Vacancies in Housing and Labor Markets

Vacancies in Housing and Labor Markets: Theory and Empirics

Yannis M. Ioannides, Tufts University

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Acknowledgement

Presentation combines two papers, jointly authored with Jeff Zabel:

1. "Housing and Labor Market Vacancies". Working paper December 2018.

2. "Housing and Labor Market Vacancies and Beveridge Curves: Theoretical Framework and Illustrative Statistics."

   Appeared in:

   Ioannides, Yannis M., ed. *Recent Developments in the Economics of Housing.* Vol. II. Edward Elgar. 2019.

Transitions: Housing Market

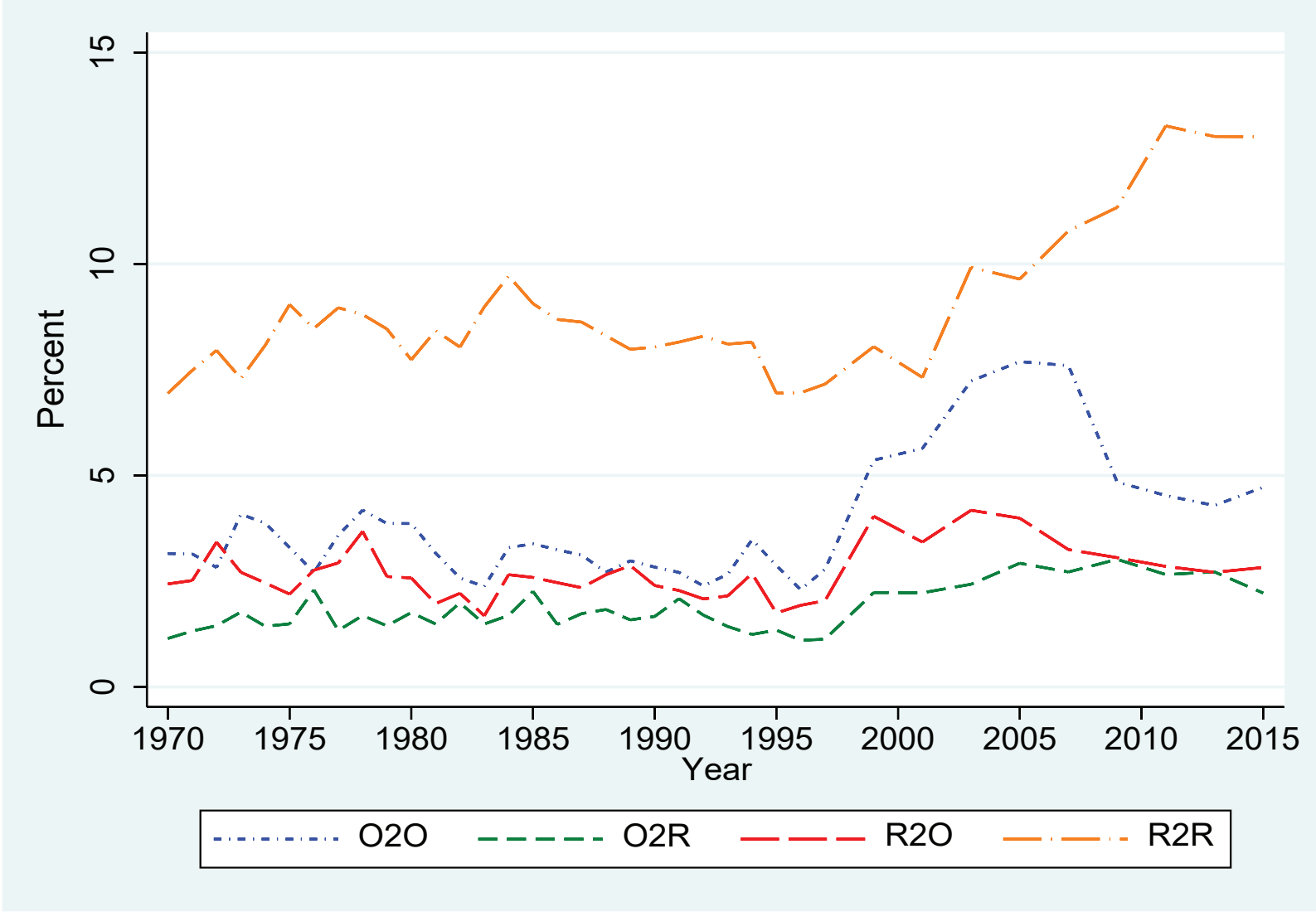

Figure 1: Housing Market Transition Rates

Source: PSID and authors' calculations. Note: Annual rates for 1970-1995 and biennial rates for 1997-2015

