Is there a leverage cycle in the US housing market? The role of government and private actors

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Abstract

Assumptions about how collateral constraints change over time are central to many models of credit cycles. We show that the distribution of combined loan-to-value ratios (CLTVs) for mortgage purchases has been remarkably stable in the US over the last two decades. While the private provision of high-CLTV loans soared during the housing boom of the early 2000s, these loans primarily replaced market share from high-CLTV loans previously underwritten by government entities such as FHA and VA. FHA/VA loans then increased back to 30% of all purchases after the financial crisis. The large house price increases in the boom precede the increased prevalence of private high-CLTV loans rather than the reverse. These findings suggest that the housing boom and subsequent financial crisis cannot be explained by changes in purchase leverage, and instead favor models that rely on changes in collateral values or broad changes in house price expectations.

JEL Classification: D30, E3, G21, G28, R30

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1 Introduction

Housing markets in the United States and other countries around the world have been marked by recurring boom and bust cycles. Several of these episodes, most notably the 2008 financial crisis, are associated with significant expansions in the amount of mortgage debt that households take on. This experience has inspired a large and growing literature to understand the factors leading to house price bubbles and valuation cycles. A number of theory papers build on the idea that the relaxation of credit standards plays an important role in facilitating housing bubbles. Without more generous access to credit, many buyers would otherwise be shut out from purchasing increasingly expensive homes. But credit is typically constrained across two dimensions. First, lenders impose loan-to-value (LTV) limits to ensure repayment in case of default and discourage strategic default. Second, lenders also impose debt-to-income (DTI) constraints to account for a borrower's ability to pay back their mortgage.

It is by now well understood that during the housing boom of the early 2000s lenders were willing to relax debt-to-income constraints. The level of mortgage credit to income rose significantly across all income groups in the US during that time period (see, for example, Adelino et al. (2017), Foote and Willen (2018), and Albanesi et al. (2019)). It is often assumed that this relaxation of DTI constraints went hand in hand with a relaxation in LTV constraints. We show that this was not the case. While the loan sizes for home purchase varied significantly with the housing cycle (driven by the changes in house values), the distribution of combined LTVs (that include all liens on a house) at origination remained largely unchanged across the population.

The main reason for the stability of the CLTV distribution is that there are two sources of very high CLTV loans (which we define as loans with a CLTV above 95%) in the US, privately originated high CLTV loans and directly government-backed mortgages through the Federal Housing Administration (FHA) and the Department of Veterans Affairs (VA). While it has been widely noted that privately supplied high-CLTV credit increased during the housing

boom, we show that these private loans replaced similarly high-CLTV loans backed by FHA and VA. After privately supplied high-CLTV loans dried up post-2008, the share of FHA and VA loans again increased significantly. Second, we show that reliance on high-CLTV loans, whether provided by government or private sources, is concentrated within the same zip codes, the same properties and even the same types of borrowers over our whole sample period. In other words, zip codes that heavily relied on FHA/VA loans pre-2000s are the ones where high-CLTV private loans expanded rapidly post-2002 and crowded out FHA/VA loans. These are also the zip codes where FHA shares surged post-2008. Similarly, at the individual property level, we find that certain types of properties are persistently bought with high CLTV loans. Only the source of the high CLTV loans changed between the boom and non-boom times.

Why does it matter how credit standards loosened across the housing boom and bust cycle? An influential literature on credit cycles going back to Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) emphasizes the role of collateral values in creating a multiplier-accelerator feedback channel in models with limited enforcement. Since firms and households are constrained by the value of their assets in how much they can borrow, an increase in asset values makes it easier to borrow, which improves productivity, and as a result increases asset values even further, making it easier to borrow. This class of models assumes that the ratio of loan-to-asset values is constant. While collateral in these models has an important externality for the economy, it does not lead to asset bubbles or crashes, since there is no uncertainty or over-optimism about future house price values. In Kiyotaki and Moore (1997), for example, leverage actually rises after a bad shock, dampening any crisis.

A recent literature has emphasized the role that endogenous changes in leverage can play in explaining house price dynamics and boom-bust cycles. For example, Geanakoplos (1997, 2010) argues that pro-cyclical fluctuations in loan-to-value (LTV) ratios can be a fundamental driver of boom-bust cycles in credit markets. When volatility is low for an extended period of time, leverage (CLTV) might rise because lenders feel more secure and are

willing to stretch the available collateral. More people can afford to purchase housing and are willing to spend more for the collateral because they can use it to borrow. The central assumption is that there is a class of buyers for whom the asset is more valuable than others (possibly because they are more optimistic). A relaxation in LTV constraints allows these borrowers to bid prices up. In fact, several models of the credit boom of the early 2000s use changes in the LTV at origination as the key credit supply variable and include large changes in LTV to fit the observed movements in house prices (Corbae and Quintin, 2015; Favilukis et al., 2017; Landvoigt et al., 2015).

Our results show that highly levered loans were available throughout the last two decades, suggesting that the housing boom and subsequent financial crisis cannot be explained by changes in aggregate purchase CLTVs. Instead, lenders expanded credit in proportion to rising house prices, and allowed DTI ratios to go up across the population. These results favor models that rely on changes in collateral values (credit cycle models) or broad changes in house price expectations.

We use the universe of home purchase transactions between 1996 and 2015 from CoreLogic, as well as BlackKnight, to look at the variation of CLTVs over the last two decades, including the housing boom, the crisis, and the subsequent recovery. We show that the distribution of combined loan-to-value ratios (CLTVs) has been stable over time, with changes in average CLTV of less than two percentage points over the whole period. In fact, even when house values were going up dramatically between 2002 and 2007, the whole distribution of CLTVs at origination remained largely unchanged, consistent with Glaeser et al. (2012) and Ferreira and Gyourko (2015).

We confirm that the CLTVs of mortgages supplied by the private-sector increased during the housing boom, consistent with Pinto (2010) and Keys et al. (2012). However, these private-sector loans displaced high-CLTV loans guaranteed by the government during this time period. When private-sector high-CLTV loans once more became unavailable after the financial crisis, the government programs "filled" in their share of the overall market.

That is, the pro-cyclical nature of private-sector LTVs is counter-balanced by the share of purchase mortgages that are explicitly guaranteed by the government.

This stability could, potentially, mask differences in the distribution of zip codes or properties that were able to access high-CLTV loans. In particular, private-sector high-CLTV loans might have been given to lower-income borrowers (or areas) during the boom, and these households might not have been able to access such loans outside of the boom. We find that this is not the case.

First, looking within zip codes, we document very high correlations between the share of purchase loans that were guaranteed by the government before the boom (in 1999) and the share of high-CLTV private-sector loans in 2006. There is a similarly high correlation between high-CLTV loans in 2006 and the share of (highly leveraged) purchases guaranteed by the government in 2013. A similar picture emerges when we look at zip codes grouped into deciles by income: decile-by-decile, the FHA/VA share of loans before the boom is almost exactly offset by high-CLTV private sector loans before the crisis. That is, at the zip-code level, the same areas relied on high-CLTV loans for a significant portion of purchases throughout the two decades we consider.

Second, a possible concern is that the type (and possibly the quality) of collateral backing transactions changed over the cycle. We use a novel application of the typical repeat-sales methodology (Case and Shiller, 1989) to show similar stability in the use of high-CLTV loans even within properties over time. This approach ensures that the general quality of the asset remains fixed. We find that during 2000 to 2008, private-sector high-CLTV loans are much more likely to have been used in home purchases that were previously financed with FHA/VA loans. And, following the bust, those same properties that used high-CLTV private loans were financed with FHA/VA loans.

Finally, we look at the purchase decisions of individual households to better understand if the users of high-CLTV, government loans pre-boom were very different from the users of privately provided, high-CLTV loans during the boom. For example, one might worry that

during the housing boom period, high-CLTV loans were taken out by more aggressive or more marginal borrowers than the FHA borrowers before. To speak to this hypothesis, our final test tracks the borrowing decisions of specific households. We turn to a dataset of deeds records (at the property level) and voter records (at the individual level) to track individuals over time, even as they move from one house to another. We find, consistent with all the evidence thus far, that the same households who used FHA or VA loans between 1996 and 2003, used private-sector loans with CLTVs $\geq$ 95% during the 2004-2007 period and then switched back to FHA-VA loans after the boom.

While the results show that the composition both at the property and at the borrower level is similar over the cycle, it is possible that the availability of privately supplied high-CLTV loans itself drives house prices higher. Private, high-CLTV loans are quicker to close and are generally available with less documentation than FHA-VA loans of equivalent CLTV (LaCour-Little (2007)). These features could help fuel increases in house prices. We show that the timing of the increase in private high-CLTV share during the housing boom does not support this interpretation. Instead, the areas where prices rose the most saw higher prices *before* the increase in private high-CLTV share (consistent with the results in Ferreira and Gyourko (2011)).

In a final test, we estimate default rates of private-sector high-CLTV loans and government-guaranteed loans. If the private-sector loans were different in ways unobservable to us, we would expect to see differences in performance. We find that, while low-CTLV loans are much less likely to ever go into delinquency or default than high-CLTV loans, the performance of all high-CLTV loans were similar within cohort regardless of whether they were government-guaranteed or not.

Our results raise important questions about how to model credit cycles: if credit constraints were indeed relaxed during the housing boom it was not because of changes in CLTVs. It is possible that some models use looser CLTV limits as a "stand-in" for a broader relaxation of credit constraints, possibly through higher debt-to-income ratios or weaker

documentation requirements. Existing work suggests, however, that different constraints bind in different states of the world. Using a general equilibrium framework, Greenwald (2018) shows important differences in relaxation of payment-to-income standards compared to loan-to-value ratios for explaining boom-bust cycles and the role of monetary policy. In addition, double trigger models of default explicitly consider separately the roles of debt overhang and ability to pay (see Foote and Willen (2018) for a review of this literature). Finally, the manner in which loans are guaranteed may matter. The fact that high-leverage loans are explicitly guaranteed by the government during some periods (through FHA/VA insurance) and then become implicitly government guaranteed (through too-big-to-fail or other government backstops) may have implications for overall financial stability.

2 Background, Motivation, and Data Description

2.1 Institutional Detail

The government programs designed and operated by the Federal Housing Administration (FHA) and the Veteran's Administration (VA) share several characteristics. They both seek to encourage home ownership among their target populations: low-income, middle-income, and first-time homeowner households for FHA and military families for VA. The FHA has stricter underwriting standards than the VA, requiring FICO scores to be above 580 in order to qualify for minimum 3.5% down payment, debt-to-income ratios to be below some maximum (31% front-end, 45% back-end), and that the borrower buy mortgage insurance from the FHA. Both the FHA and the VA require that the home be the borrower's primary residence and that the borrower has some proof of employment. FHA-insured and VA-insured loans together account for almost all of the loans backed by "the full faith and credit guarantee of the US Government."[1] Kim et al. (2018) provide an in-depth look at the current origination of FHA and VA mortgages, including the institutional details of this market and

[1] https://www.hud.gov/hudprograms/Ginnie_Mae_I, accessed August 1, 2019.

the role of non-bank mortgage companies. The paper focuses on the implications of the limited amount of capital of those companies on the stability of the financial sector and the potential need for a government bailout in an adverse event.

Securities backed by FHA loans are guaranteed by the US Government through the Government National Mortgage Association (Ginnie Mae), while the VA provides partial guarantees and servicers provide the rest. In addition, Ginnie Mae provides additional residual protection in case servicers default. Fannie Mae and Freddie Mac (other government-sponsored entities) purchase loans from the issuing lenders and then securitize mortgages they purchase. Ginnie Mae, in contrast, gives lenders approval to make FHA- or VA-loans. The lenders themselves then package their government-guaranteed loans into mortgage-backed securities. These securities are then explicitly guaranteed by Ginnie Mae. Any losses are first covered by the insurance premiums the FHA requires borrowers of its guaranteed loans to purchase. Further losses are covered by the US government.

The underlying argument for the existence of the FHA/VA programs is that they grant qualifying borrowers access to mortgage credit that they would not normally have access to in a world where mortgages are provided only by private markets. This paper shows that the share of high-CLTV loans made by the private market was highly pro-cyclical during the last two decades. Importantly, highly leveraged loans *were* made before the boom, as well as after the financial crisis, but only by government programs that had an explicit mission to encourage home ownership.

