Household Balance Sheets, Consumption, and the Economic Slump

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Abstract

The large accumulation of household debt prior to the recession in combination with the decline in house prices has been the primary explanation for the onset, severity, and length of the subsequent consumption collapse. Using novel county level retail sales data, we show that the decline in consumption was much stronger in high leverage counties with large house price declines. Levered households experiencing larger house price declines faced larger drops in credit limits, were unable to refinance mortgages into lower rates, and paid down existing debts at a faster pace. Using zip code level data on auto purchases and exploiting within-county variation, we show that the consumption response to declining house prices was stronger in areas with more reliance on housing as a source of wealth.

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Dramatic growth in household debt preceded both the Great Depression and the recent Great Recession.[1] Both episodes were also characterized by large and persistent declines in consumption. Figure 1 shows these facts for the Great Recession. As the left panel shows, the household debt to income ratio rose sharply to historically unprecedented levels before 2007. The right panel shows a sharp decline in retail sales during the recession; it also shows retail sales remained well below trend as of 2010.

Macroeconomists have increasingly recognized this pattern. Recent models hypothesize that accumulation of large debt balances in the household sector is a primary driver of deep and prolonged economic slumps (Eggertsson and Krugman (2011), Guerrieri and Lorenzoni (2011), Hall (2011), Midrigan and Philippon (2011)). While distinct in their approaches and mechanisms, the models share three main ingredients. First, ex ante *heterogeneity* among households generates elevated levels of household debt. Second, a *shock to household balance sheets* initiates the downturn as levered households pull back on consumption in response to the shock. Third, *frictions* in the economy, typically related to nominal price rigidities including the zero lower bound on nominal interest rates, dampen the consumption response by unlevered households. These three ingredients together, the argument goes, can theoretically generate long and severe downturns.

In this study, we provide evidence consistent with this argument. In particular, we show that the dramatic accumulation of household debt from 2002 to 2006 in combination with the collapse in house prices is the primary explanation for the onset, severity, and length of the subsequent consumption collapse. We exploit variation across geographic areas in the U.S. in the accumulation of household debt prior to the economic slump. Using a novel data set on county-

[1] In regards to the Great Depression, as Olney (1999) notes: "The 1930 drop in consumption resulted from the unique combination of historically high consumer indebtedness and punitive default consequences." See also Mishkin (1978).

level consumption patterns, we show that both durable and non-durable consumption fell much more dramatically in U.S. counties with high debt levels as of 2006. Further, we show that the economic downturn would have been much less severe in the absence of the household balance sheet channel.

Our empirical strategy is based on the assumption that geographic variation across the U.S. in household leverage prior to the recession proxies well for the heterogeneity in household debt levels in the models described above. In particular, we build on prior research showing that housing supply elasticity of a county is a primary factor determining the accumulation of household debt from 2002 to 2006. As Mian and Sufi (2011a) show, house price appreciation during the housing boom was much stronger in counties with inelastic housing supply. Existing homeowners in these counties responded to house price appreciation by borrowing aggressively, despite having no differences in observable measures of permanent income growth relative to homeowners in elastic housing supply counties. As a result, housing supply elasticity across counties produced a substantial amount of plausibly exogenous variation in household leverage prior to the recession.

Utilizing this variation, we begin by showing that households in high leverage counties--measured by the household debt to income ratio as of 2006--experienced a severe shock to their balance sheets in 2007 and 2008.[2] House prices in the highest decile of the household debt to income distribution declined by almost 30%, whereas house prices in the lowest decile were slightly higher. This dramatic decline pushed a large number of homeowners to have home values less than the value of their mortgages. A one standard deviation increase in debt to

[2]Throughout, household leverage refers to the instrumented (i.e., predicted) value of the 2006 household debt to income ratio where the instrument is the housing supply elasticity of a county.

income ratio as of 2006 is associated with 15% more homeowners with mortgages being underwater in 2009.

This severe balance sheet shock resulted in a significant drop in consumption. Using county-level data on retail purchases by category from MasterCard Advisors and zip code level data on auto sales purchases from R.L. Polk, we show a large negative effect of the household debt to income ratio as of 2006 on consumption growth during the slump. In terms of magnitudes, our estimates show that a one standard deviation increase in household leverage as of 2006 was associated with a 9 to 13% drop in durable consumption and a 5 to 8% drop in non-durable consumption. Alternatively, moving from the 10th to the 90th percentile of the household leverage distribution was associated with a 18 to 28% drop in durable consumption and a 10 to 18% drop in non-durable consumption.

Further, we show that the effect of high debt levels on consumption is similar when estimated using *within-county* variation in household leverage. More specifically, using zip code level data on auto sales, we show that the decline in auto sales is much larger in zip codes with a large number of subprime borrowers within counties with inelastic housing supply. These are precisely the zip codes that experienced the largest increase in home equity extraction during the housing boom (Mian and Sufi (2011)). The within-county analysis mitigates concerns that omitted county-level variables such as expectations shocks explain our results.

The household balance sheet shock in high leverage counties came from two sources: high ex ante debt levels and a large decline in house prices. One natural question to ask is: could the decline in house prices alone explain the collapse in consumption in these areas?

Our answer to this question is a definitive no--it was the *combination* of house price declines *and* high debt levels that drove the consumption decline. A number of results support

this view. First, the elasticity of consumption declines with respect to house price declines implied by our estimates are far too large to be driven by a pure housing wealth effect. We find elasticities on the order of 0.3 to 0.5 for non-durable goods and 0.5 to 0.7 for durable goods. Previous research suggests an elasticity of consumption with respect to housing wealth of 0.05 to 0.10 (Bostic, Gabriel, and Painter (2009)).

Second, we show that households responded to the balance sheet declines by aggressively reducing their debt burdens. Debt balances for households declined by $1.2 trillion from 2007 to 2010.[3] While a substantial fraction of this decline was driven by defaulting households, we also show that households that did not default reduced their debt burden by more than $250 billion during this time period. Both the increase in defaults and debt paybacks by non-defaulting households were much larger in high debt growth counties. This is consistent with the arguments in Eggertsson and Krugman (2011) and Guerrieri and Lorenzoni (2011) on the importance of the deleveraging process in explaining the severity of the recession.

Third, homeowners in high debt accumulation counties were unable to refinance their mortgages into historically low interest rates from 2008 to 2010. For example, the amount of mortgages refinanced in counties at the 10th percentile of the 2006 debt to income distribution was 90% higher in 2010 than in 2007, which reflected historically low mortgage interest rates. The amount refinanced in counties at the 90th percentile was actually 40% *lower* in 2010 than in 2007. We also find evidence that home equity credit availability for homeowners in high leverage counties declined from 2007 to 2010. These findings are consistent with the argument in Midrigan and Philippon (2011) that a reduction in home equity-based borrowing availability was a key reason for the economic downturn.

[3] These figures are based on Equifax data which have larger debt balances than the Federal Reserve Flow of Funds. See the text for more details.

Fourth, we show that the effect of house price declines on consumption declines during the recession was much stronger among zip codes with a lower non-housing wealth to total wealth ratio. In other words, the effect of house price declines was non-linear across the net wealth distribution--the consumption of households with low financial assets fell much more sharply for a given decline in house prices.

Taken together, our results show that high debt levels as of 2006 in combination with the collapse in house prices from 2007 to 2009 resulted in a sharp drop in consumption. We refer to this as the *household balance sheet channel*. We use our estimates to calculate the aggregate effect of the household balance sheet channel on consumption growth from 2007 to 2009. If we "shut down" the household balance sheet channel, auto sales would have fallen by only 13% instead of the observed 36% decline and non-auto retail sales would have grown by 2% instead of falling 12%. The details of this calculation are in Section 5. For auto sales where we have data through 2011, we show that weak household balance sheets continue to depress consumption even through the third quarter of 2011.

There is a large body of empirical research tying severe economic downturns with high levels of debt in the household sector (Glick and Lansing (2009, 2010), King (1994), Mishkin (1978), Olney (1999)). Our analysis here is most closely related to Mian and Sufi (2010) and Midrigan and Philippon (2011) who examine consumption patterns across the U.S. during the Great Recession. Relative to these studies, we use a novel measure of geographically disaggregated consumption, which allows us to estimate consumption elasticities for a broader set of goods for almost the entire population. Further, the zip code level data on auto sales is new and allows for a finer test of the household balance sheet view of the consumption collapse.

Finally, our analysis here directly ties the evidence on the balance sheet shock with the consumption decline.

The rest of the analysis proceeds as follows. The next section presents the data and summary statistics. Section 2 discusses the theoretical motivation and the empirical strategy. Section 3 shows the shock to household balance sheet, and Section 4 examines the drop in consumption. Section 5 concludes.

1. Theoretical Motivation And Data

A. Theoretical motivation

Figure 1 summarizes the key motivating facts behind this paper. The years from 2002 to 2007 saw an unprecedented buildup in household debt relative to income followed by a sharp collapse in consumption from 2007 to 2009. House prices also plummeted post 2007 after posting record highs. What explains the collapse in consumption or aggregate demand? Is there a connection between the build-up in debt, the fall in house prices, and the collapse in consumption? In this section we discuss the theoretical work that links changes in aggregate demand to household leverage and house price shocks.

Eggertsson and Krugman (2011) outline a model where an unexpected shock to the borrowing capacity of borrowers forces them to de-lever and cut back on current consumption. The authors think of the shock as "a sudden realization that assets were overvalued ..." which corresponds nicely to the house price declines in the data. Should lower consumption by borrowing households lead to a decline in aggregate consumption? In standard neo-classical models, the answer is no because any tendency for aggregate demand to fall poses downward

pressure on prices and interest rates. Hence prices and interest rates fall until sufficient new demand is created from the lenders to compensate for the fall in consumption by borrowers.

However, Eggertsson and Krugman (2011) point out that in the presence of nominal price rigidity and zero lower bound for nominal interest rates, it may not be possible to compensate for the fall in consumption by borrowers. If the initial level of household leverage and fall in borrowing capacity are large enough, the economy will be stuck in a "liquidity trap", characterized by reduced aggregate demand and zero nominal interest rates.[4]

Guerrieri and Lorenzoni (2011) present a similar model in which borrowing by debtors is driven by a desire to smooth idiosyncratic income shocks. Agents with negative prior idiosyncratic shocks have higher debt levels given a desire to smooth consumption over these shocks. As in the Eggertsson and Krugman (2011) model, an unexpected shock to the borrowing limit forces debtors to reduce consumption due to deleveraging and a need for higher precautionary savings.[5]

In related work, Midrigan and Philippon (2011) present a model where housing serves the dual purpose of a consumption good and a transactions role given a cash in advance constraint. A shock to the ability of households to extract equity from their homes forces levered households to cut back on consumption.

While the zero lower bound on nominal interest rates plays a prominent role in some general equilibrium models of aggregate demand, others assign an important role for frictions in labor force adjustment, labor mobility, and nominal wage rigidities. We do not take a stand on which of these frictions is more relevant. Instead our focus is on the common prediction of the

[4] See also Hall (2011) for a similar argument where zero lower bound on nominal interest rates prevents real interest rates from turning sufficiently negative to clear the goods market.

[5] Guerrieri and Lorenzoni (2011) also allow levered households to increase their labor supply in response to the shock; they show that under reasonable parameters levered households will choose to reduce consumption instead of increasing labor supply. For more on the employment implications of our findings here, see Mian and Sufi (2011b).

models mentioned above: in response to an unexpected shock to housing collateral, consumption fall will be stronger in more levered households and the fall in consumption is not compensated for by an equivalent increase by non-borrowing households.

B. Data

The data sets used in our analysis include county-by-year information on household debt, house prices, and measures of consumption. Given the large number of data sources that we have put together for our analysis, we have placed much of the data discussion in the appendix. The appendix includes information on the data sets that are publicly available and the contacts for buying data that we cannot share by license agreement.

Measures of household balance sheets, including debt, defaults, and home equity limits, come from Equifax Predictive Services. These data are available at the zip code level and are fully described in Mian and Sufi (2009). We also have a second data set available from Equifax that includes anonymous individual level data based on a random sample of 266,005 individuals taken in 1998 and followed through 2010. These data are fully described in Mian and Sufi (2011a). The individual level data allow us to split individuals by credit score and default status.

For the purposes of this paper, there are two disadvantages of the individual level data. First, the data set is based on a random sample as of 1998 and is not updated with new individuals over time. Second, the universe from which the data are sampled includes only zip codes for which we have Fiserv Case Shiller Weiss house price data.[6] The individual level data is limited to 3,079 zip codes that represent 52% of U.S. households. The zip code aggregated level data on the other hand covers the entire U.S. and is therefore the data set we use whenever we do not need individual level attributes.[7]

[6] Both of these restrictions were imposed given the original project for which Mian and Sufi (2011a) used the data.
[7] There is no qualitative difference in our results when we restrict ourselves to the individual level data sample.

Zip code-level data on house prices are from Fiserv Case Shiller Weiss and Zillow.com. CBSA-level data on house prices are from FHFA. Zip code level data on the amount of mortgages refinanced or taken out for home improvement are from HMDA. Information at the state level on the number of mortgages underwater is from CoreLogic. County-level information on new residential investment is from the Census, and county-level information on employment in the construction sector is from the Census County Business Patterns.