Transitions: Labor Market

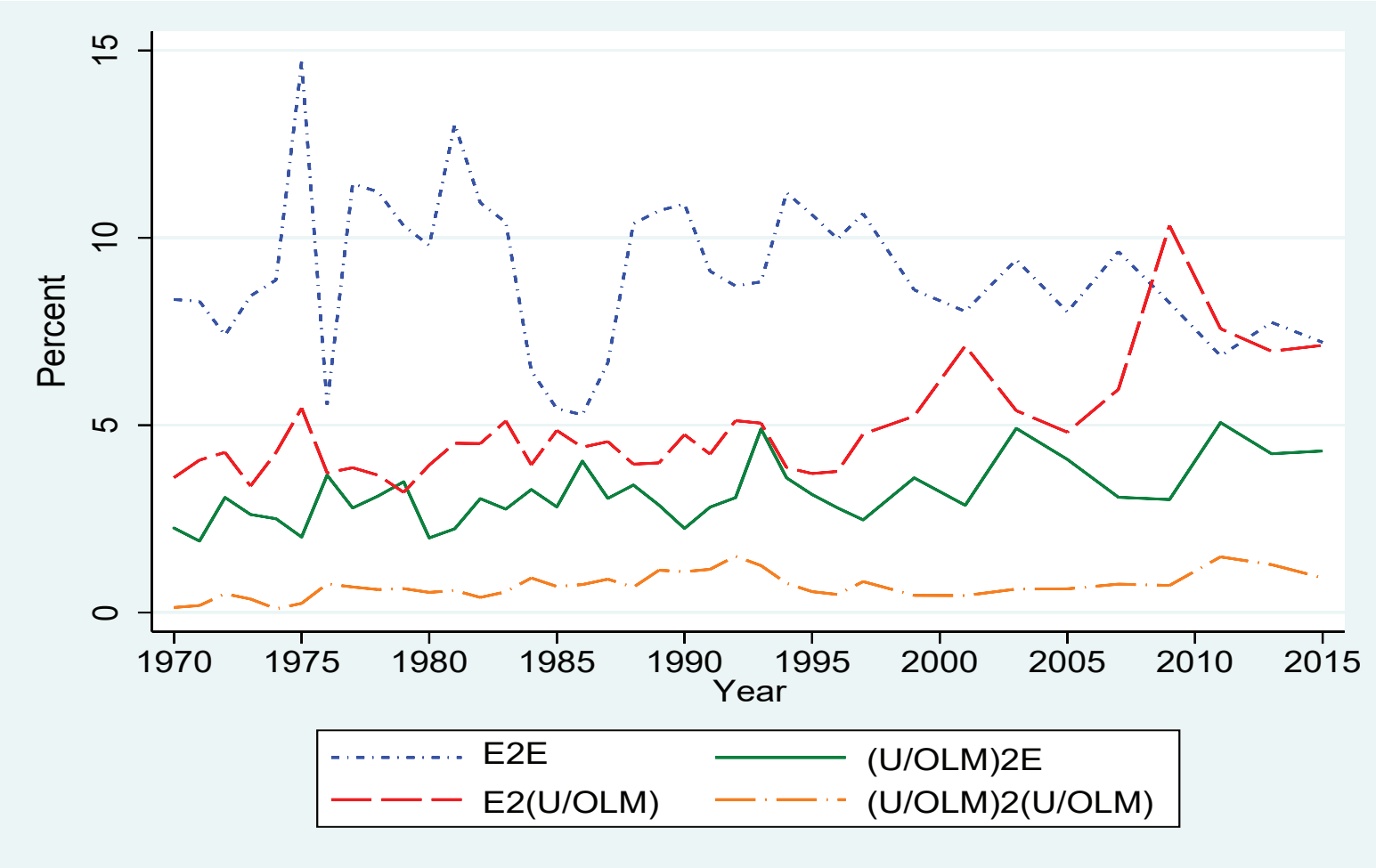

Figure 2: Labor Market Transition Rates

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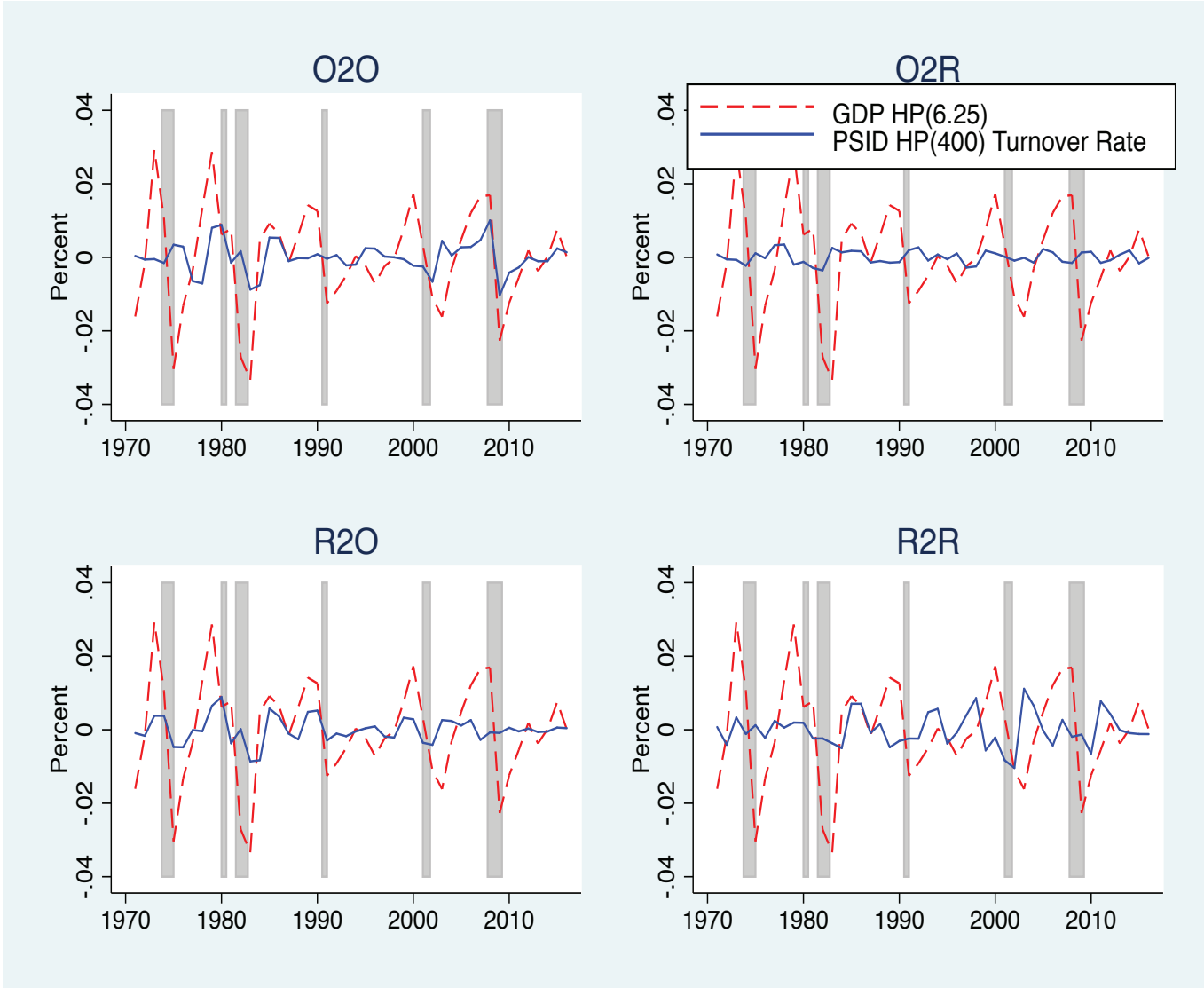

Figure 3: Cyclical Components of the Disaggregated Housing Turnover Rates

Transitions 1970-97: Joint Labor and Housing Markets

Table 1: **Bivariate Distribution, Annual Frequency: 1970-1997**

Transitions	No Change	O2O	O2R	R2O	R2R	Employ
No Change	72.95	2.36	1.03	1.78	4.63	82.74
OLM2E	1.13	0.04	0.03	0.06	0.29	1.56
OLM2U	0.22	0.00	0.01	0.00	0.06	0.29
U2E	0.93	0.04	0.05	0.03	0.32	1.37
U2OLM	0.30	0.01	0.00	0.01	0.07	0.39
E2U	1.02	0.05	0.05	0.05	0.32	1.48
E2OLM	2.26	0.13	0.06	0.05	0.25	2.75
E2E	5.84	0.50	0.36	0.48	2.24	9.42
Housing	84.65	3.12	1.59	2.47	8.17	100.00

Transitions 1999-2015: Joint Labor and Housing Markets

Table 2: **Bivariate Distribution, Biennial Frequency: 1999-2015**

Transition	No Ch	O2O	O2R	R2O	R2R	Employ
No Change	65.02	4.46	1.86	2.33	6.68	80.36
OLM2E	1.54	0.08	0.04	0.08	0.40	2.15
OLM2U	0.14	0.02	0.01	0.01	0.08	0.26
U2E	0.99	0.08	0.11	0.08	0.50	1.76
U2OLM	0.36	0.02	0.02	0.02	0.15	0.56
E2U	1.18	0.11	0.07	0.08	0.52	1.96
E2OLM	3.73	0.30	0.13	0.15	0.45	4.76
E2E	4.61	0.72	0.33	0.61	1.92	8.20
Housing	77.59	5.77	2.57	3.37	10.71	100.00

Summary Statistics: 1976-1997

Table 6: **Summary Statistics: 1976-1997**

Variable	Mean	S.D.	Min.	Max.
Housing Turnover Rate (TOR-H)	15.38	1.47	12.29	18.35
Employment Turnover Rate (TOR-E)	17.56	2.01	13.71	20.37
Real GDP	8.03	1.60	5.66	10.98
Seasonally Adjusted (SA) HPI	53.85	3.25	48.07	60.73
Real GDP Growth Rate (GDP gr)	3.28	2.09	-1.18	7.69
SA HPI Growth Rate (HPI gr)	0.52	3.40	-6.13	6.40
Jobs Vacancy Rate (VJobs)	7.63	1.50	5.28	10.55
Homeowner Vacancy Rate (VHouse)	1.50	0.21	1.00	1.77
Rental Vacancy Rate (VRental)	6.59	1.08	5.03	7.85

Correlations: Housing, Employment, and Business Cycle Variables

Table 7: **Correlations: Housing, Employment, and Business Cycle Variables**

	TOR-H	TOR-E	GDP	GDP gr	HPI	HPI gr	VJobs	VHouse
TOR-E	-0.24							
GDP	0.52	0.01						
GDP gr	0.48	-0.06	0.47					
HPI	0.02	0.25	0.67	-0.03				
HPI gr	0.39	-0.01	0.51	0.39	0.41			
VJobs	0.53	-0.04	0.87	0.38	0.67	0.68		
VHouse	-0.20	-0.42	-0.20	-0.32	-0.22	-0.64	-0.36	
VRental	-0.20	-0.47	-0.03	-0.33	0.35	0.30	0.19	-0.05

Preview results

1. Joint model of frictional housing and labor markets.
2. Labor market Beveridge curve is shifted by housing market vacancies.
3. Novel *unemployment concept* for ownership and rental housing markets.
4. Beveridge curve for ownership and rental housing markets.
5. Theoretical result is verified in the data.
6. Granger causality runs from the housing market to the labor market.
7. Impulse Response Functions show that shocks to the housing market propagate in the labor market.

