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Cross-Sectional Patterns of Mortgage Debt during the Housing Boom: Evidence and Implications

Christopher L. Foote, Lara Loewenstein, and Paul S. Willen

Abstract:

The reallocation of mortgage debt to low-income or marginally qualified borrowers plays a central role in many explanations of the early 2000s housing boom. We show that such a reallocation never occurred, as the distribution of mortgage debt with respect to income changed little even as the aggregate stock of debt grew rapidly. Moreover, because mortgage debt varies positively with income in the cross section, equal percentage increases in debt among high- and low-income borrowers meant that wealthy borrowers accounted for most new debt in dollar terms. Previous research stressing the importance of low-income borrowing was based on the *inflow* of new mortgage originations alone, so it could not detect offsetting *outflows* in mortgage terminations that left the allocation of debt stable over time. And while defaults on subprime mortgages played an important part in the financial crisis, the data show that subprime lending did not cause a reallocation of debt toward the poor. Rather, subprime lending prevented a reallocation of debt toward the wealthy.

JEL Classifications: D12, D14, E03, G21, R21

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This paper, which may be revised, is available on the web site of the Federal Reserve Bank of Boston at <http://www.bostonfed.org/economic/wp/index.htm>.

The views expressed in this paper are those of the authors and are not necessarily those of the Federal Reserve Bank of Boston or the Federal Reserve System.

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1 Introduction

The early 2000s saw a large expansion of mortgage debt in the United States. The Federal Reserve’s Flow of Funds accounts show that the aggregate stock of mortgage debt on the liability side of household balance sheets doubled from \$5.3 trillion in 2001 to \$10.6 trillion in 2007. During this period, mortgage debt grew much faster than income did, so there was a substantial increase in the debt-to-income ratio, as seen in the top panel of Figure 1. In this paper, we study this mortgage boom with particular attention to how this debt was allocated with respect to income. Our findings contradict conventional theories that the mortgage boom was driven by disproportionate borrowing at the lower end of the income distribution.¹

The most important finding of the paper is that there was no reallocation of mortgage debt toward low-income individuals during the mortgage boom. To be sure, low-income borrowing grew rapidly, with much of this new debt packaged into the subprime mortgage-backed securities that caused so many problems during the 2008 financial crisis. Yet borrowing by high-income individuals rose at similar rates, so the distribution of debt with respect to income remained stable over time. This stability emerges clearly in a number of datasets, including the Federal Reserve’s Survey of Consumer Finances (SCF), a periodic and comprehensive study of U.S. household balance sheets. The top left panel of Figure 2 depicts the shares of total outstanding mortgage debt held by households in various quantiles of wage income in the 2001 and 2007 waves of the SCF. No quantile significantly increases its share of debt in the early 2000s as aggregate debt rises. The middle left panel of Figure 2 focuses on the debt-income relationship more closely, by presenting a binned scatter plot of log mortgage debt against log wage income in 2001 and 2007. There is an approximately log-linear relationship between income and debt that shifts upward nearly equally across the income distribution, indicating that debt rose by similar percentages for low-income and high-income households alike. The top right and middle right panels in Figure 2 show similar results from a separate dataset that combines zip code-level mortgage debt data from the Equifax credit bureau with similarly aggregated income data from the Internal Revenue Service (IRS). The Equifax/IRS dataset is much larger than the SCF; there are around 40,000 zip codes in the country, while the SCF covers only about 3,000–6,000 households every three years. Despite these differences, the zip code-level dataset confirms the SCF’s bottom line: the debt distribution changed little during the mortgage boom because the debt-income

¹Amromin and McGranahan (2015) write that a “voluminous” literature on early 2000s credit markets, including mortgage markets, has noted that this period “was characterized by the liberalization of credit access to households that had previously found it difficult to qualify because of poor credit records, insufficient income, or both. The liberalization of credit access has largely been ascribed to financial innovation through securitization markets that allowed loan originators to offload credit risk to a broad set of private investors” (p. 147).

relationship shifted up nearly equally across the income distribution.² Mathematically, the combination of a stable debt distribution and a positive cross-sectional relationship between debt and income implies that, in dollar terms, most new mortgage debt went to the wealthy. This fact is illustrated in the bottom two panels of Figure 2. The Equifax/IRS panel at right shows that borrowers in the highest-income zip codes accounted for about \$1.5 trillion in new debt from 2001 to 2006, while mortgage debt for the lowest-income quintile rose by only \$320 billion.³

The stability of the debt distribution may seem surprising, because many commentators have assumed that the early 2000s featured a significant credit expansion along the *extensive margin*, with large numbers of marginal or low-income individuals able to qualify for mortgages and become homeowners for the first time. A look back at Figure 1, however, shows why the extensive-margin hypothesis has problems explaining the behavior of mortgage debt in the early 2000s. The lower panel of this figure depicts the U.S. homeownership rate, and a comparison of that panel with the debt-to-income ratio above it shows that the mortgage boom followed an increase in homeownership that originated in the mid-1990s.⁴ But the lower panel also shows that the homeownership rate ended the 2001–2007 mortgage boom about where it began. To study the extensive margin of debt more closely, we use the SCF and Equifax/IRS datasets as well as individual-level credit records in the Equifax data, which lack income information but include a type of credit score. Overall, there is no evidence of a relative expansion of mortgage borrowing among low-income or marginal borrowers during the boom, particularly after conditioning on age. In fact, income becomes a more-important, not less-important, correlate of homeownership after the mortgage boom begins, especially for young households. And, consistent with Bhutta (2015), the individual-level Equifax credit records show that transitions into first-time mortgage borrowing became less frequent for persons with low credit scores during the mortgage boom, as part of a general decline in first-time home buying. Of course, many lenders relaxed their credit standards during the boom. But the data suggest that the effect of this relaxation on the extensive margin of

²In the main text, we explain how the zip code-level dataset was constructed and why a peculiarity of IRS income-data collection in 2007 causes us to date the mortgage boom as ending in 2006 rather than 2007 when using the Equifax/IRS dataset. As discussed in the internet appendix, all of the zip code-level results remain robust to using 2007 as the last year of the mortgage boom instead. We will also show that the slight tilt of mortgage debt toward richer borrowers in the scatter plot that uses the Equifax/IRS data arises from shifts in debt between city-level housing markets, not within these markets.

³In the internet appendix, we replicate the bar charts in Figure 2 that use SCF data with 20 rather than five income categories. The same lessons hold at the higher level of disaggregation, as debt shares are generally stable so that the rich take out the most debt in dollar terms. The appendix also relates our findings to those of Kumhof, Ranci  re, and Winant (2015), who study total debt (as opposed to mortgage debt) for the top 5 percent and bottom 95 percent of SCF households from 1983 onward.

⁴See the internet appendix for an alternative measure of homeownership: the total number of owner-occupied housing units divided by the total number of adults. Movements in this alternative measure are similar to movements in the standard homeownership measure.

debt was offset by the rapid increase in house prices, which made first-time buying difficult.

Throughout this paper we highlight the distinction between the stocks of debt on household balance sheets and the two gross flows of debt, originations and terminations. This distinction is sometimes unclear in existing research. For example, Mian and Sufi (2009) use data generated by the Home Mortgage Disclosure Act (HMDA) to argue that the allocation of mortgage credit changed fundamentally during the mortgage boom, in ways that channelled credit disproportionately to marginal or low-income borrowers. HMDA is a nearly comprehensive source of data on mortgage applications and originations, and for many topics related to the allocation of credit, such as the possibility of racial discrimination, a sole focus on originations is appropriate.⁵ But many times, the origination of a new mortgage (for example, the mortgage of a home buyer) is offset by the termination of another mortgage (for example, the mortgage of a seller). Because HMDA does not cover terminations, HMDA data alone cannot be used to study the distribution of mortgage debt.

The stability of the cross-sectional distribution of debt supports an emerging “new narrative” on the housing cycle, which disputes the common claim that the cycle was driven primarily by an exogenous relaxation of credit constraints. In theory, relaxed constraints might raise effective demand and prices among low-priced homes, which could in turn spill over to higher-price segments of the market (Landvoigt, Piazzesi, and Schneider 2015). But it is hard to see how anything that raised mortgage debt among low-income borrowers by \$320 billion could have generated spillovers large enough to encourage \$1.5 trillion in new borrowing by the wealthy. By providing precise measures of debt stocks as well as flows, we build on Adelino, Schoar, and Severino (2016), the first paper to directly challenge the findings in Mian and Sufi (2009) regarding the allocation of debt. Adelino, Schoar, and Severino (2016) use HMDA data to show that the Mian-Sufi findings were driven by relatively high growth in the number of purchase mortgages originated in low-income zip codes, not by higher dollar values of mortgages. To the authors, this finding indicated that the original Mian-Sufi findings reflected only higher transaction volumes in low-income areas, not a reallocation of mortgage debt toward low-income borrowers. Yet without zip code-level data on mortgage terminations, stocks of mortgage debt, or numbers of mortgage borrowers, it is impossible to rule out the hypothesis that the higher transaction volumes in low-income zip codes resulted in more low-income homeowners—an extensive-margin expansion of credit that is consistent with the conventional theory. An analysis of both stocks and flows at different levels of geographic detail settles this question by ruling out an expansion of mortgage credit along the extensive margin. A disaggregated analysis of debt stocks also shows that even though subprime lending was disproportionately concentrated in low-income areas,

⁵The Boston Fed’s study of racial discrimination (Munnell et al. 1996) was based on HMDA data supplemented with additional information from lenders.

the overall amount of subprime debt remained relatively small, despite a rapid ramp-up of subprime originations during the last half of the boom.⁶

In the conclusion, we discuss how these empirical results might inform theoretical models. As pointed out by Foote, Gerardi, and Willen (2012), Glaeser, Gottlieb, and Gyourko (2013), and others, several empirical facts point to higher house-price expectations as a key driver of the housing cycle. The stability of cross-sectional distribution of mortgage debt with respect to income is consistent with the expectations theory as well. While capturing “bubble psychology” in a formal model is difficult, many models are now shedding light on the possible origins of such psychology, as well as the effect that bubbles could have on both the housing market and the wider economy.

2 Cross-Sectional Data on Debt Stocks and Income

2.1 Debt and Income Data from Equifax and the IRS

The zip code-level measures of mortgage debt used in this paper come from the Federal Reserve Bank of New York’s Consumer Credit Panel, a quarterly, longitudinal 5 percent sample of individual credit histories supplied by the Equifax credit bureau. The dataset begins in 1999, and because individual-level credit histories are included in the sample based on the last two digits of the individual’s social security number, the dataset can be updated to incorporate new entrants over time.⁷ Among other debt variables, the Equifax data contain detailed information on mortgage debt. Included are the amounts and dates associated with the origination of new loans, as well as outstanding balances for first mortgages, subordinate mortgages, and home equity lines of credit (HELOCs). We can also measure the number and value of mortgage terminations. A termination is defined as occurring in the last quarter that a mortgage appears in the data, and the value of that termination is defined as the remaining balance when the loan is removed.

A unique characteristic of credit-bureau data is its ability to paint a comprehensive picture of both stocks and flows of mortgage debt. The net change in the stock of mortgage debt is simply gross inflows less gross outflows:

⁶In addition to Adelino, Schoar, and Severino (2016) and Bhutta (2015), other papers in the new-narrative literature include Albanesi, DeGiorgi, and Nosal (2016), which examines debt and credit scores, rather than debt and income, and Ferreira and Gyourko (2015). The latter paper shows that most foreclosures took place among prime borrowers, not subprime borrowers, with the implication that the foreclosure crisis “was largely one of sound borrowers falling into negative equity because of very large declines in house prices” (p. 21).

⁷As discussed above, we aggregate the Equifax records by zip code in order to match them with available income data from the IRS. When we do so, we multiply the aggregated debt data by 20, because the data come from a 5 percent sample of individuals.

Net Change in Stock of Mortgage Debt =

$$\begin{aligned}
 &+ \text{Gross Inflows} \left\{ \begin{array}{l} \textbf{Purchase mortgages and other originations}, \text{ where} \\ \text{other originations include interest-rate and cash-out re-} \\ \text{finances, home equity loans, and HELOCs. The latter} \\ \text{type of mortgage is included only if it is originated with} \\ \text{a positive balance.} \\ \textbf{Increases in existing balances}, \text{ which refer mainly to} \\ \text{increases in HELOC balances.} \end{array} \right. \\
 &- \text{Gross Outflows} \left\{ \begin{array}{l} \textbf{Sales and other terminations}, \text{ which include mort-} \\ \text{gages that have been refinanced.} \\ \textbf{Decreases in existing balances}, \text{ which account for} \\ \text{standard amortization and existing repayments.} \end{array} \right.
 \end{aligned}$$

Other common data sources are exclusively focused on inflows, and specifically on originations. The HMDA data used in previous research follow a law passed in 1975 that requires certain financial institutions to report individual-level data relating to mortgage applications and originations, including the dollar amount of each new mortgage and the census tract of the house backing the loan. As far as originations go, HMDA is quite comprehensive, but, as noted earlier, HMDA data cannot be used to measure mortgage terminations or debt stocks.⁸ Data from public registries of deeds suffer from a similar limitation, in that they provide good coverage of originations but problematic coverage of terminations.⁹

In addition to information on mortgage debt, the Equifax dataset contains a small number of borrower-level characteristics, such as age and an end-of-quarter credit score called the Equifax Risk Score. This score, created by Equifax, resembles a FICO score, in that a higher value indicates a lower probability of default over the near term. We have found the mode of the credit-score distribution moves to the right somewhat over time, but this movement is

⁸HMDA's coverage of originations is very good but still incomplete. Only mortgage companies and depository institutions with offices in metropolitan areas are required to report, and the reporting of home equity lines of credit (HELOCs) is optional. There is also limited information about the individuals applying for mortgages (only race, income, and gender), and, as we note below, some researchers have questioned the accuracy of the borrower-level income data reported on HMDA forms (Mian and Sufi 2016a).

⁹The dataset in Ferreira and Gyourko (2015) is based on public-records data supplied by the DataQuick company. The lack of precise information on mortgage terminations in that dataset makes it hard for the authors to know whether a new, non-purchase mortgage represents the refinance of an existing loan or a new mortgage that adds to the homeowner's existing stock of debt. The authors assume that a new non-purchase mortgage is a refinance if its value is more than half of either the imputed current price of the home or of the total mortgage balance taken out when the home was purchased.

not very worrisome because it does not become severe until 2010, after the mortgage boom ends. Also, we only use the Equifax score to distinguish the creditworthiness of individuals within a given year, not to measure changes in individual-level creditworthiness over time.

Loan-level datasets generated by mortgage securitizers or mortgage servicers also provide information on originations and terminations, but neither type of dataset is comprehensive. The CoreLogic Private Label Securities ABS Database provides loan-level data only for mortgages that have been packaged into non-agency securities (that is, securities that are not backed by any of the government-sponsored enterprises such as Fannie Mae, Freddie Mac, and Ginnie Mae). For this specific group of mortgages, which includes the large majority of subprime loans, the coverage of the CoreLogic dataset is excellent, as it contains an expansive set of variables for loans in almost all non-agency securities issued since 1992. Yet the CoreLogic dataset cannot measure aggregate debt stocks, because (as discussed below) subprime and other types of non-agency loans made up a small share of the mortgage market throughout the early 2000s.¹⁰ CoreLogic data can be used to measure cross-sectional patterns in the use of securitized subprime and Alt-A debt, however, and we do so below.¹¹ The loan-level dataset from McDash Analytics has broader coverage, because it is based on data supplied by mortgage servicers (typically banks) and therefore includes agency and portfolio loans as well as non-agency loans. Unfortunately, the collection of servicers in McDash is not considered representative of the entire mortgage market until at least 2005.

A disadvantage of the Equifax dataset is that it contains no information on income. We therefore follow previous research and construct aggregates of debt at the zip-code level, and then merge the debt aggregates with zip code-level data on income from the IRS. Zip code-level information is available on a host of income variables, including adjusted gross income (AGI) and salary and wage income, for the years 1998, 2001, 2002, and 2004–2012.¹² In addition to the income variables, we also use the number of returns and the number of exemptions in the IRS dataset to measure zip code-level households and population, respectively.

The IRS income data are comprehensive, because they are based on the universe of tax returns, but they are still imperfect. For one thing, the IRS uses suppression rules to ensure that no individual information can be backed out of the published zip code-level data, and these suppression rules change from year to year. An additional source of potential measurement error arises from yearly changes in the share of earners who file tax returns.

¹⁰The CoreLogic database was originally called the LoanPerformance database after the company that developed it.

¹¹Alt-A loans were loans to prime borrowers that did not qualify for standard prime pools, typically because of reduced documentation. The name is derived from the fact that lenders referred to prime borrowers as “A” borrowers, as opposed to the “B” and “C” borrowers who were considered subprime.

¹²The IRS income data come from the Statistics of Income Program. See <http://www.irs.gov/uac/SOI-Tax-Stats-Individual-Income-Tax-Statistics-zip-Code-Data-%28SOI%29> for details.

The number of filers rose sharply in 2007, as people were encouraged to file returns in order to receive economic-stimulus payments, as seen in Figure 3. In the internet appendix, we show that the additional filers have little effect on income aggregates, implying that these filers reported low (or zero) incomes. However, by distorting our measure of the number of households in each zip code, the 2007 spike in returns could potentially distort some results if the mortgage boom is defined as ending in 2007. Consequently, when using the zip code-level data, we choose 2006 as the ending year of the boom instead. Fortunately, robustness checks presented in the internet appendix indicate that the distortion induced by the extra filers in 2007 is not severe, as our zip code-level results hold even with 2007 chosen as the boom’s last year. Another measurement issue related to the IRS data is what type of income to use. In the empirical work below, income is defined as salary and wage income, which is likely to be the most important type of income considered by lenders when underwriting mortgage loans. A type of income that lenders are *not* likely to consider is capital gains, which is included in AGI. Here again, measurement issues are not a great concern. The internet appendix shows that our main results are robust to defining income either as salary and wages or as AGI.

Table 1 presents summary statistics for the zip code-level Equifax/IRS dataset. The values are medians within each IRS return-weighted income quintile at the beginning and end of the mortgage boom: 2001 and 2006. The quintiles are constructed to have similar numbers of tax returns, so the negative correlation between zip code-level population and income means that low-income quintiles tend to include more zip codes than high-income quintiles. As expected, median mortgage-debt levels and house values are positively correlated with income, as are credit scores. Because credit scores are well known to rise with age, one potential explanation for the latter correlation is that richer zip codes tend to include older residents. Yet the table also shows that median age varies little across income quintiles. Two other facts relate directly to changes in the cross-sectional distribution of debt. First, the amount of total mortgage debt grew significantly for all income groups; from \$51,000 to \$73,000 per return in the lowest-income quintile of zip codes, and from \$130,000 to \$215,000 in the highest-income quintile. Second, the proportion of mortgaged households grew only modestly across the income distribution; from 27 to 32 percent for the poorest zip codes and from 51 to 58 percent for the richest. Ideally, the Equifax data would tell us whether individuals owned homes, but we only know whether individuals hold mortgage debt. Homeownership information is available in the SCF, to which we turn next.