An important contribution of our paper in terms of new data is the ability to measure consumption at a geographically disaggregated level over time. There are two different sources of consumption data. The first is zip code level auto sales data from R.L. Polk covering 1998 to 2011. These data are collected from new automobile registrations and provide information on the total number of new automobiles purchased in a given zip code and year.

The second source of consumption data is at the county level from 2005 to 2009 from MasterCard Advisors. These data provide us with total consumer purchases in a county that use either a credit card or debit card for which MasterCard is the processor. The data are based on a 5% sample of the universe of all transactions from merchants in a county.

An important advantage of the master card data is that they break down total consumer expenditure by the NAICS code attached to the merchant providing the data. There are nine categories for merchants we use: furniture, appliances, home centers (i.e., home improvement), groceries, health-related such as pharmacies and drug stores, gasoline, clothing, sports and hobby, and department stores.[8] We group the MasterCard purchases into three categories:

[8] These correspond to 3-digit NAICS codes of 442, 443, 444, 445, 446, 447, 448, 451, and 452, respectively. For more information on the exact types of stores included in each NAICS, see http://www.naics.com/free-code-search/sixdigitnaics.html?code=4445. These categories are identical to those used by the Census measures of retail sales.

durable goods (furniture, appliances, home centers), groceries, and non-grocery non-durable goods (all remaining categories).

In the appendix, we provide further detail on the MasterCard data and how it compares to the aggregate retail sales information from the Census. We also address concerns that consumption patterns using credit card and debit card purchases may affect inference on the consumption declines in high versus low debt growth counties. In this regard, it is useful to keep in mind that our auto sales data from R.L. Polk represent the universe of all auto purchases and can therefore be used as cross-check on the results using MasterCard data. As we discuss in the appendix, the bottom line is that we believe that results using the MasterCard measures of retail sales are not systematically biased relative to the results we would obtain if we had the geographic micro data underlying the Census retail sales aggregate data.

Finally, one of the critical variables in our analysis is housing supply elasticity of a county. These data are from Saiz (2011), and more information on their construction is available in his article and in Mian and Sufi (2011a). These data are constructed at the Core Based Statistical Area level and are available on his website. The Saiz (2011) data are available for 257 of the 953 CBSAs in the United States. These 257 CBSAs make up 70% of total households as of 2000, and 75% of the debt, auto sales, and total MasterCard purchases as of 2006. Our sample for the instrumental variables specifications is limited to these 257 CBSAs, and so that analysis should be thought of as applying to approximately 70 to 75% of the U.S. population. Further, all of our other variables are available at the more disaggregated county level. There are a total of 868 counties that make up the 257 CBSAs in our sample. The median CBSA contains 2 counties. Given that the ultimate source of variation that we exploit is at the CBSA level, we cluster all standard errors at the CBSA level.

C. Summary statistics

We combine all of the data described above into a county-year level data set. Table 1 presents summary statistics. The household debt to income ratio as of 2006 was on average 2.5 across counties in our sample. Household debt across counties grew on average by 37% (42% when counties are weighted by population) from 2002 to 2006, which is reflected in the high debt growth in Figure 1. House price growth over the same time period was between 27% and 33% depending on the index.

The second set of variables in Table 1 shows the sharp reversal in house price growth and debt growth. For the FCSW index, house prices declined on average by 24% from 2006 to 2009 after increasing by 33% from 2002 to 2006. Default rates jumped sharply from 2006 to 2009, and household debt *declined* by 2.6%. The decline in debt is 5.9% when counties are weighted by total population. This represents a dramatic shift in debt growth from the housing boom years. The sharp economic downturn from 2007 to 2009 is reflected in consumption patterns. Auto sales on average dropped by 40%, other durables purchases dropped by 10%, non-durable non-grocery expenditures dropped by 9%, and groceries grew by 7%.

These statistics show a clear aggregate pattern. A sharp increase in debt and house price growth from 2002 to 2006 was preceded by a sharp reversal in both of these variables during the recession. Further, the sharp reversals in debt and house price growth were accompanied by large drops in retail sales of both durable and non-durable goods. Table 1 also includes summary statistics on the control variables used in the analysis.

Finally, Table 1 shows that there is a substantial amount of variation across the sample counties in terms of population; there are only two thousand households at the 10th percentile and 73 thousand at the 90th percentile. Given a number of very small counties, we weight all of

our regressions by the number of households as of 2000. The last two columns give the weighted mean and weighted standard deviation for all variables.

2. Understanding the Growth in Household Leverage

The theoretical models discussed above predict that the drop in consumption in response to an unexpected shock to house values or borrowing constraints will be concentrated among high leverage households. We test this key prediction in the subsequent section. However, before doing so it is important to understand the economic mechanism that led some households to borrow a lot more than others during the heart of the credit boom from 2002 to 2006 period. It is this variation in leverage across households that we will later exploit to estimate the impact on consumption.

A. The role of housing supply elasticity

Mian and Sufi (2009) show that the increase in household debt in the U.S. was driven by an expansion in the supply of credit (e.g. relaxation in lending standards) and not an improvement in credit demand conditions (e.g. higher productivity). Why did the expansion in credit supply not affect all households equally? This issue is taken up in Mian and Sufi (2011a), who exploit *geographic variation in housing supply elasticity* across CBSAs to explain cross-sectional variation in household debt. The starting point of this analysis is the land topology based measure of housing supply elasticity constructed by Saiz (2011).

The increase in credit supply in the U.S. allowed more households to buy a home, putting upward pressure on house prices. However, the increase in house prices was much stronger in areas with water bodies and hills that make it more costly to expand the stock of existing

housing. In other words, house price appreciation was much stronger in areas with naturally inelastic housing supply. This can be seen by estimating the following county-level equation:

$$HousePriceGrowth_{c,2002-2006} = \rho + \gamma * HousingSupplyElasticity_c + \varepsilon_c \quad (1)$$

$HousingSupplyElasticity_c$ represents the elasticity measure introduced by Saiz (2011). Column 1 in Table 2 shows that housing supply elasticity explains 33% of the variation in house price growth from 2002 to 2006. This is a very high fraction of variation explained by a single variable. Mian and Sufi (2011a) show that borrowing against the rising value of homes in inelastic housing supply areas was one of the main drivers of cross-sectional heterogeneity in debt growth across consumers. Equation (2) summarizes this relationship at the county-level, where $\widehat{HousePriceGrowth}_{c,2002-2006}$ represents the predicted house price growth from equation (1).

$$DebtGrowth_{c,2002-2006} = \alpha + \beta * \widehat{HousePriceGrowth}_{c,2002-2006} + \Gamma * X_c + \varepsilon_c \quad (2)$$

Column 2 shows that the elasticity of household debt with respect to house prices in equation (2) is 0.56. Columns 3 and 4 show that the effect of house price growth on debt growth is driven by borrowing against the home. Column 3 examines mortgage plus home equity debt growth and column 4 examines credit card debt growth. The effect of house price growth on home-related debt is very strong, whereas the effect of house price growth on credit card debt is in fact negative.

The fact that only home debt growth is positively correlated with house price growth shows that overall debt growth is driven by house prices, and not some spurious variable (such as income shocks) driving growth in all kinds of debt. The negative correlation with credit card debt suggests that greater availability of home-equity financing in inelastic cities enables consumers to rely less on more expensive credit card debt.[9] Column 5 shows that the second stage is robust to the inclusion of control variables.

Columns 2 through 5 show how the housing supply elasticity instrument – via its impact on house prices – led to a significantly higher growth in debt in inelastic counties. The theoretical models discussed in section 1.A. predict that in response to a shock to borrowing capacity, households with high *levels* of debt in their balance sheet will be impacted the most. Therefore, in the analysis that follows, we use the cross-sectional variation in the level of debt in household balance sheets, as measure by debt to income ratio as of 2006, to test whether consumption decline is related to debt accumulated prior to the credit shock.[10]

Column 6 shows that the debt to income ratio as of 2006, is strongly correlated with the growth in debt from 2002 to 2006 with an R^2 of 0.44. Columns 7 and 8 show that debt to income ratio is also strongly related to both the housing supply elasticity instrument, as well as the instrumented house price growth from 2002 to 2006. The magnitude is very large in column 7, a one standard deviation increase in elasticity is associated with a 0.4 increase in debt growth from 2002 to 2006, which is 40% of a standard deviation.[11]

B. Is housing supply elasticity correlated with other shocks?

[9] Using individual level data, Mian and Sufi (2011) show that home-equity financing is not used to pay down credit card debt by individuals. Therefore, the negative correlation at the county level in Table 2 column (5) is driven by the extensive margin, i.e. consumers in need of new credit are more likely to access home-equity as opposed to credit cards in inelastic housing supply cities.

[10] All results are materially unchanged if we instead use the growth in debt in a county from 2002 to 2006. We illustrate this fact in the appendix.

[11] Given that all regressions in the analysis are weighted by total population, we use the weighted standard deviations when calculating magnitudes. See Table 1.

A concern with the use of housing supply elasticity as an instrument for leverage accumulation is that it may be correlated with consumption patterns from 2007 to 2009 through a channel other than debt accumulation. Table 3 checks for this concern by correlating the instrument with measures of income, population, and residential investment growth from 2002 to 2006 with the instrument.

Columns 1 and 2 show that wage growth from 2002 to 2006 and the level of wages in 2006 are negatively correlated with housing supply elasticity. The areas that experienced the largest increases in house prices and borrowing had higher wages and wage growth from 2002 to 2006. However, as Mian and Sufi (2011a) point out, areas with inelastic housing supply were already on a stronger wage growth trajectory and there was no change in wage growth trends from 2002 onwards. This is confirmed in column 3 that shows that the change in wage growth from the four years prior to 2002 to the four years after 2002 was no higher in inelastic housing supply areas. As a result, there is no evidence of a differential *permanent* income shock from 2002 to 2006 in areas with inelastic housing supply. Since income shocks impact the debt to income ratio only through permanent income shocks, such shocks cannot explain the higher accumulation of debt relative to income in inelastic housing supply areas.

Column 4 shows that there was no differential population growth in high housing supply elasticity counties.[12] This might come as a surprise given the popular argument of massive migration toward the western United States and Florida from 2002 to 2006. The reason for the discrepancy is that many areas that attracted migrants, including Las Vegas, Nevada and Phoenix, Arizona, do not have particularly low scores on housing supply elasticity.[13]

[12] Population growth is measured at the state level and comes from the Census. We do not know of a county-level data source that measures total population movements through 2009.

[13] In fact, the unconditional correlation between debt growth and population growth from 2002 to 2006 is positive. However, this correlation turns to zero when we instrument debt growth using housing supply elasticity. This is one

Another concern is that the housing boom from 2002 to 2006 has an effect on consumption patterns from 2007 to 2009 not because of the accumulated debt, but because the sectors disproportionately helped by the housing boom suffered more during the crisis period. Columns 5 through 7 test for this and show that the growth in construction employment and the level of construction employment is uncorrelated with housing supply elasticity. This again may be surprising given that these areas were experiencing strong relative house price appreciation. The reason is that despite this strong house price appreciation, it is substantially more costly to expand housing supply in counties with low scores on the housing supply elasticity index. Consistent with this argument, column 7 shows that residential investment is negatively correlated with housing supply elasticity, but only weakly so.

3. Consumption Declines: The Household Balance Sheet Channel

We can now explore how heterogeneity in debt to income ratios as of 2006, driven by differences in housing supply elasticity, affected household balance sheets and consumption during the recession. Based on the analysis above, our core empirical specification is based on the following two stage least squares specification:

$$\Delta Y_{c,2007-2009} = \alpha + \beta * \widehat{DebttoIncome}_{c,2006} + \Gamma * X_c + \varepsilon_c \quad (3)$$

$$DebttoIncome_{c,2006} = \rho + \gamma * HousingSupplyElasticity_c + \Theta * X_c + \eta_c \quad (4)$$

Equation (4) is the first stage in which the debt to income ratio in a county *c* in 2006 is regressed on housing supply elasticity, as measured by Saiz (2011). We report this specification

of the major benefits of the housing supply elasticity instrument; it down-weights the influence of migration patterns.

above in column 7 of Table 2. The second stage in equation (3) examines growth in several outcome variables from 2007 onwards including house price growth and consumption growth. The critical parameter of interest is β, which represents the effect of the debt to income ratio in a county as of 2006 on the growth in variable Y from 2007 to 2009.

A. The house price balance sheet shock

We begin with house prices. The left panel of Figure 2 plots house price growth for the lowest and highest decile of the 2006 debt to income distribution, where debt to income is predicted using the housing supply elasticity instrument.[14] Deciles are weighted by the total number of households as of 2000. Consistent with the results in Table 2, high leverage counties experienced substantial relative house price growth from 1998 through 2006. This growth accelerated from 2002 onwards. However, from 2006 to 2010, high leverage counties experienced a major negative shock to house price growth. House prices in these areas declined by almost 30%. In contrast, low leverage counties experienced no decline in house prices.

Column 1 of Table 4 shows the correlation between the 2006 debt to income ratio and house price growth from 2007 to 2009. There is a strong negative correlation. Columns 2 through 4 show the second stage estimates from the estimation of equation (3) with house price growth from 2006 to 2009 as the left hand side variable. Household leverage as of 2006 is a very strong predictor of house price declines from 2006 to 2009. A one standard deviation increase in the debt to income ratio is associated with a 24% decline in house prices.

