

House Prices, Home Equity-Based Borrowing, and the U.S. Household Leverage Crisis*

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Abstract

Using individual-level data on homeowner debt and defaults from 1997 to 2008, we show that borrowing against the increase in home equity by *existing* homeowners is responsible for a significant fraction of both the sharp rise in U.S. household leverage from 2002 to 2006 and the increase in defaults from 2006 to 2008. Employing land topology-based housing supply elasticity as an instrument for house price growth, we estimate that the average homeowner extracts 25 to 30 cents for every dollar increase in home equity. Money extracted from increased home equity is *not* used to purchase new real estate or pay down high credit card debt, which suggests that consumption is a likely use of borrowed funds. Home equity-based borrowing is stronger for younger households, households with low credit scores, and households with high initial credit card utilization rates. Homeowners in high house price appreciation areas experience a relative decline in default rates from 2002 to 2006 as they borrow heavily against their home equity, but experience very high default rates from 2006 to 2008. Our estimates suggest that home equity-based borrowing is equal to 2.3% of GDP every year from 2002 to 2006, and accounts for over 20% of new defaults in the last two years.

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U.S. household leverage sharply increases in the years immediately preceding the current financial crisis and economic downturn. The top panel of Figure 1 shows a steady rise in household debt since 1975, with a sharp acceleration beginning in 2002. In just five years, the household sector doubles its debt balance. In comparison, the contemporaneous increase in corporate debt is modest. The middle panel shows that the increase in household debt from 2002 to 2007 translates into a striking rise in household leverage as measured by the debt to income ratio. During the same time period, corporate leverage declines. The dramatic absolute and relative rise in U.S. household leverage from 2002 to 2007 is unprecedented in the last 35 years.

One reason for the rapid expansion in household leverage during this period was the increase in homeownership rates as mortgage credit became more easily available to new home buyers (Mian and Sufi (2009)). However, strong house price appreciation from 2002 to 2006, which may have been fueled by the availability of mortgage credit to a riskier set of new home buyers, could also have had an important feedback effect on household leverage through *existing homeowners*.

Our central goal in this study is to investigate how existing homeowners respond to the rising value of their home equity, a channel we refer to as the *home equity-based borrowing channel*. This is an important question for several reasons. First, given that 65% of U.S. households already owned their primary residence before the acceleration in house prices beginning in the late 1990s, a strong home equity-based borrowing channel may be an important cause of the rapid rise in household leverage preceding the economic downturn.

In addition, to the extent that homeowners use home equity-based borrowing to finance consumption, a large home equity-based borrowing channel may provide a quantitative explanation for the decline in the U.S. savings rate in the decade preceding the financial crisis.

More broadly, if house prices strongly affect existing homeowners' borrowing behavior, then dramatic swings in the housing market may have real effects on the economy through consumption and mortgage defaults.

The importance of this issue is also highlighted by the fact that theory does not provide an unambiguous prediction of the effect of house prices on homeowner borrowing. For example, house price appreciation may have no effect on homeowner borrowing because the increase in home equity wealth is counter-balanced with a higher cost of future housing consumption (Sinai and Souleles (2005), Campbell and Cocco (2007)). On the other hand, if homeowners are credit-constrained or subject to self-control issues, then house price appreciation may induce households to borrow more (Stein (1995), Ortalo-Magne' and Rady (2006), Lustig and Van Nieuwerburgh (2006), and Laibson (1997)).

We examine the home equity-based borrowing channel using a data set consisting of anonymous individual credit files of a national consumer credit bureau agency. The agency has provided us a random sample of almost 100,000 homeowners living in every major metropolitan statistical area in the United States. We track these individuals at an annual frequency from the end of 1997 until the end of 2008. This data set allows us to separate homeowners borrowing against the rising value of their home equity from renters buying into a hot housing market.

The bottom panel of Figure 1 plots the growth in debt of 1997 homeowners over time, and shows that *existing homeowners* borrow significantly more debt as their house prices appreciate from 2002 to 2006. While the aggregate trend is suggestive of a link, changes in house prices and homeowner borrowing may be jointly determined by an omitted variable such as a shock to expected income growth (King (1990), Attanasio and Weber (1994), Muellbauer and

Murphy (1997)). As a result, proper identification of the effect of house prices on borrowing requires an exogenous source of variation in house price growth.

We use two different instruments for house price growth, one based on across-MSA variation and another based on within-MSA variation. The across-MSA specification uses housing supply elasticity at the MSA level as an instrument for house prices. MSAs with elastic housing supply should experience only modest increase in house prices in response to large shifts in the demand for housing because housing supply can be expanded relatively easily. In contrast, inelastic housing supply MSAs should experience large house price changes in response to the same housing demand shock (Glaeser, Gyourko, and Saiz (2008)).

We confirm this relationship in our data using the land-topology based measure of housing supply elasticity introduced by Saiz (2008). Using this instrument, the across-MSA instrumental variables estimate uncovers a large home equity-based borrowing channel. Our preferred estimate suggests an elasticity of borrowing with respect to increased home equity of 0.70. Alternatively, we find that households borrow 25 to 30 cents on each additional dollar of home equity from 2002 to 2006.

An obvious concern with the IV estimates is that MSAs with an inelastic supply of housing also experience differential non-house price-related credit demand shocks. A number of tests mitigate this concern. First, our results are insensitive to non-parametric controls for changes in credit demand driven by individual income, credit score, age, and sex. Second, we show that there is almost no difference in income, payroll, and employment growth between inelastic and elastic MSAs during this period. Third, we find no statistically significant difference in the growth of credit card debt for homeowners living in inelastic versus elastic

MSAs. This finding suggests that the home equity borrowing channel, and not a general shift in credit demand, is driving our basic result.

Our within-MSA estimate uses the *interaction* of the 1997 fraction of subprime borrowers in a zip code with MSA level housing supply inelasticity as an instrument for house price growth. The idea for this instrument comes from Mian and Sufi (2009) who show that an expansion of mortgage credit from 2002 to 2005 is associated with stronger house price appreciation in subprime zip codes compared to prime zip codes, despite relatively declining income opportunities for subprime areas. Furthermore, as theory would suggest, the differential house price appreciation in subprime zip codes is present only in inelastic housing supply MSAs. The interaction of the 1997 share of subprime population in a zip code with MSA level housing supply inelasticity therefore serves as an instrument for within-MSA house price growth.¹ Our within-MSA estimates are similar to the across-MSA estimates.

The real effects of the home equity-based borrowing channel depend on what households do with the borrowed money. We find little evidence that borrowing in response to increased house prices is used to purchase new homes or investment properties. We also find no evidence that home equity-based borrowing is used to pay down credit card debt, even for households in the highest quartile of the 1997 credit card utilization distribution. This finding suggests that the marginal return to the use of borrowed funds is higher to households than the high interest rate on credit card debt. While we do not have data on consumption, these findings suggest that consumption is a likely use for increased home equity-based borrowing.

We use our microeconomic estimates to calculate the aggregate impact of the home equity-based borrowing channel. We find that a total of \$1.2 trillion of the rise in household debt from 2002 to 2006 is attributable to existing homeowners borrowing against the increased value

¹ See Section II.C for more on the within-MSA triple-difference identification strategy.

of their homes. This translates to 2.3% of GDP per year. This is a conservative lower-bound estimate given that it is based on a difference-in-difference estimator which ignores any *level* effect of house prices on borrowing.

Given the large effect of house prices on homeowner borrowing, a key question remains: what model of household behavior is consistent with our estimates? We explore cross-sectional heterogeneity in the effect to explore this question. We find that homeowners with high credit card utilization rates and low credit scores at the beginning of the sample have the strongest tendency to borrow against increases in home equity. In fact, we find no effect of house prices on borrowing for homeowners in the top quartile of credit score distribution as of 1997. We also find that the home-equity based borrowing channel is stronger for younger homeowners. We find no evidence of a differential effect based on either income or gender.

These results are consistent with a model of credit constraints under the assumption that low credit scores and high credit card utilization rates serve as indicators for borrowing difficulty. However, these characteristics may also proxy for individuals with self-control problems. Our finding that older individuals have a smaller home equity-based borrowing channel is inconsistent with standard life cycle-based models.

Default rate patterns also offer insight into household behavior. We find that borrowing against rising home equity is accompanied by a relative decline in default rates from 2002 to 2006. The magnitude of the drop in default rates with respect to house price appreciation is significantly larger for low credit score and high credit card utilization homeowners. However, the relative decline in default rates begins to reverse in 2006. By the end of 2008, the default rate of homeowners experiencing house price appreciation from 2002 to 2006 skyrockets past homeowners experiencing no previous house price appreciation. The reversal is especially strong

among low credit score and high credit card utilization homeowners who most aggressively borrow against rising home equity during the housing boom.

Our results are related to studies that estimate the effect of house price growth on consumption, refinancing, and borrowing behavior (Case, Quigley, and Shiller (2005), Bostic, Gabriel, and Painter (2009), Haurin and Rosenthal (2006) Hurst and Stafford (2004), Campbell and Cocco (2007), Greenspan and Kennedy (2007)). Our results complement this research by using both a novel data set and a novel empirical strategy to isolate the effect of house prices on home equity-based borrowing. We believe that the empirical strategy we utilize is of first-order importance given that house prices, borrowing behavior, and consumption are likely jointly driven by unobservable permanent income shocks. In addition, we are the first in this literature to examine default behavior as it relates to home equity-based borrowing.

Results presented here are also related to recent research on the U.S. mortgage default crisis (e.g., Demyanyk and Van Hemert (2009), Keys, Mukherjee, Seru, and Vig (2009), Mian and Sufi (2009), Gerardi, Lehnert, Sherlund, and Willen (2009), Mayer, Pence, and Sherlund (2009), Dell’Ariccia, Igan, and Laevin (2008), Mayer and Pence (2008), Mayer and Hubbard (2008), Doms, Furlong, and Krainer (2007), Gerardi, Shapiro, and Willen (2007)). However, our focus is different. We examine home equity-based borrowing and default patterns for individuals that owned their homes *before* the dramatic expansion and collapse of the housing market. In doing so, we show that the mortgage default crisis is not driven exclusively by renters buying into a hot housing market. This fact helps explain the depth of the current crisis.

The rest of our study proceeds as follows. The next section describes data and presents summary statistics. Sections II through V present empirical results and Section VI concludes.

I. Data and Summary Statistics

A. Data

The primary data set consists of detailed credit report information from Equifax for 96,496 homeowners in 3,016 zip codes located in 83 MSAs. The initial random sample includes a total of 266,272 individuals that live in 3,050 zip codes located in 83 MSAs covered by the Fiserv Case Shiller Weiss zip code level house price indices as of 1997 and included in MSAs covered by the Saiz (2008) elasticity measure. We choose to focus on the FCSW zip codes given the importance of zip code level house prices in our empirical tests. As noted in Mian and Sufi (2009), these zip codes represent over 45% of aggregate home debt outstanding. Within these zip codes, we randomly sample individuals at a rate of 0.45% per zip code.

The Equifax data do not contain an explicit measure of homeownership. Instead, we measure homeownership by splitting the sample into three groups of individuals based on 1997 credit report information. The first group (34%) contains individuals that have mortgage or home equity debt outstanding. The second group (8%) contains individuals that do not currently have mortgage or home equity debt outstanding, but their credit report indicates that they have had a mortgage or home equity account in the past. The third group (58%) contains individuals that do not have either a current or previous mortgage account. We define as “1997 homeowners” individuals in the first two groups.²

The rate of homeownership among individuals in the credit report data (42%) is significantly lower than the fraction of households that own their primary residence in census data (65%). We believe that this difference is driven by the fact that our measures are for

² The second group includes two types of individuals that we cannot separate: individuals that own their home but have paid off their mortgage and individuals who previously had a mortgage but are now renters. We choose to count this group as homeowners given that they have a low probability of moving, which suggests that they are homeowners who have paid off their previous mortgage. All results are materially unchanged if we exclude this group from our homeowner classification.

individuals, not for households. As a result, individuals with no current or previous mortgage debt that live in a home in which some other individual has mortgage debt will not be counted as a homeowner. In addition, any homeowner with no previous or current mortgage debt outstanding will be excluded in our definition of homeownership.

There are 114,339 homeowners in our sample. The final restriction we make is to exclude homeowners that move from their 1997 zip code between 1997 and 1999. Approximately 15% of homeowners move within the first two years of our sample, at which point the fraction that moves levels off significantly. We exclude these “transient” individuals since we want to ensure that when the house price shock hits, the homeowners are living in the zip code we assign them to initially. This leaves a final sample of 96,496 individuals in 3,016 zip codes located in 83 MSAs.³

Due to restrictions on the dissemination of individual credit report information, Equifax only provides us data on these 96,496 homeowners in groups of at least five individuals. We are free to sort the data in any way before the groups are formed. The primary data-sort that we utilize sorts homeowners by their 1997 zip code and then by their 1997 credit score before groups are formed. This ensures that our unit of observation, a group of 5 homeowners on average, is as homogenous as possible on observed characteristics. In a few tests where we estimate heterogeneity of our main effect, we re-sort the data to maximize available variation along the dimension of interest. For example, we re-sort data by zip code and then age when testing whether young homeowners behave differently than old homeowners.