2.2 Household-Level Data from the Survey of Consumer Finances

The large Equifax/IRS dataset allows a detailed look at cross-sectional debt patterns both within and across housing markets, but its limited demographic and housing-tenure infor-

mation, as well as its zip code-level nature, suggests the need for additional data.¹³ We generate a number of results using individual-level data from the SCF, a triennial survey of households conducted by the Federal Reserve. Sample sizes in the SCF range from just over 3,000 households in 1989 to more than 6,000 by 2010, so the SCF is too small to use when examining mortgage debt within housing markets. Yet what the SCF lacks in size it makes up for in quality, as it provides a complete characterization of household-level balance sheets, including data on various types of mortgage debt. As a result, the SCF is considered to be the best source of individual-level data on housing-related debt and wealth in the United States.¹⁴ The SCF includes separate information on debt secured by the household’s primary residence as well as data on any other real estate debt. We always combine these two measures. Like the total debt measure in the Equifax data, the SCF debt measure encompasses first mortgages, subordinate mortgages, and HELOCs. As for income, information is available on both total income (comparable to AGI) and wage and salary income. The SCF also includes a host of demographic variables, including the age, marital status, and race of the household head. We use the summary datasets that pull together key SCF variables from 1989 through 2013, which are made available to the public by the Federal Reserve’s Board of Governors.¹⁵ The internet appendix shows that both the SCF and Equifax measures of mortgage debt correlate well with the Flow of Funds measure of debt, and that our aggregates of SCF and Equifax debt match aggregates constructed from the same datasets by other researchers.

Summary statistics for SCF data in 2001 and 2007 appear in Table 2.¹⁶ The table

¹³Because the Equifax/IRS dataset is defined at the zip-code level, its results could be influenced by the migration of households across zip-code boundaries.

¹⁴In their study of wealth concentration, Saez and Zucman (2016) use a sample of anonymized individual-level tax returns, the Tax Model Files, to back out wealth estimates based on income flows and itemized deductions. Individual-level housing assets are inferred by capitalizing property tax payments in a way that is consistent with national aggregates. Mortgage debt is netted out of housing wealth by capitalizing mortgage-interest deductions in a similar way. While the Tax Model Files are a good source of housing wealth and debt for tax filers at the top of the income distribution—the focus of the Saez-Zucman study—the authors note that the tax-capitalization method is probably less accurate for less-wealthy filers, in part because these filers itemize their deductions less often. “The SCF is essential for accurately measuring housing and pension wealth, the main forms of wealth for the bottom 90 percent, and indeed our own estimates for housing and pension wealth rely on it,” the authors write. “The value added of our estimates [based on the Tax Model Files] relative to the SCF is that they cover a longer period, are annual, and are more suited to capture the very top, if only because they include the 400 richest Americans” (p. 569, insertion added). See the internet appendix for more discussion of the Tax Model Files as a potential data source.

¹⁵Variables included in the summary datasets are those used in the regular analyses of SCF data published in the *Federal Reserve Bulletin*. See Bricker et al. (2014) for the most recent *Bulletin* article, and <http://www.federalreserve.gov/econresdata/scf/scfindex.htm> to download either the raw SCF data or the summary data files.

¹⁶The SCF contains five copies, or “implicates,” of the data for each household, with missing or confidential data imputed differently across each implicate. Users of the SCF are instructed to perform statistical tests on each implicate separately, using sample weights, and then combine the resulting parameter estimates and variance-covariance matrices using the Repeated-Imputation Inference (RII) of Rubin (1987). The summary

makes it clear that the mortgage debt variable in the SCF is a comprehensive measure, including debt on properties other than the primary residence as well as HELOCs. The top panel uses data from all households and defines income as total income. The lower panel defines income as salary and wages and excludes households with zero values of that variable. As noted in the introduction, similar growth rates of mortgage debt across the income distribution generate much larger dollar increases in debt for high-income quintiles. For example, Panel A indicates that the average household in the lowest-income quintile of total income saw its mortgage debt increase from \$5,294 in 2001 to \$10,795 in 2007. The comparable increase for a household in the highest-income group was from \$122,314 to \$219,228. The table also includes information on both the share of mortgaged households in each quintile and homeownership rates. Both of these statistics are stable or rise only modestly across all income groups.¹⁷ Finally, the last two columns present information on the asset side of household balance sheets, specifically (self-reported) housing values, which rose rapidly during the boom.

3 Income and the Distribution of Mortgage Debt

3.1 Unconditional Distributions of Debt

Before we study the conditional relationship between mortgage debt and income, we first examine unconditional distributions of debt at both the household and zip-code levels. The top left panel of Figure 4 depicts household-level kernel distributions of the log of mortgage debt in 1995, 2001, and 2007 from the SCF. Over time, this distribution moves to the right as aggregate mortgage debt rises. The shape of the debt distribution also changes, narrowing from 1995 to 2001. A narrowing of the unconditional debt distribution indicates that low-debt households on the left side of the 1995 distribution experienced relatively greater increases in debt through 2001. After that, however, the distribution appears to flatten out, suggesting that from 2001 to 2007, households with high amounts of debt saw greater debt growth. An analysis of distributional statistics, such as standard deviation and interquartile range, confirms that the SCF debt distribution narrowed throughout the 1990s. These statistics remain relatively constant in the 2000s, however, implying that the boom-era widening near the mode of the distribution was offset by movements in dispersion

statistics in Table 2 are simple averages of the five within-implicate weighted averages.

¹⁷The second column of figures in the table shows the number of unweighted SCF observations for each quintile. When these observations are weighted, they generate equal numbers of households in each quintile. The number of unweighted observations is largest for the richest quintile, to allow the SCF to accurately characterize the long right tail of the wealth distribution (Kennickell 2007). The number of unweighted observations is not an integer because each SCF household is represented by five implicates, and the income fields often differ slightly across implicates for a given household.

near the tails.¹⁸

The remaining panels of Figure 4 depict returns-weighted zip code-level kernel distributions of log mortgage debt per return from Equifax. These data are not available for 1995, so the panels include distributions only at the start and end of the mortgage boom (2001 and 2006). Interestingly, in the early 2000s the movement in the aggregate debt distribution was qualitatively similar to the movement in the SCF distribution over the corresponding period (note the difference in horizontal scales, however). More importantly, the zip code-level distribution also appears to have widened, and here the behavior of the standard deviation confirms this formally, as it rises from 0.41 in 2001 to 0.48 in 2006.

The bottom two panels exploit the rich geographic dimension of the Equifax/IRS dataset to ask whether this widening stemmed from between-city or within-city movements in debt. As noted in previous research, looking within individual housing markets holds constant any factors that affect the market as a whole. In this paper, housing markets are defined as cities, more specifically as Core Based Statistical Areas (CBSAs).¹⁹ By construction, both of the within-CBSA distributions depicted in the lower left panel are centered at zero, because they are distributions of debt relative to CBSA means. The stable shape of the distributions indicates that increased dispersion in total debt from 2001 to 2006 arose from the increase in the dispersion between cities, as confirmed in the lower right panel.²⁰

Taken together, the Equifax distributions indicate that mortgage debt levels for zip codes in the same city moved together. Some cities boomed and experienced high debt growth, while other cities experienced less growth. But within each local market, debt grew at similar rates in high- and low-debt areas. This finding is inconsistent with the claim that the housing boom reallocated debt to areas with previously low levels of debt, as this type of reallocation would have narrowed the within-CBSA debt distributions over time.

A related claim is that the boom reallocated debt toward low-*income* communities. Yet if these low-income communities were also low-debt communities, then the same critique applies: there should have been a narrowing of the debt distribution in the early 2000s. However, we must be careful about using the *unconditional* distributions in Figure 4 for statements about the allocation of debt *conditional* on income. The unconditional distri-

¹⁸See the internet appendix for details. Note that households with zero levels of mortgage debt are not included in the SCF distribution of Figure 4, but these households are included in both the bar charts and binned scatter plots of Figure 2 and the debt-income analysis in the next section.

¹⁹The government defines CBSAs as groups of counties or county equivalents that are integrated around an urban core with at least 10,000 residents. Those based on urban cores with between 10,000 and 50,000 people are called micropolitan statistical areas, and CBSAs based on larger urban cores are called metropolitan statistical areas. In 2003, the CBSA classification system replaced the government's previous urban classification system, which was based on metropolitan statistical areas alone.

²⁰Formally, the between variation in the Equifax debt density rises from 0.18 in 2001 to 0.24 in 2006. The within-CBSA variation rises from 0.23 to 0.24. Note that within and between variation sum to total variation in the two years (0.41 and 0.48).

butions will be affected by changes in the debt-income relationship, but these distributions are formally determined by the way that the debt-income relationship interacts with the distribution of income across communities.²¹ The same point applies to the introductory bar charts in Figure 2. The stability of those debt distributions does not rule out a shift in the relationship between income and debt, because those distributions are also affected by shifts in the distribution of income. As a result, in order to learn about the debt-income relationship, we have to estimate this conditional relationship directly. We did so nonparametrically with the binned scatter plots that also appeared in Figure 2. We do so parametrically by regressing debt on income in the next subsection.

3.2 Debt and Income: Regression Estimates

We first specify a *conditional expectation function* for debt and income. A potential parametric form for this function is

$$E(d_{cit}|y_{cit}) = \alpha_t + \beta_t \cdot y_{cit}, \quad (1)$$

which assigns a debt stock d to unit i in housing market c in year t as a function of income y . Here, unit i could refer either to a zip code (in the Equifax/IRS data) or to a household (in the SCF). For households, the relationship between mortgage debt and income is also dependent on demographic factors including age, in part because older households have had time to amortize a larger fraction of their mortgages. Therefore, when we analyze debt at the household level we always condition on age, as well as other demographic factors discussed below. The parameters of the function, α and β , have time subscripts to allow them to change over time.

Although it is simple, the conditional expectation function easily formalizes various theories about the mortgage boom. The standard view is that credit flowed disproportionately to borrowers with low incomes. As seen in Figure 2, the cross-sectional relationship between debt and income is positive (that is, richer borrowers have more debt), so a reallocation of debt toward low-income borrowers would reduce this correlation over time ($0 < \beta_{2006} < \beta_{2001}$). An alternative theory suggested by the changes in debt across years in Figure 2 is that debt rose by equal percentage amounts across the income distribution. If income were specified in natural logs, then we would expect the intercept α_t to rise over time, with no change in the cross-sectional relationship between debt and income ($\beta_{2006} = \beta_{2001}$).

²¹To see this, note that $f_1(d) = \int_0^\infty f(d|y)g(y)dy$, where f_1 is the marginal (or unconditional) distribution of debt d , $f(d|y)$ is the distribution of debt conditional on income y , and $g(y)$ is the distribution of income. This equation makes it clear that changes in the distribution of income $g(y)$ also matter for the marginal distributions $f_1(d)$. The potential impact of $g(y)$ means that the effects of changes in the conditional debt-income relationship $f(d|y)$ may not be directly evident in the unconditional distributions.

Estimated β_{ts} are presented in Figure 5 and confirm the alternative theory. Consider first the Equifax estimates in the top panel.²² These estimates, which can be interpreted as elasticities, lie in a fairly tight range between about 1.35 and 1.45, indicating that the β_{ts} change little over time. If anything, the income effect grows slightly, with the 2006 coefficient about 0.07 higher than the 2001 coefficient, a difference that is statistically significant but economically small. Below, we investigate whether this increase resulted from between-city or within-city movements in debt, but the important point here is that the regressions provide no evidence that the conditional relationship between debt and income was reduced over time.²³

The bottom panel of Figure 5 presents household-level estimates using the SCF. Here, the income coefficients are estimated with a Poisson regression of mortgage debt on wage income and other demographic variables.²⁴ The SCF income coefficients fluctuate modestly over time, as they are somewhat elevated in 1989 and 2004 and lower than average in 2001 and 2010. As was the case with the zip code-level results, however, there is no evidence of a sustained decline in the importance of income to debt from 2001 to 2007.

3.3 Debt and Income: Within-City and Between-City Movements

The regression specification above is easily adapted to study debt patterns within and between housing markets, although only the Equifax/IRS dataset is large enough for this purpose. For the within-CBSA analysis we replace the intercept α_t in the parametric model with year-specific city fixed effects,

$$E(d_{cit}|y_{cit}) = \alpha_{ct} + \beta_t \cdot y_{cit}, \quad (2)$$

²²The estimates in top panel of Figure 5 are not generated from separate regressions, but rather from a pooled regression in which the constant and the income terms in equation 1 are interacted with yearly dummies. The two methods are equivalent statistically, although the pooled regression turns out to be easier to run. Like the scatter plots, the regressions are weighted by the number of returns in the zip code.

²³The standard error on the difference between the 2001 and 2006 income coefficients is 0.02, and the t -statistic on the difference is 3.8. Because the binned scatter plot of Equifax data in Figure 2 suggests that the debt-income relation is not exactly log-linear (specifically, that the slope of the scatter plot is steeper at low incomes), we ran some unreported regressions that also include the square of income-per-return. We found that even though the implied relationship between debt and income is not perfectly linear in logs, the relationship shifted upward uniformly across the income distribution, as the binned scatter plot suggests.

²⁴A Poisson regression of y_i on x_i is specified as $y_i = \exp(\alpha + \beta x_i + \epsilon_i)$. For the SCF regressions, the left-hand-side variable is the level (not log) of the household's total mortgage debt and the regressor of interest is the log of household wage income. The Poisson specification is preferred to a log-log specification because the latter would exclude households with zero levels of debt. Households with zero levels of wage income are excluded from the regressions, as are households with heads aged 65 years or older. In addition to the log of household income, the regressions also include dummies for the age group of the household head (younger than 35, 35–44, 45–54, and 55–64), the number of children, and dummies for nonwhite and marital status. Like the Equifax/IRS regressions, the SCF regressions are run as a single pooled regression, in which the right-hand-side variables are all interacted with yearly dummies.

so that a finding of $\beta_{2006} < \beta_{2001}$ reflects a reallocation of debt toward zip codes with low incomes relative to other areas in the same cities. The alternative story is that the within-city relationship between income and debt is stable ($\beta_{2006} = \beta_{2001}$), so that changes in debt among zip codes are driven by changes in the distribution of city-level effects, α_{ct} .

The top two panels of Figure 6 investigate these alternatives. The binned scatter plot in the top left panel is constructed by deviating both the debt and income variables from CBSA means, separately in 2001 and 2006, and then averaging these deviations into 20 bins for each year. Because debt and income are both measured as deviations, the overall increase in debt during the boom is absorbed by the city averages, so both lines of points go through the origin. There is no significant shift in the slope of these lines, and the top right panel confirms the stability of the debt-income relationship with regressions.²⁵ The estimated β_{it} s using CBSA fixed effects rise very slightly from 2001 to 2002 and fall gently thereafter, so that by 2006 the income coefficient has essentially returned to its 2001 value. The exact difference between the 2006 and 2001 coefficients is -0.01 , a gap that is neither economically nor statistically significant.

The debt-income relationship across housing markets is analyzed in the lower two panels of Figure 6. There are 937 CBSAs in the dataset, as opposed to more than 40,000 zip codes, so we use 10 rather than 20 bins for the CBSA-level scatter plot in the lower left panel. Unfortunately, even with a smaller number of bins, the CBSA-level plot is fairly choppy. The panel does suggest a mild steepening in the between-city debt-income relationship, however, and this pattern is borne out by the CBSA-level regressions in the lower right panel.²⁶ Thus, between-city movements help explain the small but statistically significant increase of 0.07 that we found for the overall income effect in the previous subsection, when Equifax debt was regressed on IRS income without regard to the CBSA location of the zip code.

To be clear, the regression estimates should not be interpreted as structural predictions of how exogenous increases in income should affect mortgage debt. For example, the across-CBSA results could reflect causality that runs from booming local housing markets to rising local incomes, not a causal relationship between city-wide income and city-wide debt. Indeed, the possibility of reverse causality at the CBSA level is one reason why the within-CBSA results are particularly useful. However, both the scatter plots and the reduced-form regressions are good ways to get a sense of how the cross-sectional relationship between debt and income might have changed over time. And in neither the SCF nor the Equifax/IRS datasets do these methods suggest a reallocation of mortgage debt toward low-income bor-

²⁵As noted in footnote 22, the regressions are run as a single pooled regression, so the introduction of CBSA fixed effects merely requires interacting CBSA dummies with the yearly dummies.

²⁶Specifically, there is an increase of 0.35 in the value of the city-wide income coefficient from 2001 to 2006, which has a t -statistic of 2.3 and a p -value of 0.021.

rowers during the early 2000s.

4 The Extensive Margin of Mortgage Debt

4.1 Income and the Extensive Margin

The movements in total debt analyzed in the previous section take place along two potential margins—the intensive margin (that is, the average amount of debt per borrower) and the extensive margin (the total number of borrowers). In this section, we focus on the extensive margin of debt in light of frequent claims regarding an expansion of credit to marginal borrowers. The first step in this analysis is to use SCF data to relate income to the presence of any mortgage debt on a household’s balance sheet—what we call “mortgageship.” This concept is related to homeownership, but mortgageship and homeownership are not equivalent because some people own their homes without any debt.²⁷ To do this, we run logit regressions of mortgageship on the household-specific variables that were also used in the total-debt regressions in the lower panel of Figure 5.²⁸ While they do not generate structural estimates, the regressions determine whether current-income differences between people with and without mortgages narrowed over time, as would be expected if growing numbers of low-income individuals were able to take out mortgages.

The top panel of Figure 7 shows that the income coefficients in the mortgageship regression trend higher from 2001 to 2007, suggesting that the current-income differences between borrowers and non-borrowers grew modestly during the mortgage boom. The lower, four-panel chart presents income coefficients that are specific to age groups, which are generated by interacting the age-group dummies with the income regressor. Because the vertical scales in these panels are identical, they make it clear that income gaps between borrowers and non-borrowers are widest among the youngest households. More important for our purposes are the changes in income effects over time. During the early 2000s, the income differences distinguishing borrowers from non-borrowers rose the most among the youngest households, but in no age group does the income difference decline significantly over time.

The Equifax dataset can be used to investigate the extensive margin of mortgage debt at the zip-code level, by relating a zip code’s income to the share of its households that have a mortgage. Figure 8 presents binned scatter plots of mortgaged-household shares against

²⁷The internet appendix shows that the income patterns we find for mortgageship are quite similar to the mortgageship results presented in this section.

²⁸See footnote 24 for the list of regressors. As with the total-debt regression, the estimates are generated by a single pooled regression in which all of the demographic factors are interacted with yearly dummies. The estimated income effects in the figure are marginal effects on probabilities (not raw logit coefficients), so the top panel shows that an increase in wage income of 100 log points raises the expected homeownership rate by around 20–25 percentage points, holding other demographic factors constant.

income in 2001 and 2006. The upper plot uses unadjusted income and mortgage share data, while the bottom panel deviates those variables from CBSA means.²⁹ As we might expect, both panels indicate a positive relationship between a zip code’s income and the share of its residents that have mortgage debt. A large part of the positive correlation undoubtedly flows from higher rates of homeownership in high-income communities, but a zip code’s share of mortgaged households is also determined by how many residents own their homes free and clear. Indeed, at very high income levels, the plots flatten out, perhaps reflecting the larger propensity of high-income persons to own their homes without any debt.

Most important are the changes in the relationship between debt and income over time. The top plot shows that this relationship shifted over the course of the boom—but at the top end of the income distribution, not the bottom. That is, in high-income zip codes, residents became more likely to hold mortgage debt during the boom, conditional on income. No such shift occurs at the other end of the income distribution. The lower panel of Figure 8 repeats the analysis on a within-CBSA basis. Here, the conditional relationships have virtually identical shapes, suggesting that the high-income shift in the top panel arises primarily from between-CBSA shifts in mortgaged-household shares. This finding lines up well with the importance of between-CBSA shifts for total debt illustrated by the regressions in section 3.

