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## The impact of housing markets on consumer debt: Credit report evidence from 1999 to 2012

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Federal Reserve Bank of New York  
Staff Reports

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

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Sarah Stein  
Basit Zafar

Staff Report No. 617  
May 2013



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# **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 nonmortgage borrowing, including student, credit card, auto, and home equity debts. For this purpose, we use CoreLogic geographic house price variation, matched with rich data on consumer liabilities from the Equifax-sourced FRBNY Consumer Credit Panel. The length and timing of our panel allow us to study the consumer debt portfolio response to house price changes during a boom-and-bust cycle of historic magnitude as well as during more ordinary times. In first-differenced instrumental variables estimation, we find that during 1999-2001, homeowners substituted out of nonhousing (largely credit card) debt and into home equity-based debt at a nearly dollar-for-dollar rate in response to house price increases. During the housing boom of 2002-06, however, homeowners abandoned the practice of substituting into less costly debt as equity grew, and instead increased obligations across the board. From 2007-12, sample homeowners experienced a 23 percent average house price decline, and withdrew from home equity debt without adding to non-housing debt. We observe substantial heterogeneity in this pattern: Substitution in both 1999-2001 and 2007-12 ranges from 50 cents to more than dollar-for-dollar for older and prime borrowers, while the decidedly nonprime borrow more modestly, show less evidence of substitution, and shed large amounts of all types of debt from 2007-12. Finally, difference-in-differences and FD-IV estimates are consistent with both 1) a 2012 relative debt overhang of at least \$1,800 on average, despite little remaining home equity advantage, for homeowners who experienced a more pronounced boom-and-bust cycle and 2) little substitution out of home equity debt into student loans in response to recent house price declines.

Key words: consumer debt, house prices

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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.<sup>1</sup> 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.<sup>2</sup> We interpret this object as non-housing-purchase consumer debt, and we refer to it as non-mortgage debt throughout the paper.<sup>3</sup> 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.<sup>4</sup> 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

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<sup>1</sup> Mian and Sufi (2009) demonstrate that a leading contributor to the run-up in household debt was increased access to mortgage credit.

<sup>2</sup> The data represented in Figures 1 and 2 are drawn from the FRBNY Consumer Credit Panel/Equifax, described in detail in section I below. All balances reported in the paper are in 2012 US dollars.

<sup>3</sup> 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.

<sup>4</sup> If anything, the rate of growth of non-mortgage debt declines from the 1999-2002 period to the 2002-2006 house price boom.

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

Influential studies of consumers' response to the unusual patterns in the housing market in recent years have most commonly emphasized the housing boom period. 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.<sup>5</sup> Of equal interest are the relationship between consumption, debt, and investment choices and the housing market under more standard macroeconomic conditions, and during the Great Recession. Does the aggressive growth in debt among existing homeowners during the housing boom demonstrated by Mian and Sufi (2011) also appear for those homeowners who realize substantial equity growth in ordinary times? How do consumer debt portfolios react to an unprecedented decline in house prices?

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

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<sup>5</sup>Mian, Rao, and Sufi (2012) and Mian and Sufi (2012) are examples of related studies that emphasize recession-era consumer behavior.

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. 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. 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.

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 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.<sup>6</sup> FD-IV estimates are generated for 1999-2001, 2002-2006, and 2007-2012.<sup>7</sup> 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: substitution in both 1999-2001 and 2007-2012 ranges from 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 every period, and shed large amounts of all types of debt from 2007-2012. Evidence is 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.

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

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<sup>6</sup> See, for example, Mian and Sufi (2009, 2011), Chetty and Szeidl (2012), Charles, Hurst, and Notowidigdo (2013), and Halket (2012).

<sup>7</sup> We use all quarters from the panel, and the above time periods are inclusive of the full beginning and endpoint years.

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.

The results show little difference in home equity debt between homeowners who will realize high and low boom-era appreciation during the pre-boom period, followed by a ballooning of HELOCs for high appreciation homeowners from 2003 to 2008, and only a very modest decline in balances with the housing bust. The credit card series reflects substitution in the pre-boom and bust periods, but plateaus during the boom. Auto debts are relatively unresponsive. Student loan debts grow for high appreciation homeowners from 2002-2006, and they continue their pace of relative growth as the high boom-era appreciation houses lose value from 2007-2012. These, and other estimates, indicate at best a modest degree of substitution out of HELOCs and into student loans for those whose houses lost substantial value during the bust. Overall, the estimates show significantly lower total non-mortgage debt for high boom-era appreciation homeowners in 2003, and yet significantly higher debt for them from 2009 on; an increase in the estimated debt difference between high and low boom-era appreciation homeowners of roughly \$3100 from 2004 to 2011; and an average non-mortgage debt overhang of at least \$1800, despite the loss of most home equity advantage, for homeowners who experienced a more pronounced boom-bust cycle.