We augment the individual level data with several additional data sets. We use the following zip code level time-varying sources of data: house price data from FCSW, IRS income

³ Appendix Tables 1 and 2 show information on renters and homeowners that move zip codes between 1997 and 1999.

data, employment and payroll information from the Census Business Statistics, aggregate consumer credit score data from Equifax. All of these additional data sets are described in detail in the appendix of Mian and Sufi (2009). The IRS data are available only for 1998, 2002, 2003, 2005, and 2006. We add information for missing years by interpolating data prior to 2006 and extrapolating data post 2006 based on observed time trends. We also use 2000 decennial census zip code level information on demographics. Finally, the primary measure of topology-based housing supply elasticity comes from Saiz (2008).

B. Summary Statistics

Table I presents summary statistics for the sample of 96,496 1997 homeowners grouped into units containing 5 to 9 individuals. The median home debt (mortgage plus home equity) outstanding as of 1997 is \$83 thousand which is higher than the average amount of \$62 thousand reported in the 1998 Survey of Consumer Finances.⁴ The discrepancy is likely due to two factors: first, we do not count as homeowners any individual that has never used debt to finance their home purchase. Second, the 1998 SCF separates out debt used for the purchase of second homes or residential investment properties, whereas we cannot separate primary residence versus other residential mortgage debt. Mortgage debt makes up over 85% of total debt outstanding for homeowners.

After remaining relatively constant from 1998 to 2002, total debt grows by 35% from 2002 to 2006. This growth is driven almost exclusively by home debt. The increase in leverage can also be seen in the sharp increase in the total debt to income ratio, which increases by 0.7 from 2002 to 2006, which is almost $\frac{1}{2}$ a standard deviation of the 1997 level. Average individual default rates are stable from 1998 to 2006, at which point they rise sharply by 3.5 percentage points from 2006 to 2008, which is a doubling of the 1997 level. Table I also includes

⁴ See Kennickell, Starr-McCluer, and Surette (2000).

information on individual 1997 credit score, 1997 credit card utilization, 1997 age, sex, and 2008 income.⁵

The housing supply elasticity measure in Saiz (2008) varies from 0 to 3 and is increasing in elasticity. Our measure is three minus the Saiz (2008) measure so that our measure increases in housing supply inelasticity. Appendix Table 3 shows the inelasticity measure for the 83 MSAs in our sample. Both the zip code level IRS wage data set and the Census business statistics payroll data set show growth of about 12% from 2002 to 2006. Employment growth is 8% over the same time period. One critical measure from Mian and Sufi (2009) that we use is the fraction of all consumers in a zip code with a “subprime” credit score, which is defined to be a score below 660. In our sample, homeowners on average live in a zip code with 29% subprime consumers.

II. The Effect of House Prices on Home Equity-Based Borrowing

A. Theoretical Motivation

How should an individual homeowner respond to an increase in their house price, all else being equal? This is the thought experiment that our empirical specification attempts to implement using instruments for house price growth. The theoretical answer to this question depends on the underlying model of consumer behavior.

A useful starting benchmark is *unconstrained long-lived* homeowners. These homeowners plan on using housing consumption in the foreseeable future, perhaps due to bequest motives, and are not credit-constrained when choosing their consumption paths. Sinai and Souleles (2005) and Campbell and Cocco (2007) show that such households are naturally hedged against house price fluctuations in the absence of credit constraints or substitution

⁵ Individual income data are only available from Equifax for 2008. This estimate is based on payroll data that Equifax matches with their records.

effects. Any increase in house prices makes future housing consumption more expensive. As a result, the propensity to borrow out of housing gains is zero.⁶

A second possible model is based on *short-lived* homeowners who do not value housing bequests very highly and plan on consuming part of their housing capital before death. Such homeowners would like to borrow against unexpected increases in home equity to finance consumption, with the propensity to borrow being strongest for older homeowners with shorter life horizons.

A third possibility is *credit-constrained* homeowners who want to borrow more today to smooth consumption over time, but are unable to do so due to limited collateral. Such homeowners would borrow more against increases in home equity to relax their budget constraints (Ortalo-Magne' and Rady 2006; Lustig and Van Nieuwerburgh 2006). Finally following Laibson (1997), homeowners with *limited self-control* may aggressively borrow against increased access to housing wealth in order to finance current consumption.

B. Across MSA Empirical Strategy Based on Housing Supply Inelasticity

Our empirical strategy is designed to estimate the effect of house prices on home equity-based borrowing. As the aggregate data in Figure 1 show, there is a strong correlation between house price growth and homeowner debt growth. However, it is possible that omitted time-varying factors drive both house prices and borrowing behavior. Perhaps the most worrisome time-varying trend is changes in productivity or permanent income over time.

Our first empirical test exploits variation across MSAs in housing supply elasticity. The intuition of the tests is straightforward: for an equivalent housing demand shock, the slope of the housing supply curve determines that degree to which housing prices rise in an area. The insight

⁶ An important caveat is a situation in which homeowners have short expected tenure or a high probability of moving. In this case, a relative house price shock may be treated as a real wealth shock.

of Glaeser, Gyourko, and Saiz (2008) is that this basic prediction holds under most models of house price evolution. As long as builders respond to house prices, an increase in housing supply puts an upper bound on house price appreciation in elastic housing supply MSAs.

In the top panel of Figure 2, we show evidence consistent with this intuition. We compare MSAs in the highest and lowest quartile categories based on the Saiz (2008) housing supply elasticity measure. The most elastic housing supply MSAs experience almost no increase in house prices from 1997 to 2008. In contrast, inelastic housing supply MSAs experience strong growth of over 100% from 2001 to 2006. The pattern in the top panel of Figure 2 is also seen in our first stage estimate in column 1 of Table II, which shows a strong effect of housing supply inelasticity on house price growth. The magnitude suggests that a one standard deviation increase in MSA housing supply inelasticity leads to a 1/3 standard deviation increase in house price growth from 2002 to 2006.

The bottom two panels of Figure 2 show a graphical version of the reduced form specification estimates from our empirical model; they show that total debt growth and the change in debt to income is significantly higher in inelastic MSAs from 2002 to 2006. The growth rate is 20 percentage points higher and the debt to income change is 0.4 higher in inelastic MSAs relative to elastic MSAs.

Figure 2 and the estimate in column 1 of Table II motivate the following first-differenced instrumental variables specification:

$$(1) \quad \text{LeverageGrowth0206}_{izm} = \theta X_{izm} + \beta \widehat{\text{HousePriceGrowth0206}}_{zm} + u_{izm}$$

$$(2) \quad \text{HousePriceGrowth0206}_{zm} = \delta X_{izm} + \rho \text{Inelasticity}_{m,1997} + \varepsilon_{izm}$$

Where $\text{LeverageGrowth0206}_{izm}$ represents the change in homeowner leverage from 2002 to 2006 for individual i living in zip code z within MSA m . Equation (2) represents the first stage, where

the instrument is MSA level housing supply inelasticity (*Inelasticity*). All standard errors are clustered at the MSA level.

Column 2 of Table II presents the instrumental variables estimate with no control variables. The estimated elasticity of debt with respect to house prices is 0.7 among homeowners. The estimate is completely insensitive to individual level control variables when added linearly (column 3) or when added non-parametrically with 50 indicator variables for 2-percentile bins (column 4). The estimate is reduced only slightly when we include a host of zip code level census demographic control variables and zip code level controls for the growth in wages, payroll, and employment (column 5).

An alternative IV specification using the debt to income ratio also shows a positive effect of house prices on leverage. The estimate of 1.6 in column 6 implies that a one standard deviation change in house prices leads to a 1/4 standard deviation increase in the debt to income ratio. As with the elasticity measures, the effect of house prices on debt to income ratios is completely insensitive to individual level controls (columns 7 and 8), and only slightly sensitive to zip code level demographics and income patterns (column 9).

Figure 3 presents the non-parametric plot of the effect of house price growth on debt growth across the full distribution. It shows the second stage of the IV estimate in column 2 of Table II by plotting total debt growth from 2002-2006 against predicted house price growth over the same period. As Figure 3 shows, the effect is close to linear with a slight convexity near the middle of the distribution. The pattern is also robust across almost the entire distribution, although the statistical precision is lower at the low end of the house price growth distribution.

In Table III, we present IV estimates of the effect of an increase in home equity on home borrowing in dollar units. The first stage estimate in column 1 implies that a one standard

deviation increase in housing supply inelasticity leads to a \$20 thousand increase in home equity. The second stage estimates in columns 2 through 5 suggest that 1997 homeowners borrow 25 to 30 cents on every dollar of additional home equity value. As columns 3 to 5 show, the estimate is completely insensitive to both individual and zip code level control variables.

One concern with the findings in Table II, Figure 3, and Table III is the validity of the exclusion restriction. In other words, it is possible that differential trends in inelastic and elastic MSAs during this time period would lead to differential borrowing patterns even in the absence of differential house price growth. The most obvious concern is that a non-housing related differential increase in the demand for credit in inelastic MSAs is responsible for the patterns that we find. Of course, the robustness of our findings to a series of rigorous control variables partially mitigates this concern, but omitted factors not captured by our control variables could still be a worry.

In Table IV, we further examine the exclusion restriction. Panel A presents evidence on the correlation between housing supply inelasticity and zip code level measures of per capita payroll, per capita wage, and total employment growth. Our goal in Panel A is to present evidence on differential permanent income or productivity shocks that may drive household borrowing and house price appreciation in inelastic areas. There is no evidence of differentially stronger growth in per capita payroll or employment growth. While there is a positive correlation between housing supply inelasticity and IRS per capita wage growth over the 2002 to 2006 time period, this correlation is not robust across the different measures of payroll and employment growth (columns 1 and 3).

However, a comparison of the *level* of income growth from 2002 to 2006 is not necessarily the proper empirical test. As permanent income theory would predict, what matters

for changes in household borrowing behavior is the *change* in expected income growth. When we examine the *difference* in growth rates between 1998-2002 and 2002-2006, we find no positive correlation with housing supply inelasticity. Instead, column 4 of Table IV presents evidence that inelastic MSAs receive a *negative* payroll shock from 2002 to 2006.

In Panel B, we conduct additional tests to examine the exclusion restriction. Columns 1 and 4 of Panel B show that the positive effect of house prices on borrowing is driven by an increase in home (mortgage plus home equity) debt. The effect of house price growth on credit card debt is statistically insignificant and very close to 0 for the debt to income ratio. These findings suggest that the channel through which consumers in inelastic MSAs increase debt outstanding is home equity related and not a general increase in the demand for credit. In columns 5 and 6, we examine renters who never buy into the rising housing market during the sample period. As the estimates show, there is no statistically significant differential increase in borrowing among renters in inelastic areas.

While it is impossible to test the exclusion restriction explicitly, there is little evidence to suggest that the increased homeowner borrowing that we find in inelastic housing supply MSAs is driven by something other than house prices. The fact that the increased borrowing is concentrated in home related debt as opposed to credit card debt is consistent with a home equity-based borrowing channel. Further evidence in support of the validity of the exclusion restriction is presented in Section V where we focus on cross-sectional heterogeneity in the effect of house prices on consumer borrowing. As we show there, there is almost no differential effect for high credit score and low credit card utilization borrowers, which suggests the absence of non-housing related factors driving our results.

C. Within-MSA Empirical Strategy Based on 1997 Fraction of Subprime Borrowers

This section presents an alternative IV strategy that exploits within-MSA variation at the level of zip codes to identify the effect of house prices on homeowner borrowing. The motivation for this test comes from Mian and Sufi (2009). They present evidence of a securitization-driven shift in the supply of mortgages for new home purchase from 2002 to 2005 toward zip codes that have a high fraction of subprime borrowers. Column 1 of Panel A in Table V replicates the basic finding, which shows a strong positive correlation between new home purchase mortgage growth from 2002 to 2006 and the fraction of borrowers with a credit score below 660 as of 1997.

Mian and Sufi (2009) show that higher credit growth for home-purchase mortgages occurs in subprime zip codes despite *declining* relative, and in some cases absolute, income growth in these areas. Furthermore, 2002 to 2005 is the only period in the last 18 years in which mortgage origination for home purchase is higher in areas with lower income growth.

In columns 2 to 5 of Table V, Panel A, we replicate another finding of Mian and Sufi (2009): the relative shift in the supply of mortgage credit for home purchase toward high subprime share zip codes occurs even in the most elastic MSAs where there is no significant house price growth. However, the shift in the supply of mortgage credit is stronger in more inelastic housing supply MSAs that experience strong house price growth. Based on these findings, Mian and Sufi (2009) argue that house price appreciation cannot fully explain the shift in the supply of mortgage credit to high subprime areas, but house price growth strengthens the effect through a collateral feedback mechanism (as in Kiyotaki and Moore (1997)).

Column 1 of Table V, Panel B presents evidence that the shift in the supply of credit toward subprime share zip codes leads to higher house price growth in subprime zip codes relative to prime zip codes within the same MSA. Columns 2 through 5 show that this effect is

only present in inelastic MSAs, as we would expect given the intuition on house prices and supply elasticity in Glaeser, Gyourko, and Saiz (2008). Mian and Sufi (2009) present evidence that the relative house price appreciation in high subprime share zip codes within inelastic MSAs is *credit-induced*: they find that house price growth and income growth are negatively correlated from 2002 to 2006 and that high subprime share zip codes experience relative house price growth despite relatively negative income growth.