The magnitude of the instrumental variables estimate is higher than the OLS estimate in column 1. This reflects the possibility that high debt to income is partly a reflection of strength of

[14] Given the linearity of the first stage, our high and low decile leverage counties based on instrumented values are exactly the same as the high and low deciles of the housing supply elasticity distribution. One can equivalently think of these graphs as showing the differences between the highest and lowest deciles of the housing supply elasticity distribution.

the assets side of the household balance sheet. However, instrumenting debt to income with the elasticity instrument isolates the growth in debt due to the home-equity borrowing effect identified in Table 2. We will see this change from OLS to IV estimates later on as well.

The instrumental variables estimate is almost identical when we add control variables other than the wage level as of 2006 and wage growth from 2002 to 2006. However, when we add these two control variables in column 4, the estimate becomes *even more negative*. The reason is that high levels of income and high levels of past income growth are positively correlated with future house price growth, as shown in column 4. Moreover as Table 3 has already shown, areas with inelastic housing supply actually had *higher* levels of income as of 2006 and *higher* levels of past income growth from 2002 to 2006. As a result, controlling for these factors leads to an even larger effect of instrumented debt growth from 2002 to 2006 on subsequent house price growth.

This result will show up many times in our analysis, including when we examine consumption patterns. In other words, we would normally expect areas with higher past income growth and higher income levels to be affected *less* in a recession. Since debt accumulation was also stronger in these areas, controlling for income level and income growth would make the effect of household leverage on the outcome variables even stronger.

B. The house price shock and household leverage

The results above highlight the twin shocks experienced by households with higher levels of debt to income. All else equal, households with high levels of leverage are more exposed to a house price shock that reduces the value of the asset side of their balance sheet. However, the housing shock of 2007 was also significantly *stronger* for more levered households.

We want to emphasize that the house price shock and level of leverage at the time of the shock are not just statistically correlated, but also likely to be economically related. We have already emphasized how the accumulation of leverage was driven by the increase in house prices. Suppose that the unexpected shock is the realization that the high rate of house price growth is not sustainable. Then areas that had the highest house price appreciation and borrowed heavily against that appreciation would be most susceptible to the negative sentiment. For example, an inability to refinance existing mortgages by marginal borrowers might lead them into delinquency and foreclosure. The rise in foreclosures could in turn put additional downward pressure on house prices, generating a negative vicious cycle. Mian, Sufi and Trebbi (2011) provide direct evidence of this channel.

Given the strong coincidence of high household leverage and house price declines, a natural question is whether the impact on consumption is driven by leverage or the wealth shock of house price declines. We investigate this question in great detail in section 4.

The combined effect of a negative house price shock and high household leverage was that a large number of homeowners went underwater. The right panel of Figure 2 uses state level data from CoreLogic to illustrate a strong positive correlation between household leverage and the fraction of homeowners underwater. Columns 5 and 6 of Table 4 show the corresponding instrumental variables estimates. The estimate in column 5 implies that a one standard deviation increase in the debt to income ratio as of 2006 is associated with 15% more homeowners being underwater. The estimate becomes less statistically precise in column 6, but this is largely a function of a very small sample size. The p-value is 0.11, and the magnitude is still quite large.

C. Consumption

<u>1. County-level evidence</u>

Households in high leverage counties experienced a severe balance sheet shock from 2007 to 2009. How did this affect consumption? The left panel of Figure 3 plots auto sales for high and low household leverage counties from 1998 through 2010. These correspond to the highest and lowest deciles of the leverage distribution, where deciles are weighted by total number of households as of 2000. There is evidence of a slight increase in auto sales growth in high debt growth counties from 2002 to 2005, but the largest discrepancy comes after 2006. Beginning in 2007 and lasting until 2010, high leverage counties experienced a very large differential decline in auto sales. Auto sales in high leverage counties dropped by more than 40% from 2007 to 2009. As the right panel shows, this translates into a drop of 700,000 cars sold in just the top decile.

Auto sales did not drop at all in lowest decile of the household leverage distribution. Further, there was a sharp increase in auto sales in low leverage counties in 2010; in contrast, auto sales remained 40% below 2006 levels in high leverage counties.

Figure 4 presents the analogous plots for measures of other durables, non-grocery non-durables, and grocery expenditures. These data are available only from 2005 to 2009. Across all three categories, consumption fell sharply from 2006 to 2009 in high leverage counties relative to low leverage counties. Purchases of other durables, which consists of purchases at home centers, furniture stores, and home appliance/electronics stores, began to diverge in high debt growth counties as early as 2007, at which point the divergence increased through the recession. For non-durables, there was basically no difference until the heart of the recession. As we would expect given differential income elasticities, the effect of household leverage is largest for durable consumption and smallest for groceries.

Figures 3 and 4 suggest some subtlety in the timing of the effect of the balance sheet shock on consumption. Households in high leverage counties respond to the initial decline in house price growth by immediately pulling back on durable purchases. However, it was only when the deleveraging process began in full swing in 2008 and 2009 that high leverage households began pulling back on non-durable consumption and even groceries.

Tables 5 and 6 present the regressions that are analogous to Figures 3 and 4. The instrumental variables estimates are slightly larger than the OLS estimates for the same likely reason as in Table 4. In terms of magnitudes, the estimate in column 2 implies that a one standard deviation increase in the debt to income ratio of a county as of 2006 leads to a 8.5% decline in auto sales from 2007 to 2009, which is half of a standard deviation. The estimate in column 6 implies a one standard deviation increase in the debt to income ratio of a county as of 2006 leads to a 13% decline in other durable purchases, which is also half of a standard deviation. As we will show in the aggregate calculation in Section 5, these estimates imply very large aggregate effects of household leverage.

The estimates are almost identical when we include all control variables except wage growth from 2002 to 2006 and the natural logarithm of the 2006 per capita wage. In columns 4 and 8, the specification adds the control variables for wage growth from 2002 to 2006 and the 2006 wage level. The coefficient estimate on the debt to income ratio becomes even more negative. This is the same point as mentioned above with regard to house prices. Prior wage growth and wage levels are *positively* related to auto sales growth from 2007 to 2009, but also *positively* related to instrumented values of household leverage as of 2006. As a result, high debt growth counties experience a sharp drop in auto sales *despite* having higher previous wage growth and wage levels.

Table 6 repeats the analysis for non-durable components of consumption. One would expect the effects of household leverage on non-durable consumption to be lower than that for durable goods. This is confirmed in Table 6, especially for groceries (columns 5 through 8). The estimate in column 6 implies that a one standard deviation increase in household leverage leads to a 5% drop in grocery expenditures, which is 1/3 a standard deviation. However, it is important to recognize that even grocery purchases decline substantially more in high leverage counties during the recession.

While the results focus primarily on the recession years 2007 to 2009, we have auto sales data available through the third quarter of 2011. In the appendix, we show that the same pattern persists. By the third quarter of 2011, auto sales in high debt growth counties remained 40% below their 2006 levels. In low debt growth counties, auto sales rebounded to above their 2006 levels. In other words, high debt growth counties continue to hold back the consumption rebound even through the third quarter of 2011.

One potential concern with the results in this section is population growth. If population growth is declining rapidly in high debt growth counties from 2007 to 2009, then the negative correlation we find here may be mechanical. In the appendix we show that this is not the case. Population growth from 2007 to 2009 is uncorrelated with instrumented values of the debt to income ratio as of 2006. We present results in the appendix from consumption specifications using per capita consumption. The results are similar.

2. Zip code level evidence

Our analysis has so far been at the county level because consumption data coming from Master Card Advisors is only available at this level. However, auto sales data is also available at the zip code level. The availability of zip code level data allows us to (a) test the robustness of

our result using only within-county variation, and (b) test the extent to which the impact on consumption is driven by a pure wealth effect versus leverage. This section focuses on the former test.

Zip code level analysis is based on the following two-stage least squares specification with county fixed effects:

$$\Delta AutoSales_{zc,2007-2009} = \alpha_c + \beta * \widehat{DebtGrowth_{zc,2002-2006}} + \Gamma * X_{zc} + \varepsilon_{zc} \quad (5)$$

$$DebtGrowth_{zc,2002-2006} = \alpha_c + \beta * Elasticity_c * LowCreditQuality_{zc} + \Theta * X_{zc} + \eta_{zc} \quad (6)$$

Equation (6) represents the first stage. It is a county fixed effects specification where the instrument is the interaction of housing supply elasticity in county *c* with $LowCreditQuality_{zc}$, which is the fraction of borrowers with a credit score below 660 in the zip code. Recall that housing supply elasticity is fixed within a county and so it drops out of the specification with county fixed effects. Included in the matrix X_{zc} is the fraction of borrowers with a credit score below 660.

The economics behind the first stage is discussed extensively in Mian and Sufi (2011a). The basic idea is that the expansion in credit supply to marginal borrowers pushed house prices differentially higher in zip codes with a large number of subprime borrowers in inelastic housing supply elasticity cities. Strong relative house price growth occurred in these zip codes despite lower income growth (Mian and Sufi (2009)). The first stage estimation utilizes this variation as it strongly predicts debt accumulation by existing homeowners in these areas. In other words, debt accumulation occurred within inelastic counties differentially more in zip codes with many

low credit quality borrowers. We can use this differential increase in debt levels within a county to predict the drop in auto sales.

Columns 1 through 4 of Table 7 present versions of the first stage regression. For ease of interpretation we have redefined elasticity as (5 - elasticity), which we call "inelasticity." As the interaction term shows in column 1 shows, debt growth was substantially higher in zip codes with a high fraction of low credit quality borrowers in inelastic housing supply counties. This is the specification that is analogous to the one estimated in Mian and Sufi (2011a).

In the county-level regressions, the correlation between the debt to income ratio as of 2006 and the growth in debt from 2002 to 2006 was very highly correlated and made no difference for the results (as shown in the appendix). However, within counties, the correlation between debt growth and the level of debt is not as strong. A county fixed effects regression of the 2006 debt to income ratio on the growth in debt from 2002 to 2006 yields a between R^2 of 0.4 but a within R^2 of only 0.2.

We believe the reason for this between and across county discrepancy is the following. County-level debt to income ratios are in large part determined by housing supply elasticity, which is the same force behind both the dramatic growth in debt from 2002 to 2006 and the high level of debt as of 2006. In contrast, debt to income ratios within counties may reflect unobservable financial wealth in some zip codes; the growth in debt from 2002 to 2006 occurred primarily in more credit constrained zip codes (Mian and Sufi (2009)) whereas the 2006 debt to income ratio may still be higher in areas that were less credit constrained. This explains why the within-county correlation is less strong.

Columns 2 through 4 of Table 7 show exactly this point. As of 2002, before the sharp increase in debt growth, debt to income levels were actually *lower* in zip codes with a larger

fraction of subprime borrowers in inelastic housing supply CBSAs. As of 2006, the correlation went to 0; the corollary of these two results is that the change in the debt to income ratio from 2002 to 2006 was larger in zip codes with low credit quality borrowers in inelastic cities. Taken together, these results suggest that the within-county instrumental variables specification should be using the *growth* in the debt, not the 2006 level. This directly follows from the results in Mian and Sufi (2011a).

Column 5 presents estimates of the reduced form, where we regress auto sales from 2007 to 2009 at the zip code level directly on the instrument. As it shows, auto sales declined disproportionately more in low credit quality zip codes in inelastic counties. Column 6 presents the second stage estimates of equation (5). The estimated elasticity of auto sales growth from 2007 to 2009 with respect to debt growth from 2002 to 2006 is -0.96. The within-county elasticity estimates help mitigate concerns that omitted county-level variables are driving the results.

4. Why did consumption fall? The role of debt

The household balance sheet channel for consumption combines two effects. Households in high leverage counties had high ex ante leverage levels and subsequently experienced a sharper decline in house prices. This section shows that while house price decline is responsible for the decline in consumption, the effect of house prices is significantly stronger when households have more levered balance sheets. It is the *interactive effect* of house price declines and high leverage that results in the decline of consumption.

A. Consumption drops too large to be explained by pure housing wealth effect

Can a pure housing wealth effect quantitatively explain the consumption declines in high leverage counties? Table 8 shows evidence that the answer to this question is no. It presents the implied elasticities of consumption with respect to house price declines from our results. We begin by picking two points in the household debt to income distribution: the 10th percentile (1.5) and the 90th percentile (3.6). Column 1 of Table 8 shows the predicted values for all outcomes from Tables 4 through 6 for these two points in the distribution.[15] The predicted values from our specification imply that for low leverage counties at the 10th percentile of the 2006 debt to income distribution, house price growth from 2007 to 2009 was 15%, auto sales dropped by 33%, other durables and non-grocery non-durables declined by 2%, and grocery expenditures increased by 9%. Column 2 shows the analogous numbers for high leverage counties at the 90th percentile of the 2006 debt to income distribution.

Column 3 presents the difference between columns 2 and 1. These numbers reveal the relative percent change in each variable moving from the 10th to the 90th percentile of the distribution. As it clearly shows, high household leverage counties experienced much larger drops in house prices and all measures of consumption. We can use the differences in column 3 to obtain the implied elasticity of consumption with respect to house price declines. The units are already in percentage changes so the elasticity is obtained by simply dividing each relative consumption decline in column 3 with the relative house price decline a the top of column 3.

