House Prices and Risk Sharing

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The question

- Home equity is the largest asset for many households.
- The popular press depicts home equity loans as “piggy banks”.
- Then, do consumers, smooth non-housing consumption more (less) when house prices go up (down)?
- Is there a differential effect for home owners and renters?
- Is the effect of negative income shocks such as displacement and disability mitigated (worsen) when house price appreciate (depreciate)?
Punchline

*Home owners smooth consumption more than renters and smoothing improves (worsens) when houses appreciate (depreciate).*
What we do

- We examine the sensitivity of consumption to income by estimating regressions on PSID data.
- We simulate a model of house ownership since the tenure choice is endogenous.
- We estimate regressions using simulated data to interpret our results and orders of magnitude.
Very brief literature review

- Large literature on risk sharing: household-level, regional-level, international-level.

- Literature on heterogenous-agent models with housing, Chambers et al., Rios-Rull and Sanchez-Marcos (2008), Diaz and Luengo-Prado, etc.

- Literature on wealth effects of housing: Case et. al (2001), Campbell and Cocco (2007), Attanasio et al. (2005), Cooper (2008), etc.

- Lustig and Van Nieuwerburgh; risk sharing with housing at the regional level. Implications for asset returns.

Regression specification: Risk Sharing

★ Notation:
- $i$ is an individual, $m$ is a region/MSA.
- $c$ is nondurable consumption growth, $y$ is income growth, and $h$ is growth of house values (median house value).
- $\bar{z}_t$ is the period $t$ mean of a generic variable $z$.

★ Run panel regression:

$$c_{it} - \bar{c}_t = \mu + \alpha (y_{it} - \bar{y}_t) + \varepsilon_{it},$$

$\alpha$ is a measure of deviation from full risk sharing.
$\alpha = 0$ full risk sharing.
$\alpha = 1$ consumption follows income perfectly.
Risk sharing and house prices

★ We estimate:

\[ c_{it} - \bar{c}_t = \mu + \alpha (y_{it} - \bar{y}_t) + \beta (h_{mt} - \bar{h}_t) + \gamma (y_{it} - \bar{y}_t) \times (h_{mt} - \bar{h}_t) + \varepsilon_{it}, \]

- Risk sharing measure: \( \alpha + \gamma (h_{mt} - \bar{h}_t) \).
- \( \gamma < 0 \): more risk sharing with house price changes.

We control for age in simulated data and age and family size when using actual data.
Risk sharing, displacement and house prices

We estimate:

\[ c_{it} - \bar{c}_t = \mu + \alpha (y_{it} - \bar{y}_t) + \beta (h_{mt} - \bar{h}_t) + \xi (D_{it} - \bar{D}_t) \]

\[ + \zeta (D_{it} - \bar{D}_t) \times (h_{mt} - \bar{h}_t) + \varepsilon_{it}, \]

- \( D_{it} \): indicator for displacement/disability.
- Effect of disability: \( \xi + \zeta \times (h_{mt} - \bar{h}_t) \).
- \( \zeta > 0 \): more risk sharing with house price appreciation.
Risk sharing: Owners vs. Renters

- Estimate equations from owners and renters separately, but $\bar{c}_t$, $\bar{y}_t$ are for the full sample.

- Interpretation: deviation from perfect risk sharing between U.S. residents.

- Renter and owner defined as of initial period.

- Part of the differential consumption smoothing may come from changes in tenure choice.
The data

Data are from the PSID (1968-), except house prices for metro areas from the OFHEO (1975-) repeat sales of houses with mortgages bought by Fannie Mae or Freddie Mac. Sample 1980-2003.

- Stable family composition.
- Food consumption [data break in 1993].
- Displacement: plant relocation/employer died or fired.
- Disability: physical or nervous condition which limits work.
- Income: labor and transfer income of head and wife.
- Regressions over 4-year periods (better signal-to-noise than annual).
### Table 3: Risk Sharing in Data. All shocks

<table>
<thead>
<tr>
<th></th>
<th>Owners</th>
<th>Renters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income G.</td>
<td>0.095***</td>
<td>0.177***</td>
</tr>
<tr>
<td></td>
<td>(11.05)</td>
<td>(11.89)</td>
</tr>
<tr>
<td>House price G.</td>
<td>0.112***</td>
<td>0.132***</td>
</tr>
<tr>
<td></td>
<td>(5.20)</td>
<td>(3.15)</td>
</tr>
<tr>
<td>Inc. G. x House price G.</td>
<td>−0.140**</td>
<td>−0.115</td>
</tr>
<tr>
<td></td>
<td>(−2.32)</td>
<td>(−1.05)</td>
</tr>
<tr>
<td>Adj. R sq.</td>
<td>0.090</td>
<td>0.059</td>
</tr>
<tr>
<td>F</td>
<td>179.4</td>
<td>96.3</td>
</tr>
<tr>
<td>N</td>
<td>17287</td>
<td>7489</td>
</tr>
</tbody>
</table>

