Time-Varying Wage Risk, Incomplete Markets, and Business Cycles

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Question

- How do changes in **idiosyncratic labor income risk** affect aggregate fluctuations?
- In particular, how is **labor market dynamics** affected?

Motivation

- Growing interests in fluctuations in uncertainty
  - uncertainty shocks by Bloom 2009
  - various measures of uncertainty rose in the recent financial crisis
- Cyclical variation in idiosyncratic labor earnings risk
  - Storesletten, Telmer, and Yaron 2004, Heathcote, Perri, and Violante 2010
  - previous DSGE analyses typically omit labor supply decisions $\Longrightarrow$ little is known about the impact on labor market dynamics

What this paper does

- Augment DSGE model widely used for labor market analyses
  - idiosyncratic wage/productivity risk
  - incomplete asset markets
  - indivisible labor
  - aggregate shocks
    - TFP shocks
    - **uncertainty shocks (fluctuations in idiosyncratic wage risk)**
- Analyze the impact of uncertainty shocks on business cycles through stochastic simulation
  - infer the size of uncertainty shocks using individual wage data

Main findings

- Uncertainty shocks move key statistics closer to data
  - $corr(H, Y/H)$ decreases from $\mathbf{0.83}$ to $\mathbf{-0.40}$
  - σ_{wedge} increases from **17%** of data to **90%**
- Aggregation bias (composition effect)
  - impacts of uncertainty shocks on employment differ across productivity groups

Related literature

- Varying uninsured idiosyncratic earnings risk
  - Krusell and Smith 1997, 1998, 1999, Krusell, Mukoyama, Şahin, and Smith 2009, Lopez 2010, Mukoyama and Şahin 2006, Pijoan-Mas 2007, Storesletten, Telmer, and Yaron 2001, 2007,
  - **exogenous earnings** or **divisible labor**
- Uninsured Idiosyncratic wage risk under indivisible labor
  - Chang and Kim 2006, 2007, Alonso-Ortiz and Rogerson 2010, Krusell, Mukoyama, Rogerson, and Şahin 2010, 2011
  - **constant risk**

Outline

- **Model**
- Parameter values and steady state
- Business cycle results
- Conclusion

Individuals

- Momentary utility: $u(c, h)$
  - c : consumption
  - h : labor hours, $h \in \{\bar{h}, 0\}$
- Time-varying uninsured idiosyncratic wage risk
  - **idiosyncratic wage risk**: person-specific labor productivity x

$$\ln x' = \rho_x \ln x + \varepsilon_x', \varepsilon_x' \sim N(0, \sigma_{\varepsilon_x}^2)$$

  - **uninsured**: single asset k (physical capital), $k \geq \underline{k}$ ($\underline{k} \leq 0$)
  - **time-varying**: σ_{ε_x} is a Markov chain

Beginning-of-period value

$$V(k,x;z,\sigma_{\varepsilon_x},\mu) = \max\{V^E(k,x;z,\sigma_{\varepsilon_x},\mu), V^N(k,x;z,\sigma_{\varepsilon_x},\mu)\}$$

- Value functions
  - V : beginning-of-period value
  - V^E : employment value
  - V^N : nonemployment value
- State variable
  - k : individual asset holding
  - x : idiosyncratic productivity
  - z : aggregate TFP, AR(1) process
  - σ_{ε_x} : idiosyncratic wage risk, learned one period in advance
  - μ : individual distribution over k and x, $\mu' = \Gamma(z,\sigma_{\varepsilon_x},\mu)$

Value of employment

$$V^E(k, x; z, \sigma_{\varepsilon_x}, \mu) = \max_{c,k'} \{u(c, \bar{h}) + \beta E[V(k', x'; z', \sigma'_{\varepsilon_x}, \mu') | x, z, \sigma_{\varepsilon_x}, \mu]\}$$

$$s.t.\ c + k' = w(z, \sigma_{\epsilon_x}, \mu) x \bar{h} + [1 + r(z, \sigma_{\epsilon_x}, \mu)] k$$

$$k' \geq \underline{k}$$

$$c \geq 0$$

Law of motion for $x, z, \sigma_{\varepsilon_x},$ and μ

Value of nonemployment

$$V^N(k, x; z, \sigma_{\varepsilon_x}, \mu) = \max_{c,k'} \{u(c, 0) + \beta E[V(k', x'; z', \sigma'_{\varepsilon_x}, \mu') | x, z, \sigma_{\varepsilon_x}, \mu]\}$$