4.2 Credit Scores and the Extensive Margin

So far, the focus of this paper has been on mortgage debt and income, but a high-income person can also be a bad credit risk and thus a marginal borrower. We therefore examine the extensive margin using the individual-level Equifax Risk Scores.³⁰ Any study of credit scores and debt must confront two potential problems, the first being endogeneity. When a borrower purchases a home and then makes a series of on-time payments, her credit score typically rises. Reverse causation therefore influences the correlation between the presence of mortgage debt and an individual’s current credit score. A second problem confounding the study of credit scores and debt is that people typically borrow to buy homes early in their adult lives. On average, young people have low credit scores, because they have yet to build up substantial savings and have only managed debt for a short time. Consequently, the life-cycle borrowing pattern exerts a negative influence on the cross-sectional relationship between credit scores and debt, regardless of the current state of lending standards.

²⁹The share of households in a zip code that have a mortgage is calculated by taking the average of two estimates. The upper bound is the number of outstanding first liens divided by the number of IRS tax returns. This does not correct for joint mortgages. The lower bound is the number of “couples” in the Equifax dataset with a mortgage: the number of people with a mortgage, with any joint mortgage divided by two.

³⁰As noted below, the relationship between credit scores and mortgage debt is the key focus of Albanesi, DeGiorgi, and Nosal (2016) and is also explored in Bhutta (2015).

Fortunately, information in the Equifax data allows us to circumvent both problems. Although the New York Fed Consumer Credit Panel begins in 1999, it contains a variable indicating the age of the oldest mortgage on record that is not covered in the dataset but that is covered in Equifax’s master files. So, even though someone taking out a mortgage in (say) 1985 may not have a “mortgage tradeline” for that loan in the Consumer Credit Panel, a separate variable indicates that this person does have a mortgage originated in 1985. Unless the mortgage still has a positive balance during or after 1999, we will not know the size of the 1985 mortgage, only its existence. Yet this knowledge is sufficient to identify individuals taking out first mortgages after 1999, and focusing on the flow of those persons into first-time borrowing solves the endogeneity problem that arises when borrowers make on-time payments on existing stocks of debt. Of course, the flow of first-time borrowers will include many young people, who tend to have low credit scores. But the potential bias arising from the life-cycle borrowing pattern can be addressed by conditioning on age.

Figure 9 plots a collection of hazard ratios for individuals obtaining a mortgage for the first time.³¹ For each year t , the denominator of the hazard ratio is the number of persons in a given credit-score group who had not taken out a mortgage by year $t-1$. The numerator is the flow of persons from this risk set who take out their first-ever mortgage in year t . This approach builds on work in Bhutta (2015), who also investigates first-time mortgage borrowing using Equifax data. An important difference between Figure 9 and Bhutta (2015) is that the figure defines Equifax Risk Scores *relative* to CBSA means, in order to hold constant factors that affect the creditworthiness of individuals throughout a given housing market.³² The top panel shows a near-monotonic relationship between the probability of obtaining a first mortgage and creditworthiness throughout the sample period. In all years, individuals in the two best credit-score categories are always most likely to obtain a mortgage for the first time, and individuals in the bottom group are always the least likely.³³ Importantly, the probability of transitioning into mortgageship declines during the mortgage boom for all credit-score groups. In absolute terms, declines for the highest groups are more substantial because these groups start the housing boom with the highest transition rates.

³¹See the internet appendix for details regarding sample construction and a check of implied first-time mortgageship rates against other data.

³²The CBSA-level means are generated from all residents of the CBSA appearing in the Equifax dataset, not just those residents who have yet to obtain their first mortgage and are therefore included in the risk set. Also, we analyze the hazard ratios using individual years rather than the two-year groupings in Bhutta (2015) and we use a more-granular classification of credit scores.

³³From 2004 to 2007, the top credit-score group is marginally less likely to transition to mortgageship than the second-best group. This pattern could indicate that the top group already owns homes free and clear. As we will see, after subsetting by age, the top group of young persons is substantially more likely to transition than the second-highest group in all years. This pattern indicates that a previous home purchase is much less likely to be a confounding factor for individuals near the start of the life cycle.

The four panels in the bottom half of Figure 9 split the sample by age. Credit-score quintiles are calculated within age groups, so the credit score of a young person in the top quintile for her age group may be lower than that of an older person in a lower quintile. Looking across panels, a hump-shaped hazard of first-time mortgageship can be inferred, as transition rates are highest for 25–34 year-olds. Transition rates are monotonic for the youngest two groups, as persons in the highest credit-score groups are always most likely to flow into first-time mortgageship, those in the second group are second-most likely, and so on. For the two older groups, however, individuals in the highest two groups have only moderate transition rates. These age-specific patterns most likely result from selection: young people with high credit scores are more likely to have high incomes than high wealth, so they still must take on mortgage debt to acquire homes. Older people with high credit scores either already own their homes or are wealthy enough to purchase them without debt. By and large, however, no panel suggests a substantial extensive-margin shift in favor of poor credit risks.

Results on the flow of persons into first-time borrowing complement the earlier extensive-margin analysis in two ways. First, the SCF regressions showed that current-income differences between borrowers and non-borrowers did not decline during the housing boom. Yet these differences are influenced by labor market developments, which may have favored people likely to own homes over those likely to rent. For example, if technical change tilts the distribution of income toward highly skilled workers, and if these workers are more likely to own homes, then the income differences between mortgage borrowers and non-borrowers in the SCF may grow, even if loosened lending standards allow more low-income people to buy homes. Using the individual-level data in the Equifax data to study the flow into mortgage borrowing is less susceptible to this potential confounding issue.

A second reason that Figure 9 is valuable is that it suggests that rising housing prices during the boom had strong negative effects on first-time buying across the credit-score distribution. Loosened lending standards make it more likely that previously constrained individuals will buy homes, holding other factors constant. But in the early 2000s, other factors were not held constant, as house prices rose rapidly. The negative effect of higher prices appears to have offset or outweighed the positive effect of relaxed credit standards, so that first-time buying among low-credit score groups declined during the mortgage boom, along with first-time buying by everyone else. Given the sharp rise in house prices, perhaps the truly surprising feature of the mortgage boom is not that most of the dollar increase in mortgage debt went to the wealthy. The real surprise is that the low-income individuals, who were the least likely to own homes at the start of the mortgage boom, were able to increase their mortgage debt levels at the same rates as everyone else.

Later in the paper, we investigate how the growth of subprime lending helped low-income

individuals raise their debt levels at the same rates as high-income individuals did. Before we do, we shift the focus from debt stocks and the flows into mortgageship to the two gross flows of debt, mortgage originations and terminations. A gross-flow analysis provides some helpful context for the housing boom, just as the study of gross job and worker flows has generated valuable insights on labor markets (Davis, Haltiwanger, and Schuh 1996; Shimer 2005). Gross-flow analysis is also useful for showing how the results above relate to previous studies of the mortgage boom.

5 Rising Mortgage Churn in Low-Income Areas

Figure 10 examines the zip code-level relationship between gross debt flows and income on a within-CBSA basis.³⁴ Each of the two rows of Figure 10 contains a binned scatter plot of income and either originations (top row) or terminations (bottom row), along with the plot of corresponding income coefficients. The panels are therefore analogous to the panels in the top row of Figure 6, which analyzed total debt stocks on a within-CBSA basis. In contrast to the results for debt stocks, the relationships between income and the two gross debt flows change over time. The binned scatter plots at left show a significant decline in the positive relationship between the two flows and income; in each plot, the slopes for the 2006 points are shallower than the slopes for the 2001 points. The two panels at right express these changes as falling estimates of income coefficients, which are generated from regressions analogous to the earlier debt-stock regressions. Yet the shifts in originations and terminations are the same. As a result of the offsetting nature of these shifts, the gross flow data imply that relative “mortgage churn” rose in low-income areas, even as relative debt stocks remained stable.

What accounts for the rising churn in low-income areas? One factor is undoubtedly the disproportionate participation of high-income borrowers in the refinancing boom of 2001–2003.³⁵ The reasons behind this boom are well known.³⁶ Due in part to aggressive monetary easing by the Federal Reserve during and after the 2001 recession, the 30-year mortgage rate fell from around 8½ percent in early 2000 to about 5½ percent in mid-2003.³⁷ Higher levels of refinancing generate higher amounts of mortgage churn, and Figure 10 suggests that high-income borrowers were more likely to participate in the 2001–2003 refinancing boom,

³⁴See the internet appendix for analogous results without zip code-level fixed effects.

³⁵Because we do not have IRS income data for 2003, we cannot investigate the flow-income relationships for that year. But it is likely that the 2003 income effects for both originations and terminations were even larger than the 2002 values.

³⁶For a discussion of the boom with a focus on cash-out refinancing, see Bhutta and Keys (2016).

³⁷The interest rate cited is the 30-year contract rate for conventional 30-year mortgages as measured by Freddie Mac.

consistent with previous research on the propensity to refinance.³⁸ As this wave fell off after 2003, the *relative* amount of churn in low-income communities increased.

Another reason that relative mortgage churn increased in low-income communities is that sales volumes rose. In theory, the Equifax data could be used to measure the number of purchase-and-sale transactions that involved debt, but unfortunately we cannot consistently distinguish purchases from refinances in that dataset. We can, however, construct a measure of “purchase-mortgage intensity” by dividing a zip code’s number of purchase-mortgage originations (as measured by HMDA) by its number of first liens (as measured by Equifax). The top panels of Figure 11 show that purchase-mortgage intensity rose in low-income communities from 2001 to 2006, looking across all zip codes (top left panel) or within CBSAs (top right panel). The lower two panels correct the measure of purchase-mortgage intensity for the presence of investors. In HMDA, each purchase mortgage is attached to the location of the house being purchased, not the zip code of the purchaser, and these locations differ in the case of non-owner-occupiers. The lower panels of Figure 11 depict a purchase-mortgage intensity measure that excludes investor purchases, and this correction substantially reduces the relative increases in purchase-mortgage intensity in low-income areas over time.³⁹ Although the corrected increases in low-income purchases are not particularly large, they do contribute to rising relative rates of mortgage churn in low-income areas that are apparent in Figure 10.

It is critical to understand, however, that higher purchase-mortgage intensity in low-income areas does *not* indicate that mortgage debt was shifting down the income distribution, because these purchase mortgages typically replaced the sellers’ mortgages on the homes being transacted.⁴⁰ As a result of this offset, higher purchase-and-sale volumes have only indirect impacts on overall mortgage debt and cannot be used to infer cross-sectional changes in household balance sheets. Fortunately, the Equifax data allow us to correctly attach

³⁸In his presidential address to the American Finance Association, Campbell (2006) highlighted three major financial mistakes often made by U.S. households, one of which is the failure to refinance a fixed-rate mortgage when declining interest rates make it profitable to do so. Using early 2000s data from the American Housing Survey, Campbell finds that “younger, smaller, better educated, better off, white households with more expensive houses were more likely to refinance their mortgages between 2001 and 2003. These patterns suggest that prompt refinancing requires financial sophistication” (p. 1581).

³⁹Investor information in the HMDA data must be used with caution, because an investor might inaccurately report his status as an owner-occupier during the loan-application process if doing so improves his chance of approval. But this potential misreporting bias means that the number of investor purchases as measured in the HMDA data is best considered a lower bound.

⁴⁰The impact of simultaneous originations and terminations on credit allocation plays an important role in Gerardi and Willen (2009), which links HMDA data to property-level deed records in order to study the effect of subprime lending on urban neighborhoods in Massachusetts. The authors find that during the housing boom, African-Americans accounted for a disproportionately large share of buyers in the state’s urban neighborhoods. But African-Americans also accounted for an equally high percentage of sellers. The implication is that subprime lending increased sales turnover without affecting minority homeownership rates.

mortgages to borrower locations and then keep track of mortgage debt stocks as well as flows. Although we cannot separate total gross flows in Equifax into purchases, refinances, and sales, we can measure both total stocks of debt and total gross flows. And as this section has illustrated, we can tie stocks and flows together by showing how changes in the patterns of the total gross flows offset each another, leaving the distribution of mortgage debt stocks stable over time.

6 Relationship to Other Research

6.1 Research on Debt and Income

Understanding that rising purchase-mortgage intensity does not necessarily signal a reallocation of debt is important for evaluating existing work on the housing boom. In an early contribution, Mian and Sufi (2009) used HMDA data to argue that the boom had reallocated debt toward low-income borrowers, a development they linked to incentive problems in the origination and securitization of subprime loans. The key piece of evidence that led the authors to make this claim was that at the zip-code level, changes in HMDA purchase-mortgage originations became *negatively correlated* with changes in incomes during the boom. One can show that, using Mian and Sufi’s specific regression framework, the decline in the positive *levels* relationship between originations and income that we outlined in the previous section would generate a negative correlation between debt and income *changes*, like the one that Mian and Sufi found. Because Mian and Sufi looked primarily at purchase-mortgage originations and did not ask whether these originations were offset by terminations, they misinterpreted the increase in mortgage churn in low-income areas as a credit expansion to low-income borrowers.

In a recent paper, Adelino, Schoar, and Severino (2016) also argue that Mian and Sufi misinterpreted an increase in mortgage churn in low-income areas, but data issues prevented them from fully examining the empirical consequences of that result. Much of the analysis in Adelino, Schoar, and Severino (2016) uses HMDA data on purchase-mortgage flows, but the paper exploits the borrower-level nature of HMDA data to separate that gross flow into two components: the *number* of new purchase mortgages in a zip code and the *average amount* of each individual mortgage. Adelino, Schoar, and Severino (2016) shows that the key results in Mian and Sufi (2009) result from higher mortgage churn—what they call the “velocity” of mortgage origination—not from residents of low-income zip codes getting larger mortgages. In fact, the authors found that in relative terms, average mortgage size rose more in high-income zip codes than in low-income zip codes. The implication of this positive correlation between changes in average mortgage size and income was that “[t]he apparent

decoupling of zip code-level credit growth and per capita income growth [implied by Mian and Sufi’s negative correlation] is due solely to the negative relation between the number of new originations and per capita income growth” (p. 1637, insertion added). While Adelino, Schoar, and Severino (2016) recognized that higher mortgage churn is critical to Mian and Sufi’s original finding, they were unable to explore the implication of that result because they lacked data on debt stocks and mortgaged-household shares at the zip-code level. They were therefore unable to determine whether the rising numbers of originations they found in low-income areas simply reflected higher transaction volumes or instead signaled that larger numbers of low-income borrowers were buying homes, which is the definition of an extensive-margin expansion of credit. The inability of HMDA data to rule out the extensive-margin possibility highlights the need for data on debt stocks and shares of mortgaged households, which can rule out that possibility.⁴¹

The debate about gross-flow patterns continues in Mian and Sufi (2016a), which argues that average mortgage size displays a small negative correlation with zip code-level income after accounting properly for second liens.⁴² Mian and Sufi therefore claim that it is incorrect to state, as Adelino and coauthors did, that the negative correlation in their original 2009 paper resulted *completely* from higher churn in low-income areas, with no contribution from average mortgage size. While potentially interesting, this new finding has no bearing on our results. First, whether average mortgage size in low-income zip codes rose or fell slightly does not invalidate the finding that mortgage churn rose in low-income areas, and that this increase was originally confused in the literature with a significant credit expansion to low-income borrowers. Second, the apportionment of purchase-mortgage flows into average mortgage size and transaction volumes is a second-order issue. As we have illustrated, data on mortgage stocks can be used to directly measure the distribution of mortgage debt as well as any shifts in shares of mortgaged households over time, which are the ultimate objects of interest when calculating household debt burdens.⁴³

⁴¹Adelino, Schoar, and Severino (2016) includes one figure that uses SCF data to measure stocks of debt, but that figure does not include data from people with zero debt, so it does not address the potential for a credit expansion along the extensive margin. Also, as noted above, the relatively small size of the SCF means that the Equifax data are needed to measure debt shifts across and between housing markets—a crucial distinction in Mian and Sufi (2009).

⁴²The presence of second liens means that the number of total mortgage applications is larger than the number of purchase-and-sale transactions. Using the latter concept as the denominator when calculating average mortgage size generates a modest negative correlation of average size with income growth.

⁴³Mian and Sufi (2016a) is also critical of the use of borrower-level income data in HMDA by Adelino, Schoar, and Severino (2016), because, Mian and Sufi claim, these data are more likely to be fraudulent in low-income zip codes. That critique is not relevant to this paper, because we never use HMDA data to measure income.

6.2 Research on Credit Scores and Income

Another research project related to ours is Albanesi, DeGiorgi, and Nosal (2016), which focuses on the relationship between debt and credit scores, not debt and income. As noted above, the endogenous feedback between debt and credit scores is likely to be larger than that between debt and income. Although taking out a mortgage to buy a home might raise one's income, doing so will almost certainly raise one's credit score if the subsequent mortgage payments are made on time.⁴⁴ Figure 12 illustrates the endogenous relationship between credit scores and debt in a way that clarifies both the contribution of Albanesi, DeGiorgi, and Nosal (2016) and some responses to their work. The figure presents a series of debt statistics for a random sample of individuals in the Equifax sample as of 1999, the dataset's initial year. The individuals are divided into separate groups corresponding to age in 1999 and Equifax Risk Scores in 1999. The top panel shows, first, that individuals in middle age had higher average levels of mortgage debt in 1999, and second, that within each age group, debt was positively related to credit score.⁴⁵ Both findings are intuitive. Middle-aged persons, who have recently entered their prime home-buying years, tend to have significant mortgage balances that are paid off as they grow older. And the positive relationship between debt and income within age groups reflects the two-way street of causality between debt and credit scores: persons with high scores can amass more debt, and having debt tends to raise one's score if payments are made on time.

Now consider a basic question about the mortgage boom: who took out the most debt, individuals with high credit scores in 1999 or low ones? It would be unsurprising to find that persons with low scores in 1999 took on the most debt in the mortgage boom, because young people, who tend to have low credit scores, take on mortgage debt to become homeowners in the normal state of affairs. We might therefore investigate debt growth within age groups. The middle panel of Figure 12 graphs the average dollar-value increases in debt for persons in the various demographic bins. The general within-age pattern of debt growth is positive, as individuals with high credit scores in 1999 subsequently added more dollars to their debt balances than similarly aged persons with lower scores.⁴⁶ The bottom panel of Figure 12 measures debt increases *relative* to each group's initial debt level. Now the within age-group relationship between debt growth and 1999 credit score is negative. That is, abstracting from individuals with the lowest credit scores (300-499), the bars in the bottom panel of Figure 12 get smaller within each age group as 1999 credit scores rise.

⁴⁴As noted, our analysis of the flow of persons into first-time mortgageship status is not affected by this problem, as it abstracts from the effect of current debt on credit scores: no one in the risk set for transition into mortgage borrowing has any debt to begin with.

⁴⁵The positive relation between debt and credit score is monotonic for all but the oldest age group.

⁴⁶The positive relation is monotonic for the youngest age group and for the lower three credit-score groups among older age groups.

Because the relative changes in the bottom row are defined as the absolute changes in the middle row divided by the initial levels in the top row, it is easy to see why measuring debt growth in relative or absolute terms gives different answers about the boom. The middle panel shows that the better credit risks within each age group added more dollars to their debt levels between 1999 and 2007, but they started in 1999 with relatively more debt, too. The extra dollars they added were not enough to outweigh the effect of their high initial debt levels, so relative to their initial debt levels, their debt increases were lower than the increases for lower-score groups. The key factor driving these results is the endogeneity of the credit score in 1999, which reflects the ability of good credit risks to borrow more early on as well as the positive impact that their 1999 debt levels had on their 1999 credit scores.

