Non-Recourse Mortgage and Housing Price Boom, Bust, and Rebound

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Abstract: *This paper investigates the impact of non-recourse vs. recourse mortgages on housing price dynamics in major US metropolitan statistical areas for the period from 2000 to 2013. We find evidence that non-recourse states experience faster price growth during the boom period (2000-2006), a sharper price drop during the bust period (2006-2009) and faster price recovery in the rebound period after a crisis (2009-2013). Moreover, the volatility of housing prices is higher in non-recourse states than in recourse states, particularly during the rebound period.*

Key words: non-recourse loan, mortgage, housing market, boom-bust cycles.

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

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1. **Introduction**

A non-recourse mortgage is a type of loan that is secured by collateral (the house) but in which the borrower who defaults is not personally liable for the outstanding amount of the loan if the sale price of the house is below the value of the remaining loan. As noted by Pavlov and Wachter (2009), a non-recourse mortgage provides the borrower with a put option: the borrower is entitled to capture all capital gains from the appreciation of the property but has no obligation for losses due to price drops because he can simply use the put option to sell the asset to the bank and walk away.

Are non-recourse mortgages "good" or "bad" for the housing market? One intuitive argument is that because borrowers have limited liability with non-recourse loans, they have a greater incentive to make speculative purchases, particularly during a market boom, which can create or magnify price "bubbles." Indeed, one of the main results of Pavlov and Wachter (2009) is that the embedded put option in a non-recourse loan is typically underpriced in equilibrium, indicating that the loan is cheaper for the borrower than it should be. Thus, borrowers' rational reaction is to borrow more, causing housing prices to remain above their fundamental values.

Similarly, when the market experiences a downturn, buyers with non-recourse mortgages face lower losses because they can put their houses and walk away, leading to excess supply in the secondary housing market and a further decrease in housing prices. Thus, non-recourse loans may also magnify the price plunge when a bubble bursts.

Nevertheless, there are reasons to defend non-recourse mortgages. For example, suppose that the housing market experiences a large price crash. If all the mortgages are recourse mortgages, borrowers will be forced to spend years paying back their remaining debts before they can purchase another house, which can be extremely harmful to price recovery. If the loans are non-recourse loans, borrowers have no further obligation to the banks after using their put option on their house. Demand will pick up when buyers' income is restored, and the market does not have to endure a prolonged recession.

This study examines the potential benefits and costs of non-recourse mortgages by using housing price data from US metropolitan statistical areas (MSAs). The reason for not performing an international comparison is simple: the US is the only country in the world where non-recourse loans are implemented. Although a boom-bust pattern is indeed apparent in US housing prices during the 2000s, this cycle is also observable in some other countries, such as the UK and Spain, whereas the housing market remains very stable in countries such as Germany. Drawing any conclusions regarding the role of non-recourse mortgages via a comparative study of the US and other countries would be difficult.

Based on the report from the Case-Shiller index, we divide the years since 2000 into three phases: the boom phase (2000Q1-2006Q2), the crash/bust phase (2006Q3-2009Q1), and the rebound/recovery phase (2009Q2-2013Q3). We collect data on changes in the housing price index (HPI) for 100 MSAs, which are divided into two groups: areas from recourse states and areas from non-recourse states.

[Insert Figure 1 about here]

Figure 1 illustrates the total percentage change in the HPI of MSAs in non-recourse vs. recourse states during the boom, bust, and rebound phases. The patterns regarding the total percentage change in the HPI lend support to our divisions among the boom, bust, and rebound phases: the HPI is non-negative for all MSAs during the boom phase (the appreciation is between 0% and 200%) and mostly non-positive for all MSAs during the bust phase (the depreciation is between 0% and 60%), and mostly positive for most MSAs (0% to 40%) during the rebound phase.

Figure 1 also shows that when the change in income during the same period is controlled for, the total price growth is indeed higher in most of the non-recourse MSAs than in their recourse peers. The price plunge is more severe in non-recourse MSAs than in recourse MSAs. The difference between non-recourse and recourse MSAs is less pronounced during the rebound phase, although the non-recourse MSAs seem to have a slightly higher average total price appreciation.

Controlling for other economic variables in the fundamentals of housing prices, we find that non-recourse states experience faster price appreciation/depreciation/recovery than recourse states during the boom/bust/rebound period. The volatility (standard error) of housing prices is higher in non-recourse states than in recourse states, particularly during the recovery period. Our results suggest that while non-recourse mortgages act as a destabilizing factor that renders the housing market more volatile, it also makes the market more resilient by aiding price recovery.

Our study fits into the broad literature on housing bubbles in the US, e.g., Case and Shiller (2003), Wheaton and Nechayev (2009) and Mayer (2011). Many researchers have sought to explain housing bubbles from the perspective of market psychology and speculation (Shiller, 2007), mortgage rates (Hubbard and Mayer, 2009), easy credit and subprime mortgages (Khandani et al, 2009, Mayer and Sinai, 2009, Glaeser et al, 2010), and the supply elasticity of the housing market (Glaeser et al, 2008). Lambrecht et al. (2003), Ghent and Kudlyak (2011), and Li and Oswald (2013) use micro-level loan data to study the default rate of recourse and non-recourse mortgages. To our knowledge, we are the first researchers to study housing price dynamics in recourse versus non-recourse states.

Our results may be useful to legislators and policy makers in designing legislation and regulatory policies for the mortgage market from the perspective of enhancing the stability of housing prices. According to a report on the Bloomberg website (Smyth, 2011) quoted by Meir and Harris (2012), a recent heated debate in Spanish parliament due to aggressive lobbying by mortgage debtors focused on the implementation of some form of non-recourse law. Although the bill was rejected, the issue remains on the table. Based on the results of this study, it may be better for Spain and the European countries faced with similar situation to move towards non-recourse mortgage.

The rest of this paper is organized as follows: section 2 describes the data, section 3 conducts the econometric analysis, and section 4 concludes.

2. Data Description

2.1 Housing Price Index (HPI)

This paper mainly uses the quarterly HPI published by the Office of Federal Housing Enterprise Oversight. The HPI is a seasonally adjusted, purchase-only index for 100 largest MSAs. The HPI also provides all-transaction non-seasonal adjusted data covering 401 MSAs. We do not use all-transactional data because such data also contain appraisal data for commercial properties, which is less relevant to the discussion on mortgages.