$$s.t.\ c + k' = [1 + r(z, \sigma_{\epsilon_x}, \mu)]k$$

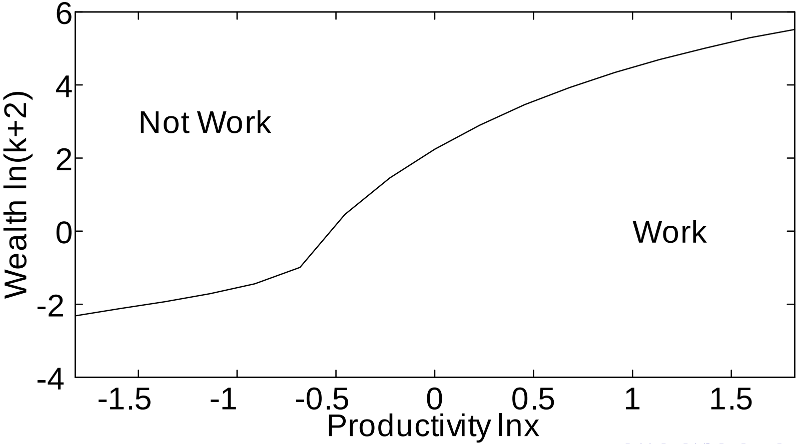
$$k' \geq \underline{k}$$

$$c \geq 0$$

Law of motion for $x, z, \sigma_{\varepsilon_x},$ and μ

Employment choice

$$h = \begin{Bmatrix} \bar{h} \text{ if } V^E \geq V^N \\ 0 \text{ otherwise} \end{Bmatrix}$$



Representative firm

- Produce the good Y
- Rent capital K and labor L from individuals
- Production function
  - $Y = zF(K, L)$
  - constant returns to scale in K and L
- Maximize static profits

$$
\begin{aligned}
r(z, \sigma_{\epsilon_x}, \mu) &= (1-\alpha) z F_K(K, L) - \delta \\
w(z, \sigma_{\epsilon_x}, \mu) &= \alpha z F_L(K, L)
\end{aligned}
$$

  - δ : capital depreciation rate

Equilibrium

A recursive competitive equilibrium consists of a set of functions,

$$(w, r, V^E, V^N, V, c, k', h, K, L, \Gamma),$$

that satisfy the following conditions:

- Individual optimization
- Firm optimization
- Market clearing (labor, capital, and good)
  - Labor: $L = \int xh(k, x; z, \sigma_{\epsilon_x}, \mu)\mu([dk \times dx])$
  - Hours: $H = \int h(k, x; z, \sigma_{\epsilon_x}, \mu)\mu([dk \times dx])$
- Law of motion for the distribution across individuals is consistent with individuals' behavior and the underlying stochastic processes

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Parameter values

Parameter	Value
β	0.9829
B	1.0203
$\bar{h}$	1/3
$\underline{k}$	–2.0
α	0.64
δ	0.025
ρ_z	0.950
σ_{ε_z}	0.007

$$u(c,h) = \begin{array}{l} \ln c - B \text{ when work} \\ \ln c \text{ when not work} \end{array}$$

$$y = zF(K,L) = zK^{1-\alpha}L^{\alpha}$$

$$\ln z' = \rho_z \ln z + \varepsilon_z', \ \varepsilon_z' \sim N(0, \sigma_{\varepsilon_z}^2)$$

Parameters on idiosyncratic productivity

$$\ln x' = \rho_x \ln x + \varepsilon_x', \ \varepsilon_x' \sim N(0, \sigma_{\varepsilon_x}^2)$$

- σ_{ε_x} is a 3-state Markov chain
  - $(1+\lambda)\bar{\sigma}_{\varepsilon_x}, \bar{\sigma}_{\varepsilon_x}, (1-\lambda)\bar{\sigma}_{\varepsilon_x}$
  - remain unchanged with prob $\rho_{\sigma_{\varepsilon_x}}$, transition to each of the other states with $(1-\rho_{\sigma_{\varepsilon_x}})/2$, independent of z
- Parameters

$$\rho_x \quad \bar{\sigma}_{\varepsilon_x} \quad \lambda \quad \rho_{\sigma_{\varepsilon_x}}$$

