

The Impact of Housing Markets on Consumer Debt: Credit Report Evidence from 1999 to 2012

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Abstract

We investigate the impact of large swings in the housing market on non-mortgage borrowing, using CoreLogic geographic house price variation and Equifax-sourced FRBNY Consumer Credit Panel data for 1999 to 2012. First-differenced instrumental variables (FD-IV) estimates indicate that all homeowner types increased both housing and non-housing debt in response to the housing boom. However, older and prime homeowners responded to house price changes by reallocating obligations between home equity and credit card debt, with little change in total debt, during both the comparatively stable 1999-2001 period and the 2007-2012 downturn. Younger and marginally creditworthy homeowners' non-mortgage debts moved with house prices during both expansions and downturns. These results suggest meaningful wealth effects of the housing market on consumption only for the boom period, but collateral effects throughout. A difference-in-differences estimation approach yields similar results. Finally, despite broad speculation, we find little substitution out of home equity debt into student loans in response to recent house price declines.

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If house prices increase, how should we expect a homeowner's consumption to respond? This question is the basis of an ongoing discussion in the consumption-saving and housing literatures. Campbell and Cocco (2007), and Sinai and Souleles (2005), point out that it is unclear that we should observe any response of homeowner consumption to a house price increase.¹ Setting aside substitution effects, a homeowner with long expected tenure and no collateral constraints experiences a housing wealth increase along with an offsetting increase in the price of future housing services, and may not adjust consumption at all in response to the house price change.

However, as Campbell and Cocco argue, older homeowners may intend shorter tenure in the house, and therefore they may experience real net wealth effects when house prices rise. Young homeowners, however, on average intend longer tenure and hold more limited housing assets. They are imperfectly hedged against housing market fluctuation, and may even decrease consumption in response to a house price increase. Hence the wealth effect of a house price increase should lead older homeowners to increase consumption more than younger homeowners do, all else equal. Campbell and Cocco demonstrate precisely this relationship for U.K. homeowners between 1988 and 2000.

In addition, young homeowners are more often subject to collateral constraints, as described by Ortalo-Magne and Rady (2006) and Jappelli (1990). If young homeowners' consumption is limited by collateral constraints, we can expect their consumption to covary positively with house price changes. Hence evidence of a positive relationship between consumption and house prices among older homeowners suggests meaningful wealth effects of house prices for shorter-tenured homeowners. On the other hand, a positive relationship between consumption and house prices for the young and the less creditworthy suggests an important role for credit constraints.

Our question, then, becomes whether consumer debt changes at all in response to house price increases, and if so, for whom? In comparison to Campbell and Cocco, we study consumer debt rather than direct consumption measures, and we pose the question in the U.S. context for the last 13 years (encompassing unprecedented growth and decline in U.S. house prices).

Further, while the prior literature has emphasized the response of consumption to house price growth, for obvious reason, recent events lead us to consider the consumption effect of a

¹ Sinai and Souleles study the relationship between rent volatility and demand for homeownership, and hence do not aim to explain consumption empirically.

housing market downturn.² Do consumers respond symmetrically to housing market growth and decline? Do we see older, shorter-tenured consumers decreasing consumption and debt more in response to lost housing wealth? Do we see younger homeowners forced to decrease borrowing in response to lost collateral?

Large movements in housing markets have the additional effect of changing the availability and relative pricing of competing loan products considered by homeowners. Our data allow us to study not only the response of overall non-mortgage debt to house price changes, but also the allocation of consumer debt portfolios. An obvious question is whether homeowners substitute out of relatively expensive uncollateralized debt into relatively inexpensive home-collateralized debt as house prices grow (and whether they choose and are able to return to uncollateralized debt when home equity debt becomes inaccessible). Evidence of simultaneous plateauing of credit card debt and rapid growth of the home equity line of credit (HELOC) market from 2002-2006 motivates more rigorous analysis of substitution.

Further, the ongoing growth of the student loan market in the face of consumer deleveraging has spawned recent speculation that parent homeowners turned to conventional student loan funding as home equity-based funding dried up. We are able to study the extent to which the simultaneous decline in HELOC and rise in student debt from 2007-2012 is generated by parents' home equity losses.

Our study relies on quarterly zip code-level home price data from CoreLogic over the period 1999 to 2012, in combination with detailed consumer liability data from the FRBNY Consumer Credit Panel/Equifax (CCP). The CCP is a new panel on consumer debts based on credit reports from Equifax, one of three national credit reporting agencies, and is described in more detail in section I. The CCP comprises the credit reports of five percent of the population of U.S. individuals with credit reports, drawn on a quarterly basis from 1999 to 2012, ongoing. These data permit unique insight into the question at hand as a result of the size, representativeness, frequency, and recentness of the dataset. Unlike most related studies, we are able to track the behavior of consumer debt from before the house price boom into the boom and then through the subsequent house price bust and recession. Further, we are able to examine simultaneous

² Influential studies of consumers' response to the unusual patterns in the housing market in recent years including Charles and Hurst (2012), Mian and Sufi (2009, 2011), Lovenheim (2011), Lovenheim and Reynolds (2012), and Lovenheim and Mumford (forthcoming), for example, use data from 2007 and before. Dynan (2012), Mian, Rao, and Sufi (2013), and Mian and Sufi (2012) are examples of related studies that emphasize recession-era consumer behavior.

movements in the use of all major consumer loan products at the individual level. The sampling scheme of the dataset allows extrapolation to national aggregates and spares us most concerns regarding attrition and representativeness over the course of a long panel.

We begin by estimating the dependence of HELOC, auto, credit card, student loan, and total non-housing debt on changes in local house prices using a first differenced instrumental variables (FD-IV) approach. We instrument house price changes at the MSA level using the widely accepted Saiz (2010) land topology-based predictor.³ FD-IV estimates are generated for 1999-2001, 2002-2006, and 2007-2012.⁴ We find that 1999-2001 homeowners substituted out of non-housing (largely credit card) debt and into home equity-based debt at nearly a dollar-for-dollar rate in response to house prices increases. During the housing boom of 2002-2006, however, homeowners abandoned the practice of substituting into less costly debt as equity grows, and instead increased obligations across the board. These results confirm the findings of Mian and Sufi (2011). From 2007-2012, sample homeowners experienced a 23 percent average house price decline, and they withdrew from home equity debt without adding to non-housing debt, on average.

We observe substantial heterogeneity in this pattern. Older and prime borrowers exhibit close to dollar-for-dollar substitution out of non-housing and into HELOC debt as house prices increase from 1999-2001, and the reverse as house prices decline from 2007-2012, with little net change in non-mortgage debt. The wealth effect of house price changes during these two periods, then, appears to be minimal. Older and prime borrowers appear simply to execute sensible portfolio reallocation as opportunities arise.

Young and less creditworthy borrowers, on the other hand, increase total non-mortgage debt substantially in response to the house price growth observed during 1999-2001 and 2002-2006, and they shed large amounts of debt, through some combination of paydown, inaccess, and default, during the housing market downturn. Hence the contribution of existing homeowners to the 2002-2006 run-up in aggregate debt, and to its 2007-2012 decline, appears to be attributable in large part to the young and the marginally creditworthy, and to the collateral effect as opposed to the wealth effect of house price movements.

³ See, for example, Mian and Sufi (2009, 2011), Chetty and Szeidl (2012), Charles, Hurst, and Notowidigdo (2013), Halket (2012), and Mian et al. (2013).

⁴ We use all quarters from the panel, and the above time periods are inclusive of the full beginning and endpoint years.

Since the FD-IV approach relies on only the portion of the house price variation in the data that is attributable to topological factors, and identifies only relationships between house prices and debt that occur within an individual credit report and over a narrow time frame, we also report descriptive measures and estimation results from a more aggregated and inclusive difference-in-differences approach. Controlled difference-in-differences point estimates comparing boom-era high and low appreciation renters and owners are reported for each of the 54 panel quarters for each major debt product, as well as total non-mortgage consumer debt. This approach reveals patterns of substitution (or lack thereof) that are similar to those we obtain in the FD-IV case. It also produces an estimated increase in the debt difference between high and low boom-era appreciation homeowners of roughly \$3100 from 2004 to 2011, despite the loss of most equity advantage for high boom-era appreciation homeowners by the end of the period.

In light of the ongoing growth of the student loan market, consumer substitution between home equity and student loans has received some attention.⁵ Lovenheim (2011) and Lovenheim and Reynolds (2012), taken together, demonstrate that home equity increases during the boom were associated with greater likelihood of college attendance, greater college quality, lower rates of work while in college, and higher rates of college completion, suggesting that families did rely on home equity increases from 2002 to 2006 to finance higher education. These papers register concerns regarding the potential impact of the downturn in the housing market on the prevalence and quality of higher education. However, our analysis, using both the FD-IV and the difference-in-differences approach, reveals little to no substitution between HELOC and student debt in response to house price changes.

Mian and Sufi (2011) estimate the equity extraction of existing homeowners in response to the housing boom (2002-2006). They frame the question similarly, and they, too, look at the debt response by age and creditworthiness. Their results indicate no significant difference in equity extraction by age, but a substantial difference by creditworthiness, suggesting that it was the collateral rather than the wealth effect of the housing boom that drove the run-up in debt among existing homeowners. In this context, we add evidence on the debt response to house prices, and the relative contributions of wealth and collateral effects of house price changes, under more

⁵ See, for example, Liberty Street Economics blog postings “Grading Student Loans,” <http://libertystreeteconomics.newyorkfed.org/2012/03/grading-student-loans.html>, and “Young Student Borrowers Retreat from Housing and Auto Markets,” <http://libertystreeteconomics.newyorkfed.org/2013/04/young-student-loan-borrowers-retreat-from-housing-and-auto-markets.html> (last visited June 13, 2013).

ordinary housing market conditions and during a historic housing market downturn. The behavior of homeowners during the bust and the heterogeneity that we find is consistent with that documented by both Mian et al. (2013), who estimate a large elasticity of consumption with respect to housing net worth, of 0.6-0.8, during the slump, and a higher marginal propensity to consume out of housing wealth for the constrained and poorer households, and Dynan (2012), who finds larger consumption declines for the highly leveraged.

Finally, it is worth noting that in this study we deal with consumer debt, and not with explicit consumption. In light of recent financial market events, we believe that consumer debt is an object of interest in itself. We study both debt levels and consumers' management of portfolios of competing loan products. In addition, however, we are interested in the information consumer debt provides about consumption. While some individual debt changes may be balanced by unobserved changes in assets, most of the debt categories discussed in this paper function largely to support consumption. High interest rates on credit card debt make it a poor vehicle for funding investment. Auto debt as we observe it is, in approximately all cases, associated with the purchase or lease of a durable consumption good. Brady, Canner, and Maki (2000), Canner, Dynan, and Passmore (2002), and Mian and Sufi (2011) provide evidence that the majority of funds borrowed against home equity are used for consumption or for home improvement, the majority of which, in turn, constitutes consumption. The lone exception is student debt, which we treat in a separate section below. This approach is incomplete, in that it misses all consumption changes funded by changes in positive savings, or changes in income, with no associated change in debt. However, this limitation may be weighed against the challenges of small sample sizes or narrow consumption bundles that face researchers working with direct consumption measures.