2.2 Previous work on CLTVs over the time series

A few papers have looked at the time series of average LTVs in the whole population and found stable averages over time. Glaeser et al. (2012) show, using a similar deeds dataset to ours, that down payments did not change in the years between 1998 and 2008 and are therefore an unlikely culprit for the dramatic increase in house prices. Ferreira and Gyourko (2015) also use deeds data to show a time series of combined loan-to-value ratios for

prime loans, subprime loans (those made by subprime lenders), FHA/VA and small lenders. More recently, Adelino et al. (2018) also show that the distribution of purchase CLTVs over time has been stable. To the best of our knowledge the prior work has not considered the role of FHA and VA guarantees in supplying high-CLTV loans over the cycle, and how this interacted with the supply of those loans by the private sector along the distribution of households and properties.

Other work has considered segments of the mortgage data and measured CLTVs within those segments. A number of studies has looked specifically at mortgages held in private-label mortgage-backed securities (originally using data from LoanPerformance and now CoreLogic). Using this data, Demyanyk and Van Hemert (2009), Keys et al. (2012), and Gerardi et al. (2008) document a number of important features of these loans, including that their CLTVs increased dramatically in the early 2000's. Another highly cited paper by Pinto (2010) documents that the share of mortgages purchased by Fannie Mae and Freddie Mac using CLTVs above 97% increased from 5% in 1996 to 40% in 2007. The data used to determine these shares comes from the FHA 2009 Actuarial Study.[2] The analysis in these papers applies to particular segments (private-label and agency loans, respectively), and should not be interpreted as showing an increase in CLTVs for the market as a whole.

2.3 Data description

To overcome the limitations discussed in Section 2.2, we require a dataset that meets three requirements. First, it must include every loan (including second and third mortgages) that the borrower used to finance the purchase of their home (Figure A1 shows the indidence of second and third liens over time in the data). Second, the data must include a value of the home at the time the mortgage was originated. Third, the dataset must include the universe of mortgages, and not just those packaged in private-label securities or originated by one

[2]The 2009 FHA Actuarial Study is available here: https://www.hud.gov/sites/documents/DOC_16571.pdf. The actuarial study includes refinance loans and imputes the values for those properties when calculating its loan-to-value ratios.This imputation may lead to measurement error in CLTVs (see Aragon et al. (2010) for a more thorough explanation).

bank. The deeds data, kept in county recorder's offices and then collected and published by data company CoreLogic, meet all three of these criteria.

In this project we focus on purchase transactions. An important limitation of the deeds data – and indeed almost every dataset on mortgages – is that measures of value are only reliable at time purchase. By using the actual sale value of the home we assuage concerns about bias in appraisal values (which would affect measured CLTVs for refinance loans, see Agarwal et al. (2015)). One potential solution is to use data from a lender as in Bernstein (2018), but then we no longer observe the universe of loans.

In the deeds data we cannot observe the income or credit scores of the borrowers. In order to answer questions that require credit scores and income we also use data from Credit Risk Insight Servicing McDash (CRISM) dataset, developed by Equifax using a proprietary algorithm to match Mcdash's mortgage servicing records to individual-level Equifax credit data. This dataset covers approximately two thirds of first mortgages originated in the market from the second half of 2005 to the end of 2015. Mcdash contains mortgage characteristics such as mortgage type (FHA, VA, or private), origination month, original loan amount, original property value, credit score at origination, front-end debt-to-incommt (DTI), and also mortgage performance over time. On the other hand, Equifax keeps track of consumer's liabilities and we can observe the number of both closed-end second (CES) and home equity line of credit (HELOC) taken by the individual as well as the date and the amount of the two largest loans of each type that are active at each month. This allows us to capture all second liens for over 90 percent of consumers. We then estimate original CLTV by matching Mcdash's first mortgages to Equifax's second mortgages taken by the same person at the same month.

3 Two Key Features of the Data

Using the deeds data for all US counties covered by CoreLogic, we calculate the CLTV of every purchase loan and whether that loan was an FHA- or VA-guaranteed loan. The CLTV is defined as follows: we sum the loan amounts for each loan, up to three loans, used to finance the purchase and then divide that sum by the sale price. Cash purchases (those that did not use any leverage) are not included in any of the results presented below (we show the share of transactions that were cash only in Figure A2).

3.1 A Steady Distribution of CLTVs over the Time Series

[FIGURE 1 HERE]

The first presentation of our findings is shown in Figure 1. To create this figure we took all purchases with mortgages originated in a given year and then calculated the mean CLTV of those loans along with the 5th, 25th, 75th, and 95th percentile CLTV. These five statistics are plotted every year between 1996 and 2015. The figure illustrates a remarkably steady distribution of CLTVs over the entire time series. During this same period, house prices experienced a large run-up (up to 2005) and subsequent collapse and recovery. That is, even while "V" was changing dramatically, the debt per dollars of housing collateral being used to finance purchases hardly changed. Importantly, it is not the case that the mean stayed the same while the tails of the distribution moved around. Specifically, what we do *not* see is a distribution where the 75th and 95th percentiles of the distribution increased during the bubble. We obtain a very similar picture when we value-weight each loan (Figure A3) and when we split states into recourse and non-recourse (Figure A6) (suggesting that the dynamics of collateral rates were not very affected by creditors' ability to pursue legal action against defaulting borrowers).

3.2 A Changing Share of Government-Guaranteed Loans

[FIGURE 2 HERE]

The steadiness of the CLTVs is perhaps unexpected given the huge increase in origination of private-sector mortgages with very low down payments documented during the housing boom. This increase can be clearly seen in Panel A of Figure 2. The share of private-sector loans with CLTVs $\geq 95\%$ increases from less than ten percent of all origination to nearly thirty percent of all purchase loans at the height of the housing boom in 2006. How can the share of such high CLTV mortgages have increased so dramatically with no contemporaneous increase in the distribution of CLTVs? The answer becomes clear in Panel B of the same Figure.

Panel B plots the share of all purchase loans guaranteed by the FHA and the VA that also had CLTVs $\geq 95\%$. What this figure shows is that the share of all loans (both government guaranteed and private-sector) with CLTVs $\geq 95\%$ hardly budged during the housing boom. And the steadiness of the CLTVs documented in Figure 1 becomes clear in light of this fact.

[FIGURE 3 HERE]

Figure 3 provides another look at the role of government guaranteed loans in the mortgage market. To create this figure we classified loans into one of five types. FHA- and VA-guaranteed loans with CLTV either below 95% or not, and then all other loans. The key takeaways from this figure are twofold. First, as seen in Panel B of Figure 2, the share of loans guaranteed by FHA or VA dropped from 25% before the boom to about 5% during the boom and then up to nearly 50% of all purchase loans in 2010. The second takeaway is that almost all of the loans guaranteed by these two programs are very high CLTV loans. In no year are fewer than 90% of FHA- and VA- insured loans mortgages with CLTVs of at least 95%.

3.3 Revisiting the Distribution of CLTVs

[FIGURE 4 HERE]

In Figure 4, we revisit the distribution of CLTVs. Instead of plotting just the mean and four percentiles of the distribution, we plot the entire cumulative density function. In Panel A, we plot the CDFs of purchase-loan CLTVs in 1999 and 2006. In 1999, we see that fewer than 10% of loans have CLTVs above 95%, about 30% of loans have CLTVs over 90%, and roughly half of all loans have CLTVs above 80%. The story, as expected given Panel A of Figure 2, is dramatically different in 2006. In 2006, 30% of loans not guaranteed by the FHA or the VA had CLTVs above 95% (compared with fewer than 10% in 1999). Similarly, the share of loans with CLTVs of at least 90% increases from 30% to more than 40%.

Panel B of Figure 4 illustrates the importance of using the universe of purchase loans if we want to know the economy-wide importance of debt for home purchases. First, the CDF of CLTVs of all purchase loans in 1999 shifts significantly to the right when compared to the CDF of private-sector loans. This is because the private-sector only 1999 distribution of loans does not include 25% of loans originated 1999, almost all of which were very high CLTV loans. Second, the "All loans, 2006" and "Private loans, 2006" lines are very similar. Given the tiny share of loans guaranteed by the FHA or VA in 2006, this is not surprising. Finally, and most importantly, comparing the two lines in Panel B tells a very different story than would be told using only Panel A. Specifically, when looking at all purchase loans, we see that approximately 30% of loans in both years have CLTVs above 95% and approximately 40% of loans in both years had CLTVs above 90%. That is, the share of loans with low down payments did not change.

4 Evidence of Switching

Section 3.1 shows that the share of purchase loans with high CLTV ratios did not change over the time series, nor did the overall distribution of CLTVs. Despite wildly changing

house prices and dramatic shifts in purchase and mortgage origination activity, the debt capacity of housing did not change. What did change was the share of the high-CLTV loans that were explicitly guaranteed by the government through the FHA and VA programs. This section of the paper asks an important follow-up question. Were the high-CLTV loans that were being guaranteed by the government before the boom and then being displaced by the private-sector going to the same types of borrowers? Or does the steadiness of the CLTV distributions mask shifts in where the high-CLTV loans were going. To answer this question we subdivide our sample of purchase mortgages in three different ways: by zip code, by parcel, and by specific borrower. In all cases we find compelling evidence that it is the same parts of the country and same types of borrowers, and indeed even the exact same properties and exact same borrowers, that use government-guarantees to access high-CLTV loans pre- and post-boom but switch to the private sector during the years 2003-2007.

4.1 Switching within Zip Codes

Our first test uses publicly available IRS data from 1998 to divide zip codes into ten population-weighted deciles of adjusted gross income.

[FIGURE 5 HERE]

To create Figure 5, we compute the share of purchase loans in each income decile that are FHA/VA and private, high-CLTV. We compute these shares at three different points in time: pre-boom (1999), boom (2006), and post-boom (2013). There are three key takeaways from this figure. First, there is a downward trend in the use of high-CLTV mortgages as income increase. Second, this downward trend stays roughly the same over the whole time series. That is, within each income decile over time, the share of purchase loans that are high-CLTV remains similar. Third, in contrast to the smoothness of the first two takeaways, within each income decile over time the share of high-CLTV loans that are government guaranteed goes from almost all of them, to almost none of them, and then back to almost

all of them.

The results for zip codes split into income deciles are also present within zip codes themselves.

[FIGURE 6 HERE]

Panel A of Figure 6 plots zip codes with at least five purchase transactions with mortgages in both 1999 and 2006. The figure shows a positive relationship between the share of loans that were in 1999 guaranteed by either the FHA or the VA and the increase between 2006 and 1999 of the share of private-sector high-CLTV loans. The correlation between these two variables is .464 and demonstrates that, within 5-digit zip codes, knowing the importance of government-guaranteed loans in the mortgage market is strongly predictive of the share of the 2006 cohort of purchase loans that will be private-sector high-CLTV loans. This result helps to rule out the possibility that the steadiness of the CLTV distribution is masking shifts in the geographic distribution of high-CLTV loans. For example, it could have been that high-CLTV, government-guaranteed loans were going to some parts of the country in 1999 (zip codes not in the sand states of AZ, CA, FL, and NV) and then, during the boom, the private-sector's high-CLTV loans were all made to borrowers buying homes in the sand states. But this is not consistent with the results in Panel A of Figure 6.

Panel B of the figure moves along the time series and plots an analogous scatter plot comparing the increase in share of purchase loans insured by the FHA or the VA during the recovery to the share of loans that were in 2006 high-CLTV, private-sector mortgages. As before, we document a strong correlation consistent with the idea that zip codes are switching their source of high-CLTV loans from the government, to the private sector, and then back to the government.

4.2 Switching within Parcels

The correlations within zip codes discussed in the previous section are not themselves sufficient evidence that the same types of borrowers or geographies switch their source of high-CLTV loan from the government guaranteed part of the market to the private market. New construction in zip codes, the types of homes and properties that are listed for sale and eventually sold, or the people looking to buy and the properties they are interested in all might change over the time series in ways correlated with preferences for type of mortgage. To rule out some of the geography-related alternative hypotheses, we focus on the sample of properties that traded both pre-boom and during the boom or both during the boom and post-boom.

Figure A7 shows a repeat-sales index of LTVs constructed using the same methodology employed for measuring house prices over time (see, for example, Case and Shiller (1989)). The figure shows that, within the same properties, changes in LTVs over time vary within a band of 4 percentage points and are, if anything, inversely related to house price movements. We obtain a very similar picture when we include bank-by-county fixed effects rather than property fixed effects, suggesting that even within lenders the patterns are the same (Figure A8).

As we have discussed before, the results on average CLTVs are the result of changes in the providers of high-CLTV loans over time. We employ the repeat-sales methodology to also answer the question of whether switching between private and public sources of high-CLTV loans is visible within properties. The results are presented in Table 1.