The time scope of this study is 2000-2013. Beginning in 2007, the US economy was greatly shocked by a subprime mortgage crisis and underwent a recession that lasted for the next five years. This crisis was rooted in the mortgage market and thus greatly affected housing prices. Housing prices showed a growth-plunge-rebound pattern in the national US housing market. To represent this pattern, we divide this period into three phases and create three dummy variables:

- *Boom Phase:* 2000Q1 to 2006Q2
- *Bust Phase:* 2006Q3 to 2009Q1
- *Rebound Phase*: 2009Q2 to 2013Q3

The division of the study period is based on the report from the Case-Shiller National Home Price Index (Maitland, M. F., and Blitzer, 2012, Table 1). The Case-Shiller National Home Price Index reached its peak in 2006Q2 (June) and hit its local minimum (trough) in 2009Q1 (March). Subsequently, because of the economy's slow recovery process, housing prices struggled over a certain range but returned to the path of growth, which can be defined as the rebound period. Figure 2 plots the time series of the Case-Shiller national index for the period from 2000Q1 to 2012Q2.

[Insert Figure 2 about here]

2.2 Recourse vs. Non-Recourse

We adopt the classification in Ghent and Kudlyak (2011): in some US states, "recourse in residential mortgages is limited to the value of the collateral securing the loan," while in the other states, the lender "may be able to collect on debt not covered by the proceedings from a foreclosure sale." States in the former group are considered non-recourse states, while states in the latter group are considered recourse states.

A dummy variable for recourse mortgages is used to denote whether an MSA/state is a recourse or non-recourse MSA/state (taking the value of 1 for a recourse MSA/state and 0 otherwise). According to Ghent and Kudlyak's (2011) classification, 11 US states are non-recourse states, while the other 40 states are recourse states. North Carolina, where purchase mortgages are non-recourse loans while the other mortgages are recourse loans, is a special case.

In the MSA dataset, some MSAs span several states. If the MSA spans both recourse and non-recourse states[1], it is categorized as a recourse (non-recourse) when more than 50% of the population of this MSA reside in the recourse (non-recourse) state. Notice that no sample selection bias arises here because the recourse dummy can be assumed to be strictly exogenous, namely, the legislation on recourse versus non-recourse was made at least half a century before the housing boom in 2000s. In other cases, the variable '$recourse_i$' is defined according to the recourse status of the state(s). Following this classification, out of 100 MSAs in our dataset, 77 MSAs are categorized as recourse MSAs and 23 are categorized as non-recourse MSAs.

Furthermore, we create an interaction term between the recourse dummy and the time dummy variables for the boom and bust phases (the rebound phase is used as the baseline phase) to investigate the role of (non-)recourse mortgages in different stages of the recent housing cycle. Creating the interaction term enables us to address three questions simultaneously: (1) Do non-recourse states experience higher price growth during the boom phase? (2) Do non-recourse states experience a more severe price plunge during the bust phase? (3) Do

[1] 5 MSAs are concerned: Virginia Beach-Norfolk-Newport News, VA-NC (recourse); Worcester, MA-CT (recourse); Charlotte-Concord-Gastonia, NC-SC(nonrecourse); Lake County-Kenosha County, IL-WI (recourse); and Omaha-Council Bluffs, NE-IA(recourse)

non-recourse states experience better price recovery during the rebound phase?

2.3 Control variables

Control variables from both the supply and demand side are used, and the list of variables is shown in Table 1. Among these variables, the national interest rate, construction cost index, and local housing supply elasticity are exogenous variables. Local macroeconomic variables (population, income, and unemployment) can be influenced by the housing market. To address the issue of two-way causality, different specifications with lagged macroeconomic variables are used as robustness checks. The Im-Pesaran-Shin unit root test (Im et al. 1999) is conducted for all the variables that can change over time, and the null hypothesis of unit root non-stationarity is always rejected at the 1% level.

[Insert Table 1 about here]

First, the selection of the controlling variables for local macroeconomic conditions is mainly based on the study by Jud and Winkler (2002). These authors find strong evidence that real housing price appreciation is strongly influenced by population growth and real changes in income, construction costs, and interest rates. Moreover, Reichert (1990) argues that income and employment rates are important factors that explain differences among housing prices in different regions. Intuitively, population growth reflects changes in the demand side of the real estate market, while the unemployment rate influences average default choice, which affects the mortgage market and thus the real estate market. In addition to the two papers cited above, many other papers (Clapp and Giaccotto, 1991, Case and Mayer, 1996, Englund and Ioannides, 1997, Hwang and Quigley, 2006 and more recently, Agnello and Schuknecht, 2011) in the literature on the determinants of housing price dynamics draw similar conclusions.

The mortgage interest rate is a primary cost of a home purchase. We use the prime interest rate provided by Freddie Mac as the mortgage interest rate in our paper. The original data are monthly, and we use the average for each 3 month period within the same quarter. Another important factor that influences households' investment decisions is the long-term interest rate. According to Adams and Fuss (2010), "A higher long-term interest rate increase the return of other fixed-income assets… thus shifting the demand from real estate into other assets."

Monthly unemployment data are collected from the website of the Bureau of Labor Statistics and entered into the model in the form of 3-month averages. Personal income data for MSAs are collected from the website of the Bureau of Economic Analysis (BEA). The population data are based on the 2000 and 2010 Censuses[2] conducted by the United States Census Bureau, while annual population estimates are from the BEA. Monthly long-term interest rates are available on the U.S. Department of the Treasury's website: the interest rate for 20-year Treasury bills. Loan-to-price (LTP) ratio is collected from Monthly Interest Rate Survey of the FHFB, where annual data for each US state and 34 MSAs is available. Except

[2] http://www.census.gov/popest/data/metro/totals/2012/tables/CBSA-EST2012-01.csv. This figure is actually the estimate of USSB for MSA populations in 2010 based on census data.

those directly available MSA-level data, we use the state LTP ratio for other MSAs.