Column 4 presents the implied elasticities. The elasticity of consumption with respect to house prices is lowest for groceries and highest for other durables. The latter estimate reflects the fact that other durables includes furniture, home appliances, and expenditures at home improvement stores, which are all goods closely linked to the housing market. But the most

[15] The predicted values for house price growth are based on column 2 from Table 4, auto sales are from column 2 of Table 5, other durables are from column 6 of Table 5, non-grocery non-durables are from column 2 of Table 6, and grocery expenditures are from column 6 of Table 6.

important fact is how large the elasticities are. They range from 0.27 to 0.73; these are many orders of magnitude higher than the estimated elasticities in the extant literature. For example, Bostic, Gabriel, and Painter (2009) survey the literature and report estimates between 0.05 and 0.17.

The implied elasticities in Table 8 cast suspicion on the view that the drop in housing wealth alone in high leverage counties can explain the sharp declines in consumption. The effects are simply too large. We now turn to evidence on the important role of debt in explaining the magnitude.

B. Delinquency, deleveraging, and collateral-based borrowing

The notion that consumption declines are driven by deleveraging of highly indebted households plays an important role in the theoretical models of Eggertsson and Krugman (2011) and Guerrieri and Lorenzoni (2011). Deleveraging can occur through two channels; delinquency and active repayments in debt principal. Both channels appear to be very important.

Figure 5 plots the household default rate for high and low leverage counties, which are defined to be the top and bottom decile of the debt to income 2006 distribution after instrumenting with housing supply elasticity. High leverage counties experienced a relative decline in default rates from 2001 to 2005. From 2006 onwards, default rates reached historically unprecedented levels in these areas. By 2009, the default rate neared 20%. The default rate in low leverage counties increased, but by much less.

It is important to emphasize that delinquency can have important implications for consumption, perhaps even larger than pure deleveraging without default channel. First, a necessary condition for delinquency on home debt is negative home equity. Therefore, by the time a borrower defaults, he is likely to have lost a substantial fraction of his savings. Second,

delinquency has serious costs and as a result, we should expect the consumption of households to plummet before they choose to default. Third, delinquency sours credit scores, which can have knock-on effects on consumption (see for example Demyanyk, Koijen, and Van Hemert (2010)). Fourth, delinquencies lead to foreclosures, and Mian, Sufi, and Trebbi (2011) find important effects of foreclosures on durable consumption and residential investment.

In short, one of the reasons that debt has both good ex ante incentive and bad ex post risk sharing implications is that it is costly for a borrower to default. As a result, we should not interpret deleveraging via delinquency as having no consumption effects.

Figure 6 shows direct evidence on deleveraging. The solid blue line in Figure 6 plots total debt normalized to be 1 in 2007. As the line shows, household debt declined by about 13% from 2007 to 2010.[16] How much of the deleveraging is driven by defaults versus actual pay-backs to creditors? In the left and right panel of Figure 6, we use the individual level data from Equifax to answer this question. An individual is classified as a defaulter if at any time during 2008 to 2010 he is 120 days or more late on any of his debt payments, declares bankruptcy, or goes through foreclosure.

As the left panel shows, households that default at some point from 2008 to 2010 are precisely the households that increased their debt levels most dramatically prior to 2006. The decline in debt is very large for these households: debt obligations drop by 40% from 2007 to 2010. However, even households that do not default on debt obligations experience a decline in debt. The decline is more modest in percentage terms, but it represents a much larger segment of the population and a sharp reversal from borrowing during the 2002 to 2006 period.

[16] Figures 6 through 8 are based on the individual level data described in Section 1. Individual level data allows us to look at debt growth separated by borrower attributes such as credit scores and default status.

The left panel of Figure 6 uses individual level data described in Section 1. While these data are based on a random sample of individuals, the sampling frame was limited to zip codes with zip-level house price data available.[17] The selected zip codes tend to be more urban and are hence more susceptible to credit cycle swings. This can be seen from the fact that the drop in total debt from 2007 to 2010 is 13.1% in the individual level data but 6.8% in the aggregate data. Therefore, if we extrapolate the decline from individual level data to the entire population using the 0.45% sampling rate, we would be overestimating the decline in debt.

However, the individual data is still very informative in telling us about the relative contribution of defaulters and non-defaulters to the overall reduction in debt. The right panel does so by normalizing the total debt reduction in individual level data from 2007 to 2010 to the *actual* aggregate reduction in debt (i.e. $1.16 trillion). Defaulters are responsible for $870 billion dollars reduction in household debt between 2007 and 2010, while non-defaulters reduce debt by $287 billion during the same period.[18]

Figure 7 splits the deleveraging effect of Figure 6 by high and low leverage counties, where the counties are split into the top and bottom decile based on the predicted value of the 2006 debt to income ratio using housing supply elasticity as an instrument. Given the linearity of the first stage prediction, the deciles are equivalently the top and bottom decile of the housing supply elasticity distribution. The left panel shows a disproportionately large increase in debt for inelastic housing supply counties from 2002 to 2006. This disproportionate rise starts in 2002; there is no evidence of a rise before. The left panel also shows a disproportionate decline in total debt from 2007 to 2010.

[17] These zip codes represent 45% of total borrowing at the time of sample selection.
[18] These aggregate figures are based on Equifax data, which has higher amounts of total debt than the Flow of Funds, and therefore a larger nominal dollar decline in total debt from 2007 to 2010. This is primarily due to double-counting of individuals with joint accounts in the Equifax data. See Lee and van der Klaauw (2010).

The right panel shows in nominal dollar terms the differential deleveraging of high and low leverage counties from 2008 to 2010. Recall that these are equivalently the bottom and top deciles of the housing supply elasticity distribution. Counties with the highest leverage ratio as of 2006 reduced their debt by $150 billion from 2007 to 2010. Counties with the lowest leverage ratios reduced their debt by only $50 billion.

Another useful cut of the data to consider is between high and low credit quality individuals. Mian and Sufi (2011a) show that low credit quality borrowers were much more aggressive in their extraction of home equity in response to house price growth from 2002 to 2006. The left panel of Figure 8 splits the sample based on the top and bottom quartile of 2000 credit score and shows the same result. Low credit quality households were more aggressive in the deleveraging process from 2007 to 2010. The right panel quantifies this effect in dollars terms. While the deleveraging effect is stronger for individuals with low credit scores in percentage terms, low credit score individuals tend to borrow smaller loan amounts. Therefore total debt reduction in dollar terms is not much different between low and high credit score borrowers.

The first four columns of Table 9 show the second stage estimation of equation (3) with debt growth from 2007 to 2010 as the left hand side variable. Consistent with the evidence in Figure 7, the instrumented value of the 2006 debt to income ratio has a strong negative effect on debt growth from 2007 to 2010. The magnitudes are very large: a one standard deviation increase in the debt to income ratio leads to a 5.5% decline in debt, which is 2/5 a standard deviation.

It is important to emphasize that deleveraging is not the only manner in which high levels of debt may affect consumption. For example, Midrigan and Philippon (2011) emphasize the loss in the ability to borrow against the home as the crucial reason consumption declines. Columns 5

and 6 present the second stage estimation of equation (3) where home equity limit growth from 2007 to 2010 is the left hand side variable. There is a strong negative effect. A one standard deviation increase in the 2006 debt to income ratio is associated with a 5% reduction in home equity limits, which is 1/4 a standard deviation.

Given the extremely low interest rate environment from 2008 to 2010, another relevant measure of collateral-based borrowing is refinancing behavior. In column 7 and 8, we examine the growth in the flow of mortgage debt for refinancing or home improvement purposes from HMDA. It is important to emphasize that this is the growth in a *flow* variable. The results show that high household leverage is associated with a sharply negative effect on refinancing from 2007 to 2010. The estimate in column 7 is very large. A one standard deviation increase in the 2006 debt to income ratio is associated with a 63% decline in refinancing growth from 2007 to 2010, which is more than a one standard deviation decline.

Alternatively, using the estimate in column 7, counties in the 10th percentile of the debt to income distribution increased mortgage refinancing activity by 90 percent in 2010 relative to 2007. This is consistent with an effect we would expect given sharply lower interest rates. In contrast, for counties in the 90th percentile of the 2006 debt to income distribution, mortgage refinancing activity was actually down by 40 percent. This dramatic difference is consistent with arguments that underwater homeowners have been unable to refinance into historically low interest rates (e.g., Boyce, Hubbard, and Mayer (2011)).

C. House prices, consumption, and non-housing wealth

The household balance sheet channel represents the combination of high ex ante debt levels and a dramatic collapse in house prices. The evidence above on deleveraging, delinquency, and collateral-based borrowing suggest that debt levels matter because they lead to

a sharper drop in consumption than a standard wealth effect. We test this idea more formally in Table 10. The idea behind the test is that if debt matters, house price declines should have a larger affect for home owners with less financial wealth.

We test this hypothesis by constructing the ratio of non-housing wealth to total wealth in a zip code as of 2007. The numerator of this variable is computed by taking the total non-housing wealth for the U.S. economy from the Federal Reserve Flow of Funds data, and distributing it across zip codes according to the share of total capital income (i.e. income from dividends, interest and business) represented by a zip code according to IRS data. The denominator of this variable is the numerator plus the total value of owned homes in the zip code. The latter is computed using the number of homes owned by households in a zip code according to the 2000 census, scaling up the number of homes over time using population growth and increase in homeownership rate, and estimating the market value of these houses using the house price data from Zillow.com.

Column 1 in Table 10 shows that the elasticity of auto sales with respect to consumption is very large: 0.7. As in Table 7, this estimate shows that the elasticity of consumption with respect to house price declines is too large to be explained by a housing wealth effect alone. Column 2 shows that the elasticity of auto sales growth to house price growth is significantly *smaller* in zip codes with a high fraction of non-housing wealth to total wealth. The magnitude is large. For counties where all wealth is tied to the home, the elasticity is twice as large as the average effect.

Columns 3 and 4 repeat the analysis in columns 1 and 2 with county fixed effects. These estimates exploit only within-county variation. The results are nearly identical. The interpretation is as follows: two homeowners in the same county respond very differently to house price

declines depending on their non-housing wealth to total wealth ratio. In particular, the homeowner is much more elastic to house price changes if they depend more heavily on housing as a source of their wealth. In other words, for a given change in house prices, homeowners with lower financial wealth respond much more aggressively. This is inconsistent with a standard wealth effect operating equally across the entire population.

5. Aggregate Calculation

We are now in a position to calculate the aggregate effect of the household balance sheet channel on consumption patterns during the recession. We begin with the estimated effect of consumption growth from 2007 to 2009 with respect to the debt to income ratio as of 2006. To be conservative, we use the instrumental variables estimate from specifications with no control variables. For each county, we estimate the predicted 2007 to 2009 consumption change based on the instrumental variables regression. We then subtract from this predicted consumption change, the predicted consumption change for the county in the lowest percentile of 2006 debt to income ratio.[19] We then multiply this number by the level of the county's consumption in 2007, and add up the result across all counties. We conduct this exercise for two variables: auto sales and total non-auto retail purchases from the MasterCard data.

The number computed above represents the total "in-sample" impact of the household balance sheet channel. It is calculated by integrating the cumulative effect of the debt to income ratio as of 2006 as we move from the 1st percentile to the county with the highest 2006 debt to income ratio, where the debt to income ratio is instrumented using housing supply elasticity. We scale this total in-sample effect by total consumption as of 2007, which provides us the percentage change in consumption that is due to the household balance sheet channel.

[19] This calculation is set to zero for counties below the 1st percentile in (instrumented) debt growth from 2002-06.

Using this methodology, our estimates imply that the cross-county variation in the household debt to income ratio as of 2006 is responsible for a 22% decline in auto sales and a 14% decline in other retail sales. The actual in-sample growth in these variables from 2007 to 2009 was -36% for auto sales and -12% for non-auto retail sales. If we subtract the household debt to income effect from the actual change in consumption, we obtain an estimate of the "counter-factual," i.e., the change in consumption growth in the absence of the household balance sheet channel. Our estimates suggest that in the absence of this channel auto sales would have declined by only 15% and non-auto retail sales would have grown by 2%. In other words, the consumption declines during the recession would have been much less severe.

6. Conclusion

Until recently, macroeconomic models often abstracted away from variation across households in balance sheet strength. In this paper, we show that weak household balance sheets played a central role in the dramatic collapse in aggregate demand from 2007 to 2009, and the continued weakness in consumption through 2011. We show that the presence of high levels of leverage implies that a large negative shock, like the shock to the housing market, has serious distributional implications. In particular, households with high debt balances experience the sharpest reduction in net worth when a large asset class such as housing loses value.

We also show that net worth declines resulting from high household debt and a collapse in asset values have serious implications for the real economy through their impact on consumption. Highly levered households cut back drastically on their consumption in order to repair their impaired balance sheets. Despite a sharp reduction in interest rates, there is no

compensating increase in consumption by the non-levered households. The net result is therefore a large reduction in aggregate demand.

We quantify this effect in this paper through the use of disaggregated, county-level consumption data. Measuring consumption has long been a challenge, especially at a disaggregated level and over long time periods. We overcome these challenges with a novel data set on county and zip code level consumption of new automobiles, and county level consumption of durable, non-durable and grocery purchases. Using prior literature on the relationship between housing supply elasticity and house prices, we instrument the household debt levels with housing supply elasticity of the county.