As mentioned above, 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.

## **I. Data**

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.<sup>8</sup>

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

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<sup>8</sup> 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.<sup>9</sup> Aggregates extrapolated from the data match those based on the Flow of Funds Accounts of the United States and SCF well.<sup>10</sup>

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, 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.<sup>11</sup> 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.<sup>12</sup> 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.

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<sup>9</sup> A clear exception is payday lending, which does not appear on credit reports and is omitted in the following analysis.

<sup>10</sup> See Lee and van der Klaauw (2010) and Brown, Haughwout, Lee, and van der Klaauw (2011a).

<sup>11</sup> 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).

<sup>12</sup> Mian and Sufi (2011) discuss the accuracy of this method of identifying homeowners in Equifax-derived data.

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 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 match zip code-level CoreLogic house price indices with the CCP estimation samples, we estimate a specification in individual-level differences, and we 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.

The Saiz land topology instrument for house prices has been widely adopted.<sup>13</sup> 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

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<sup>13</sup> As noted above, applications include Mian and Sufi (2009, 2011), Chetty and Szeidl (2010), Charles, Hurst, and Notowidigdo (2011), and Halket (2012).

homeowners. 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

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

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,  $\widehat{H_{izt_2} - H_{izt_1}}$  represents the predicted change in house prices in zip code  $z$  between  $t_2$  and  $t_1$  from the first stage,  $H_{izt_2} - H_{izt_1}$  the observed change in house prices,  $L_z$  is Saiz's (static) land price scarcity measure for the MSA in which the homeowner resided at the date of homeownership measurement, and  $\nu_{iz,t_2,t_1}$  and  $\xi_{iz,t_2,t_1}$  are (uncorrelated) idiosyncratic errors.

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*

Estimates from the second stage for each of these periods, for each debt category and total non-housing debt, are reported in Table 2. First stage results are available in the appendix as Table A1. The coefficient estimate from each second stage regression that appears in Table 2 is the  $\delta^D$  coefficient on predicted home price change. 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  $\delta^D$  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.<sup>14</sup>

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  $\delta^D$  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.<sup>15</sup> The 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

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<sup>14</sup> 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, at least in most instances.

<sup>15</sup> 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.)

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.<sup>16</sup> 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.

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.<sup>17</sup> However, models such as Laibson (1997), on borrowers with limited self-control, Ortalo-Magne and Rady (2006) and

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<sup>16</sup> These effects are each significant at the one percent level.

<sup>17</sup> See, for example, Sinai and Souleles (2005) and Campbell and Cocco (2007).

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 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. Though qualitatively similar, the HELOC response to house price changes was of significantly larger magnitude in the boom and bust than in the pre-boom.) 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.<sup>18</sup> The estimated effect on total non-housing debt was an insignificant decrease of \$190, owing in part to a significant and not insubstantial estimated 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

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<sup>18</sup> The auto debt point estimate is significant at the five percent level.

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 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, though not student, debt.<sup>19</sup> 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 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.

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<sup>19</sup> Each of these estimates is significant at the one percent level.

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.<sup>20</sup> 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.<sup>21</sup>

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, with a one percentage point increase in house prices.<sup>22</sup> 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.<sup>24</sup> Given evidence on the growth in

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<sup>20</sup> These results are each significant at the one percent level, with the exception of auto which is significant at the 5 percent level.

<sup>21</sup> Presumably a second contributor to this finding is the lower average income of a 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.

<sup>22</sup> These estimates are significant at the one percent level.

<sup>24</sup> These estimates are each significant at the one percent level.

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-off.<sup>25</sup>

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 an ability of auto bank and auto finance firms to accommodate information on changing asset values in the lending decision, 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 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

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<sup>25</sup> Add charge-off cite.

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.<sup>26</sup> 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 default associated with house price movements during the housing bust.

### **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*

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<sup>26</sup> The point estimates mentioned in this paragraph are significant at the one percent level.

The first differenced instrumental variables 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 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.

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

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 homeowners residing in high and low house price appreciation zip codes. 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.

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.<sup>27</sup> 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),

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<sup>27</sup> See, for example, *Quarterly Report on Household Debt and Credit* (2012), Whitehouse (2010), Brown, Haughwout, Lee, and van der Klaauw (2010, 2011b), and Haughwout, Lee, Scally, and van der Klaauw (2012).

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 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 difference in differences 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.<sup>28</sup> The simple difference in differences estimator is

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

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<sup>28</sup> 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  $t$  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 difference in differences 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 difference in differences 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 difference in differences estimation.