**Notes:** Controls include age, age sq. and family size growth. Prais-Wisten regressions; robust standard errors clustering by MSA.
### Table 3: **Risk Sharing-Data—Negative Shocks**

<table>
<thead>
<tr>
<th></th>
<th>Owner</th>
<th>Renter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Income Growth</strong></td>
<td>0.095***</td>
<td>0.094***</td>
</tr>
<tr>
<td></td>
<td>(9.91)</td>
<td>(10.73)</td>
</tr>
<tr>
<td><strong>House price Growth</strong></td>
<td>0.116***</td>
<td>0.114***</td>
</tr>
<tr>
<td></td>
<td>(5.21)</td>
<td>(5.28)</td>
</tr>
<tr>
<td><strong>Displaced</strong></td>
<td>-0.035***</td>
<td>-0.044***</td>
</tr>
<tr>
<td></td>
<td>(-2.89)</td>
<td>(-3.65)</td>
</tr>
<tr>
<td><strong>Disp. x House P. G.</strong></td>
<td>0.137*</td>
<td>0.133*</td>
</tr>
<tr>
<td></td>
<td>(1.81)</td>
<td>(1.73)</td>
</tr>
<tr>
<td><strong>Disabled</strong></td>
<td>-0.029**</td>
<td>-0.034***</td>
</tr>
<tr>
<td></td>
<td>(-2.48)</td>
<td>(-2.99)</td>
</tr>
<tr>
<td><strong>Disa. x House P. G.</strong></td>
<td>0.249***</td>
<td>0.252***</td>
</tr>
<tr>
<td></td>
<td>(3.35)</td>
<td>(3.25)</td>
</tr>
<tr>
<td><strong>Adj. R sq.</strong></td>
<td>0.090</td>
<td>0.090</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>136.6</td>
<td>131.4</td>
</tr>
</tbody>
</table>

*Notes: Controls include age, age sq. and family size growth. Prais-Wisten regressions; robust standard errors clustering by MSA.*
Robustness

- Food at home vs. food away, and imputed total nondurable consumption.
- Non-overlapping growth rates.
- House price residual.
- IV regressions.
In order to interpret our empirical results we need a model with somewhat realistic features. We use a framework based on by Díaz and Luengo-Prado (2008).

Salient features:

- Life cycle model with house ownership and rental housing.
- Income shocks and house price appreciation.
Preferences, endowments and demography

Households may live for up to $T$ periods. Each period they face an exogenous probability of dying. Expected lifetime utility of a household born in period 1:

$$E \sum_{t=0}^{T} \frac{1}{(1 + \rho)^t} \zeta_t u(c_t, s_t),$$

- $c_t$: Non housing consumption.
- $s_t = x_t f_t + (1 - x_t) h_t$: Housing services.
- $f_t$: Housing services purchased in the market.
- $h_t$: Services yielded by owner occupied housing.
- $x_t = \{0, 1\}$: Households cannot rent and be homeowners at the same time.
- $\zeta$: probability of being alive at $t$. $\rho$: discount rate. No bequest motive.
Preferences, endowments and demography

- If age ≤ R, households are workers and receive idiosyncratic stochastic labor earnings.

- Working-age households are subject to moving shocks.

- At age R, households retire and receive a pension. Retirees are not subject to moving shocks.

- When a household dies, it is replaced by a newborn.
  - wealth is liquidated and passed to the descendant (accidental bequests).
Working-age individuals: Labor earnings:

\[ w_t = P_t \nu_t, \quad P_t = P_{t-1} \gamma \epsilon_t s_t, \quad s_t = \begin{cases} \lambda < 1, & p, \\ 1, & 1 - p. \end{cases} \]

Retirees: \( w_t = bP_R \); pension proportional to permanent earnings in last period of working life.

- \( \gamma \): Non stochastic life cycle component.
- \( \log \epsilon \sim N \left( -\frac{\sigma^2_\epsilon}{2}, \sigma^2_\epsilon \right) \), permanent shock.
- \( \log \nu \sim N \left( -\frac{\sigma^2_\nu}{2}, \sigma^2_\nu \right) \), transitory shock.
- \( s_t \): displacement shock. \( p \), probability of “displacement.”
At the beginning of period $t$, a household has:

- $h_{t-1} \geq 0$ in housing stock.
- $d_{t-1} \geq 0$ in deposits, with interest rate $r^d_t$.
- $m_{t-1} \geq 0$ in mortgage debt; interest rate is $r^m_t$. 
Market arrangements

Houses serve as collateral for loans

Whenever a household buys a house:

\[ m_t \leq (1 - \theta) q_t h_t \]