Finally, two variables are controlled for on the supply side: construction costs and the supply elasticity of local markets. We use the structure cost for single-family housing unit in 46 large MSAs provided by the Lincoln Institute. Higher construction costs should be associated with higher housing prices. Boom-bust cycles can reasonably be assumed to be less likely to occur in a local housing market with higher supply elasticity. We use two indices as a measure of supply elasticity: (1) the index of supply elasticity based on the geographical characteristics of the region as defined by Saiz (2010) and (2) the Wharton Residential Land Use Regulatory Index (WRLURI) defined by Gyourko et al. (2008), which describes how strictly the local land supply is regulated. Saiz only provides data for metro areas with population more than 500,000. In our data set, Saiz elasticity cannot be found for 2 MSAs (Boise City, Idaho; Honolulu, Hawaii) because it is not available for Idaho and Hawaii. For other missing observations, Saiz index are constructed by taking average of other MSAs in the same state. Regarding the expected signs of the coefficients, (1) higher supply elasticity according to Saiz (2010) should be correlated with lower price growth, and (2) stricter regulation according to Gyourko et al. (2008) implies a more rigid housing supply and thus should be correlated with higher price growth. The missing observations in construction cost data and Saiz supply elasticity leaves 45 effective observations when the variables on the supply side are controlled jointly.

The summary statistics for the variables are presented in Table 2. The baseline period for the

HPI is 1990 ($HPI_{1990} = 100$). The average HPI growth is lower in the boom period because this period covers a greater number of years and because the HPI started at a relatively low level. The average income per capita is approximately 38000 USD per year. The average population maintains a mild growth rate. The average unemployment rate is approximately 6%, and it is higher in the bust and rebound phases than in the boom phase.

[Insert Table 2 about here]

3. Data Analysis

3.1 Non-Parametric test

To quickly identify the difference between recourse and non-recourse MSAs/states, Table 3 shows the comparison for the median price change between the recourse and the non-recourse states during the growth, crash, and bounce periods. To avoid the problem of unbalanced sample sizes, the Mann-Whitney rank sum test, which compares only the median behavior of the two groups, is used. In the growth and crash periods, the ranks of recourse MSAs are significantly lower at the 5% level, indicating that the percentage change in the HPI is smaller in recourse states and in non-recourse states. This difference is not significant in the recovery period. This result provides support for the primary argument that the bubble-crash pattern is more salient in non-recourse states than in recourse states.

[Insert Table 3 about here]

3.2 The Estimation

We conduct a panel data regression analysis on the HPI data with the following specification:

$$hpi_{it} = \beta_1 recourse_i + \beta_2 boom_{it} + \beta_3 burst_{it} + \beta_4 recourse_i * boom_{it} + \beta_5 recourse_i * burst_i + \sum \gamma_k ControlVariables_{k,it} + \varepsilon_{it} \qquad (1)$$

We use $hpi_{i,t} = 100dlog(HPI_{it})$ that measures the percentage change in the HPI for each MSA in each quarter. When the interaction terms of the dummy variables for (non-)recourse MSAs and phases for the housing price boom, bust, and rebound are included, β_1 captures the difference in average growth rates of the HPI during the baseline (rebound) phase. During the boom and bust periods, the difference in the growth rates between non-recourse and recourse states is measured by $\beta_1 + \beta_4$ and $\beta_1 + \beta_5$, respectively. β_2 and β_3 are indicator variables that capture the difference in the growth rate of the HPI between the boom and the rebound periods and between the bust and the rebound periods, respectively. Intuitively, the growth rate is higher during the boom period and lower during the bust period, and the expected signs are therefore $\beta_2 > 0, \beta_3 < 0$.

The regression applies a random effect model because if fixed effects for MSAs are introduced, the effect of (non-)recourse mortgages will be absorbed by the fixed effects for the MSAs. To ensure that the assumption under the random effect model is satisfied, we perform a Hausman test after we run the regressions. We find that the null hypothesis that the random effect model is preferred cannot be rejected even at the 10% level.

The key research question concerns how the recourse rule influences regional housing prices. The expected signs of the coefficients are as follows:

1) $\beta_1 < 0, \beta_1 + \beta_4 > 0, \beta_1 + \beta_5 < 0$. Theoretically, home buyers with non-recourse mortgages have limited liability and thus have an incentive to make more speculative purchases. Non-recourse states/MSAs should experience higher price growth owing to greater demand during the growth period. Because non-recourse states experience greater demand from speculators who face lower losses—because they can use the put option on their houses and walk away when the price drops—housing prices in these states should also show a greater decline during the crisis owing to increased defaults.[3] Finally, if the mortgages are recourse mortgages, home buyers who default must pay back the remaining loan even after their houses are sold. Thus, buying another house in the following years is more difficult for these buyers than for home buyers who default in non-recourse states. Housing prices should therefore more easily recover after the crisis in non-recourse states.
2) For the control variables, given we use the percentage change of HPI, $income$ and pop are also used in terms of percentage changes, namely, $100dlog(income)$ and

[3] We understand that while theory based on rational choice predicts that borrowers should immediately execute the put option by walking away in non-recourse states when housing prices go "underwater", many borrowers do not use this option because of various reasons, such as transaction costs (Harding, 1997), social and moral concerns (Guiso et al. 2013, White, 2010), bounded rationality (Deng and Quigley, 2012), and time preferences (Deng and He, 2013). These factors tend to narrow the difference in the default rates, as well as the price depreciation rate, between non-recourse and recourse states during the boom period.

$100dlog(pop)$. Moreover, the difference is taken between these variables and its 4 periods (quarters) lagged term because they are yearly data. To keep consistency in the time frame and scale of the macroeconomic variables, the unemployment rate is also used in percentage and in terms of the difference between the current term and the 4 periods lagged term, $100dunempl$. The coefficients should generally be positive for $income$, pop, and $wrluri$ and negative for $unempl$, $prime$, $treasury20yr\_cmt$, and $saiz$ because housing prices should be higher in richer, more populated states and in states with lower unemployment rates. Higher interest rates decrease the attractiveness of investment in housing, increase the cost of mortgage rates, and thus should be associated with lower housing price growth.

This conjecture can be formulated into the following hypotheses:

Hypothesis 1: The HPI growth rate is higher in non-recourse states than in recourse states during the boom phase (2000-2006).

Hypothesis 2: The absolute value of the (negative) HPI growth rate is higher in non-recourse states than in recourse states in the crash phase (2006-2009).

