Revisiting Subprime Lending: Cross-Sectional Patterns of Mortgage Debt During the Housing Boom

Christopher Foote, Lara Loewenstein, and Paul Willen

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Disclaimer: I do not speak for:
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Eric Rosengren, President of Boston Fed
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Janet Yellen, Chair of Federal Reserve
Conventional Wisdom on the Housing Boom

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  higher low-income lending $\rightarrow$ higher house prices
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  - Distorted beliefs/over-optimism:
    - higher house prices $\rightarrow$ higher low-income lending
This paper: Fact #1

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   - Subprime did not cause a reallocation of debt.
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There was no reallocation of mortgage debt to low-income borrowers.

- Subprime did not cause a reallocation of debt.
- It prevented one.
Distribution of Mortgage Debt

Sources: NY Fed Consumer Credit Panel/Equifax, IRS, and SCF.

**Shares of Mortgage Debt (Equifax)**

- **2001**
- **2007**

**Levels of Mortgage Debt (Equifax)**

- **2001**
- **2007**

**Shares of Mortgage Debt (SCF)**

- **2001**
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**Levels of Mortgage Debt (SCF)**

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- but HMDA measures neither the other gross flow (terminations) nor the stock of debt.

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This paper: Fact #2

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- Mian and Sufi (2009, p. 1459, emphasis added): “...it is critical to understand the variation [in debt] within counties if we are to understand the causes and consequences of the mortgage default crisis.”

- Distribution of ZIP-level debt on within-CBSA basis:
New York Fed Consumer Credit Panel/Equifax

- 5% sample of all individuals in Equifax from 1999 to present.
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- Geographic identifiers (down to the census block).
- We correct for joint mortgages by dividing both number and dollar values by two.
- Disadvantage: No income or demographic info (except age).
IRS Statistics of Income


- Wage income: income reported on a W2.
- AGI: all types of income, including capital gains, minus deductions.

- Includes the number of returns and the number of exemptions.

Disadvantages:
- Data is available at the ZIP-code level, not the taxpayer level.
- Data-suppression rules change over time.
- Not everyone is required to file a tax return.

The number of returns in 2007 increased sharply, especially in low income areas, due to the availability of a stimulus payment.
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- Triennial survey of household-level balance sheets and income.

Disadvantages:
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\[ Debt_{ict} = \beta_0 + \beta_1 Income_{ict} + \epsilon_{ict} \]

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  - Tax returns in ZIP for Equifax/IRS regressions.
  - Sample weights for SCF regressions.
- Standard errors are clustered by CBSA or county for ZIP-level regs.
Stable Debt Distributions: Two Potential Explanations

\[ Debt_{ict} = \beta_0 + \beta_1 Income_{ict} + \epsilon_{ict} \]

1. Equal percentage increase in debt

There is no change in the relationship between income and debt over time. Estimates of \( \beta_1 \) remain stable from year to year. Increases in debt are accomplished by higher values of \( \beta_0 \) over time.

"Decoupling" of income from debt \( \beta_1 \) declines over time (but remains positive). A decline in \( \beta_1 \) would tend to raise the low-income share of debt... unless an adverse shift in the distribution of income masked the \( \beta_1 \) decline. We need to estimate \( \beta_1 \) in each year to rule out this possibility.
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   - We need to estimate $\beta_1$ in each year to rule out this possibility.
Levels Binscatters: Year-by-Year

Log Levels

year=2001

Source: NY Fed Consumer Credit Panel/Equifax and IRS.

FLW (Boston Fed)  Cross-Sectional Debt Patterns  December 9, 2015  13 / 42
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Levels Binscatters: Year-by-Year

Log Levels

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Levels Binscatters: Year-by-Year

Log Levels

\[ \text{Ln}(\text{Stock of Debt} / \text{Returns}) \]

year=2005

year=2001

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Levels Binscatters: Year-by-Year

Log Levels

- year=2006
- year=2001

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Levels Binscatters: Year-by-Year

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Levels Regressions: Income Effects

Income Effects in Income-Only Regression

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Levels Regression with CBSA-Level Fixed Effects

\[ Debt_{ict} = \beta_c + \beta_1 Income_{ict} + \epsilon_{ict} \]

- Including area-level fixed effects identifies \( \beta_1 \) using only within-area variation.
Levels Regression with CBSA-Level Fixed Effects

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- Additionally, the intercepts (\( \beta_c \)) can be analyzed in their own right.
  - Why did debt rise more in Phoenix than in Wichita?
CBSA-Deviated Levels Binscatters: Yr-by-Yr

Deviated from CBSA-Year Means

-1 1

Ln(Stock of Debt / Returns)

year=2001

0

Ln(Income / Returns)

-.5

-1

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
CBSA-Deviated Levels Binscatters: Yr-by-Yr

Deviated from CBSA-Year Means

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
CBSA-Deviated Levels Binscatters: Yr-by-Yr

Deviated from CBSA-Year Means

\[ \ln(\text{Stock of Debt} / \text{Returns}) \]
\[ \ln(\text{Income} / \text{Returns}) \]

year=2004
year=2001

Deviated from CBSA-Year Means

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
CBSA-Deviated Levels Binscatters: Yr-by-Yr

Deviated from CBSA-Year Means

Ln(Stock of Debt / Returns) vs Ln(Income / Returns) for year=2005 and year=2001.