[TABLE 1 HERE]

The sample used in the first model includes more than two million properties across the United States. These properties were all purchased by one household at some point between 1996 and 2003 (pre-boom) and by a different household between 2004 and 2007 (boom). We restrict the sample to properties where both trades were at arm's length and utilized a

mortgage. Our specification asks what the relationship is between the likelihood a property is purchased with a high-CLTV private-sector loan during the boom if it was financed with a government-guaranteed loan (FHA or VA) when purchased pre-boom. We run regressions of the following form for each property i:

$$HighCLTV_{i,2004-2007} = GovtGuarantee_{i,1996-2003} + \eta_t + \eta_{t+1} + \eta_{County} + \varepsilon_i \quad (1)$$

Where η_{County} represents county fixed effects to absorb differences across the country the average use of government-guaranteed mortgages, and η_t and η_{t+1} represent year fixed effects for the first and second transactions to absorb overall changes in the rate that borrowers used different types of loans over time. We run regressions of a similar form for the crisis and recovery period, where we are interested in the switching back from private high-CLTV loans to government-guaranteed loans.

$$GovtGuarantee_{i,2008-2015} = HighCLTV_{i,2004-2007} + \eta_t + \eta_{t+1} + \eta_{County} + \varepsilon_i \quad (2)$$

We find a statistically significant and economically meaningful relationship. A property is 11.4 percentage points more likely to be purchased with a high-CLTV private mortgage if the property was purchased pre-boom with a government-guaranteed loan. To illustrate the economic importance of this estimated magnitude, we present some simple summary statistics in Table 2. We show that, among loans taken out in the period 2004-2007 for this sample, 24% ((379,697 + 193,464) / (2,362,748)) were private, high-CLTV loans. So an 11.4 percentage point increase is equivalent to a nearly 50% increase. The unconditional results presented in Table 2 tell a similar story. Of properties financed with FHA/VA loans during the pre-boom, 33.1% of them are financed with high-CLTV private loans during the boom, compared to just 21.4% of properties that were not financed with government-guaranteed loans pre-boom.

[TABLE 2 HERE]

The second model in Table 1 and second panel of Table 2 are analogous and focus on those properties traded first during the boom and then again during the recovery (2008-2015). The results are qualitatively very similar. In short, even at the property level, we document a striking switching between a government-guaranteed, high-CLTV mortgage and a high-CLTV mortgage provided by the private-sector. While it can be argued that the zip code correlations might not be evidence of switching if the types of houses trading are dramatically different pre- and post-boom compared to during the boom, that same argument cannot explain the results just presented.

4.3 Switching within Individual Borrowers

Even with the evidence on zip codes and properties, the results can be explained with something other than strict switching between two different types of providers of high-CLTV mortgages. Consider, for example, the possibility that the only people purchasing during the boom were the high-earners in each zip code and high-earners only use private-sector loans. In order to show results within-households, we use a subsample of the deeds data within which we can track households moving across the state. To build this dataset, we merge the North Carolina deeds data with the North Carolina voter registration records. The voter rolls data includes the address of the registered voter, and, if that voter moves, their address is updated in their voter registration record.[3] The results presented in Table 3 and Table 4 are analogous to those in Table 1 and Table 2 except instead of focusing on properties that transact twice, we use borrowing households that purchase twice at two different properties for documenting switching.

[TABLE 3 HERE]

The sample used to estimate the models is small but still produces magnitudes that are both statistically and economically significant. Borrowing households that use government-

[3]See a more thorough description of the construction of this dataset in McCartney (2017).

guarantees for access to high-CLTV loans pre-boom switch to private, high-CLTV loans during the boom. And those households that first purchase during the boom and use high-CLTV, private mortgages switch to government-guaranteed mortgages post-boom. Specifically, looking at the first specification we see that borrowers are 11.3 percentage points more likely to use a private-sector loan with a high CLTV if their pre-boom loan was FHA- or VA-guaranteed. 17.1% ((1,026 + 282) / (7660)) of in-sample purchase mortgages originated in NC during the boom were private, high-CLTV mortgages. So an 11.3 percentage point increase amounts to a 66% increase from the mean. The model estimating switching in the second half of the time series finds a 6.74 percentage point increase or 34.7%[4] increase from the mean.

[TABLE 4 HERE]

As with the property switching results, the unconditional results for borrower switching presented in Table 2 tell the same story. In North Carolina, 15.5% of households who did not use FHA or VA loans for their pre-boom mortgage used a high-CLTV, private mortgage during the boom compared to 27% of households who did. Similarly, the rate of use FHA or VA loans during the post-boom was 24.7% for those borrowers that used high-CLTV, private mortgages for the boom purchase, compared to a smaller 18% of borrowers that did not.

5 Timing of house price increases and changes in high-CLTV loans

One question that our results raise is whether the changes in the source of high-CLTV loans are merely correlated with the house price cycle, or whether there is a causal link between the two. While we cannot provide a definitive answer to this question, one natural approach is to ask which comes first – the change in house prices or the switch between private and

[4].0674/[(1,686 + 613) / (11,858)]

FHA-VA sources of high-CLTV loans. We show the results of this analysis in Figure 7 and Table 5. In both cases we find that the increase in house prices during the housing boom precedes the large increase in private high leverage lending rather than the reverse.

Figure 7 sorts zip codes into deciles based on the house price growth between 2002 and 2006 and plots both house price growth and the change in private high-CLTV share at the zip code level. The three panels split the time period of 1999-2006 into three subperiods (the first four years and then 2003-2004 and 2005-2006). The figure shows clearly that changes in house prices were higher for the top deciles both in the beginning of the period and in the middle, whereas the changes in private high-CLTV share only sort on house prices strongly at the end of the period. While it is, of course, possible that prices rose in anticipation of looser credit, this simple analysis suggests that it is more likely that higher prices were, instead, the reason behind the reduction in FHA-VA share and the increase in the private high-CLTV segment (possibly because these allowed borrowers to participate in "hotter" markets). These results are consistent with Ferreira and Gyourko (2011) who show that increases in subprime lending happen *after* prices start rising more significantly in most neighborhoods in the US.

In Table 5 we use the same instrument developed in Palmer (2015) and Guren et al. (2018) to generate a cross-section of commuting zones (CZ) in the US by their propensity to exhibit large house price movements. Panel A shows that the instrument is highly predictive of house prices. In Panels B and C we look at how the instrument sorts CZs based on changes in the FHA-VA share and changes in private high-CLTV loans. As in the previous analysis, we see that the increase in private high-leverage loans is only related to the places with larger price movements at the peak of the boom and not before. This suggests that it is unlikely that the switch to high CLTV-private loans was causally responsible for the higher prices. Instead it appears that they were the results of increasing house prices.

6 Debt-to-income by Loan-to-Value

In Figure A we consider how the debt-to-income ratio (DTI) of FHA loans compares to private high-CLTV loans of similar and higher credit scores at the peak of the housing boom (2005-2007). DTI is computed as the share of a household's income that goes toward mortgage and mortgage-related expenses (like insurance). Panel A shows that FHA loans have a DTI of around 37%, measured as payments relative to the mortgage (including FHA insurance premia) as a share of monthly income. Panel B considers borrowers with a credit score below 660 and shows that those borrowers carry higher DTIs of around 39 to 40%. This is consistent with more aggressive lending standards by subprime lenders in particular who specialized in these types of loans. Middle and high credit score borrowers have either equal or lower debt-to-income as FHA loans.

7 Performance of Government-Guaranteed vs. Private

The last section of this paper uses the ex-post performance of high-CLTV loans guaranteed by the government versus those provided by the private-sector to provide further evidence that two types of mortgages were being used interchangeably by the same types of borrowers in the same types of places.

[FIGURE 10 HERE]

Figure 10 plots the share of loans of each type by origination-year cohort that are at some point 90+ days delinquent within three years of origination. As expected, private-sector loans with CLTVs < 95% have significantly lower delinquency rates than any loan with a CLTV ≥ 95%. Strikingly, though, is the finding that within cohort the rates of delinquency for FHA/VA loans is the same as for private loans with CLTVs ≥ 95%. These results are completely unconditional and we interpret them with caution.

8 Conclusion

This paper shows that the distribution of purchase mortgage CLTVs has been steady for the last two decades. Underlying this stability is a large change in the way high-leverage mortgages are supplied. Specifically, before the large housing boom of the 2000s, high-CLTV mortgages were guaranteed by the government primarily through the FHA and VA programs. The boom saw an increase in the supply of private-sector high-CLTV loans, which then dried up again in the crisis, with a return of the FHA/VA for a significant share of the market.

The findings in the paper show that, despite the large expansion in the volume of credit during the boom, and the increase and drop in house prices in this time period, the share of high-CLTV loans is stable but provided by different sources. The fact that the government *explicitly* guarantees high-leverage loans during certain times, and then *implicitly* guarantees them during others through too-big-to-fail or other government backstops for financial institutions can have implications for overall financial stability.

Our paper also shows that empirical models of the housing market will be broadly accurate in assuming relatively stable "collateral rates" (in the language of Geanakoplos (2010) ,as is the case of Kiyotaki and Moore (1997)). As a matter for future research it is important, however, to consider two facts related to this paper: first, when and why does the private sector "drive-out" the government in supplying high-leverage loans, and, second, how do different sources of high-CLTV loans influence the path of house prices and the indebtedness of households.

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Figure 1: A Steady Distribution of Purchase Loan CLTV Ratios Over Time

This figure plots the combined loan-to-value ratios (CLTVs) of the universe of purchase transactions financed with at least some debt covered in the CoreLogic deeds data between 1996 and 2015. Each purchase transaction includes data on up to three mortgages, one primary mortgage and up to two piggyback mortgages. The percentiles and mean are calculated using all purchase loans originated in the calendar year.

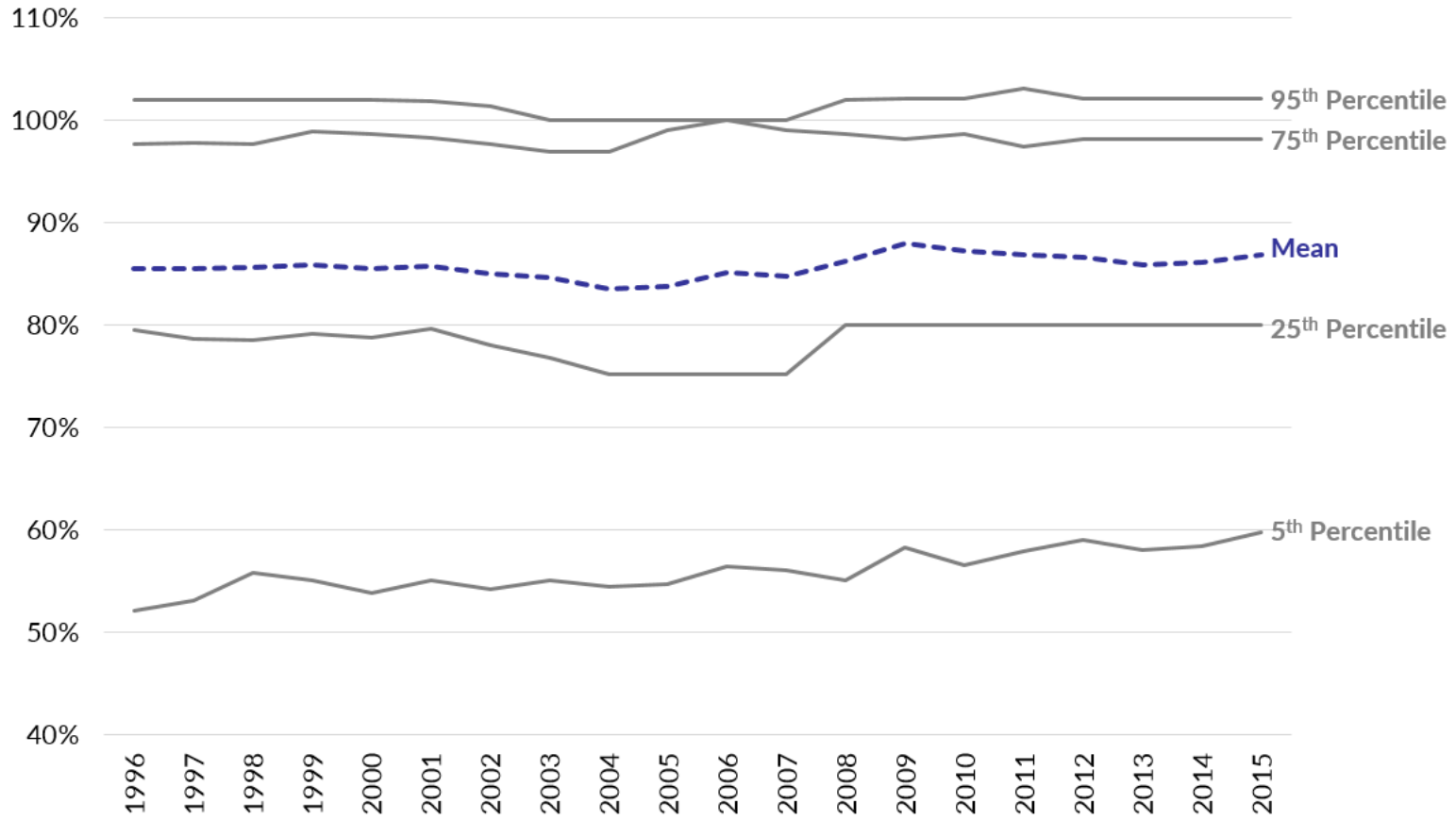


Figure 2: Share of all Purchase Loans by Year

In this figure purchase loans are grouped into one of four types: FHA- with CLTV ≥ 95%, VA-guaranteed with CLTV ≥ 95%, and all other loans with CLTV ≥ 95%. The top figure plots the share of all purchase loans were not explicitly government guaranteed and had CLTV ratios ≥ 95%. The second plot adds the share of high-CLTV loans explicitly guaranteed by the government.