We estimate the expression

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

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),  $\delta_z$  is a random effect at the zip code level, and  $\varepsilon_{it}$  is an idiosyncratic error. Controlled difference in

differences point estimates of  $\alpha_3$  are derived for each major consumer debt category, for each of the 54 quarters of the panel, and are depicted in Figure 6.<sup>30</sup> Estimates based on the simple difference in differences 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 difference in differences 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 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).<sup>31</sup> The credit card curve in the pre-boom, however,

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<sup>30</sup> Note that each of the 54 quarterly difference in differences estimates is cross-sectional, though we will be comparing the patterns over time. Hence the specification contains no time period regressors.

<sup>31</sup> 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.

shows significantly higher credit card debt in 1999Q1 for boom-era high appreciation homeowners that is followed by a steady decline.<sup>32</sup> 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 diverge markedly in the boom. The primary effect of the rapid house price growth on existing homeowners is clear. From a 2002Q4  $\alpha_3$  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  $\alpha_3$  estimate for home equity debt peaks in 2009Q2 at \$2237, for a total 2002Q4 to 2009Q2 increase in quarterly  $\alpha_3$  point estimates of \$2667.<sup>33</sup> 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

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<sup>32</sup> Credit card  $\alpha_3$  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'  $\alpha_3$  estimates in 2004, 2005, and 2006 differ significantly from zero.

<sup>33</sup> The home equity debt  $\alpha_3$  estimates differ significantly from zero for most quarters from 2004Q4 on, and (perhaps obviously) the 2002Q4 and 2009Q2 estimates mentioned here differ significantly from each other.

appreciation zip code declines following 2009, but only modestly. By 2012, with house prices having returned approximately to their pre-boom levels,  $\alpha_3$  point estimates indicate that home 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. 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.<sup>34</sup> 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 difference in differences 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  $\alpha_3$  point estimates climbing from -\$370 in 2006Q4 to \$428 in 2012Q1, or \$394 in 2012Q2.<sup>35</sup> This growth in credit card debt coincides with a less than -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 difference in differences estimates align nicely with the FD-IV estimates above, despite deriving from

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<sup>34</sup> The Case Schiller annual house price index for 2002 is 123.74. The 2012Q1 Case Schiller quarterly index was 124.03. The final difference in mean house price appreciation for our two quartiles over the 2002-2012 period is just over a quarter of the difference we observe for 2002-2006.

<sup>35</sup> The difference in these two point estimates is significant at the one percent level.

different sources of house price variation, and treating lagged and cumulative responses differently.

Differences in differences estimates of the effects of house price appreciation on auto loans reflect little contemporaneous response of auto debt to the housing boom, and  $\alpha_3$  point estimates for auto debt preceding 2008 are each insignificant. Estimates become negative and significant in 2008, however, and by 2012Q2 the  $\alpha_3$  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 available owner equity and home equity-based credit. This finding also aligns with the FD-IV results.

As intimated in footnote 30, 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  $\alpha_3$  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  $\alpha_3$  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 difference in differences 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  $\alpha_3$  estimate of -\$873. From there high appreciation homeowners steadily gain non-mortgage debt relative to their low appreciation peers, with estimates of  $\alpha_3$  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 difference in differences 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.

#### **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).

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. Evidence is 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. Student loan balances are about \$800 higher, all else equal, for high boom era appreciation (high bust era depreciation) region homeowners than for low boom era appreciation region homeowners by 2012, according to our estimates. Further, FD-IV estimates indicate that older homeowners increased (parental) student loan debt by roughly \$12.00 on average in response to house price declines from 2007-2012. Preliminary FD-IV estimates using zip code-level aggregation are reported in Table 5. Here we regress total student loan debt of 18-22 year olds in the zip code on first house price changes and then HELOC balance changes for the zip

code. The results suggest significant HELOC-student loan substitution *only* in the pre-boom era, and, overall the question bears further analysis.

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Table 1: Descriptive statistics for the one percent estimation sample