Facts: GDP, House Prices, Unemployment

1. Fig. 1: US Real GDP and Real House Price Growth: 1976:1–2015:3

Figure 1

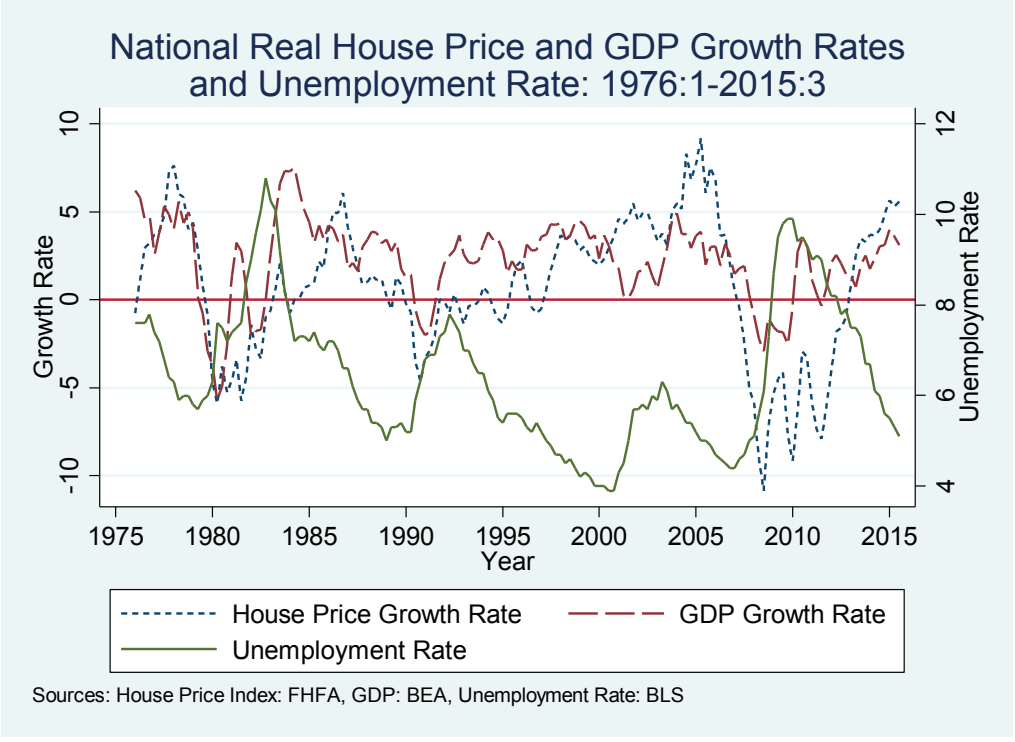

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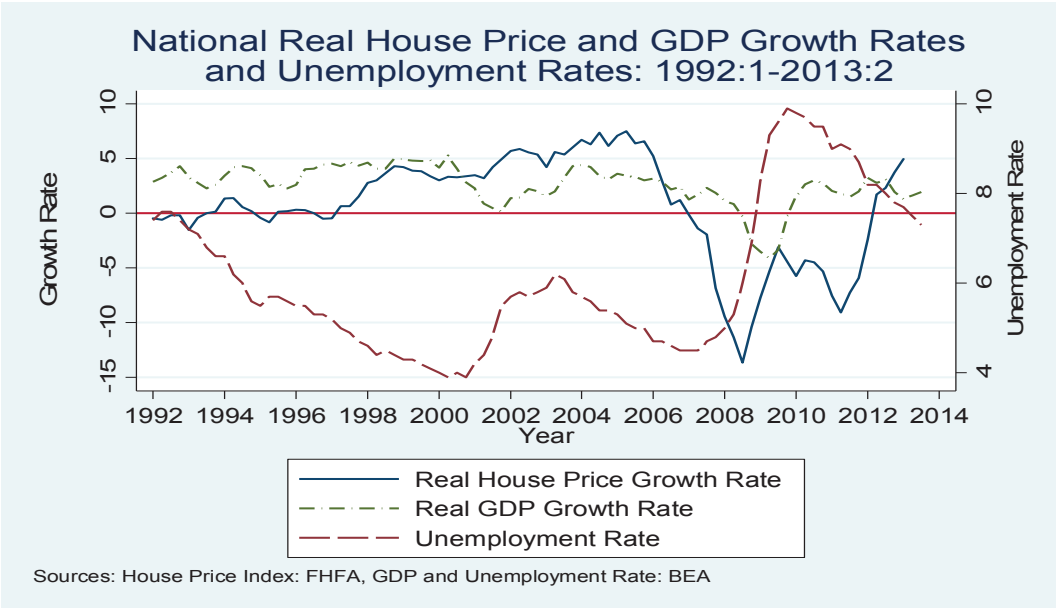
Fig. 1B: Motivation



- Approx. Correlations: House Prices and GDP = 0.5
- House Prices and Unemployment = -0.5
- GDP and Unemployment = -0.5

Figure 8: Real GDP, Real House Prices, Unemployment:1976:1–2015:3

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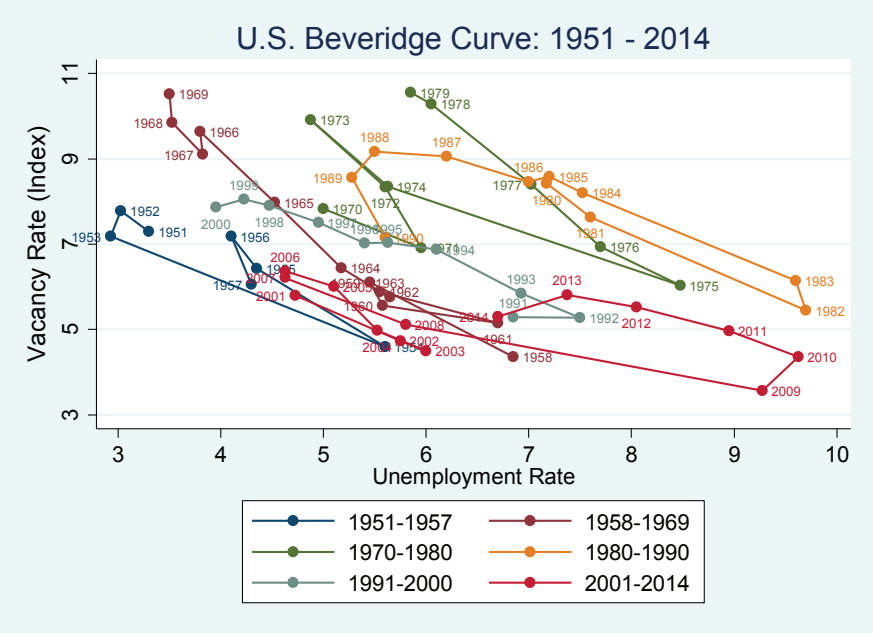
Facts: Beveridge Curve

1. Fig. 4: Beveridge curve; Labor Vacancy rate against unemployment rate tracks cyclical episodes

Figure 4



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1. Why the shift?

   matching efficiency, skill mismatch, LF participation rate, policy uncertainty.

2. Why slow recovery, since 2009:6?

   Many reasons, but we think it also has to do with the housing market.

Goal

1. Model captures the interdependence of the housing and labor markets.
2. Unlike standard approaches, here based on job and housing vacancy rates
3. Data back to the early 1950s, use to estimate interdependence.

Housing and Labor Markets with Frictions

- The **D**iamond-**M**ortensen-**Pissarides** model (DMP) of labor markets with frictions: search
- Based on twin concepts of unemployment and job vacancies: workers' search vs. firms' search
- Well understood theoretically and empirically.
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  Labor and housing markets are interdependent:

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  Labor and housing markets are interdependent:

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  Treat labor and housing markets jointly.

Key concepts of DMP theory

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- Nash bargain over gains to share: sets wages, transaction prices
- Gains in labor market: individual, incr. utility from employment; firm, from filling vacancy
- Gains in housing market: incr. utility from homeownership , selling house
- stocks of unemployed are matched with vacancies: rate of contacts

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- stocks of unemployed are matched with vacancies: rate of contacts
- Adopt DMP-type housing market model by Head and Lloyd-Ellis (2012).
  - Paper extends model to labor markets with frictions;
  - and to rental markets with frictions.
  - Specific result: housing market spillovers shift the Beveridge curve, labor market

DMP theory of the housing market

- Natural unemployment rate in the housing market?

DMP theory of the housing market

- Natural unemployment rate in the housing market? Owning vs renting: central friction, due to mismatch, costs to upsizing/downsizing, unanticipated moving, life cycle events.
- *Unfulfilled* agents: *renters(owners)* who would rather own(rent) but *cannot*:

$$\text{uhr} = \frac{N_{u,rent}}{N_{u,rent} + N_{own}} \leq \%\text{renters}; \ \text{urr} = \frac{N_{u,own}}{N_{u,own} + N_{rent}} \leq \%\text{owners}.$$

- Normalize: $\text{ur}^H \equiv$ uhr/share renters: Unfulfilled ownership rate="unemployment" rate^H, $0 \leq \text{ur}^H \leq 1$:

$$\text{ur}^H = \frac{\text{uhr}}{n^{WR} + n^{UR}}; \ \widehat{\text{ur}^H} = 42\%.$$

- Normalize: urr/share owners : Unfulfilled rental rate="unemployment" rate, $0 \leq \text{ur}^R \leq 1$:

$$\text{ur}^R = \frac{\text{urr}}{n^{WH} + n^{UH}}; \ \widehat{\frac{N_{u,own}}{N_{own}}} = 27\%.$$

Model in a nutshell

- $\theta =$ labor market tightness $= \frac{\text{vacancy rate}}{\text{unemp. rate}}$

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  Housing tenure affects wages via bargaining; w^H, w^R.

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  If owners never change status, $w^H(\theta)$ increasing

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  Job creation curve ("demand"):

  % owners $\times$ w^H + % renters $\times$ w^R = price - cap. value firm's hiring cost (θ)

$$h(1 - \text{vown}) \times w^H + r(1 - \text{vrent}) \times w^R = p_g - (\rho + \delta)\frac{p_g c}{q(\theta)}.$$

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- Wage curves and job creation curve determine (w^H, w^R, θ).
- unemp. rate = $\frac{\text{rate job destruction}}{\text{rate job destruction}+\text{empl. rate}(\theta)}$
- Beveridge curve, accounting relationship, holds at steady state:

  downwards sloping, empl. rate(θ) incr. in vacancy rate.

Model: Head and Lloyd-Ellis (1992)

- Supply conditions for rental stock, owner-occupied stock; rental market frictionless; owners remain owners.
- renters contact with sellers, rate prop. $\frac{\text{renters}}{\text{stock not owned}}$.
- Gains to share in setting P^W, P^R, by buyer, $W^H - W^R, U^H - U^R$, seller selling price, P.
- Value of vacant unit: $\rho V = \gamma \mathcal{E} \max_{j=\text{empl., unempl.}} \left\{ P^j - V \right\}$.
- transaction price $= \sigma$ value to seller $+ (1 - \sigma)$ utility gain to renter from becoming owner.

Model: Head and Lloyd-Ellis (1992), cont'd

- Bellman equations for renters, depend on those for owners

$$\rho W^R = \pi^R(w) + \delta[U^R - W^R] + \gamma\left[W^H - P^W - W^R\right];$$

$$\rho U^R = \pi^R(b) + \mu[W^R - U^R] + \gamma\left[U^H - P^U - U^R\right].$$

  return to renter^W = flow utility + capital loss if become unempl. + capital gain if become owner

  return to renter^U = flow utility + capital gain if become empl. + capital gain if become owner

- Bellman equations, owners

$$\rho W^H = \pi^H(w) + \delta[U^H - W^H];$$

$$\rho U^H = \pi^H(b) + \mu[W^H - U^H].$$

- Extensions: "Moving House", mismatch of renters, owners (unfulfilled).