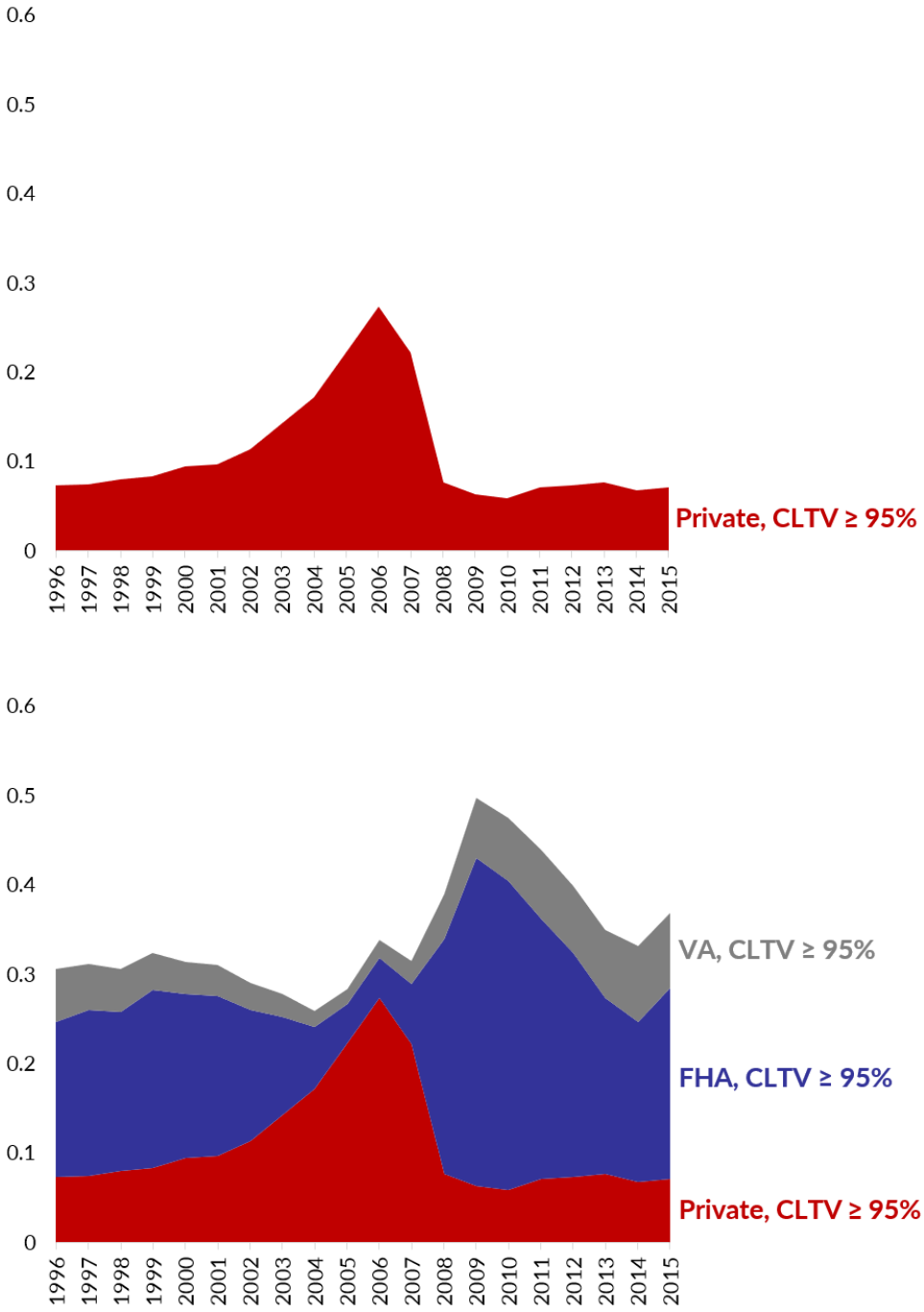


Figure 3: A Changing Share of Government-Guaranteed Mortgages

To produce this figure, purchase loans are grouped into one of five types, the four explicitly plotted below and everything else. The figure plots the share of each type totaling up to 100% of all purchase loans. Data is from CoreLogic.

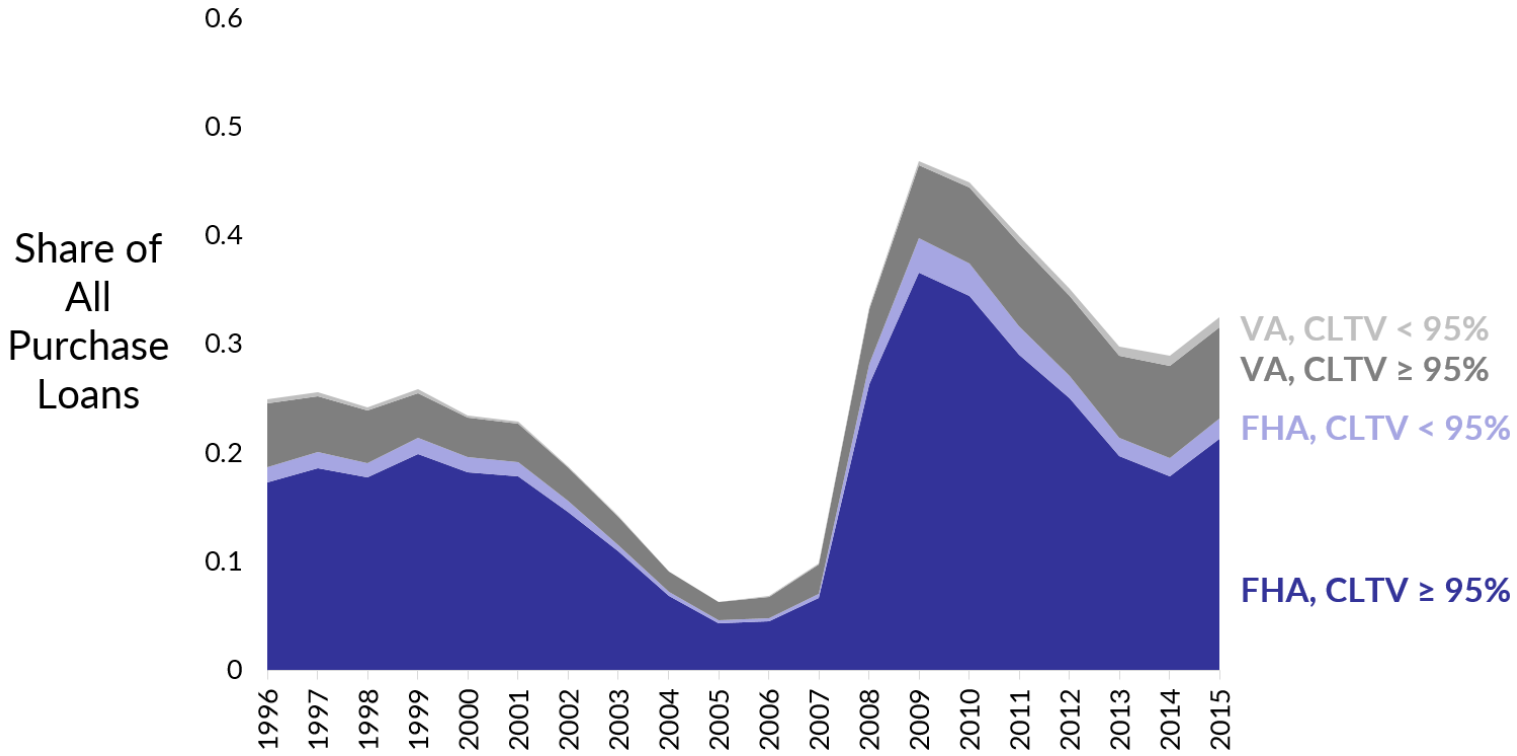
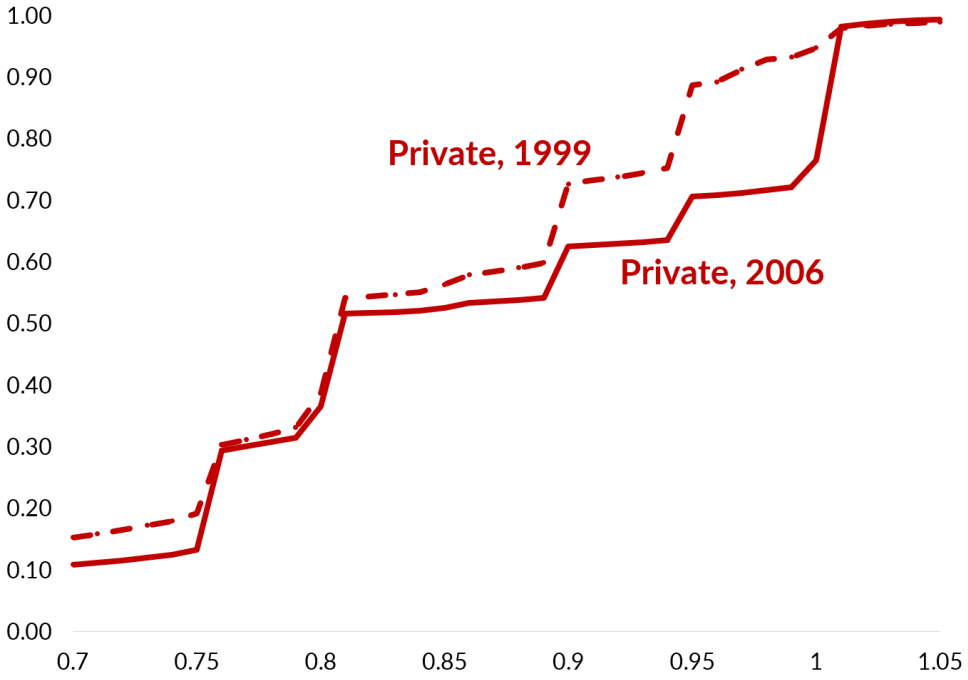


Figure 4: Cumulative Distribution Functions of CLTVs

This figure shows cumulative distribution of combined loan-to-value ratios in CoreLogic that are not classified as either FHA or VA loans (Panel A) and all transactions (Panel B). This includes Fannie Mae and Freddie Mac, any privately securitized loans, or loans held on the portfolios of private financial institutions.