Moments compared between PSID and model

$$\ln x_{i,t} = \rho_x \ln x_{i,t-1} + \varepsilon_{i,x,t},\ \varepsilon_{i,x,t} \sim N(0, \sigma^2_{\varepsilon_x,t})$$

$$\ln w_{i,t} = \ln x_{i,t} + \ln w_t$$

$$\Downarrow$$

$$\ln w_{i,t} = \rho_x \ln w_{i,t-1} + (\ln w_t - \rho_x \ln w_{t-1}) + \varepsilon_{i,x,t},,\ \varepsilon_{i,x,t} \sim N(0, \sigma^2_{\varepsilon_x,t})$$

1. Pooled estimation

   $$\Longrightarrow \hat{\rho}_x,\ \widehat{\bar{\sigma}}_{\varepsilon_x}$$

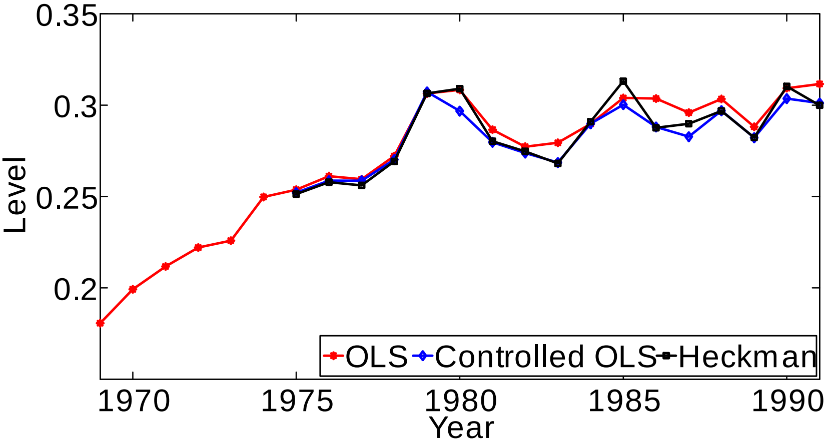
   - PSID, Model: OLS

2. Year-by-year estimation

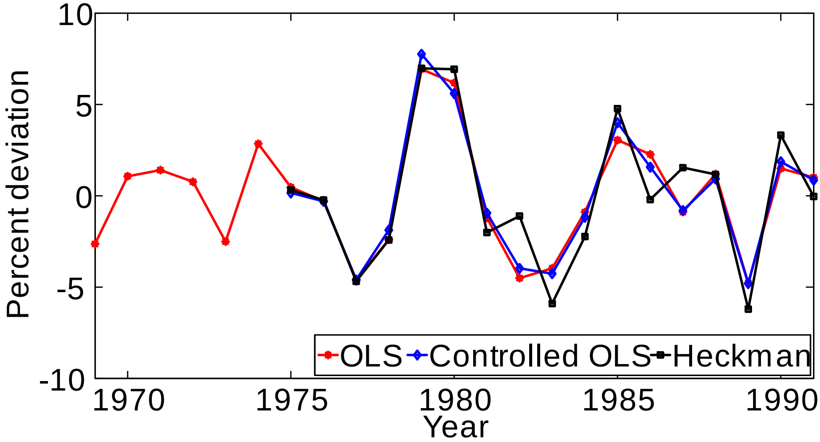
   $$\Longrightarrow std(\hat{\sigma}_{\varepsilon_x,t}),\ corr(\hat{\sigma}_{\varepsilon_x,t}, \hat{\sigma}_{\varepsilon_x,t-1})$$