Supply Side

- Four states: WR, UR, WH, UH
- Housing supply, rental; housing supply, ownership
- Value of vacant unit, V; transaction price, P^W, P^U
- Flows across states determine ownership, rental rates.

$$n^{WH} + n^{UH} + n^{WR} + n^{UR} = 1;$$

$$(\nu + \delta + \lambda)n^{WR} - \mu n^{UR} = 0;$$

$$(\mu + \nu)n^{UH} - \delta n^{WH} - \lambda n^{UR} = 0;$$

$$\nu n^{WH} + \delta n^{WH} - \lambda n^{WR} - \mu n^{UH} = 0.$$

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$$\nu n^{WH} + \delta n^{WH} - \lambda n^{WR} - \mu n^{UH} = 0.$$

- With rationing (housing "unemployment"), modify:

$$\lambda^H = \bar{\lambda}^H(1 - \text{msm}^R);\ \lambda^R = \bar{\lambda}^R(1 - \text{msm}^H),$$

where $\text{msm}^R = \frac{N_{u,rent}}{N^{WR}+N^{UR}}$, $\text{msm}^H = \frac{N_{u,own}}{N^{WH}+N^{UH}}$.

Demand side

- Pissarides-type model: frictional labor, ownership and rental housing markets.
  1. Wage curve, owners, increasing in θ :

$$w^H = \frac{\delta+\rho}{\delta+\rho+(1-\sigma_L)\mu(\theta)}\sigma_L b + \frac{\delta+\rho+\mu}{\delta+\rho+(1-\sigma_L)\mu(\theta)}(1-\sigma_L)p_g,$$

  2. Wage curve, renters: w^R, function of w^H, θ

$$\frac{\delta+\rho+(1-\sigma_L)\mu+(1-\sigma_L)\gamma^H\sigma}{\delta+\mu+\rho+\gamma^H\sigma}(w^R-b)$$

$$+\frac{\sigma_L\gamma^H\sigma}{(\delta+\mu+\rho)(\delta+\mu+\rho+\gamma^H\sigma)}(w^H-b)=\frac{1-\sigma_L}{\rho+\delta}p_g.$$

     w^R reflects likelihood of becoming an owner, thus spillover from the ownership market

     Expected return from availing of option of becoming an owner.

     Employment while an owner is a perfect substitute

- $\left(w^H, w^R; \theta\right)$ determined simultaneously

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- $\left(w^H, w^R; \theta\right)$ determined simultaneously
- housing market spillovers

Spillovers across labor and housing markets

- housing market spillovers:

  shift the Beveridge curve in labor market for renters

- and for owners, in more general model.

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  - Vacancy rates: rental, ownership
  - Unemployment in housing markets?

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- Beveridge curve for housing

  - Vacancy rates: rental, ownership
  - Unemployment in housing markets?
    Unfulfilled desire on the part of renters to own a home.

- labor market spillovers:

  shift the Beveridge curve for housing market

Beveridge Curve for housing markets

- Vacancy rates: rental, ownership, "Unemployment"?

  Unfulfilled demand: renters who wish own; owners to rent. Estimate tenure choice (Own vs. Rent); impute "unfulfilled", $N_{rent,t}, N_{own,t}$ observed renters, owners.

- *unfulfilled owners* $= N_{u,rent,t} = \sum_{i=\text{renters}} \Phi(\mathcal{X}_{i,m,t}\hat{\alpha})$.

  Unfulfilled homeownership rate:

$$\text{ur}_t^H = 100 \times \frac{\frac{N_{u-rent,}}{N_{u-rent,t}+N_{own,t}}}{\frac{N_{rent,t}}{N_{rent,t}+N_{own,t}}},$$

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- Beveridge Curve, ownership: $\frac{v^H}{H}$ as a function of ur^H.

- Model predicts: $\text{vown} = \frac{v^H}{H} = 1 - \frac{1}{h} + \frac{1}{h}\frac{\nu}{\mu}\frac{1}{\text{ur}^H}$.

Beveridge Curve for housing markets: cont'd

- *unfulfilled renters* $= N_{u,own,t} = \sum_{i=\text{owner}} \left[1 - \Phi(\mathcal{X}_{i,m,t}\hat{\alpha})\right]$,?

$$\text{ur}_t^R = 100 \times \frac{\frac{N_{u,own,t}}{N_{u,own,t}+N_{rent,t}}}{\frac{N_{own,t}}{N_{rent,t}+N_{own,t}}},$$

Beveridge Curve for housing markets: cont'd

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- Beveridge Curve, rental: $\frac{v^R}{R}$ as a function of ur^R.
- Model predicts:

$$\text{vrent} = \frac{v^R}{R} = \text{vrent} = 1 - \frac{1}{r} + \frac{1}{r}(n^{WH} + n^{UH}) = 1 - \frac{1}{r} + \frac{1}{r}\frac{\text{urr}}{\text{ur}^R}.$$

Incomplete form, solution for the n^{WH}, n^{UH} with owner mismatch is much messier to solve for explicitly.

List of Regressions

1. Summary statistics
2. Beveridge Curve 1956 –2014: Dependent Variable is Job Vacancy Rate
3. Housing Beveridge Curve Results: 1985-2011
4. VAR Regressions for Vacancy Rates: Homeowner, Rental, and Job, CBSA Level

Data: Housing vacancies

- Census Bureau Housing Vacancy Survey (HVS), part of CPS.
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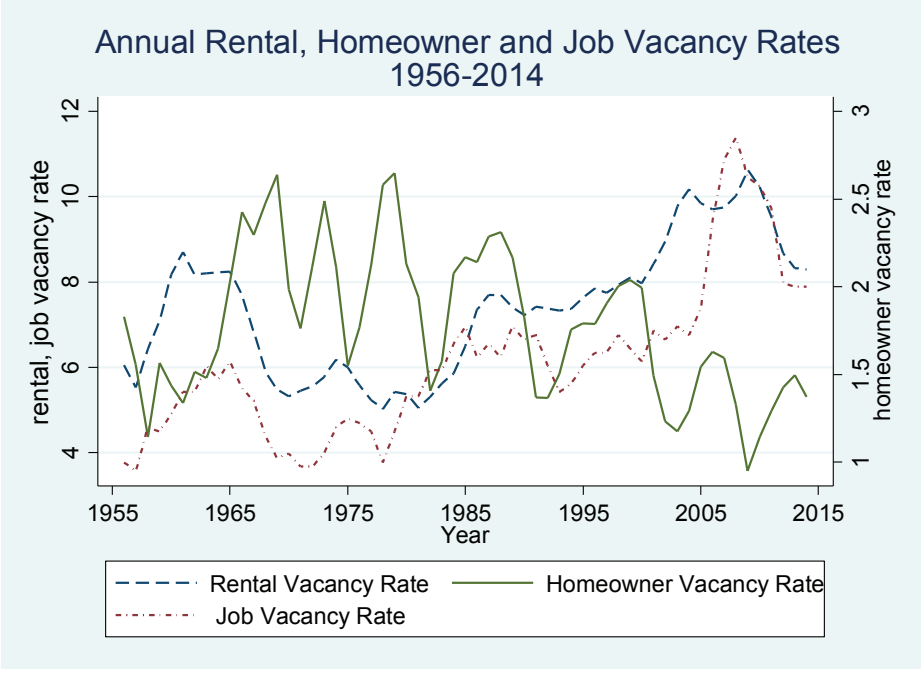

Correlations

	Rental Vacancy	Home Vacancy	Job Vacancy
Home vacancy	0.805		
Job Vacancy	-0.591	-0.495	
Unemployment Rate	0.003	0.294	-0.468

Data, cont'd: Job vacancies

- Job vacancies
- Help-Wanted Index: monthly job vacancies starting in 1951.

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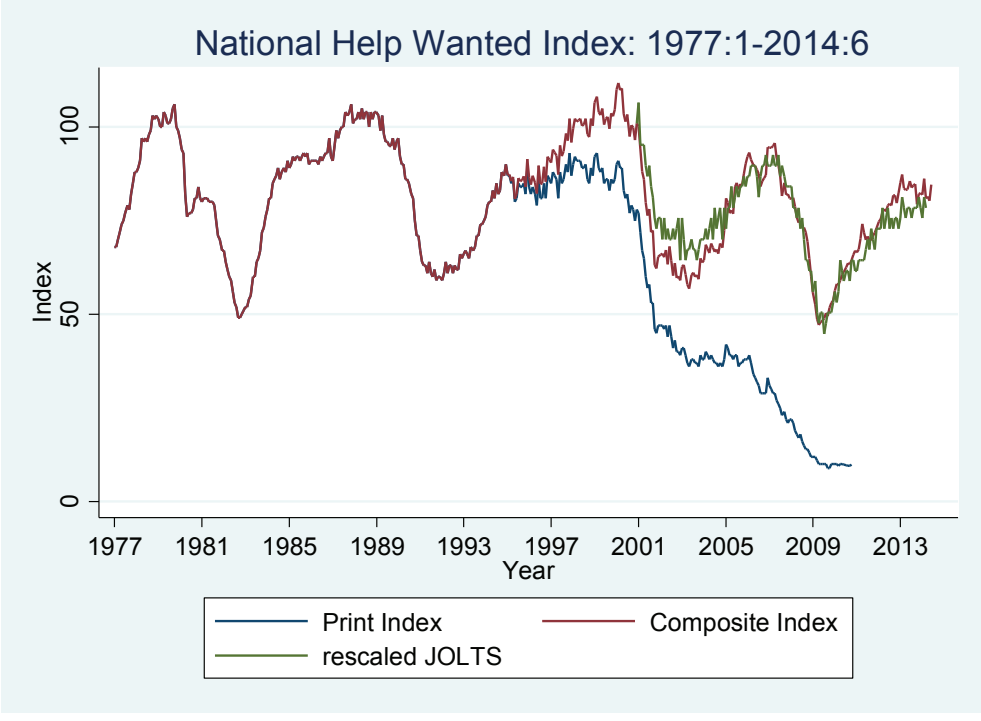
- Help-Wanted Index: monthly job vacancies starting in 1951.
- An aggregate of ads carried by printed press, provided by the Conference Board
- Nationally and for the largest MSAs
- Problem: "print-"based measure of vacancy posting has become increasingly unrepresentative as advertising over the internet has become more prevalent.
- Figure 2 plots the National print Help-Wanted Index starting in 1977.
- One can see the drop off around 2000.
- HWI: 1977:1–2014:6

Data, cont'd: Job Vacancies: Barnichon 1977:1–2014:6

- Barnichon (2010) combines the National print with the online Help-Wanted Index published by the Conference Board since 2005.
- Replicated Barnichon's index (2009), extended it through June 2014. Same data at the MSA level for 40 MSAs.

