Consumption Responses to House Price Heterogeneity

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RBNZ Housing Household Debt and Policy Conference

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Motivation

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- How can we characterize house price variation faced by households?
  - Variation in the aggregate, across cities, across neighborhoods, and across individual houses
- What is the consumption response to movements in different house price components?
  - Does consumption respond more to neighborhood price movements than to city price movements?
  - Are there stronger responses to idiosyncratic price shocks than other shocks?

Motivation

- House prices may affect consumption through:
  1. Substitution effects
  2. Wealth effects
  3. Collateral effects
- Wealth effects may be small if higher house prices today imply higher housing costs in the future (Buiter (2008))
- Older households may experience strong wealth effects since they are likely to downsize housing or sell-up soon (Campbell and Cocco (2007))
- But consider consumption responses to price movements given:
  - **Differential price movements across houses in different locations**
  - **Some probability of moving across those locations**

Motivation

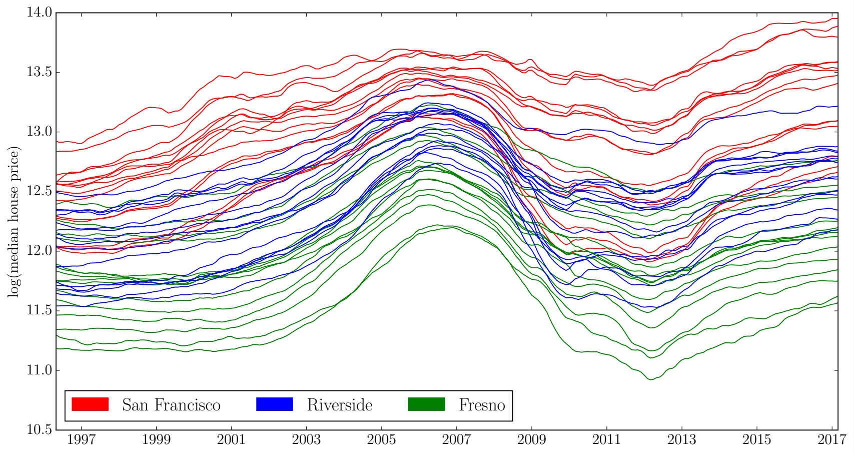


Figure 1: Median house prices by zip code (Source: Zillow)

Motivation

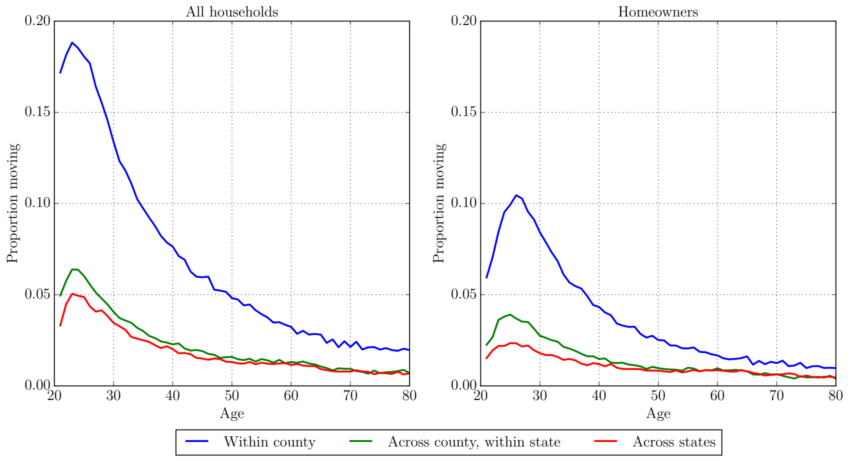


Figure 2: Proportion moving across locations (Source: CPS)