\( \theta \) : down payment

\( q_t \) : housing price

- Must also be satisfy for home equity loans of existing home owners.
- Existing homeowners who do not move and have negative equity can simply service debt (\( m_t < m_{t-1} \)).
Market arrangements

Owner occupied housing is an illiquid asset

- When moving household pays a selling cost, $\chi q_t (1 - \delta^h) h_{t-1}$, and a buying cost $\kappa q_t h_t$.
- Maintenance cost equal to the fraction $\delta^h$ of the housing stock.
Tax arrangements

Tax-free imputed rents and deductible interest mortgage payments

Income: labor earnings plus interest income.
\[ y_t = w_t + r^d_t d_{t-1}. \]

Taxable income: income minus mortgage interest deduction.
\[ y^\tau_t = y_t - \tau_m r^m_t m_{t-1}. \]

Proportional income taxation at the rate \( \tau_y \).
We choose 3 parameters to match 3 targets from the SCF. Other parameters calibrated using various sources.

**Housing weight in utility function:** $\alpha = 0.2$ to match the the median $H/W$ ratio.

**Discount rate:** 3.15% is set to match the median ratio $W/Y$ in the SCF (for workers).

**Size of smallest house:** 1.65 permanent income, set to obtain a 70% ownership rate.
Calibration: Preferences

Utility function:

\[ u(c_t, s_t) = \frac{[c_t^{\alpha} s_t^{1-\alpha}]^{1-\sigma}}{1 - \sigma} \]

Risk aversion parameter: \( \sigma = 2 \)
Households are born at 24, die by 86, retire at 66.

One period is two years.

**Survival Probabilities**: U.S. Vital Statistics (for females in 2003)

**Moving shocks**: CPS.
Endowments (in annual terms):

- **Permanent shock:** \( \sigma_\varepsilon = 0.01 \) (Li and Yao 2005)
- **Transitory shock:** \( \sigma_\nu = 0.073 \) (Li and Yao 2005)
- **Displacement shock:** \( p = 0.03 \), income loss 25%
- **Pension:** 50\% of permanent income in the last period
The housing price follows (Li and Yao 2005)

\[
\frac{q_{t+1}}{q_t} - 1 = \varrho, \quad \varrho \sim N \left(0, \sigma_\varrho^2\right)
\]

where \(\sigma_\varrho = 0.0132\).

Serially uncorrelated and not correlated with households’ earnings.
Calibration: Market arrangements

In annual terms

- The return to deposits is $r^d = 4\%$
- The mortgage interest rate is $r^m = r^d + 0.5\%$
- The down payment, $\theta = 20\%$
- The adjustment costs in houses, 6% selling cost, 2% buying cost. The depreciation rate: $\delta^h = 1.5\%$.
- The rental price of housing:

$$r_t^f = \frac{q_t \left( 1 - \frac{1 - \delta^h - \bar{\tau}_t}{1 + \bar{\tau}_t^d} \right)}{1 - \tau_y}$$
Home Ownership over the Life Cycle

Figure 1: Life-cycle Profiles
Figure 2: Life-cycle Profiles
Simulations

- Given a set of parameters, we solve the household problem numerically.
- Then, we generate shocks to income, etc., for 27 regions of 5,000 individuals for several periods.
- Individuals in a given region share the house price shocks. In the last 5 periods of the simulations one third of the regions experiences house price depreciation, one third house price appreciation and one third no house price changes. (4-year overlapping growth rates for those 5 periods are used for estimations on simulated data.)
Regressions on simulated data. Owners vs. Renters (ages 24-65)

Table 4: Risk Sharing in Model. All Shocks

<table>
<thead>
<tr>
<th></th>
<th>Owners</th>
<th>Renters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Growth</td>
<td>0.14***</td>
<td>0.42***</td>
</tr>
<tr>
<td></td>
<td>(156.72)</td>
<td>(218.37)</td>
</tr>
<tr>
<td>House Price Growth</td>
<td>0.21***</td>
<td>–0.03***</td>
</tr>
<tr>
<td></td>
<td>(116.63)</td>
<td>(–6.08)</td>
</tr>
<tr>
<td>Income G. x House Price G.</td>
<td>–0.03***</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(–9.60)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Adj. R sq.</td>
<td>0.282</td>
<td>0.425</td>
</tr>
<tr>
<td>N</td>
<td>190981</td>
<td>97328</td>
</tr>
</tbody>
</table>

Overlapping 4-year log differences. Prais-Wisten estimation, robust s.e. clustering by region.
Regressions on simulated data. Owners vs. Renters (ages 24-65)