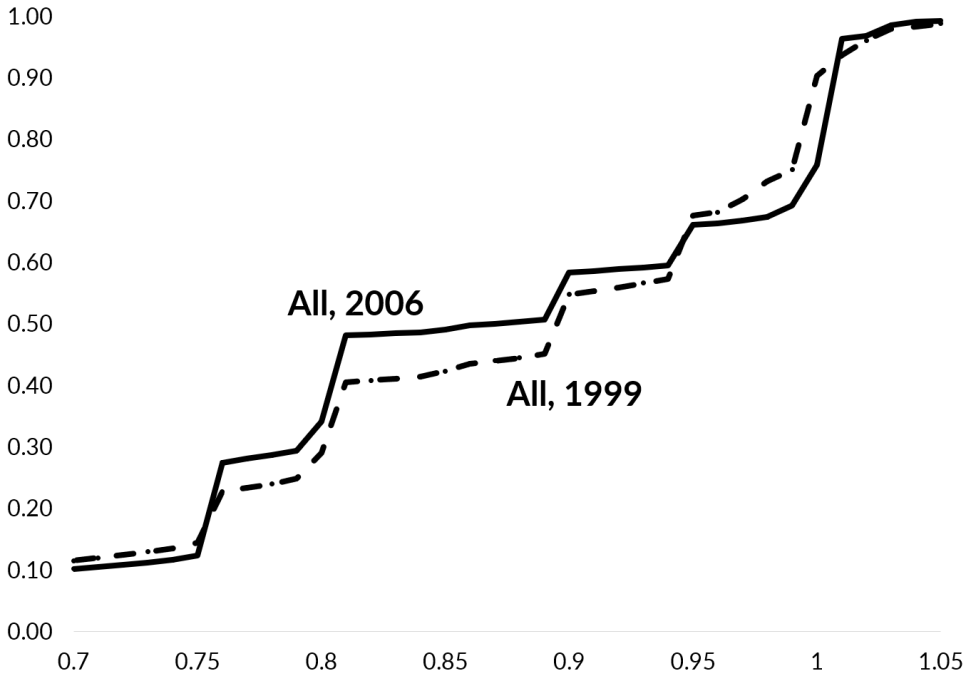


Figure 5: Share Government-Guaranteed and Private Sector across Incomes Deciles over Time

To produce this graph we created ten deciles of 1998-zip code income. Deciles are population weighted such that each decile contains ten percent of the population of the United States. For each year, we calculate the share of purchase loans that are guaranteed by the government and the share that private-sector with CLTVs ≥ 95%. The zip-code level income data is from the IRS, https://www.irs.gov/statistics/soi-tax-stats-individual-income-tax-statistics-zip-code-data-soi.

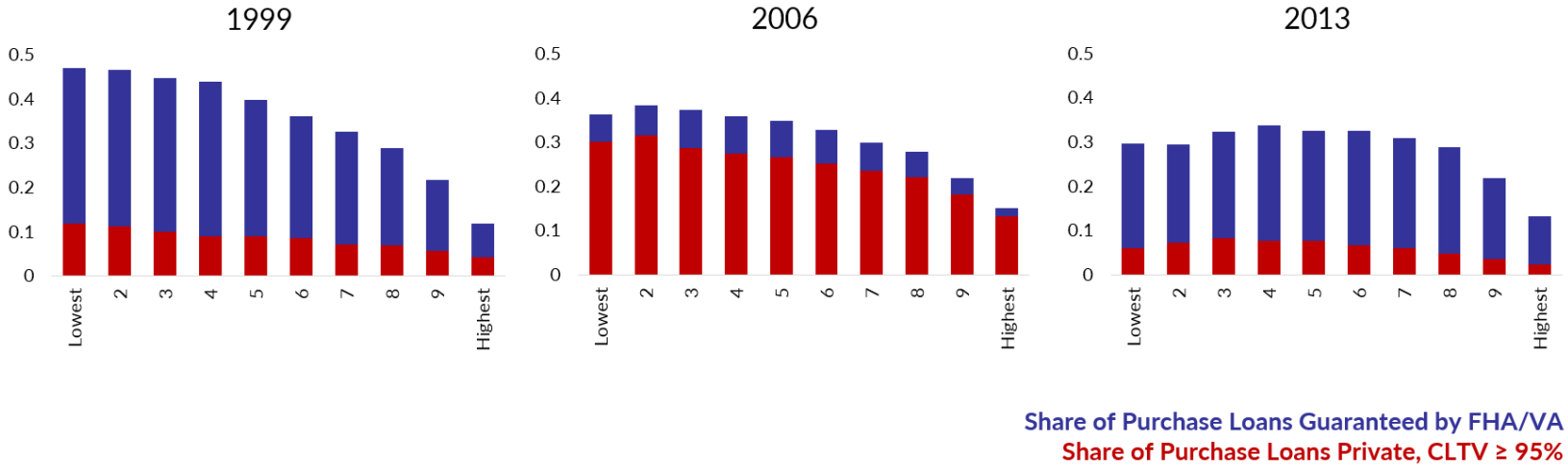
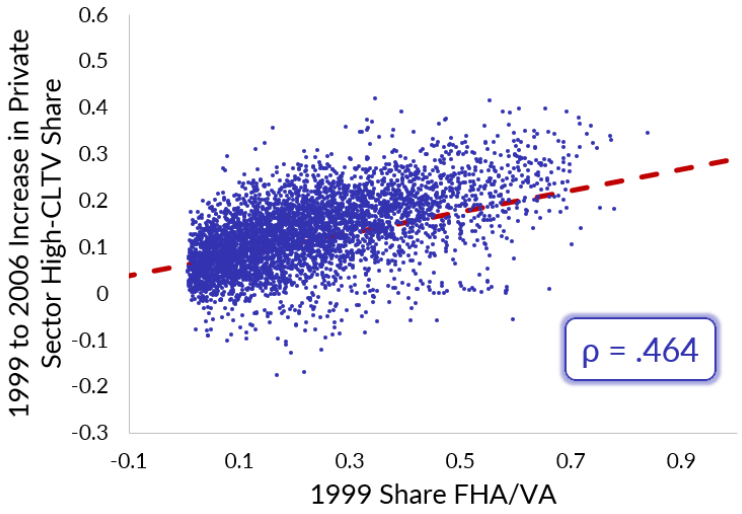


Figure 6: Change in Zip Code Level Share of Loan Types

This first panel of this figure plots zip codes based on the share of 1999 purchase loans in that zip code that were FHA- or VA-guaranteed (on the x-axis) and the difference between the share 2006 purchase loans in that zip code that were not FHA or VA and had CLTVs ≥ 95% and the share of such loans in 1999 (on the y-axis). The second panel of this figure plots zip codes based on the share of 2006 purchase loans in that zip code that were not FHA or VA and had CLTVs ≥ 95% (on the x-axis) and the difference in the share of 2013 purchase loans guaranteed by either the FHA or VA and the share of such loans in 2006. (on the y-axis).



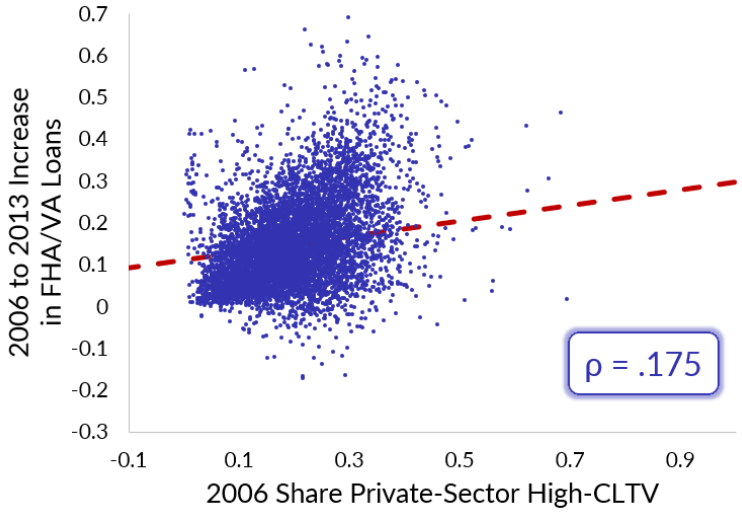


Figure 7: Changes in Private, High-CLTV Share by House Price Change

Figure shows averages of house price changes and the change of high-CLTV purchase loans at the ZIP code level. Zip codes are grouped into deciles by the change in house prices between 2002 and 2006.

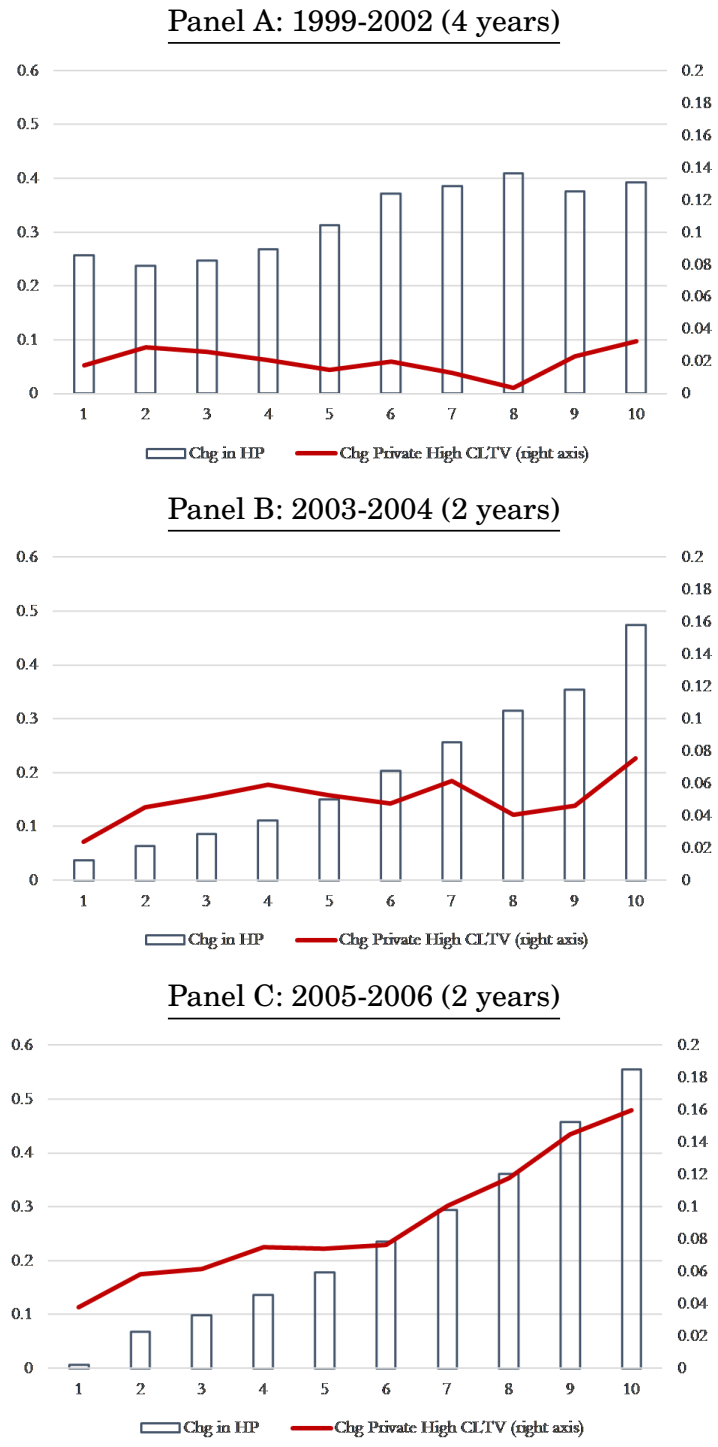
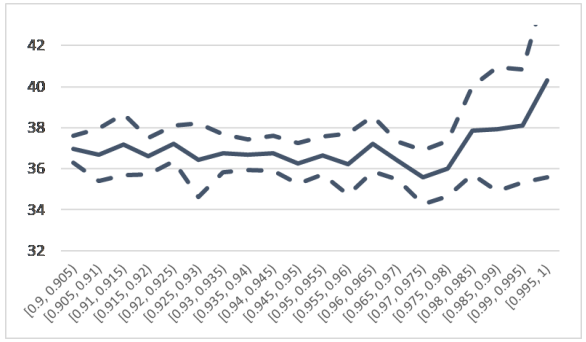


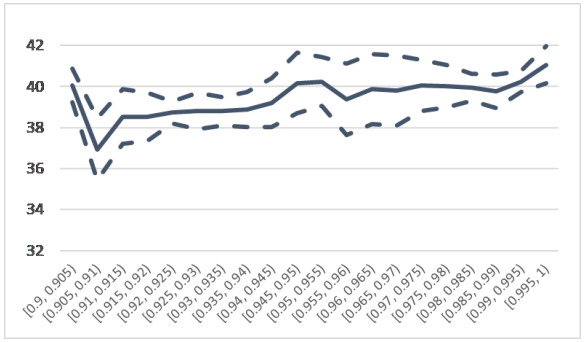
Figure 8: Debt-to-Income by Loan-to-Value, 2005-2007 Originations

Figure shows point estimates and standard errors for debt-to-income levels regressed on loan-to-value bin indicators. Figure only includes full documentation loans and loans with a combined loan-to-value ratio above 90%. Data comes from First American LoanPerformance, McDash Analytics.