I. Data

a. Motivating evidence

During the first decade of this century, U.S. consumer debt grew at an unprecedented rate. While roughly 70 percent of consumer debt throughout the period is attributable to mortgage debt (excluding home equity lending), given the unprecedented growth in house prices from 2002 to 2006, it is unclear to what extent mortgage growth meant growth in real consumption of

housing services.⁶ Where the object of interest is debt used to support consumption, it is helpful to isolate the component of consumer debt that is not associated with home purchases. Figure 1 depicts the trajectory of U.S. consumer debt, excluding first mortgages but including both home equity loans and home equity lines of credit, from 1999 to 2012.⁷ We interpret this object as non-housing-purchase consumer debt, and we refer to it as non-mortgage debt throughout the paper.⁸ Unlike the rate of growth of total U.S. consumer debt over this period, the rate of growth of real non-mortgage consumer debt does not increase during the 2002-2006 house price boom from its pre-2002 level. In fact, the slope of the non-mortgage consumer debt trajectory is roughly constant from 1999Q1 to 2008Q1, at an annual growth rate of about 10 percent.⁹ At a glance, debt used to support general consumption, as opposed to home purchase, shows little evidence of a response to events in the housing market.

At the same time, real home equity-based borrowing more than tripled, from \$219 billion to \$751 billion. Its annual rate of growth averaged 12 percent from 1999 to 2001, but 24 percent from 2002 to 2005. Figure 2 disaggregates total non-mortgage debt into the leading debt categories. While the growth of total non-mortgage debt was roughly constant from 1999 to 2008, its composition changed dramatically. In 2000, auto loans and credit cards were clearly the leading sources of consumer credit, with home equity and student loans playing only a minor role in consumer lending. From 2002 to 2006, home equity and student loans emerged as major consumer loan products, and, by the time real consumer debt peaked in 2008, aggregate home equity loan balances were roughly on par with aggregate balances in the more traditional debt categories. Aggregate auto and credit card balances, by contrast, were approximately flat during the house price boom. This assemblage of evidence begs the question: how much of the observed growth in home equity lending represents true growth in consumer debt in response to rising house prices (and supports additional consumption), and how much is the result of substitution

⁶ Mian and Sufi (2009) demonstrate that a leading contributor to the run-up in household debt was increased access to mortgage credit. Duca, Muellbauer, and Murphy (2011) demonstrate substantial improvements in the fit of standard price-to-rent ratio models, both before and after the boom, with the addition of credit supply data, in the form of LTV series. Gropp, Krainer, and Laderman (2013) analyze mortgage responses to the downturn using the credit bureau data that appear in this study.

⁷ The data represented in Figures 1 and 2 are drawn from the FRBNY Consumer Credit Panel/Equifax, described in detail in subsection b, below. All balances reported in the paper are in 2012 US dollars.

⁸ Brady, Canner, and Maki (2000), Canner, Dynan, and Passmore (2002), and Mian and Sufi (2011) provide evidence that the majority of funds borrowed against home equity are used for consumption or home improvement.

⁹ If anything, the rate of growth of non-mortgage debt declines from the 1999-2002 period to the 2002-2006 house price boom.

away from more expensive or otherwise less desirable competing loan products?

Finally, in light of the ongoing growth of the student loan market, consumer substitution between home equity and student loans has received some attention. As is clear in Figure 2, while all other major consumer debt categories have declined from 2008-9 peaks, only student loan balances continue to grow in real terms. In fact, while all other consumer debt is off 17 percent since 2008Q3, student loans have grown by 41 percent since 2008Q3. Our analysis of substitution across competing loan products is able to address both the extent to which HELOC use absorbed growing demand for educational debt from 2002 to 2006, and the extent to which the ongoing growth of the student loan market is driven by parents' loss of home equity as a source of higher education funding.

b. The FRBNY Consumer Credit Panel/Equifax and other data sources

The FRBNY Consumer Credit Panel/Equifax (CCP) is a new longitudinal dataset on consumer liabilities and repayment. Panel data are collected quarterly since 1999Q1, and the panel is ongoing. Data are typically available within the Federal Reserve system with approximately a one quarter lag. Sample members have Social Security numbers ending in one of five arbitrarily selected pairs of digits (for example, 10, 30, 50, 70, or 90), which are assigned randomly within the set of Social Security number holders, and therefore the sample comprises 5 percent of U.S. individuals with credit reports (and Social Security numbers). Household members of the primary sample are also included, and datasets representative of U.S. households can also be constructed.

The CCP sample design refreshes the panel by including all new reports with Social Security numbers ending in the above-mentioned digit pairs. Therefore the panel remains representative for any given quarter, and includes both representative attrition, as the deceased and emigrants leave the sample, and representative entry of new consumers, as young borrowers and immigrants enter the sample.¹⁰

While the sample is representative only of those individuals with credit reports, the coverage of credit reports is fairly complete in the U.S. Lee and van der Klaauw (2010) extrapolate similar populations of U.S. residents aged 18 and over using the CCP and the American Community Survey (ACS). Jacob and Schneider (2006) find that 10 percent of U.S. adults had no credit

¹⁰ See Lee and van der Klaauw (2010) for details on the sample design.

reports in 2006, and Brown, Haughwout, Lee, and van der Klaauw (2011a) estimate that 8.33 percent of the (representative) Survey of Consumer Finances (SCF) households in 2007 include no member with a credit report. Further, where the focus of the analysis is aggregate debt balances, delinquency, foreclosure, or default, or conditional distributions of these objects, the omission of non-report holders is without consequence, as those without credit reports generally do not hold standard consumer debts.¹¹ Aggregates extrapolated from the data match those based on the Flow of Funds Accounts of the United States and SCF well.¹²

For computational reasons, our estimation data consist of 4 to 20 percent random subsamples of the original CCP sample, which therefore constitute 0.2 to one percent random samples of all U.S. (Equifax) individual credit reports. Our estimates are based on data from 1999Q1 to 2012Q4. Variables used in the estimation include total non-mortgage balance, the sum of HELOC and HELoan balances (which we refer to as HELOCs below),¹³ credit card, auto, and student loan balances, the age of the file holder, an Equifax risk score that is similar to the FICO score, and the geographic location of the residence of the file holder at the zip code level.¹⁴ We identify pre-2002 homeowners based on the presence of any home-secured debt in their credit files between 1999Q1 and 2001Q4, including mortgages, home equity loans, and home equity lines of credit. Thus homeowner samples are restricted according to this standard.¹⁵ Renters are defined as all file holders with no home-secured debt from 1999Q1 to 2001Q4, and therefore “renters” in our estimation sample may hold mortgage and other home secured debts in 2002 and beyond.

Annual county-level unemployment data are drawn from the Bureau of Labor Statistics’s (BLS) Local Area Unemployment Statistics (LAUS) program. The unemployment data are reported on a monthly basis, and they cover a total of 3,218 counties, which in turn contain 32,038 zip codes. Zip code-level income data for 1998, 2001, 2002, and 2004-2008 were provided by the IRS Individual Income Tax Statistics zip Code Data. Interpolation for zip codes

¹¹ A clear exception is payday lending, which does not appear on credit reports and is omitted in the following analysis.

¹² See Lee and van der Klaauw (2010) and Brown, Haughwout, Lee, and van der Klaauw (2011a).

¹³ Given that we are interested in how much of the increase in home equity lending supports additional consumption, we would want to exclude home equity borrowing used as piggyback loans at the point of home purchase. However, it is not the case that HELoans in our sample originate mostly at the time of the mortgage origination. Therefore, we retain them in our analysis.

¹⁴ The consumer credit score provided by Equifax is based on a different methodology than the FICO score, but it predicts the same probability of severe delinquency over the next 24 months. See Lee and van der Klaauw (2010).

¹⁵ Mian and Sufi (2011) discuss the accuracy of this method of identifying homeowners in Equifax-derived data.

with at least 3 observations was used to estimate income in missing years and from 2009-2012. The final sample of income data covers 39,708 zip codes. Estimates are not sensitive to the inclusion or exclusion of these (interpolated) income data, perhaps due to differencing and the inclusion of zip code fixed effects in much of our estimation. House price appreciation values are calculated at the zip code level using data from the CoreLogic housing price index (HPI). The CoreLogic HPI uses repeat sales transactions to track changes in sale prices for homes over time, and it is the most comprehensive monthly house price index available. The CoreLogic data cover a total of 6739 zip codes (representing 58% of the total U.S. population) in all 50 states and the District of Columbia. Descriptive statistics for the estimation variables are presented in Table 1.

II. Instrumental variables estimates before, during, and after the housing boom

a. Specification and sample

We seek to identify the causative effect of house price changes on the debt portfolio choices of existing homeowners. Ordinary least squares estimates of the dependence of debt changes on house prices among existing homeowners may be biased for a number of reasons. First, individual credit file holders may buy or sell homes in response to debt portfolio characteristics, leading to consequential sample selection. We address this issue by estimating in samples of existing homeowners, with the intention of studying the response of their debt choices to plausibly exogenous variation in their potential equity growth following the date at which homeownership is measured.

Second, underlying homeowner heterogeneity may be correlated with the level or growth of neighborhood house prices. Third, unsurprisingly, the CCP lacks measures of home prices for homeowners. Even survey data on home prices, as in the Survey of Consumer Finances, or external appraisal data, as in some loan-level sources, are likely to contain errors that are correlated with consumer debt choices. In response to these concerns, we (1) match zip code-level CoreLogic house price indices with the CCP estimation samples, (2) estimate a specification in individual-level differences, and (3) adopt an instrument for house prices that has become standard in the literature.

Saiz (2010) develops an instrument for house price growth using topological features of major U.S. MSAs. Our data for MSA-level housing supply elasticities come from Saiz and cover

153 unique MSAs. These elasticities are estimated using the land gradient and the presence of bodies of water to calculate the exogenous availability of land for use in housing. The MSAs are then matched to zip codes using Geographic Information Systems (GIS). For zip codes that intersect multiple MSAs, the average supply elasticity is used. In total, the supply elasticity data cover 10,923 zip codes.

As noted in footnote 7, the Saiz land topology instrument for house prices has been widely adopted. Mian and Sufi (2011), as well as Saiz, demonstrate that it is correlated with growth in home prices from 2002 to 2006, and, using Equifax-sourced data, Mian and Sufi (2011) demonstrate that the land topology instrument is not correlated with either total debt for renters or credit card debt for homeowners. Furthermore, Mian et al. (2013) show that the inelastic areas with high house price growth suffered the largest decline in housing net worth, and that the housing supply elasticity index remains a strong instrument during the housing market downturn. We instrument the zip code-level growth in house prices, based on the CoreLogic index, using the Saiz land topology instrument in a first stage. In the second stage we study the dependence of homeowners' debt balances on the resulting predicted growth in house prices. Our specification constitutes a first-differenced instrumental variables approach, and is applied over three separate periods of interest.