Overview

Motivation

House price decomposition

Consumption response to house prices

Model

Elasticity of consumption with respect to house prices

Conclusion

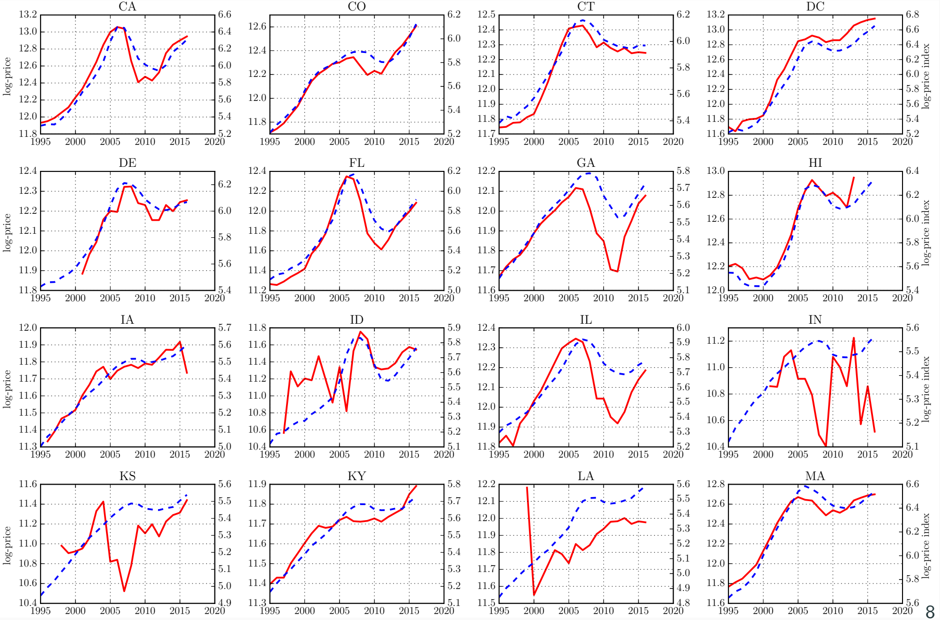
House price decomposition

Housing data

- Zillow Transaction and Assessment (ZTRAX) dataset[1]
  - Contains over 350 million residential and commerical property transactions, for over 2700 counties in the US, for up to 20 years
  - Detailed information on deed transfers, mortgages, foreclosures, property characteristics, geographic information, assessor valuations
- Want housing market transactions by households:
  - Non-commerical, single family residences.
  - Housing sales only (no mortgages or refinancing)
  - Arm's-length and non-foreclosure sales
- Final data set:
  - 13 million individual transactions
  - 38 states + D.C.
  - 1993–2016

[1] Calculated based on data from Zillow (US). The conclusions drawn from the Zillow data are those of the researchers and do not reflect the views of Zillow. Zillow is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

ZTRAX average state prices vs. FRED all-transactions index



House price decomposition

- Estimates of **idiosyncratic** price variation **within** a housing market/city:
  - $\sigma \approx 8 - 15\%$ (Landvoigt et al. (2015), Giacoletti (2016))
- But prices fluctuate **across** individual houses, neighborhoods, and cities
- Consider an unobserved error components model:

$$\log p_{m,z,i,t} = \beta_{m,t} X_{i,t} + u_t + v_{m,t} + w_{z,t} + \varepsilon_{i,t}$$

- $X_{i,t}$: observable house characteristics (hedonic component)
- u_t: aggregate component
- $v_{m,t}$: city component (CBSA/MSA)
- $w_{z,t}$: neighborhood component (zip code)
- $\varepsilon_{i,t}$: idiosyncratic component

Cross-sectional variance of house price components

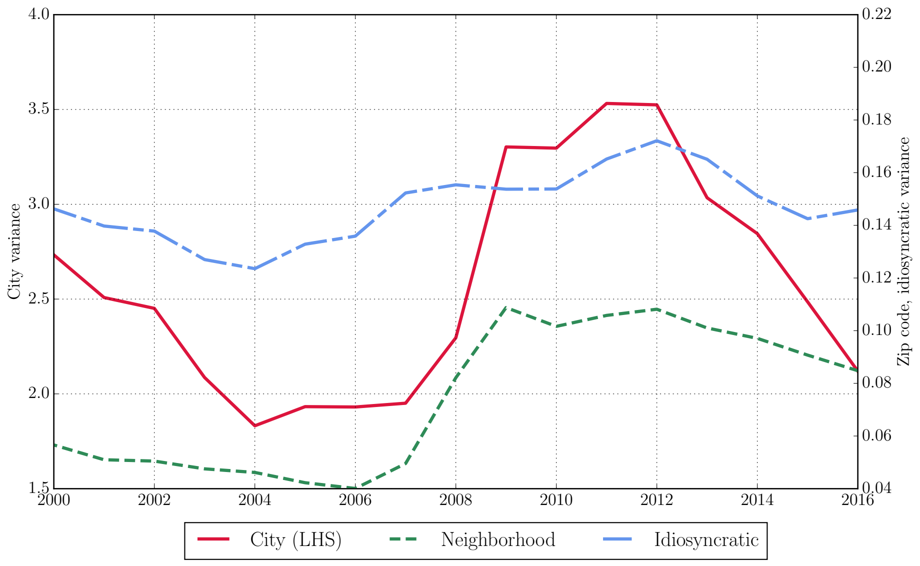


Figure 3: Variance of house price components (Source: ZTRAX)

Consumption response to house prices

Consumption response to house prices

- Consumption data: Nielsen Consumer Panel[2]
  - 40,000-60,000 households, 2004-2015
  - Households report all purchases tracked by Nielsen ($\sim$ 30% of consumption categories)
  - Demographically balanced panel across: age, race, education, occupation, income, household size, presence of children
  - Observe the zip code and CBSA of a household
- Merge with ZTRAX house price data