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
CBSA-Deviated Levels Binscatters: Yr-by-Yr

Deviated from CBSA-Year Means

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Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Regressions w/CBSA FEs: Income Effects

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Total, Within- and Between-CBSA Variation

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Between and Within Variation in Regressions

Standard Deviations of ZIP-Level Debt

Residual Std. Deviations: Reg with Income Only

Resid. Std. Deviations: Regs w/Income and Area FEs

Standard Deviations of Area-Level Fixed Effects

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Credit Allocation Function in Long-Difference Form

\[
Debt_{ic,2007} = \beta_{c,2007} + \beta_1 Income_{ic,2007} + \epsilon_{ic,2007}
\]

\[
Debt_{ic,2001} = \beta_{c,2001} + \beta_1 Income_{ic,2001} + \epsilon_{ic,2001}
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How does debt for a given ZIP code change over time?
Credit Allocation Function in Long-Difference Form

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- If $\beta_1$'s do not change over time, then estimating a long-difference regression is easy:

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- If \( \beta_1 \)'s do change, then we need to put an income level in the regression as well.
Long-Difference Specification Issues

\[
\begin{align*}
  y_2 &= \beta_2 x_2 \\
  y_1 &= \beta_1 x_1 \\
  y_2 - y_1 &= \beta_2 x_2 - \beta_1 x_1 \\
  y_2 - y_1 &= \beta_2 (x_2 - x_1) + x_1 (\beta_2 - \beta_1) \\
  y_2 - y_1 &= \beta_1 (x_2 - x_1) + x_2 (\beta_2 - \beta_1)
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Note that coefficient on level (\(x_1\) or \(x_2\)) is always the same: \(\beta_2 - \beta_1\).
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  - ...depends on which level is included...
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- Note that coefficient on level (\(x_1\) or \(x_2\)) is always the same: \(\beta_2 - \beta_1\).
- Coefficient on change (\(x_2 - x_1\))...
  - ...depends on which level is included...
  - ...but always reflects a level effect (\(\beta_1\) or \(\beta_2\)).
# Long-Difference Regression Results

**Dependent Variable:** 2001-07 ZIP-Level Change in Ln Mortgage Debt per Return

<table>
<thead>
<tr>
<th>Sample Restriction</th>
<th>(1) None</th>
<th>(2) None</th>
<th>(3) 1% Trim</th>
<th>(4) 5% Trim</th>
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</thead>
<tbody>
<tr>
<td><strong>2001-07 Change in Ln Income per Return</strong></td>
<td>1.071***</td>
<td>1.050***</td>
<td>1.170***</td>
<td>1.031***</td>
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<tr>
<td></td>
<td>(0.040)</td>
<td>(0.043)</td>
<td>(0.054)</td>
<td>(0.061)</td>
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<td><strong>2001 Ln Income per Return Level</strong></td>
<td>0.019</td>
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<tr>
<td></td>
<td>(0.012)</td>
<td>(0.014)</td>
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<tr>
<td><strong>Constant</strong></td>
<td>0.527***</td>
<td>0.527***</td>
<td>0.528***</td>
<td>0.528***</td>
</tr>
<tr>
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<td>(0.008)</td>
<td>(0.008)</td>
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<tr>
<td><strong>R-sq.</strong></td>
<td>0.122</td>
<td>0.122</td>
<td>0.150</td>
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<td><strong>Observations (No. of ZIP Codes)</strong></td>
<td>35,595</td>
<td>35,595</td>
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<tr>
<td><strong>Expected Diff. in Debt Growth:</strong></td>
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<td></td>
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<tr>
<td>90th 2001 Income Pctile vs. 10th 2001 Income Pctile</td>
<td>0.017</td>
<td>0.009</td>
<td>0.027</td>
<td></td>
</tr>
</tbody>
</table>

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
# Long-Difference Regression Results