Specifically, we estimate

$$\begin{aligned} D_{izt_2} - D_{izt_1} &= (X_{izt_2} - X_{izt_1})\beta^D + \delta^D \left(\frac{\widehat{(H_{izt_2} - H_{izt_1}) * 100}}{H_{izt_1}} \right) + \gamma^D (t_2 - t_1) + v_{iz,t_2,t_1} \\ \frac{\widehat{(H_{izt_2} - H_{izt_1}) * 100}}{H_{izt_1}} &= (X_{izt_2} - X_{izt_1})\beta^H + \rho L_z + \xi_{iz,t_2,t_1}, \end{aligned} \quad (1)$$

where D_{izt} represents the debt balance (home equity, credit card, auto, student loan, or total non-mortgage) of individual i in zip code z in quarter t , X_{izt} is a vector of observable (individual- and zip code-level) characteristics, including third order polynomials in age and Equifax consumer risk score, IRS zip code-level average income, and BLS MSA-level unemployment, H_{izt} represents the observed house price index at time t , $\frac{\widehat{H_{izt_2} - H_{izt_1}}}{H_{izt_1}}$ the predicted proportional change in house prices in zip code z between t_2 and t_1 from the first stage, L_z is Saiz's (static) land price scarcity measure for the MSA in which the homeowner resided at the date of

homeownership measurement (and which varies only at the MSA level), and v_{iz,t_2,t_1} and ξ_{iz,t_2,t_1} are (uncorrelated) idiosyncratic errors.¹⁶

We estimate the changes in each debt category, and total non-housing debt, for three separate periods. The first is the pre-period, with $\{t_1, t_2\} = \{1999, 2001\}$. The second is the period of most rapid house price growth, according to the CoreLogic indices, $\{t_1, t_2\} = \{2002, 2006\}$. The third covers the housing bust, Great Recession, and recovery through the most recent observed quarter, so that $\{t_1, t_2\} = \{2007, 2012\}$. Since the data accumulate at a quarterly rate, each observation window is inclusive of the first quarter of year t_1 through the last quarter of year t_2 .

In the FD-IV estimation, we examine a sample of homeowners in zip codes within or overlapping MSAs for which Saiz (2010) estimates land topology-based housing supply elasticities, and for which we observe at least two quarters in the relevant pre-boom, boom, or post-boom estimation period. Hence the time indices of the estimation might better be denoted as t_{i1} and t_{i2} , the first and last quarterly observations in the relevant estimation window for individual i . We impose these sample restrictions on the one percent random sample of credit file holders, leading to estimation samples of 456,979, 449,627, and 396,785 homeowners in the 1999-2001, 2002-2006, and 2007-2012 estimation periods, respectively; these individuals reside in 8,090 zip codes located in or overlapping 79 MSAs.

b. Results

First stage results are presented in the appendix as Table A1. The coefficient on land supply elasticity is of the expected sign and very precise during each of the three estimation periods. In each estimation period, the coefficient on land supply elasticity is large relative to the mean change in the house price index over the period. Table 1 shows that the average percentage changes in the house price index in the pre-boom, boom, and bust periods were 22.62, 54.02, and -22.94, respectively. Estimated coefficients on the land supply elasticity index in the (first stage) percentage change in house prices regression are substantial, at -6.83, -19.83, and 6.82, and highly significant. Elastic areas experienced smaller increases in home prices during the pre-

¹⁶ Errors in the second stage are clustered at the state level.

boom and boom periods, and lower declines in home prices during 2007-2012.

Estimates from the second stage for each of these periods, for each debt category and total non-housing debt, are reported in Table 2. The coefficient estimate from each second stage regression that appears in Table 2 is the δ^D coefficient on the predicted percentage change in home prices. Other coefficient estimates, and measures of fit, for these nine sets of FD-IV estimates are available from the authors.

The first column of estimates reports the results for the 1999-2001 sample window. Each δ^D coefficient reflects the estimated dollar amount of the response of the relevant debt balance to a one percentage point increase in house prices in the homeowner's zip code. In the (comparatively stable) pre-boom period, we find decisive evidence of both a homeowner response through HELOCs to house price increases and consumer substitution between home equity and relatively expensive uncollateralized debt. A one percentage point increase in house prices in a homeowner's zip code is associated with an increase of 67.84 dollars in HELOC debt during the pre-boom period. At the same time, non-housing debt declines by 57.16 dollars, an offset of more than 80 cents on the HELOC dollar. Most of this decline in non-housing debt is estimated to come from credit cards, with a one percentage point increase in home prices bringing a 44.40 dollar decline in card balances.¹⁷

Table 2 also reports average effect sizes in brackets. The average effect is calculated by multiplying the average house price change in the sample over the estimation window with the point estimate. On average, zip code house prices grew by 22.5 percentage points from 1999-2001 for sample homeowners. Hence, the average resulting change in home equity debt was an increase of \$1535. This was offset by a decrease in non-housing debt of \$1293, operating mostly through declines in card balances.

Estimated student and auto debt δ^D coefficients are comparatively small. One likely reason is that these debts are less prevalent than credit card debt, though, of course, home equity debt is even less prevalent in the aggregate over this period. It may be helpful to note at this point that home-secured debt and student debt do not typically appear on the same credit report.¹⁸ The

¹⁷ Each of these effects is significant at the one percent level. Given sample sizes, precision is rarely a concern in these estimates. Therefore we address precision in footnotes from this point onward, in most instances.

¹⁸ Student loans borrowed by parents of students have, however, increased in prevalence during the past decade. See, for example, Department of Education PLUS loan program data available at <http://studentaid.ed.gov/about/data-center/student/title-iv>. (This website was last visited April 3, 2013.)

more typical situation is one in which parents take on home-secured debt, and their children, as students, carry student loan debt. Hence one might expect substitution between home equity and student loan debt taking place at the level of the family, if it is indeed taking place, to be observed primarily across credit reports. The first differencing approach employed here is valuable for its ability to account for time invariant individual heterogeneity, but it does little to identify HELOC-student loan substitution. We return to this issue below.

The middle column of Table 2 reports boom-era estimates. During the housing boom, substitution out of comparatively expensive into comparatively inexpensive debt gives way to debt accumulation in *both* home equity and non-housing loan markets. The growth in home equity loans associated with a one percentage point increase in homeowners' zip code home prices is a more aggressive \$96.25 on average; this is accompanied by a \$25.53 increase in non-housing balances, for a total resulting increase in consumer debt of \$121.78.¹⁹ In terms of effect sizes, sample homeowners saw house prices increase by 54.0 percentage points, on average, from 2002-2006. Hence the average estimated effect of home prices on HELOC balances over the period is \$5199, and the average effect on non-housing debt is \$1379, for a total average increase in non-mortgage debt associated with the home price increase of \$6579.

Credit cards are estimated to have a zero average response to the boom-era home price changes, and this coefficient is fairly precise. In terms of both HELOC and credit card responses to boom-era house price changes, our findings align closely with those of Mian and Sufi (2011). Student loan and auto debt relationships are again modest, and the increase in non-housing debt appears to come largely from other consumer debts.²⁰

The increase in both home-secured and non-housing loan balances in response to house price changes raises the question of the theoretical effect of home equity growth on debt among existing owners. Theories of homeowner consumption and saving under long lives and perfect credit markets predict zero effect of price changes on borrowing, as the change in the value of the home just offsets the change in the imputed stream of rents.²¹ However, models such as Laibson (1997), on borrowers with limited self-control, Ortalo-Magne and Rady (2006) and Lustig and Van Nieuwerburgh (2005), on credit constrained homeowners, and Mian and Sufi (2011), on short-lived homeowners, predict an increase in debt demand associated with increases

¹⁹ These effects are each significant at the one percent level.

²⁰ The other debt category includes retail debt and consumer finance balances.

²¹ See, for example, Sinai and Souleles (2005) and Campbell and Cocco (2007).

in the value of this large, illiquid asset. While homeowners in the 1999-2001 sample increased debts by only \$10.68 with a one percentage point increase in house prices, homeowners in the 2002-2006 sample increased their average balances by \$121.78. If home equity loan availability is limited and house price growth substantial, the resulting increase in demand for debt may exhaust available home equity credit and spill over into other loan markets. We interpret the contrast between the estimates for 1999-2001 and 2002-2006 as evidence of a larger debt demand response to a given house price increase during the boom, in combination with a less than unlimited supply of home equity-based credit.

The home equity debt coefficient is similar to that estimated for 2002-2006; pairwise comparisons fail to reject the null hypothesis that they are the same. They do, however, reject the null hypotheses that each of the 2002-2006 and 2007-2012 house price-HELOC balance relationships are the same as the 1999-2001 relationship. Our finding of significantly different effects of housing wealth on debt, and, by inference, consumption, over time recalls Aron, Duca, Muellbauer, Murata, and Murphy's (2012) discussion of "housing collateral effects on consumption (that)...shift over time due to credit market liberalization."

While the HELOC response to house price changes was of somewhat larger magnitude in the boom and bust than in the pre-boom, one notes that it was qualitatively similar. Hence our estimates indicate that the relationship between local home prices and home equity-based borrowing during the housing boom was not unique; rather, unprecedented growth in house prices generated unprecedented growth in home equity-based borrowing, but following a pattern that was in keeping with homeowner behavior in less ebullient times.

It may be helpful to focus on average effect values for the housing bust period, given that the point estimates reflect the balance response to a one percentage point increase in house values, while more than 75 percent of sample homeowners experienced price declines in their zip codes from 2007-2012. On average, sample homeowners' zip code price indices declined by 22.8 percentage points over the period. This was associated with an average HELOC balance decline of \$2382. In an evident resumption of the substitution seen during 1999-2001, the effect on average auto balances was an increase of \$179. However, the effect on average credit card balances was small and insignificant.²² The estimated effect on total non-housing debt was an insignificant decrease of \$190, owing in part to a significant and not insubstantial estimated

²² The auto debt point estimate is significant at the five percent level.

student debt increase of \$16. Note that such an increase is not consistent with speculation regarding HELOC-student loan substitution in the downturn, though the full sample may not be the appropriate context in which to search for such evidence.

In sum, the qualitative effect of house price changes on home equity debt is stable over the 13 year panel, with one percentage point price growth effects ranging from \$68 to \$104. Home price changes led to significant, if in some cases modest, substitution out of non-housing debts into home equity debt during the more standard 1999-2001 housing market period, but substantial growth in non-housing debt alongside home equity debt during the boom. Where observed, much of the substitution is between credit card and home equity debt. Homeowners increased total non-mortgage debt significantly in response to house price growth, or decreased it significantly in response to house price decline, in each period, with a particularly aggressive debt response observed during the housing boom.

c. Heterogeneity by creditworthiness and age

There is substantial heterogeneity in this pattern, however, and this is particularly true for the housing bust era. Table 3 reports the Table 2 estimates for three subsamples, based on the Equifax risk scores of the homeowners. Most homeowners are prime borrowers, and our sample of prime risk score homeowners, those with credit scores of 700 or more, constitutes roughly two thirds of the estimation sample. Estimates for these prime homeowners are reported in the right panel of Table 3. Although the estimated 1999-2001 HELOC response to house price changes lies very close to the full sample estimate, the associated decline in non-housing debt is (insignificantly) larger, at \$70.90 on average in response to a one percentage point house price increase, and is driven by significant decreases in auto, credit card, *and* student debt. The boom-era estimates are close to the full sample estimates, though the overall increase in non-housing debt masks a significant decline in credit card debt as house prices increase for the most creditworthy group even during the boom. During the housing bust, the prime borrowers substitute out of home equity-based debt and into auto and credit card,²³ though not student debt. Bust-era substitution between non-housing and housing debt is roughly 75 cents on the dollar for this group, with prime borrowers responding to a one percentage point decrease in house prices during the bust with an average decrease of \$44.09 in home equity debt, and an average increase

²³ Each of these estimates is significant at the one percent level.

of \$32.52 in non-housing debt.