Albanesi, DeGiorgi, and Nosal (2016) address the endogeneity concerns by essentially running the following regression:

$$\frac{\Delta D_{it}}{D_{i0}} = \alpha + \beta \text{Score}_{i,t-2} + \varepsilon, \quad (3)$$

where the left-hand side variable is the relative growth in mortgage debt D for individual i from an initial year zero to year t , and the regressor is the individual's credit score lagged by two years.⁴⁷ This specification can be thought of as intermediate choice between two polar cases. One polar case would regress relative debt growth on the individual's year-0 credit score: $\text{Score}_{i,0}$. As we have seen, life-cycle effects would bias downward this within-age-group estimate of β , because first-time home buyers are often young, and young people tend to have low credit scores. Even if age terms were added to the regression, causing β to be identified solely from within age-group comparisons, the mean reversion illustrated by the bottom panel of Figure 12 would continue to bias downward the coefficient. Additionally, using 1999 credit scores gives an increasingly out-of-date estimate of creditworthiness as time passes, and at the same time it prevents anyone entering the dataset after 1999 from contributing to the analysis. At the other polar extreme, we could regress debt growth on the time- t credit score: $\text{Score}_{i,t}$. In this case β would be biased upward if poor credit risks were exogenously extended credit during the boom and the mere extension of this credit raised their credit scores. By choosing a specification that lies between these two extremes, Albanesi, DeGiorgi, and Nosal (2016) hope to arrive at a specification that is as close as possible to the truth.

Clearly, sorting out the endogeneity issues related to credit scores is an important topic for future work. But so far, no substantial evidence has emerged that debt was reallocated

⁴⁷In practice, regressions of this type are not run on individual data, but rather on data that has been grouped along demographic characteristics, as in Figure 12. The main advantage of using grouped data is that doing so obviates the need to figure out what to do with individuals who have zero debt in the initial year.

toward bad credit risks during the boom.⁴⁸ The specification of Albanesi, DeGiorgi, and Nosal (2016) indicates that debt rose by at least 50 percent for all credit-score quartiles during the boom, and that the largest growth rates were in the center of the credit-score distribution. These findings are consistent with our results on the expansive nature of the mortgage boom across the income distribution. And our own credit-score analysis—which is based on the flow of persons into first-time borrowing and is thus less affected by reverse causation than the analysis of debt stocks—provides no evidence that persons with poor credit risks found it easier to enter mortgageship as the mortgage boom progressed.

7 What About Subprime?

The emerging research on the broadly based nature of the mortgage boom contradicts the common characterization of the mortgage boom as a subprime event, driven primarily by the disproportionate use of a complex mortgage instrument that turned toxic during the bust. Subprime mortgages and other forms of privately securitized debt did play a critical role in the 2008 financial crisis, because losses on those mortgages were not insured by the government, as were the prime loans packaged into agency securities by Fannie Mae, Freddie Mac, and other government-sponsored enterprises. But a close look at both outstanding stocks of debt and foreclosures confirms that the housing cycle was just that—a housing cycle—and not a subprime cycle alone.

7.1 Subprime Debt and Income

The first step in this analysis is simply to measure the amount of subprime debt, and in Figure 13 we focus on the subprime loans that were subsequently packaged into private-label mortgage backed securities. During the mortgage boom these securities included most subprime and Alt-A mortgages and some jumbo prime loans as well.⁴⁹ The heavy black line in the top panel of Figure 13 depicts the total amount of home mortgage debt on the liability side of household balance sheets as measured by the Federal Reserve’s Flow of Funds. The lighter gray line is a counterfactual amount of mortgage debt that would have occurred if the only growth in mortgage-debt liabilities after 2001:Q1 had been privately

⁴⁸Mian and Sufi (2016b) also investigate individual-level growth in debt using the Equifax records, with a specification that is essentially equation 3 augmented with age effects. As Figure 12 illustrates, however, mean reversion is likely to bias the resulting estimate of β downward, and thereby overstate the relative debt growth enjoyed by poor credit risks.

⁴⁹According to the Mortgage Market Statistical Annual, securitization rates for subprime and Alt-A loans as a class ranged from around two-thirds in 2002 to around 80 percent in 2005 and 2006. Securitization rates for prime jumbo loans ranged from about one-third to one-half over the same period.

securitized debt, which is also available in the Flow of Funds.⁵⁰ The chart shows that some time after 2003, growth in privately securitized debt accounted for a nontrivial fraction of the growth in overall mortgage debt. But the large majority of debt accumulated during the mortgage boom was allocated outside of the private-label securities channel, through avenues that included portfolio lending, agency mortgage-backed securities (MBS), state and local housing authorities, and other sources.

The Flow of Funds does not disaggregate privately securitized debt into subprime, Alt-A, and prime jumbo loans. However, we can calculate the size of these components by aggregating the loan-level records in the CoreLogic ABS Private Label Securities ABS Database discussed in the data section. The red dashed line in the bottom panel of Figure 13 shows how much total mortgage debt would have grown if the only debt growth after 2001:Q1 had been privately securitized subprime loans. According to the aggregated CoreLogic data, outstanding subprime debt grew from about \$100 billion in 2001:Q1 to about \$955 billion by the middle of 2007, for an increase of about \$855 billion. The dashed blue line in the panel adds the even larger increase in Alt-A debt, which rose from about \$60 billion in 2001:Q1 to about \$1.04 trillion by mid-2007, an increase of about \$980 billion. The last counterfactual, depicted by the dashed gray line, adds the relatively small amount of growth in prime jumbo securities. The main message is that even though subprime debt grew nontrivially during the mortgage boom, the vast majority of new mortgage debt was generated through other channels.

The relative unimportance of subprime debt may seem odd to those who remember the wide attention that subprime originations received during the mortgage boom. But the stock-flow distinction we note many times above is especially important when studying subprime mortgages. For the most part, these mortgages were designed to be refinanced quickly, so the higher originations would have coincided with higher terminations.⁵¹ The quantitative relationship between originations and stocks of subprime debt is illustrated by Figure 14, where the top panel depicts the share of subprime and Alt-A origination values as shares of all new originations during the 2000s. The red line shows that subprime accounted for about 20 percent of new origination values from 2004 to 2006. The bottom panel provides data on outstanding stocks of subprime and Alt-A loans that were privately securitized as a share of all mortgage debt. The subprime share hits a point of inflection in 2004, when subprime originations take off. But because any rapid increase in a flow generates a less-

⁵⁰The privately securitized debt level is the total amount of debt issued by asset-backed securities (ABS) issuers on mortgages for 1–4 family structures. In mortgage data, privately securitized debt is labeled ABS debt to distinguish it from the MBS that are backed by the government-sponsored agencies.

⁵¹One of the most common types of subprime mortgages had a so-called hybrid structure, in which the interest rate would be fixed for the first two or three years of the loan, and then reset to float at a rate that was several percentage points above a benchmark short-term rate. The thinking was that the borrower would refinance at or shortly before the reset.

rapid increase in the corresponding stock, and because large amounts of subprime debt were being terminated as the new subprime mortgages were being originated, the corresponding increase in the subprime stock of debt was modest. Privately securitized subprime debt peaked at just over 9 percent of total outstanding mortgage debt in 2006. This share was comparable to the share of privately securitized Alt-A debt, which generally consisted of reduced-documentation loans to borrowers with prime credit scores.

To study the cross-sectional allocation of private-label debt with respect to income, we combine loan-level CoreLogic data with the zip code-level Equifax/IRS dataset. Specifically, for each zip code in the Equifax/IRS data, we figure the total amount of subprime and ABS debt in CoreLogic. Then, for each zip code, we subtract these totals from the total amount of Equifax mortgage debt, which generates the amount of prime debt as a remainder. Figure 15 shows the average contributions of subprime, Alt-A, and prime debt to growth rates of total debt across the income distribution of zip codes from 2001 to 2006. The top panel ranks zip codes based on wage and salary income without regard to their CBSA location. As we would expect, the panel shows that subprime debt growth grew at faster rates in low-income areas, although some residents of wealthy zip codes also took out subprime loans. The bottom panel bins the zip codes based on their incomes relative to CBSA means. The story here is generally the same, although the negative relationship between the importance of subprime debt and average zip code-level income appears somewhat greater. Combined with the earlier results on the overall stability of the debt distribution, the relatively small amount of subprime debt and its disproportionate allocation to low-income communities indicates that subprime did not cause a reallocation of debt toward low-income borrowers and communities. But by allowing these communities to keep up with aggregate housing demand, subprime lending helped prevent a reallocation of mortgage debt toward the wealthy.

7.2 Foreclosures and Income

Of course, the attention paid to the increase in subprime during the boom paled in comparison to the headlines that subprime received during the bust. As noted by Ferreira and Gyourko (2015), most economics papers written early in the crisis focused on the large number of subprime foreclosures, and thereby encouraged focusing on potential incentive problems in the subprime origination and securitization models. This focus undoubtedly received additional encouragement from the importance of subprime losses to the financial crisis. But using a large sample of public deeds records data that cover 96 metropolitan areas, Ferreira and Gyourko (2015) also show that defaults during the course of the housing bust occurred on prime mortgages. To be sure, subprime mortgages had higher default rates. But because they made up a relatively small share of mortgages, Ferreira and Gyourko (2015) estimate more than twice as many prime as subprime borrowers lost their homes over their

full sample period (2009:Q1–2012:Q3).

The high proportion of subprime lending in low-income communities leads naturally to the question of how mortgage defaults were distributed across the income distribution. The cross-sectional relationship between foreclosures and either income or credit scores has received much recent attention. For example, Adelino, Schoar, and Severino (2016) use data from HMDA and the McDash mortgage-servicer dataset to infer that foreclosure rates are typically higher in low-income communities, as we would expect. However, the paper also shows that during the housing bust, the share of total McDash delinquency value accounted for by low-income zip codes went *down*. This movement occurred because the percentage increases in the (generally high) delinquency rates of low-income zip codes were smaller than the percentage increases in the (generally low) rates of high-income areas.

We can replicate and extend these results using the Equifax data.⁵² Individual mortgages in Equifax are classified as either current or delinquent, with the latter group further delinquent by length of delinquency: 30, 60, 90, or 120+ days. The Equifax dataset is quarterly, so we can define the default rate in quarter t as the share of all active first liens in quarter $t - 1$ that transition to 90-day delinquency in quarter t .⁵³ The two panels in Figure 16 present binned scatter plots of the log of this default rate against log of income per return in 2001:Q4 and 2009:Q4. As was the case with debt, the use of natural logs means that a uniform percentage increase in defaults shows up as a uniform shift upward across the income distribution. The upper panel of Figure 16 shows the default-income relationship across all zip codes without regard to CBSA location. The lower panel deviates both variables from CBSA means. Both panels show a strong negative relationship between default rates and income, as defaults are always higher in low-income zip codes. But the plots also confirm that the default rate grew somewhat more in percentage terms in high-income zip codes, as the slopes of the conditional expectation functions flatten from 2001 to 2009.⁵⁴

For our purposes, what is most striking about these plots is how they mirror the earlier results on mortgage debt, and thus support the idea that the housing cycle was an aggregate event. High-income borrowers tend to have a lot of mortgage debt, so an aggregate increase

⁵²An extension is useful because, as noted in the data section, the McDash dataset does not become fully representative of the mortgage market until 2005. We also focus on foreclosure rates, rather than shares of total delinquency value, because the latter measure is influenced by differences in the average size of mortgages across zip codes, as well as differences in homeownership rates.

⁵³The resulting ratio is, of course, similar to a sample hazard. We define the number of active first liens in the previous quarter as all liens that are fewer than 90 days delinquent. These liens, therefore, comprise the risk set for loans that can become 90 days delinquent in the current quarter.

⁵⁴In a paper that uses individual-level credit scores rather than zip code-level income, Mian and Sufi (2016b) also find that the share of housing distress accounted for by the relatively creditworthy borrowers rose during the bust. But that paper’s use of 1996 credit scores understates the total share of defaults during the housing bust that was generated by high-score borrowers, because borrower scores tend to rise with age (and thus with time).

in debt across all borrowers leads to large dollar-value increases in debt among the rich. Conversely, low-income borrowers have relatively high foreclosure rates, so the same percentage increase in defaults among all borrowers generates large absolute numbers of low-income foreclosures. While many of these low-income foreclosures were on subprime mortgages, the relatively small share of subprime on the overall market meant that, as Ferreira and Gyourko (2015) found, most defaults would come on prime mortgages. And the slightly larger percentage increases in foreclosures among richer communities—who were underrepresented in subprime—provides a further indication that the housing bust was not limited to the subprime market alone. All told, cross-sectional analysis of both debt accumulation and foreclosures indicates that research should focus on the aggregate factors behind the housing cycle, not on potential problems that are specific to any particular corner of the market.

8 Implications for Theory and Policy

If the bottom line of this paper is that aggregate factors drove the housing cycle, then the obvious follow-up question is what those factors were. One candidate is an exogenous expansion in the supply of loanable funds that reduced mortgage rates in the U.S. housing market. The interest-rate hypothesis is examined in detail by Glaeser, Gottlieb, and Gyourko (2013), as part of a broader examination of whether “cheap credit” can explain the boom.⁵⁵ The authors find that neither theory nor data support the interest-rate hypothesis. “Interest rates do influence house prices,” they write, “but they cannot provide anything close to a complete explanation of the great housing market gyrations between 1996 and 2010” (p. 350). The authors conclude by noting that overly optimistic house-price expectations could have fueled the boom, as borrowers would have wanted to buy houses that were rising in price, and lenders would have been eager to write mortgages against this rapidly appreciating collateral. Shifting beliefs can also explain widespread foreclosures during the bust. When beliefs became less optimistic and housing prices fell, homeowners across the income distribution found themselves with negative equity, a necessary condition of default (Kau, Keenan, and Kim 1994).

The expectations theory of the housing cycle is supported by a number of facts about mortgage finance during the past several decades (Foote, Gerardi, and Willen 2012), and it is easy to find evidence that both borrowers and lenders were optimistic about house-price appreciation during the mortgage boom (Case and Shiller 2003; Case, Shiller, and Thompson 2012; Gerardi et al. 2008). But constructing a rational model of shifting beliefs

⁵⁵This investigation into cheap credit as a potential driver of the cycle involved the availability of credit as well as its price. Glaeser, Gottlieb, and Gyourko (2013) correlated house prices with both loan-approval rates and average down payments, but found that the empirical impact of these two factors on prices was limited as well.

about future house prices is a theoretical challenge. A recent paper by Kaplan, Mitman, and Violante (2016) captures “bubble psychology” in a rational-expectations framework by assuming that agents move exogenously between two regimes regarding future housing preferences. In one regime, the agents believe that preferences for housing will be much higher in the future, while the other regime is less optimistic. Survey data on house-price expectations are used to calibrate this shock. Two other shocks occur to regulation in the mortgage market (summarized by household borrowing limits and borrowing costs) and to labor income. The recent U.S. housing cycle is then characterized as a particular set of shocks to beliefs, regulation, and income.

The belief shock emerges as by far the most important driver of housing prices in the Kaplan, Mitman, and Violante (2016) model. The importance of regulation shocks, by contrast, is tempered by the presence of an elastic rental market. The authors explain that in general, changes in borrowing constraints will matter to the aggregate housing market only if a substantial number of agents are constrained beforehand. In their model, the housing choices of households are not constrained very much, because households without the requisite down payment can simply rent. Moreover, whenever down payment restrictions are relaxed, these households wind up buying houses that are comparable to the ones they would have been renting, with minimal effects on aggregate housing demand or house prices.⁵⁶ More to the point of this paper, the model predicts that household debt levels rise proportionately across the income distribution, as long as optimistic beliefs about the housing market are widely shared.

Other theoretical questions follow naturally from the importance of beliefs to the housing cycle. Kaplan, Mitman, and Violante (2016) takes the shift in beliefs as exogenous, but papers in the so-called distorted beliefs literature go beyond the standard rational-expectations framework to ask how beliefs can be affected by psychological factors, social interactions, or both.⁵⁷

⁵⁶Expanded credit availability also has a small effect on housing prices in the model of Kiyotaki, Michaelides, and Nikolov (2011): “In our economy, tenants or credit-constrained homeowners are relatively poor and own a small share of aggregate wealth as a group. As a result, the effect of relaxing the collateral constraint on housing prices is largely absorbed by a modest conversion from rented to owned units” (p. 257). Interestingly, the authors model can match the empirical skews in the earnings and wealth distributions, but a general implication of Krusell and Smith (1998) still holds: In heterogeneous-agent economies, the behaviour of the poorest agents has a limited effect on wealth aggregates, because the share of total wealth held by these agents is small.

⁵⁷Papers that explore the formation of beliefs and the financial consequences of distorting them include Gennaioli and Shleifer (2010), Gennaioli, Shleifer, and Vishny (2012), Barberis (2013), Brunnermeier, Simsek, and Xiong (2014), Simsek (2013), Fuster, Laibson, and Mendel (2010), Geanakoplos (2009), and Burnside, Eichenbaum, and Rebelo (2016). In addition to Adelino, Schoar, and Severino (2016), empirical papers supporting the price-expectations theory include Cheng, Raina, and Xiong (2014) and Bayer, Mangum, and Roberts (2016). In the internet appendix, we discuss a contrasting theory of the debt boom proposed by Kumhof, Rancière, and Winant (2015), who link increases in overall debt to consumption rather than investment motives.

The aggregate nature of the housing cycle also raises important questions for policy. If a surge in unaffordable mortgages targeted at low-income borrowers had in fact caused a destabilizing housing cycle, then restricting non-traditional mortgages would have been good for both the macroeconomy and the borrowers themselves. But trade-offs emerge if subprime instead helped low-income borrowers keep up with everyone else. Restricting subprime lending would have reduced low-income borrowing and thus reduced the number of ensuing foreclosures. Yet the small amount of debt at the bottom of the income distribution suggests that this policy would not have derailed the boom itself, and most defaults turned out to be on prime mortgages anyway. More importantly, the relationship between foreclosures and income implies that restricting low-income lending will *always* reduce the foreclosure rate, because foreclosure is more common in low-income areas than high-income areas. Indeed, authors such as Goodman (2016) believe that after the housing crisis, the “credit box” shrank too much from a social point of view, causing too many people to be shut off from the benefits of homeownership.⁵⁸ If society believes that homeownership has positive externalities and should thus be widely shared, then regulators should be willing to tolerate a higher number of average foreclosures as credit flows down the income distribution. On the other hand, the case for low-income lending is weakened if foreclosure externalities are large, or if we believe that large declines in nationwide housing prices can no longer be ruled out. This paper has outlined how the distribution of mortgage debt *did* evolve during the mortgage boom. Its findings imply that the policy question of how this distribution *should* evolve in the future is more complicated than conventional explanations of the mortgage boom would suggest.

⁵⁸The title of Goodman (2016) states that “squeaky-clean loans [have led] to near-zero borrower defaults—and that is not a good thing.”