Hypothesis 3: The HPI growth rate is higher in non-recourse states than in recourse states in the bounce phase (2009-2013).

The result of the estimation of equation (1) is presented in Table 4. The dependent variable is $100dlog(HPI)$ so that the marginal effect of the coefficients can be easily interpreted based on percentage points. Robust standard errors are used to produce appropriate test statistics to protect against heteroskedasticity. Because some time may be required before the changes in income, population, and interest rates are incorporated into housing prices, we use lagged terms (L4 for 4 periods, meaning lagged by one year) of these variables for robustness checks in the specifications in columns (6)-(7).

[Insert Table 4 about here]

The estimated coefficients are generally robust against different specifications. For the recourse dummies, we find that the HPI growth/drop/recovery rate is significantly higher in non-recourse states than in recourse states during the boom/bust/rebound period (the t-test for $\beta_1 = 0$ against $\beta_1 < 0$ is rejected at 5% level except for model (5), the F-test for $\beta_1 + \beta_5 = 0$ against $\beta_1 + \beta_5 < 0$ is rejected at 5% level except for model (5), and the F-test for $\beta_1 + \beta_4 = 0$ against $\beta_1 + \beta_4 > 0$ is always rejected at the 5% level). In the most elaborate model (model (7)), the HPI growth rate is approximately 0.48% per quarter (1.9.% per year) higher during the boom, 1.6% per quarter (6.4% per year) lower during the bust (namely, the drop rate is 1.6% higher quarterly), and 0.54% per quarter (2.2% per year) higher during the recovery phase in non-recourse states than in recourse states.

For the phase dummies (boom and bust), the HPI growth rate is estimated to be 1.5%-3%

higher per quarter during the boom phase and 2-4% lower per quarter during the bust phase, compared to the baseline phase (rebound phase).

The signs of the control variables are mostly consistent with our expectations. Income growth has positive sign and is usually significant at 5% level. Population growth has positive sign but is insignificant. The coefficient for the unemployment rate is negative and always significant at 1% level. The coefficients for the prime mortgage rate and long-term Treasury bill returns are negative and significant if they are included separately but non-significant or positive if they are both included in the model. This result suggests that these two interest rates are correlated. Further, the prime mortgage rate is likely a more important channel of influence over housing prices than long-term Treasury bill returns given that its coefficient is larger and always carries the expected sign. The coefficient for the loan to price ratio is negative but small and not always significant. The coefficient for the WRLURI index for regulation strength is positive and significant at 5% level, and the coefficient for the supply elasticity index according to Saiz (2010) is not significant. The coefficient for construction costs has the expected sign (negative) and significant but rather small.

When we conduct robustness checks on two additional specifications where the income, population, and unemployment variables are each lagged by 4 periods (one year), we find that the estimated coefficient for the recourse dummy is robust against the change in the lags of the control variables. In particular, the between R squared of the panel data regression increases when the macroeconomic variables are lagged, indicating that models with lagged macroeconomic variables indeed have greater descriptive power. These findings are summarized in Result 1:

Result 1: We find evidence supporting all our hypotheses. The HPI growth/drop/recovery rate is higher in non-recourse states than in recourse states during the housing boom/bust/rebound period, and the difference is almost always significant.

Why is the difference between non-recourse and recourse states larger during the bust phase than during the boom phase? There are two possible explanations for this result: (1) The boom phase consists of a greater number of periods than the bust phase, and even though housing prices decrease by almost the same percentage during the bust phase as they increase during the boom phase, the rate at which the prices drop per period during the bust phase is higher than the rate at which they increase during the boom phase. In other words, the price change is more intensive during the bust phase than during the boom phase. The difference between non-recourse and recourse states is amplified by the same scale. (2) When borrowers default and their houses are auctioned by the court, they are typically sold at a particularly large discount relative to houses sold in other markets, exacerbating the depreciation of the average housing price during the bust phase.

3.3 Robustness Check

In this section, we estimate equation (1) without the time dummies for boom and bust. [4]

[4] We thank our referee for his recommendation for us to conduct the robustness check in this section.

$$hpi_{it} = \beta_1 recourse_i + \sum \gamma_k ControlVariables_{k,it} + \varepsilon_{it} \qquad (2)$$

This model addresses the potential concern for equation (1) on whether there is a difference between the HPI growth rate between recourse and non-recourse states over the entire period. While the theoretical models predict a difference between the volatility of price between recourse and non-recourse states, the models do not predict a difference between the average price growths.

The results are reported in Table 5. In general, the coefficient of the recourse dummy changes signs across different specifications, and is not significant even at 10% level. This result rules out the concern that the difference between recourse and non-recourse states in each of the boom, bust and rebound phases is caused by the difference in the overall trend of HPI.

[Insert Table 5 about here]

3.4 Price Volatility

The standard deviation of housing prices is an indicator for the rate of fluctuation of housing prices. The results in section 3.2 suggest that non-recourse states experience a higher price change in each of the boom, bust and rebound periods, the price volatility is very likely to be higher in non-recourse states than in recourse states. We run a simple cross-sectional regression on the standard deviations of housing prices with the following specification:

$$s.d._i = \alpha_0 + \alpha_1 recourse_i + \sum \theta_k Control\ Variables_{k,i} + \epsilon_i \qquad (3)$$

The control variables include the standard deviation of population, income and unemployment in each period, the standard deviation of loan to price ratio, and the supply elasticity in each MSA. In addition to running this regression on the entire sample, we also estimate the equation separately for the boom, bust, and recovery phases by using the control variables for the same time window. Since controlling for construction cost will leave too few observations by reducing the number of observations from 100 to 46, we decide not to control it in this cross-section model. The national interest rate variables are not controlled for in this section because they are the same for all MSAs. If housing prices show greater variation in non-recourse states than in recourse states, the coefficient for recourse should always be negative. This proposition is formulated in Hypothesis 4.

Hypothesis 4: $\alpha_1 < 0$. In non-recourse states, because borrowers have less liability, they may have a greater incentive to make speculative purchases, which introduces more uncertainty into the system. Therefore, the standard deviation of housing prices should be higher in non-recourse states than in recourse states.

