004-06	(3) 2-Bed in 2004-06	(4) 3-Bed in 2004-06	(5) 4-Bed in 2004-06
Non-recourse X Fraction of GSE mortgages in 2004-06	0.308*** (0.080)	0.238* (0.129)	0.290*** (0.087)	0.343*** (0.081)	0.348*** (0.082)
Non-recourse X Fraction of Non-GSE mortgages in 2004-06	0.320*** (0.070)	0.522*** (0.103)	0.378*** (0.069)	0.337*** (0.072)	0.361*** (0.075)
Fraction of GSE mortgages in 2004-06	-0.016 (0.048)	-0.069 (0.101)	-0.042 (0.056)	-0.045 (0.048)	-0.060 (0.050)
Fraction of NonGSE mortgages in 2004-06	0.059** (0.029)	-0.089 (0.063)	-0.006 (0.035)	0.016 (0.031)	-0.010 (0.031)
Non-recourse	-0.202*** (0.043)	-0.274*** (0.070)	-0.226*** (0.044)	-0.217*** (0.044)	-0.228*** (0.046)
GDP growth in 2004-06	0.671*** (0.102)	0.913*** (0.174)	0.705*** (0.111)	0.599*** (0.101)	0.609*** (0.106)
Pop growth in 2004-06	2.164*** (0.337)	4.416*** (0.500)	2.932*** (0.341)	2.391*** (0.355)	2.500*** (0.358)
Income growth in 2004-06	0.177*** (0.052)	0.279*** (0.080)	0.169*** (0.055)	0.133** (0.052)	0.107** (0.052)
Edu high in 2000	0.089** (0.040)	0.065 (0.070)	0.057 (0.044)	0.078* (0.040)	0.076* (0.040)
Age over 60 in 2005-06	0.107* (0.061)	-0.017 (0.103)	0.090 (0.074)	0.079 (0.064)	0.025 (0.059)
Female ratio in 2005-06	-0.202 (0.235)	1.293*** (0.415)	-0.094 (0.271)	-0.200 (0.238)	-0.029 (0.243)
Married in 2000	-0.062* (0.033)	0.016 (0.046)	-0.038 (0.037)	-0.060* (0.033)	-0.056* (0.033)
Judicial	0.033*** (0.004)	0.029*** (0.008)	0.031*** (0.005)	0.030*** (0.004)	0.030*** (0.004)
Property tax in 2004-06	-0.032*** (0.005)	-0.007 (0.008)	-0.026*** (0.006)	-0.030*** (0.005)	-0.030*** (0.005)
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	30332	6211	22104	28155	24603
Adjusted $R^2$	0.463	0.431	0.446	0.456	0.467

Table 11: Non-Recourse Law and Real Effect on Consumption

This table reports estimates and standard errors for regressions of consumption per capita on non-recourse law in state-level for the sample period, 2004-2009. The dependent variable is per capita personal consumption expenditures for non-durable goods by state from Bureau of economic analysis. A state is classified as a *Non-recourse* state if the state does not allow lender to claim deficiency judgments in the event of mortgage default. *High Age* and *Low Age*, *High Income* and *Low Income* are defined by the sample median of household age and income from American Community Survey in 2005-2006. The other variables are defined in Table 1. All standard errors are robust to heteroskedasticity. Coefficients marked \*\*\*, \*\* and \* are significant at the 1%, 5% and 10% level, respectively.

	Non-durable good consumption per capita				
	(1) Pooled Sample	(2) High Age	(3) Low Age	(4) High Income	(5) Low Income
Non-recourse	0.005 (0.004)	0.012*** (0.004)	-0.001 (0.007)	-0.007 (0.006)	0.011** (0.005)
Non-recourse X Recession	-0.013** (0.005)	-0.018** (0.008)	-0.011 (0.007)	-0.001 (0.009)	-0.023*** (0.007)
GDP growth in 2004-09	0.577*** (0.048)	0.649*** (0.057)	0.511*** (0.072)	0.621*** (0.078)	0.525*** (0.070)
Pop growth in 2004-09	-0.857*** (0.213)	-0.845*** (0.316)	-1.004*** (0.219)	-1.076*** (0.333)	-1.081*** (0.194)
Income growth in 2004-09	0.451*** (0.056)	0.397*** (0.077)	0.548*** (0.086)	0.422*** (0.081)	0.537*** (0.082)
Edu high in 2000	0.027 (0.040)	0.092 (0.056)	-0.062 (0.075)	0.148* (0.081)	-0.085 (0.070)
Age over 60 in 2005-06	0.038 (0.071)	0.059 (0.103)	0.298** (0.146)	-0.053 (0.130)	0.066 (0.088)
Female ratio in 2005-06	-0.282 (0.326)	-0.649 (0.473)	0.009 (0.701)	-0.626 (0.455)	-0.007 (0.665)
Married in 2000	0.103** (0.048)	0.073 (0.126)	0.196** (0.087)	0.028 (0.055)	0.138 (0.145)
Judicial	0.000 (0.003)	0.003 (0.005)	-0.003 (0.004)	-0.004 (0.005)	0.003 (0.005)
Property Tax in 2004-09	-0.001 (0.003)	-0.003 (0.005)	0.003 (0.005)	-0.001 (0.006)	-0.003 (0.005)
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	350	175	175	175	175
Adjusted $R^2$	0.662	0.673	0.671	0.624	0.707