Our instrumental variable strategy is designed to exploit credit-induced house price appreciation in high subprime share zip codes within inelastic MSAs to estimate the effect of house price appreciation on homeowner borrowing. The exact thought experiment is as follows. Take two homeowners IP and IS with the same credit score as of 1997. The homeowners live in the same inelastic MSA, but differ in the neighborhood of residence. Homeowner IP lives in a prime neighborhood, while IS lives in a subprime neighborhood. We know from Mian and Sufi (2009) that IS experiences a larger house price increase than IP as a result of the aggregate credit supply expansion. Let ΔB_{IS} and ΔB_{IP} be the change in household borrowing for IS and IP respectively during the price boom period. Then the double difference $(\Delta B_{IS} - \Delta B_{IP})$ provides one possible reduced form measure of the effect of house prices on homeowner borrowing. However, a concern with this estimate is that despite IS and IP having the same initial credit score, the fact that they live in different neighborhoods potentially makes them different on unobserved dimensions. The unobserved dimensions could also affect the borrowing decisions in a way that makes $(\Delta B_{IS} - \Delta B_{IP})$ a biased estimate of the direct house price effect.

How does one control for the unobserved neighborhood effect of subprime versus prime neighborhoods? The triple-difference strategy exploits the additional variation in housing supply elasticity. In particular, as mentioned earlier, the difference in house prices of subprime versus

prime neighborhood disappears in elastic MSAs due to easily adjustable housing supply.

However, the unobserved dimension of neighborhood effects is still operating on homeowners living in elastic MSAs. Let ES and EP be two homeowners with the same initial credit scores as IS and IP . ES and EP live in subprime and prime neighborhoods of an elastic MSA respectively. Then we can control for the unobserved neighborhood effect of homeowners living in subprime areas by computing the triple difference: $[(\Delta B_{IS} - \Delta B_{IP}) - (\Delta B_{ES} - \Delta B_{EP})]$.

This idea translates into estimating the following reduced form regression equation:

$$(3) \quad y_{izmt} - y_{izm,1998} = \alpha_m + \delta^t * X_{izmt} + \gamma^t * Subprime_{zm,1997} + \beta^t * Subprime_{zm,1997} * Inelasticity_{m,1997} + \varepsilon_{izmt} \quad for \ t = 1999, 2000, \dots, 2008$$

which examines the growth in y from the base year 1998 to t for individual i living in zip code z within MSA m . We relate the growth in y to MSA fixed effects, individual and zip code level control variables (X), the fraction of subprime borrowers ($Subprime$) in zip code z within MSA m in 1997, and the interaction between the zip code fraction of subprime borrowers and the housing supply inelasticity ($Inelasticity$) of MSA m . The coefficient of interest is β .

Figure 4 presents the reduced-form triple-difference estimate of β for years 1999 to 2008. The top panel examines the relative growth in house prices for high subprime share zip codes in highly inelastic MSAs. Consistent with the estimates in Panel B of Table V, house price growth is strongest in subprime zip codes of inelastic MSAs. In terms of magnitudes, the coefficient estimate for 2006 implies that in the most inelastic MSA, a one standard deviation increase in the 1997 subprime share of the zip code leads to a 15% increase in house prices from 2002 to 2006.

The bottom two graphs show a relative increase in debt growth and debt to income ratios for homeowners living in high subprime share zip codes within highly inelastic MSAs. Once again, these graphs are based on a triple-difference estimate which compares homeowner

leverage in high subprime share zip codes within inelastic MSAs to both homeowners in high subprime share zip codes in elastic MSAs and homeowners in low subprime share zip codes in the same MSA. In terms of magnitudes, the coefficient estimate for 2006 implies that in the most inelastic MSA, a one standard deviation increase in the 1998 subprime share of the zip code leads to an 8% increase in debt and a 0.44 standard deviation increase in the homeowner debt to income ratio from 2002 to 2006.

Figure 4 suggests that a potential instrument for house prices is the zip code level share of subprime borrowers as of 1997 interacted with the MSA housing supply inelasticity. In Panel C of Table V, we examine how this instrument is correlated with total debt and debt to income levels in 2002. As Panel C shows, homeowners' debt amounts in high subprime share zip codes within inelastic MSAs are not significantly different than homeowners in high subprime share zip codes within elastic MSAs prior to the house price acceleration in 2002. There is some evidence of higher debt to income ratios in column 3, but the effect is significantly lowered by individual control variables that we employ in our IV specification below.

The results in Table VI and Figure 4 together with the results in Mian and Sufi (2009) motivate the following within-MSA instrumental variables specification:

$$(4) \quad \text{LeverageGrowth0206}_{izm} = \alpha_m + \theta X_{izm} + \mu \text{Subprime}_{zm,1997} + \beta \widehat{\text{HousePriceGrowth0206}}_{zm} + u_{izmt}$$

$$(5) \quad \text{HousePriceGrowth0206}_{zm} = \alpha_m + \delta * X_{izmt} + \gamma \text{Subprime}_{zm,1997} + \rho \text{Subprime}_{zm,1997} * \text{Inelasticity}_{m,1997} + \varepsilon_{izmt}$$

Equation (5) represents the first stage in which house price growth from 2002 to 2006 is instrumented with the interaction of zip code level subprime share as of 1997 and MSA level housing supply inelasticity. Equation (4) represents the second stage in which we examine the growth in leverage for homeowners as a function of predicted house price growth. The control

variables in X include median home value in the zip code and individual credit score, income, sex, and age. The control variables imply that we are comparing two homeowners with the same age, same credit score, same sex, and same income, but one resides in a high subprime share zip code within an inelastic housing supply MSA.

The second stage estimates for both debt growth and the change in debt to income are presented in Table VI. The estimates from the within-MSA specification are slightly higher than the estimates from the across-MSA analysis presented in the previous sub-section. The inclusion of control variables does not change the debt growth specification estimate. However, the effect of house price growth on the change in debt to income is more sensitive to the inclusion of control variables.

The within-MSA approach in Table VI explores a different source of house price variation relative to the across-MSA approach of Table II. In econometric terms, both the across and within approaches are local average treatment effect (LATE) estimators with the “local average” computed over mutually exclusive parts of the house price distribution. Yet the two approaches produce quite consistent estimates of the effect of house prices on homeowner borrowing. It should be kept in mind that the majority of the overall house price variation is across MSAs.⁷ For this reason, the across-MSA estimate is economically more meaningful, while the within-MSA estimate serves as a useful robustness check.

III. The Macroeconomic Impact of the Home Equity-Based Borrowing Channel

A. What Are Consumers Doing with Borrowed Money?

What do homeowners do with the money borrowed against home equity? The question is important in order to understand the real effects of the home equity-based borrowing channel.

⁷ Variance decomposition of house price growth from 2002 to 2006 at the zip code level reveals a between-MSA standard deviation of 0.22 and a within-MSA standard deviation of 0.06. See also Table I in Mian and Sufi (2009).

For example, if home equity borrowing is used to pay down other more expensive forms of consumer credit such as credit card debt, then home equity borrowing may not have a large aggregate impact. However, if home equity-based borrowing is used primarily for consumption, then the real and policy implications are substantial.

We first test whether high house prices lead homeowners to “trade up” by taking a bigger mortgage to move to a bigger home. Our data records the current zip code of each individual borrower. We can therefore construct an indicator variable for whether a homeowner moves from 2002 to 2006. Columns 1 and 2 of Panel A show that house price appreciation is not correlated with the probability of moving. This is true when examining the OLS specification or when using MSA housing supply inelasticity as an instrument for house price growth. These estimates are inconsistent with the argument that households are much more likely to move to new homes after realizing an increased value of home equity. In columns 3 and 4, respectively, we split the sample into homeowners that move and do not move zip codes between 2002 and 2006. The elasticity of debt growth with respect to house price growth is similar in both samples. Taken together, the estimates in Panel A are inconsistent with the argument that homeowners use borrowed money primarily to finance the purchase of new homes.

In Panel B, we examine whether homeowners use the increased value of home equity to buy investment properties. This may be a concern given that the percentage of households in the Survey of Consumer Finances that have outstanding debt on a residential property other than their primary residence increased from 4.6% in 2001 to 5.5% in 2007 (Bucks, Kennickell, Mach, and Moore (2009), Aizcorbe, Kennickell, and Moore (2003)). While we do not have data on the purchase of investment properties, the consumer credit reports contain the number of mortgage accounts. Under the assumption that consumers must obtain a new mortgage to purchase an

investment property, we should detect any systematic use of increased home equity to purchase an investment property by examining the number of mortgage accounts.

Column 1 and 2 of Panel B show that the change in the number of mortgage accounts from 2002 to 2006 is *negatively* correlated with house price growth. In other words, our estimates suggest that homeowners in high house price appreciation MSAs are less likely to buy investment properties. In column 3, we control for the change in the number of mortgage accounts and find a similar elasticity of debt growth with respect to house price growth. Finally, in column 4, we exclude any consumer with any change in the number of mortgage accounts and find a similar estimate of the effect of house price growth on debt growth. Taken together, the evidence in Panel B is inconsistent with the hypothesis that households use increased home equity to buy investment properties.

We do not have individual information on financial assets. However, evidence from the Survey of Consumer Finances is inconsistent with the view that homeowners use borrowing to buy additional financial assets.⁸ According to the SCF, the fraction of families holding almost every class of financial security *declined* from 2001 to 2007. This is true of stocks (21.3% to 17.9%), savings bonds (16.7% to 14.9%), and pooled investment vehicles (17.7% to 11.4%). Only retirement accounts increased slightly (52.2% to 52.6%). Conditional on having a financial asset, the SCF reports a decline in the median value of financial assets from \$29.8 thousand to \$25.3 thousand from 2001 to 2007.

One additional fact is also inconsistent with the hypothesis that consumers use home equity-based borrowing to purchase financial assets. As we show in the next section, the home equity borrowing channel is stronger among low credit quality and high credit card utilization

⁸ See Bucks, Kennickell, Mach, and Moore (2009), Aizcorbe, Kennickell, and Moore (2003), and Bucks, Kennickell, and Moore (2006)

individuals. Evidence from the SCF suggests that participation among lower income and lower net worth individuals dropped even more dramatically than the average from 2001 to 2007.

The evidence is inconsistent with the argument that consumers borrowed against increased home equity to purchase real estate or financial assets. In Panel C, we explore whether consumers use increased home equity-based borrowing to pay down outstanding credit card debt. This is a useful exercise given that the mean interest rate on outstanding credit card debt is 12.5% according to the SCF (Bucks, Kennickell, Mach, and Moore (2009)). If consumers do not pay down credit card debt, then it suggests that homeowners derive considerable marginal utility from the use of home-equity based borrowing.

Panel C isolates the sample to homeowners in the top quartile of the credit card utilization distribution as of 1997. The mean credit card debt outstanding among this group is almost \$10 thousand and the mean credit card utilization rate (amount outstanding divided by the high limit) is 0.58. Column 1 shows an elasticity of home debt borrowing with respect to house price growth of 0.9 among this sample. Despite the large increase in home-equity based borrowing and the large amount of outstanding credit card debt, the estimates in columns 2 and 4 show that these individuals do not pay down credit card debt in response to house price growth. While we cannot see the exact use of borrowed funds in our data, the results in Panel C suggest that the marginal return to the use of borrowed funds is quite high.

While we do not have direct data on individual level consumption, we are able to demonstrate that consumers do not use home equity-based borrowing to buy real estate or financial assets, and consumers do not use borrowed funds to pay down credit card debt with a high interest rate. While more evidence is needed, our findings are suggestive that a large

fraction of home equity-based borrowing is used for consumption.

B. The Macroeconomic Impact of the Household Borrowing Channel

Since our estimates of the home equity-based borrowing channel is based on a representative sample of the U.S., we can integrate our estimated effect to compute the economy wide magnitude of home equity-based borrowing due to higher house prices.

How much of the increase in mortgage credit can be attributed to a direct effect of existing homeowners borrowing against the increasing value of their housing equity? We start with our baseline estimate of column 2 in Table II that suggests that homeowners increase their total borrowing by 0.7 percent for every 1.0 percent increase in house prices. Since our estimated effect is based of a difference in differences approach, the *level* impact of house prices on borrowing is not identifiable. Therefore, the appropriate in-sample aggregate effect of our estimate should be computed using relative differences in house price growth.

Let i index an MSA such that the MSAs are ordered by their housing supply inelasticity with $i=1$ being the most elastic. Let $\Delta\widehat{P}_i$ be the predicted percentage change in house prices for MSA i given its supply inelasticity. Given our home equity-based borrowing elasticity estimate of 0.7, the average percentage change in total borrowing due to the house price channel for homeowner living in MSA i is given by $[0.7 * (\Delta\widehat{P}_i - \Delta\widehat{P}_1)]$. Since we know each homeowner's level of initial debt, we can convert the percentage change in debt into new debt taken out in dollars. Aggregating this procedure for all MSAs gives us an aggregate borrowing due to house price appreciation effect of \$1.2 trillion dollars over four years from 2002 to 2006.⁹ This increase represents 55% of the overall increase in debt of homeowners from 2002 to 2006.