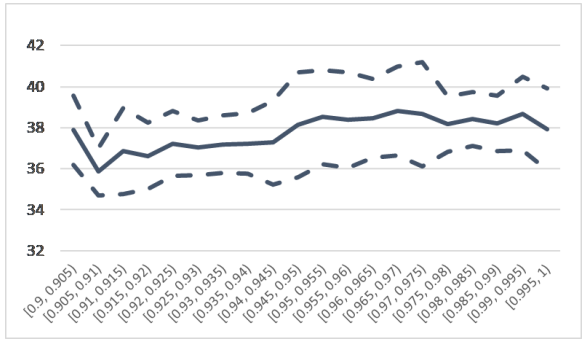
Panel A: FHA loans



Panel B: Non-FHA loans, Credit score ≤ 660



Panel C: Non-FHA loans, 660 < Credit score ≤ 720



Panel D: Non-FHA loans, Credit score > 720

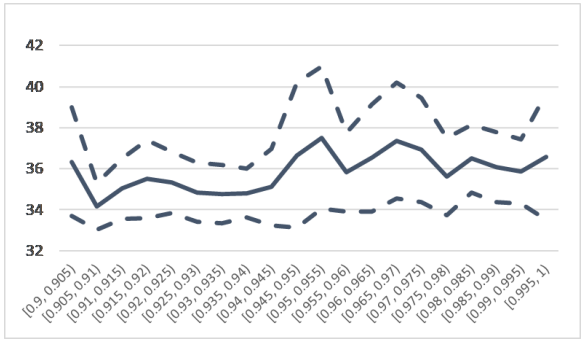
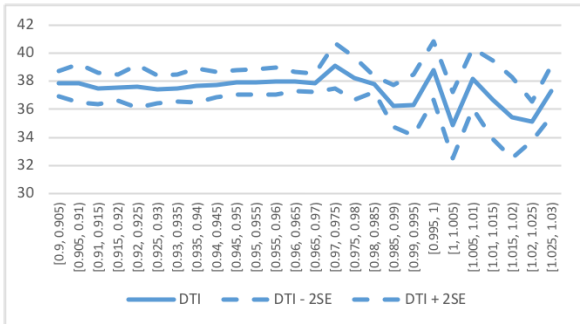


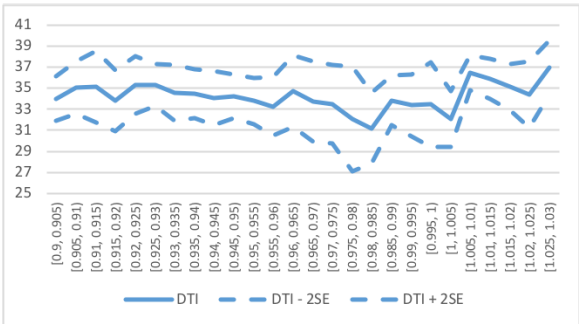
Figure 9: Debt-to-Income by Loan-to-Value, 2011-2015 Originations

Figure shows point estimates and standard errors for debt-to-income levels regressed on loan-to-value bin indicators. Figure only includes full documentation loans and loans with a combined loan-to-value ratio above 90%. Data comes from First American LoanPerformance, McDash Analytics.

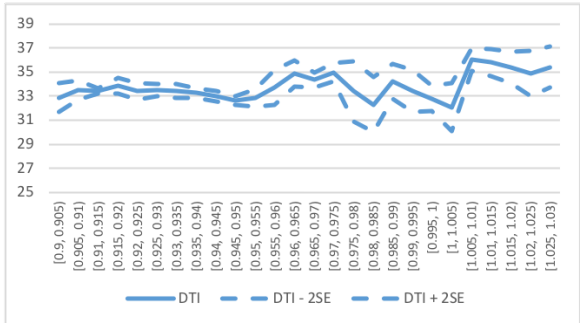
Panel A: FHA loans



Panel B: Non-FHA loans, Credit score ≤ 660



Panel C: Non-FHA loans, 660 < Credit score ≤ 720



Panel D: Non-FHA loans, Credit score > 720

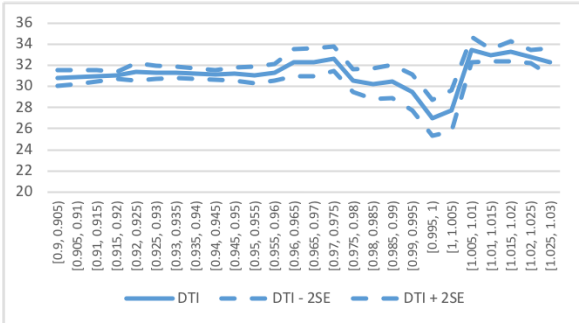


Figure 10: Share 90+ Days Delinquent Within 3 Years of Origination

This figure uses McDash data starting in the second half of 2005. Year by year, we calculate the share of loans originated within in category that were 90+ days delinquent at some point in the three years after origination.

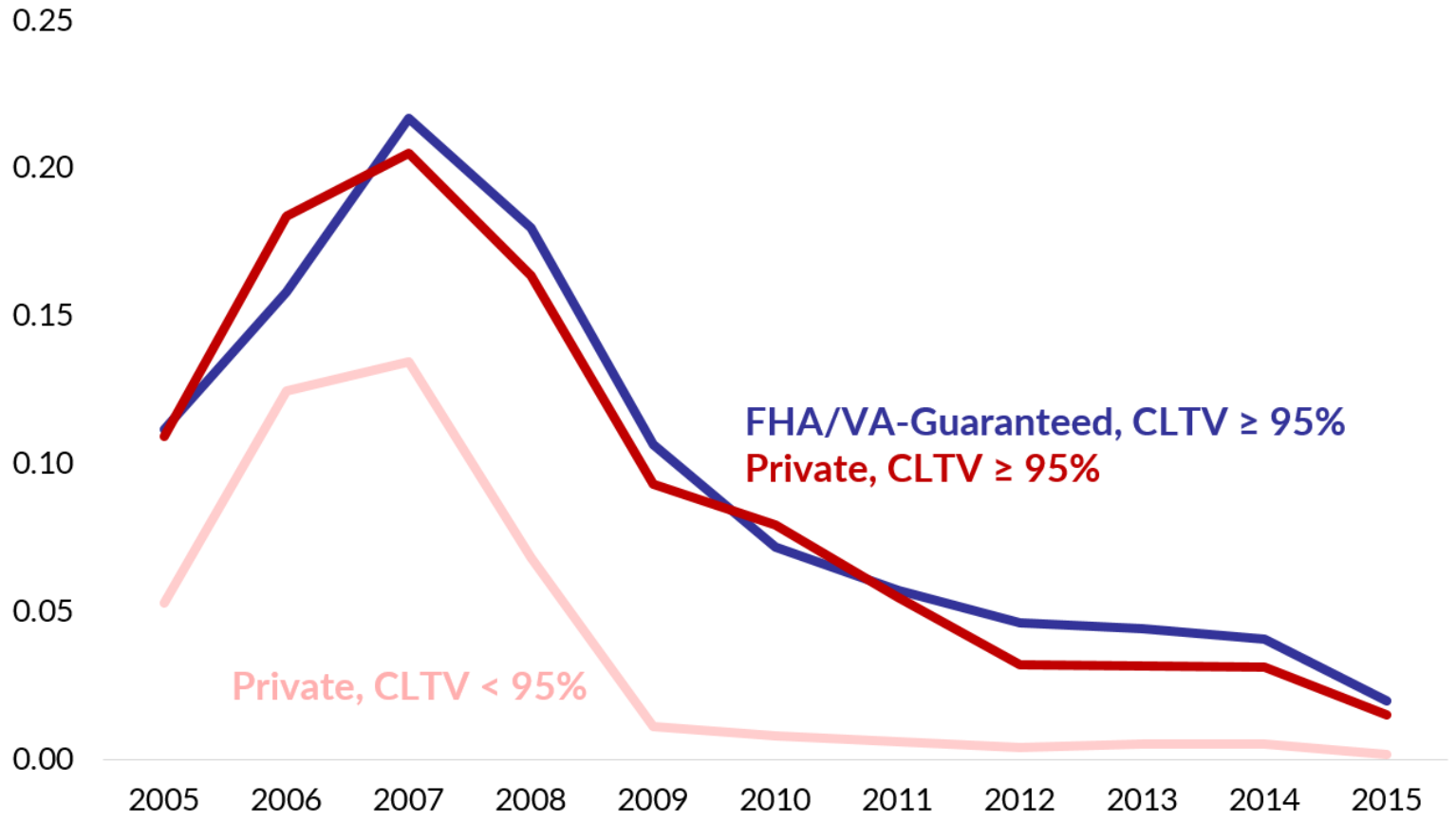


Table 1: Properties in the United States that Transacted Twice

This table uses CoreLogic data. The first sample includes all those properties we observe trade at arms-length exactly one time in the period 1996-2003 and exactly one time in the period 2004-2007. The second sample is analogous for the periods 2004-2007 and 2008-2015. Standard errors clustered at the county level are reported in parentheses. Coefficients significant at the 10%, 5%, and 1% levels are marked with a *, **, and ***, respectively.

Sample:	*Properties with 1 purchase in 96-03 and 1 purchase in 04-07*	*Properties with 1 purchase in 04-07 and 1 purchase in 08-15*
Dependent Variable:	04-07 Loan is Private with CLTV ≥ 95%	08-15 Loan is FHA/VA
96-03 Loan FHA or VA	0.114***	
	(0.007)	
04-07 Loan Private with CLTV ≥ 95%		0.0941***
		(0.006)
Fixed Effects		
County	Y	Y
Year of First Loan	Y	Y
Year of Second Loan	Y	Y
N	2,362,748	634,495
R-squared	0.098	0.088

Table 2: Properties in the United States that Transacted Twice

This table uses CoreLogic data and presents counts and shares of certain types of mortgages originated in the 1996-2003, 2004-2007, and 2008-2015 periods for those properties that saw exactly one transaction during the boom and exactly one transaction pre-boom (panel A) or post-boom (panel B).

Sample:		*Properties with 1 purchase in 96-03 and 1 purchase in 04-07*		
		04-07 Loan		
		NOT Private, CLTV ≥ 95%	IS Private, CLTV ≥ 95%	
96-03 Loan	NOT FHA/VA	1,398,185 78.6%	379,697 21.4%	1,777,882 100%
	IS FHA/VA	391,460 66.9%	193,464 33.1%	584,924 100%

Sample:		*Properties with 1 purchase in 04-07 and 1 purchase in 08-15*		
		08-15 Loan		
		Not FHA/VA	IS FHA/VA	
04-07 Loan	NOT Private, CLTV ≥ 95%	286,135 63.5%	164,593 36.5%	450,728 100%
	IS Private, CLTV ≥ 95%	95,383 51.9%	88,417 48.1%	183,800 100%

Table 3: Households in North Carolina that Borrowed Twice

This table uses CoreLogic and voter registration data from North Carolina. The first sample includes all those households we observe take out exactly one loan in the period 1996-2003 at one property and exactly one loan in the period 2004-2007 at another property in North Carolina. The second sample is analogous for the periods 2004-2007 and 2008-2015. Standard errors clustered at the county level are reported in parentheses. Coefficients significant at the 10%, 5%, and 1% levels are marked with a *, **, and ***, respectively.

Sample:	*NC Households with 1 purchase in 96-03 and 1 purchase in 04-07*	*NC Households with 1 purchase in 04-07 and 1 purchase in 08-15*
Dependent Variable:	04-07 Loan is Private with CLTV ≥ 95%	08-15 Loan is FHA/VA
96-03 Loan FHA or VA	0.113***	
	(0.014)	
04-07 Loan Private with CLTV ≥ 95%		0.0674***
		(0.011)
Fixed Effects		
County	Y	Y
Year of First Loan	Y	Y
Year of Second Loan	Y	Y
N	7,660	11,858
R-squared	0.031	0.054

Table 4: Households in North Carolina that Borrowed Twice

This table uses CoreLogic data and voter registration data from North Carolina. The table presents counts and shares of certain types of mortgages originated in the 1996-2003, 2004-2007, and 2008-2015 periods for those households that made exactly one purchase transaction during the boom and exactly one purchase transaction pre-boom (panel A) or post-boom (panel B).