   - PSID: OLS, controlled OLS, Heckman-type estimation
   - Model: OLS

Estimated idiosyncratic wage risk in PSID



Cyclical component of estimated wage risk



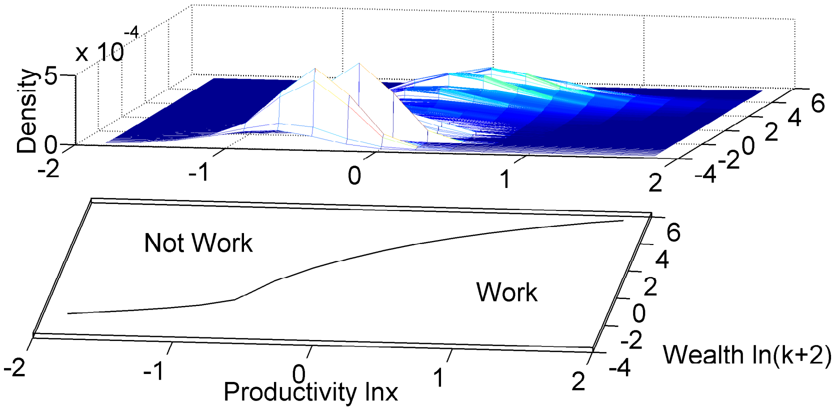
	OLS	Controlled OLS	Heckman
$std(\hat{\sigma}_{\varepsilon_x,t})$	0.032	0.035	0.039
$corr(\hat{\sigma}_{\varepsilon_x,t}, \hat{\sigma}_{\varepsilon_x,t-1})$	0.185	0.236	0.056

Moments and parameter values

Moments (annual)	U.S.	Varying risk	Constant risk
$\hat{\rho}_x$	0.854	0.855	0.855
$\widehat{\bar{\sigma}}_{\varepsilon_x}$	0.282	0.283	0.279
$std(\hat{\sigma}_{\varepsilon_x,t})$	0.032	0.032	0.008
$corr(\hat{\sigma}_{\varepsilon_x,t}, \hat{\sigma}_{\varepsilon_x,t-1})$	0.185	0.158	–0.240

Parameters (quarterly)		Varying risk	Constant risk
ρ_x	–	0.930	0.930
$\bar{\sigma}_{\varepsilon_x}$	–	0.223	0.223
λ	–	0.090	–
$\rho_{\sigma_{\varepsilon_x}}$	–	0.90	–

Steady state



	U.S.	Model
Gini labor income	0.60∼0.63	0.60
Gini wealth	0.78	0.69
corr(labor income, wealth)	0.23	0.30

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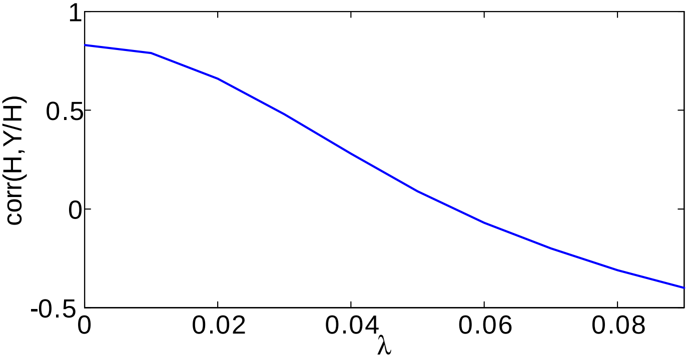
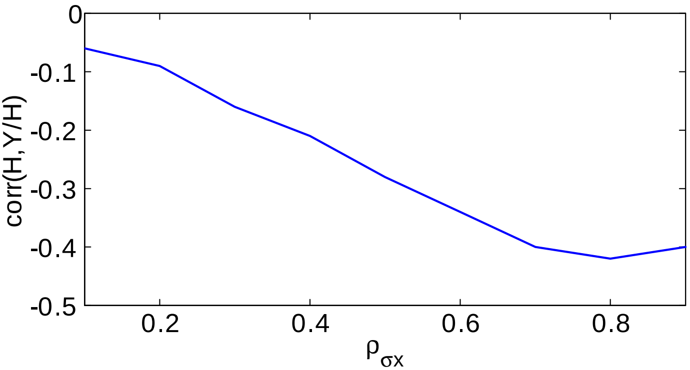
Business cycle statistics

	U.S.	Constant risk	Varying risk
σ_Y	1.69	1.37	1.43
σ_C	0.54	0.32	0.33
σ_I	2.85	3.10	3.15
σ_H	1.00	0.57	0.81
$\sigma_{Y/H}$	0.63	0.48	1.00
$corr(Y, C)$	0.78	0.90	0.86
$corr(Y, I)$	0.80	0.99	0.99
$corr(Y, H)$	0.80	0.96	0.41
$corr(Y, Y/H)$	0.31	0.95	0.67
$corr(H, Y/H)$	**–0.32**	**0.83**	**–0.40**