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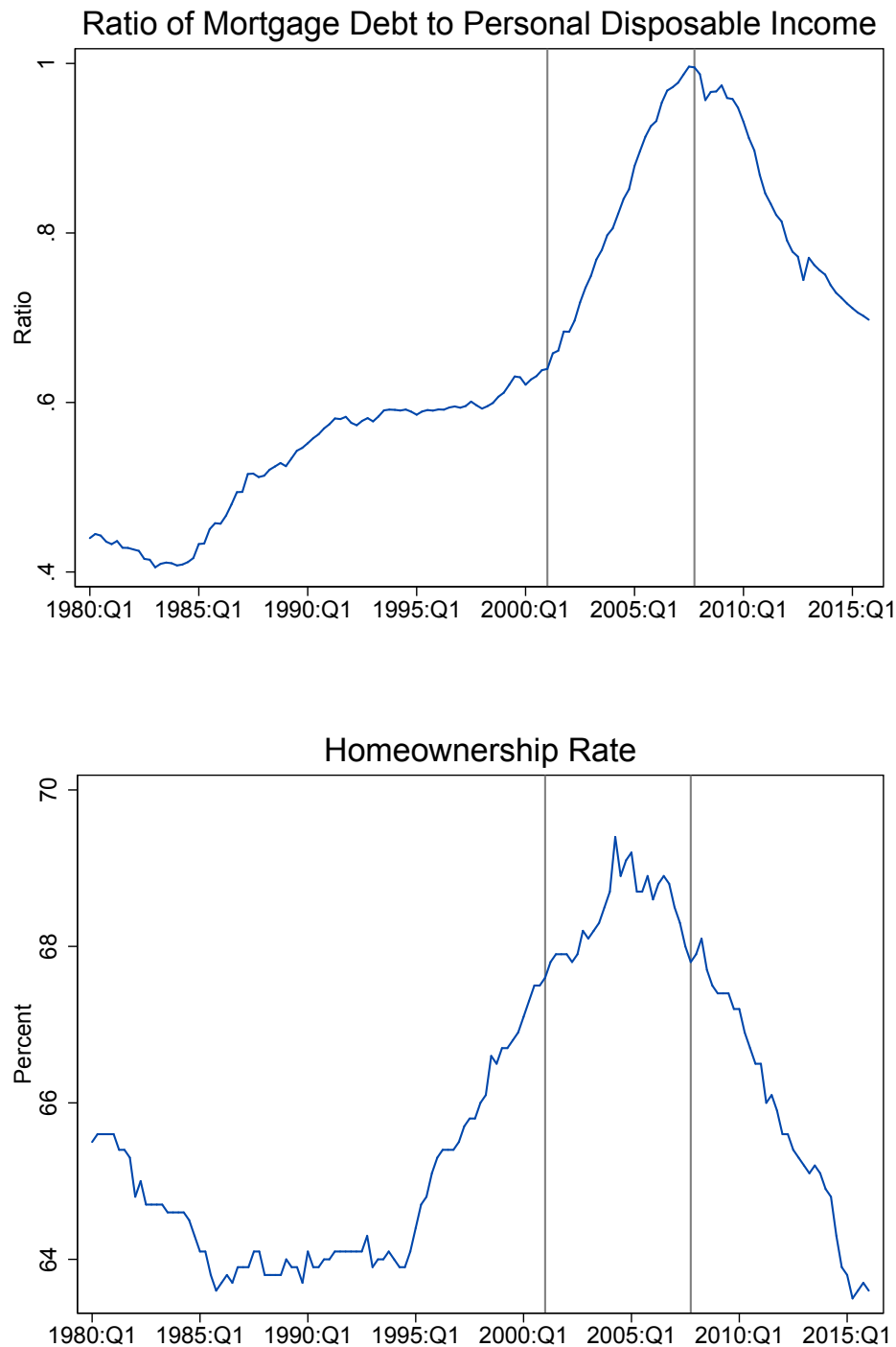


Figure 1. MORTGAGE DEBT AND HOMEOWNERSHIP RATES IN THE UNITED STATES: 1980:Q1 TO 2015:Q4. *Note:* The mortgage debt ratio in the top panel is defined as total home mortgage liabilities in the household sector divided by total personal disposable income for the household and nonprofit sector. The income variable is seasonally adjusted at an annual rate. The homeownership rate in the lower panel is also seasonally adjusted. The gray vertical lines in each panel denote the quarters 2001:Q1 and 2007:Q4. *Source:* Board of Governors of the Federal Reserve System (Flow of Funds) for mortgage debt and income and Bureau of the Census for the homeownership rate.

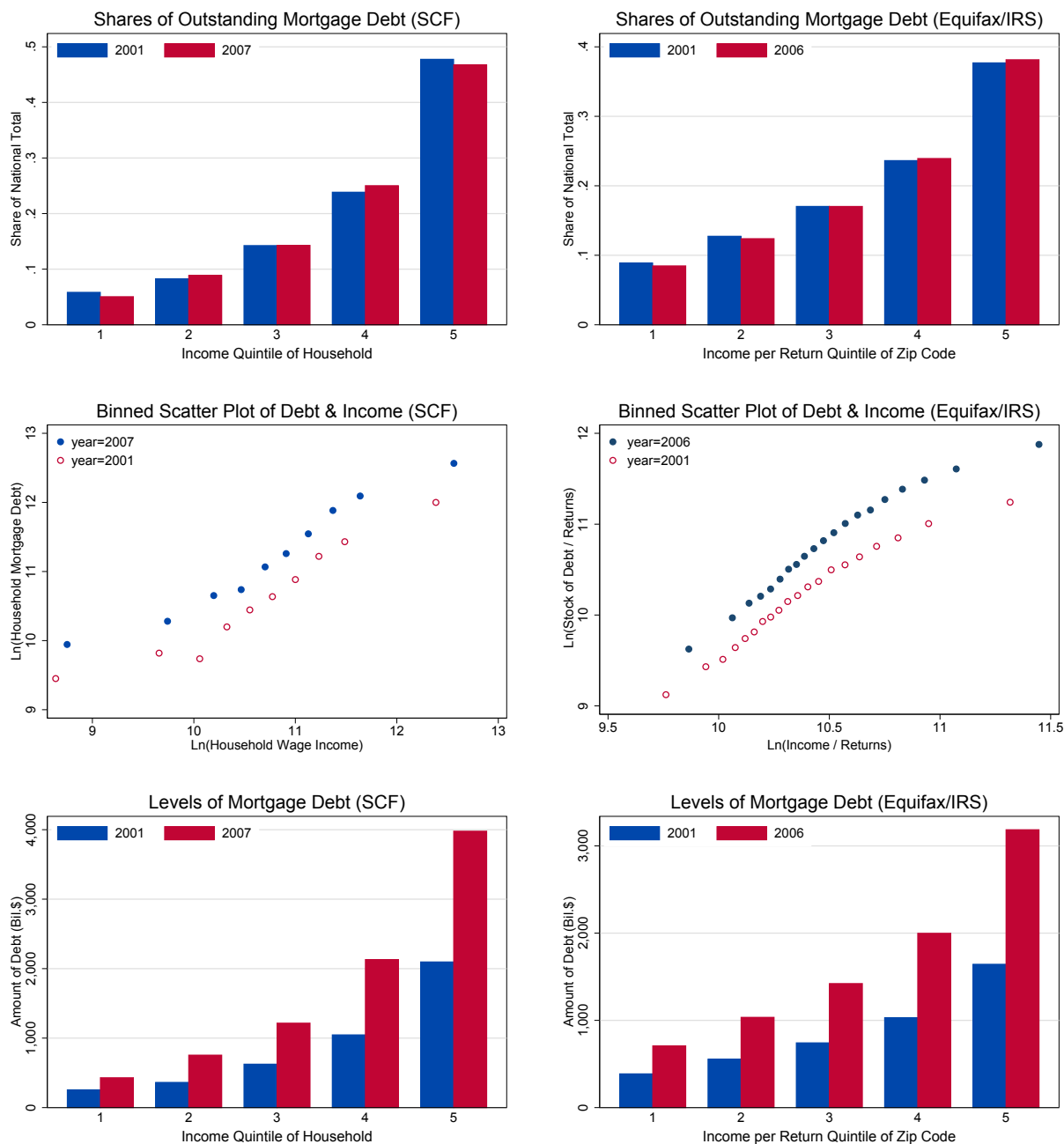


Figure 2. THE RELATIONSHIP BETWEEN MORTGAGE DEBT AND INCOME AMONG U.S. HOUSEHOLDS (LEFT PANELS) AND ZIP CODES (RIGHT PANELS). *Note:* The panels at left use data from the Survey of Consumer Finances to depict the household-level relationship between wage income and mortgage debt in 2001 and 2007. The panels at right use debt data from the Equifax credit bureau and income data from the Internal Revenue Service to show the zip code-level relationship in these variables in 2001 and 2006. Households with no wage income in the SCF and zip codes with no reported wage and salary income from the IRS are not included. *Source:* NY Fed Consumer Credit Panel/Equifax, IRS Statistics of Income, and Survey of Consumer Finances.

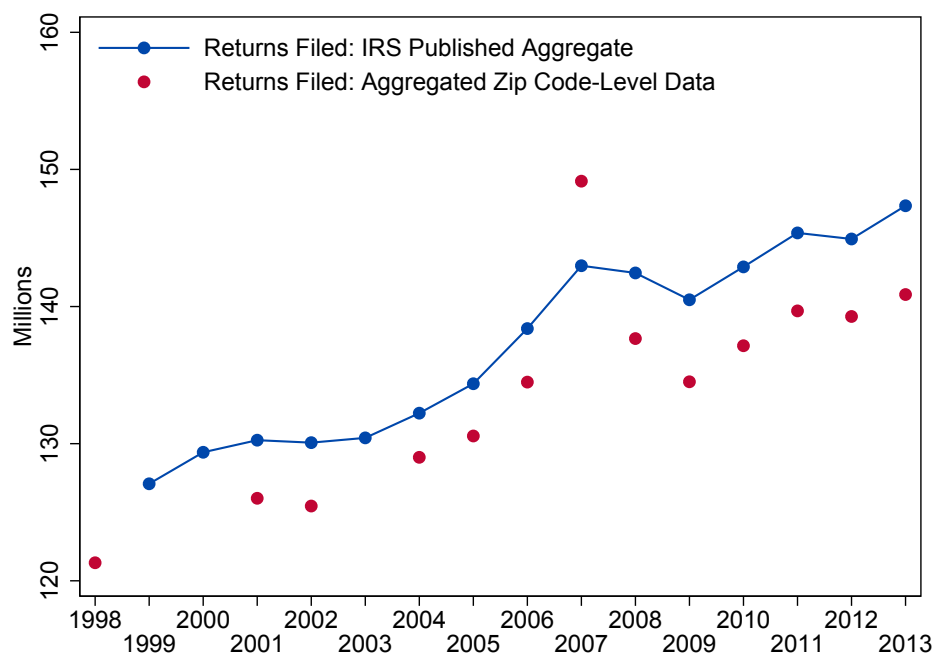


Figure 3. TWO MEASURES OF AGGREGATE INDIVIDUAL INCOME RETURNS FILED. *Note:* The blue line depicts the total number of individual income returns filed for the given tax year as published by the IRS. The 2007 value for this series omits returns filed by individuals for the sole purpose of receiving the 2007 economic stimulus payment. The red dots depict annual aggregates implied by the zip code-level IRS data; the 2007 value for this series includes all filers. *Source:* Internal Revenue Service, Statistics of Income Historical Table 1 (available at <https://www.irs.gov/uac/SOI-Tax-Stats-Historical-Table-1>), and Internal Revenue Service (2007).

| | Income per Return Quintile | | | | |
|-------------------------------|----------------------------|-----|-----|-----|-----|
| | 1 | 2 | 3 | 4 | 5 |
| 2001 | | | | | |
| Zip Codes (#,000) | 17 | 9 | 6 | 4 | 4 |
| S&W per Return (\$,000) | 22 | 26 | 31 | 38 | 52 |
| AGI per Return (\$,000) | 28 | 34 | 39 | 49 | 71 |
| Avg. Mortgage Debt (\$,000) | 51 | 60 | 74 | 92 | 130 |
| Avg. 1st Mortgage (\$,000) | 41 | 47 | 57 | 70 | 94 |
| Avg. 2nd Mortgage (\$,000) | 6 | 5 | 4 | 4 | 4 |
| Avg. HELOC (\$,000) | 2 | 2 | 3 | 3 | 4 |
| Mortgaged Households (%) | 27 | 34 | 39 | 44 | 51 |
| Median Age | 45 | 45 | 44 | 44 | 45 |
| Median Risk Score | 657 | 684 | 700 | 721 | 742 |
| Median House Price (\$,000) | 79 | 97 | 119 | 156 | 243 |
| 2006 | | | | | |
| Zip Codes (#,000) | 16 | 8 | 6 | 4 | 4 |
| S&W per Return (\$,000) | 24 | 30 | 35 | 42 | 59 |
| AGI per Return (\$,000) | 32 | 39 | 46 | 57 | 87 |
| Avg. Mortgage Debt (\$,000) | 73 | 88 | 112 | 147 | 215 |
| Avg. 1st Mortgage (\$,000) | 57 | 66 | 81 | 100 | 137 |
| Avg. 2nd Mortgage (\$,000) | 9 | 8 | 9 | 11 | 13 |
| Avg. HELOC (\$,000) | 6 | 8 | 9 | 12 | 18 |
| Mortgaged Households (%) | 32 | 40 | 45 | 52 | 58 |
| Median Age | 47 | 47 | 47 | 46 | 47 |
| Median Risk Score | 656 | 689 | 707 | 729 | 754 |
| Median House Price (\$,000) | 133 | 148 | 189 | 249 | 390 |
| House Price Apprec. 2001–2006 | 51 | 41 | 42 | 43 | 44 |

Table 1. SUMMARY STATISTICS FOR ZIP CODES IN THE EQUIFAX/IRS DATASET. *Note:* Values at the zip-code level are summarized by return-weighted salary and wages per return quintiles from the IRS, so there are approximately the same number of returns in each quintile. The reported values are return-weighted medians within each quintile. Average mortgage debt is the total stock of mortgage debt divided by the number of people in the zip code holding a mortgage, after correcting for joint mortgages. The average value of each type of mortgage is the total stock of debt for that mortgage type divided by the number of outstanding mortgages of that type in each zip code. The percentage of mortgaged households is the number of couples or individuals holding a mortgage divided by the number of returns from the IRS. The median house price is from Zillow, and house price appreciation at the zip-code level is calculated from the CoreLogic zip code-level house price index. *Source:* NY Fed Consumer Credit Panel/Equifax, IRS Statistics of Income, CoreLogic, and Zillow.

| | | | | | Debt on Primary Residence | | | | | | | | Real Estate Assets | |
|---|----------|------------|---------------|----------|---------------------------|---------|--------|----------|---------|-----------|-----------|-------------|--------------------|--|
| | Income | No. of | Mortgaged | Total | | | | Other | | Home | Value of | Value of | | |
| Year | Quintile | Unweighted | Households | Mortgage | Total | Non- | HELOC | Mortgage | Income | Ownership | Primary | All Resid. | | |
| | | Obs. | (% of Hholds) | Debt | | HELOC | | Debt | | Rate (%) | Residence | Real Estate | | |
| Panel A: Income Defined as Total Income (Zero Incomes Included) | | | | | | | | | | | | | | |
| 2001 | 1 | 683.6 | 14 | 5,294 | 5,219 | 5,090 | 129 | 75 | 10,167 | 41 | 31,051 | 32,175 | | |
| | 2 | 659.4 | 28 | 13,044 | 12,510 | 12,166 | 344 | 535 | 24,453 | 58 | 63,403 | 69,047 | | |
| | 3 | 719.6 | 47 | 30,539 | 28,670 | 28,196 | 474 | 1,869 | 41,142 | 67 | 81,736 | 91,029 | | |
| | 4 | 705.2 | 64 | 55,464 | 52,439 | 51,451 | 988 | 3,025 | 66,705 | 82 | 136,648 | 153,193 | | |
| | 5 | 1,674.2 | 79 | 122,314 | 110,457 | 105,987 | 4,470 | 11,858 | 211,252 | 93 | 311,906 | 389,058 | | |
| 2007 | 1 | 664.2 | 15 | 10,795 | 9,661 | 9,321 | 340 | 1,134 | 12,690 | 41 | 56,960 | 64,258 | | |
| | 2 | 616.8 | 32 | 22,170 | 20,809 | 19,686 | 1,123 | 1,360 | 28,977 | 56 | 87,176 | 95,520 | | |
| | 3 | 648.8 | 52 | 56,299 | 54,035 | 52,965 | 1,070 | 2,264 | 47,872 | 70 | 137,874 | 152,275 | | |
| | 4 | 685.6 | 72 | 106,882 | 96,519 | 92,614 | 3,905 | 10,363 | 77,131 | 84 | 227,398 | 263,010 | | |
| | 5 | 1,801.6 | 81 | 219,228 | 184,652 | 174,227 | 10,425 | 34,576 | 257,914 | 94 | 537,018 | 714,545 | | |
| Panel B: Income Defined as Wage Income (Zero Incomes Excluded) | | | | | | | | | | | | | | |
| 2001 | 1 | 590.8 | 26 | 15,581 | 14,953 | 14,451 | 502 | 628 | 10,713 | 44 | 52,955 | 66,497 | | |
| | 2 | 556.2 | 34 | 22,068 | 19,777 | 19,380 | 396 | 2,291 | 27,045 | 49 | 56,305 | 63,681 | | |
| | 3 | 563.2 | 55 | 38,015 | 35,834 | 35,159 | 676 | 2,180 | 43,065 | 69 | 85,389 | 94,221 | | |
| | 4 | 581.8 | 70 | 63,617 | 59,797 | 58,578 | 1,219 | 3,820 | 67,481 | 81 | 127,975 | 142,824 | | |
| | 5 | 1,091.8 | 84 | 127,374 | 117,407 | 112,853 | 4,553 | 9,968 | 168,217 | 92 | 292,371 | 349,305 | | |
| 2007 | 1 | 550.4 | 26 | 25,039 | 23,108 | 21,831 | 1,278 | 1,930 | 11,717 | 43 | 78,536 | 86,943 | | |
| | 2 | 522.8 | 39 | 43,960 | 39,013 | 37,286 | 1,727 | 4,948 | 30,618 | 52 | 93,208 | 106,750 | | |
| | 3 | 503.6 | 62 | 70,726 | 67,731 | 64,087 | 3,645 | 2,995 | 49,518 | 72 | 153,338 | 176,989 | | |
| | 4 | 560.0 | 77 | 123,914 | 110,677 | 106,423 | 4,255 | 13,237 | 77,340 | 83 | 234,546 | 271,525 | | |
| | 5 | 1,117.2 | 87 | 231,376 | 199,942 | 191,041 | 8,901 | 31,434 | 197,649 | 94 | 501,207 | 655,585 | | |

Table 2. SUMMARY STATISTICS FOR HOUSEHOLDS IN THE SURVEY OF CONSUMER FINANCES. *Note:* All variables are calculated as simple means of weighted averages from the five multiple implicates of the public-use summary data of the SCF. Figures are nominal dollar values unless otherwise noted. *Source:* Survey of Consumer Finances.