Sample	Variable	1999-2012				1999-2001				2002-2006				2007-2012			
		Prev.	Mean	Median	Std. dev.	Prev.	Mean	Median	Std. dev.	Prev.	Mean	Median	Std. dev.	Prev.	Mean	Median	Std. dev.
Full sample	Total balance	0.75	33,169	4,822	80,002	0.75	23,832	3,617	49,744	0.75	32,012	4,749	75,006	0.75	38,893	5,623	94,816
	Non-housing balance	0.72	7,949	1,677	17,510	0.72	6,869	1,352	14,873	0.72	8,032	1,692	18,437	0.72	8,414	1,866	17,844
	Auto balance	0.26	2,423	0	7,280	0.21	1,970	0	6,336	0.26	2,652	0	8,977	0.28	2,443	0	5,861
	Credit card balance	0.57	2,535	179	6,833	0.58	2,438	202	6,727	0.58	2,623	211	6,798	0.55	2,503	140	6,915
	Student loan balance	0.10	1,486	0	7,996	0.06	571	0	4,089	0.08	1,135	0	6,745	0.14	2,260	0	10,155
	HELOC balance	0.10	2,314	0	14,510	0.07	1,161	0	8,244	0.10	2,299	0	13,672	0.11	2,906	0	17,387
	Δ Total balance	-0.01	8,328	0	64,434	0.00	3,359	0	38,286	0.00	10,092	0	73,466	0.00	-3,627	0	69,461
	Δ Non-housing balance	-0.01	1,125	0	16,033	0.00	955	0	13,682	0.00	955	0	15,807	0.00	-339	0	15,518
	Δ Auto balance	0.00	346	0	5,918	0.01	527	0	5,868	0.01	354	0	7,829	-0.01	-383	0	6,478
	Δ Credit card balance	-0.04	15	0	6,692	0.01	393	0	7,029	0.00	125	0	6,658	-0.04	-456	0	6,322
	Δ Student loan balance	0.08	1,284	0	8,738	0.00	172	0	3,605	0.03	712	0	6,652	0.04	866	0	7,871
	Δ HELOC balance	-0.01	823	0	13,191	0.00	329	0	8,138	0.02	1,263	0	14,924	-0.03	-578	0	15,262
Homeowners	Total balance	0.93	60,705	42,555	81,455	0.98	63,682	49,413	70,839	0.93	61,733	43,722	82,472	0.87	56,486	31,545	89,111
	Non-housing balance	0.86	10,632	4,763	18,811	0.90	10,906	5,451	18,000	0.88	11,332	5,398	20,436	0.82	9,444	3,371	17,208
	Auto balance	0.35	3,395	0	8,185	0.33	3,201	0	7,040	0.38	3,893	0	9,812	0.33	2,924	0	6,670
	Credit card balance	0.75	4,077	991	8,760	0.79	4,178	1,188	8,841	0.76	4,227	1,067	8,818	0.70	3,782	727	8,598
	Student loan balance	0.06	730	0	4,977	0.05	547	0	4,220	0.05	649	0	4,611	0.07	1,012	0	5,998
	HELOC balance	0.25	5,063	0	18,505	0.22	3,612	0	14,234	0.25	5,278	0	18,392	0.26	6,174	0	21,886
	Δ Total balance	0.00	-8,096	-9,078	82,568	0.00	-6,267	-3,424	51,695	-0.03	3,895	-1,972	79,178	-0.05	-10,589	-4,913	66,803
	Δ Non-housing balance	0.00	500	0	22,160	0.00	1,477	3	17,621	-0.01	30	0	20,624	-0.05	-1,643	-22	18,860
	Δ Auto balance	0.01	542	0	8,640	0.01	733	0	7,408	0.03	186	0	9,474	-0.06	-725	0	7,180
	Δ Credit card balance	0.00	138	0	10,744	0.00	578	0	9,371	-0.02	30	0	9,324	-0.06	-651	0	7,923
	Δ Student loan balance	0.00	423	0	6,165	0.00	42	0	3,274	-0.01	295	0	5,086	0.01	284	0	4,867
	Δ HELOC balance	0.00	1,410	0	21,898	0.00	3	0	13,750	0.03	2,283	0	22,014	-0.06	-838	0	19,833
Renters	Total balance	0.70	25,008	1,732	77,714	0.64	4,957	480	12,695	0.69	22,383	1,472	69,758	0.73	35,351	3,650	95,532
	Non-housing balance	0.68	7,153	1,060	17,024	0.64	4,957	480	12,695	0.67	6,963	967	17,609	0.70	8,206	1,579	17,963
	Auto balance	0.23	2,135	0	6,963	0.16	1,386	0	5,884	0.23	2,251	0	8,651	0.27	2,347	0	5,680
	Credit card balance	0.51	2,077	27	6,071	0.48	1,614	0	5,248	0.52	2,103	33	5,907	0.53	2,245	53	6,494
	Student loan balance	0.11	1,710	0	8,679	0.06	583	0	4,025	0.09	1,293	0	7,297	0.15	2,512	0	10,782
	HELOC balance	0.05	1,500	0	12,982	0.00	0	0	0	0.05	1,334	0	11,579	0.08	2,248	0	16,252
	Δ Total balance	0.04	9,473	0	61,590	-0.01	745	0	10,794	0.03	10,660	0	70,582	0.02	-2,324	0	69,511
	Δ Non-housing balance	0.03	1,224	0	16,494	-0.01	745	0	10,794	0.02	1,090	0	15,723	0.01	-88	0	15,556
	Δ Auto balance	0.04	275	0	6,993	0.02	371	0	4,965	0.03	347	0	8,745	0.00	-314	0	6,293
	Δ Credit card balance	0.00	14	0	5,837	0.02	265	0	5,343	0.02	133	0	5,789	-0.02	-407	0	5,989
	Δ Student loan balance	0.08	1,327	0	8,818	0.01	204	0	3,617	0.03	770	0	6,786	0.05	948	0	8,201
	Δ HELOC balance	0.02	553	0	12,105	0.00	0	0	0	0.04	922	0	12,968	-0.02	-488	0	14,257