[2] Calculated based on data from The Nielsen Company (US), LLC and marketing databases provided by the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the Nielsen data are those of the researchers and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

Consumption response to house prices

$$\log c_{m,z,i,t} = \alpha_i + \beta x_{i,t} + \delta q_{m,t} + \gamma_a \log p_t + \gamma_m \log p_{m,t} + \gamma_z \log p_{z,t} + \varepsilon_{m,z,i,t}$$

- α_i: household fixed effects
- $x_{i,t}$: observable household characteristics:
  - Age, education, race, marital status, household size
- $q_{m,t}$: city-level observables;
  - Real personal income per capita (BEA), unemployment rate (BLS).
- p_t: aggregate price
- $p_{m,t}$ city price
- $p_{z,t}$: zip code price

Consumption response to house prices

Dependent variable:	log(real consumption expenditure)			
	(1)	(2)	(3)	(4)
$\log(p_t)$	0.079***			0.081***
	(0.008)			(0.008)
$\log(p_{m,t})$		−0.040		0.043
		(0.033)		(0.034)
$\log(p_{z,t})$			0.077***	0.056***
			(0.019)	(0.015)
$\log(Y_{m,t})$	−0.285***	−0.343***	−0.381***	−0.321***
	(0.056)	(0.052)	(0.056)	(0.052)
$\log(U_{m,t})$	0.365	−2.443***	−2.417***	0.442
	(0.223)	(0.293)	(0.270)	(0.285)
Household controls	✓	✓	✓	✓
Household fixed effects	✓	✓	✓	✓
Observations	966,997	966,997	966,997	966,997
R^2	0.705	0.704	0.704	0.705
Within R^2	0.04	0.04	0.04	0.04

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Consumption response to house prices

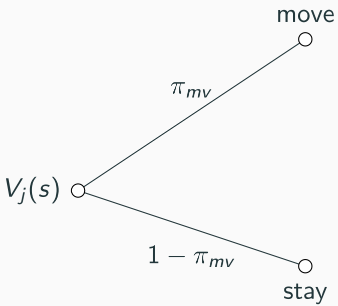
- Result: Neighborhood-level prices have a stronger association with consumption than city-level prices
- Preliminary evidence in favor of hypothesis:
    - Neighborhood level prices have a stronger wealth effect, since households are more likely to move across neighborhoods than across cities
    - Need a structural model to check this intutition

Model

Model: overview

- Partial equilibrium, life-cycle model
- Households can rent or own housing
- Houses can be purchased using long-term mortgages
- House prices consist of:
    - City component P_m, follows an AR(1)
    - Neighborhood component P_z, follows an AR(1)
- Households can be forced to move across neighborhoods by exogenous moving shocks
    - New neighborhood price $\tilde{P}_z$ drawn from stationary distribution of the AR(1)
    - Moving opens a wedge between sale price $P_m P_z$ and purchase price $P_m \tilde{P}_z$

Model: household decision timeline



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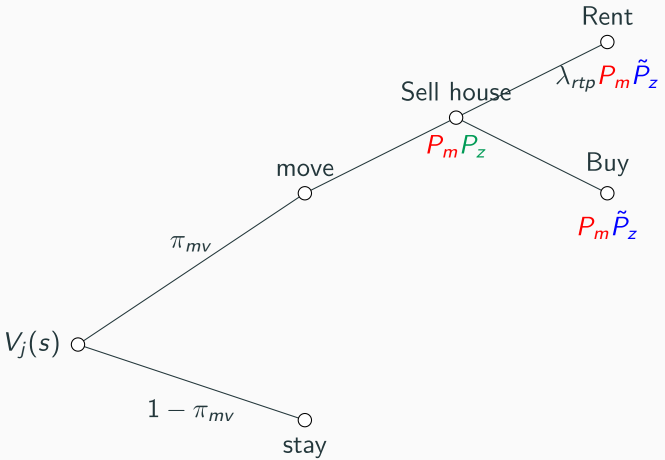