Our estimates show that the household balance sheet channel is responsible for a very large fraction of the decline in consumption during and after the recession. Further, household balance sheet problems continue to depress consumption through 2011. The distributional implications of large wealth shocks in the presence of leverage cannot be ignored.

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Figure 1
U.S. Household Leverage and Retail Sales

The left figure plots the household debt to income for the United States. Household debt is from the Federal Reserve Flow of Funds and income is measured as wages from the NIPA accounts. The right panel plots U.S. retail sales from the Census. It is natural logarithm scale with 1992 substracted. The dotted line represents the predicted linear trend using pre-2007 data and restricting the constant to be equal to the 1992 level.

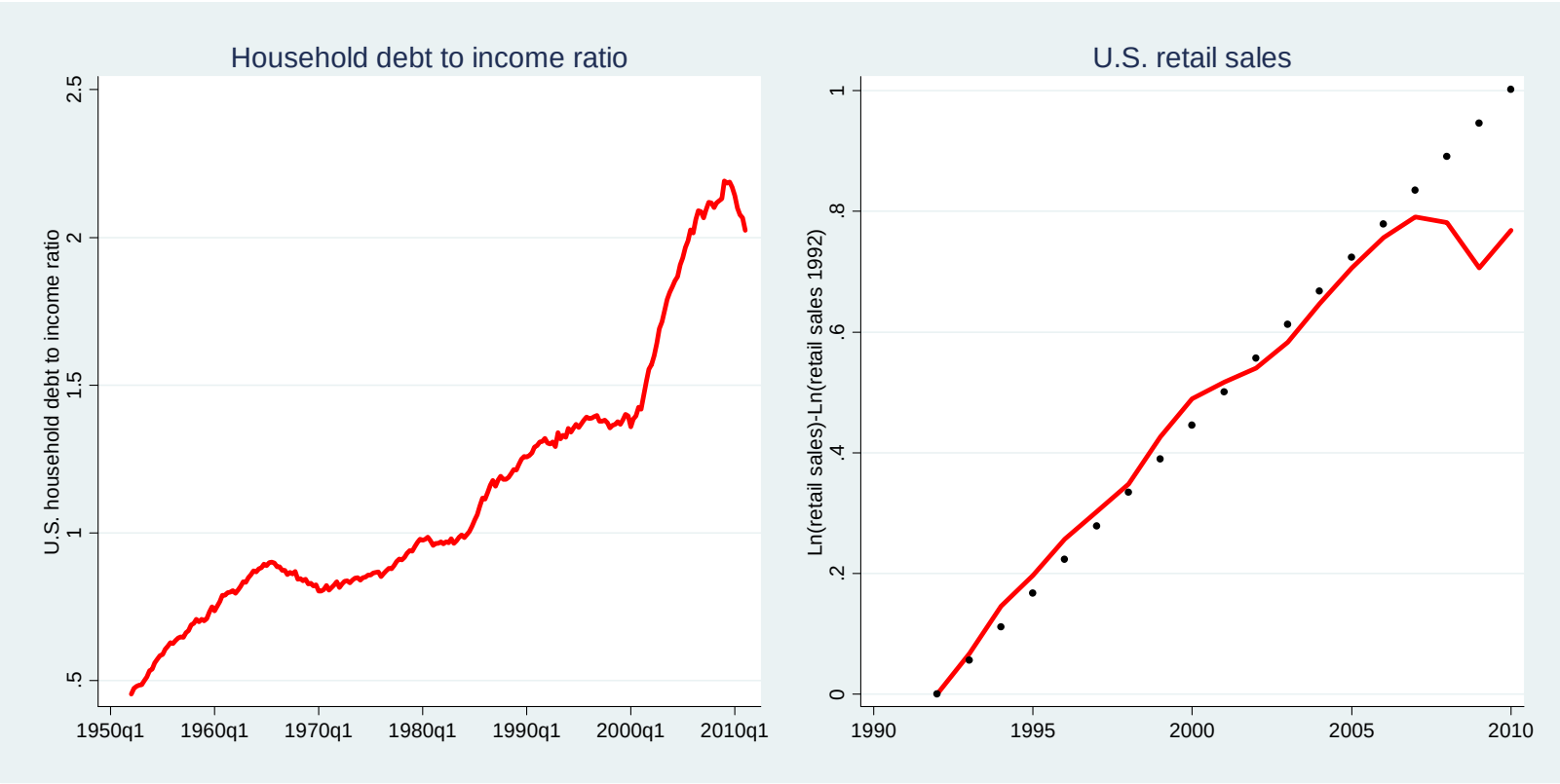

Figure 2

House Prices and Underwater Homeowners for High and Low Leverage Counties

The left panel of this figure plots house price growth from FHFA for high and low leverage counties. High and low are defined to be the top and bottom decile of the predicted value of the 2006 debt to income ratio, where housing supply elasticity is used as an instrument. Given the linearity of the first stage prediction, high and low debt growth counties are also the highest and lowest decile of the housing supply elasticity distribution. The deciles are weighted by population, and both series are normalized to be 1 in 2006. The right panel presents the state-level correlation between the 2006 debt to income ratio and the fraction of homeowners with mortgages that are underwater as of 2009. The latter data are from CoreLogic.

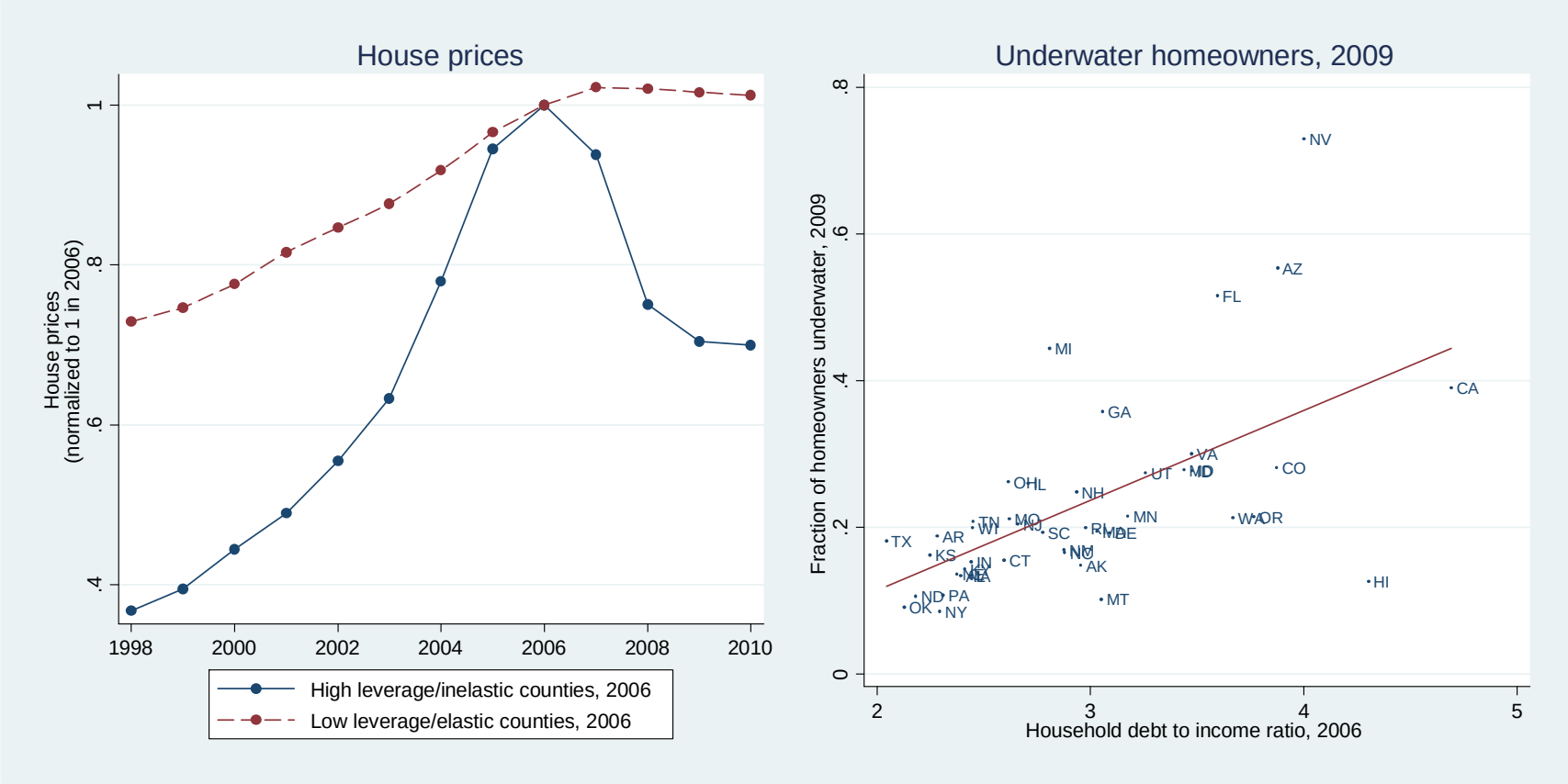

Figure 3
Auto Sales for High and Low Leverage Counties

The left panel plots auto sales for high and low leverage counties, where both series are normalized to be 1 in 2006. High and low are defined to be the top and bottom decile of the predicted value of the 2006 household debt to income ratio, where housing supply elasticity is used as an instrument. The deciles are weighted by population. Given the linearity of the first stage prediction, high and low leverage counties are also the highest and lowest decile of the housing supply elasticity distribution. The right panel shows the change in auto sales since 2006 for high and low leverage counties.

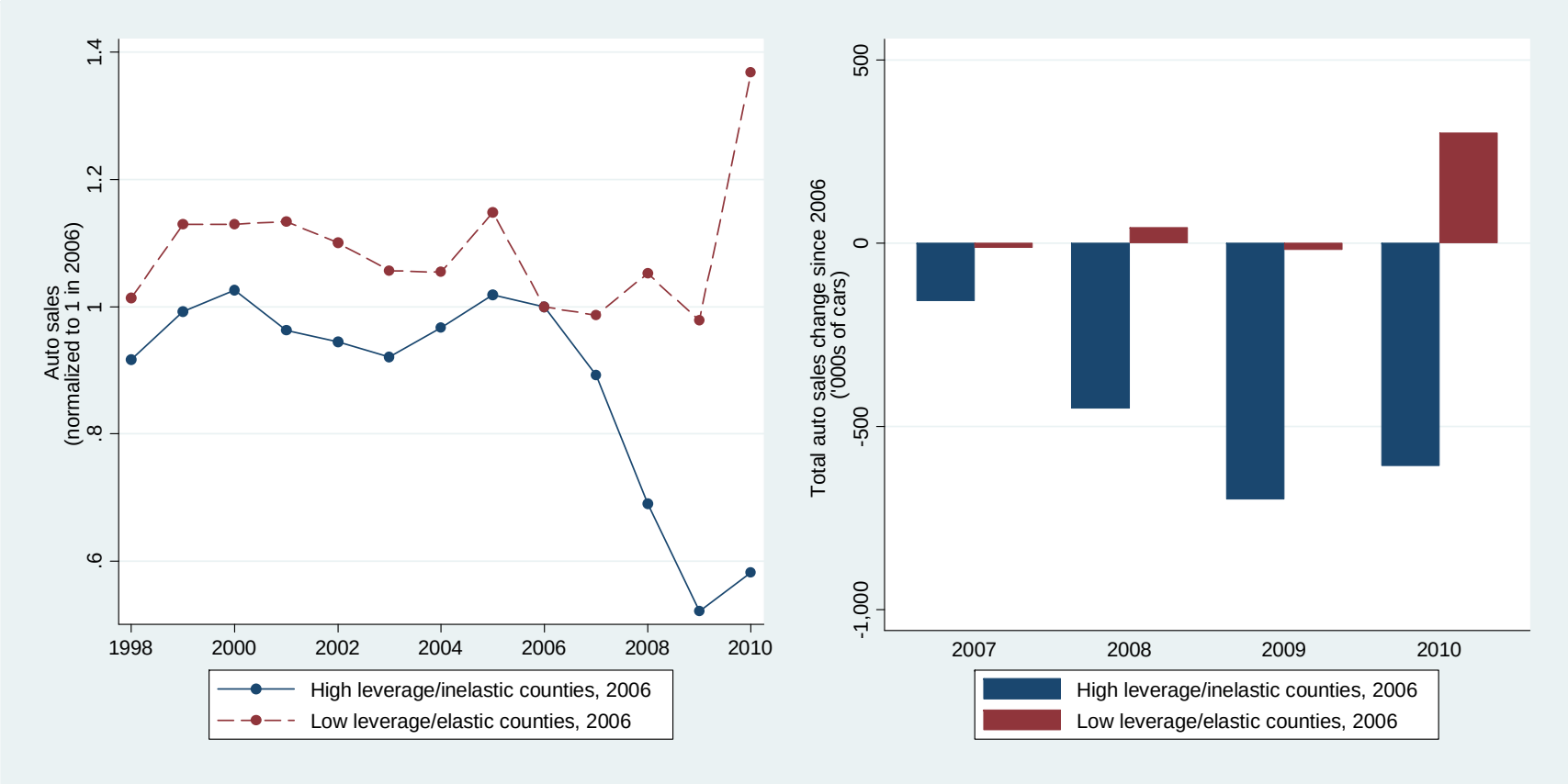

Figure 4
Retail Sales for High and Low Leverage Counties

These three panels plot consumption growth from 2006 to 2009 for high and low leverage counties, where all series are normalized to be 1 in 2006. High and low are defined to be the top and bottom decile of the predicted value of 2006 debt to income ratio, where housing supply elasticity is used as an instrument. The deciles are weighted by population. Given the linearity of the first stage prediction, high and low leverage counties are equivalently the highest and lowest decile of the housing supply elasticity distribution. Durables include purchases at furniture, home appliance, and home center stores. Non-durables, non-grocery are purchases at health, gasoline, clothing, hobby & sporting, and department stores. See the text for the corresponding NAICS codes.