Prime homeowners are particularly likely, among credit report holders, to have college-bound children. Hence this is another opportunity to uncover evidence of HELOC-student loan substitution in the downturn, and yet we find none. Again, this may be due to the fact that changes in individual credit reports are not the ideal measure for a study of substitution between (ordinarily parent-level) home equity debt and (ordinarily child-level) student debt.

Consumers with risk scores below 620 are decidedly non-prime, and can be expected to have relatively limited access to credit, and to pay relatively high prices for credit where it is available. These low credit score homeowners constitute about 20 percent of our full estimation sample, and their debt behavior in response to local house price changes differs markedly from that of prime homeowners. Estimates for the non-prime group appear in the left panel of Table 3. As their home equity rises during the pre-boom period, they increase both their HELOC and their auto debts substantially, at rates of \$53.16 and \$22.95 per house price percentage point, respectively. This increase in all major secured debts coincides with an aggressive decrease in credit card debt as house prices increase, at an average rate of \$62.07 per percentage point of house price.²⁴ Note that the HELOC response to house price changes is somewhat more modest in comparison to the increase observed for the prime group and the broader sample. This pattern is true throughout the non-prime estimates: in most instances in which housing market changes lead to large average balance increases in the broader sample, they lead to small increases in debt among the non-prime. We interpret this finding as evidence of supply side credit limitations for non-prime borrowers.²⁵ This is broadly consistent with the findings in Mian et al. (2013) of poorer households experiencing larger reductions in credit limits and refinancing likelihood in the slump, and of a larger marginal propensity to consume out of housing wealth for this group during this period.

During the housing boom, non-prime consumers increased both HELOC and non-housing debts significantly in response to house price growth, though the magnitude of the HELOC coefficient is relatively modest. HELOC debt grew by \$23.64, and non-housing debt by \$22.55,

²⁴ These results are each significant at the one percent level, with the exception of auto which is significant at the 5 percent level.

²⁵ Presumably a second contributor to this finding is the lower average income of the low risk score estimation sample, despite the fact that, within estimation samples, income differences are controlled through individual effects and zip code-level income differences.

with a one percentage point increase in house prices.²⁶ Hence the pattern for this subsample resembles the boom-era pattern for the broader sample, though magnitudes may be altered by income and credit supply differences. The major deviation of this group's estimates from those of the full sample appears during the housing bust era, when non-prime customers shed large amounts of all varieties of debt. Their HELOC debt declined by \$161.17, their non-housing debt by \$121.21, their student debt by \$18.34, their credit card debt by \$43.44, and their auto debt by \$40.17 with a one percentage point decrease in house prices.²⁷ Given evidence on the growth in charge-offs in consumer debt markets during 2007-2012, and this group of homeowners' high estimated risk of default, a substantial portion of this debt decline may be attributable to charge-offs.^{28, 29}

There is no significant response of student loan balances to house price changes for this group in either 1999-2001 or 2002-2006. This may be unsurprising, given that they are likely to have fewer college-bound children on average, as descriptive evidence on risk scores indicates that they are younger and draw lower average income. In each period, the estimated response of auto debt to increases in house prices for the non-prime group is positive and significant. This suggests either an ability of auto bank and auto finance firms to accommodate information on changing asset values in the lending decision, or auto demand that increases with wealth for non-prime customers, or some combination of the two.

Table 4 reports estimates for older and younger subsamples. We divide the sample into those 50 and older and those under 50. The median age in the full estimation sample is near 50, and so, roughly speaking, this amounts to dividing the sample into its older and younger halves. Estimates for the over 50 homeowners resemble those for the prime homeowners: evidence of substitution in the pre-boom and the bust is stronger, and substitution is driven by reduction in credit card balances as house prices and HELOC debt grow. In our first indication of HELOC-student loan substitution during the downturn, older homeowners increase their average student

²⁶ These estimates are significant at the one percent level.

²⁷ These estimates are each significant at the one percent level.

²⁸ For evidence of the time pattern in aggregate charge-offs, see, for example, Brown, Haughwout, Lee and van der Klaauw (2013).

²⁹ It is worth noting that our results are unable to attribute shares of the debt shed by younger and less creditworthy borrowers in the downturn separately to paydown, inaccess, and default. Dynan (2012), for example, demonstrates an independent negative effect of leverage itself on consumption between 2007 and 2009. Given that younger and less creditworthy borrowers typically exhibit higher leverage, her findings support a contribution of paydown and inaccess, in some combination, to the observed declines.

loan debts by about five dollars for each percentage point decrease in bust-era home prices, and this effect is significant at the five percent level. By contrast, the debt outcomes of young homeowners more closely resemble those of non-prime borrowers. They show less evidence of substitution in each period, and they shed substantial amounts of debt during the housing bust.

Peculiarities of younger borrowers in this study include that the young were responsible for the lion's share of debt growth in response to house price growth during the boom, with an average boom-era increase of \$148.54 in total debt for each one percentage point increase in house prices. In addition, instead of adding to student loan debt during the bust, as in the substitution pattern we observe for older and prime borrowers, the young dropped substantial amounts of student debt during this bust, with an average decrease in student debt associated with a one percentage point decrease in house prices of \$36.65.³⁰ Hence, despite inherent measurement difficulties, the estimates localize any bust-era HELOC-student loan substitution to older homeowners, a population in which substitution out of HELOCs and into parental student loans in order to fund children's education is comparatively plausible.

In sum, consumers respond to house price growth (decline) with substantial and significant extensions (retractions) of home equity-based obligations in all three periods. The association between home equity borrowing and growth in home values previously documented for 2002-2006 was not unique. Further, consumers showed significant evidence of substitution between home equity and non-housing debt in only the pre-boom era, while during the housing boom they added substantially to both major debt categories as house prices grew. Older and prime borrowers show high rates of substitution between home equity and non-housing debts, primarily credit card debt, in the non-boom eras, and older borrowers performed modest but significant substitution between home equity and student loan debt during the bust. Non-prime and younger borrowers show less evidence of substitution throughout the panel and considerably more evidence suggestive of supply side credit limitations, and of default associated with house price movements during the housing bust.³¹

³⁰ The point estimates mentioned in this paragraph are significant at the one percent level.

³¹ Note that our results bear on the discussion of the extents to which consumption responses to housing wealth arise from wealth and collateral effects (see, for example, Cooper and Dynan 2013). Cooper (forthcoming) uses PSID data to 2007, and finds evidence for the collateral channel over the wealth channel. While we find extensive evidence of collateral effects throughout the period, unlike Cooper, we also find that older and more creditworthy consumers expanded non-mortgage debt across the board during the housing boom, suggesting meaningful wealth effects of house values in that period.

d. The relationship between student and home equity debt

So far our only evidence of bust-era substitution between HELOC and student debt comes from older homeowners, who increase student debt by \$5 in response to a one percentage point decline in house prices. As discussed, this may be due either to an absence of substitution, or to our inability to track debt across credit reports.

In order to address the latter concern, one could use household-level data, whether in the CCP or in survey data like the Survey of Consumer Finances. The problem with this approach, however, is that college students typically attain independence, and leave the sampled household, at some point during their college years. A failure to find evidence of substitution, then, could arise either from its absence or from, again, the inability to track the movement of debt from parent- to child-level obligations.

As an alternative, we study the relationship between home equity and student debt at a more aggregated, regional level. The analysis asks the question: does student debt increase in the zip codes in which we see (instrumented) decreases in house prices or home equity borrowing? To the extent that college students either retain their parents' home as a permanent address, or study near home, we should be able to pick up any movements out of home equity borrowing into student borrowing in response to house price declines.

We estimate the specification

$$S_{z,t_2} - S_{z,t_1} = (X_{z,t_2} - X_{z,t_1})\beta^S + \delta^S \left(\frac{(H_{z,t_2} - H_{z,t_1}) * 100}{H_{z,t_1}} \right) + \nu_{z,t_2,t_1}$$

$$\frac{(H_{z,t_2} - H_{z,t_1}) * 100}{H_{z,t_1}} = (X_{z,t_2} - X_{z,t_1})\beta^h + \rho^S L_z + \zeta_{z,t_2,t_1},$$

where $S_{z,t}$ represents aggregate student debt among 18-22 year olds in zip code z at time t , all regressors represent zip code means, and the (predicted) change in house prices is, as before, measured at the zip code level. Further, we estimate an identical specification in which, in the second stage, we regress aggregated student debt changes on aggregated home equity debt changes (instead of house price changes), again instrumenting using land supply elasticity. Results are reported in Table 5.

We find evidence of significant substitution only for the pre-boom era, and even there the magnitudes of the estimated coefficients are small. Once again homeowners are observed to increase debt across the board during the boom. During the downturn, the predicted house price and home equity debt declines are associated with an insignificant decline in the student debt of

college-goers. Hence this approach yields no new evidence of bust-era HELOC-student loan substitution.

III. Comparison of high and low 2002-2006 appreciation homeowners: A difference-in-differences approach

a. A simple comparison of debt use among homeowners by house price appreciation rate

The FD-IV specification is our preferred approach; it relies on a source of variation in house prices that is widely accepted by the literature, and differencing removes any confounding effects arising from time-constant homeowner heterogeneity. The method does have some drawbacks, however. First, it relies on only a portion of the house price variation in the data, that which is induced by topological factors. House price growth may vary across zip codes for a host of other regions. Second, it identifies only responses that occur within the 1999-2001, 2002-2006, and 2007-2012 time frames, without allowing us to address cumulative or substantially lagged effects of house price changes on debt. In this section we adopt a different perspective on the relationship between house price appreciation and the debt side of the consumer balance sheet. Using a difference-in-differences (DD) approach, we estimate the effect of boom-era appreciation on debt *levels* in each of the 54 quarters of the panel. These new estimates incorporate other sources of house price variation, and they allow any cumulative and lagged effects to be expressed.³²

We begin by considering some descriptive facts regarding the differences in consumer debt behaviors between homeowners living in high and low house price appreciation zip codes. The initial Equifax 0.2 percent random sample contains 498,056 individuals living in 34,385 zip codes. For the descriptive comparison and differences in differences estimation, we restrict our sample to individuals living in either “high” or “low” house price appreciation zip codes. As discussed above, the CoreLogic house price data cover a total of 6,739 zip codes. These are generally the more populous zip codes, and so, though the number of zip codes represented drops substantially with the requirement of house price data, we lose only about a fifth of credit report holders to this requirement. We define “high” and “low” house price appreciation zip codes as the top and bottom quartiles of the 6,739 CoreLogic zip codes in terms of the change in their

³² Gropp, Krainer, and Laderman model homeowner and renter debt behavior during the bust, and find that renters with low credit scores decrease debt most in response to regional housing market declines. This demonstrates the importance of supply factors in the observed deleveraging.

house price index over the boom period (2002-2006). Retaining only high and low appreciation zip code residents (whether homeowners or renters) results in a final sample of 199,988 individuals living in 3,369 zip codes in each quarter, on average.