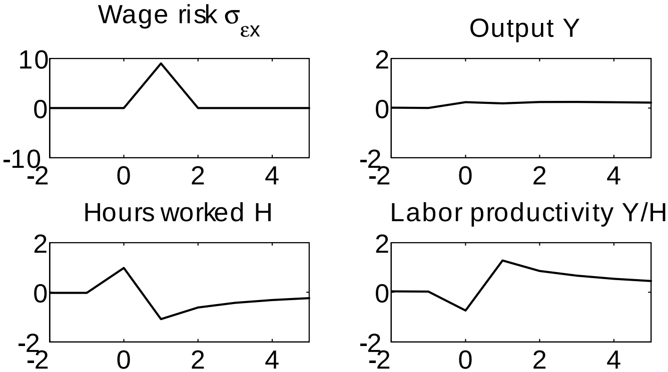
Sensitivity analysis



Sensitivity analysis

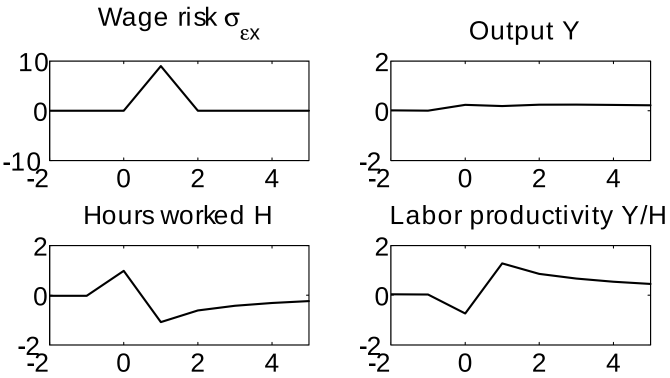


One-period increase in idiosyncratic wage risk



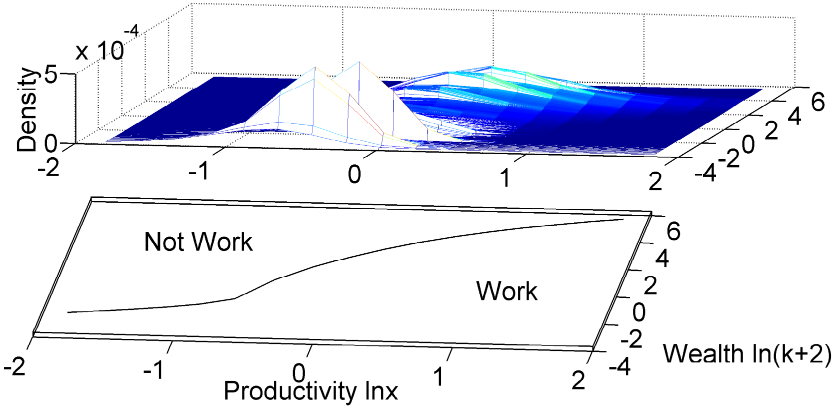
Horizontal axis – period
Vertical axis – percent deviation

Underlying two effects

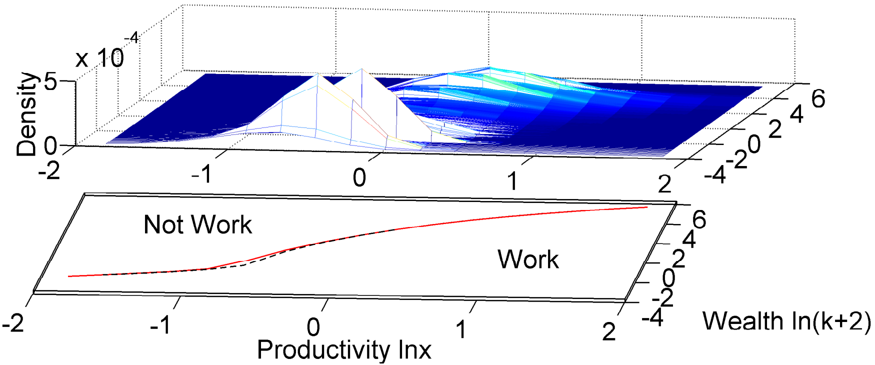


- Uncertainty effect (period 0)
  - uncertainty about future wages rises $\Longrightarrow H \uparrow, Y/H \downarrow$
- Distribution effect (period 1)
  - the productivity-wealth distribution shifts $\Longrightarrow H \downarrow, Y/H \uparrow$