⁹ The sum of home equity-based borrowing over our sample is equal to \$3.5 billion. Since our sample of homeowners comes from a random sample of 266,700 U.S. consumers out of a total of 91.3 million individuals in the credit bureau data as of December 1997, we multiply \$3.5 billion with $(91.3/0.266)$ to get the economy wide home equity based borrowing.

The aggregate increase in debt due to house price appreciation represents 2.3% of GDP per year over the four years. While we do not have data on consumption, our previous evidence suggests that it is likely that some of the borrowings are used to increase consumption. If we take the extreme view that all of borrowed money is used for consumption, then our estimate goes a long way toward explaining the drop in the savings rate during this time period.

IV. Does the Home Equity-Based Borrowing Channel Vary By Consumer Type?

Our estimates above suggest a large response of homeowner borrowing to increases in the value of home equity. In this section, we explore cross-sectional heterogeneity of the effect. Our goal is to provide insight into the underlying model of consumer behavior that is most consistent with the home equity-based borrowing channel.

We first examine how the propensity to borrow against increased home equity varies by the homeowner's base year credit score and credit card utilization rate. Credit scores play an important role in the availability and pricing of consumer credit, and consumers below critical thresholds are often unable to obtain financing at reasonable interest rates.¹⁰ Credit card utilization rate is measured by the fraction of the total available credit card limit that is used. Credit scores and credit card utilization rates have a correlation coefficient of -0.88 in our sample of homeowners, and an OLS regression of one on the other yields an R^2 of 0.78. The literature on consumer credit often interprets low credit scores and high credit card utilization rates as indicators for liquidity constrained households (see Gross and Souleles (2002)). However, such variables may also be systematically correlated with an underlying behavioral attribute of households such as self-control problems.

¹⁰ See <http://www.freddiemac.com/corporate/reports/moseley/chap6.htm> and congressional testimony of Staten (2004) at <http://financialservices.house.gov/media/pdf/033004ms.pdf#page=3>.

The top four panels of Figure 5 examine debt growth patterns for inelastic and elastic MSAs by 1997 homeowner credit score and credit card utilization rate. We define “high” and “low” categories as the top and bottom quartile of the respective distribution. The top panel of Figure 5 shows a very strong home equity-based borrowing effect for low credit quality borrowers. In contrast there is almost no effect for high quality borrowers as both elastic and inelastic debt growth path are similar throughout the sample period. A similar pattern is revealed in the middle panel that uses 1997 credit card utilization to separate borrowers.¹¹

The top four panels of Figure 5 provide support for the exclusion restriction in our instrumental variables specification. The fact that there is almost no difference in borrowing between inelastic and elastic MSAs for high credit quality and low credit card utilization zip codes is inconsistent with a general non-housing related credit demand shift in inelastic MSAs. An alternative channel for higher borrowing in inelastic MSAs must explain why the effect is absent in high credit score and low credit card utilization individuals.

As we discuss in Section II.A, a standard model without liquidity constraints hypothesizes that older consumers should be more willing to extract cash from the increased value of home equity. The bottom two panels of Figure 5 do not show evidence in favor of this hypothesis. We split the sample into consumers in the lowest and highest quartile of the age distribution, and we find that inelastic-elastic differential in debt growth is not significantly different for young and old homeowners.

Table VIII presents regression equivalent results for Figure 5 by estimating the following specification:

$$(6) \quad \text{LeverageGrowth0206}_{izm} = \theta X_{izm} + \beta \widehat{\text{HousePriceGrowth0206}}_{zm} + \tau \widehat{\text{HousePriceGrowth0206}}_{zm} * \text{InteractionTerm}_{izm} + u_{izm}$$

¹¹ We obtain similar patterns when examining debt to income ratio instead of debt growth over time.

$$(7) \quad \text{HousePriceGrowth0206}_{zm} = \delta * X_{izm} + \rho \text{Inelasticity}_{m,1997} + \\ \omega \text{Inelasticity}_{m,1997} * \text{InteractionTerm}_{izm} + \varepsilon_{izm}$$

As equation (7) shows, the instruments in the first stage are housing supply inelasticity and housing supply inelasticity interacted with the relevant interaction variable listed at the top of the column in Table VIII. In column 1, the estimated coefficient on the interaction term is negative, which implies that the effect of house price growth on home equity-based borrowing from 2002 to 2006 is lower for individuals with a higher 1997 credit score. The magnitude of the difference is large. For a consumer one standard deviation above the mean 1997 credit score, the elasticity of debt with respect to house prices is 0.36. For a consumer one standard deviation below the mean 1997 credit score, the elasticity is 0.94.

The positive estimate on the interaction term in column 2 implies that individuals with a high credit card utilization rate have a larger borrowing response to house price growth. The estimate implies that for a consumer one standard deviation below the mean 1997 credit card utilization rate, the elasticity of debt with respect to house prices is 0.41. For a consumer one standard deviation above the mean 1997 credit card utilization rate, the elasticity is 0.96.

The coefficient estimate on the interaction term is not significant for either sex or household income. The coefficient estimate on the age interaction term in column 4 is negative and marginally statistically significant with a p-value of 0.11. In column 5, we create an independent interaction term for homeowners over the age of 65. As the interaction term coefficient estimate shows, individuals over 65 have a *lower* sensitivity of borrowing to house price growth. The evidence suggests that the borrowing of older consumers is less responsive to

house price growth than young consumers, which is inconsistent with standard life-cycle models of consumer financial behavior.¹²

V. Home Equity-Based Borrowing and Defaults

A unique advantage of our data set relative to other studies of home equity-based borrowing is the availability of default rates. Our data set enables us to see the default rate implications of aggressive home equity-based borrowing when house price growth decelerates and turns negative.

The top panel in Figure 6 examines total debt default rates for 1997 homeowners in the highest and lowest quartile MSAs based on house price inelasticity. As previous results show, homeowners in inelastic MSAs experience both a sharp rise in house price growth and home equity-based borrowing from 2002 to 2006 relative to homeowners in elastic MSAs. As the top panel shows, there is a contemporaneous relative decline in the default rate for homeowners in inelastic versus elastic MSAs. From 2006 to 2008, default rates for homeowners in inelastic MSAs experience a sharp increase in default rates, surpassing the default rate in elastic areas.

We also split the sample into borrowers in the lowest and highest quartile of the credit quality distribution. As the middle panel shows, low credit quality borrowers in inelastic MSAs experience a very sharp relative decline in default rates. From 2001 to 2005, the default rate falls by almost five full percentage points in inelastic MSAs, whereas it falls by only two percentage points in elastic MSAs. Recall that it is precisely low credit quality borrowers in inelastic MSAs that experience the largest increase in both house prices and home equity-based borrowing during this time period.

¹² In unreported results, we conduct the same analysis of the cross-sectional heterogeneity of the home equity-based borrowing effect using the within-MSA specification outlined in Section III.B. We find similar results with this alternative empirical strategy.

When house prices begin to decelerate and fall from 2006 to 2008, the default rate for low credit quality borrowers in inelastic MSAs skyrockets past the default rate for high credit quality borrowers. The magnitude is very large. The default rate for low credit quality homeowners increases by more than 10 percentage points from 2005 to 2008 in inelastic MSAs. The corresponding increase in elastic MSAs is less than 5 percentage points.

Table IX presents estimates of the effect of house price growth on the change in default rates from 2002 to 2006. The instrumental variables specification in columns 1 and 2 is similar to the specification outlined in equations (1) and (2) above, except we examine default rates as the outcome variable. Consistent with Figure 6, we find a negative correlation between default rates and house price growth from 2002 to 2006. The estimate in column 2 implies that a one standard deviation increase in house prices leads to a 1% decrease in default rates.

In columns 3 through 7, we examine how house price growth differentially affects the decline in default rates from 2002 to 2006 for different homeowners. The instrumental variables specification is similar to the specification outlined in equations (6) and (7) above. The estimates in columns 3 and 4 show that lower credit quality and higher credit card utilization rate homeowners experience an even stronger decline in default rates from 2002 to 2006. In other words, the exact same borrowers experiencing the largest effect of house prices on home equity-based borrowing also experience the largest declines in default rates from 2002 to 2006.

Table X presents the analogous specifications that examine the increase in default rates from 2006 to 2008. The coefficient estimate on house price growth in column 2 is positive and statistically distinct from zero at a high confidence level. In other words, lagged house price growth strongly predicts future default rates. As the specifications with interaction terms show, the effect of lagged house price growth on future defaults is strongest among low credit quality

and high credit card utilization households. The magnitude of the difference is very large. Among homeowners one standard deviation above the mean 1997 credit card utilization rate, a one standard deviation increase in house prices from 2002 to 2006 leads to a one standard deviation increase in default rates from 2006 to 2008. In contrast, among homeowners one standard deviation below the 1997 credit card utilization rate, a one standard deviation increase in house prices from 2002 to 2006 leads to 1/5 standard deviation increase in default rates from 2006 to 2008.

The results in Figure 6 and Tables IX and X show that high credit card utilization and low credit score individuals in high house price growth MSAs who borrow heavily against the increased value of home equity experience a sharp relative decline in default rates from 2002 to 2006. These same individuals experience a very large relative increase in default rates when house prices decelerate and fall from 2006 to 2008.

To obtain the macroeconomic magnitudes, we can repeat our analysis from Section III.B to examine the effect of house price appreciation on total defaults for the U.S. economy. Taking the estimate of 0.085 from column 1 of Table X, we find that defaults due to the home equity-based borrowing channel represent 21 percent of total new defaults in the U.S. economy. This suggests that the current mortgage default crisis is not entirely driven by first time homeowners buying into a rising housing market. A significant part of the default crisis is driven by earlier homeowners borrowing heavily against the rising value of their homes.

VI. Conclusion

We provide evidence of a strong link between asset prices and household borrowing decisions. The use of individual level data and an instrumental variables methodology enables us to precisely estimate the magnitude of the home equity-based borrowing channel. Since our

individual level data is representative of U.S. household sector, we can provide an estimate of the economy-wide effect of the rise in house prices on household borrowing during the period of strong house price growth from 2002 to 2006.

The macroeconomic estimate of the effect of house price on household borrowing is large. We also show evidence that the increase in homeowner borrowing is not used to buy new houses, buy investment properties, or pay down costly consumer debt. Taken together, these findings lend support to the view that home equity-based borrowing is used for consumption. Our evidence suggests that fluctuations in house prices and household credit availability may play an important role in the evolution of business cycles (Iacoviello (2005)). Exploring this link is an important question moving forward.

Our results also highlight the importance of understanding the microeconomic foundations of household behavior. We find that the home equity-based borrowing channel is driven primarily by homeowners with low credit scores and high credit card utilization rates. This may suggest that house price appreciation allows previously credit-constrained homeowners to move toward their optimal level of borrowing and consumption. However, it may also imply house price appreciation provides greater access to borrowing for homeowners that suffer from behavioral biases such as dynamically inconsistent preferences or self-control problems.

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Table I
Summary Statistics

This table presents summary statistics for 96,496 individuals who have either an existing mortgage account with positive balance as of 1997 or a previous mortgage account. The sample is further restricted to individuals that do not move zip codes between 1997 and 1999. Individuals are sorted into groups of at least 5 individuals. Each group consists of individuals living in the same zip code as of 1997, and the individuals are sorted by 1997 credit score before groups are formed. The income in the denominator of the debt to income ratio comes from zip level IRS data. The zip code level median home value as of 2002 comes from the 2000 value reported in the decennial Census multiplied by the growth rate from 2000 to 2002 reported in the Fiserv Case Shiller Weiss data. The housing supply inelasticity measure we use is three – the Saiz (2008) measure. The Saiz (2008) measure is increasing in elasticity from 0 to 3. There are 3,016 zip codes and 83 MSAs that are represented in the sample.