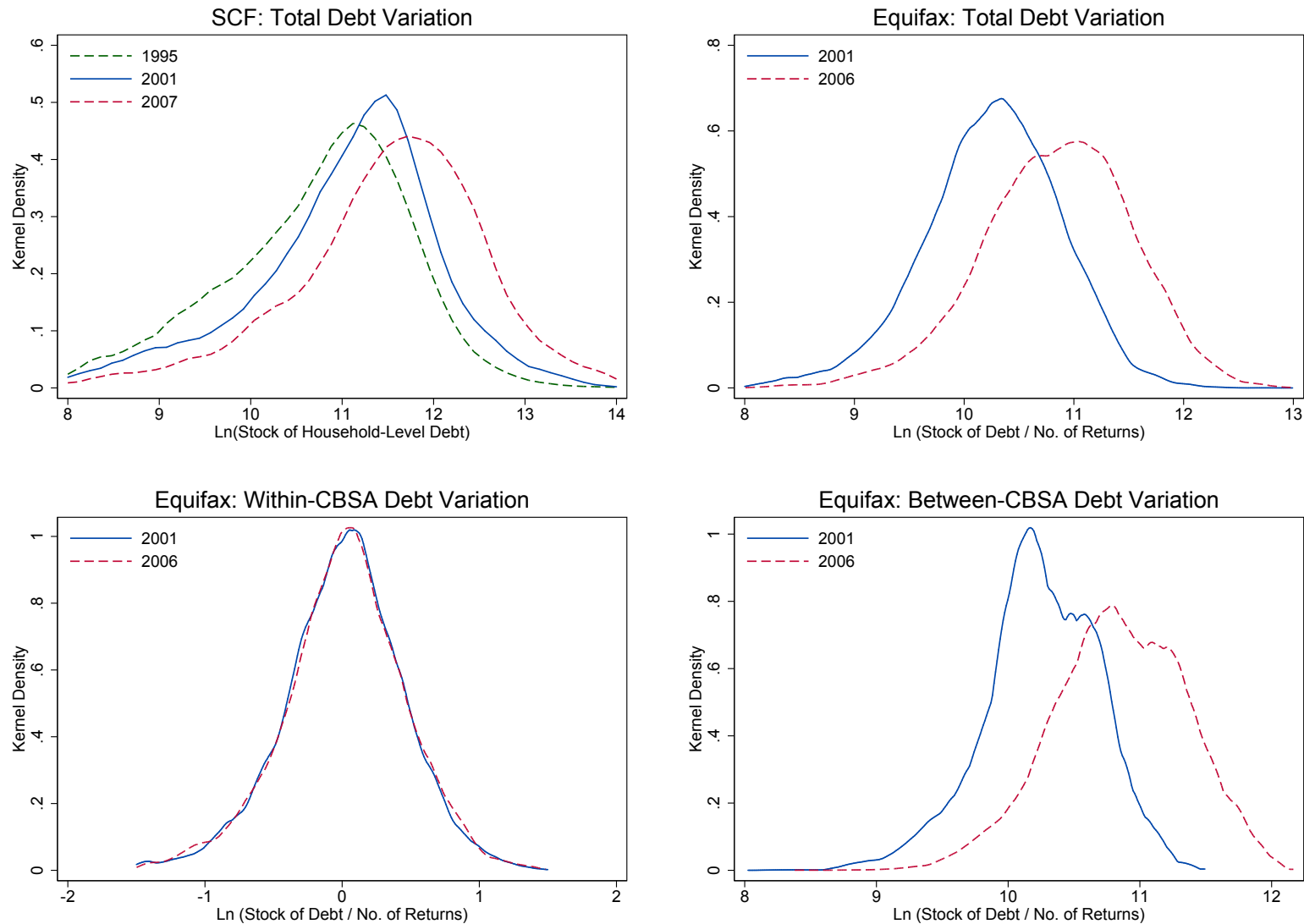


Figure 4. DISTRIBUTIONS OF MORTGAGE DEBT. *Note:* All densities are weighted kernel densities of the log of household-level mortgage debt (SCF distribution in top left panel) or average zip code-level mortgage debt per tax return (Equifax distributions in remaining panels). Household-level weights are used for the SCF distribution, and the number of income tax returns in the zip code is used to weight the Equifax distributions. The bottom left panel depicts Equifax densities after the log of zip code-level debt per return is deviated from means corresponding to Core Based Statistical Areas (CBSAs). The bottom right panel depicts the kernel densities of CBSA averages of debt. In all three distributions using the Equifax data, zip codes outside of CBSAs are excluded. *Source:* Survey of Consumer Finances, NY Fed Consumer Credit Panel/Equifax and IRS Statistics of Income.

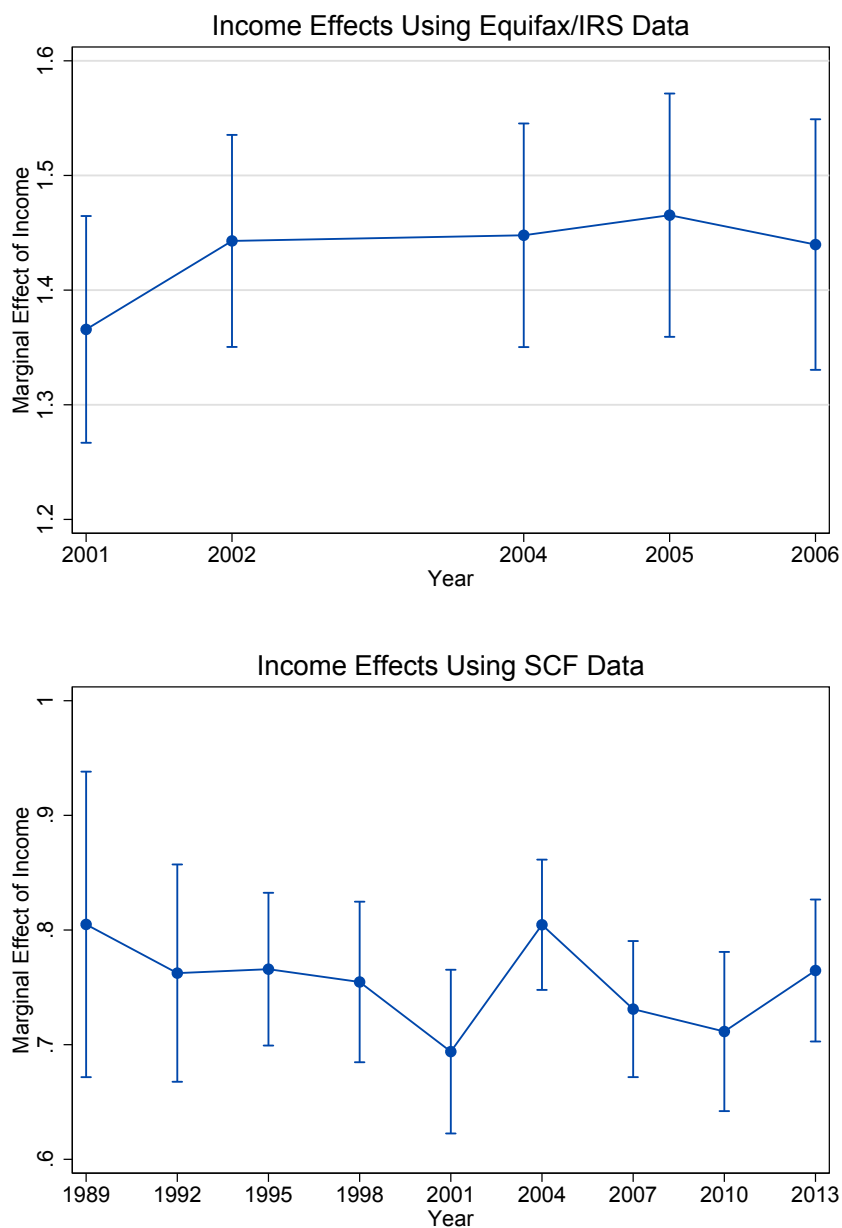


Figure 5. REGRESSION EVIDENCE ON THE RELATIONSHIP BETWEEN MORTGAGE DEBT AND INCOME AMONG U.S. ZIP CODES AND HOUSEHOLDS. *Note:* The top panel graphs income coefficients (and 95 percent confidence intervals) from a returns-weighted regression of zip code-level mortgage debt on income for all years between 2001 and 2007, save for 2003 (when IRS income data are not available). Coefficients are generated from a single pooled regression that includes interactions of the income variable with yearly dummies, and standard errors are clustered by CBSA (not CBSA-year). The bottom panel depicts income coefficients from a pooled Poisson regression for household debt in the SCF, in which the log of wage and salary income, dummies for the age of the household head (younger than 35, 35–44, 45–54, and 55–64), the number of children, and dummies for nonwhite and marital status are each interacted with yearly dummies. Households with heads 65 and older and households with no wage income are excluded. The reported coefficients are averages of estimates using the five implicates of the SCF. Standard errors are calculated as in Rubin (1987), but with no degrees-of-freedom adjustment. *Source:* NY Fed Consumer Credit Panel/Equifax and IRS Statistics of Income, and Survey of Consumer Finances.

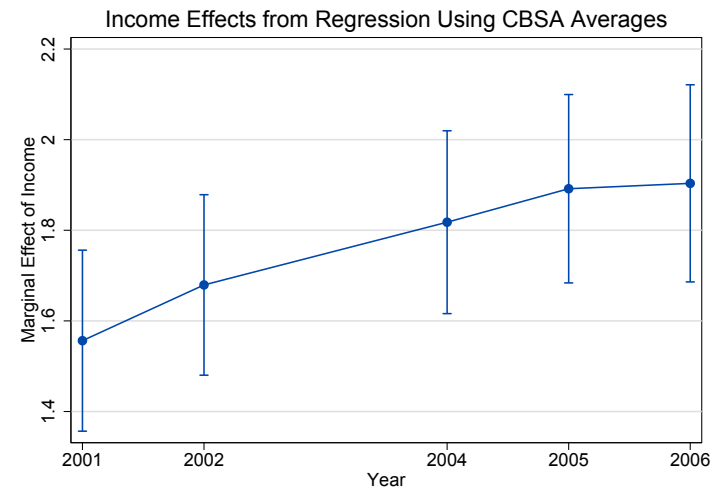
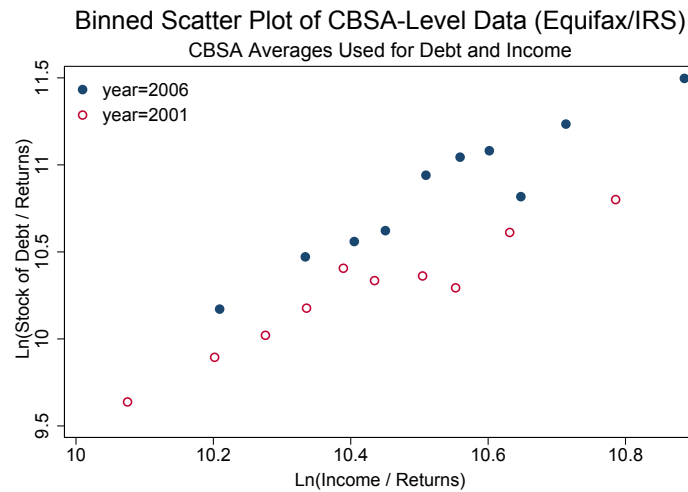
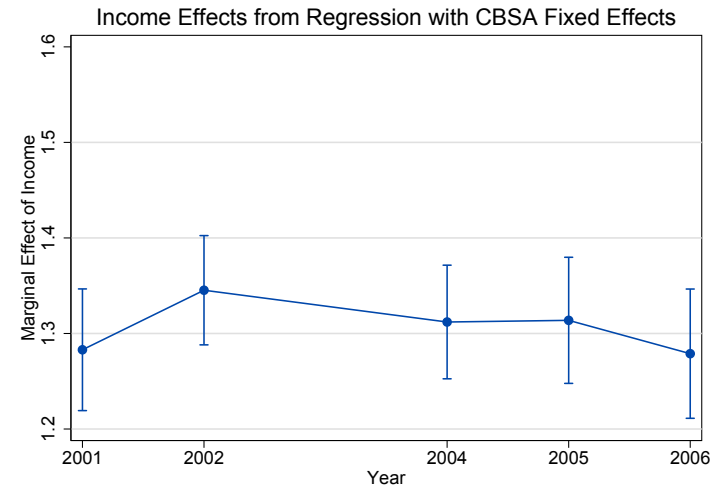
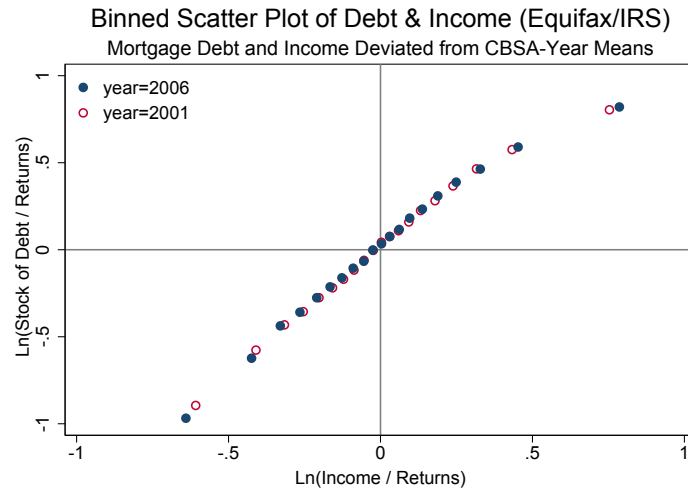


Figure 6. WITHIN-CBSA AND BETWEEN-CBSA RELATIONSHIPS BETWEEN MORTGAGE DEBT AND INCOME AMONG U.S. ZIP CODES. The top left panel is a binned scatter plot of zip code-level debt and income after both variables have been deviated from returns-weighted CBSA-year means. The top right panel depicts the income coefficients from a returns-weighted debt regression that includes CBSA \times year fixed effects as well as income \times year interactions. Standard errors are clustered by CBSA. The lower two panels use data on CBSA-level averages of total mortgage debt and wage and salary income across the 937 CBSAs in the Equifax/IRS dataset. *Source:* NY Fed Consumer Credit Panel/Equifax and IRS Statistics of Income.

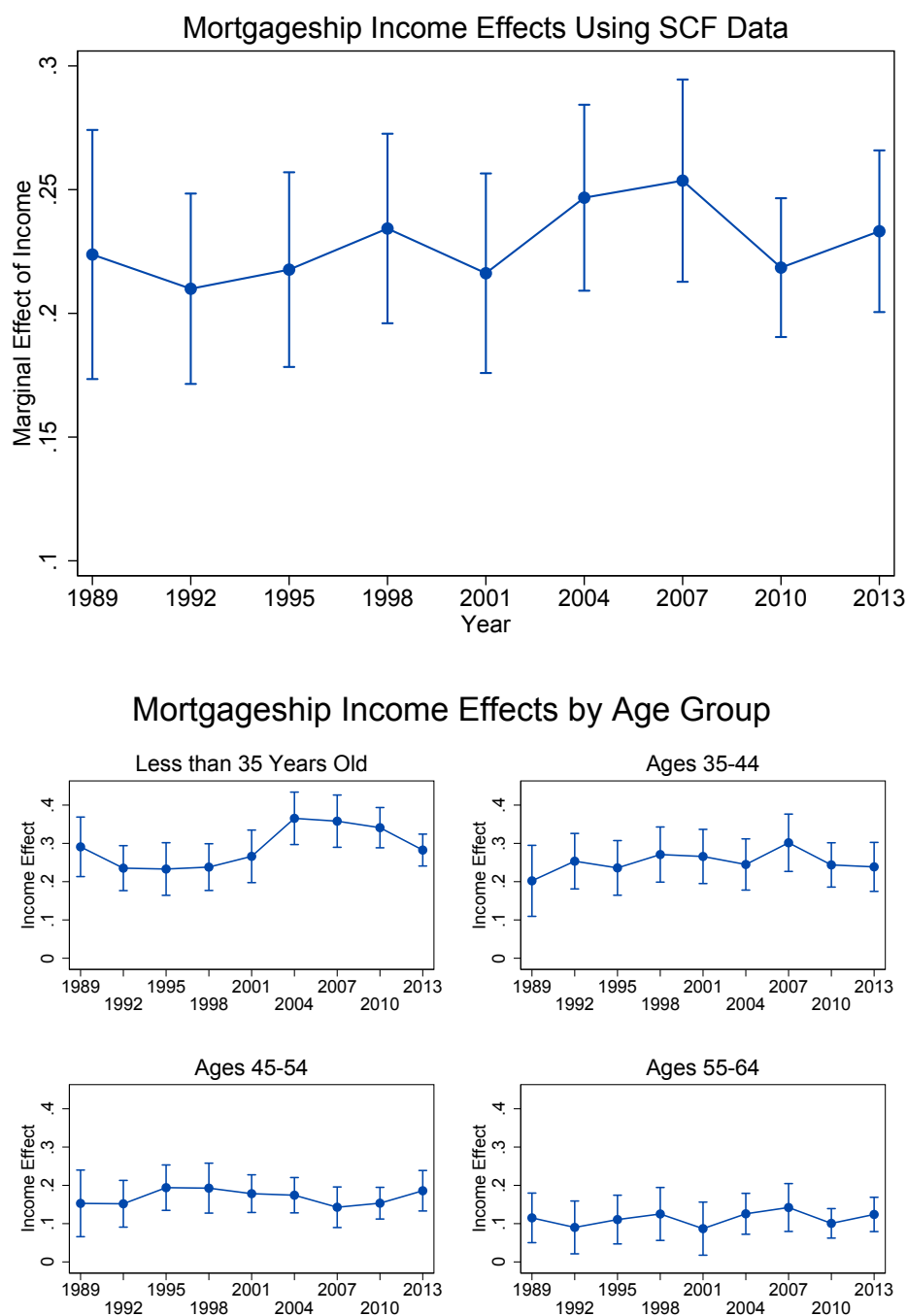


Figure 7. MORTGAGESHIP AND INCOME IN THE SURVEY OF CONSUMER FINANCES. *Note:* Each panel depicts estimated effects of log income on binary indicators for “mortgageship,” which is defined to be the presence of any mortgage debt for the household. All income effects are generated from logit regressions with the same right-hand-side variables and sample restrictions as the debt-value Poisson regressions depicted in the bottom panel of Figure 5. The panels at bottom interact the wage-income variable with indicators for the age group of the household head. All marginal income effects are calculated at the means of the regressors as measured by the first SCF implicate. *Source:* Survey of Consumer Finances.