**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.

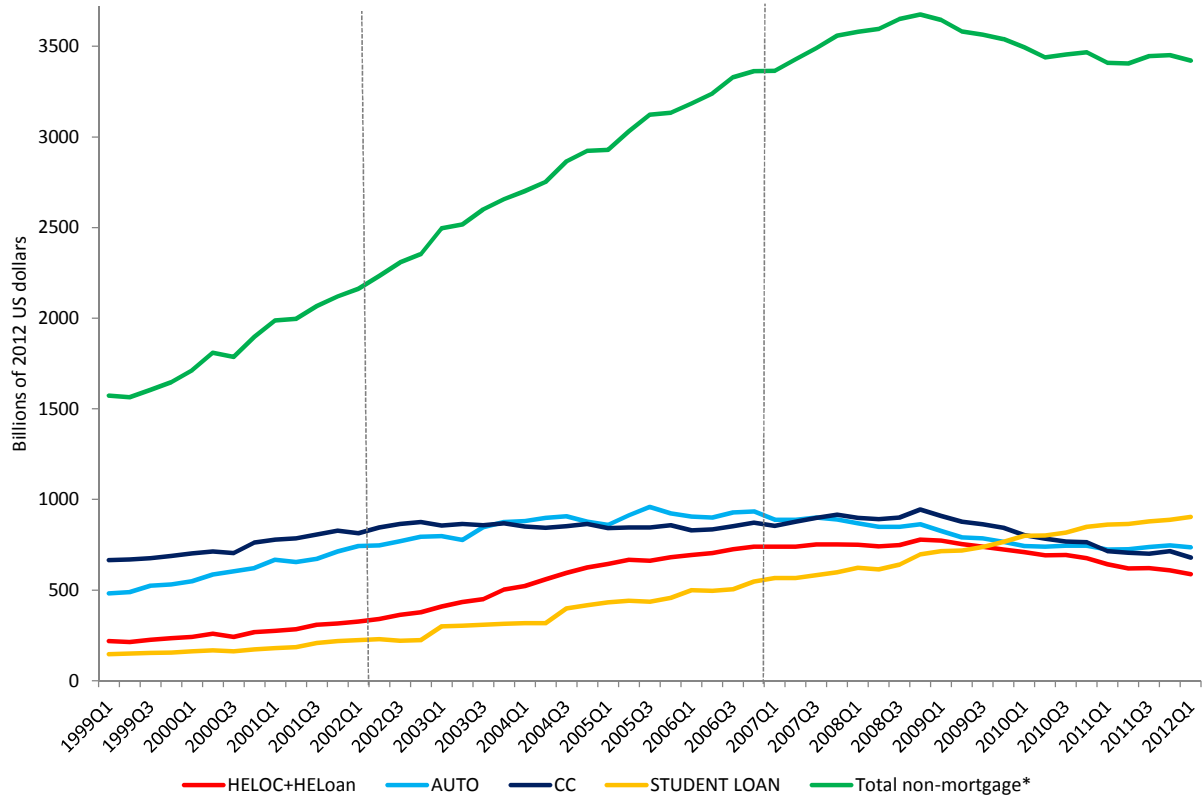
**Table 5: Zip code aggregate first-differenced instrumental variables estimates of the effects of house price and HELOC changes on student loan balances**