	N	Mean	Median	St. Dev.
<i>Equifax individual level data</i>				
Total debt, 1997, \$thousands	17347	101	95	72
Home debt, 1997, \$thousands	17347	89	83	70
Growth in total debt, 1998-2002	17347	0.087	0.077	0.619
Growth in total debt, 2002-2006	17347	0.346	0.322	0.669
Growth in home debt, 1998-2002	17347	0.098	0.049	0.895
Growth in home debt, 2002-2006	17347	0.395	0.356	0.878
Total debt to income ratio, 1997	17054	2.468	2.450	1.495
Change in debt to income ratio, 1998-2002	17342	-0.006	-0.085	0.887
Change in debt to income ratio, 2002-2006	17346	0.733	0.420	1.346
Total debt default rate, 1997	17347	0.036	0.000	0.108
Change in default rate, 1998-2006	17342	-0.005	0.000	0.129
Change in default rate, 2006-2008	17336	0.035	0.000	0.162
Credit score, 1997	17347	783	792	94
Credit card utilization fraction, 1997	17346	0.327	0.255	0.253
Age, 1997	17345	58	57	7
Male	17330	0.512	0.500	0.255
Income, 1997, \$thousands	17345	79	74	34
<i>Fiserv Case Shiller Weiss zip level data</i>				
House price growth, zip level, 1998-2002	17294	0.416	0.444	0.142
House price growth, zip level, 2002-2006	17347	0.440	0.442	0.222
<i>Saiz (2008) MSA level elasticity measure</i>				
Housing supply inelasticity	17347	2.004	2.080	0.438
Median home value, 2002, \$thousands	17336	235	203	133
<i>IRS zip level income data</i>				
Per capita wage growth, 2002-2006	17346	0.115	0.111	0.060
<i>Census business statistics zip level data</i>				
Per capita payroll growth, 2002-2006	16936	0.117	0.116	0.118
Employment growth, 2002-2006	16936	0.078	0.067	0.188
<i>Equifax zip level aggregate data</i>				
Fraction of zip code with credit score under 659, 1997	17345	0.293	0.278	0.113

Table II
The Effect of House Prices on Household Borrowing for 1997 Homeowners

This table presents estimates of the effect of house prices on household borrowing for individuals who have either an existing mortgage account with positive balance as of 1997 or a previous mortgage account. Individual dummy variables are quintile indicator variables for 2% bins of the 1997 credit score, 2008 income, and 1997 age variables. Census controls are zip code level variables for the vacancy rate, fraction white, fraction black, education indicator variables for less than high school and high school diploma only, the unemployment rate, the poverty rate, and the fraction of households in the zip code living in an urban setting, all measured as of 2000. Income controls are zip code level variables from the IRS and Census business statistics for the logarithm of the 2002 employment, per capita wage, and per capita payroll level, and the growth in wage, payroll and employment from 1997 to 2000, 2000 to 2002, and 2002 to 2006. All standard errors are clustered at the MSA level.

Left hand side variable	(1) HP growth 2002-2006	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Total debt growth 2002-2006				Change in total debt to income ratio 2002-2006			
Housing supply inelasticity	0.174** (0.058)								
Instrumented HP growth, 2002-2006		0.703** (0.213)	0.689** (0.189)	0.697** (0.186)	0.621** (0.120)	1.605** (0.366)	1.703** (0.371)	1.720** (0.370)	1.394** (0.248)
(Credit score, 1997)/100			-0.027* (0.011)				-0.112** (0.024)		
Ln(household income, 2008)			0.144** (0.018)				0.212** (0.037)		
Age, 1997			-0.011** (0.001)				-0.034** (0.003)		
Male dummy variable			0.005 (0.022)	0.008 (0.021)	0.001 (0.022)		0.147** (0.051)	0.152** (0.048)	0.087+ (0.047)
Additional control variables				Individual dummy variables	Individual dummy, census, income variables			Individual dummy variables	Individual dummy, census, income variables
N	17347	17347	17328	17328	16526	17346	17327	17327	16526
R ²	0.12	0.00	0.00	0.01	0.03	0.00	0.04	0.06	0.11

**,* , + coefficient statistically distinct from 0 at the 1, 5, and 10% level, respectively.

Table III

The Effect of House Prices on Household Borrowing for 1997 Homeowners, Dollar for Dollar Changes

This table presents estimates of the effect of house prices on household borrowing for individuals who have either an existing mortgage account with positive balance as of 1997 or a previous mortgage account. Individual dummy variables are quintile indicator variables for 2% bins of the 1997 credit score, 2008 income, and 1997 age variables. Census controls are zip code level variables for the vacancy rate, fraction white, fraction black, education indicator variables for less than high school and high school diploma only, the unemployment rate, the poverty rate, and the fraction of households in the zip code living in an urban setting, all measured as of 2000. Income controls are zip code level variables from the IRS and Census business statistics for the logarithm of the 2002 employment, per capita wage, and per capita payroll level, and the growth in wage, payroll and employment from 1997 to 2000, 2000 to 2002, and 2002 to 2006. All standard errors are clustered at the MSA level. All standard errors are clustered at the MSA level.

Left hand side variable	(1) Change in home value 2002-2006 \$thousands	(2)	(3) Change in total debt 2002-2006 \$thousands	(4)	(5)
Housing supply inelasticity	45.859* (18.369)				
Instrumented change in home value, 2002-2006	0.480** (0.085)	0.236** (0.067)	0.281** (0.075)	0.296** (0.080)	0.231** (0.073)
Median home value, 2002		0.027 (0.038)	-0.012 (0.048)	-0.023 (0.045)	-0.043 (0.074)
(Credit score, 1997)/100			-8.081** (1.126)		
Ln(household income, 2008)			27.167** (3.606)		
Age, 1997			-2.148** (0.199)		
Male dummy variable			8.521* (4.041)	8.839* (3.910)	6.418+ (3.737)
Additional control variables				Individual dummy variables	Individual dummy, census, income variables
N	17336	17336	17317	17317	16526
R ²	0.52	0.03	0.07	0.08	0.10

** , * , + coefficient statistically distinct from 0 at the 1, 5, and 10% level, respectively.

Table IV
Examining Exclusion Restriction for MSA-level Analysis

This table presents evidence on the exclusion restriction for the MSA-level analysis in Tables II and III. Panel A examines the correlation between economic activity and housing supply elasticity in the sample of homeowners. “Growth shocks” represent the differences in 1998 to 2002 and 2002 to 2006 growth rates for each respective variable. Panel B examines the home and credit card debt for homeowners and debt patterns for renters. Renters are defined as individuals that have no housing related debt from 1997 to 2006. All standard errors are clustered at the MSA level.

Panel A: Income and employment measures

Left hand side variable	(1) Business payroll growth 2002-2006	(2) IRS wage growth 2002-2006	(3) Employment growth 2002-2006	(4) Payroll growth shock	(5) Wage growth shock	(6) Employment growth shock
Housing supply inelasticity	0.004 (0.009)	0.024** (0.005)	-0.020 (0.019)	-0.019* (0.009)	-0.003 (0.007)	-0.015 (0.016)
N	2938	3015	2938	2909	3013	2909
R ²	0.00	0.03	0.00	0.00	0.00	0.00

Panel B: Home, credit card, and renters’ debt

Sample	(1) Homeowners	(2) Homeowners	(3) Homeowners	(4) Homeowners	(5) Renters	(6) Renters
Left hand side variable	Home debt growth 2002-2006	Credit card debt growth 2002-2006	Change in home debt to income 2002-2006	Change in credit card debt to income 2002-2006	Total debt growth 2002-2006	Change in total debt to income 2002-2006
Instrumented HP growth, 2002-2006	0.729** (0.232)	0.327 (0.251)	1.461** (0.323)	0.038 (0.033)	0.189 (0.152)	0.030 (0.038)
N	17347	17347	17346	17346	6373	6372
R ²	0.00	0.00	0.01	0.00	0.00	0.00

**,* , + coefficient statistically distinct from 0 at the 1, 5, and 10% level, respectively.

Table V

Motivation for Within-MSA Test Based on 1997 Subprime Share of Zip Code Population

Panel A shows the effect of subprime fraction in the zip code on mortgage origination growth for home purchase at the zip code level by MSA housing supply elasticity. The zip code level mortgage origination growth data come from HMDA. Panel B shows the effect of the 1997 fraction of subprime individuals in the zip code on house price growth from 2002 to 2006 by MSA housing supply elasticity. Panel C shows the correlation between the instrument, subprime share of total population interacted with housing supply elasticity, and measures of debt as of 2002. Individual dummy variables are quintile indicator variables for 2% bins of the 2002 median home value in the zip code, 1997 credit score, 2008 income, and 1997 age variables. All specifications include MSA fixed effects and standard errors are clustered at the MSA level.

Panel A: Mortgage origination growth for new home purchase (HMDA), 2002-2006

	(1) Full	(2) Most elastic	(3) 2 nd quartile	(4) 3 rd quartile	(5) Most inelastic
Fraction in zip code with credit score under 660, 1997	1.385** (0.150)	0.649* (0.234)	0.739** (0.234)	1.727** (0.169)	1.751** (0.189)

Panel B: House price growth, 2002-2006

	(1) Full	(2) Most elastic	(3) 2 nd quartile	(4) 3 rd quartile	(5) Most inelastic
Fraction in zip code with credit score under 660, 1997	0.288** (0.044)	-0.007 (0.021)	0.129* (0.047)	0.356** (0.042)	0.414** (0.064)

Panel C: Correlation of instrument with measures of debt as of 2002

Dependent variable	(1) Ln(total debt, 2002)	(2)	(3)	(4)
Fraction in zip code with credit score under 660, 1997	-0.154 (0.160)	0.151 (0.121)	0.638+ (0.354)	0.332 (0.376)
*Housing supply inelasticity				
Fraction in zip code with credit score under 660, 1997	-1.142** (0.291)	-0.276 (0.291)	1.152+ (0.670)	1.937* (0.821)
Additional control variables		Individual dummy variables		Individual dummy variables

**,* , + coefficient statistically distinct from 0 at the 1, 5, and 10% level, respectively.

Table VI
The Effect of House Prices on Household Borrowing for 1997 Homeowners
Using Within-MSA Variation

This table presents second stage estimates from a within-MSA instrumental variables specification where the first stage instrument for house price growth from 2002 to 2006 is the fraction in the zip code with a credit score under 660 as of 1997 interacted with MSA level housing supply inelasticity. Individual dummy variables are quintile indicator variables for 2% bins of the 2002 median home value in the zip code, 1997 credit score, 2008 income, and 1997 age variables. All specifications (both first and second stage) include MSA fixed effects and standard errors are clustered at the MSA level.

Dependent variable	(1)	(2) Total debt growth 2002-2006	(3)	(4)	(5) Change in total debt to income 2002-2006	(6)
Instrumented house price growth, 2002-2006	1.068** (0.334)	1.067** (0.299)	1.090** (0.293)	4.979** (1.317)	4.110** (1.139)	3.059** (0.943)
Fraction in zip code with credit score under 660, 1997	-0.274** (0.088)	-0.074 (0.079)	-0.018 (0.094)	0.082 (0.337)	0.450 (0.276)	1.025** (0.287)
Median home value, 2002		0.000 (0.000)			-0.001** (0.000)	
(Credit score, 1997)/100		-0.048** (0.008)			-0.154** (0.017)	
Ln(household income, 2008)		0.162** (0.021)			0.523** (0.042)	
Age, 1997		-0.009** (0.001)			-0.028** (0.002)	
Male dummy variable		0.001 (0.021)	0.005 (0.020)		0.104* (0.047)	0.109* (0.044)
Additional control variables			Individual dummy variables			Individual dummy variables
N	17345	17315	17315	17344	17315	17315
R ²	0.01	0.03	0.05	0.04	0.10	0.12

** , * , + coefficient statistically distinct from 0 at the 1, 5, and 10% level, respectively.

Table VII
What Do Homeowners Do with Borrowed Money?

Panel A examines whether households in high house price growth areas are more likely to move to a new zip code and whether movers and non-movers experience differential growth rates in debt from 2002 to 2006. Panel B examines whether households in high house price growth areas are more likely to increase their number of mortgages, which is a proxy for the purchase of an investment property. Panel C isolates the sample to individuals in the top quartile of the 1997 credit card utilization distribution and examines whether households in high house price appreciation areas are more likely to pay down credit card debt. All specifications include control variables for individual 1997 credit score, 2008 income, age, and sex. Standard errors are clustered at the MSA level.

Panel A: Purchase of new homes?				
Sample	(1)	(2)	(3)	(4)
Left hand side variable	MSA averages	Full	Movers	Non-movers
	Probability of moving	Probability of moving	Total debt growth 2002-2006	
HP Growth, 2002-2006	0.032 (0.028)			
Instrumented HP Growth, 2002-2006		-0.176 (0.137)	0.756** (0.212)	0.607** (0.175)
N	83	17326	8596	8730
R ²	0.39	0.00	0.00	0.01

Panel B: Purchase of investment properties?				
Sample	(1)	(2)	(3)	(4)
Left hand side variable	Full	Full	Full	No change in # of mortgages
	Change in # of mortgages 2001-2005		Total debt growth 2002-2006	
HP Growth, 2002-2006	-0.032+ (0.018)			
Instrumented HP Growth, 2002-2006		-0.202** (0.062)	0.784** (0.185)	0.810** (0.262)
Change in # of mortgages, 2001-2005			0.639** (0.024)	
N	17008	17008	17008	5109
R ²	0.02	0.01	0.09	0.01

Panel C: Paying down credit card balances?				
Sample	(1)	(2)	(3)	(4)
Left hand side variable	Top quartile credit card utilization as of 1997			
	Home debt growth 2002-2006	Credit card debt growth 2002-2006	Change in home debt to income 2002-2006	Change in credit card debt to income 2002-2006
Instrumented HP Growth, 2002-2006	0.893** (0.208)	0.295 (0.239)	2.180** (0.433)	0.046 (0.035)
N	4324	4324	4324	4324
R ²	0.03	0.01	0.06	0.01

** , * , + coefficient statistically distinct from 0 at the 1, 5, and 10% level, respectively.

Table VIII

Cross-Sectional Heterogeneity in Effect of House Prices on Household Borrowing for 1997 Homeowners

This table presents estimates of the cross-sectional heterogeneity of the effect of house prices on household borrowing for individuals that have either positive outstanding mortgage debt as of 1997 or a previous mortgage account. In each column, we interact house price growth with the variable in the top of the column. The instruments in the first stage are MSA level housing supply elasticity and MSA level housing supply elasticity interacted with the interaction variable listed in the top of the column. In all columns, we use the data sorts that maximize variation in the interaction variable. More specifically, in columns 1 and 2 we use data sorted by credit score before groups are formed. In columns 3 to 6, we use data sorted by each interaction variable before groups are formed. All standard errors are clustered at the MSA level.