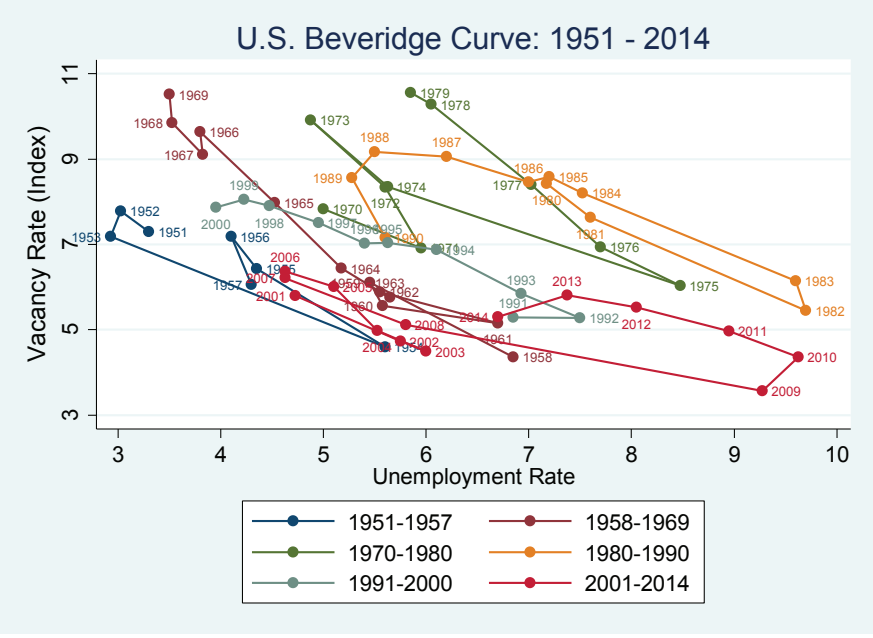
Figure 2



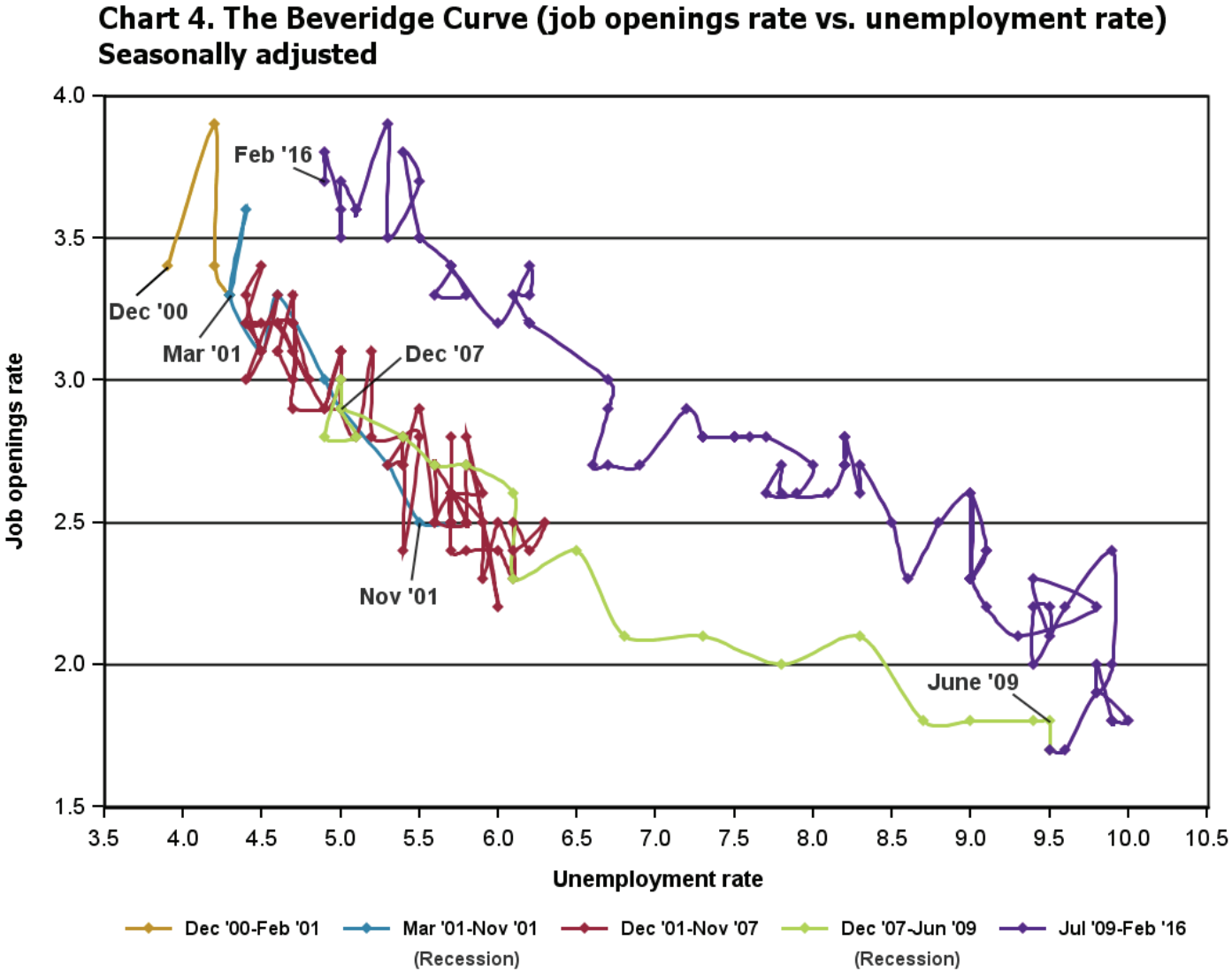
Data, cont'd: JOLTS

- Job vacancies: JOLTS
- Additional data on monthly job vacancies starting in December 2000 from the Bureau of Labor Statistics in the Job Openings and Labor Turnover Survey (BLS–JOLTS).
- Only provided at the level of the four Census regions (NE, MW, S, W) for total nonfarm employment as well as aggregated by a number of industrial categories.