## Dependent Variable: 2001-07 ZIP-Level Change in Ln Mortgage Debt per Return

<table>
<thead>
<tr>
<th>Sample Restriction</th>
<th>(1) None</th>
<th>(2) None</th>
<th>(3) 1% Trim</th>
<th>(4) 5% Trim</th>
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<tbody>
<tr>
<td>Panel B: CBSA ZIP Codes without Fixed Effects</td>
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<tr>
<td>2001-07 Change in Ln Income per Return</td>
<td>1.088***</td>
<td>1.059***</td>
<td>1.192***</td>
<td>1.028***</td>
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<td>(0.043)</td>
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<td>(0.064)</td>
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<td>2001 Ln Income per Return Level</td>
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<td>0.010</td>
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<td>(0.018)</td>
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<td>(0.008)</td>
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<tr>
<td>R-sq.</td>
<td>0.141</td>
<td>0.142</td>
<td>0.164</td>
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<td>Observations (No. of ZIP Codes)</td>
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<td>27,567</td>
<td>21,634</td>
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<td>Expected Diff. in Debt Growth:</td>
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<td>90th 2001 Income Pctile vs. 10th 2001 Income Pctile</td>
<td>0.023</td>
<td>0.009</td>
<td>0.028</td>
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Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
### Long-Difference Regression Results

#### Dependent Variable: 2001-07 ZIP-Level Change in Ln Mortgage Debt per Return

<table>
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<tr>
<th>Sample Restriction</th>
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<th>(4) 5% Trim</th>
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<tr>
<td><strong>Panel C: CBSA ZIP Codes with CBSA Fixed Effects</strong></td>
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<td>2001-07 Change in Ln Income per Return</td>
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<td>0.858***</td>
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<td>2001 Ln Income per Return Level</td>
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<td>−0.057***</td>
<td>−0.052***</td>
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<td>Expected Diff. in Debt Growth:</td>
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Expected Diff. in Debt Growth:

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<th>Expected Diff. in Debt Growth:</th>
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<tbody>
<tr>
<td>90th 2001 Income Pctile vs. 10th 2001 Income Pctile</td>
<td>−0.023</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
## Determinants of CBSA-Level Debt Growth

**Dependent Variable:** CBSA-Level Fixed Effects from ZIP-Level Long-Diff Regressions

<table>
<thead>
<tr>
<th></th>
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<tr>
<td>2001-07 Change in Ln CBSA Income</td>
<td>0.68***</td>
<td>0.55**</td>
<td>-0.28</td>
<td>-0.45*</td>
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<td>(0.17)</td>
<td>(0.18)</td>
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<tr>
<td>2001 Ln CBSA Income Level</td>
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<tr>
<td>2001-07 Change in Ln CBSA House Price</td>
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<td>0.40***</td>
<td>0.44***</td>
<td>0.45***</td>
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<td>(0.04)</td>
<td>(0.04)</td>
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<tr>
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<td>0.53***</td>
<td>0.53***</td>
<td>0.36***</td>
<td>0.35***</td>
<td>0.34***</td>
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<td>(0.02)</td>
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<tr>
<td>Observations (No. of CBSAa)</td>
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<td>934</td>
<td>934</td>
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<tr>
<td>R-sq.</td>
<td>0.00</td>
<td>0.05</td>
<td>0.13</td>
<td>0.31</td>
<td>0.32</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Household-Level Data from SCF

Binned Scatterplot

- \( \text{Ln(Household Mortgage Debt)} \)
- \( \text{Ln(Household Wage Income)} \)

- Red dots: year=2007
- Blue dots: year=2001

FLW (Boston Fed)
SCF Regression Model

- Dependent variable is all mortgage debt of household

\[ \text{Debt}_i = \exp(\beta_0 + \beta \ln\text{WageInc}_i + \ldots) \]

Other regressors:
- Indicators for age group of household head (<35, 35-44, 45-54, 55-64), nonwhite, and marital status.
- Number of children.

Households headed by persons 65 or older are excluded, as are people with no wage income.
SCF Regression Model

- Dependent variable is all mortgage debt of household
- Poisson specification allows for zero holdings of debt:

\[ Debt_i = \exp(\beta_0 + \beta \ln \text{WageInc}_i + \ldots) \]
SCF Regression Model

- Dependent variable is all mortgage debt of household
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- Dependent variable is all mortgage debt of household
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SCF Regression Model

- Dependent variable is all mortgage debt of household
- Poisson specification allows for zero holdings of debt:

\[
Debt_i = \exp(\beta_0 + \beta \ln\text{WageInc}_i + ...)
\]

- Other regressors:
  - Indicators for age group of household head (<35, 35-44, 45-54, 55-64), nonwhite, and marital status.
  - Number of children.
- Households headed by persons 65 or older are excluded, as are people with no wage income.
SCF Results

Income Effects

Marginal Effect of Income

Income Effects

FLW (Boston Fed)
SCF Results: With Age × Income Interactions

Less than 35 Years Old

Ages 35-44

Ages 45-54

Ages 55-64

FLW (Boston Fed) Cross-Sectional Debt Patterns December 9, 2015 29 / 42
The Negative Correlation in Mian and Sufi (2009)

Note: All correlations calculated on a within-county basis.