Interaction variable	(1) (Credit score, 1997)/100	(2) Credit card utilization, 1997	(3) Ln(household income, 2008)	(4) Age, 1997	(5) Age>=65, 1997	(6) Male
Left hand side variable	Total debt growth 2002-2006					
Instrumented house price growth, 2002-2006	3.084** (0.696)	0.324* (0.136)	1.349* (0.645)	1.340** (0.471)	0.764** (0.184)	0.722** (0.186)
Instrumented house price growth, 2002-2006 *Interaction term (listed at top of column)	-0.311** (0.076)	1.097** (0.313)	-0.157 (0.126)	-0.012 (0.008)		0.005 (0.156)
Age>=65 indicator					0.188+ (0.098)	
Instrumented house price growth, 2002-2006 *Age>=65					-0.463* (0.211)	
(Credit score, 1997)/100	0.068+ (0.038)	-0.071** (0.019)	-0.048 (0.033)	-0.029 (0.029)	-0.027 (0.029)	-0.087** (0.025)
Credit card utilization, 1997	-0.183** (0.055)	-0.678** (0.132)	-0.113* (0.051)	0.013 (0.042)	0.016 (0.041)	-0.201** (0.056)
Ln(household income, 2008)	0.152** (0.020)	0.155** (0.020)	0.265** (0.059)	0.156** (0.018)	0.154** (0.017)	0.154** (0.019)
Age, 1997	-0.010** (0.001)	-0.010** (0.001)	-0.011** (0.002)	-0.009** (0.003)	-0.014** (0.001)	-0.010** (0.001)
Male dummy variable	0.007 (0.022)	0.007 (0.022)	-0.015 (0.023)	-0.019 (0.024)	-0.020 (0.024)	0.011 (0.065)
N	17327	17327	16575	16932	16932	15469
R ²	0.00	0.00	0.02	0.05	0.05	0.00

**,* , + coefficient statistically distinct from 0 at the 1, 5, and 10% level, respectively.

Table IX**The Effect of House Prices on Default Rates from 2002-2006 for 1997 Homeowners**

This table presents the effect of house price growth on default rates from 2002 to 2006. In columns 3 to 6, we interact house price growth with the variable in the top of the column. The instruments in the first stage are MSA level housing supply elasticity and MSA level housing supply elasticity interacted with the interaction variable listed in the top of the column. In all columns, we use the data sorts that maximize variation in the interaction variable. More specifically, in columns 3 and 4 we use the data sorted by credit score before groups are formed. In columns 5 to 7, we use the data sorted by each interaction variable before groups are formed. All standard errors are clustered at the MSA level.

Interaction variable	(1)	(2)	(3) (Credit score, 1997)/100	(4) Credit card utilization, 1997	(5) Ln(HH income, 2008)	(6) Age, 1997	(7) Male
Left hand side variable	Change in default rate, 2002-2006						
Instrumented house price growth, 2002-2006	-0.024* (0.010)	-0.033** (0.008)	-0.265* (0.105)	-0.002 (0.016)	0.014 (0.116)	-0.068 (0.064)	-0.023 (0.019)
Instrumented house price growth, 2002-2006 *Interaction term (listed at top of column)			0.030* (0.013)	-0.091+ (0.051)	-0.011 (0.026)	0.001 (0.001)	0.016 (0.029)
(Credit score, 1997)/100		0.009** (0.002)	-0.003 (0.006)	0.011** (0.003)	0.010** (0.003)	0.007* (0.003)	0.009** (0.003)
Ln(household income, 2008)		0.001 (0.002)	0.000 (0.002)	0.000 (0.002)	0.004 (0.013)	-0.002 (0.003)	-0.003 (0.002)
Age, 1997		0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.001)	0.000 (0.000)
Male dummy variable		0.001 (0.004)	0.001 (0.004)	0.001 (0.004)	0.010+ (0.005)	0.007 (0.004)	-0.003 (0.013)
Credit card utilization, 1997			0.007 (0.009)	0.048+ (0.026)	-0.003 (0.010)	-0.013 (0.008)	0.006 (0.010)
N	17341	17325	17324	17324	16539	16924	15461
R ²	0.00	0.01	0.01	0.01	0.00	0.01	0.01

** , * , + coefficient statistically distinct from 0 at the 1, 5, and 10% level, respectively.

Table X**The Effect of House Prices from 2002-2006 on Default Rates from 2006-2008 for 1997 Homeowners**

This table presents the effect of house price growth from 2002 to 2006 on default rates from 2006 to 2008. In columns 3 to 6, we interact house price growth with the variable in the top of the column. The instruments in the first stage are MSA level housing supply elasticity and MSA level housing supply elasticity interacted with the interaction variable listed in the top of the column. In all columns, we use the data sorts that maximize variation in the interaction variable. More specifically, in columns 3 and 4 we use the data sorted by credit score before groups are formed. In columns 5 to 7, we use the data sorted by each interaction variable before groups are formed. All standard errors are clustered at the MSA level.

Interaction variable	(1)	(2)	(3) Credit score, 1997	(4) Credit card utilization, 1997	(5) Ln(HH income, 2008)	(6) Age, 1997	(7) Male
Left hand side variable	Change in default rate, 2006-2008						
Instrumented house price growth, 2002-2006	0.085** (0.018)	0.113** (0.021)	0.758** (0.194)	0.020 (0.020)	0.098 (0.097)	0.295** (0.090)	0.093** (0.029)
Instrumented house price growth, 2002-2006 *Interaction term (listed at top of column)			-0.085** (0.024)	0.266** (0.076)	0.001 (0.023)	-0.003* (0.002)	0.018 (0.039)
(Credit score, 1997)/100		-0.022** (0.002)	0.020+ (0.010)	-0.018** (0.003)	-0.020** (0.004)	-0.017** (0.004)	-0.023** (0.004)
Ln(household income, 2008)		-0.008* (0.003)	-0.009** (0.003)	-0.008* (0.003)	-0.005 (0.012)	-0.014** (0.004)	-0.013** (0.004)
Age, 1997		-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)	0.001 (0.001)	-0.001** (0.000)
Male dummy variable		0.000 (0.005)	0.001 (0.005)	0.001 (0.005)	0.006 (0.006)	0.008 (0.006)	-0.007 (0.018)
Credit card utilization, 1997			0.017 (0.012)	-0.103** (0.033)	0.006 (0.013)	0.012 (0.011)	0.009 (0.014)
N	17336	17320	17319	17319	16522	16916	15454
R ²	0.02	0.04	0.05	0.04	0.02	0.03	0.03

** , * , + coefficient statistically distinct from 0 at the 1, 5, and 10% level, respectively.

Figure 1

Aggregate U.S. Leverage and House Price Patterns

This figure presents aggregate U.S. leverage and house price patterns. Aggregate debt information come from the Federal Reserve flow of funds data, aggregate income comes from NIPA, and aggregate house price index data come from OFHEO. In the bottom right panel, aggregate debt for 1997 homeowners comes from Equifax data where homeowners are defined to be individuals who have either an existing mortgage account with positive balance as of 1997 or a previous mortgage account.

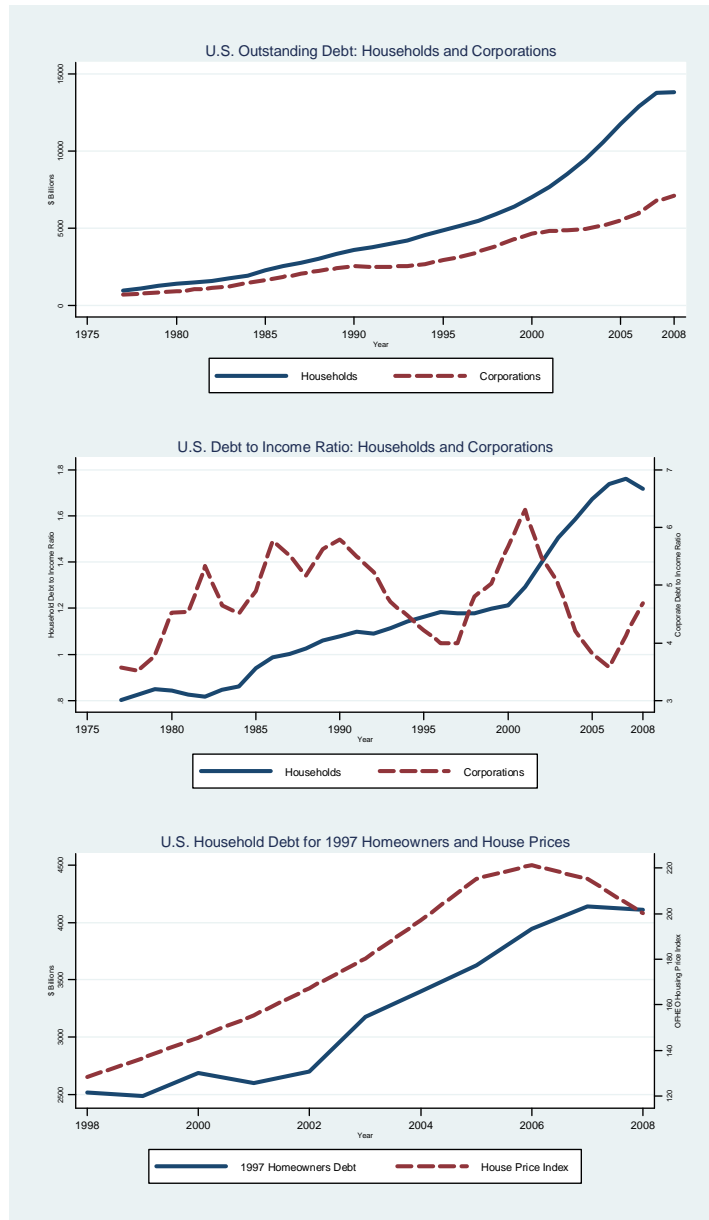


Figure 2

House Price and Leverage Patterns, Inelastic versus Elastic Housing Supply MSAs

This figure presents house price, total debt, and total debt to income patterns for the top and bottom quartile MSAs based on housing supply elasticity from Saiz (2008). The sample includes individuals with mortgage debt outstanding as of 1997 or with a previous mortgage account.

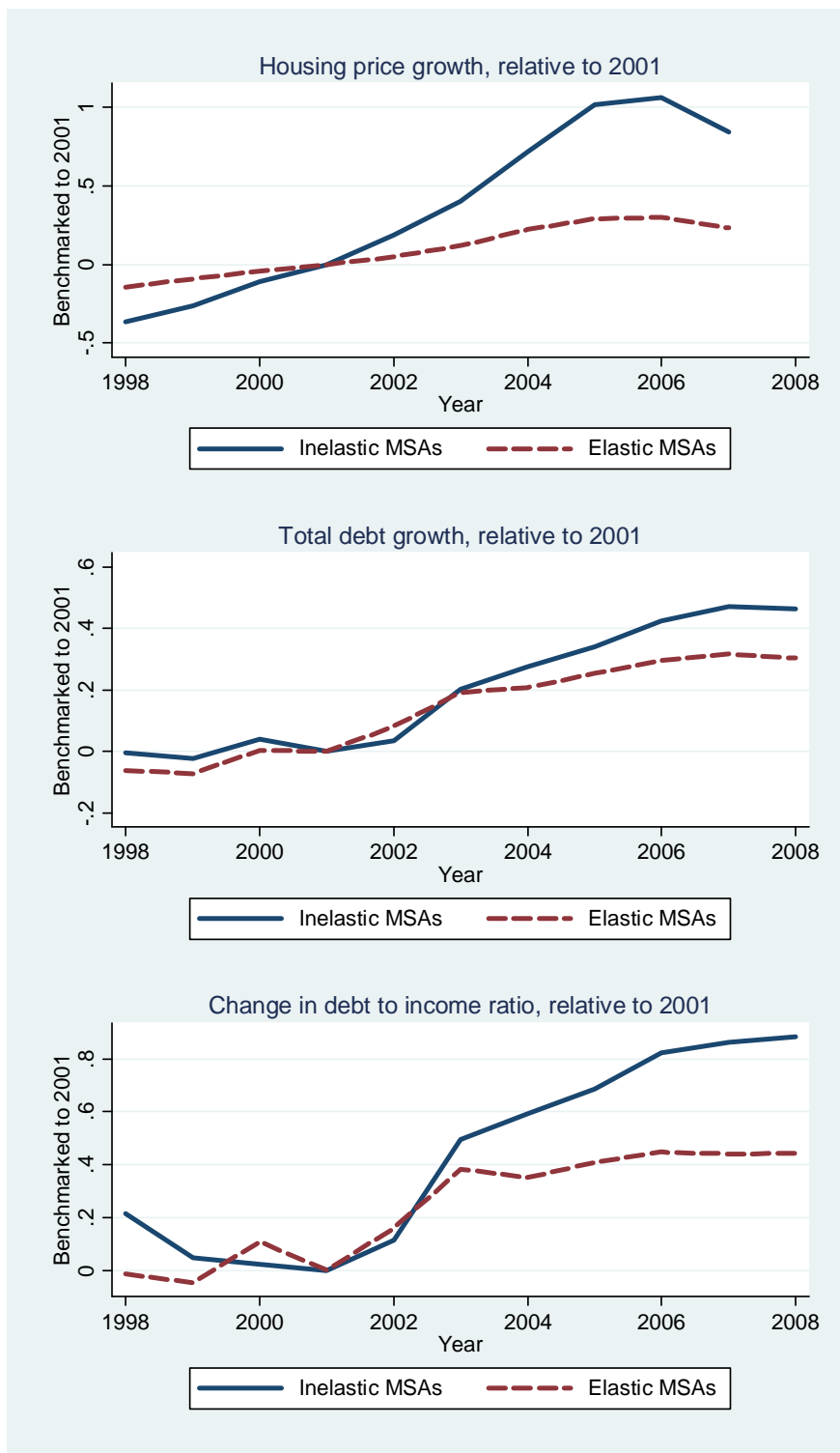


Figure 3

The Effect of House Prices on Total Debt Growth for 1997 Homeowners

This figure presents the effect of house price growth on total debt growth from 2002 to 2006 across the full distribution. The first stage instrument is the MSA-level housing supply elasticity from Saiz (2008). The sample includes individuals with mortgage debt outstanding as of 1997 who do not move zip codes between 1997 and 1999.