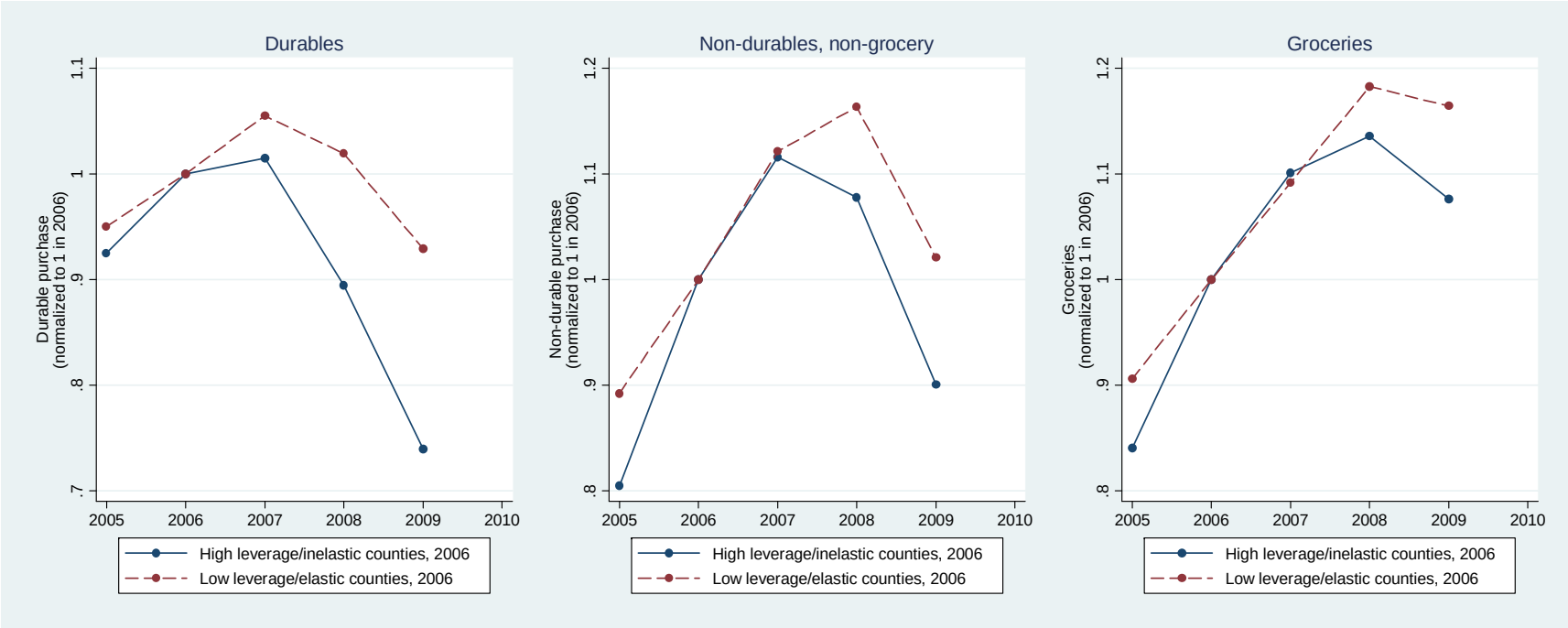

Figure 5
Household Default Rate for High and Low Leverage Counties

This figure plots the household default rate for high and low leverage counties. High and low are defined to be the top and bottom decile of the predicted value of 2006 debt to income ratio, where housing supply elasticity is used as an instrument. The deciles are weighted by population. Given the linearity of the first stage prediction, high and low leverage counties are also the highest and lowest decile of the housing supply elasticity distribution.

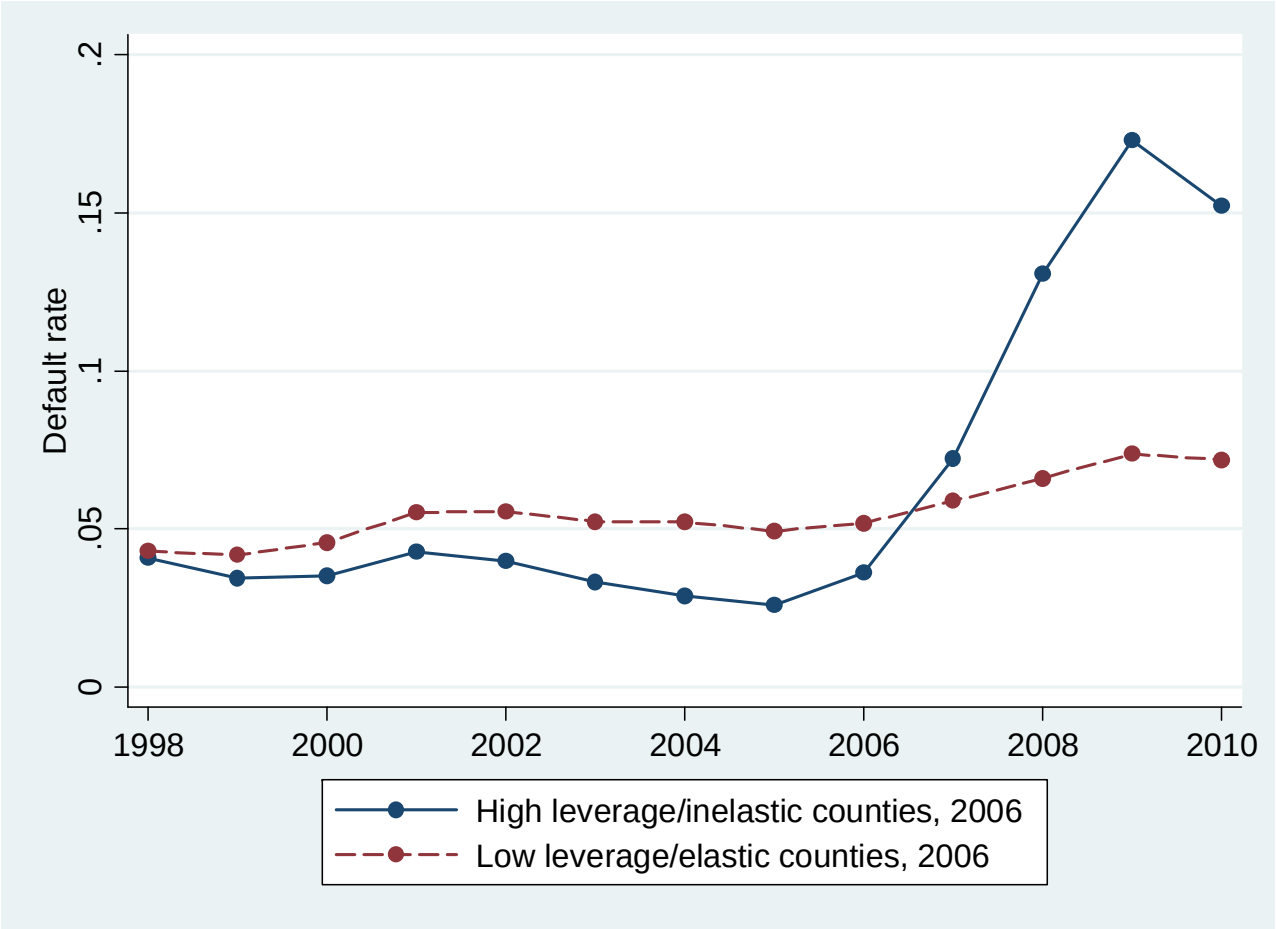

Figure 6

Deleveraging and Delinquency: The Aggregate Evidence

This figure plots debt aggregate debt growth from 1997 to 2010. We split the sample based on individual level data into consumers who default at some point in the 2008 to 2010 period and those that don't. We use the proportion of debt growth for each category from the individual level data to predict trends at the aggregate level. The left panel shows the level of debt normalized to be 1 in 2006. The right panel shows deleveraging for each category for 2008 through 2010.

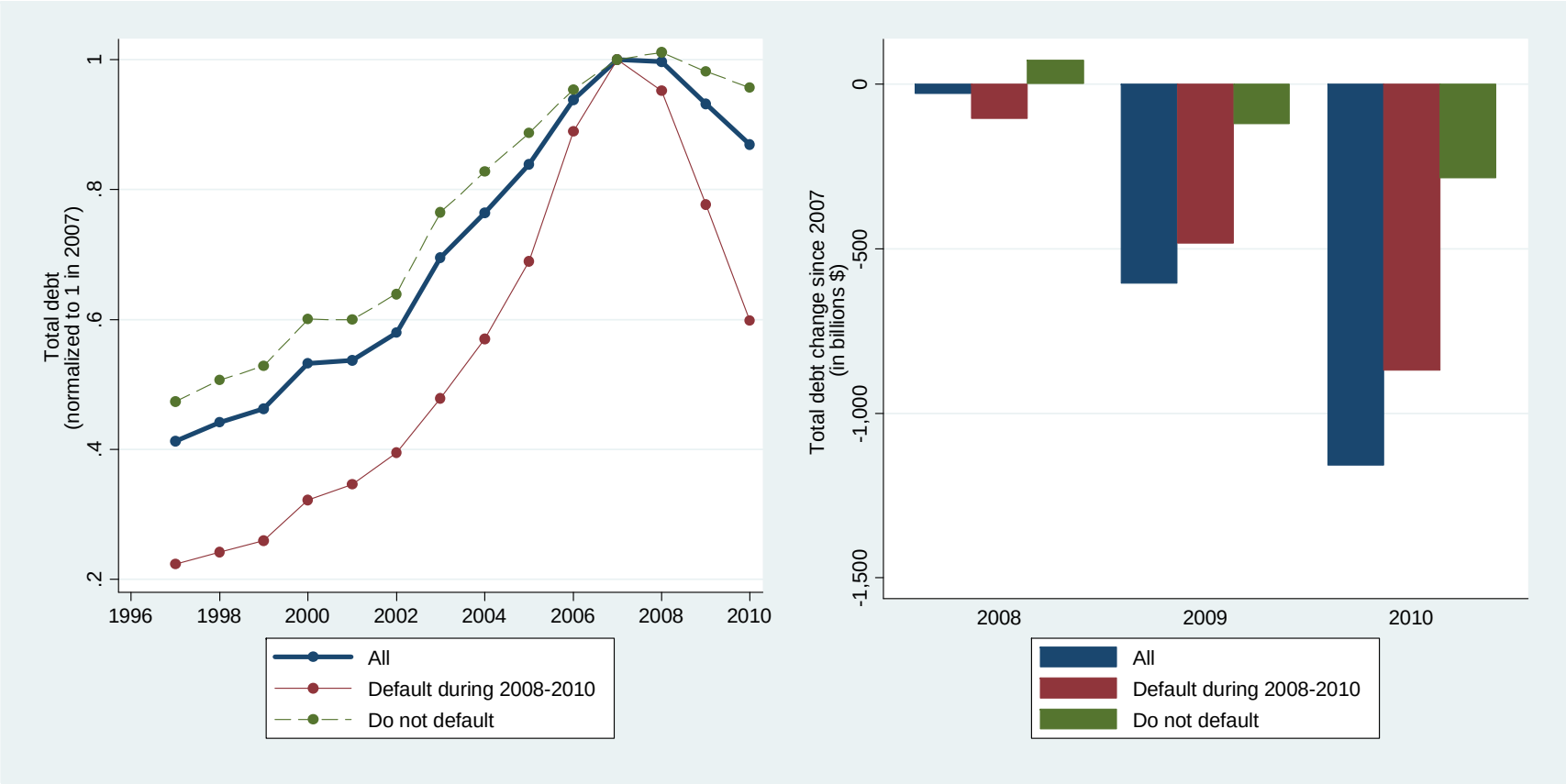

Figure 7
Deleveraging for High and Low Leverage Counties

This figure plots debt growth from 1997 to 2010 for high and low leverage counties. High and low are defined to be the top and bottom decile of the predicted value of household debt to income ratio as of 2006, where housing supply elasticity is used as an instrument. The deciles are weighted by population. Given the linearity of the first stage prediction, high and low debt growth counties are also the highest and lowest decile of the housing supply elasticity distribution. The left panel shows the level of debt normalized to be 1 in 2007; the right panel shows deleveraging in dollar amounts from 2008 to 2010.