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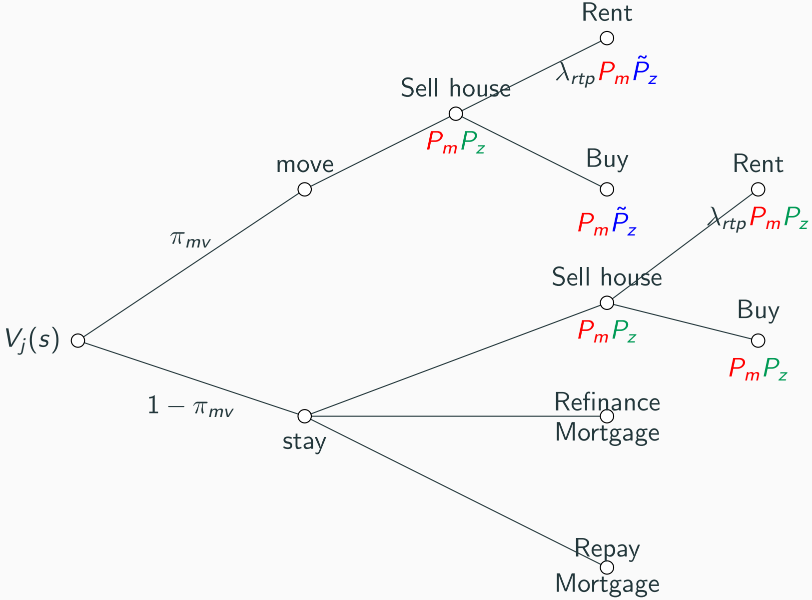
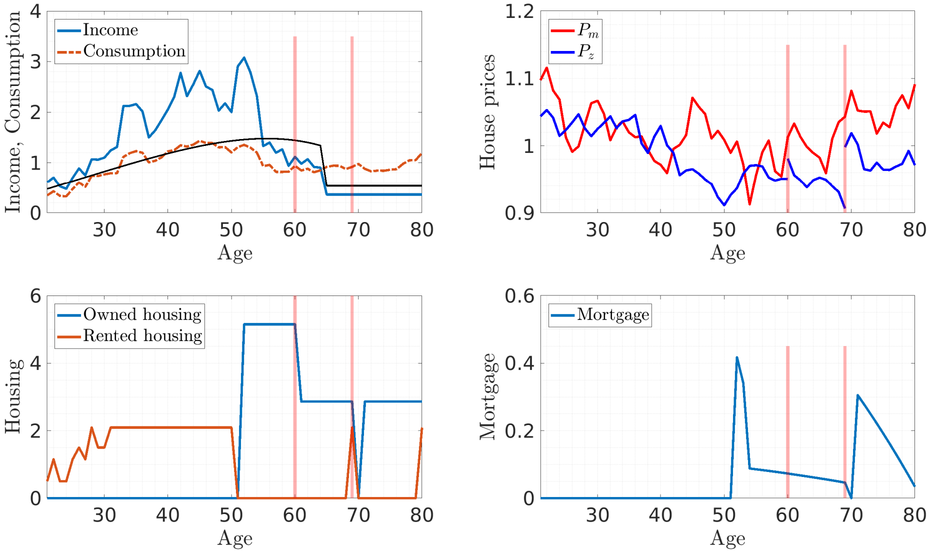


Model: household simulation



Elasticity of consumption with respect to house prices

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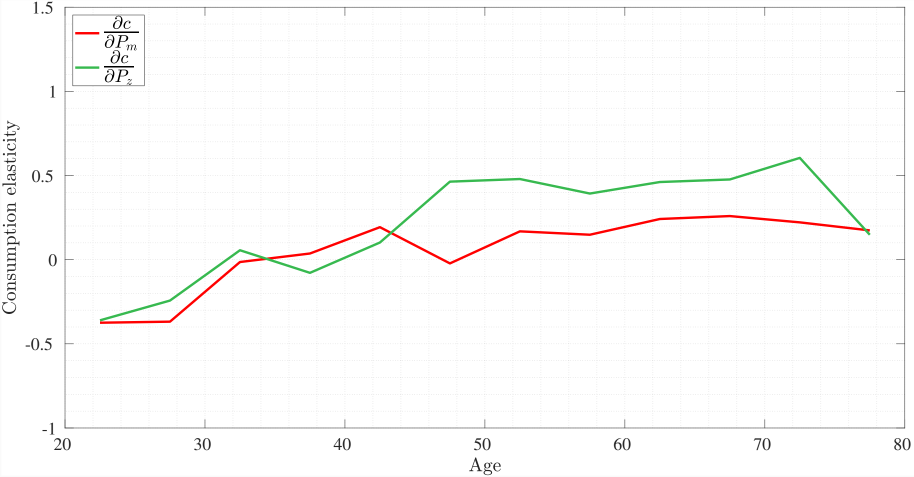