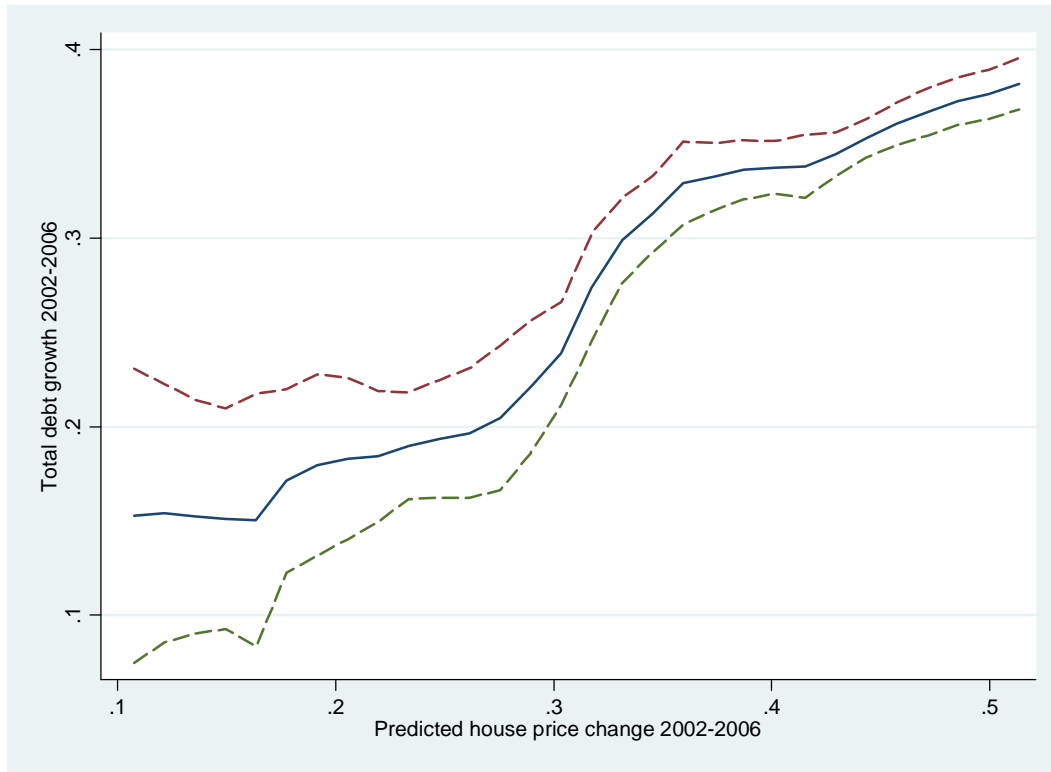


Figure 4
House Price and Leverage Patterns for Homeowners Living in High Subprime Share Zip Codes in Inelastic Housing Supply MSAs

This figure plots the coefficient estimates for β^l for the following specification for each year t :

$$y_{ict} - y_{ic,1998} = \delta^t * Subprime_{ic,1998} + \beta^t * Subprime_{ic,1998} * Inelastic_{c,1998} + \alpha_c + \varepsilon_{ict}$$

where y is the natural logarithm of house prices in the top graph, the natural logarithm of total debt in the middle graph, and the debt to income ratio in the bottom graph. The graphs show differential patterns for homeowners living in high subprime share zip codes in inelastic housing supply MSAs relative to both homeowners living in low subprime share zip codes in the same MSA and homeowners in high subprime share zip codes in elastic housing supply MSAs.

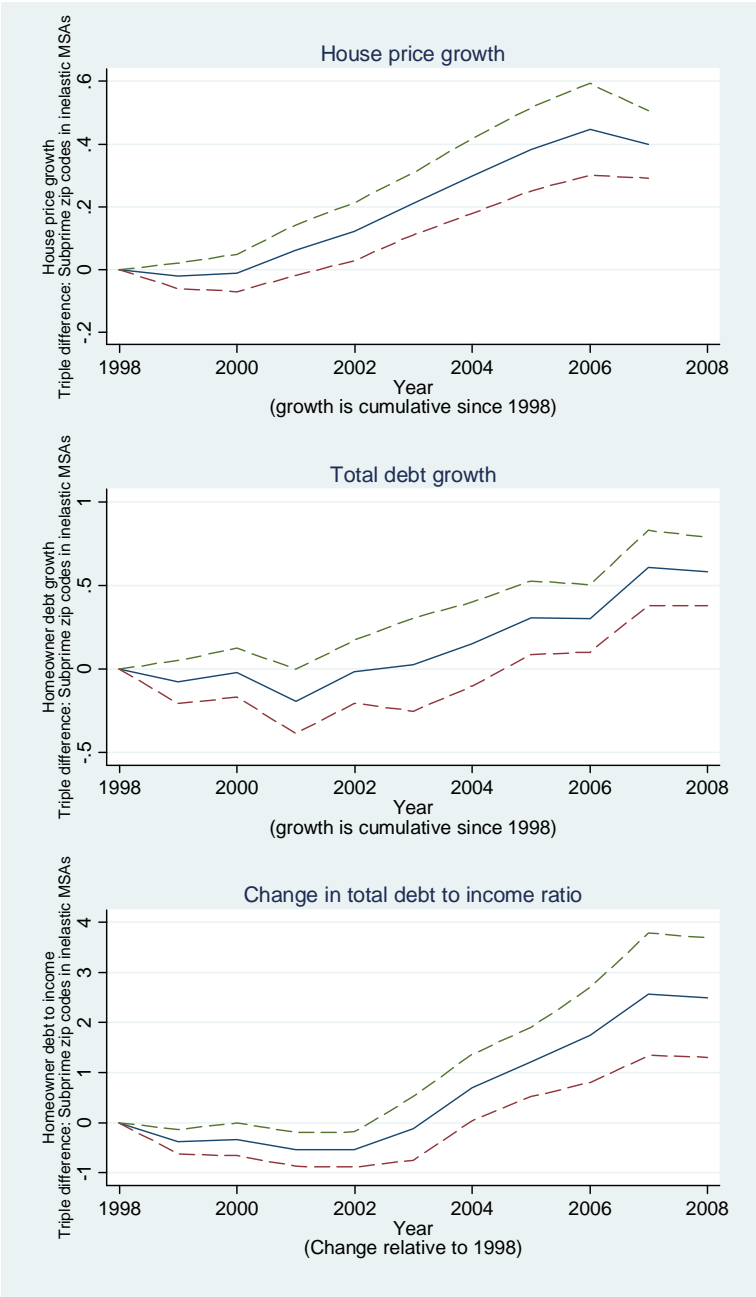


Figure 5 Cross-Sectional Heterogeneity in Leverage Patterns for 1997 Homeowners By Housing Supply Elasticity

This figure presents household leverage patterns for the highest and lowest quartile of housing supply elasticity MSAs, by the credit quality of borrowers as of 1997 (top two panels), the credit card utilization rate of borrowers as of 1997 (middle two panels), and the age of borrowers (bottom two panels). The sample includes individuals with mortgage debt outstanding as of 1997 or with a previous mortgage account.

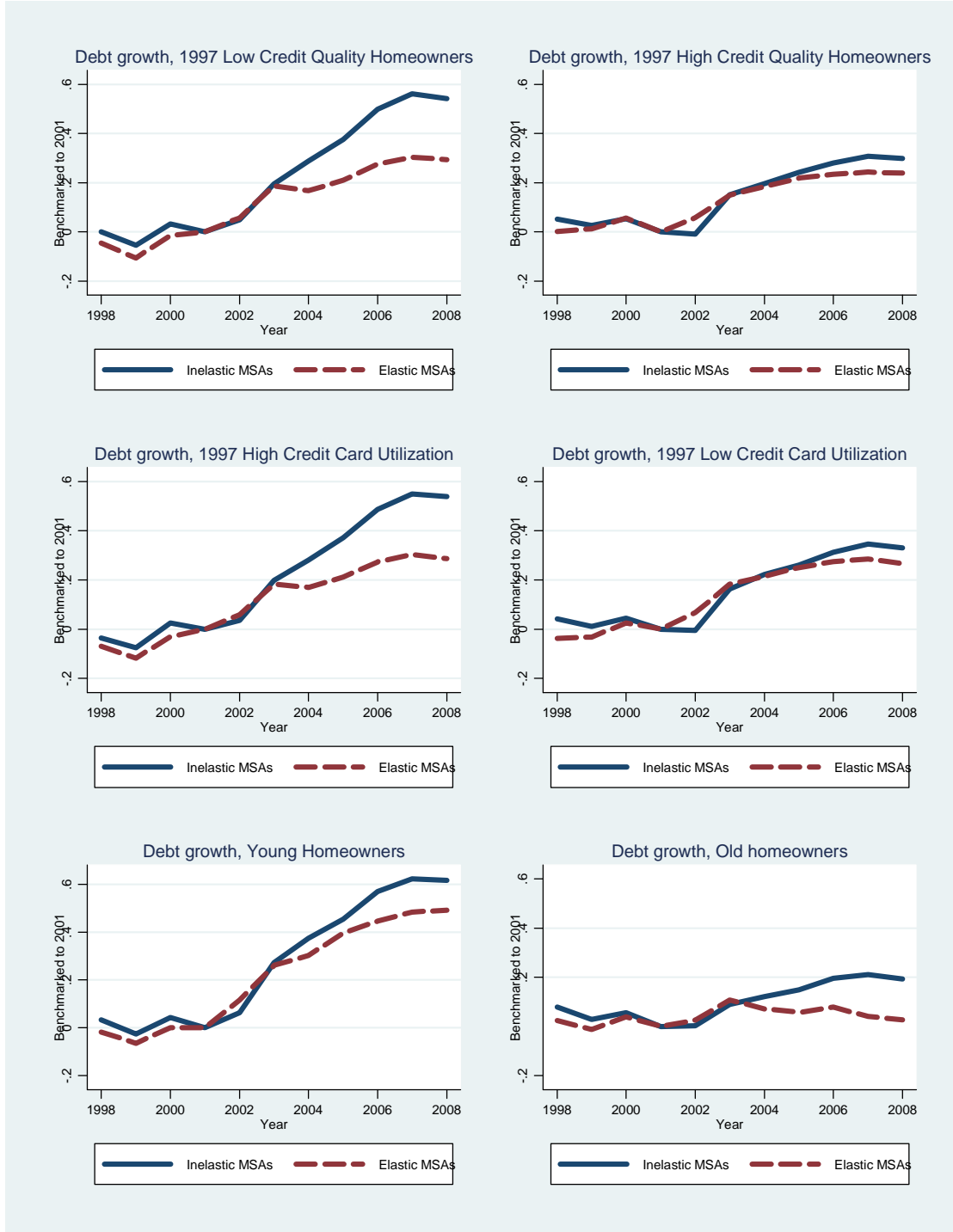
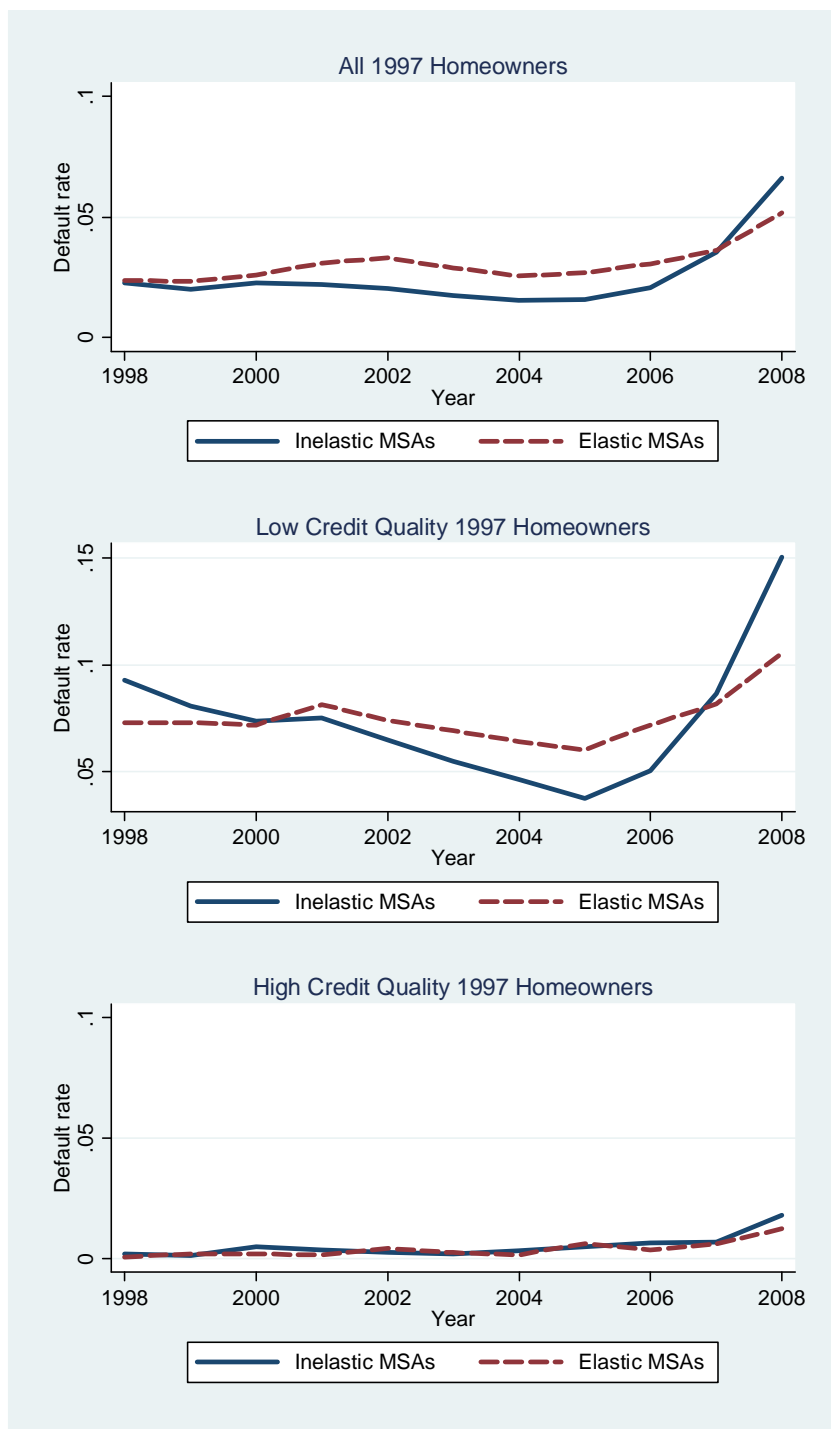