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

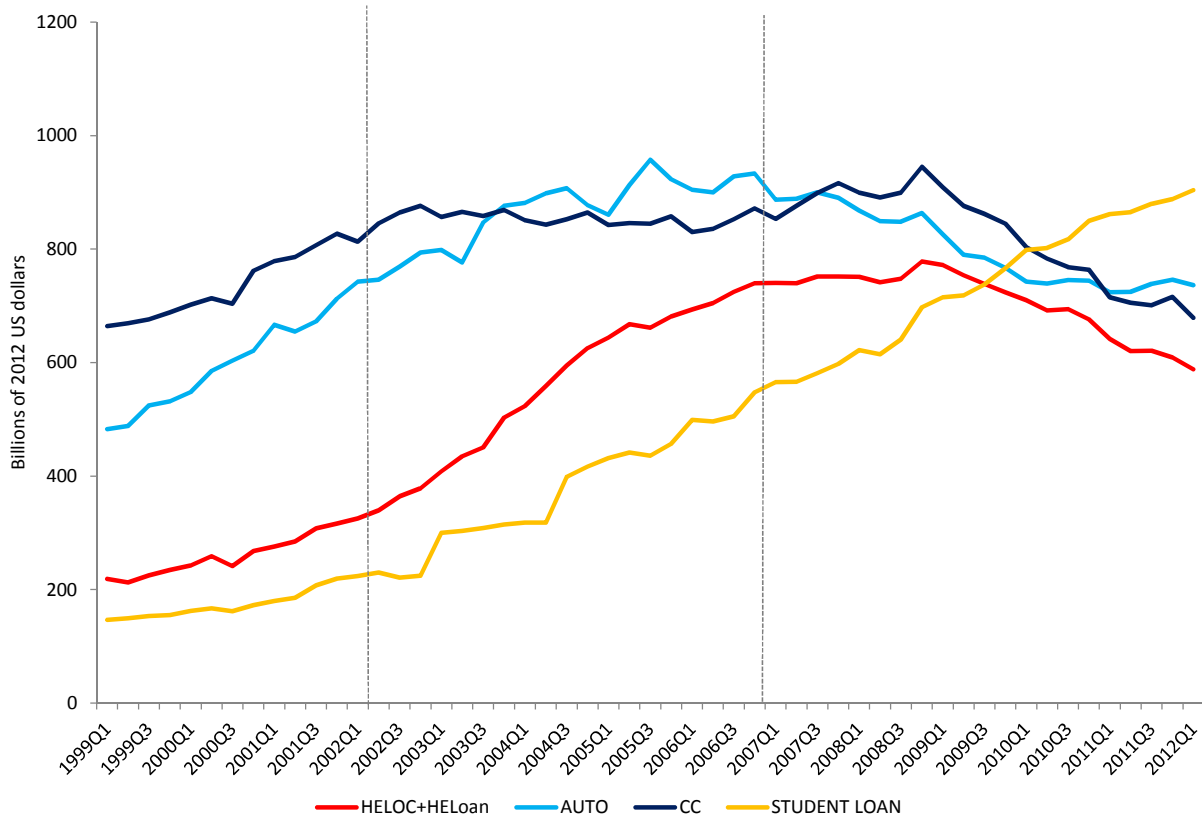
\* denotes significance at the 10 percent, \*\* at the five percent, and \*\*\* at the one percent level.