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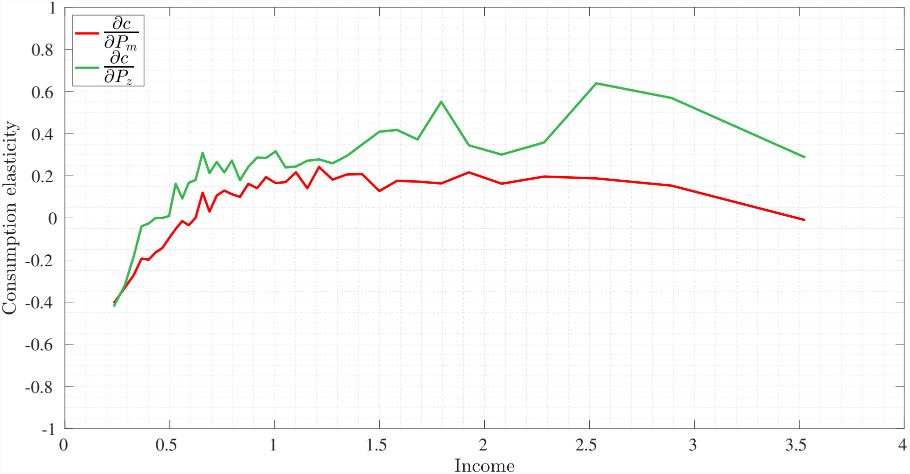

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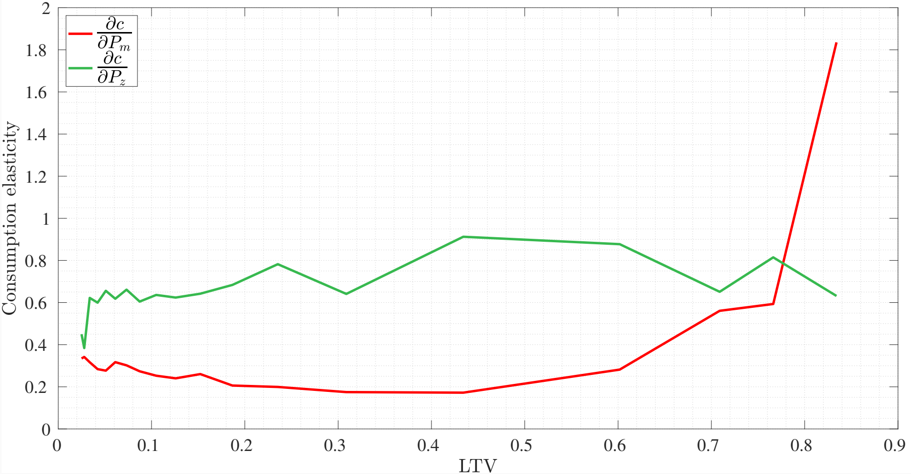


Conclusion

Conclusion

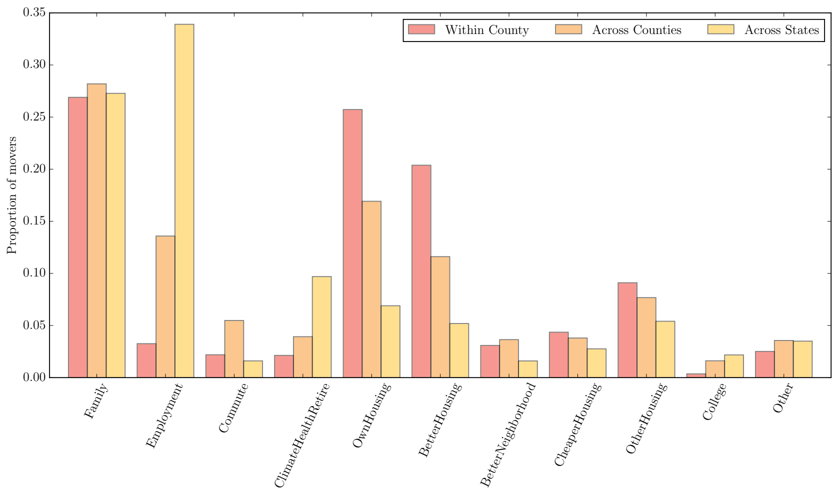
- Decompose house price variation by levels of geographic aggregation:
  - City-level variation dominates neighborhood and idiosyncratic variation
  - However, significant time-variation in the importance of each component
- Empirical link between consumption and house price components:
  - Household consumption more strongly associated with neighborhood price variation than city price variation
- Study life-cycle model with possibility of movement across neighborhoods:
  - Neighborhood moves generate wedge between house **sale** prices and house **purchase** prices
  - Possibility of moving exposes households to cross-neighborhood housing wealth effects
  - $\Rightarrow$ Household consumption more sensitive to neighborhood price movements than city price movements