Figure 6

Default Patterns for Homeowners, By Housing Supply Elasticity and 1997 Credit Quality

This figure presents default patterns for the highest and lowest quartile of housing supply elasticity MSAs, by the credit quality of borrowers as of 1997. The top graph examines the full sample. The middle graph examines borrowers in the lowest quartile of the 1997 credit score distribution, and the bottom graph examines borrowers in the highest quartile of the 1997 credit score distribution. The sample includes individuals with mortgage debt outstanding as of 1997 or with a previous mortgage account.



Appendix Table I
Summary Statistics for Renters

This table presents summary statistics for individuals who have no current or previous mortgage debt outstanding. Individuals are sorted into groups of at least 5 individuals. Each group consists of individuals living in the same zip code as of 1997, and the individuals are sorted by 1997 credit score before groups are formed. The income in the denominator of the debt to income ratio comes from zip level IRS data. The zip code level median home value as of 2002 comes from the 2000 value reported in the decennial Census multiplied by the growth rate from 2000 to 2002 reported in the Fiserv Case Shiller Weiss data. The housing supply inelasticity measure we use is three – the Saiz (2008) measure. The Saiz (2008) measure is increasing in elasticity from 0 to 3. There are 3,016 zip codes and 83 MSAs that are represented in the sample.

	N	Mean	Median	St. Dev.
<i>Equifax individual level data</i>				
Total debt, 1997, \$thousands	28216	5.656	4.344	5.461
Home debt, 1997, \$thousands	28216	0.000	0.000	0.000
Growth in total debt, 1998-2002	28064	0.914	0.811	1.231
Growth in total debt, 2002-2006	27880	0.660	0.521	1.303
Growth in home debt, 1998-2002	28064	1.307	0.000	1.892
Growth in home debt, 2002-2006	27880	0.934	0.302	1.960
Total debt to income ratio, 1997	27357	0.165	0.122	0.163
Change in debt to income ratio, 1998-2002	27973	0.501	0.200	0.724
Change in debt to income ratio, 2002-2006	27862	0.798	0.260	1.320
Total debt default rate, 1997	28155	0.131	0.000	0.262
Change in default rate, 1998-2006	27210	-0.038	0.000	0.280
Change in default rate, 2006-2008	26853	0.044	0.000	0.266
Credit score, 1997	28216	709	709	103
Credit card utilization fraction, 1997	28181	0.459	0.424	0.341
Age, 1997	27935	54	50	14
Male	26758	0.479	0.500	0.341
Income, 1997, \$thousands	27773	59	54	31
<i>Fiserv Case Shiller Weiss zip level data</i>				
House price growth, zip level, 1998-2002	28094	0.428	0.457	0.143
House price growth, zip level, 2002-2006	28216	0.471	0.474	0.225
<i>Saiz (2008) MSA level elasticity measure</i>				
Housing supply inelasticity	28216	2.029	2.140	0.431
Median home value, 2002, \$thousands	28084	225	196	131
<i>IRS zip level income data</i>				
Per capita wage growth, 2002-2006	28197	0.116	0.111	0.060
<i>Census business statistics zip level data</i>				
Per capita payroll growth, 2002-2006	27429	0.119	0.118	0.119
Employment growth, 2002-2006	27429	0.065	0.053	0.190
<i>Equifax zip level aggregate data</i>				
Fraction of zip code with credit score under 659, 1997	28162	0.321	0.305	0.122

Appendix Table 2
Summary Statistics for Moving Homeowners

This table presents summary statistics for individuals who have either an existing mortgage account with positive balance as of 1997 or a previous mortgage account, and move zip codes between 1997 and 1999. Individuals are sorted into groups of at least 5 individuals. Each group consists of individuals living in the same zip code as of 1997, and the individuals are sorted by 1997 credit score before groups are formed. The income in the denominator of the debt to income ratio comes from zip level IRS data. The zip code level median home value as of 2002 comes from the 2000 value reported in the decennial Census multiplied by the growth rate from 2000 to 2002 reported in the Fiserv Case Shiller Weiss data. The housing supply inelasticity measure we use is three – the Saiz (2008) measure. The Saiz (2008) measure is increasing in elasticity from 0 to 3. There are 3,016 zip codes and 83 MSAs that are represented in the sample.

	N	Mean	Median	St. Dev.
<i>Equifax individual level data</i>				
Total debt, 1997, \$thousands	2929	122.707	116.928	79.612
Home debt, 1997, \$thousands	2929	107.385	101.489	77.429
Growth in total debt, 1998-2002	2929	0.155	0.142	0.592
Growth in total debt, 2002-2006	2929	0.415	0.405	0.622
Growth in home debt, 1998-2002	2929	0.153	0.130	0.824
Growth in home debt, 2002-2006	2929	0.473	0.446	0.830
Total debt to income ratio, 1997	2784	2.963	2.892	1.619
Change in debt to income ratio, 1998-2002	2855	0.169	0.073	1.057
Change in debt to income ratio, 2002-2006	2912	1.112	0.811	1.559
Total debt default rate, 1997	2929	0.052	0.000	0.114
Change in default rate, 1998-2006	2929	-0.012	0.000	0.131
Change in default rate, 2006-2008	2929	0.049	0.000	0.168
Credit score, 1997	2929	766	770	77
Credit card utilization fraction, 1997	2928	0.345	0.303	0.211
Age, 1997	2929	54	54	6
Male	2929	0.562	0.571	0.240
Income, 1997, \$thousands	2929	86	82	31
<i>Fiserv Case Shiller Weiss zip level data</i>				
House price growth, zip level, 1998-2002	2921	0.405	0.430	0.140
House price growth, zip level, 2002-2006	2929	0.478	0.492	0.221
<i>Saiz (2008) MSA level elasticity measure</i>				
Housing supply inelasticity	2929	1.995	2.080	0.429
Median home value, 2002, \$thousands	2816	235	203	134
<i>IRS zip level income data</i>				
Per capita wage growth, 2002-2006	2912	0.113	0.109	0.069
<i>Census business statistics zip level data</i>				
Per capita payroll growth, 2002-2006	2807	0.123	0.121	0.121
Employment growth, 2002-2006	2807	0.113	0.085	0.230
<i>Equifax zip level aggregate data</i>				
Fraction of zip code with credit score under 659, 1997	2869	0.309	0.294	0.127

Appendix Table 3
Sample MSAs and Inelasticity Scores

MSA name	Inelasticity	MSA name	Inelasticity
Los Angeles-Long Beach-Glendale, CA	2.43	Lakeland FL	1.97
Miami-Miami Beach-Kendall, FL	2.43	Detroit-Livonia-Dearborn, MI	1.96
Santa Rosa-Petaluma CA	2.41	Florida - Rest of State	1.94
San Francisco-San Mateo-Redwood City, CA	2.41	Vallejo-Fairfield CA	1.94
Nassau-Suffolk, NY	2.36	Jacksonville FL	1.94
Poughkeepsie-Newburgh-Middletown NY	2.36	Sacramento--Arden-Arcade--Roseville CA	1.94
New York-White Plains-Wayne, NY-NJ	2.36	Bethesda-Gaithersburg-Frederick, MD	1.93
Manchester-Nashua NH	2.35	Philadelphia, PA	1.9
Essex County, MA	2.35	Oxnard-Thousand Oaks-Ventura CA	1.885
Massachusetts - Rest of State	2.35	Santa Barbara-Santa Maria, CA	1.885
Cambridge-Newton-Framingham, MA	2.35	Port St. Lucie-Fort Pierce FL	1.85
Worcester MA	2.35	Orlando-Kissimmee, FL	1.85
Boston-Quincy, MA	2.35	Memphis TN-MS-AR	1.83
Springfield MA	2.35	Denver-Aurora CO	1.82
Rockingham County-Strafford County, NH	2.35	Minneapolis-St. Paul-Bloomington MN-WI	1.82
Oakland-Fremont-Hayward, CA	2.34	Hartford-West Hartford-East Hartford CT	1.81
San Diego-Carlsbad-San Marcos CA	2.32	Washington-Arlington-Alexandria, DC-VA-MD-WV	1.72
Fort Lauderdale-Pompano Beach-Deerfield Beach, FL	2.29	Phoenix-Mesa-Scottsdale AZ	1.71
Chicago-Naperville-Joliet, IL	2.27	Fresno CA	1.69
Salinas CA	2.25	San Luis Obispo-Paso Robles CA	1.66
San Jose-Sunnyvale-Santa Clara CA	2.25	Visalia-Porterville CA	1.66
Santa Cruz-Watsonville CA	2.25	Bakersfield CA	1.66
Atlantic City NJ	2.22	Warren-Farmington Hills-Troy, MI	1.63
Seattle-Bellevue-Everett, WA	2.22	Durham NC	1.5
Camden, NJ	2.22	Raleigh-Cary NC	1.5
New Jersey - Rest of State	2.22	Stockton CA	1.47
Edison, NJ	2.22	Modesto CA	1.47
Trenton-Ewing NJ	2.22	Merced CA	1.47
Baltimore-Towson MD	2.14	Ann Arbor MI	1.3
New Haven-Milford CT	2.14	Las Vegas-Paradise NV	1.18
Santa Ana-Anaheim-Irvine, CA	2.08	Columbus OH	1.12
Newark-Union, NJ-PA	2.08	Akron OH	1.1
California - Rest of State	2.08	Toledo OH	1.07
Riverside-San Bernardino-Ontario CA	2.08	Ohio - Rest of State	1.07
Providence-New Bedford-Fall River RI-MA	2.03	Atlanta-Sandy Springs-Marietta GA	1.06
West Palm Beach-Boca Raton-Boynton Beach, FL	2.01	Canton-Massillon OH	0.88
Portland-Vancouver-Beaverton OR-WA	1.99	Youngstown-Warren-Boardman OH-PA	0.88
Norwich-New London CT	1.975	Cincinnati-Middletown OH-KY-IN	0.85
Bridgeport-Stamford-Norwalk CT	1.975	Greensboro-High Point NC	0.61
Connecticut - Rest of State	1.975	Charlotte-Gastonia-Concord NC-SC	0.41
Tampa-St. Petersburg-Clearwater FL	1.97	Dayton OH	0.09
Sarasota-Bradenton-Venice FL	1.97		