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

**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**

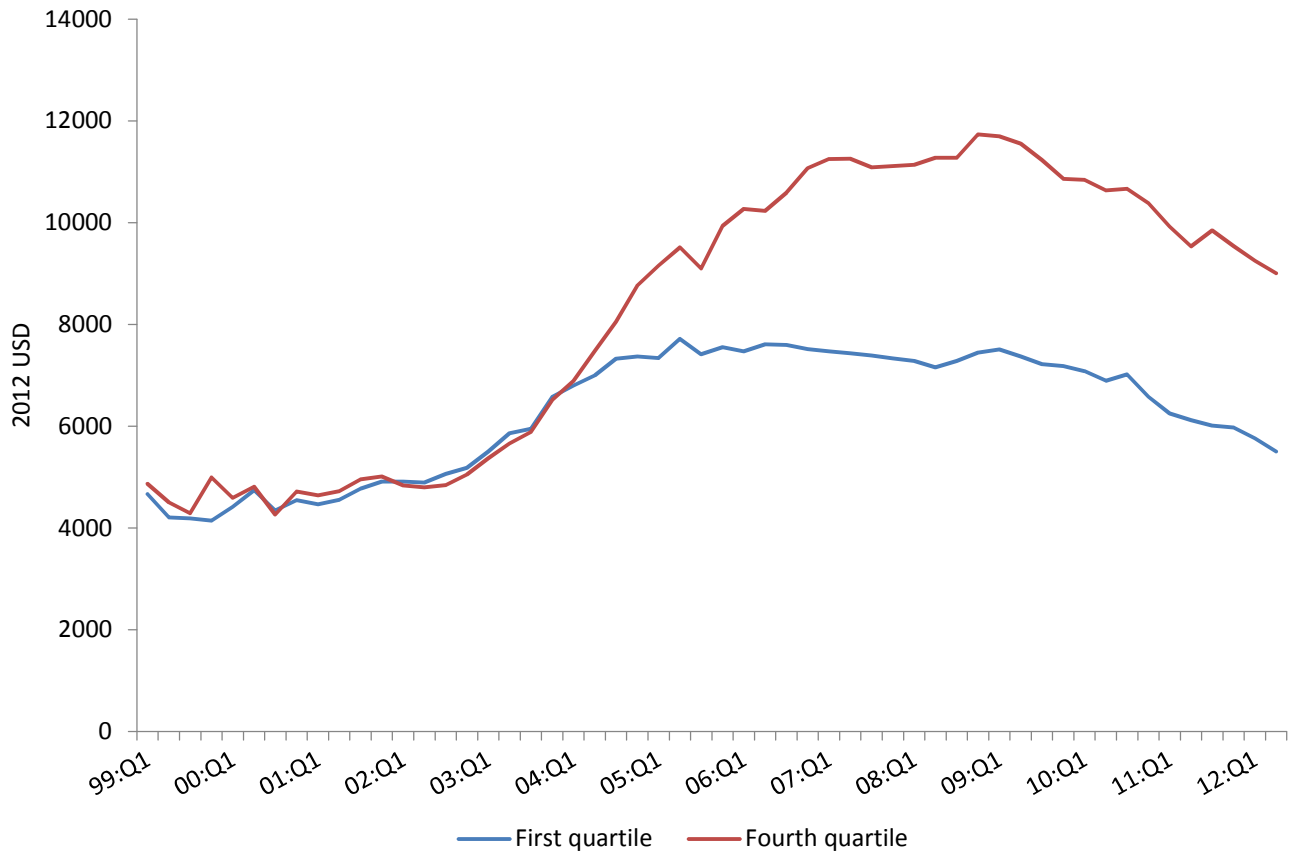


Figure 4: Mean non-mortgage debt among homeowners in high & low house price appreciation zip codes