APPENDIX

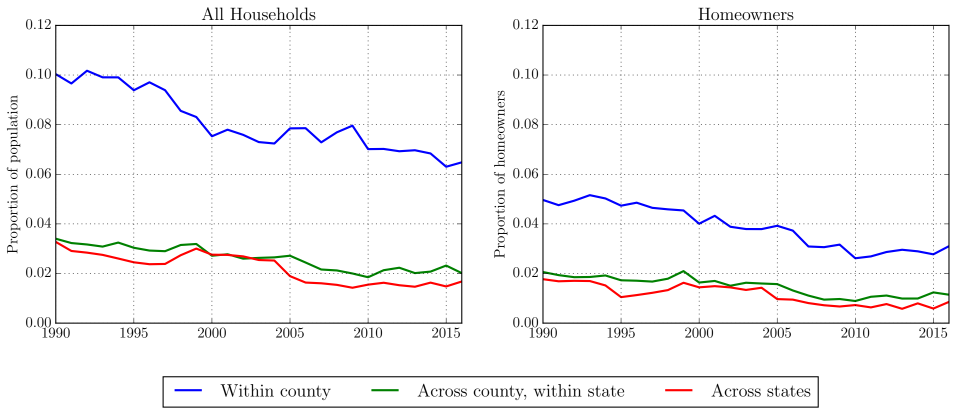
Contribution to literature

- **House price risk**:
  - Sinai and Souleles (2005), Landvoigt et al. (2015), Giacoletti (2016)
- **Housing effect on consumption behavior**:
  - Campbell and Cocco (2007), Mian et al. (2013), Stroebel and Vavra (2014), Kaplan et al. (2016), Aladangady (2017), Guren, McKay, Nakamura, and Steinsson (2017)
- **"New Canonical" macro housing models**:
  - Chen et al. (2013), Berger et al. (2015), Favilukis et al. (2017), Gorea and Midrigan (2017), Kaplan et al. (2017), Beraja et al. (2017)