Sample:	*NC Households with 1 purchase in 96-03 and 1 purchase in 04-07*			
		04-07 Loan		
		NOT Private, CLTV ≥ 95%	IS Private, CLTV ≥ 95%	
96-03 Loan	NOT FHA/VA	5,593 84.5%	1,026 15.5%	6,619 100%
	IS FHA/VA	763 73.0%	282 27.0%	1,045 100%

Sample:	*NC Households with 1 purchase in 04-07 and 1 purchase in 08-15*			
		08-15 Loan		
		Not FHA/VA	IS FHA/VA	
04-07 Loan	NOT Private, CLTV ≥ 95%	7,690 82.0%	1,686 18.0%	9,376 100%
	IS Private, CLTV ≥ 95%	1,874 75.4%	613 24.7%	2,487 100%

Table 5: Changes in HP and Private, High-CLTV Loans on HP Instrument

Table shows regressions by sub-periods of changes in three outcome variables (shown in panel titles) at the commuting zone level on the gamma instrument in Guren et al. (2018). Standard errors and t-statistics shown.

Panel A: Change in HP

Period:	00-02	02-04	04-06	06-08	08-10
Gamma	0.054	0.185	0.111	-0.124	-0.141
	0.016	0.030	0.013	0.019	0.012
	3.45	6.10	8.84	-6.37	-11.52
N	150	175	229	285	305
R-squared	0.11	0.43	0.21	0.32	0.44

Panel B: Change in FHA/VA

Period:	00-02	02-04	04-06	06-08	08-10
Gamma	-0.147	-0.152	-0.169	12.508	-0.173
	0.024	0.032	0.042	3.387	0.022
	-6.10	-4.78	-4.00	3.69	-7.77
N	149	168	223	281	301
R-squared	0.23	0.00	0.03	0.03	0.14

Panel C: Change in Private, high CLTV loans

Period:	00-02	02-04	04-06	06-08	08-10
Gamma	0.026	0.101	0.433	-2.302	0.029
	0.049	0.065	0.076	0.714	0.045
	0.53	1.54	5.72	-3.23	0.65
N	149	173	220	270	302
R-squared	0.00	0.00	0.16	0.03	0.00

A Online Appendix – Supplemental Tables

Figure A1: Use of Junior Liens Over Time

This figure plots the share of all home purchases financed, as per the deeds records, with more than one mortgage among home purchases financed with at least one mortgage. These second and third mortgages are often called "piggyback" mortgages.

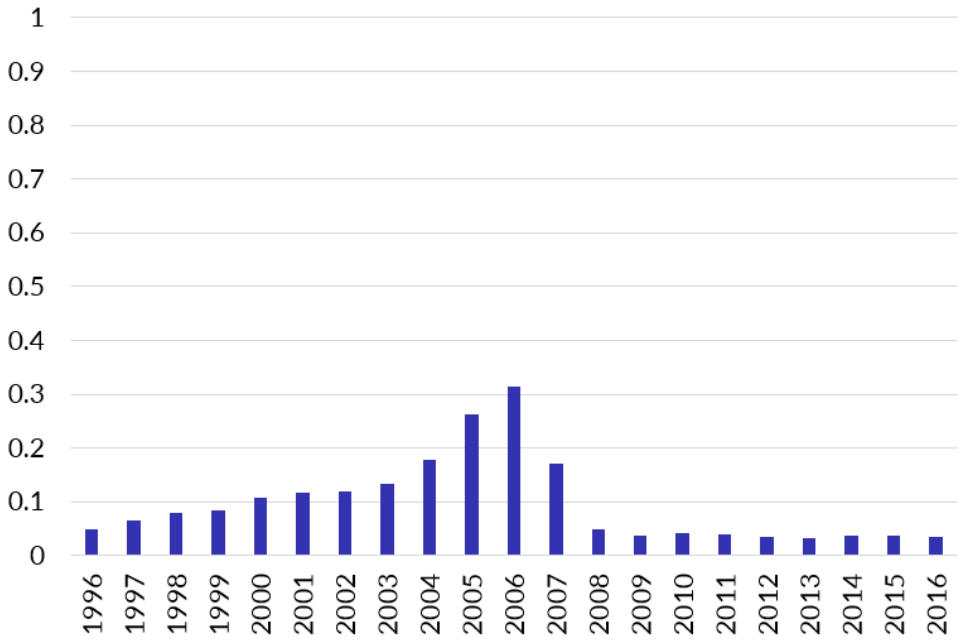


Figure A2: Cash Purchases Over Time

This figure plots the share of all home purchases financed, as per the deeds records, with 100% cash.

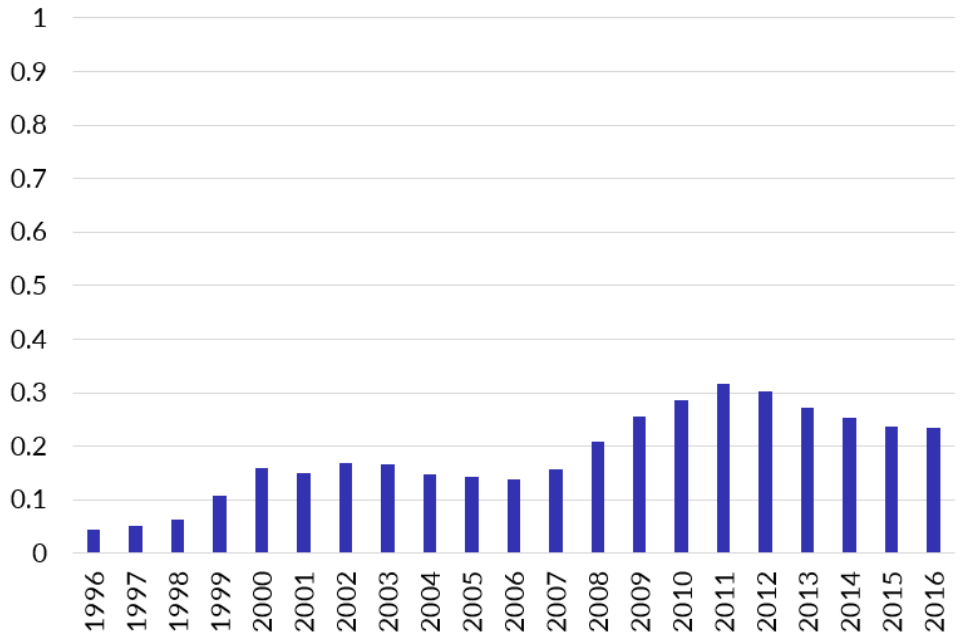


Figure A3: Value-Weighted Distributions of Purchase Loan CLTV Ratios Over Time

This figure plots the combined loan-to-value ratios (CLTVs) of the universe of purchase transactions financed with at least some debt covered in the CoreLogic deeds data between 1996 and 2015. Loans are weighted by loan amount. Each purchase transaction includes data on up to three mortgages, one primary mortgage and up to two piggyback mortgages. The percentiles and mean are calculated using all purchase loans originated in the calendar year.

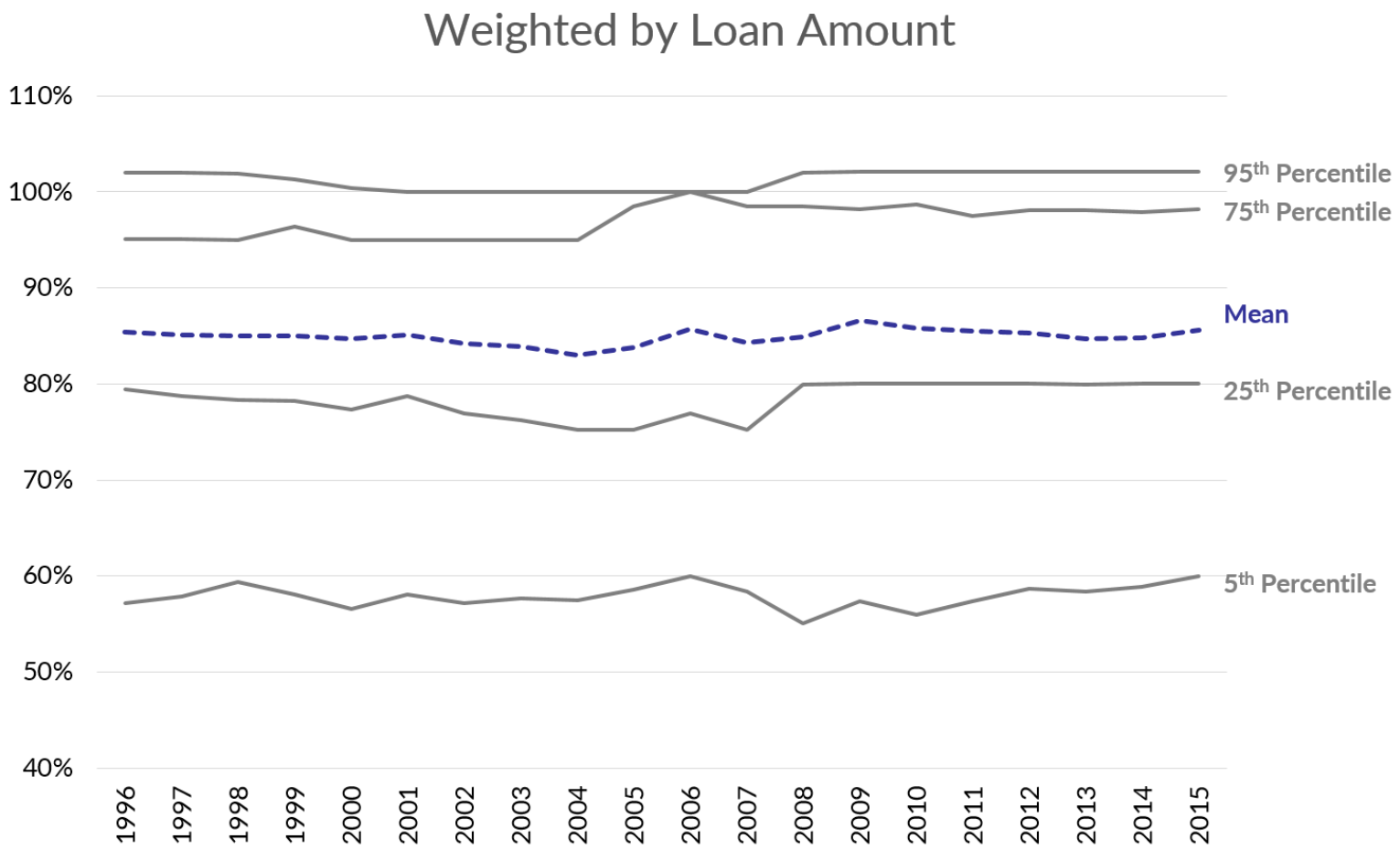


Figure A4: Median Zip Code House Prices Relative to June 2002 by Growth Between June, 2002 and June, 2006

To create this figure we use median zip code house prices from Zillow. For each zip code, we calculate the growth in median house prices between June, 2002 and June 2006. Zip codes are then divided into ten population weighted deciles, such that each decile has the same population. We then graph the evolution of house prices within each decile over the full time series.