Uncertainty effect

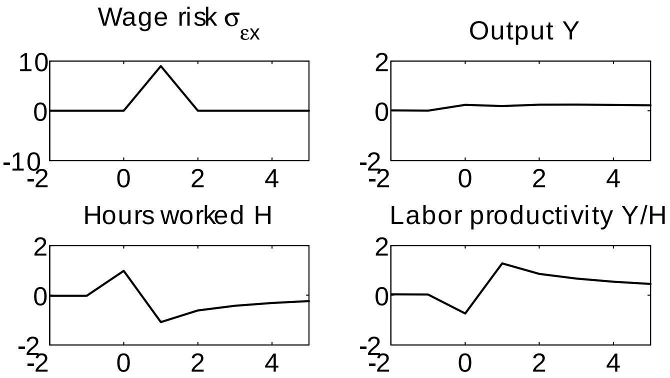


Uncertainty effect



Employment		Aggregate	
low productivity	high productivity	H	Y/H
↑↑	↓	↑	↓

Underlying two effects



- Uncertainty effect (period 0)
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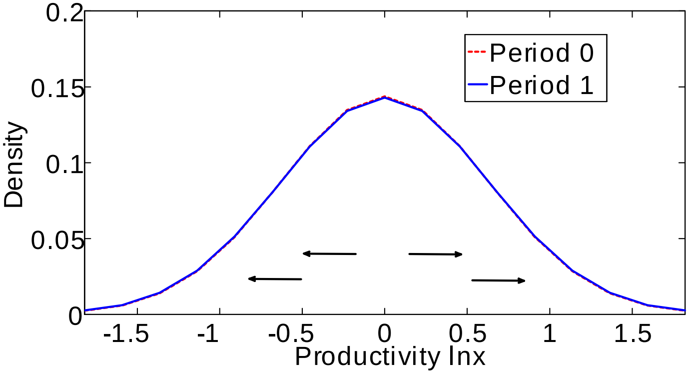
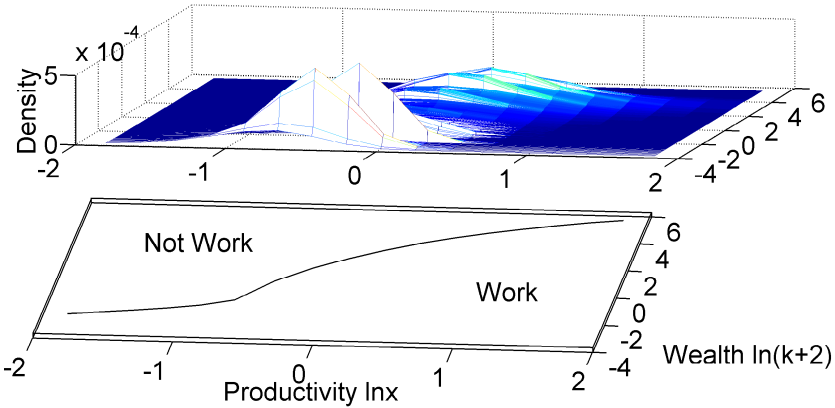
Distribution effect



Distribution effect



Employment		Aggregate	
low productivity	high productivity	H	Y/H
↓↓	↑	↓	↑

Uncertainty versus distribution effects

- Psych risk: only uncertainty effect, individuals receive signals for changes in σ_{ε_x}, but those changes in σ_{ε_x} never materialize (Bachmann and Bayer 2013)

	U.S.	Constant risk	Varying risk	Psych risk
σ_Y	1.69	1.37	1.43	1.37
σ_C	0.54	0.32	0.33	0.33
σ_I	2.85	3.10	3.15	3.10
σ_H	1.00	0.57	0.81	0.61
$\sigma_{Y/H}$	0.63	0.48	1.00	0.52
$corr(Y, C)$	0.78	0.90	0.86	0.89
$corr(Y, I)$	0.80	0.99	0.99	0.99
$corr(Y, H)$	0.80	0.96	0.41	0.91
$corr(Y, Y/H)$	0.31	0.95	0.67	0.87
$corr(H, Y/H)$	**–0.32**	**0.83**	**–0.40**	**0.58**