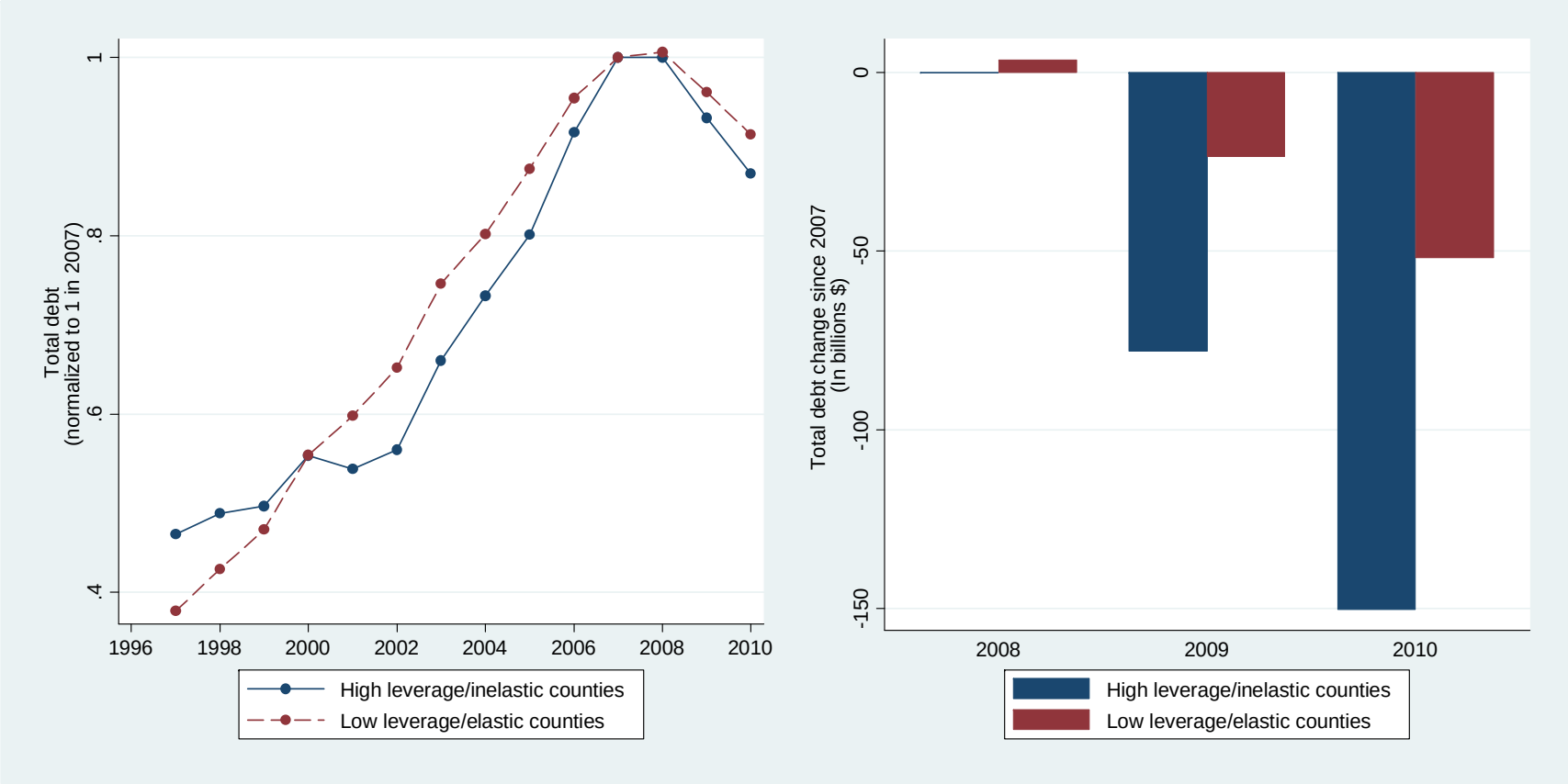

Figure 8
Deleveraging for High and Low Credit Quality Borrowers

This figure debt growth from 1997 to 2010 for high and low credit quality individuals. High and low credit quality individuals are defined to be the top and bottom quartile of the 1998 credit score distribution. The quartiles are weighted by population. The left panel shows the level of debt normalized to be 1 in 2007; the right panel shows deleveraging in dollar amounts from 2008 to 2010.

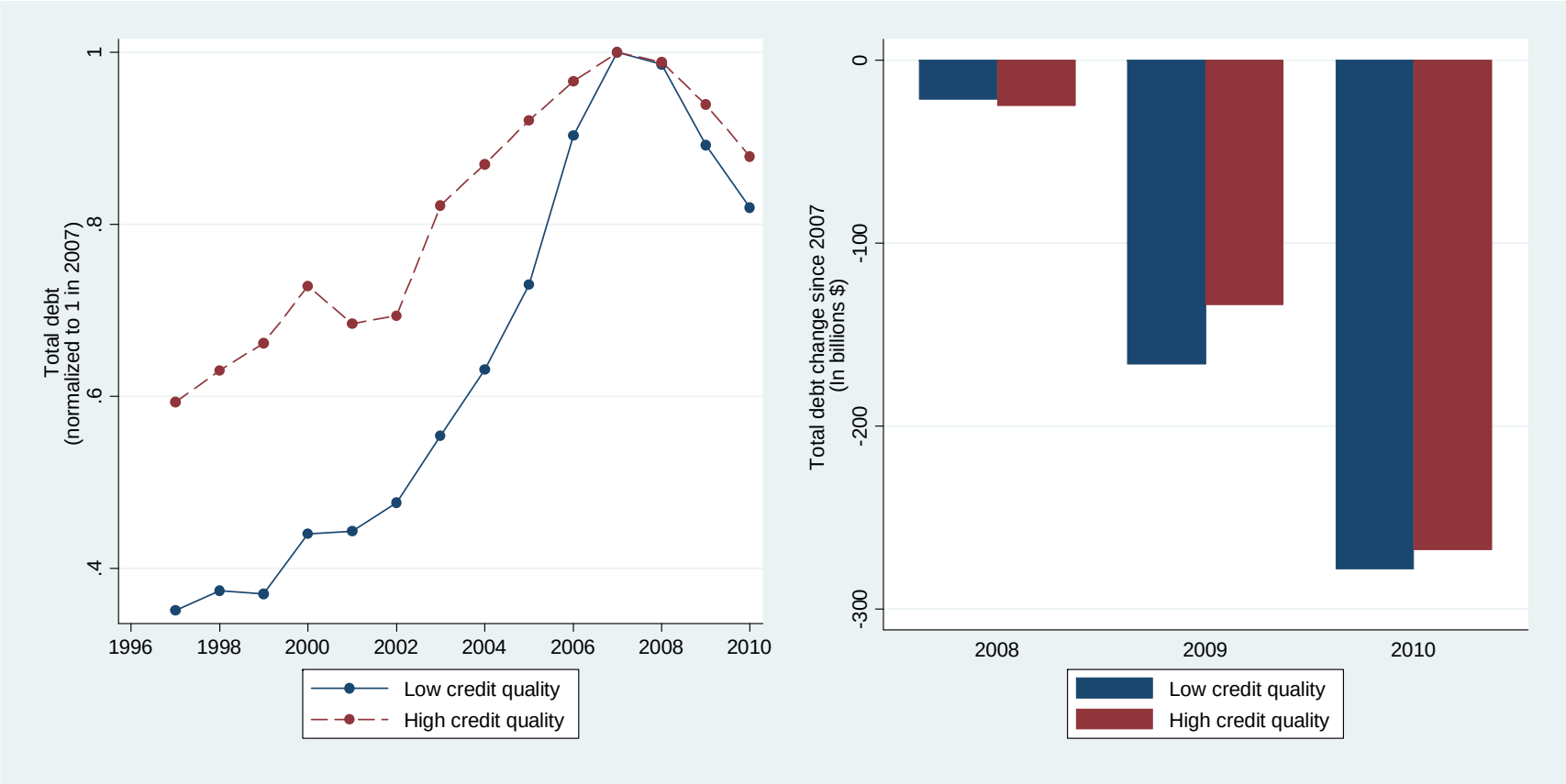

Table 1
Summary Statistics

This table presents summary statistics for the counties in our sample. Other durables include purchases at furniture, home appliance, and home center stores. Non-durables, non-grocery include purchases at health, gasoline, clothing, hobby & sporting, and department stores. See the text for the corresponding NAICS codes.

	N	Mean	SD	10th	90th	Weighted mean	Weighted SD
Household debt to income ratio, 2006	3136	2.456	0.960	1.494	3.596	2.941	0.967
Household debt growth, 2002 - 2006	3135	0.368	0.315	0.115	0.642	0.422	0.175
Number of households, 2000, thousands	3136	36927	110839	2417	72622	369513	620538
FHFA house price growth, 2002-2006	1092	0.270	0.156	0.114	0.527	0.342	0.193
Fiserv CSW house price growth, 2002-2006	309	0.331	0.183	0.105	0.584	0.381	0.200
Zillow.com house price growth, 2002-2006	623	0.332	0.194	0.105	0.587	0.352	0.197
Housing supply elasticity (Saiz (2011))	868	2.509	1.349	1.059	4.004	1.801	1.079
FHFA house price growth, 2006-2009	1092	-0.056	0.138	-0.235	0.062	-0.141	0.182
Fiserv CSW house price growth, 2006-2009	308	-0.242	0.228	-0.582	-0.006	-0.319	0.240
Zillow.com house price growth, 2006-2009	653	-0.167	0.199	-0.433	0.031	-0.214	0.207
Change in default rate, 2006-2009	3134	0.028	0.045	-0.010	0.071	0.054	0.048
Household debt growth, 2007 - 2010	3131	-0.026	0.242	-0.222	0.178	-0.059	0.131
Home equity limit growth, 2007-2010	3095	-0.110	0.397	-0.489	0.262	-0.125	0.190
Refinanced mortgages growth, 2007-2010	3123	0.060	0.516	-0.511	0.606	-0.003	0.540
Auto sales growth, 2007-2009	3125	-0.402	0.188	-0.633	-0.182	-0.441	0.168
Other durables growth, 2007-2009	2997	-0.101	0.626	-0.648	0.529	-0.196	0.261
Non-durable, non-grocery growth, 2007-2009	3115	-0.085	0.265	-0.308	0.143	-0.136	0.118
Grocery growth, 2007-2009	3094	0.072	0.372	-0.272	0.429	0.024	0.163
Wage growth, 2002-2006	3129	0.112	0.052	0.058	0.173	0.109	0.042
Ln (wage), 2006	3136	3.246	0.242	2.968	3.546	3.506	0.254
Change in wage growth, (02-06) - (98-02)	3129	-0.014	0.064	-0.077	0.052	-0.014	0.044
Population growth, 2002-2006	3136	0.036	0.030	0.006	0.081	0.036	0.032
Construction share of employment, 2007	3135	0.130	0.065	0.067	0.210	0.115	0.042
Growth in construction share, 2002-2007	3088	0.871	0.499	0.269	1.452	0.906	0.315
New residential investment growth, 2002-2006	2742	0.072	0.760	-0.693	0.916	0.021	0.544

Table 2
Household Leverage, House Price Growth, and Housing Supply Elasticity

This table presents coefficients from county-level regressions relating debt growth to house price growth. The specifications are motivated by the analysis in Mian and Sufi (2011a). Column 1 presents the first stage of the instrumental variables specifications in columns 2 through 5, where housing supply elasticity is used as an instrument for 2002 to 2006 house price growth. Standard errors are heteroskedasticity robust, clustered at the CBSA level. All regressions are weighted by total number of households in the county.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	House price growth, 2002-2006	Debt growth, 2002-2006	Home debt growth, 2002-2006	Credit card debt growth, 2002-2006	Debt growth, 2002-2006		Debt to income ratio, 2006	
FHFA house price growth, 2002-2006		0.564**	0.515**	-0.109*	0.432**			3.55**
		(0.057)	(0.061)	(0.052)	(0.052)			(0.71)
Housing supply elasticity (Saiz (2011))	-0.104**						-0.368**	
	(0.014)						(0.086)	
Debt to income ratio, 2006						0.104**		
						(0.013)		
Wage growth, 2002-2006					1.200**			
					(0.204)			
Ln (wage), 2006					0.115**			
					(0.027)			
Change in wage growth, (02-06) - (98-02)					-1.295**			
					(0.187)			
Population growth, 2002-2006					0.218			
					(0.321)			
Construction share of employment, 2007					0.216			
					(0.171)			
Growth in construction share, 2002-2006					0.023			
					(0.016)			
Residential investment growth, 2002-2006					-0.005			
					(0.008)			
Constant	0.530**	0.240**	0.321**	0.084**	-0.329**	0.119*	3.679**	1.8**
	(0.039)	(0.016)	(0.018)	(0.015)	(0.104)	(0.048)	(0.246)	(0.18)
Estimation type	OLS	IV	IV	IV	IV	OLS	OLS	IV
N	868	868	868	868	852	868	868	868
R^2	0.328	0.477	0.439	0.008	0.595	0.437	0.177	0.35

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 3
Exclusion Restriction Evidence: Correlation of Elasticity with Control Variables

This table presents coefficients from county-level univariate regressions regressing control variables on the housing supply elasticity instrument. Each row is a separate regression. Standard errors are heteroskedasticity robust, clustered at the CBSA level. All regressions are weighted by total number of households in the county.