Figure 3 depicts mean home equity debt balances across the panel for (pre-2002) homeowners residing in high and low house price appreciation zip codes (labeled as fourth and first quartiles respectively, in the figures).³³ We observe the emergence of home equity lending, and differences in home equity lending by house price appreciation quartile, over the course of the decade. Among homeowners, home equity lending balloons starting in 2003, and declines steadily only after 2010. Moreover, home equity loan balances diverge between high and low house price appreciation quartiles in 2004, and high house price appreciation quartile residents experience roughly twice the growth in home equity-based debt of low house price appreciation quartile residents by 2008. Both groups reach average balances of \$6800 in 2004Q1. By 2009, however, the high appreciation group's home equity loan balances peak at an average of roughly \$11,700, while the low appreciation group's average balance does not rise above \$7500. This first figure demonstrates the large positive association between house price appreciation and home equity lending that was described by Mian and Sufi (2011) and is evident in the above FD-IV estimates.

Tracing levels of debt over the panel also allows us to address the extent to which post-boom balance changes reverse any differences that emerged during the boom. The difference in CoreLogic index growth between the high and low boom-era appreciation quartiles is 93.7 percentage points over the 2002-2006 housing boom. For these same two zip code groups, the difference in house price growth is 23 percentage points during 1999-2001, but only 25 percentage points for the full 2002-2012 period. In other words, the high boom-era appreciation quartile gave back almost all of their relative gains by the end of the housing bust. In figure 3, we observe the limited extent to which high boom-era appreciation homeowners are able to close the home equity debt gap by the end of the panel, suggesting that, despite their modest remaining equity advantage, these homeowners may have retained substantial amounts of home equity debt that was accumulated in response to the housing boom.

³³ As mentioned earlier, following Mian and Sufi (2010), we identify homeowners based on the presence of any home-secured debt in their credit files between 1999Q1 and 2001Q4.

Figure 4 shows total non-mortgage balances for the high and low appreciation groups. High appreciation owners' non-mortgage debt lies below that of low appreciation homeowners from 1999 through 2004. During the latter part of the housing boom, however, high appreciation homeowners' balances grow quickly. By 2009, the non-mortgage debt of high appreciation homeowners exceeds that of low appreciation homeowners by \$3000, before both decline in the widely documented deleveraging of the post-recession period.³⁴ As in Figure 3, most of the high appreciation-low appreciation debt gap persists throughout the deleveraging period. The figure suggests that, relative to low appreciation homeowners, high appreciation homeowners accumulated substantial debt during the housing boom, and failed to repay at a rate commensurate with their pace of relative equity loss.

Of course, differences may exist in macroeconomic conditions, among other things, between the high and low house price appreciation zip codes. These differences, rather than homeowners' response to rising home prices, may drive some of the differences we observe in Figures 3 and 4. In an attempt to understand differences in consumer behavior unrelated to home equity growth, we plot the non-mortgage debt by house price appreciation zip code comparison for (pre-2002) renters in Figure 5. Since levels of debt owed by renters and homeowners may be very different for other reasons (such as life-cycle factors, with homeowners tending to be older), it is the difference in the growth of debt between renters in high and low appreciation zip codes that is of interest for our purposes.

In Figure 5, low appreciation zip code renters' debt exceeds that of high appreciation renters at the start of the period, and through 2004. Each group experiences a rapid, and initially quite similar, growth in non-mortgage debt over the decade. However, the high appreciation renters' balance overtakes the low appreciation renters' balance in the start of 2005, and by their 2009 peaks the average balance for high appreciation renters exceed that for low appreciation renters by \$2000. During the subsequent deleveraging, high appreciation homeowners shed enough non-mortgage debt to all but close the \$2000 debt gap. Hence forces outside of homeowners' unanticipated home equity growth may drive some part of the relative speed of non-mortgage debt accumulation in high appreciation zip codes. However, the magnitude of the

³⁴ See, for example, *Quarterly Report on Household Debt and Credit* (2012), Whitehouse (2010), Brown, Haughwout, Lee, and van der Klaauw (2011b, 2013), and Haughwout, Lee, Scally, and van der Klaauw (2012).

differential for homeowners is not fully explained by the pattern among renters, and neither is the failure to return to more comparable debt levels following the recession.

b. Difference-in-differences estimates of the effect of home price growth on homeowners' use of consumer loan products from 1999 to 2012

The comparisons in the above subsection lead directly to a difference-in-differences estimate of the effect of house price appreciation on consumer debt balances. In order to interpret the DD point estimates, recall that the difference in the mean house price appreciation rates of the high and low appreciation zip codes from 2002 to 2006 (inclusive) is 93.7 percentage points.³⁵ The simple DD estimator is

$$\hat{\Delta}_t = \left(\overline{D}_t^{H,O} - \overline{D}_t^{L,O} \right) - \left(\overline{D}_t^{H,R} - \overline{D}_t^{L,R} \right),$$

where t indexes the quarter, D denotes debt for the loan product of interest, H and L indicate the high and low appreciation groups, respectively, and O and R indicate pre-2002 owners and renters.

An appealing feature of the simple DD estimates is that they impose little structure on a large and informative dataset, and instead allow the data to address the above, straightforward questions regarding household debt accumulation. However, if the difference between high and low house price appreciation zip code renters deviates from the difference between high and low appreciation zip code owners in ways unrelated to owner equity, then our effort to control for non-equity factors in the DD estimates will be incomplete, and will yield biased estimates. Of particular concern is the age difference between 2001Q4 renters and owners in our sample. One way of addressing this concern is to add observable controls to the DD estimation.

We estimate the expression

$$D_{izt} = X_{izt}\beta + \alpha_1 O_i + \alpha_2 Q_{4i} + \alpha_3 O_i * Q_{4i} + \delta_z + \varepsilon_{it}, \quad (2)$$

³⁵ The CoreLogic price index increases by 105.7 percent on average for the fourth quartile house price appreciation zip codes, and 12 percent for the first quartile zip codes.

where D_{izt} again represents the debt balance (home equity-based, credit card, auto, or student loan) of individual i in zip code z in quarter t , X_{izt} is, again, a vector of observable characteristics including third order polynomials in age and Equifax consumer risk score, IRS income data for zip code z in quarter t , and BLS unemployment data measured in quarter t for the MSA intersected by zip code z , O_i is an indicator for whether individual i is a homeowner (before 2002), Q_{4i} is an indicator for whether individual i resides in a fourth quartile house price appreciation zip code in 2001Q4 (or the most recent preceding quarter of observation), δ_z is a random effect at the zip code level, and ε_{it} is an idiosyncratic error.³⁶ α_3 is the difference-in-differences estimator, conditional on these observable controls. We derive controlled DD point estimates of α_3 for each major consumer debt category, for each of the 54 quarters of the panel. They are depicted in Figure 6.³⁷ Estimates based on the simple (that is, uncontrolled) DD estimator are qualitatively similar. The only major differences between the two sets of results are a slight decrease in the magnitude of the estimated HELOC differences during and after the boom and modest upward shifts of the credit card, auto, and student loan curves with the addition of the controls in expression (2).

The size of the dataset, and the simplicity of the estimator, permit a fair amount of precision in the estimates. While we do not include confidence intervals in the DD estimate curves in Figure 6 in order to avoid clouding the presentation, which point estimates differ significantly from zero can be inferred reasonably reliably from the figure. We discuss the significance of the estimates underlying various segments of the curves depicted in Figure 6 informally in the following analysis.

The homeowner-renter differencing, and additional controls, employed in the estimation are intended to remove the influence of outside factors influencing consumer debt balances that may differ between high and low price appreciation areas but are unrelated to the growth in available owner equity. If these measures are effective, and if boom era high and low appreciation zip codes differ little in the pre-boom era, then our point estimates should each be zero for the pre-2002 period. A glance at Figure 6 indicates that this method is reasonably

³⁶ Errors are clustered at the state level.

³⁷ Note that each of the 54 quarterly DD estimates is cross-sectional, though we will be comparing the patterns over time. Hence the specification contains no time period regressors.

effective. Estimated effects of the 23.2 percentage point difference in house price appreciation from 1999 through 2002 are very close to zero for auto, student, and home equity loans (with a single exception for HELOCs in 1999Q4).³⁸ The credit card curve in the pre-boom, however, shows significantly higher credit card debt in 1999Q1 for boom-era high appreciation homeowners that is followed by a steady decline.³⁹ The 2004Q4 point estimate for credit card debt is negative and differs significantly from the 1999 estimates, indicating a significant relative decline in credit card debt for the fourth quartile homeowners during the early years of the panel, as they realize a substantial relative gain in home prices. This is consistent with the significant credit card/home equity debt substitution evident in the FD-IV estimates for this period.

Having clung to the zero line, for the most part from 1999 through 2001, and even until 2003, the curves representing the quarterly point estimates for home equity debt diverge markedly in the boom. The primary effect of the rapid house price growth on existing homeowners is clear. From a 2002Q4 α_3 point estimate of -\$430, the estimates grow steadily to a late boom, 2006Q4 level of \$1705, for a \$2135 increase in the point estimates over four years. The broadly increasing trend continues for more than two years from the end of the standard definition of the boom period, and the α_3 estimate for home equity debt peaks in 2009Q2 at \$2237, for a total 2002Q4 to 2009Q2 increase in quarterly α_3 point estimates of \$2667.⁴⁰ Again, this increase is associated with a 93.7 percentage point difference in home price appreciation in the high appreciation group relative to the low appreciation group during the boom, implying a modest but not insubstantial average response.

The length of our panel allows us to examine differences in home equity-based borrowing between high and low appreciation zip codes following the collapse of house prices as well. The estimated increment to home equity borrowing associated with residing in a high appreciation zip code declines following 2009, but only modestly. By 2012, with house prices having returned approximately to their pre-boom levels, α_3 point estimates indicate that home

³⁸ However, we should note that the pre-2003 student loan data do not reflect the present, preferred methodology of the FRBNY/Equifax CCP, and should therefore be interpreted with caution.

³⁹ Credit card α_3 point estimates are positive and significant for almost all quarters between 1999Q1 and 2002Q4. In 2003Q1 the estimate ceases to differ significantly from zero. The 2004-2007 point estimates for credit card debt are negative, and several quarters' α_3 estimates in 2004, 2005, and 2006 differ significantly from zero.

⁴⁰ The home equity debt α_3 estimates differ significantly from zero for most quarters from 2004Q4 on. The 2002Q4 and 2009Q2 estimates mentioned here (perhaps obviously) differ significantly from each other.

equity-based debt for homeowners in high house price appreciation zip codes remains more than \$2000 higher, on average, than that for homeowners in low appreciation zip codes.⁴¹ This estimate does not differ significantly from the \$2237 estimated peak difference in 2009Q2, so that any decline in balances associated with the decline in house prices is not significant. This finding indicates a substantial distortionary effect of the housing market boom and bust on the balance sheets of pre-2002 homeowners.

In the case of credit cards, following the significant decline from 1999 to late 2004 described above, the credit card DD point estimates plateau from late 2004 until 2007, with quarterly point estimates being, for the most part, statistically indistinguishable and hovering near -\$300. Relative credit card balances for high appreciation zip code homeowners rebounded from these low levels between 2007 to 2012, with α_3 point estimates climbing from -\$370 in 2006Q4 to \$428 in 2012Q1, or \$394 in 2012Q2.⁴² This growth in credit card debt coincides with a 35 percentage point difference in house prices between the high and low groups during the housing bust. Homeowners in high appreciation zip codes accumulated credit card debt significantly more quickly during and after the housing bust, as they experienced a substantial loss of relative equity. The magnitude, direction, and significance of the credit card debt responses to housing market trends emerging from the DD estimates align nicely with the FD-IV estimates above, despite deriving from different sources of house price variation, and treating lagged and cumulative responses differently.