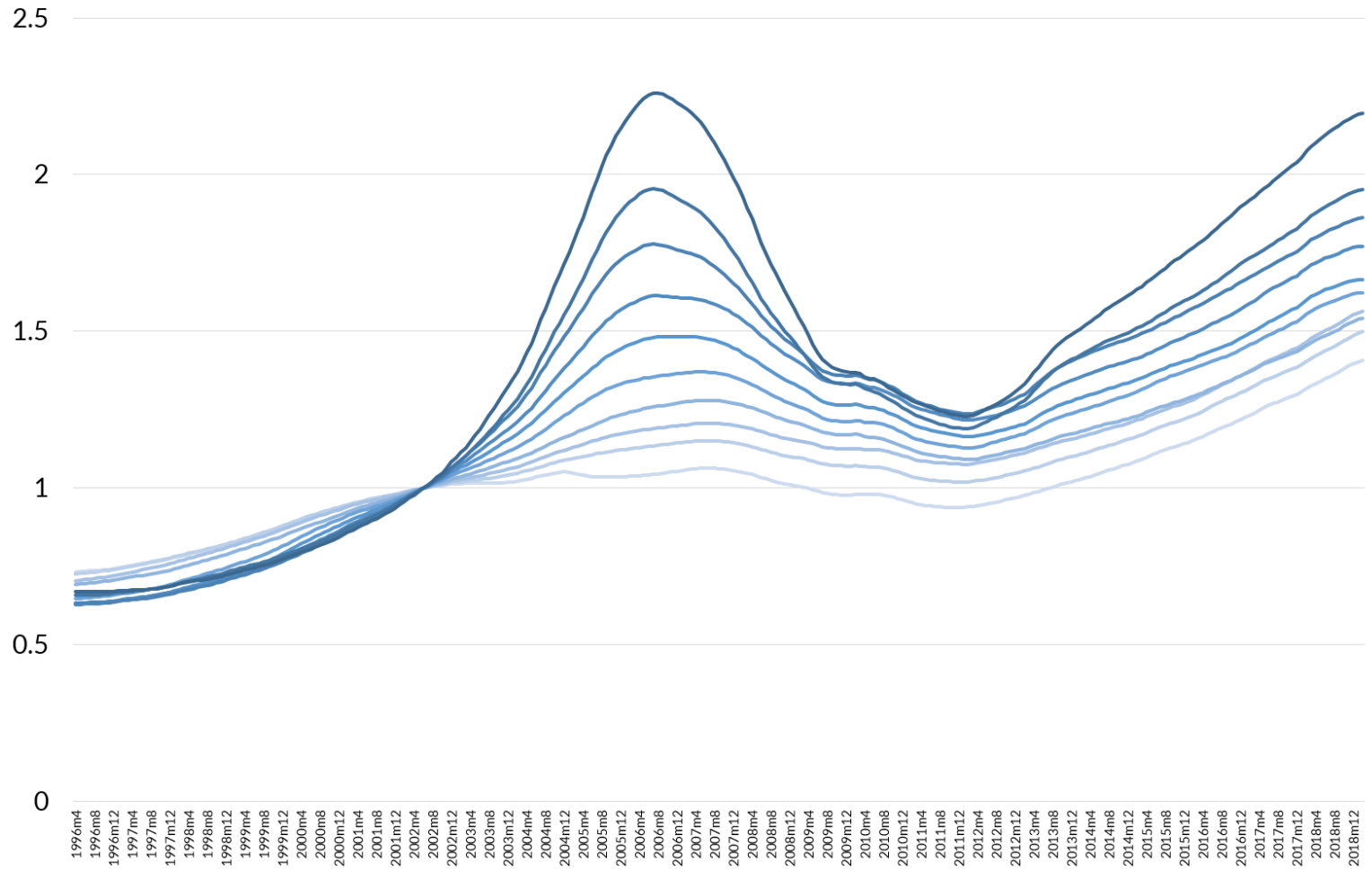


Figure A5: Comparing Low- and High-HP Growth Regions

These figures plot the combined loan-to-value ratios (CLTVs) of the universe of purchase transactions financed with at least some debt covered in the CoreLogic deeds data between 1996 and 2015. Each purchase transaction includes data on up to three mortgages, one primary mortgage and up to two piggyback mortgages. The percentiles and mean are calculated using all purchase loans originated in the calendar year. States are classified as low-HP growth regions corresponding to the bottom two deciles in Figure A4 (left panel), or high-HP growth regions, corresponding to the top two deciles in Figure A4 (left panel).

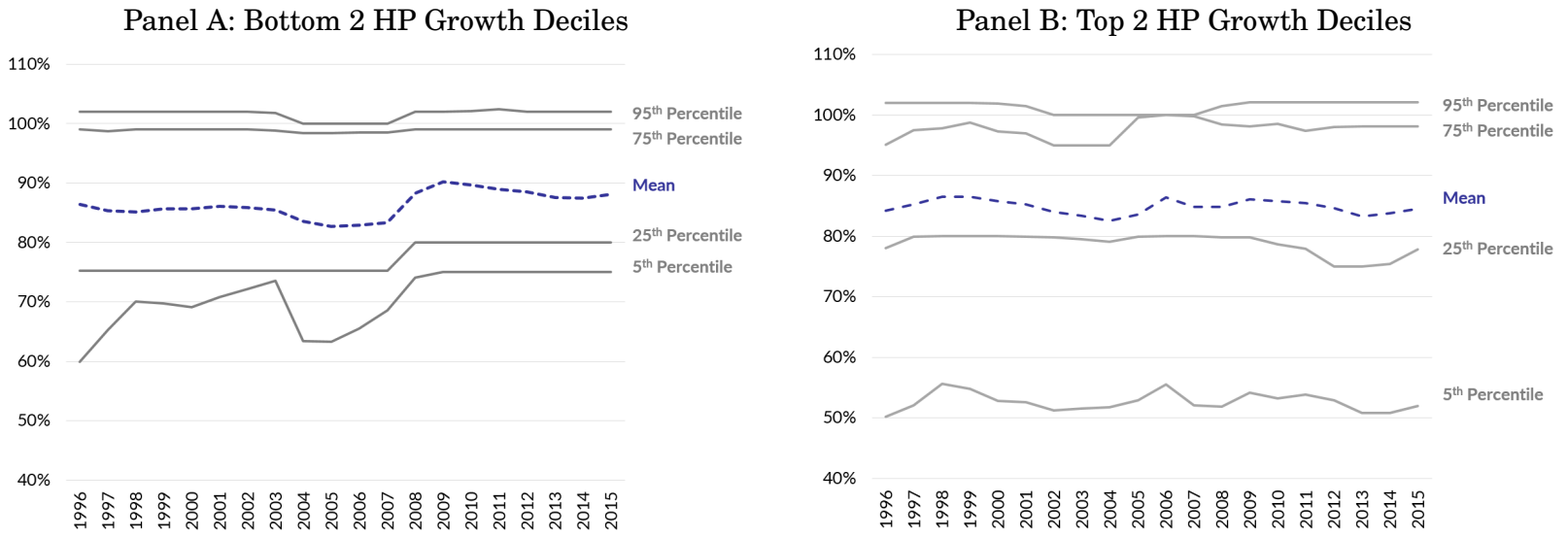


Figure A6: Comparing Recourse and Non-Recourse States

These figures plot the combined loan-to-value ratios (CLTVs) of the universe of purchase transactions financed with at least some debt covered in the CoreLogic deeds data between 1996 and 2015. Each purchase transaction includes data on up to three mortgages, one primary mortgage and up to two piggyback mortgages. The percentiles and mean are calculated using all purchase loans originated in the calendar year. States are classified as either recourse (left panel) or non-recourse (right panel).

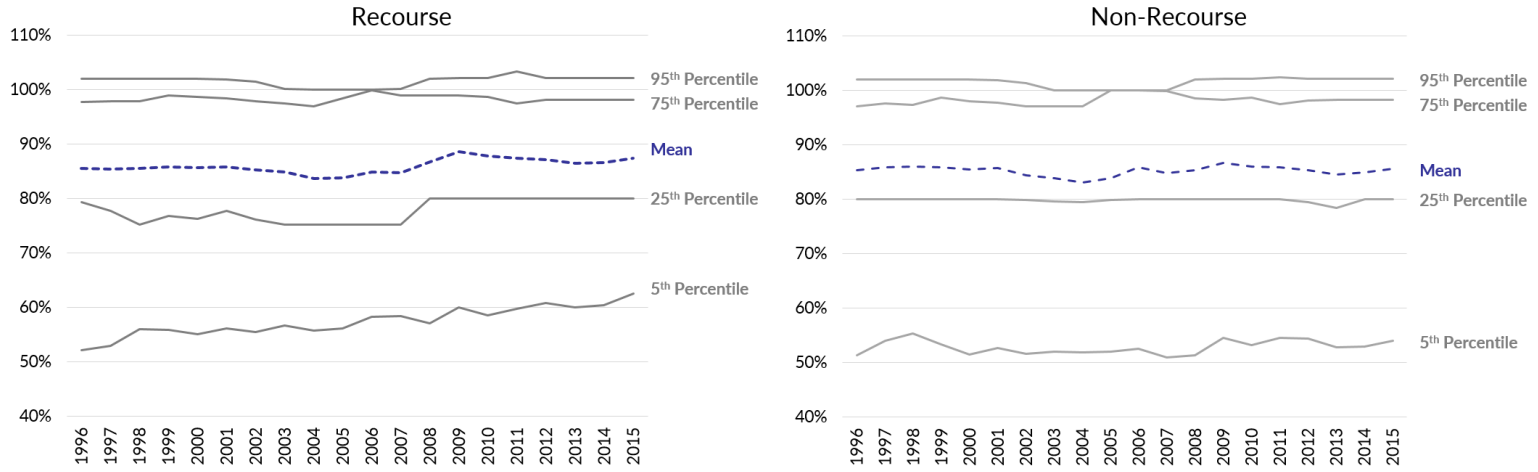


Figure A7: CLTV Repeat Sales Index (Relative to 2001 Baseline)

This figure plots a CLTV repeat sales index relative to a 2001 baseline. The construction is analogous to the standard house price index. CLTVs of purchase loans are regressed on year fixed effects and, importantly, property fixed effects. In this way, CLTV differences are calculated using only within-property variation over time. The estimates and standard errors of each year's effect are graphed below.

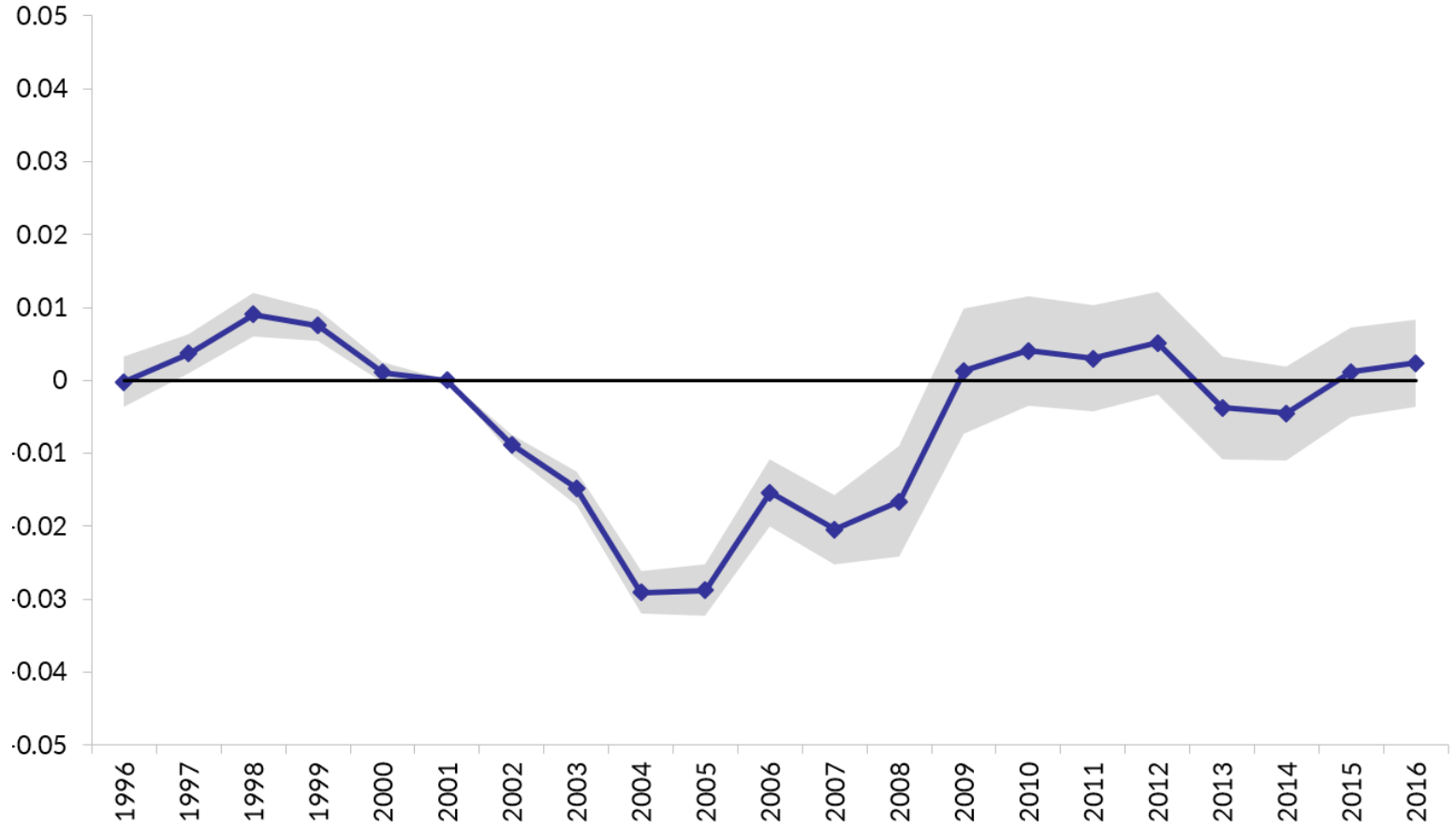


Figure A8: CLTV Lender-by-County Index (Relative to 2001 Baseline)

This figure plots a CLTV index relative to a 2001 baseline. Instead of property fixed effects as used in Figure A7, this figure includes lender-by-county fixed effects. In this way, CLTV differences are calculated using only variation with lender-by-county loans over time. The estimates and standard errors of each year's effect are graphed below.