Potential specifications for regressions of $\Delta$ debt on $\Delta$ income:

- Dependent variable: Flows (HMDA) or stocks (Equifax)?)
- Regressors: Include income-level term?
- Regressors: Use AGI or salary and wages to measure income?
- Adelino et al. (2015): Value of loans versus number of loans?
The Negative Correlation in Mian and Sufi (2009)

Note: All correlations calculated on a within-county basis.

- Potential specifications for regressions of $\Delta$ debt on $\Delta$ income:
  1. Dependent variable: Flows (HMDA) or stocks (Equifax)?
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Potential specifications for regressions of $\Delta$ debt on $\Delta$ income:

1. Dependent variable: Flows (HMDA) or stocks (Equifax)?
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3. Regressors: Use AGI or salary and wages to measure income?
4. Adelino et al. (2015): Value of loans versus number of loans?
## 2002-06 Debt-Growth Regressions

All regressions include county FEs and use AGI as income measure

<table>
<thead>
<tr>
<th>Stock or Flow?</th>
<th>Control for 2002 level?</th>
<th>Value or Number of Loans?</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
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</tr>
<tr>
<td>Δ ln(AGI/Returns)</td>
<td></td>
<td></td>
<td>0.42***</td>
<td>0.09**</td>
<td>0.29***</td>
<td>0.14***</td>
<td>0.29***</td>
<td>0.60***</td>
<td>0.17***</td>
<td>-0.34***</td>
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<td>(0.04)</td>
<td>(0.05)</td>
<td>(0.03)</td>
<td>(0.04)</td>
<td>(0.07)</td>
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<tr>
<td>ln(AGI/Returns in 2006)</td>
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<td>(0.05)</td>
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<tr>
<td>R-sq.</td>
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<td>0.28</td>
<td>0.39</td>
<td>0.28</td>
<td>0.67</td>
<td>0.63</td>
<td>0.67</td>
<td>0.57</td>
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<tr>
<td>R-sq. w/o County FE</td>
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</table>

Standard errors in parentheses

* $ p < 0.05, ** $ p < 0.01, *** $ p < 0.001

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
## 2002-06 Debt-Growth Regressions

All regressions include county FErs and use salary and wages as income measure.

<table>
<thead>
<tr>
<th>Stock or Flow?</th>
<th>Control for 2002 level?</th>
<th>Value or Number of Loans?</th>
<th>(1)</th>
<th>(2)</th>
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<tr>
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<tr>
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<td>(0.02)</td>
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<td>$</td>
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</tbody>
</table>

- \( \Delta \ln(\text{Salary/Returns}) \)
- \( \ln(\text{Salary/Returns in 2006}) \)
- Constant

<table>
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<tr>
<th></th>
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<tbody>
<tr>
<td>R-sq.</td>
<td>0.41</td>
<td>0.30</td>
<td>0.41</td>
<td>0.30</td>
<td>0.67</td>
<td>0.62</td>
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<td>0.09</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

* \( p < 0.05 \), ** \( p < 0.01 \), *** \( p < 0.001 \)

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Stocks vs. Flows: Total Value of Originations

![Binned Scatterplot: Originations](image1)

![Income Effects: Originations](image2)

Source: NY Fed Consumer Credit Panel/Equifax and IRS.

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Stocks vs. Flows: Stock of Debt

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Stocks vs. Flows: Stock of Debt

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This is also what we found with the long-difference regressions.

Only difference was time period (2001-07) and use of CBSA (not county) fixed effects.

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
What About Credit Scores?

Source: NY Fed Consumer Credit Panel/Equifax.
Conclusion: The “New View” of the Mortgage Boom

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- Distorted beliefs/over-optimism:
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Adjusted Gross Income (AGI) vs. Salary and Wages

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Growth in ZIP-level Debt, House Prices, and Income

Solid line: House price appreciation (HPA); dashed line: income growth

Source: NY Fed Consumer Credit Panel/Equifax and IRS.
Distribution of Mortgage Debt by Type

Shares of Mortgage Debt (Equifax)

Shares of 1st-Mort. Debt (Equifax)

Shares of 2nd-Mort. Debt (Equifax)

Shares of HELOC Debt (Equifax)

Source: NY Fed Consumer Credit Panel/Equifax and IRS.

FLW (Boston Fed)
Comparing Debt Aggregates

Flow of Funds
Microlevel SCF: Henriques and Hsu (2014)
Microlevel SCF: Combined Extract Data
FRBNY Consumer Credit Panel/Equifax