Reasons for moving



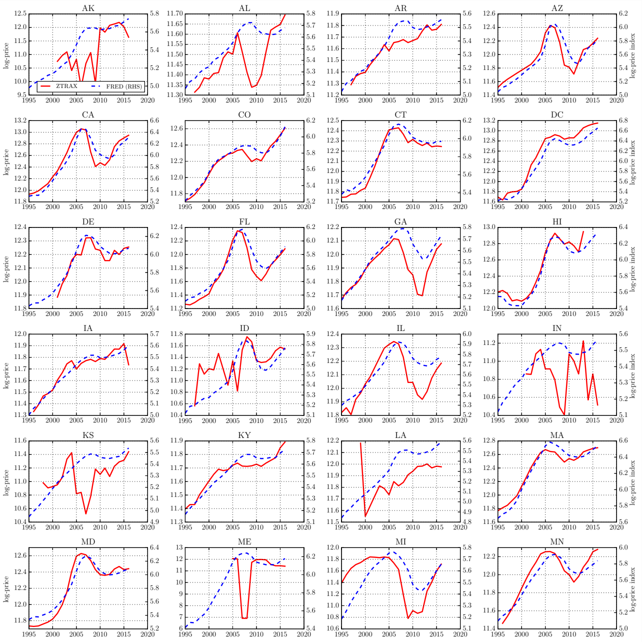
Probability of moving across locations



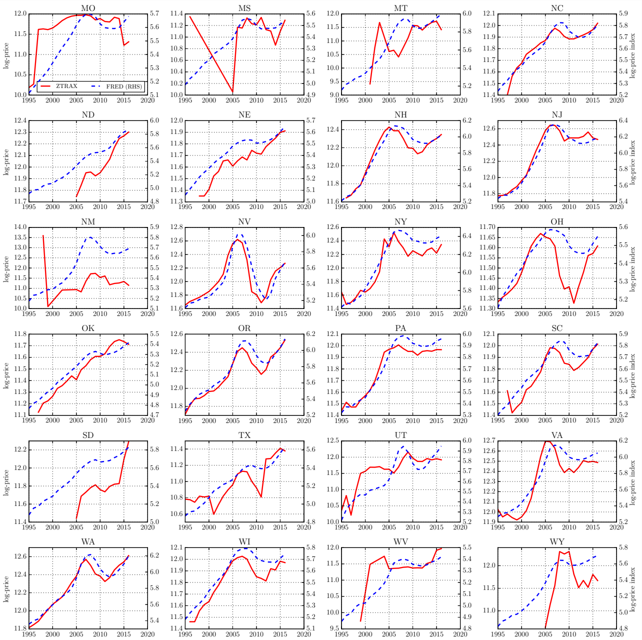
ZTRAX: number of observations by state

State	Total	Non-zero	State	Total	Non-zero
AK	87,481	0.6	AL	764,753	76.7
AR	525,394	74.7	AZ	3,870,789	77.0
CA	12,695,929	81.2	CO	2,465,752	83.8
CT	977,941	95.3	DC	153,775	90.8
DE	186,550	84.2	FL	1,0549,532	83.7
GA	2,946,447	75.9	HI	318,845	90.1
IA	343,278	83.0	ID	282,022	0.9
IL	2,756,664	78.8	IN	1,315,892	5.4
KS	436,669	5.6	KY	542,103	89.5
LA	73,519	86.4	MA	2,312,393	94.7
MD	3,332,529	82.4	ME	155,485	3.2
MI	1,990,535	72.3	MN	1,373,273	94.7
MO	1,264,435	31.1	MS	203,776	20.9
MT	89,388	4.6	NC	1,019,788	81.3
ND	59,523	47.1	NE	248,312	85.4
NH	359,665	92.0	NJ	802,287	90.9
NM	27,992	2.0	NV	1,722,843	83.5
NY	2,766,500	88.3	OH	3,644,017	78.6
OK	981,942	75.3	OR	1,166,150	88.9
PA	2,685,987	93.4	SC	1,207,735	83.8
SD	19,872	66.4	TX	7,651,403	1.6
UT	1,188,371	0.9	VA	2,088,157	93.1
WA	2,647,489	82.8	WI	443,308	87.7
WV	42,623	67.1	WY	36,137	5.7

ZTRAX state-level prices vs. FRED all-transactions index



ZTRAX state-level prices vs. FRED all-transactions index



Nielsen Consumer Panel number of observations

Year	Total Panelists	Remaining Panelists	Year	Total Panelists	Remaining Panelists
2004	39577	37331	2010	60658	56974
2005	38863	36605	2011	62092	58450
2006	37786	35627	2012	60538	57045
2007	63350	59302	2013	61097	57565
2008	61440	57539	2014	61557	57996
2009	60506	56734	2015	61380	57880

House price decomposition: Algorithm

- The residual error component as

$$\hat{p}_{m,z,i,t} = \log p_{m,z,i,t} - \beta_t X_{i,t} - u_t$$

- Estimate city-level component via within-city mean of residual error:

$$v_{m,t} = \frac{1}{n_{m,t}} \sum_{z \in m} \sum_{i \in z} \hat{p}_{m,z,i,t}$$

- The residual error component is then:

$$\hat{\hat{p}}_{m,z,i,t} = \hat{p}_{m,z,i,t} - v_{m,t}$$

.

- Estimate zip code component via within-zip mean of the residual error:

$$w_{z,m,t} = \frac{1}{n_{z,t}} \sum_{i \in z} \hat{\hat{p}}_{m,z,i,t}$$

- The idiosyncratic component is the remaining residual error:

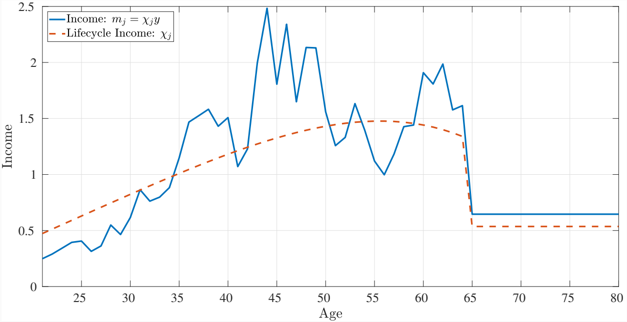
$$\varepsilon_{m,z,i,t} = \hat{\hat{p}}_{m,z,i,t} - w_{z,m,t}$$

Model: life-cycle and income

- Household lifetime: 21 to 80
- Working-age: 21 to 65
- Working-age income:

$$\log m_j = \log \chi_j + \log y$$
$$\log y' = \rho_y \log y + \epsilon_y$$

- Retirement income is a constant fraction of final working-life income



Model: preferences

- Cobb-Douglas utility over consumption and housing services

$$u(c, s) = \frac{(c^{\chi} s^{1-\chi})^{1-\sigma}}{1-\sigma}$$

- Housing services s may be rented, or derived from owned housing
- One unit of owned housing generates greater housing service flow than one unit of rented housing
- Households leave 'warm glow' bequests in the period after death:

$$\nu(\alpha) = \psi \frac{(\alpha + \underline{\alpha})^{1-\sigma}}{1-\sigma}$$

Model: mortgages

- New mortgages are issued subject to a fixed cost
- The size of a new mortgage is restricted by:
  - Loan-to-value constraint: $b' \leq \theta P_m P_z h'$
  - Payment-to-income constraint: $d_j(b') \leq \lambda_\pi m_j$
- Mortgages above a conforming LTV limit, θ_c, incur a 'discount' on the mortgage size: $qb' < b'$.
- Mortgage payments are constant each period, with the mortgage balance amortizated over the household's remainging life:

Model

- Choose consumption, size of rental unit, and liquid assets
- Any previous house is sold at the current neighborhood price

$$
\begin{aligned}
V_j^S = \max_{c,s,a'} & u(c,s) + \beta \mathbb{E}(\pi_{mv} V_{j+1}^{move} + (1-\pi_{mv}) V_{j+1}^{stay}) \\
\text{s.t.} \quad & c + a' + P_r s + (1+r_b)b \\
& \quad = m_j + a(1+r) + (1-\delta_h - F_s) P_m P_z h - b(1+r_b) \\
& a' \geq 0 \\
& z', b', h' = 0 \\
& s \in \mathcal{S} \\
& P_r = \lambda_{rtp} P_m P_z
\end{aligned}
$$

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- Choose consumption, size of rental unit, and liquid assets
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& P_r = \lambda_{rtp} P_m \tilde{P}_z
\end{aligned}
$$

Model

- Choose consumption, liquid assets, size of new housing unit, and size of new mortgage
- Any previous house is sold at the current neighborhood price
- New housing is purchased at the current neighborhood price
- The new mortgage is subject to LTV and PTI restrictions

$$V_j^A = \max_{c,a',h',b'} u(c,h') + \beta \mathbb{E}(\pi_{mv} V_{j+1}^{move} + (1-\pi_{mv}) V_{j+1}^{stay})$$

$$\begin{aligned}
\text{s.t.} \quad & c + a' + P_m P_z h' + b(1+r_b) + F_m \\
& \qquad = m_j + a(1+r) + P_m P_z h(1-\delta_h - F_s) + qb' \\
& a' \geq 0 \\
& b' \leq \theta P_h h', \quad d(b') \leq \lambda_d m_j \\
& h' \in \mathcal{H}
\end{aligned}$$

Model

- Choose consumption, liquid assets, size of new housing unit, and size of new mortgage
- Any previous house is sold at the current neighborhood price
- New housing is purchased at the new neighborhood price
- The new mortgage is subject to LTV and PTI restrictions

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V_j^A = & \max_{c,a',h',b'} u(c,h') + \beta \mathbb{E}(\pi_{mv} V_{j+1}^{move} + (1-\pi_{mv}) V_{j+1}^{stay}) \\
\text{s.t.} \quad & c + a' + P_m \tilde{P}_z h' + b(1+r_b) + F_m \\
& \qquad = m_j + a(1+r) + P_m P_z h(1-\delta_h - F_s) + qb' \\
& a' \geq 0 \\
& b' \leq \theta P_h h', \quad d(b') \leq \lambda_d m_j \\
& h' \in \mathcal{H}
\end{aligned}
$$

Model

- Choose consumption, and liquid assets
- Make a mortgage payments according to the amortization formula

$$
\begin{aligned}
V_j^N = & \max_{c,a'} u(c,h) + \beta \mathbb{E}(\pi_{mv} V_{j+1}^{move} + (1-\pi_{mv}) V_{j+1}^{stay}) \\
\text{s.t.} \quad & c + a' + \delta_h P_m P_z h + d_j(b) = m_j + a(1+r) \\
& a' \geq 0 \\
& b' = (1+r_b)b - \pi
\end{aligned}
$$

Model

- Choose consumption, liquid assets, and the size of a new mortgage
- New mortgage is subject to LTV and PTI restrictions at current neighborhood prices

$$V_j^R = \max_{c,a',b'} u(c,h) + \beta \mathbb{E}(\pi_{mv} V_{j+1}^{move} + (1-\pi_{mv}) V_{j+1}^{stay})$$

$$\text{s.t.} \quad c + a' + b(1+r_b) + \delta_h P_m P_z h + F_m = m_j + a(1+r) + qb'$$

$$a' \geq 0$$

$$b' \leq \theta P_m P_z h, \quad d(b') \leq \lambda_d m_j$$

Model

Preferences		
Discount factor	β	0.96
Risk aversion	σ	2
Non-durables consumption share	χ	0.85
Desirability of bequests	ψ	100
Luxuriousness of bequests	$\underline{\alpha}$	7.7
Housing		
Maximum LTV ratio, conforming	θ_c	0.8
Maximum LTV ratio, non-conforming	θ_{nc}	0.9
House sale fixed cost	F_s	0.06
New mortgage cost	F_m	0.0385
House depreciation	δ_h	0.015
Median house price-to-income ratio	λ_{pti}	2.25
Rent-to-house price ratio	λ_{rtp}	0.075
Interest rates		
Risk-free rate	r	0.015
Mortgage interest rate	r_b	0.025
Liquid asset borrowing constraint	$\underline{a}$	0
Income process		
Transitory income persistence	ρ_y	0.938
Transitory income std. dev.	σ_y	0.20
House prices		
City-level persistence	ρ_m	0.95
City-level std. dev.	σ_m	0.015
Neighborhood-level persistence	ρ_z	0.90
Neighborhood-level std. dev.	σ_z	0.025
Probability of neighborhood moving shock	π_{mv}	0.05