Implication for the labor wedge

- Labor wedge is calculated by

$$\begin{aligned} \ln wedge &= \ln MPL - \ln MRS = \ln \frac{Y}{H} - \ln B_R H^{1/\gamma} C \\ U(C,H) &= \ln C - \frac{B_R H^{1+1/\gamma}}{1+1/\gamma}, \gamma = 1.5 \end{aligned}$$

	U.S.	Constant risk	Varying risk	Psych risk
σ_{wedge}	1.40	0.23	1.26	0.38
$corr(H, wedge)$	–0.94	–0.96	–0.84	–0.83

- Fluctuations in the labor wedge arise from those in the deviation of w and MRS (Karabarbounis 2014)

Countercyclical risk

- Introduce negative comovement of σ_{ϵ_x} with z
  - $z > (1 + 0.017)\bar{z} \Longrightarrow \sigma_{\epsilon_x} = (1 - \lambda)\bar{\sigma}_{\varepsilon_x}$
  - $z < (1 - 0.017)\bar{z} \Longrightarrow \sigma_{\epsilon_x} = (1 + \lambda)\bar{\sigma}_{\varepsilon_x}$
  - otherwise, $\sigma_{\epsilon_x} = \bar{\sigma}_{\varepsilon_x}$
  - $\rho_{\sigma_{\varepsilon_x}}$ is implied by z's persistence, λ is unchanged
- Recalibrate varying risk model to match the volatility and persistence of σ_{ϵ_x} in the countercyclical risk model
  - $\lambda = 0.058$, $\rho_{\sigma_{\varepsilon_x}} = 0.925$

Countercyclical risk

	Countercyclical risk	*Recalibrated* varying risk	Constant risk
σ_Y	1.32	1.38	1.37
σ_C	0.37	0.33	0.32
σ_I	2.98	3.11	3.10
σ_H	0.56	0.68	0.57
$\sigma_{Y/H}$	0.61	0.74	0.48
σ_{wedge}	**0.60**	**0.83**	**0.23**
$corr(Y, C)$	0.91	0.88	0.90
$corr(Y, I)$	0.99	0.99	0.99
$corr(Y, H)$	0.84	0.68	0.96
$corr(Y, Y/H)$	0.87	0.73	0.95
$corr(H, Y/H)$	**0.46**	**0.00**	**0.83**
$corr(H, wedge)$	–0.67	–0.77	–0.96

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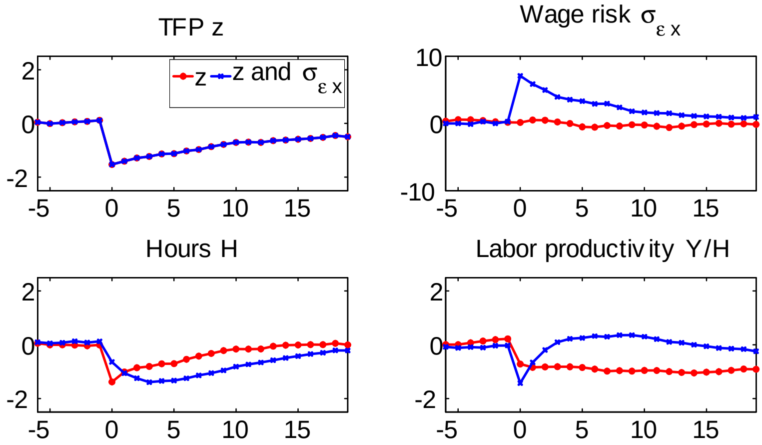
Conclusion

- Examine how time-varying idiosyncratic wage risk affects aggregate fluctuations in the heterogenous-agent model commonly used for labor market analyses
- Including uncertainty shocks improves the model's performance concerning labor market dynamics
- Future work
  - uncertainty on asset income, endogenous uncertainty
  - other shocks than aggregate TFP and uncertainty shocks
  - home production, family labor supply, and so on

Increase in wage uncertainty during recessions



U.S. hours and labor productivity