DD estimates of the effects of house price appreciation on auto loans reflect little contemporaneous response of auto debt to the housing boom, and α_3 point estimates for auto debt preceding 2008 are each insignificant. Estimates become negative and significant in 2008, however, and by 2012Q2 the α_3 point estimate is -\$389, and is significant at the five percent level. Overall, the estimates show a declining dependence on auto credit following the boom for homeowners who experienced a more pronounced boom and bust housing cycle, and, unlike the case of credit cards, no evident return to auto debt in response to the post-recession decline in

⁴¹ High house price growth quartile residents had given back most of their boom era gains by 2012. The Case Schiller annual house price index for 2002 is 123.74. The 2012Q1 index is very near the 2002 level, at 124.03, despite the intervening decade. The final difference in mean house price appreciation for our high and low appreciation quartiles over the 2002-2012 period is roughly 23 percentage points, well below the 93.7 percentage point difference we observed during the 2002-2006 housing boom.

⁴² The difference in these two point estimates is significant at the one percent level.

available owner equity and home equity-based credit. This finding also aligns with the FD-IV results.

As intimated in footnote³⁵, the recently built loan-level student debt measures associated with the FRBNY/Equifax Consumer Credit Panel are available for 2003 on, and so we emphasize the more recent decade in our treatment of student loan debt. The α_3 point estimates for student debt are increasingly positive and significant from 2003 forward, with a modest and insignificant decrease in the estimated student debt differences from 2003-2005 and a steep and significant increase in the estimated student debt differences from 2006 to 2012. The estimated effect of house price appreciation on student debt is insignificant and, if anything, negative during the housing boom. In the end of the boom and through the housing bust and beyond, however, homeowners who experienced a large house price appreciation during the boom, and associated large depreciation during the bust, significantly increase their reliance on student loans. From an α_3 estimate of \$299 in 2005Q4, the student loan differences increase to a peak of \$932 in 2011Q4, and remain at comparably high levels of \$909 in 2012Q1 and \$799 in 2012Q2. From 2009 to 2012, as HELOC debt plateaus for high appreciation homeowners, student loan debt increases steadily and (marginally) significantly. Though not decisive, this evidence is the strongest we have found for HELOC-student loan substitution during the downturn. In combination with the evidence of a \$5 increase in (presumably parent) student loans associated with a one percentage point decrease in house prices for older borrowers during the housing bust, and the lack of HELOC-student loan substitution evidence elsewhere, we conclude that the evidence for HELOC-student loan substitution during the downturn is weak, and does not clearly support speculation that a major contributor to the ongoing growth of student debt in the face of consumer deleveraging is the recent loss of parents' home equity credit.

Returning to the question of the effect of house price appreciation on total non-mortgage debt, Figure 7 depicts quarterly DD point estimates for total non-mortgage debt alone over the panel. The series begins with a positive and significant \$955 for 1999Q1, but declines quickly. By 2002Q4 high appreciation homeowners have significantly lower non-mortgage debt than low appreciation homeowners, with an α_3 estimate of -\$873. From there high appreciation homeowners steadily gain non-mortgage debt relative to their low appreciation peers, with estimates of α_3 peaking at \$2137 in 2011Q3, and averaging roughly \$1850 over the last four

quarters of observation. Again, this is associated with a small difference in differences in house price growth since 2002. Thus the estimates indicate that homeowners who experienced comparatively (and historically) large house price appreciation during the boom and depreciation during the bust end the period with substantial additional debt but little additional equity, relative to peers who experienced a more moderate boom-bust cycle.

In sum, the controlled DD estimates depict ballooning home equity borrowing among homeowners who experienced rapid equity growth, a modest degree of substitution between home equity-based and student debt by these homeowners as they experienced owner equity and available credit losses during the housing bust, and no clear differential repayment of the accumulated debt by this group as their owner equity fell. Overall, the results using this identification approach are qualitatively similar to the conclusions we reach using the FD-IV approach.

IV. Conclusions

This paper examines homeowners' debt behavior through three very different periods for the U.S. housing market. It studies the extent to which consumers substitute between more and less costly, uncollateralized and collateralized, debts as owner equity changes. It asks whether these patterns are consistent for homeowners experiencing house price growth under very different conditions in the broader housing market, and for homeowners with different underlying characteristics. Finally, it investigates the hypothesized homeowner substitution into the student loan market in order to finance education during the Great Recession. The inquiry relies on data from the new FRBNY Consumer Credit Panel/Equifax, matched with CoreLogic house price indices, IRS income data, BLS unemployment data, and a land topology-based elasticity measure at the MSA level from Saiz (2010).

Existing literature has largely focused on the housing boom period to analyze the response of consumers' debt portfolio to changes in home prices. To our knowledge, this is one of the first papers to investigate the response of consumer debt in the pre-boom period, as well as during the bust. Moreover, we exploit the heterogeneity in their responses to shed light on whether the seemingly rational behavior of US households is driven by demand or supply factors.

In first-differenced instrumental variables estimation, we find that, during 1999-2001, homeowners substituted out of non-housing (largely credit card) debt and into home equity-based debt at a rate of roughly dollar-for-dollar in response to house prices increases. During the housing boom of 2002-2006, however, homeowners abandoned the practice of substituting into less costly debt as equity grows, and instead increased obligations across the board. From 2007-2012, sample homeowners experienced a 23 percent average house price decline, and withdrew from home equity debt without adding to non-housing debt, on average. We observe substantial heterogeneity in this pattern: substitution in both 1999-2001 and 2007-2012 ranges from about 50 cents to more than dollar-for-dollar for prime borrowers, while the decidedly non-prime borrow more modestly, show less evidence of substitution in each period, and shed large amounts of all types of debt from 2007-2012. These patterns are suggestive of portfolio-based, demand-driven debt changes for older and prime borrowers, and supply-driven debt changes with extensive default for younger and non-prime borrowers.

Difference-in-differences estimates demonstrate that, in response to a 93.7 percentage point differential in house price appreciation, homeowners increased home equity-based borrowing by between \$2237 and \$2667, on average. On net, the house price expansion of 2002 to 2006 led to a substantial, significant increase in non-mortgage borrowing by homeowners who experienced high house price appreciation.

The difference-in-differences estimates also indicate that these homeowners did not pay down the resulting debts at a significantly higher rate than their counterparts in low house price appreciation areas, resulting in a large remaining debt surplus relative to low appreciation region homeowners by 2012, despite the loss of most of the owner equity gains produced for the high appreciation homeowners during the boom. Claims that student lending has increased since the house price bust as a result of the end of easy home equity lending find limited support in our estimates.

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Table 1: Descriptive statistics for the three estimation samples

Variable	Sample	Prevalence	Mean	Median	SD
Total debt	pre	0.75	23,832	3,617	49,744
	boom	0.75	32,012	4,749	75,006
	post	0.75	38,893	5,623	94,816
Non-housing debt	pre	0.72	6,869	1,352	14,873
	boom	0.72	8,032	1,692	18,437
	post	0.72	8,414	1,866	17,844
HELOC debt	pre	0.07	1,161	0	8,244
	boom	0.10	2,299	0	13,672
	post	0.11	2,906	0	17,387
Credit card debt	pre	0.58	2,438	202	6,727
	boom	0.58	2,623	211	6,798
	post	0.55	2,503	140	6,915
Auto debt	pre	0.21	1,970	0	6,336
	boom	0.26	2,652	0	8,977
	post	0.28	2,443	0	5,861
Student debt	pre	0.06	571	0	4,089
	boom	0.08	1,135	0	6,745
	post	0.14	2,260	0	10,155
Variable	Sample	Mean	SD	Minimum	Maximum
Home price index change	pre	22.62	12.06	-11.73	69.15
	boom	54.02	37.81	-17.90	182.65
	post	-22.94	16.2	-63.30	31.80
N =	pre	314,202	boom	449,627	post 565,768

All financial variables reported in 2012 US dollars.

Table 2: First-differenced instrumental variables estimates of the effect of house price changes on auto, credit card, and student loan balances

Dependent variable	Period		
	1999-2001	2002-2006	2007-2012
Auto loan	-10.97*** (3.47) [\$-248.14]	3.64** (1.51) [\$196.63]	-7.79** (3.03) [\$178.70]
Credit card	-44.40*** (3.72) [-\$1,004.33]	0.04 (1.41) [\$2.16]	-2.65 (3.12) [\$60.79]
Student loan	-1.84 (1.55) [-\$41.62]	-1.61* (0.83) [-\$86.97]	15.80*** (2.47) [-\$362.45]
Non-housing debt	-57.16*** (11.23) [-\$1,292.96]	25.53*** (4.01) [\$1,379.13]	8.30 (8.32) [-\$190.40]
HELOCs	67.84*** (6.10) [\$1,534.54]	96.25*** (3.40) [\$5,199.43]	103.83*** (9.04) [-\$2,381.86]
N =	314,202	449,627	565,768

* denotes significance at the 10 percent, ** at the five percent, and *** at the one percent level.

Table 3: First-differenced instrumental variables estimates of the effect of house price changes on auto, credit card, and student loan balances, by risk score

Dependent variable	Risk score < 620			Risk score 620 to 699			Risk score 700+		
	1999-2001	2002-2006	2007-2012	1999-2001	2002-2006	2007-2012	1999-2001	2002-2006	2007-2012
Auto loan	22.95** (11.59)	14.46*** (3.77)	40.17*** (5.91)	-13.15 (9.33)	5.18 (3.80)	15.14** (6.62)	-15.80*** (3.78)	-0.74 (1.74)	-19.01*** (4.03)
Credit card	-62.07*** (11.10)	-6.41** (2.56)	43.44*** (5.69)	-79.42*** (10.60)	4.14 (3.44)	38.70*** (7.67)	-37.04*** (4.08)	-8.56*** (1.85)	-10.74*** (4.00)
Student loan	5.04 (5.82)	-1.73 (2.07)	18.34*** (6.69)	1.42 (4.26)	-0.63 (2.07)	5.90 (5.91)	-2.72* (1.59)	1.09 (0.97)	-2.13 (2.70)
Non-housing debt	-12.84 (27.07)	22.55*** (6.95)	121.21*** (14.60)	-64.03** (26.05)	30.22*** (8.48)	72.51*** (16.80)	-70.90*** (13.94)	15.50*** (5.60)	-32.52*** (11.59)
HELOCs	53.16*** (13.86)	23.64*** (3.69)	161.17*** (12.83)	77.07*** (15.28)	105.73*** (7.28)	281.23*** (24.91)	61.27*** (7.47)	103.61*** (4.99)	44.09*** (11.67)
N =	47,575	76,198	97,440	60,485	78,593	103,713	206,142	294,836	364,615

* denotes significance at the 10 percent, ** at the five percent, and *** at the one percent level.