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

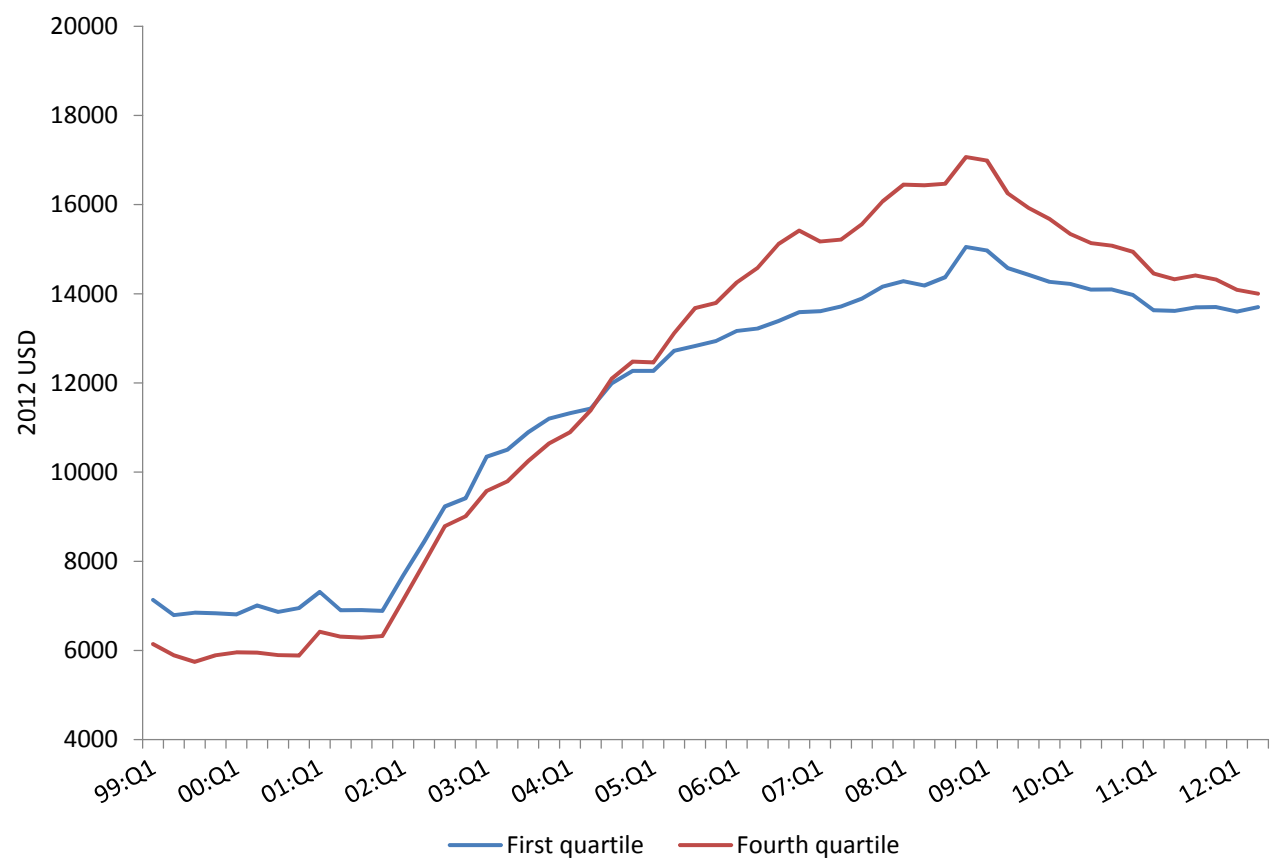
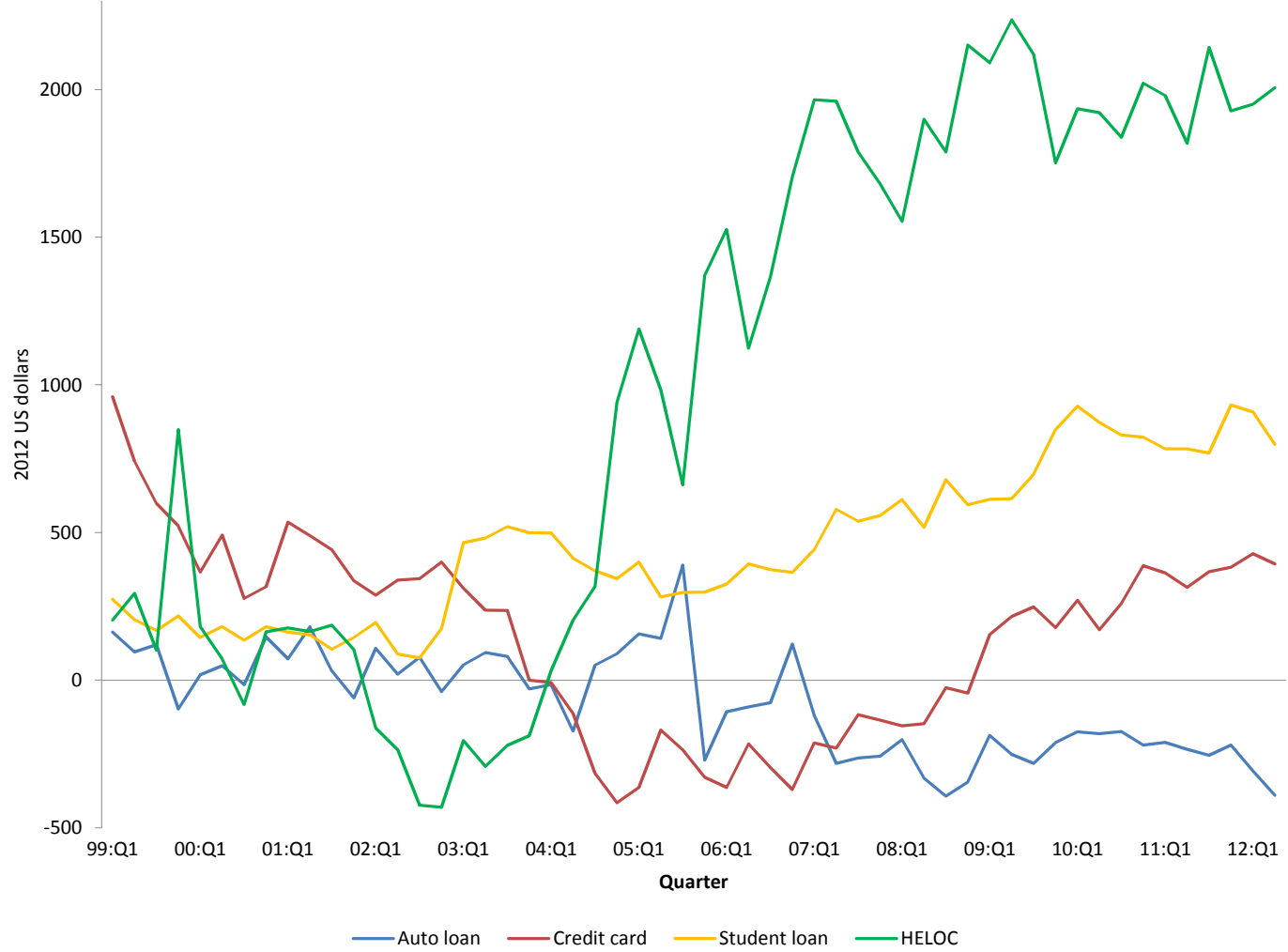


Figure 6: Controlled difference in differences estimates of the effect of house price appreciation quartile on consumer debts



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