The regression results are reported in Table 6. When controlled for volatility of population, income and unemployment, the coefficient for recourse is significant at 1% level in boom and rebound period and significant at 10% level in bust period. Within the most elaborate model specification, where supply elasticity and LTP are controlled, the difference in the volatility of housing prices between non-recourse and recourse states is significant at the 1% in rebound period, yet not significant in other periods. The coefficients of recourse stay negative for all specification, which supports hypothesis 4. The volatility of housing prices is in general higher in states with a greater volatility in population, income rates, and unemployment rates. Supply elasticity can reduce the volatility of housing prices, while stricter regulation increases the volatility of housing prices. The volatility of housing prices is not significantly correlated with loan to price ratios and construction costs. These findings are summarized in Result 2:

Result 2: The evidence shows that housing prices are more volatile in non-recourse states than in recourse states over the entire period, although the coefficient is not significant after the supply elasticity is controlled for. The volatility of housing prices is significantly higher in non-recourse states than in recourse states during the rebound period.

[Insert Table 6 about here]

4. Conclusion

This study examines the effect of non-recourse mortgage policy on US housing price dynamics for the period from 2000 to 2013. Our analysis shows that after other factors affecting the fundamental value are controlled for, the change in housing prices is indeed greater in non-recourse states than in recourse states during the boom, bust, and rebound periods. Further, non-recourse mortgages are associated with higher market volatility, particularly during the rebound period. The implications of these findings are twofold: (1) non-recourse mortgages indeed appear to be a destabilizing factor in the housing market; (2) non-recourse mortgages may improve the resilience of the market, in that the price recovery is faster in these markets.

Based on the sharp difference between recourse and non-recourse states observed in our study, some policy implications can be drawn from our results with caution. In general, our findings suggest that authorities could adjust regulation regarding recourse vs. non-recourse mortgages according to the housing price cycle.

First, when the market has been in a long recession, as the situation in some European countries at the current stage, introducing non-recourse mortgages in a formerly recourse state or country may improve the price recovery.

Second, given the larger price volatility in the non-recourse states in the US, the policy maker may consider moving towards recourse when the market is not in a recession to avoid future price fluctuations. We understand that moving towards recourse may go against the ideology behind the liberal and "pro-debtor" bankruptcy rules since the bankruptcy law reform in 1978. Meanwhile, Berkowitz and Hynes (1999) noticed that given the mortgage lender's right to foreclose on the home at any time, they are "senior" to homestead exemptions (the amount of property individual borrowers may retain when filing a bankruptcy that would otherwise be taken by creditors) in terms of seeking the collaterals when a debtor filed bankruptcy. The debtor's decision on defaulting on a mortgage and filing bankruptcy may operate in a relatively independent way. For example, some homeowners default on their mortgage without filing bankruptcy, while some others may pay the mortgage while discharging other debts by filing bankruptcy. This means changes in recourse law may not directly change debtor's strategic decision on filing bankruptcy *per se*. Policy makers may not need to worry very much about that moving towards recourse mortgage reduces people's freedom to file bankruptcy.

However, our results face the limitation that distinguishing recent recovery from new bubbles can be difficult. If the additional demand associated with non-recourse mortgages is primarily driven by speculation, the long-run cost of introducing non-recourse mortgages may be much greater than the short-run gain in price recovery and resilience.

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References

1. Adams, Z., and R. Füss. 2010. Macroeconomic Determinants of International Housing Markets. *Journal of Housing Economics*, 19(1), 38-50.
2. Agnello, L., and R. Schuknecht, 2011. Booms and Busts in Housing Markets: Determinants and Implications. *Journal of Housing Economics*, 20(3), 171-190.
3. Berkowitz, J., and R. Hynes. 1999. Bankruptcy Exemptions and the Market for Mortgage Loans. *Journal of Law and Economics*, 42(2), 809-830.
4. Calomiris, C. W., S. D., Longhofer, and W. Miles. 2008. The Foreclosure-House Price Nexus: Lessons From The 2007-2008 Housing Turmoil (No. w14294). *National Bureau of Economic Research Working Paper*.
5. Case, K. E., and C. J. Mayer. 1996. Housing Price Dynamics within a Metropolitan Area. *Regional Science and Urban Economics*, 26(3), 387-407.
6. Case K, and Shiller R. (2003). Is There A Bubble In The Housing Market? *Brookings Papers on Economic Activity*, 2:299-342.
7. Clapp, J. M., and C. Giaccotto. 1994. The Influence of Economic Variables on Local House Price Dynamics. *Journal of Urban Economics,* 36(2), 161-183.
8. Deng, Y., and J. He. 2013. Time Preferences and Mortgage Default. Unpublished Manuscript.
9. Deng, Y., and J.M. Quigley. 2012. Woodhead Behavior and the Pricing of Residential Mortgages. NUS Institute of Real Estate Studies Working Paper Series IRES2012-025.
10. Englund, P., and Y.M. Ioannides. 1997. House Price Dynamics: An International Empirical Perspective. *Journal of Housing Economics*, 6(2), 119-136.

11. Ghent, A. C., and M. Kudlyak. 2011. Recourse and Residential Mortgage Default: Evidence from US States. *Review of Financial Studies*, 24(9), 3139-3186.

12. Glaeser, E., J. Gyourko and A. Saiz. 2008. Housing Supply and Housing Bubbles. *Journal of Urban Economics*. 64(2):198-217.

13. Guiso, L., P. Sapienza, and L. Zingales. 2013. The Determinants of Attitudes toward Strategic Default on Mortgages. *Journal of Finance*, 68(4), 1473-1515.

14. Gyourko, J., A. Saiz, and A. Summers. 2008. A New Measure of the Local Regulatory Environment for Housing Markets: The Wharton Residential Land Use Regulatory Index. *Urban Studies*, 45(3), 693-729.

15. Hubbard, R. G., and C. J. Mayer. 2009. The Mortgage Market Meltdown and House Prices. *BE Journal of Economic Analysis & Policy*, 9(3), 1935-1682.

16. Hwang, M., and J.M. Quigley. 2006. Economic Fundamentals in Local Housing Markets: Evidence from US Metropolitan Regions. *Journal of Regional Science*, 46(3), 425-453.

17. IHS Global Insight (USA) (2011). U.S. Metro Economies S. Metro Economies GMP and Employment Forecasts, the United States Conference of Mayors.