Figure 4



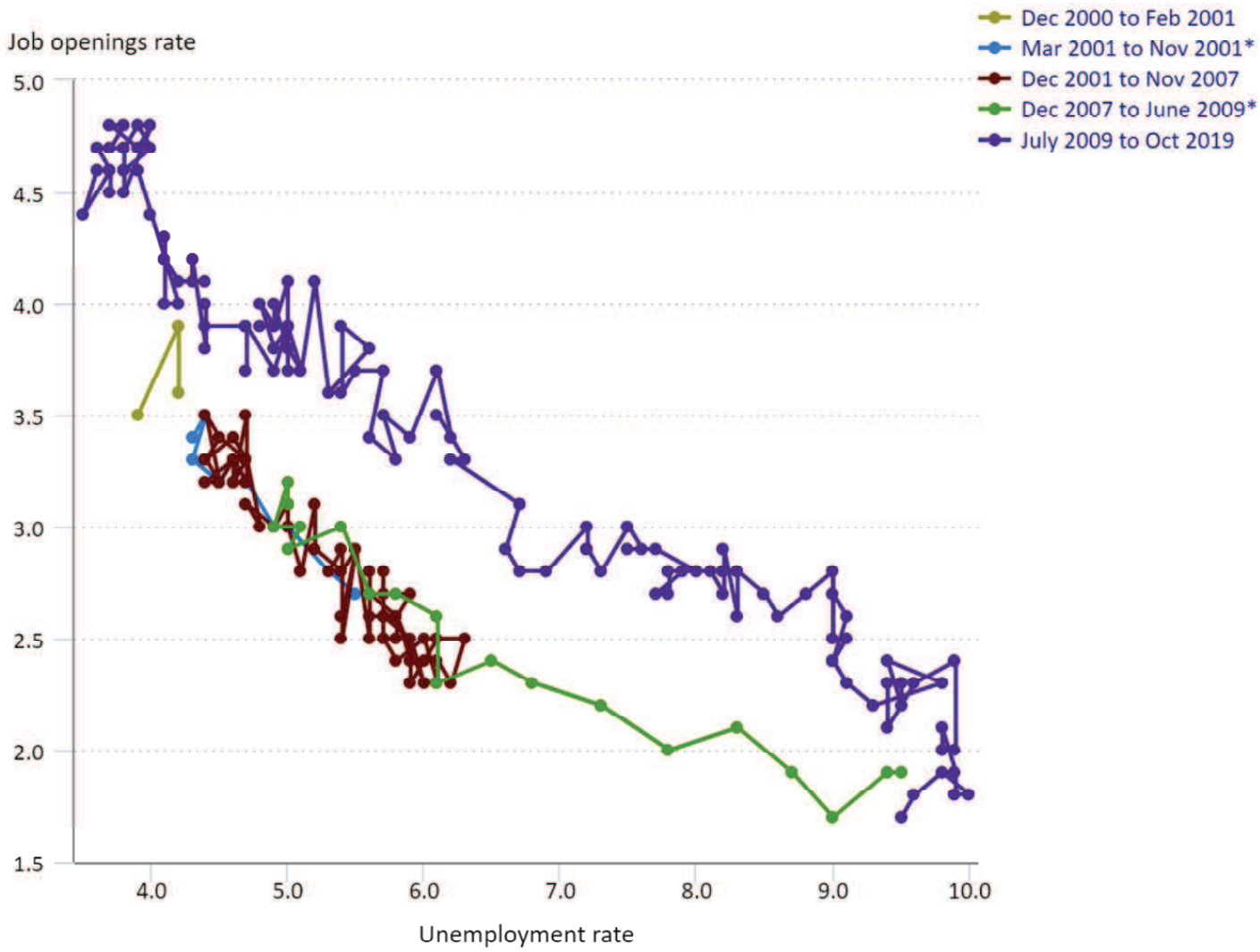
Beveridge Curve: 2000:12–2016:2 BLS



Source: Bureau of Labor Statistics, Current Population Survey and Job Openings and Labor Turnover Survey, April 5, 2016.

Beveridge Curve: 2000:12–2019:10 BLS

Click and drag within the chart to zoom in on time periods



Note: * represents recession, as determined by the National Bureau of Economic Research
Source: U.S. Bureau of Labor Statistics

Beveridge Curve, labor: regressions

- Augmented Beveridge curve, 1956–2014:

$$\ln \text{vjobs}_{i,t} = \alpha_{0i} + \alpha_1 \ln \text{unempl}_{i,t} + \alpha_2 \ln \text{vown}_{i,t} + \alpha_3 \ln \text{vrent}_{i,t} + \epsilon_{i,t}$$

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- $\text{vjobs} = \dfrac{\text{Help-Wanted Index}}{\text{Labor Force}}$
- Beveridge Curve: 1951–1958, 1951–1971, 1951–1989, 1951–2000, 1959–2014, 1951–2014.

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  Figure 4

- Table 2: Beveridge Curve, 1950–2014

Beveridge Curve, labor regressions: Table 2

Table 2: Beveridge Curve Results: 1956-2014
Dependent Variable is Natural Log of Job Vacancy Rate

	OLS	IV	OLS	IV
Variables	(1)	(2)	(3)	(4)
ln(Unem)	-0.641***	-0.679***	-0.936***	-0.923***
	(0.064)	(0.086)	(0.070)	(0.067)
ln(Owner Vacancy; OV)	0.308***	0.412**	0.088	-0.107
	(0.104)	(0.196)	(0.085)	(0.199)
ln(Rental Vacancy; RV)	-1.101***	-1.321***	-0.294**	-0.483**
	(0.128)	(0.280)	(0.118)	(0.188)
1 if 1970-1979* ln(Unem)			0.152***	0.113***
			(0.023)	(0.022)
1 if 1980-1990* ln(Unem)			0.036	0.009
			(0.042)	(0.035)
1 if 1991-2000* ln(Unem)			0.139	0.203
			(0.101)	(0.135)
1 if 2001-2014* ln(Unem)			1.582***	2.113***
			(0.177)	(0.634)
1 if 2001-2014*ln(OV)			-0.625***	-0.667
			(0.219)	(0.518)
1 if 2001-2014*ln(RV)			-1.029***	-1.473***
			(0.160)	(0.463)
1 if 1970-1979			0.182***	0.163***
			(0.034)	(0.034)
1 if 1980-1990			0.093**	0.183***
			(0.038)	(0.065)
1 if 1991-2000			-0.003	0.095
			(0.076)	(0.077)
1 if 2001-2014			-0.390**	-0.348
			(0.177)	(0.227)
Constant	5.115	5.575	4.009***	4.407***
	(0.266)***	(0.582)***	(0.194)	(0.326)
		IV Test Statistics		
Over ID: p-value		0.21		0.63
Endogeneity: p-value		0.26		0.0065
1st Stage F stat:				
Owner Vacancy		45.67		45.67
Rental Vacancy		21.33		21.33
Observations	56	56	56	56
R-squared	0.74	0.73	0.94	0.92

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Instruments: natural logs of: 1 unit permits, 2 or more unit permits, 1 unit starts, 2or more unit starts

Estimating unfulfilled ownership rate: uhr_{it}

- Estimating unfulfilled homeownership rate.
- Use the National version of the American Housing Survey (NAHS).
-
  - An unbalanced panel of more than 50,000 housing units that are interviewed every two years.
  - Contains detailed information on dwelling units and their occupants through time, including the current owner's evaluation of the unit's market value.
  - Use the NAHS for survey years 1997-2011.
- Each t, estimate propensity for i in MSA m, at t, to be homeowner.

Housing Market Beveridge Curve: "Unemployment" in the Housing Market

- Unfulfilled desire on the part of renters to own: Down payment constraints, credit history, unable to get a mortgage: Frictions
- Unfulfilled desire on the part of owners to rent: life cycle events, moving costs: Frictions
- Estimate a tenure choice equation (Own/Rent)
- Renters with probability of homeownership greater than or equal to 0.5 are unfulfilled owners.
- Number of this group is denoted as $N_{u,rent}$. Reported number of owners: N_{own}

  Unfulfilled homeownership rate: ur^H.
- Owners with probability of homeownership less than 0.5 are unfulfilled renters.
- Number of this group $N_{u,own}$. Reported Number of renters: N_{rent}

  Unfulfilled rental rate: ur^R.

Impute housing "unemployment" rates: ur_t^H, ur_t^R: cont'd

- Estimating unfulfilled homeownership rate, uhr_t
  - Estimate propensity for i in MSA m, at t, to be homeowner:

$$own^*_{i,m,t} = \alpha_0 + \alpha_1 \frac{index^{value}_{mt}}{index^{rent}_{mt}}$$

$$+\alpha_2 income^p_{imt} + \alpha_2 income^T_{imt} + \mathbf{X}_{imt}\alpha_4 + \epsilon_{it}$$

  - $own^*_{i,m,t} = 1$, if

$$\epsilon_{it} \geq -\left(\alpha_0 + \alpha_1 \frac{index^{value}_{imt}}{index^{rent}_{imt}} + \alpha_2 income^p_{imt} + \alpha_2 income^T_{imt} + \mathbf{X}_{imt}\alpha_4\right)$$

$$own^*_{i,m,t} = 0, \text{otherwise}$$

  - $index^{value}_{imt}, index^{rent}_{imt}$ rental and house value indices.
    Value to rent: captures relative cost of owning versus renting.
  - $income^p_{imt}, income^T_{imt}$: permanent, transitory annual HH income.
    Different impacts.
    $income^p_{imt}$ proxy for wealth
  - $\mathbf{X}_{i,m,t}$ i's education, gender, race, age, HH size.

Impute housing "unemployment" rates: ur_t^H, ur_t^R: cont'd

- Generate $\text{index}_{mt}^{\text{value}}, \text{index}_{mt}^{\text{rent}}$ from from hedonic equations:
  - $\text{index}_{imt}^{\text{rent}}$:

$$\ln(\text{rent}_{imt}) = \alpha_{0,m} + \alpha_1 \mathbf{Y}_{1,i,m,t} + \epsilon_{1,i,t}$$

    rent_{imt} : monthly rent paid

    and
  - $\text{index}_{mt}^{\text{value}}$

$$\ln(\text{price}_{imt}) = \beta_{0,m} + \beta_1 \mathbf{Y}_{1,i,m,t} + \beta_2 \mathbf{Y}_{2,i,m,t} + \epsilon_{2,i,t}$$

    value_{mt} respondent's estimate of property's market price
  - $\mathbf{Y}_{1,i,m,t}$: vector of unit characteristics

    $\mathbf{Y}_{2,i,m,t}$: property tax and lot size

    The intercepts of above hedonic equations vary by MSA. Then the rent and value indices are calculated by:
  - $\text{index}_{mt}^{\text{value}} = 100 \times \exp[\beta_{0,m}]$
  - $\text{index}_{mt}^{\text{rent}} = 100 \times \exp[\alpha_{0,m}]$

Beveridge curve, housing: generate $\text{income}^{p}_{imt}, \text{income}^{T}_{imt}$:

- $\text{income}^{p}_{imt}, \text{income}^{T}_{imt}$: predicted value, residual from:

$$\ln\left(\text{income}_{imt}\right) = \gamma_{0,m} + \gamma_1 \mathbf{Z}_{i,m,t} + \epsilon_{2.m,t}$$

$\mathbf{Z}_{i,m,t}$: includes functions of education, age, race, gender.