Table 4: First-differenced instrumental variables estimates of the effect of house price changes on auto, credit card, and student loan balances, by age

Dependent variable	Age 50+			Age < 50		
	1999-2001	2002-2006	2007-2012	1999-2001	2002-2006	2007-2012
Auto loan	-5.40 (5.01)	1.30 (1.90)	-8.65** (4.03)	-9.71** (4.73)	7.56*** (2.29)	-6.57 (4.58)
Credit card	-47.92*** (6.39)	-2.07 (2.14)	-14.49*** (4.56)	-38.31*** (4.51)	4.08** (1.87)	7.90* (4.19)
Student loan	-1.28 (1.64)	0.16 (0.87)	-5.29** (2.45)	-2.05 (2.36)	-2.22 (1.36)	36.65*** (4.47)
Non-housing debt	-50.36*** (19.54)	30.30*** (6.19)	-24.70** (11.98)	-49.54*** (13.41)	27.56*** (5.26)	38.32*** (11.45)
HELOCs	60.40*** (10.07)	74.27*** (5.14)	67.68*** (11.81)	80.14*** (7.64)	120.98*** (4.55)	149.89*** (13.91)
N =	125,772	210,610	303,780	188,430	239,017	261,988

* denotes significance at the 10 percent, ** at the five percent, and *** at the one percent level.

Table 5: Zip code aggregate first-differenced instrumental variables estimates of the effects of house price and HELOC changes on student loan balances

Independent variable	Period		
	1999-2001	2002-2006	2007-2012
<u>Specification (1)</u>			
House price index	-0.44*	0.77***	0.85
	(0.23)	(0.24)	(1.03)
<u>Specification (2)</u>			
HELOC dollars	-0.02*	0.01***	0.01
	(0.01)	(0.00)	(0.02)
N =	4770	4770	4770

* denotes significance at the 10 percent, ** at the five percent, and *** at the one percent level.

Sample size is number of zip codes with sufficient information to estimate.

Table A1: First stage regression of house price index change on land supply elasticity instrument

Independent variable	1999-2001	2002-2006	2007-2012
Land supply elasticity index	-6.833*** (0.027)	-19.832*** (0.067)	6.823*** (0.026)
Constant	33.395*** (0.122)	85.226*** (0.356)	-31.291*** (0.096)
Change in risk score / 100	0.235 (0.240)	4.876*** (0.480)	2.890*** (0.210)
Change in risk score ² / 100,000	0.017 (0.189)	1.660*** (0.376)	2.820 (0.162)
Change in county unemployment rate	0.089*** (0.023)	30.30*** (6.19)	-2.755*** (0.013)
Change in zip code mean income / 10,000	0.431*** (0.026)	0.272*** (0.044)	0.930*** (0.014)
Number of quarters	-0.022** (0.011)	-0.704*** (0.019)	0.252*** (0.004)
R-squared	0.218	0.378	0.2772
T-statistic for H0: land supply elasticity index coefficient = 0	-257.74	-298.64	258.92

* denotes significance at the 10 percent, ** at the five percent, and *** at the one percent level.

Figure 1: US Non-Mortgage Consumer Debt, 1999-2012

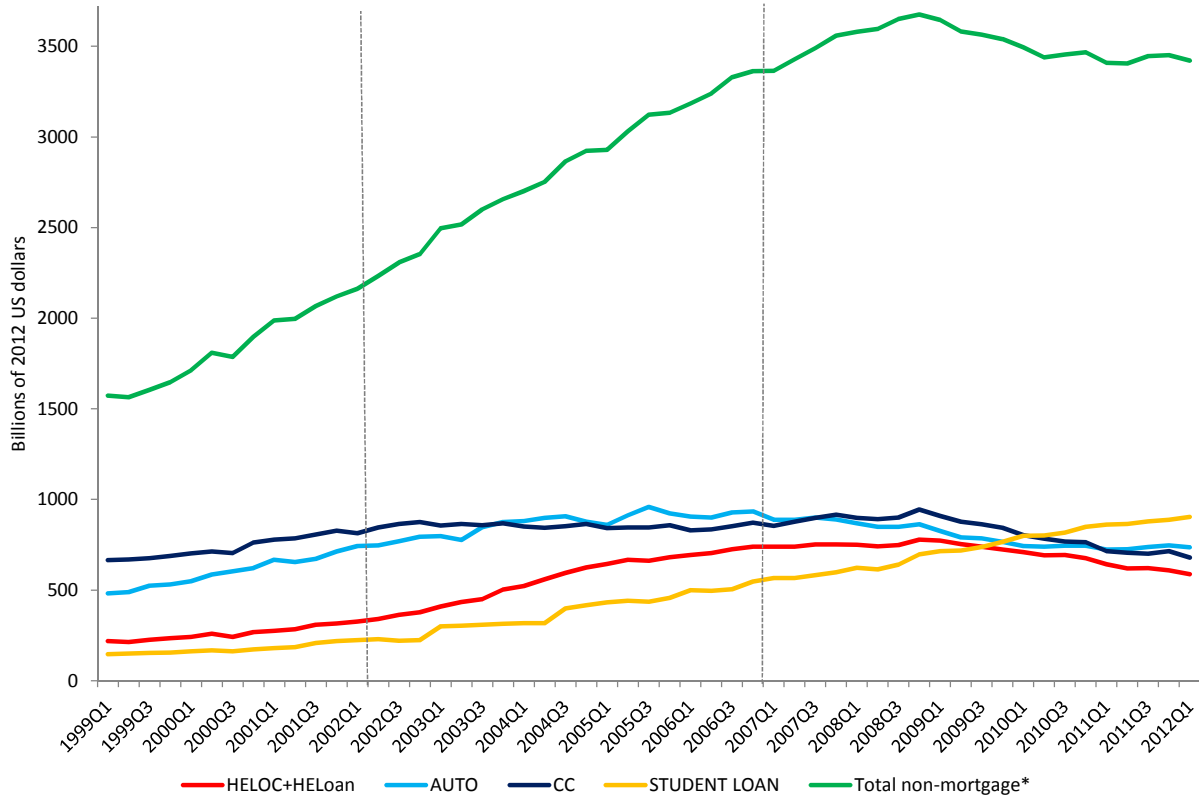


Figure 2: Leading Non-Mortgage Debt Categories, 1999-2012

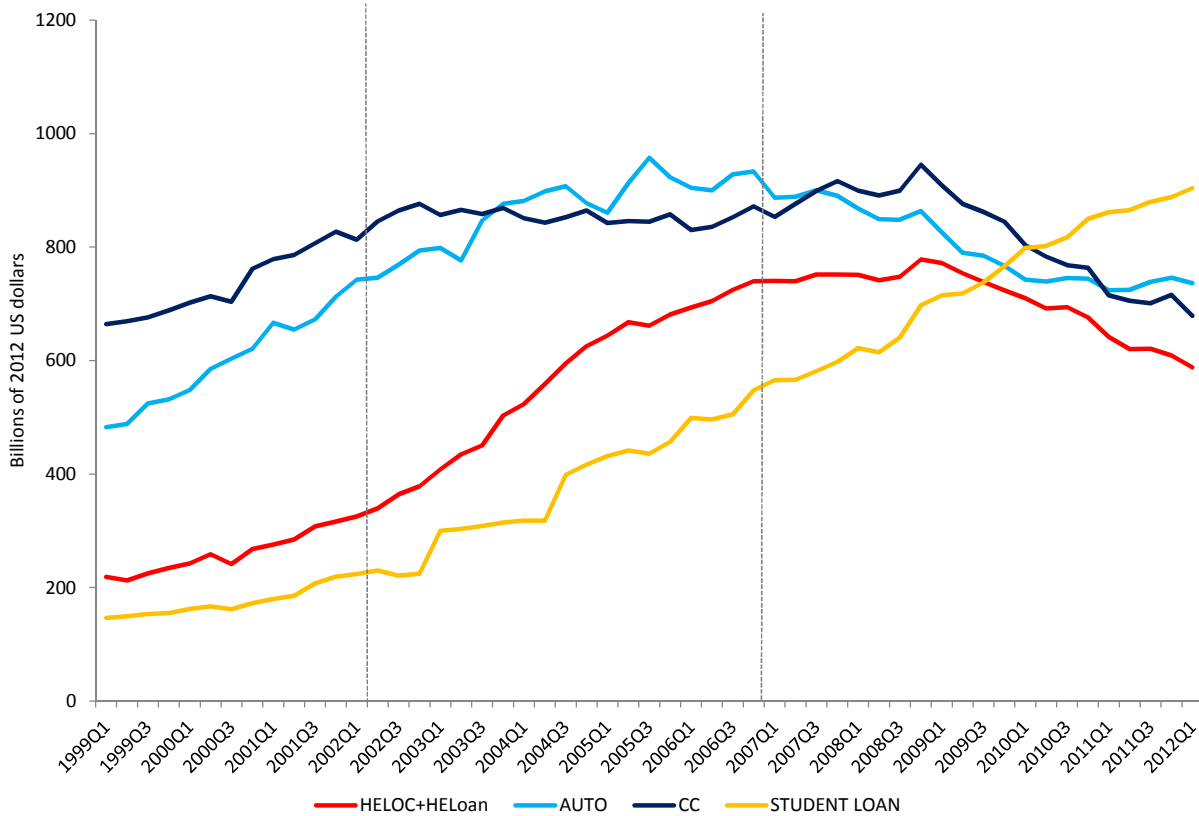


Figure 3: Mean home equity debt among homeowners in high & low house price appreciation zip codes

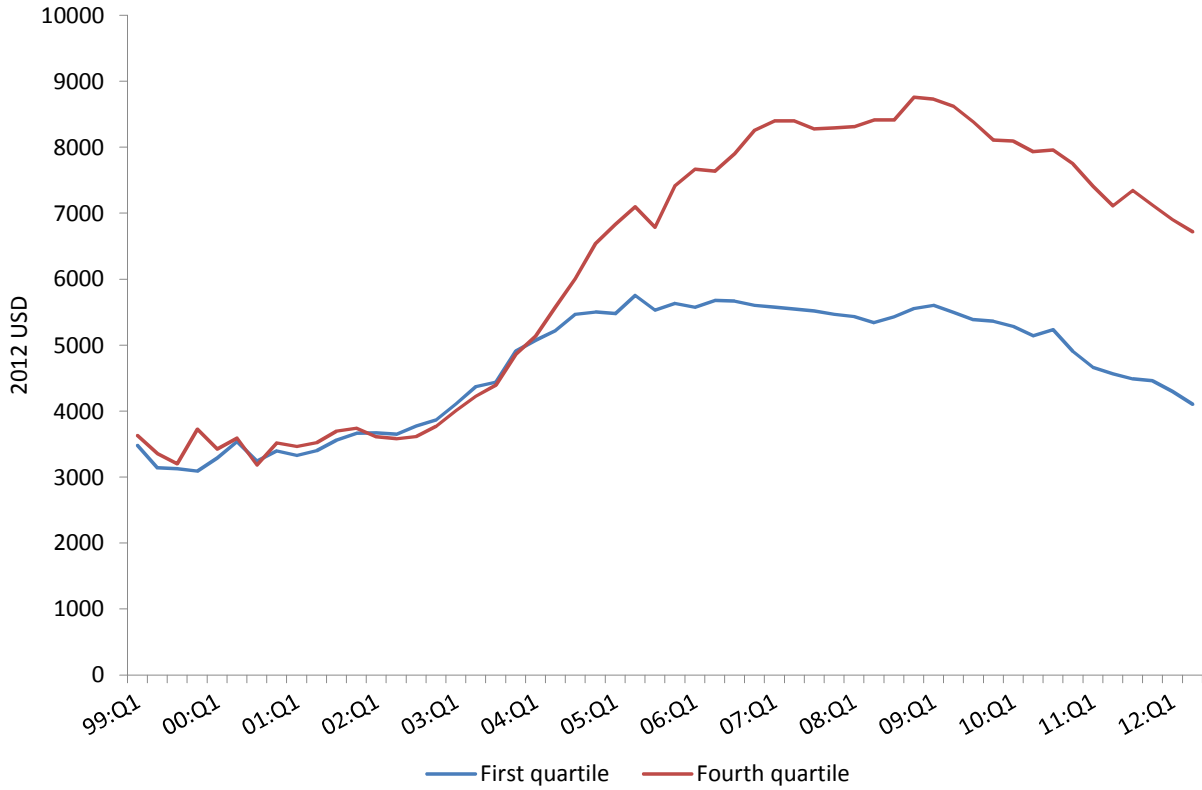


Figure 4: Mean non-mortgage debt among homeowners in high & low house price appreciation zip codes