18. Im, K. S., M.H. Pesaran, and Y. Shin 2003. Testing For Unit Roots in Heterogeneous Panels. *Journal of Econometrics*, 115(1), 53-74.

19. Jud, G. D. and T. D. Winkler. 2002. The Dynamics of Metropolitan Housing Prices. *Journal of Real Estate Research*, 23(1), 29-46.

20. Khandani, A. E., A. W. Lo, and R.C. Merton. 2013. Systemic Risk and the Refinancing Ratchet Effect. *Journal of Financial Economics*, 108(1), 29-45.

21. Klein, M. 2014. Bubble to burst to recovery, *Bloomberg Review*, Bloomberg Visual Data. (http://www.bloomberg.com/dataview/2014-02-25/bubble-to-bust-to-recovery.html)

22. Lambrecht, B., W.R., Perraudin, and S. Satchell. 2003. Mortgage Default and Possession under Recourse: A Competing Hazards Approach. *Journal of Money, Credit, and Banking*, 35(3), 425-442.

23. Maitland, M. F., and D. M. Blitzer. 2012. S&P/Case-Shiller Home Price Indices 2011 Year in Review: http://www.housingviews.com/wp-content/uploads/2012/03/SP_Case-Shiller_2011_Year-End_Review1.pdf .

24. Mayer, C. 2011. Housing Bubble: A Survey. *Annual Review of Economics*, 3:559-577.

25. Mayer C, and T. Sinai. 2009. U.S. House Price Dynamics and Behavioral Economics. In *Policy Making Insights on Behavioral Economics*, ed. CL Foote, L Goette, S Meier, pp. 261-295. Boston: Federal Reserve Bank Boston.

26. Meir, A., and R. Harris. 2012. Private Valuation and Private Information: Can Mandatory Non-Recourse Mortgage Legislation Restore a Missing Market? SSRN Working Paper, No. 2011417.

27. Li, W., and F. Oswald. 2013. Recourse and Mortgage Default: the Case of Nevada. Unpublished Manuscript.

28. Pavlov, A., and S. Wachter. 2004. Robbing The Bank: Non-Recourse Lending And Asset Prices. *Journal of Real Estate Finance and Economics*, 28(2-3), 147-160.

29. Reichert, A. K. 1990. The Impact of Interest Rates, Income, and Employment upon Regional Housing Prices. *Journal of Real Estate Finance and Economics*, *3*(4), 373-391.

30. Saiz, A. 2010. The Geographic Determinants of Housing Supply. *Quarterly Journal of Economics*, 125(3), 1253-1296.

31. Shiller, R.J. 2007. Low Interest Rates and High Asset Prices: An Interpretation in Terms of Changing Popular Economic Models. *Brookings Papers on Economic Activity*, 111-132.

32. Solomon, D., and O. Minnes. 2011. Non-Recourse, No Down Payment and the Mortgage Meltdown: Lessons from Undercapitalization. *Fordham Journal of Corporate* and Finance Law, 16, 529.

33. Smyth, S. 2011. Dial-a-Crowd Battles Spanish Banks Trying to Repossess Homes, http://www.bloomberg.com/news/2011-07-13/dial-a-crowd-confronts-debt-laden-spanish-banks-by-thwarting-foreclosures.html

34. U.S. Bureau of Economic Analysis, "CA1-3 Personal income summary" (accessed May 01, 2014).

35. Wheaton, W. C., and G. Nechayev. 2008. The 1998-2005 Housing "Bubble" and the current "Correction": What's Different This Time? *Journal of Real Estate Research*, 30(1), 1-26.

36. White, B. T., 2010. Take this House and Shove It: The Emotional Drivers of Strategic Default, Arizona Legal Studies Discussion Paper No. 10-17.

Figure 1: Total percentage change in the HPI during the boom, bust, and rebound periods plotted against the total change in real local income per capita during the same time window. Circles represent MSAs in non-recourse states, and triangles represent MSAs in recourse states.

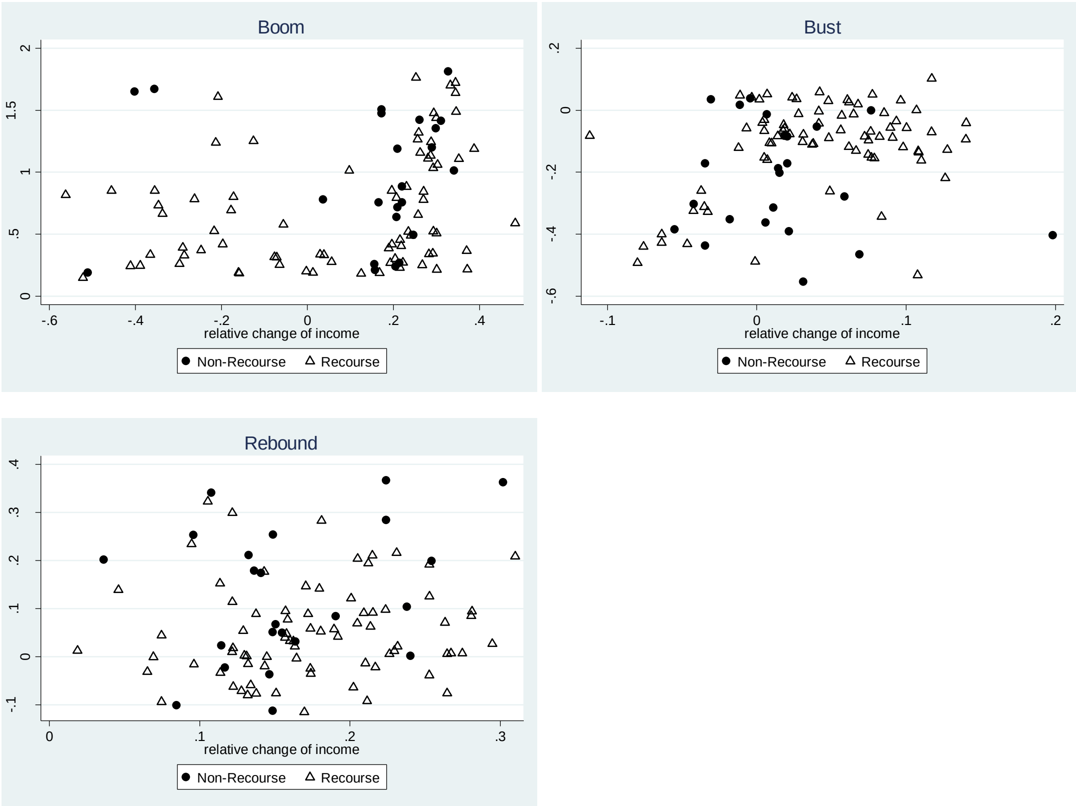

Figure 2: Case-Shiller National Index January 2000–June 2012 (2000 January=100). Data is taken from S&P Dow Jones Indices. The index increase steadily and peaked at about 210 at the beginning of 2006. Then the index slumped and hit the bottom (140) at year 2009, followed by a period of mild growth and drop after 2009.