		Elasticity	Constant	N	R^2
(1)	Wage growth, 2002-2006	-0.009**	0.125**	868	0.056
		(0.002)	(0.005)		
(2)	Ln (wage), 2006	-0.050**	3.661**	868	0.064
		(0.010)	(0.027)		
(3)	Change in wage growth, (02-06) - (98-02)	-0.002	-0.010	868	0.002
		(0.003)	(0.006)		
(4)	Population growth, 2002-2006	0.001	0.036**	868	0.000
		(0.002)	(0.007)		
(5)	Construction share of employment, 2007	-0.000	0.112**	868	0.000
		(0.002)	(0.006)		
(6)	Growth in construction share, 2002-2006	0.003	0.936**	866	0.000
		(0.013)	(0.036)		
(7)	Residential investment growth, 2002-2006	-0.047	0.114	854	0.010
		(0.029)	(0.077)		

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 4
Household Leverage, House Prices, and Underwater Homeowners

This table presents coefficients from county-level instrumental variable regressions relating house prices and homeowners underwater from 2006 to 2009 to the household debt to income ratio as of 2006. In columns 2 through 6, the 2006 debt to income ratio is instrumented with housing supply elasticity; the first stage is reported in column 8 of Table 2. Columns 5 and 6 use state level data on the fraction of homeowners with mortgages that are underwater (i.e., the value of the home is below the value of the mortgage) from CoreLogic. These specifications are estimated at the state level. Standard errors are heteroskedasticity robust, clustered at the CBSA level. Regressions reported in columns 1 through 4 are weighted by total number of households in the county.

	(1)	(2)	(3)	(4)	(5)	(6)
	FHFA house price growth, 2006-2009				Fraction of mortgages underwater, 2009	
Debt to income ratio, 2006	-0.143**	-0.236**	-0.231**	-0.263**	0.153**	0.115
	(0.015)	(0.035)	(0.031)	(0.036)	(0.034)	(0.070)
Wage growth, 2002-2006				0.479		-0.822
				(0.564)		(1.030)
Ln (wage), 2006				0.171**		-0.019
				(0.065)		(0.138)
Change in wage growth, (02-06) - (98-02)			-0.541	-0.960		0.672
			(0.288)	(0.510)		(0.757)
Population growth, 2002-2006			-0.500	-0.344		2.893**
			(0.419)	(0.427)		(0.753)
Construction share of employment, 2007			1.305**	1.542**		-2.363
			(0.363)	(0.423)		(1.798)
Growth in construction share, 2002-2006			0.004	0.010		0.080
			(0.034)	(0.038)		(0.142)
Residential investment growth, 2002-2006			-0.029	-0.033		-0.136
			(0.028)	(0.031)		(0.076)
Constant	0.295**	0.569**	0.419**	-0.192	-0.212*	0.155
	(0.039)	(0.091)	(0.045)	(0.236)	(0.091)	(0.523)
Estimation type	OLS	IV	IV	IV	IV	IV
Level of analysis	County	County	County	County	State	State
N	1,092	868	852	852	40	40
R^2	0.545	0.347	0.448	0.371	0.463	0.757

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 5
Household Leverage and Durable Consumption

This table presents coefficients from county-level instrumental variable regressions relating auto sales and other durables growth from 2007 to 2009 to the debt to income ratio as of 2006. Other durables include purchases at furniture, home appliance, and home center stores. In columns 2 through 4 and 6 through 8, the debt to income ratio as of 2006 is instrumented with housing supply elasticity; the first stage is reported in column 8 of Table 2. Standard errors are heteroskedasticity robust, clustered at the CBSA level. All regressions are weighted by total number of households in the county.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Auto sales, 2007-2009				Other durables, 2007-2009			
Debt to income ratio, 2006	-0.069**	-0.085**	-0.083**	-0.114**	-0.080**	-0.133**	-0.129**	-0.144**
	(0.013)	(0.022)	(0.017)	(0.027)	(0.008)	(0.024)	(0.022)	(0.026)
Wage growth, 2002-2006				0.963*				0.951*
				(0.411)				(0.379)
Ln (wage), 2006				0.104				-0.021
				(0.062)				(0.050)
Change in wage growth, (02-06) - (98-02)			-0.066	-0.776*			-0.252	-0.886*
			(0.253)	(0.370)			(0.253)	(0.410)
Population growth, 2002-2006			-2.205**	-2.079**			-0.501	-0.472
			(0.371)	(0.379)			(0.380)	(0.376)
Construction share of employment, 2007			-0.008	0.130			0.735*	0.697*
			(0.264)	(0.307)			(0.310)	(0.317)
Growth in construction share, 2002-2006			0.030	0.036			0.016	0.018
			(0.037)	(0.040)			(0.029)	(0.028)
Residential investment growth, 2002-2006			-0.045**	-0.058**			-0.040*	-0.055**
			(0.015)	(0.016)			(0.017)	(0.019)
Constant	-0.238**	-0.200**	-0.151**	-0.566**	0.038	0.184**	0.091*	0.098
	(0.048)	(0.068)	(0.049)	(0.200)	(0.025)	(0.068)	(0.038)	(0.183)
Estimation type	OLS	IV	IV	IV	OLS	IV	IV	IV
N	3,125	868	852	852	2,997	860	845	845
R^2	0.157	0.176	0.372	0.359	0.087	0.047	0.104	0.085

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 6
Household Leverage and Non-Durable Consumption

This table presents coefficients from county-level instrumental variable regressions relating consumption growth from 2007 to 2009 to the debt to income ratio as of 2006. Non-grocery non-durables are purchases at health, gasoline, clothing, hobby & sporting, and department stores. See the text for the corresponding NAICS codes. In columns 2 through 4 and 6 through 8, the 2006 debt to income ratio is instrumented with housing supply elasticity; the first stage is reported in column 8 of Table 2. Standard errors are heteroskedasticity robust, clustered at the CBSA level. All regressions are weighted by total number of households in the county.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Non-grocery Non-durables, 2007-2009				Groceries, 2007-2009			
Debt to income ratio, 2006	-0.044**	-0.084**	-0.082**	-0.094**	-0.038**	-0.050**	-0.050**	-0.061**
	(0.004)	(0.015)	(0.013)	(0.017)	(0.004)	(0.015)	(0.014)	(0.018)
Wage growth, 2002-2006				0.518				0.308
				(0.269)				(0.320)
Ln (wage), 2006				0.023				0.035
				(0.027)				(0.029)
Change in wage growth, (02-06) - (98-02)			-0.087	-0.451			-0.091	-0.320
			(0.121)	(0.244)			(0.121)	(0.258)
Population growth, 2002-2006			-0.140	-0.097			-0.379*	-0.337*
			(0.177)	(0.183)			(0.161)	(0.163)
Construction share of employment, 2007			0.674**	0.702**			0.422*	0.469*
			(0.172)	(0.199)			(0.182)	(0.193)
Growth in construction share, 2002-2006			0.015	0.017			0.000	0.002
			(0.014)	(0.016)			(0.018)	(0.020)
Residential investment growth, 2002-2006			-0.018	-0.026*			0.007	0.003
			(0.010)	(0.012)			(0.011)	(0.012)
Constant	-0.007	0.107*	0.015	-0.097	0.136**	0.164**	0.132**	-0.008
	(0.012)	(0.042)	(0.023)	(0.100)	(0.014)	(0.043)	(0.025)	(0.102)
Estimation type	OLS	IV	IV	IV	OLS	IV	IV	IV
N	3,115	868	852	852	3,094	868	852	852
R^2	0.130	0.027	0.139	0.087	0.052	0.076	0.094	0.086

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 7
Within-County Zip Code Analysis of Auto Sales

This table presents the within-county zip code level analysis of household leverage and auto sales from 2007 to 2009. The sample is restricted to zip codes for which we have housing supply elasticity information available. Columns 1 through 4 are different versions of a first stage specification, where the the fraction of borrowers with a credit score below 1998 interacted with housing supply elasticity is the instrument. All specifications include county fixed effects so housing supply elasticity is absorbed. Column 5 presents the reduced form version of the instrumental variables specification. Column 6 presents the instrumental variables estimates of zip code level auto sales on zip code household debt growth from 2002 to 2006. The first stage is in column 1. Standard errors are heteroskedasticity robust. All regressions are weighted by total number of households in the zip code.

	(1) Debt growth, 2002-2006	(2) Debt to income, 2002	(3) Debt to income, 2006	(4) Change in debt to income, 2002-2006	(5) Auto sales growth, 2007-2009	(6)
Debt growth, 2002 to 2006						-0.960**
						(0.156)
Share with credit score < 660, 1998	-0.692**	-1.443**	-2.312**	-0.866**	-0.378**	-1.042**
	(0.052)	(0.088)	(0.119)	(0.086)	(0.050)	(0.056)
Share with credit score < 660, 1998* Housing supply inelasticity	0.189**	-0.150**	-0.001	0.147**	-0.182**	
	(0.022)	(0.043)	(0.062)	(0.043)	(0.020)	
County fixed effects?	Y	Y	Y	Y	Y	Y
Estimation Type	OLS	OLS	OLS	OLS	OLS	IV
N	13,347	13,358	13,351	13,343	13,371	13,347
R^2	0.367	0.655	0.723	0.508	0.531	

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 8
Elasticity of Consumption Decline with Respect to House Price Decline

This table presents the implied elasticities of the consumption decline with respect to the house price decline, using variation across the 2006 household leverage distribution. Columns 1 and 2 present the predicted declines in all outcomes for the 10th and 90th percentile of the household leverage distribution, respectively, based on the instrumental variables specifications reported in Tables 4 through 6 with no control variables. Column 3 presents the difference between the 90th and 10th percentile of the household leverage distribution. Column 4 presents the implied elasticities of the consumption decline with respect to the house price decline for each consumption type in question.

	10th percentile of debt to income distribution	90th percentile of debt to income distribution	Difference	Implied Elasticity
House price growth, 2007-2009	0.148	-0.236	-0.384	
Auto sales growth, 2007-2009	-0.327	-0.505	-0.179	0.466
Other durables growth, 2007-2009	-0.016	-0.296	-0.280	0.730
Non-grocery non-durables, 2007-2009	-0.018	-0.195	-0.177	0.461
Groceries, 2007-2009	0.090	-0.014	-0.104	0.271

Table 9
Household Leverage, Deleveraging, and Collateral-Based Borrowing

This table presents coefficients from county-level instrumental variable regressions relating deleveraging, home equity limit growth, and refinanced mortgage growth from 2007 to 2010 to the debt to income ratio as of 2006. In all columns except for column 1, the 2006 debt to income ratio is instrumented with housing supply elasticity; the first stage is reported in column 8 of Table 2. Standard errors are heteroskedasticity robust, clustered at the CBSA level. All regressions are weighted by total number of households in the county.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Debt growth, 2007-2010			Home equity limit growth, 2007-2010		Refinanced mortgages growth, 2007-2010	
Instrumented debt growth, 2002-2006	-0.044**	-0.055**	-0.058**	-0.071**	-0.047**	-0.060**	-0.627**	-0.887**
	(0.006)	(0.009)	(0.009)	(0.013)	(0.014)	(0.019)	(0.170)	(0.195)
Wage growth, 2002-2006				0.342		0.049		4.234*
				(0.318)		(0.333)		(2.043)
Ln (wage), 2006				0.050		0.074*		1.559**
				(0.031)		(0.034)		(0.275)
Change in wage growth, (02-06) - (98-02)			-0.114	-0.374		0.006		-4.857*
			(0.162)	(0.207)		(0.232)		(2.312)
Population growth, 2002-2006			-0.671*	-0.616*		-0.627		-0.739
			(0.287)	(0.283)		(0.339)		(2.489)
Construction share of employment, 2007			0.324*	0.392*		0.115		5.672**
			(0.150)	(0.157)		(0.219)		(2.176)
Growth in construction share, 2002-2006			0.018	0.020		-0.010		-0.087
			(0.015)	(0.015)		(0.021)		(0.127)
Residential investment growth, 2002-2006			0.013	0.008		0.000		-0.286
			(0.009)	(0.009)		(0.012)		(0.173)
Constant	0.070**	0.098**	0.077**	-0.117	0.008	-0.202	1.873**	-3.957**
	(0.014)	(0.026)	(0.020)	(0.103)	(0.040)	(0.108)	(0.448)	(1.028)
Estimation type	OLS	IV	IV	IV	IV	IV	IV	IV
N	3,131	868	852	852	868	852	867	851
R^2	0.105	0.154	0.184	0.184	0.159	0.203		

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively

Table 10
House Prices, Consumption, and Non-housing Wealth

This table presents coefficients relating auto sales growth from 2007 to 2009 to house price declines from 2007 to 2009 interacted with measures of household net worth. Columns 3 and 4 include county fixed effects. Standard errors are heteroskedasticity robust. All regressions are weighted by total number of households in the zip code.

	(1)	(2)	(3)	(4)
	Auto sales growth, 2007 to 2009			
House price growth, 2007 to 2009	0.744**	1.439**	0.590**	0.967**
	(0.022)	(0.092)	(0.039)	(0.091)
Non-housing wealth to total wealth ratio, 2007		0.016		0.287**
		(0.035)		(0.035)
Non-housing wealth to total wealth ratio, 2007* House price growth, 2007 to 2009		-1.227**		-1.030**
		(0.140)		(0.138)
Constant	-0.360**	-0.379**	-0.384**	-0.609**
	(0.004)	(0.025)	(0.006)	(0.025)
County fixed effects?	N	N	Y	Y
N	10,387	10,385	10,385	10,387
R^2	0.192	0.195	0.220	0.466

**,* Coefficient statistically different than zero at the 1% and 5% confidence level, respectively