Beveridge curve, housing

- Use Probit to estimate tenure choice: $\Phi(\mathcal{X}_{i,m,t}\hat{\alpha})$.
  - Impute unfulfilled owners: renters who would rather own
    $N_{\text{u,rent}_{m,t}} = \sum_{\text{own}_{i,m,t}=0} \Phi(\mathcal{X}_{i,m,t}\hat{\alpha})$
    $\text{ur}_t^H = 100 \times \frac{N_{u,rent,t}}{N_{u,rent,t}+N_{own,t}} \text{share renters}^{-1}$.

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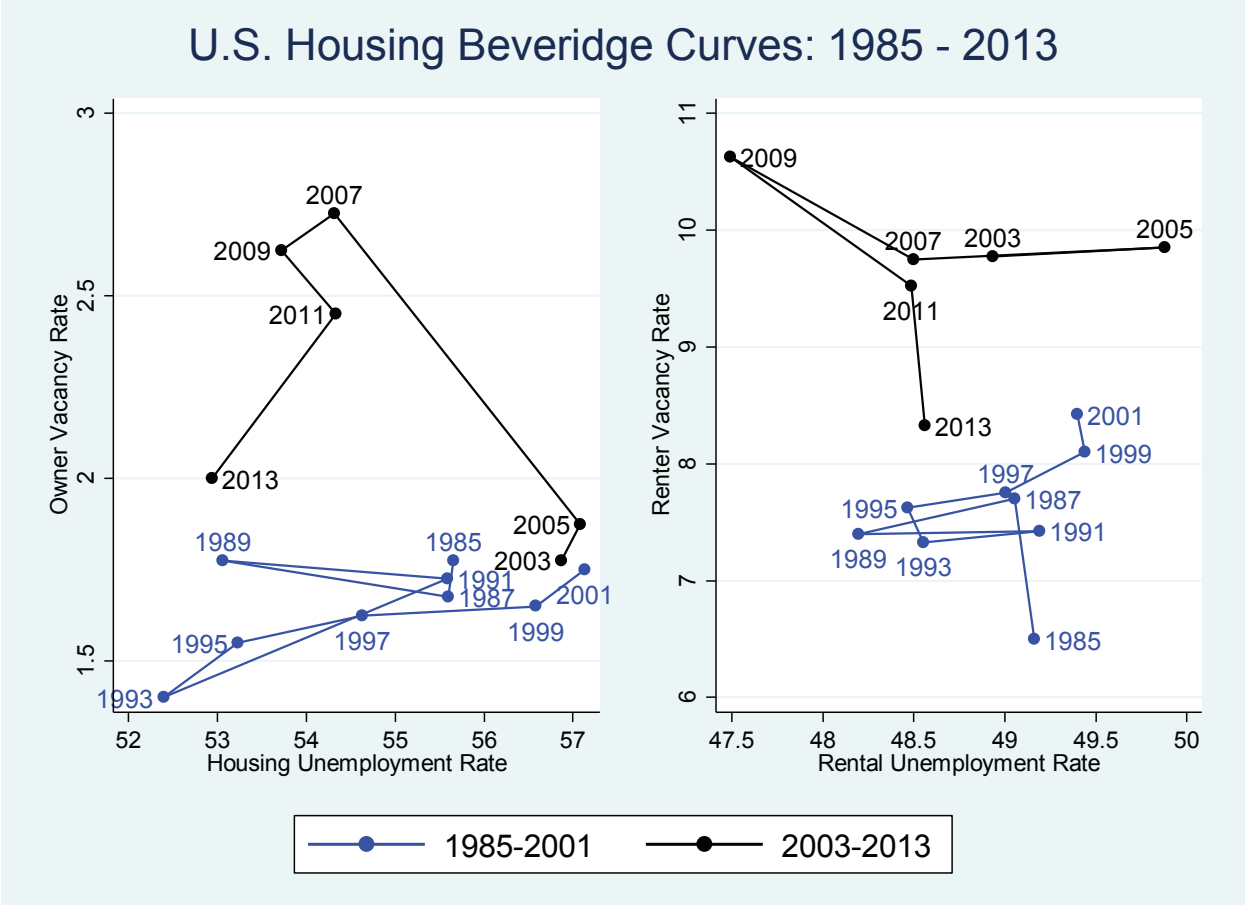
  - Impute unfulfilled renters: owners who would rather rent
    $N_{\text{u,own}_{m,t}} = \sum_{\text{own}_{i,m,t}=1} [1 - \Phi(\mathcal{X}_{i,m,t}\hat{\alpha})]$
    $\text{ur}_t^R = 100 \times \frac{N_{u,own,t}}{N_{u,own,t}+N_{own,t}} \text{share owners}^{-1}$.
  - Beveridge Curve: 1985–2011
  - Revise with elaborate estimation of mismatch probabilities.

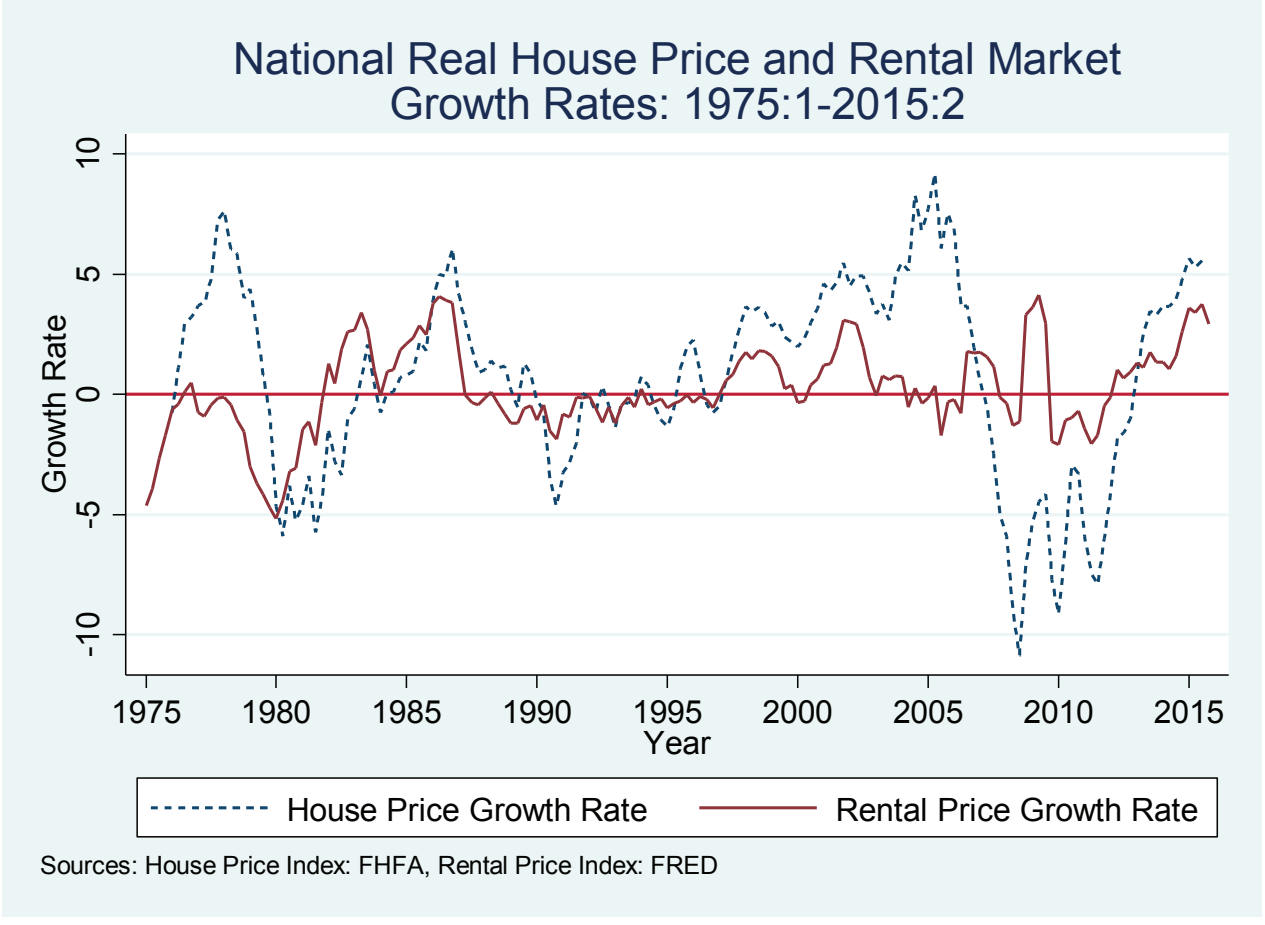
Beveridge curve, housing: plot

Figure 6



House prices and rents: 1975:1–2015:2

Figure 7



Dynamic model of housing and labor vacancies rates

- Dynamic versions of *augmented* Beveridge curves, labor markets and housing markets.

  Data for 37 largest CBSAs, 1985–2011.

- Purpose:

  Establish the interrelationship between the two markets

  Labor markets: Table 2. Housing markets: Table 3

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  Labor markets: Table 2. Housing markets: Table 3

  Calculate how a shock in the housing market propagates in the labor market using an impulse response function (and vice versa).