**Table 3: Risk Sharing in Model. Negative Shocks**

<table>
<thead>
<tr>
<th></th>
<th>Owners</th>
<th>Renters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Growth</td>
<td>0.14***</td>
<td>0.41***</td>
</tr>
<tr>
<td></td>
<td>(87.32)</td>
<td>(214.50)</td>
</tr>
<tr>
<td>House Price Growth</td>
<td>0.21***</td>
<td>–0.03***</td>
</tr>
<tr>
<td></td>
<td>(113.84)</td>
<td>(–5.80)</td>
</tr>
<tr>
<td>Displaced</td>
<td>–0.16***</td>
<td>–0.15***</td>
</tr>
<tr>
<td></td>
<td>(–93.34)</td>
<td>(–45.09)</td>
</tr>
<tr>
<td>Displaced x House Price G.</td>
<td>0.04***</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(8.29)</td>
<td>(1.02)</td>
</tr>
<tr>
<td>Adj. R sq.</td>
<td>0.317</td>
<td>0.432</td>
</tr>
<tr>
<td>N</td>
<td>190981</td>
<td>97328</td>
</tr>
</tbody>
</table>

Overlapping 4-year log differences. Prais-Witten estimation, robust s.e. clustering by region.
Model Extensions

- **Correlation** between income shocks and house price shocks (adding a regional permanent shock perfectly correlated with house price shock).

- A bequest motive.

- CES utility.

- Recalibration. Home ownership rate, median wealth to income and house value to wealth ratios constant.
Model Extensions. Home ownership

Figure 3: Life-cycle Profiles
Regressions on simulated data. Robustness. Owners

Table 5: **Risk Sharing in Model: Owners**

<table>
<thead>
<tr>
<th></th>
<th>Accidental Bequests</th>
<th>Bequest Motive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No co.</td>
<td>Co.</td>
</tr>
<tr>
<td>Income Growth</td>
<td>0.14***</td>
<td>0.14***</td>
</tr>
<tr>
<td></td>
<td>(145.24)</td>
<td>(197.83)</td>
</tr>
<tr>
<td>House Price Growth</td>
<td>0.20***</td>
<td>0.31***</td>
</tr>
<tr>
<td></td>
<td>(115.87)</td>
<td>(197.25)</td>
</tr>
<tr>
<td>Income G. x House Price G.</td>
<td>–0.03***</td>
<td>–0.01***</td>
</tr>
<tr>
<td></td>
<td>(–8.59)</td>
<td>(–3.36)</td>
</tr>
<tr>
<td>Displaced</td>
<td>–0.16***</td>
<td>–0.16***</td>
</tr>
<tr>
<td></td>
<td>(–96.69)</td>
<td>(–82.34)</td>
</tr>
<tr>
<td>Displaced x House Price G.</td>
<td>0.03***</td>
<td>0.02**</td>
</tr>
<tr>
<td></td>
<td>(6.34)</td>
<td>(2.69)</td>
</tr>
<tr>
<td>Adj. R sq.</td>
<td>0.318</td>
<td>0.395</td>
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<tr>
<td>N</td>
<td>190981</td>
<td>190951</td>
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</table>
### Table 6: Risk Sharing in Model: Renters

<table>
<thead>
<tr>
<th></th>
<th>Accidental Bequests</th>
<th>Bequest Motive</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No co.</td>
<td>Co.</td>
</tr>
<tr>
<td>Income Growth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income Growth</td>
<td>0.41***</td>
<td>0.44***</td>
</tr>
<tr>
<td></td>
<td>(216.10)</td>
<td>(207.07)</td>
</tr>
<tr>
<td>House Price Growth</td>
<td>−0.03***</td>
<td>0.06***</td>
</tr>
<tr>
<td></td>
<td>(−5.94)</td>
<td>(13.16)</td>
</tr>
<tr>
<td>Income G. × House Price G.</td>
<td>0.00</td>
<td>0.02**</td>
</tr>
<tr>
<td></td>
<td>(0.17)</td>
<td>(2.34)</td>
</tr>
<tr>
<td>Displaced</td>
<td>−0.15***</td>
<td>−0.14***</td>
</tr>
<tr>
<td></td>
<td>(−45.09)</td>
<td>(−35.07)</td>
</tr>
<tr>
<td>Displaced × House Price G.</td>
<td>0.01</td>
<td>0.03**</td>
</tr>
<tr>
<td></td>
<td>(1.06)</td>
<td>(2.19)</td>
</tr>
<tr>
<td>Adj. R sq.</td>
<td>0.432</td>
<td>0.465</td>
</tr>
<tr>
<td>N</td>
<td>97328</td>
<td>97604</td>
</tr>
</tbody>
</table>
Model Extensions. Summary

- The sign of the interaction terms seem robust across specifications. Differential risk sharing for owners and renters.
Conclusions

- Home owners are better able to share income risks than renters, particularly in periods of house price appreciation.
- But they do suffer when prices go down.
- It is tricky business to uncover ‘wealth effects’.