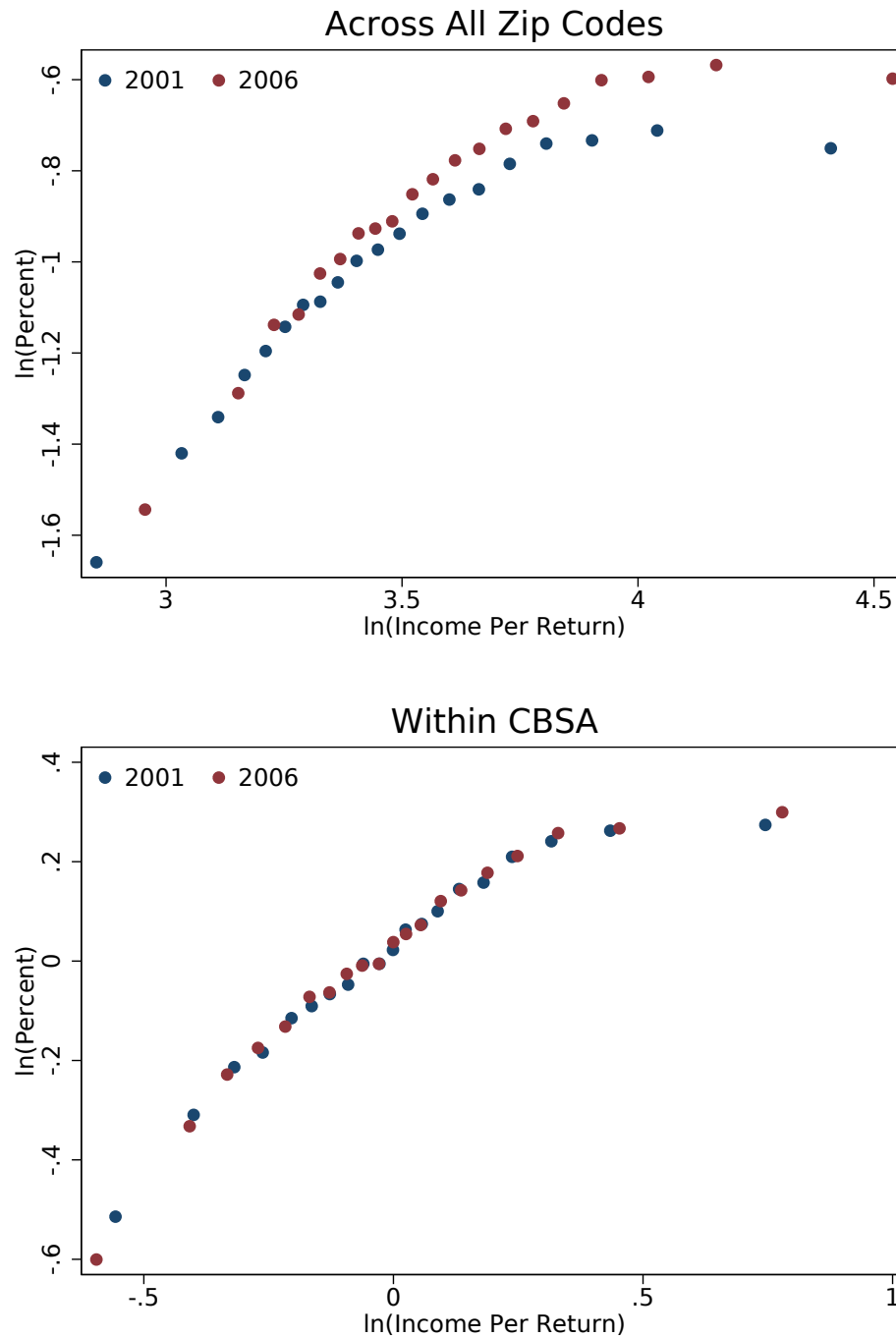


Figure 8. THE EXTENSIVE MARGIN OF MORTGAGE DEBT ACROSS ZIP CODES: 2001 AND 2006. *Note:* These panels plot the log of “mortgageship rates” across the wage-income distribution of zip codes, where mortgageship for a household is defined as the presence of any mortgage debt on a credit record. The debt and income data for the top panel are based on the distribution of income across all zip codes, while the bottom panel uses both log income and log mortgageship rates that have been deviated from CBSA means. *Source:* NY Fed Consumer Credit Panel and IRS Statistics of Income.

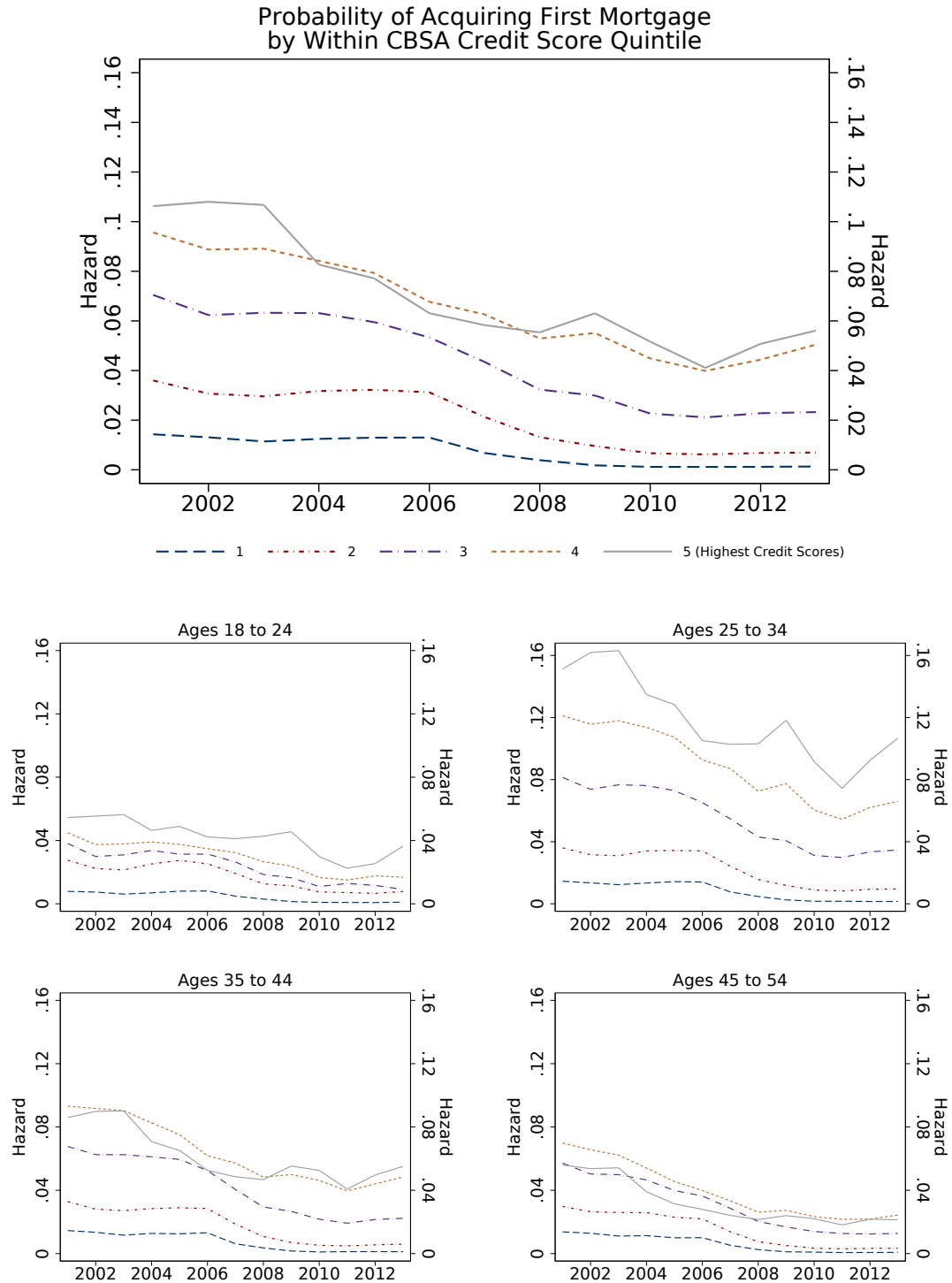


Figure 9. THE HAZARD RATE OF FIRST-TIME ENTRY INTO MORTGAGESHIP BY CREDIT-SCORE QUINTILE: 2001-2013. *Note:* These graphs plot the probability of obtaining a mortgage for the first time for individuals in specific credit-score quintiles over time. The probabilities are calculated by dividing the number of all individuals acquiring their first mortgages in a given year by the number of all people who had never taken out a mortgage by the previous year. The quintiles are based on credit scores relative to the average credit score of all residents of the CBSA; in the lower panels, the quintiles are calculated within age groups. The top panel displays rates for all individuals born in 1950 or later, while the bottom panels split this sample by age group. *Source:* NY Fed Consumer Credit Panel/Equifax.

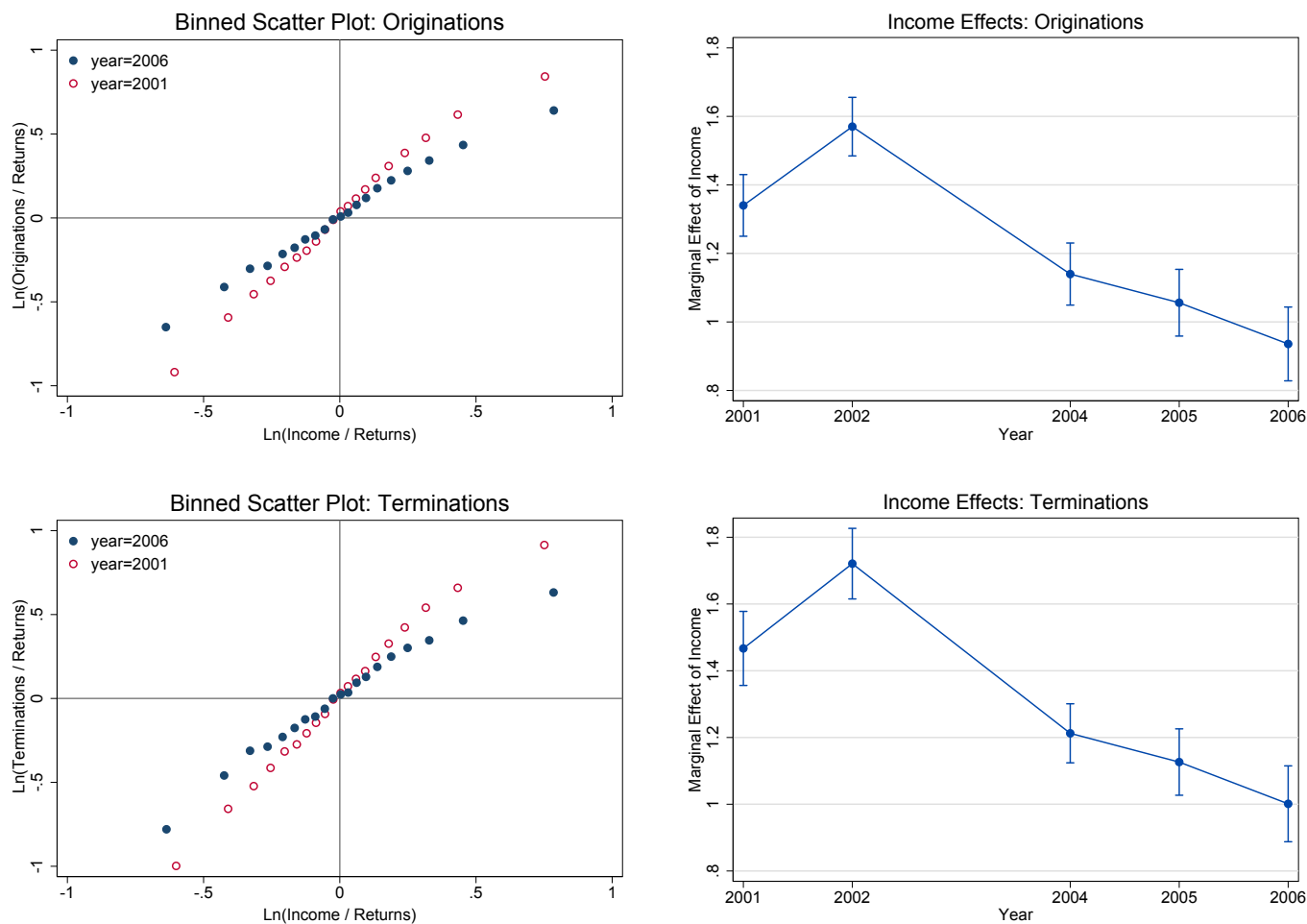


Figure 10. THE RELATIONSHIP BETWEEN GROSS MORTGAGE FLOWS AND WAGE AND SALARY INCOME IN CBSA-DEVIATED DATA. *Note:* The binned scatter plots in the panels at left are generated from deviations of log originations or terminations per tax return and wage income per tax return from CBSA \times year means. The income coefficients in the panels at right are generated from returns-weighted regressions of either log originations or terminations per tax return on both income \times year interactions and CBSA \times year fixed effects. Standard errors are clustered by CBSA. *Source:* NY Fed Consumer Credit Panel/Equifax and IRS Statistics of Income.

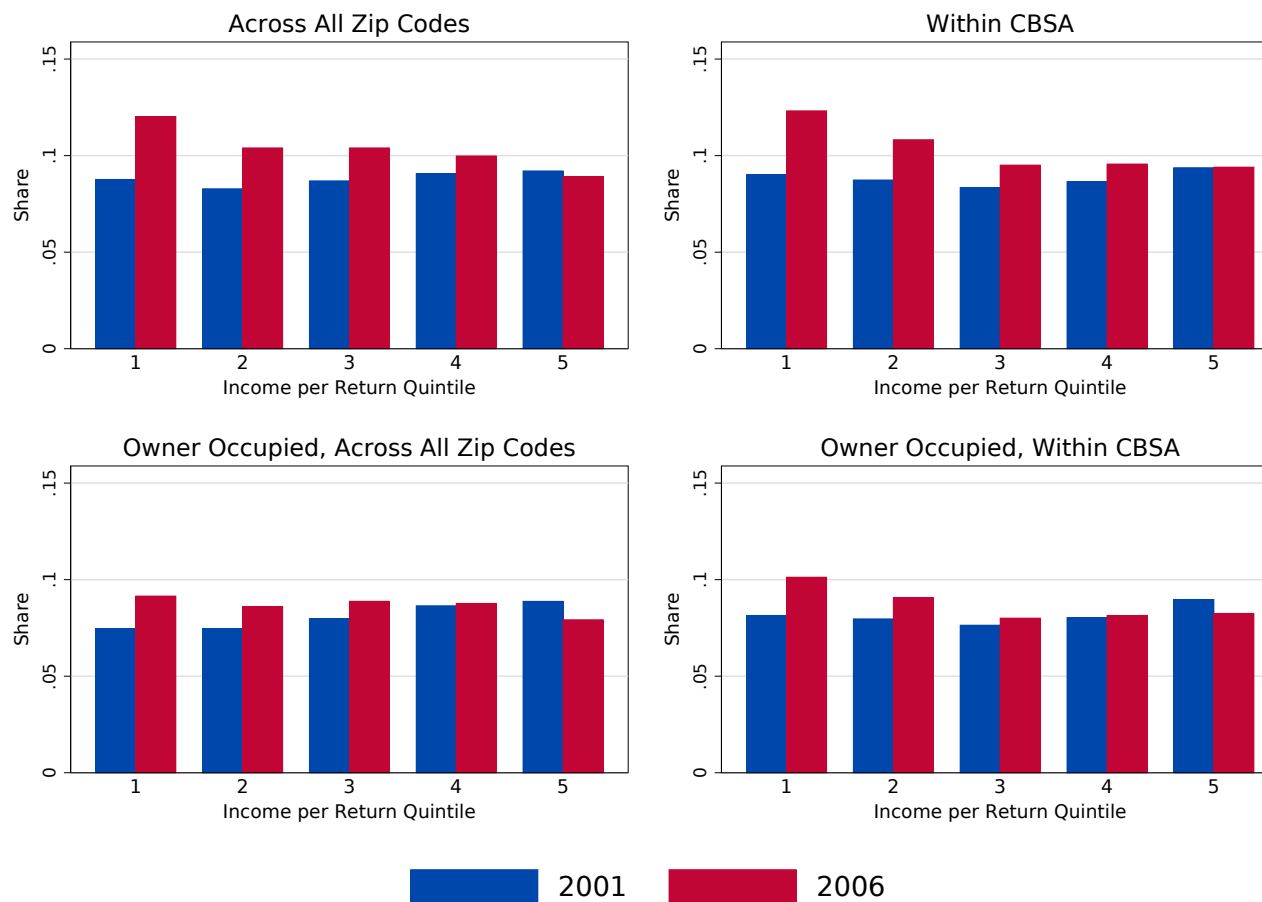


Figure 11. PURCHASE-MORTGAGE INTENSITY ACROSS INCOME CATEGORIES: 2001 AND 2006. *Note:* Purchase-mortgage intensity is defined as the ratio of new purchase mortgages (as measured in HMDA) to outstanding first liens (as measured in Equifax). The top two panels show that over the course of the mortgage boom, this intensity increased relatively more in low-income zip codes. This pattern obtains both when looking across all zip codes (top left panel) and within CBSAs by using CBSA-deviated zip code-level data (top right panel). The bottom two panels measure purchase-mortgage intensity in the same way but use only self-reported owner-occupied purchases from HMDA. These panels indicate that much of the increase in purchase-mortgage intensity apparent in the top two panels was driven by investors rather than by owner-occupiers. *Source:* Home Mortgage Disclosure Act (for mortgage originations), NY Fed Consumer Credit Panel/Equifax (for outstanding first liens), and IRS Statistics of Income.

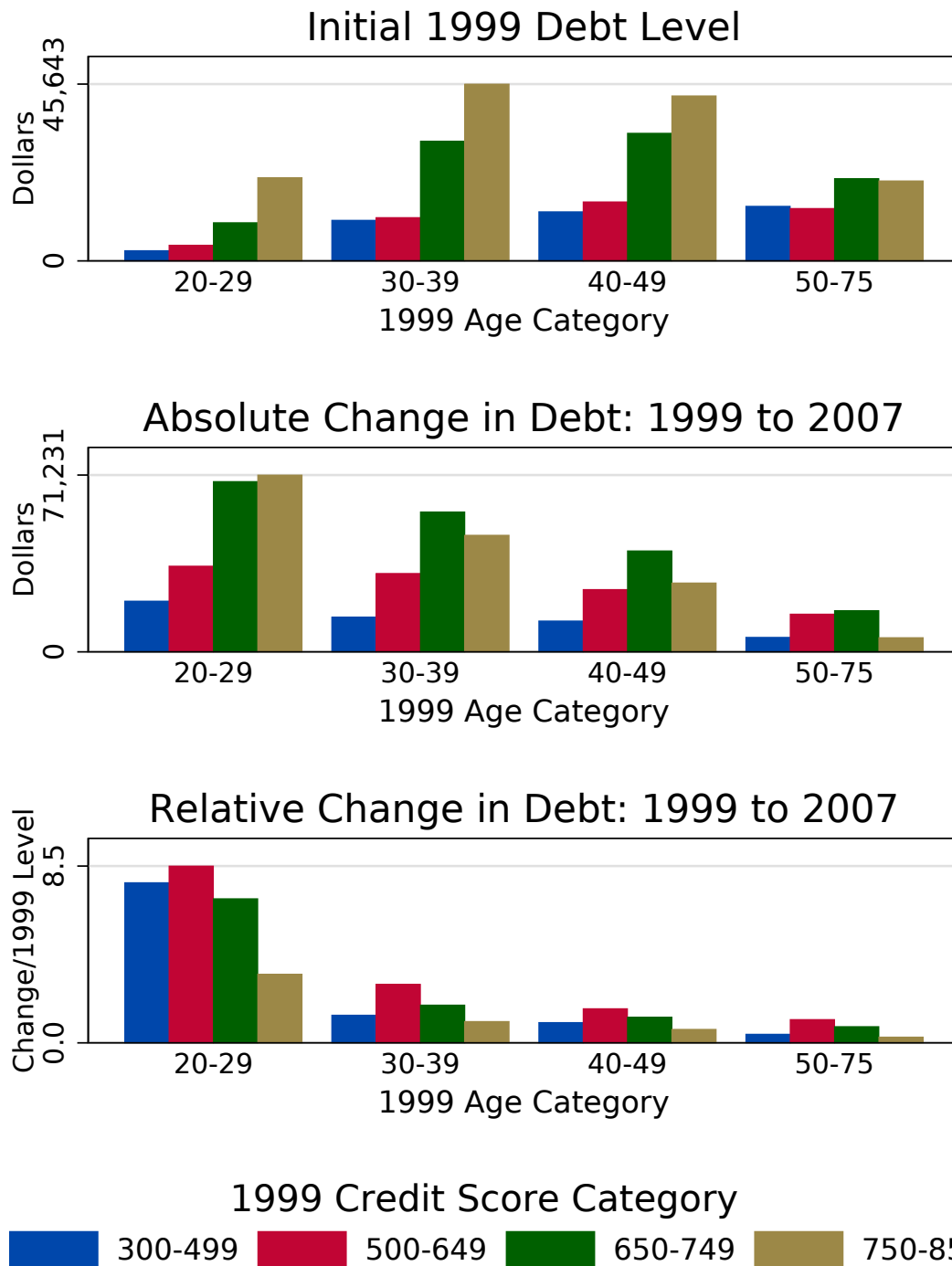


Figure 12. THE RELATIONSHIP BETWEEN 1999 DEBT LEVELS AND 1999-2007 DEBT GROWTH BY CREDIT SCORES AND AGE IN 1999. *Note:* The top panel depicts average dollar values of mortgage debt for demographic groups based on 1999 age and 1999 Equifax Risk Score, a type of credit score. The middle panel shows average absolute dollar-value changes in debt between 1999 and 2007 based on 1999 age and 1999 credit score. The bottom panel depicts average relative changes in debt, constructed by dividing the absolute changes in the middle panel by the initial levels in the top panel. *Source:* NY Fed Consumer Credit Panel/Equifax.