  Table 4

Augmented Beveridge curve, housing

- $$\ln vh_{i,t} = \beta_{0t} + \beta_1 \ln \text{ur}^H_{i,t} + \beta_2 \ln \text{vjobs}_{i,t} + \varepsilon_{i,t}$$
$$\ln vr_{i,t} = \beta_{0t} + \beta_1 \ln \text{ur}^R_{i,t} + \beta_2 \ln \text{vjobs}_{i,t} + \varepsilon_{i,t}$$

where $h = \text{own}$, $r = \text{rent}$.

Vacancy rates: $\text{vjobs}_{i,t}$, jobs; $\text{vh}_{i,t}$, ownership; $\text{vr}_{i,t}$: rental.

Table 3: Housing Beveridge Curve Results: 1985-2013

	Dependent Variable in Logs			
	Owner Vacancy Rate		Rental Vacancy Rate	
Variables	(1)	(2)	(3)	(4)
ln(Unfulfilled Ownership)	-0.404	-0.517		
	(1.630)	(1.212)		
ln(Unfulfilled Rental)			0.769	-0.633
			(2.536)	(1.910)
ln(Job Vacancy Index)	-0.368*	0.01	-0.402***	-0.118
	(0.18)	(0.064)	(0.116)	(0.120)
1 if 2001-2015				1.191***
				(0.057)
1 if 2003-2015		0.290***		
		(0.070)		
Constant	2.910	2.575	-0.135	4.706
	(6.523)	(4.854)	(9.780)	(7.330)
Observations	15	15	15	15
R-squared	0.26	0.59	0.52	0.76

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Diagnostics, Interpretations

- Test for panel unit roots, using all variables, including the unemployment rate (and its inverse) and the owner house price index.
  - All variables have unit roots; Estimate in first differences
  -
  - Granger causality, whether run in levels or first differences:
  - Granger causality runs from owner and renter vacancy rates to job vacancy rates.

VAR Model

Reduced form (no contemporaneous variables included as explanatory variables):

$$\Delta\ \mathrm{vx}_{i,t} = \alpha_{0,x} + \sum_{j=1,2} \alpha_{1,j,x} \Delta \mathrm{vown}_{i,t-j} + \sum_{j=1,2} \alpha_{2,j,x} \Delta \mathrm{vrent}_{i,t-j}$$

$$+ \sum_{j=1,2} \alpha_{3,j,x} \Delta \mathrm{vjobs}_{i,t-j} + \sum_{j=1,2} \alpha_{4,j,x} \Delta \mathbf{X}_{i,t-j} + u_{t,x} + v_{i,x} + \varepsilon_{it,x},$$

- vx = own, rent, job vacancy rates, that is, o, r, j
- $\mathbf{X}_{i,t-j}$ = (unemployment rate^{-1}, house price index).

Impulse Response Functions (IRFs)

- Shock each equation by adding a one standard deviation increase in the error term.
- Look how this propagates into other two markets.
- IRFs are cumulative in the levels of owner, rental, and jobs vacancy rates.
    - Shock to rental vacancies: effect on owner vacancy rates small, not significantly different from zero (and vice versa).
    - Shocks to owner and rental vacancies: effect on job vacancies negative and significant.

      Shock to owner vacancies: long-term negative and significant impact of about -0.04

      Shock to rental vacancies: negative and significant impact, first few periods, long-term impact, -0.15, not significant.
    - RMSE from the VAR equation for job vacancies is 0.27 : ratio of the long-term impact from the shock to the owner vacancy rate is 0.15, reasonably large.
- Results reinforce the Granger Causality results.

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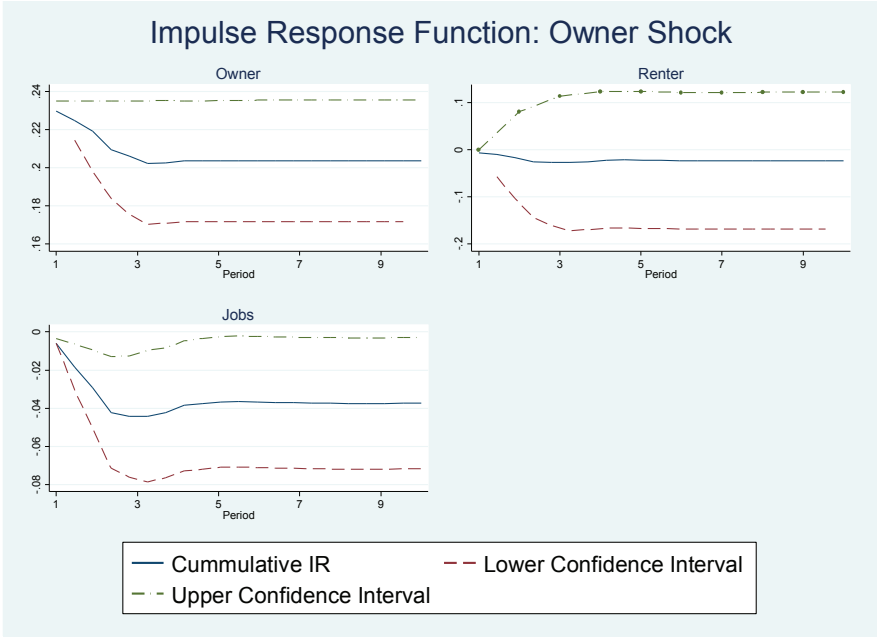
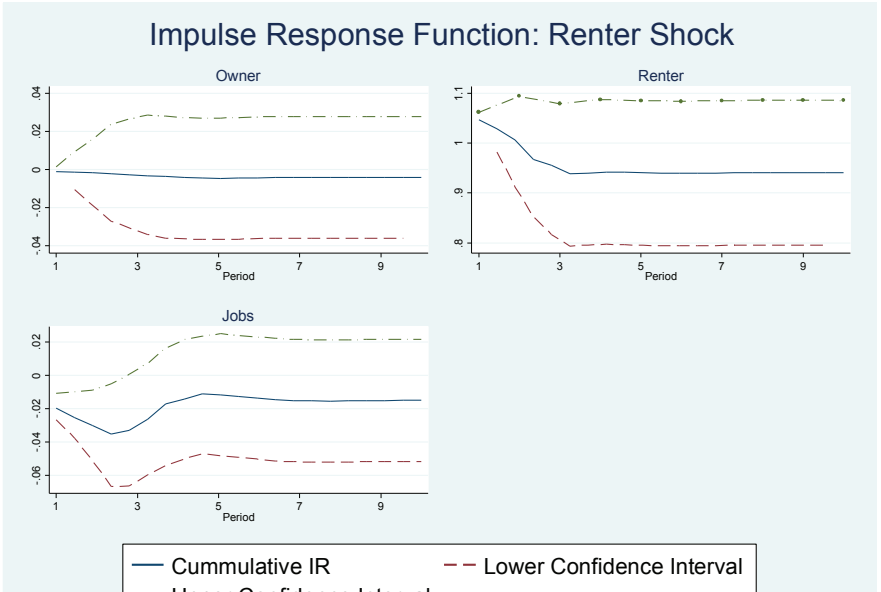
Figure 7

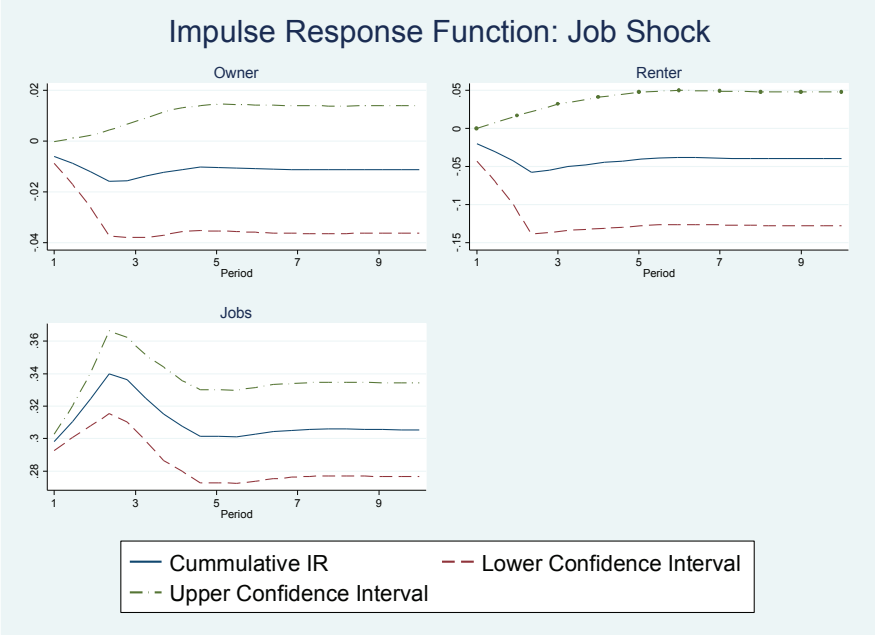
Impulse Response Functions

Figure 8: Impulse Response Functions





Impulse Response Functions: cont'd



Conclusion

1. Joint model of frictional housing and labor markets.
2. Labor market Beveridge curve is shifted by housing market vacancies.
3. Novel *unemployment concept* for ownership and rental housing markets.
4. Beveridge curve for ownership and rental housing markets.
5. Theoretical result is verified in the data.
6. Granger causality runs from the housing market to the labor market.
7. Impulse Response Functions: shocks to housing markets propagate into labor markets.

THANK YOU!