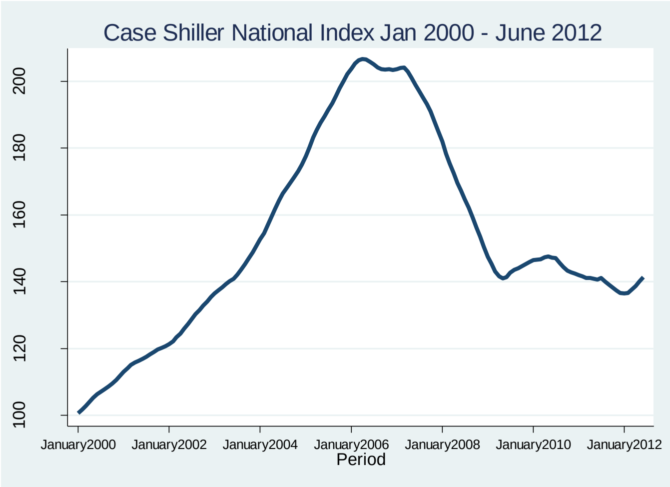

Table 1: Description of Variables and Symbols. There are 2 missing observations for Saiz supply elasticity and 54 for cost data. All other variables have full coverage over the 100 MSAs.

Variable	*Description*
Demand Side	
pop:	Population for MSAs, assume to be constant in the same year
$unempl$:	3-month average estimate of unemployment rate
$income$:	real income(per capita) assume to be constant in the same year
$treasury20$:	Return rate of a Treasury bill with constant maturity of 20 years.
$prime$:	Prime mortgage interest rate.
ltp:	Loan to price ratio in the local market
Supply Side	
cost:	Residential construction cost (or structure cost) of each MSA provided by Lincoln Institute.
saiz:	Index of housing supply elasticity in US MSAs due to geographical reasons defined by Saiz (2010).
wrluri:	The Wharton Residential Land Use Regulatory Index defined by Gyourko et al. (2008), which describes how strictly the local land supply is regulated. A higher index is associated with stricter regulation and lower supply elasticity.

Table 2: Summary Statistics Panel

		Mean	Std. Dev.	Min	Max
HPI		189.18	46.85	85.57	419.69
	00-06	176.65	44.89	85.57	389.78
	06-09	218.89	50.04	112.66	419.69
	09-13	189.11	38.75	99.79	327.4
Unemployment rate (%3-month average)		6.34	2.45	2	17.57
	00-06	5.06	1.42	2	12.13
	06-09	5.34	1.74	2.27	13.8
	09-13	8.79	2.14	3.87	17.57
Population (logarithm seasonal estimate)		14.11	1.02	11.55	16.81
	00-06	14.06	1.02	11.55	16.75
	06-09	14.12	1.02	11.6	16.76
	09-13	14.17	1.02	11.63	16.81
Income per capita		38736.15	8562.926	18235.5	83529.25
	00-06	34490.68	6740.78	18235.5	73696.5
	06-09	41212.15	7850.22	24903.5	78503.75
	09-13	43355.39	8348.84	27217.25	83529.25
Loan-to-price ratio (%)		76.02	3.83	64.84	88.71
Prime mortgage rate		5.72	1.19	3.36	8.32
Saiz		1.77	0.91	0.6	5.45
WRLURI		0.065	0.676	-1.13	2.32
Treasury long-term average rate		4.57	1	2.36	6.58

Table 3: Two-sample Wilcoxon rank-sum (Mann-Whitney) test on the difference between the HPI growth rates in recourse versus non-recourse MSAs.

Ho: HPI (recourse==0) =HPI(recourse==1)			
	Boom		
	Rank sum	Expected	P value
Recourse	2528	2730	0.00
Nonrecourse	2523038.5	2603601	
		P{HPI(recourse)>HPI(non-recourse)}= 0.567	
	Bust		
	Rank sum	Expected	P value
Recourse	444507	466273.5	0.00
Nonrecourse	161043	139276.5	
		P{HPI(recourse)>HPI(non-recourse)}= 0.602	
	Rebound		
	Rank sum	Expected	P value
Recourse	1244955	1248093	0.7353
Nonrecourse	375945	372807	
		P{HPI(recourse)>HPI(non-recourse)}= 0.505	

Table 4: Estimation Output for Equation (1). The dependent variable is the percentage change of HPI, $hpi = 100dlog(HPI)$. Names of the variables are explained in Table 1. Income, population and unemployment are also in terms of percentage change. Z-statistic based on robust standard error is reported between brackets. * are added to denote significance level: *** for p<0.01, ** for p<0.05, and * for p<0.1.