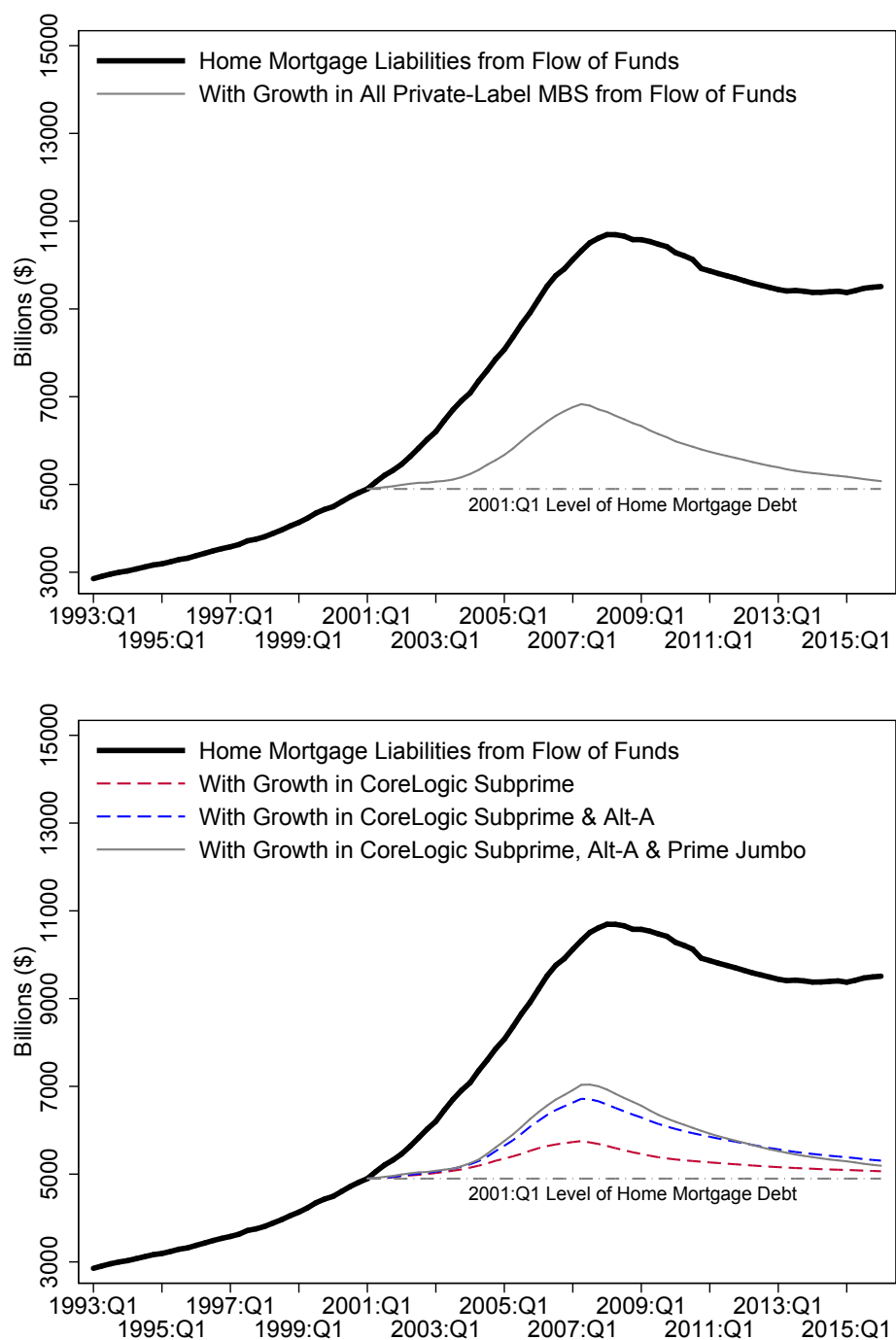


Figure 13. THE CONTRIBUTION OF PRIVATELY SECURITIZED MORTGAGE DEBT TO TOTAL MORTGAGE DEBT GROWTH. *Note:* In both panels, the heavy black line depicts U.S. aggregate mortgage liabilities for the household sector from the Federal Reserve’s Flow of Funds. The top panel also depicts a counterfactual series for aggregate debt growth assuming post-2001:Q1 growth only in the Flow of Funds measure of privately securitized mortgage debt. The bottom panel presents counterfactuals assuming exclusive growth in selected components of privately securitized mortgage debt from the CoreLogic Private Label Securities ABS Database. *Source:* Federal Reserve Board of Governors (Flow of Funds) and CoreLogic Private Label Securities ABS Database.

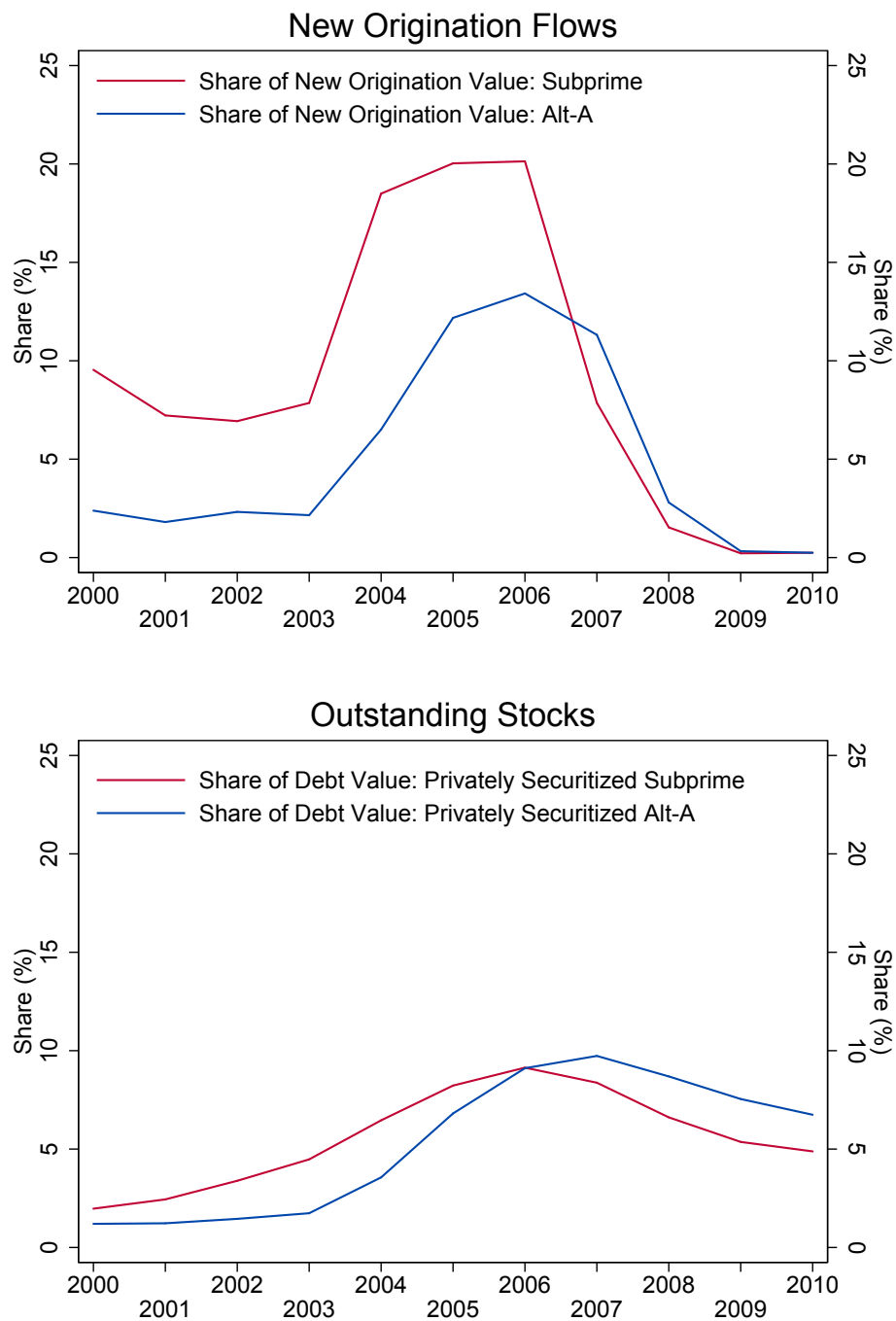


Figure 14. SHARES OF SUBPRIME AND ALT-A DEBT AMONG NEW ORIGINATIONS AND OUTSTANDING STOCKS OF DEBT. Note: The top panel graphs the dollar value of new originations for all subprime and Alt-A loans as a share of the dollar value of total originations, according to the Mortgage Market Statistical Annual. The bottom panel depicts the dollar value of outstanding stocks of privately securitized subprime and Alt-A loans from the CoreLogic ABS database as a share of the total outstanding mortgage liabilities of households from the Flow of Funds. *Source:* Mortgage Market Statistical Annual, CoreLogic Private Label Securities ABS Database, Federal Reserve Flow of Funds, and Mortgage Bankers Association.

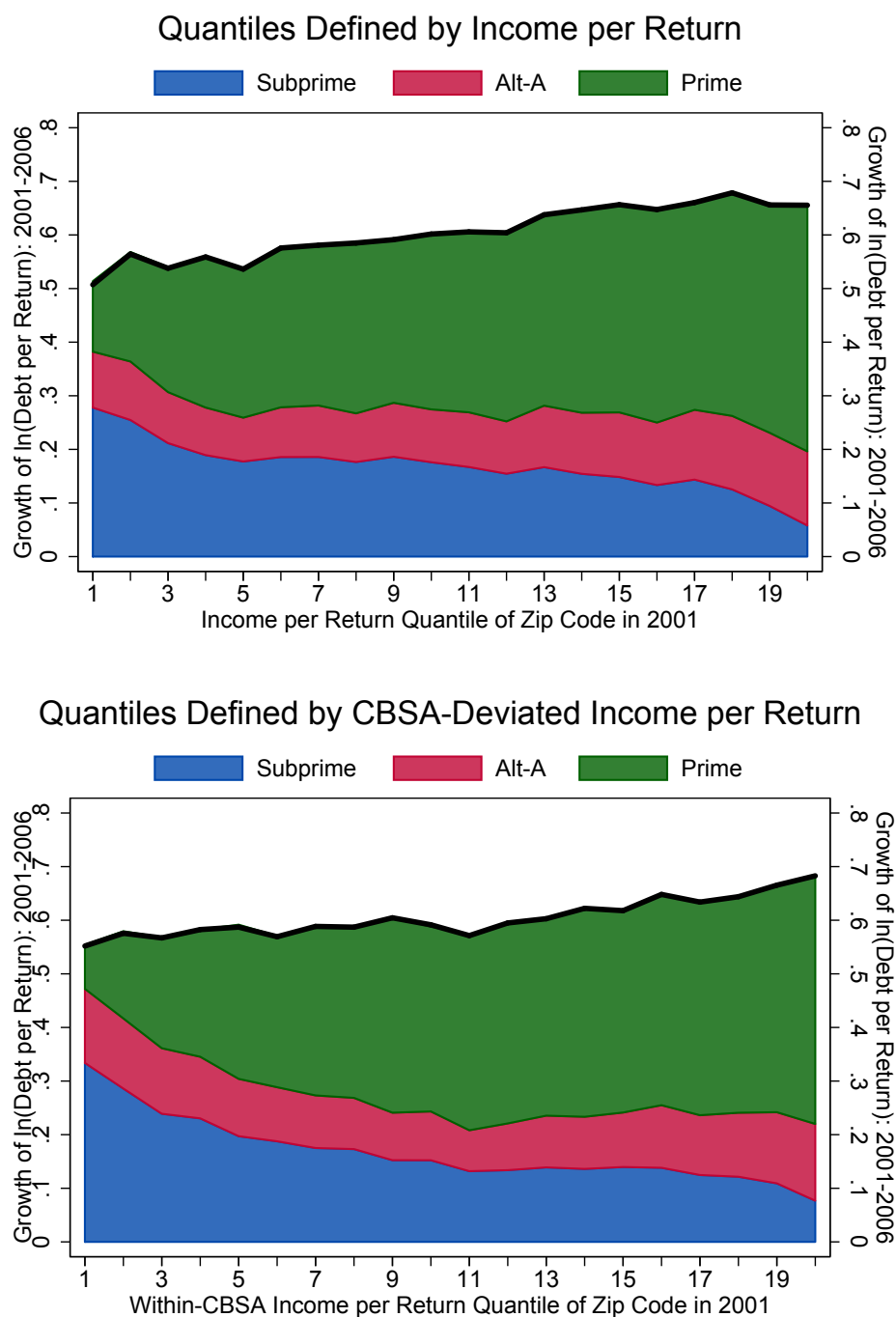


Figure 15. MORTGAGE DEBT GROWTH BY DEBT TYPE ACROSS THE INCOME DISTRIBUTION OF ZIP CODES: 2001–2006. *Note:* These graphs use data on subprime and Alt-A mortgage debt from the CoreLogic Private Label Securities ABS Database to show the 2001–2006 contributions of prime, subprime, and Alt-A debt for total debt growth among individual zip codes, sorted into 20 income-per-return categories. The top panel is based on the income distribution across all zip codes, while the bottom panel uses income per return deviated from CBSA means. To be included in the sample for either panel, a zip code must be located within a CBSA and have at least 500 returns from 2001 through 2006. *Source:* NY Fed Consumer Credit Panel/Equifax, CoreLogic Private Label Securities ABS Database, and IRS Statistics of Income.

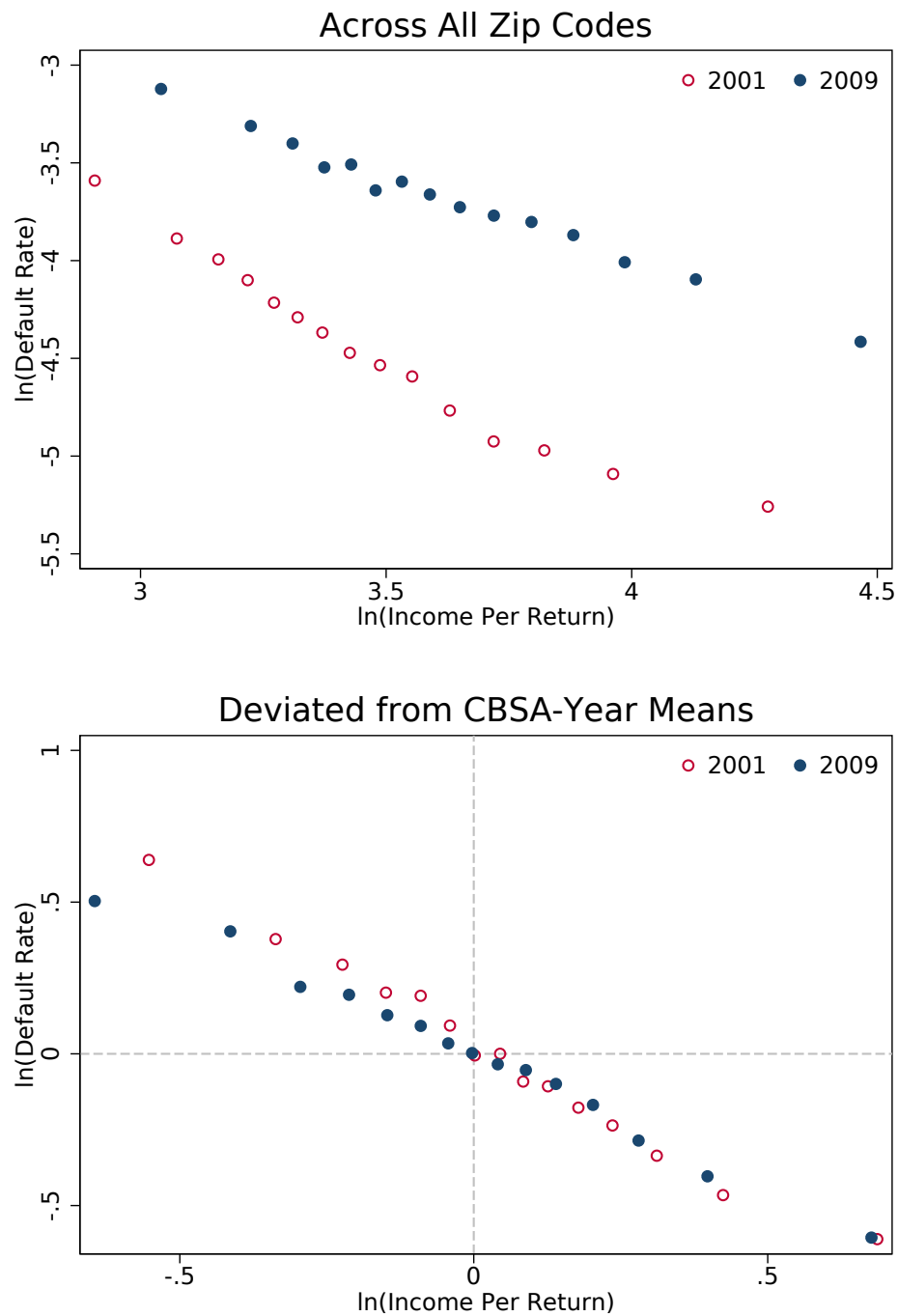


Figure 16. INCOME AND MORTGAGE DEFAULT RATES AT THE ZIP-CODE LEVEL. *Note:* These two panels are binned scatter plots of default rates from Equifax and IRS salary and wage income for zip codes in 2001 and 2009. Income is expressed as the log of per-return values, while the default rate is the ratio of all transitions to 90-day delinquency divided by those at risk of transitioning. The default rate is a quarterly measure; for an estimate of the yearly default rate, take the anti-log and multiply by four. In the top panel, the variables are not deviated from CBSA means, while in the bottom panel they are. *Source:* NY Fed Consumer Credit Panel/Equifax and IRS Statistics of Income.