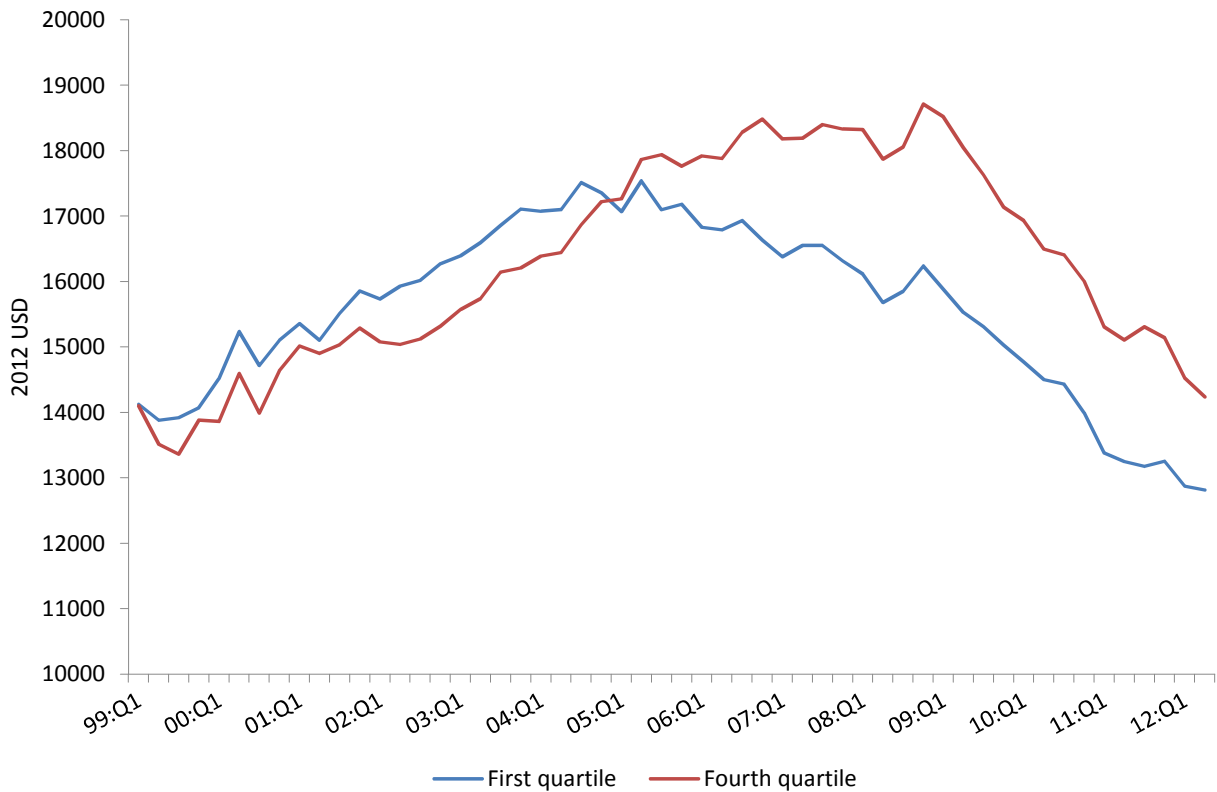


Figure 5: Mean non-mortgage debt among renters in high & low house price appreciation zip codes

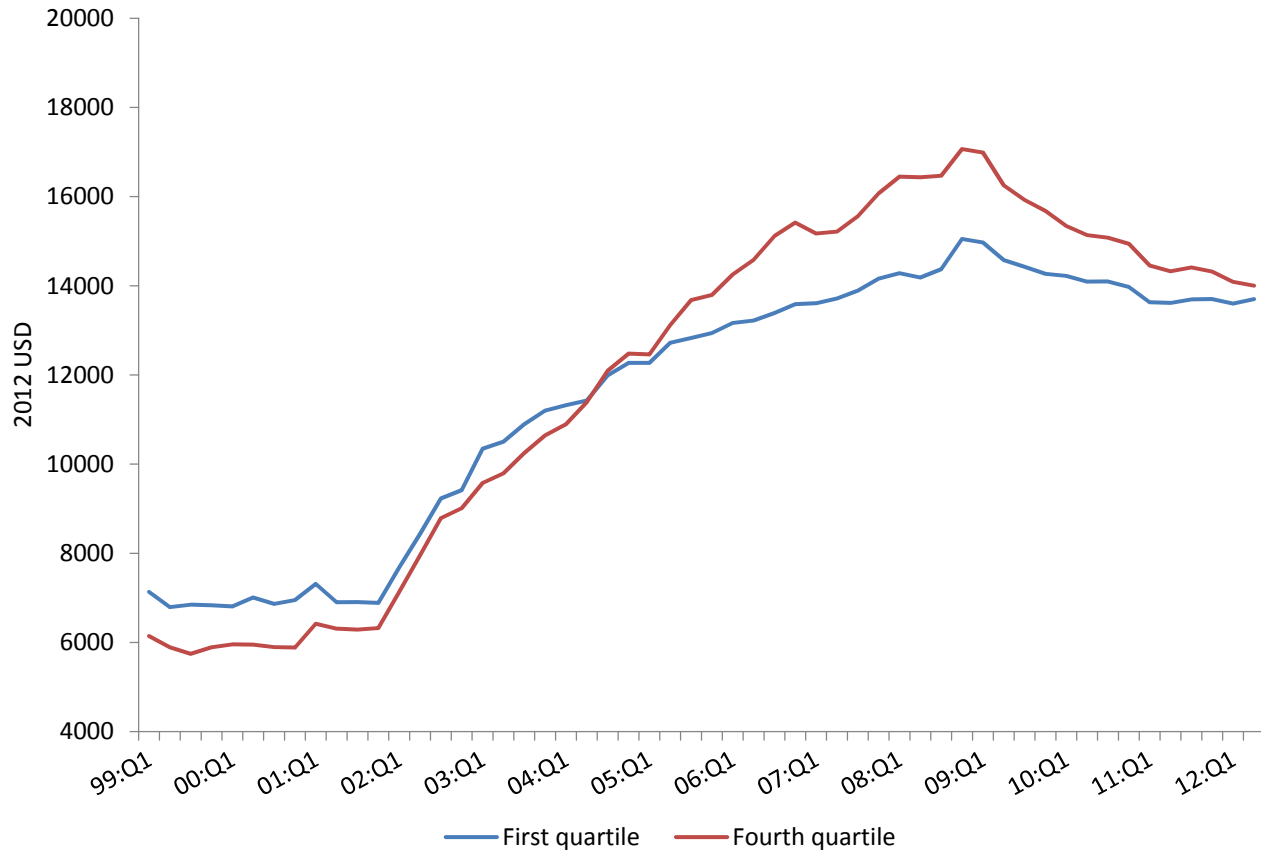


Figure 6: Difference in differences estimates of the effect of house price appreciation quartile on consumer debts

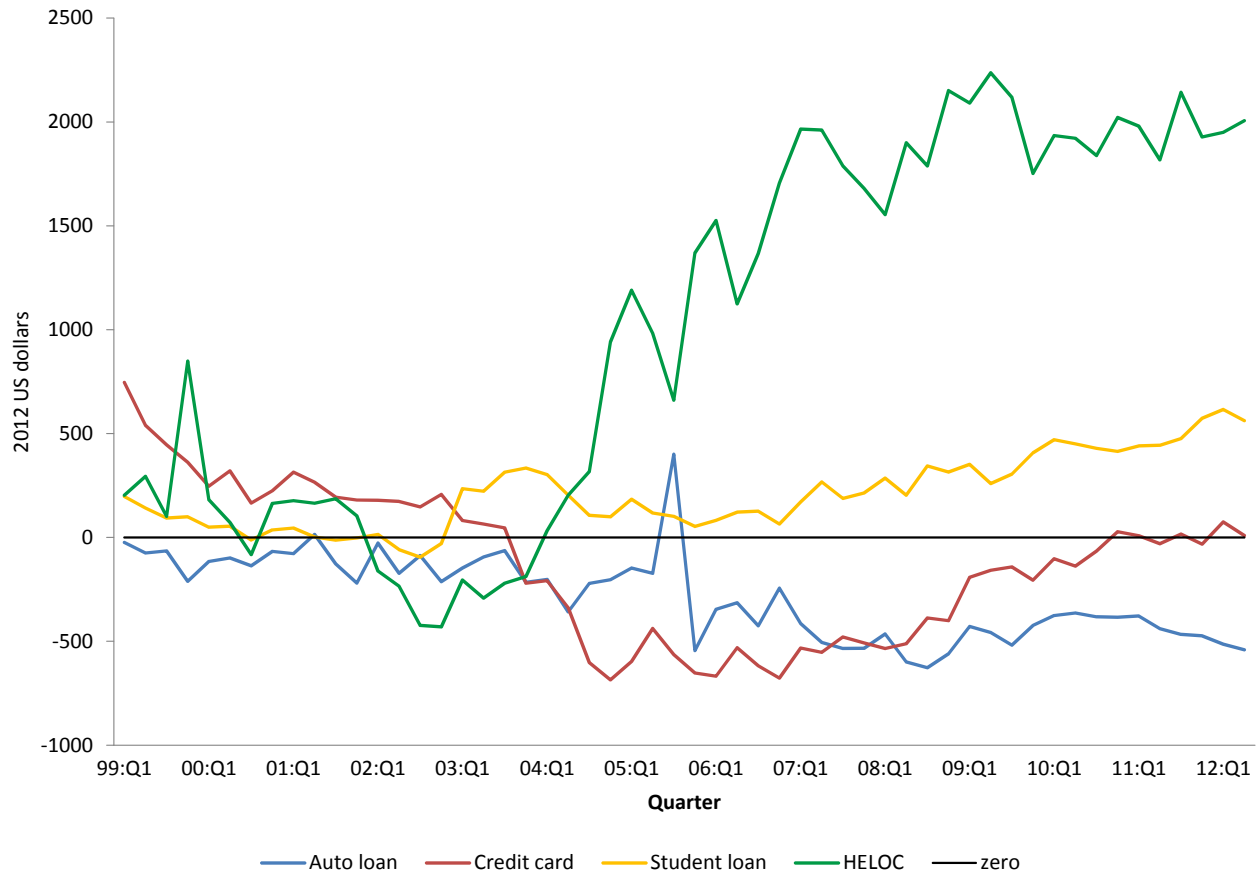


Figure 7: Difference in differences estimates of the effect of home price appreciation on total non-mortgage debt