	1	2	3	4	5	6	7
recourse	-0.37**	-0.35**	-0.35**	-0.35**	-0.39*	-0.50***	-0.54**
	(-2.3)	(-2.3)	(-2.3)	(-2.3)	(-1.8)	(-3.0)	(-2.4)
boom	1.97***	1.89***	2.95***	2.63***	2.30***	1.65***	1.81***
	(9.8)	(8.8)	(10.7)	(10.1)	(6.9)	(7.8)	(5.2)
burst	-3.10***	-2.83***	-1.89***	-2.37***	-2.00***	-3.98***	-2.29***
	(-5.2)	(-5.0)	(-3.4)	(-4.1)	(-3.3)	(-6.4)	(-3.4)
boom_recourse	-0.2	-0.15	-0.17	-0.16	-0.07	-0.13	0.06
	(-0.8)	(-0.6)	(-0.7)	(-0.6)	(-0.2)	(-0.5)	-0.2
burst_recourse	1.67***	1.54**	1.55**	1.55**	1.88***	1.79***	2.15***
	(2.6)	(2.5)	(2.5)	(2.5)	(2.6)	(2.8)	(2.9)
pop		0.00	0.00	0.00	0.00		
		(0.3)	(0.5)	(0.5)	(0.4)		
unempl		-0.43***	-0.33***	-0.35***	-0.20***		
		(-7.0)	(-5.1)	(-5.4)	(-2.7)		
income		0.05*	0.07**	0.06**	0.08***		
		(1.7)	(2.4)	(2.1)	(2.7)		
prime			-0.56***		-0.57***		-2.11***
			(-8.6)		(-3.0)		(-6.6)
treasury20				-0.44***	-0.07		1.69***
				(-7.0)	(-0.4)		(5.3)
ltp					-0.03		-0.07***
					(-0.9)		(-2.7)
cost					-0.00***		-0.00***
					(-3.2)		(-3.5)
saiz					-0.03		0.05
					(-0.4)		(0.7)
wrluri					0.33***		0.25**
					(2.7)		(2.0)
L4. pop						0.01	0.01
						(0.7)	(0.7)
L4.unempl						-0.54***	-0.54***
						(-12.1)	(-8.0)

L4. income						0.09***	0.12***
						(4.5)	(3.4)
Constant	0.56***	0.54***	2.90***	2.03***	6.66***	0.94***	10.57***
	(3.8)	(3.1)	(9.5)	(8.7)	(3.2)	(5.4)	(5.7)
Observations	5,400	5,100	5,100	5,100	2,295	4,700	2,115
Number of id	100	100	100	100	45	100	45
within	0.258	0.309	0.317	0.315	0.321	0.338	0.378
between	0.02	0.211	0.229	0.224	0.217	0.246	0.349
overall	0.255	0.306	0.315	0.312	0.319	0.336	0.377

Table 5: Estimation Output for Equation (2). The dependent variable is the percentage change of HPI, $hpi = 100dlog(HPI)$. Names of the variables are explained in Table 1. Income, population and unemployment are also in terms of percentage change. Z-statistic based on robust standard error is reported between brackets. * are added to denote significance level: *** for p<0.01, ** for p<0.05, and * for p<0.1.

	1	2	3	4	5	6	7
recourse	-0.12	-0.09	-0.09	-0.08	0.11	-0.1	-0.01
	(-1.6)	(-1.4)	(-1.3)	(-1.2)	(0.6)	(-1.4)	(-0.1)
pop		0.01	0.00	0.00	0.00		
		(0.7)	(0.4)	(0.0)	(0.0)		
unempl		-0.52***	-0.60***	-0.67***	-0.39***		
		(-7.1)	(-7.7)	(-8.0)	(-4.6)		
income		0.08**	0.04	0.02	0.08**		
		(2.4)	(1.3)	(0.6)	(2.5)		
prime			0.24***		-1.26***		-2.66***
			(5.8)		(-4.6)		(-6.7)
treasury20				0.51***	1.18***		2.02***
				(9.8)	(4.1)		(5.6)
ltp					-0.10***		-0.06***
					(-2.9)		(-2.7)
cost					-0.00***		-0.00***
					(-5.5)		(-3.4)
saiz					0.00		0.10
					(0.2)		0.7
wrluri					0.50***		0.23**
					(2.7)		(2.0)
L4. pop						0.01	0.01
						(0.6)	(0.8)
L4.unempl						-0.51***	-0.52***
						(-10.5)	(-7.9)
L4. income						-0.01	0.12***
						(-0.4)	(-3.7)
boom							2.41***
							(8.6)
Constant	0.84***	0.69***	-0.50**	-1.35***	13.48***	0.88***	11.13***
	(13)	(6.2)	(-2.4)	(-7.1)	(5.7)	(9.1)	(6.3)

Observations	5,400	5,100	5,100	5,100	2,295	4,700	2,115
Number of id	100	100	100	100	45	100	45
Within	0	0.087	0.094	0.111	0.225	0.051	0.35
Between	0.02	0.231	0.2	0.163	0.106	0.104	0.384
Overall	0	0.088	0.094	0.111	0.198	0.051	0.351

Table 6: Estimation Output for Equation (3). Names of the variables are explained in Table 1. Z-statistic based on robust standard error is reported between brackets. * are added to denote significance level: *** for p<0.01, ** for p<0.05, and * for p<0.1. *pop*, *income*, *unempl* and *ltp* are taken as volatility of population, income, unemployment rate and loan-to-price value in the corresponding time window respectively.

Dependent Variable: s.d. of HPI								
Variables	Boom		Bust		Recovery		Whole Period	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Recourse	-10.57***	-2.31	-4.97*	-2.01	-2.87***	-2.48***	-9.10**	-0.42
	(-2.9)	(-0.7)	(-1.8)	(-0.7)	(-2.9)	(-2.7)	(-2.5)	(-0.1)
Pop	0.00	0.00*	0.00	0.00	-0.00	-0.00		-6.45***
	(0.9)	(1.8)	(0.5)	(1.0)	(-0.1)	(-0.6)		(-3.7)
Income	0.01***	0.01***	0.01**	0.00	0.00	0.00		2.47
	(6.3)	(4.2)	(2.3)	(1.3)	(0.7)	(1.3)		(0.9)
Unempl	-15.73***	-14.39***	29.77***	26.18***	4.49***	4.35***		0.00
	(-2.7)	(-3.2)	(10.9)	(9.5)	(5.1)	(5.6)		(0.9)
Saiz		-5.82***		-3.65**		-1.63***		0.00
		(-3.3)		(-2.4)		(-3.0)		(1.1)
Wrluri		6.71**		0.53		0.88		10.12***
		(2.4)		(0.2)		(1.1)		(3.9)
ltp		-1.03*		-0.54		0.22		-0.54
		(-1.9)		(-1.0)		(0.9)		(-0.8)
Constant	21.86**	114.02***	-24.27***	28.33	6.71***	-7.61	38.72***	56.67
	(2.6)	(2.9)	(-4.1)	(0.7)	(3.9)	(-0.4)	(12.1)	(1.0)
Observations	100	98	100	98	100	98	100	98
R-squared	0.407	0.669	0.612	0.674	0.333	0.481	0.059	0.540