UNIVERSITY OF TORONTO

ECO2103 | QUANTITATIVE MACROECONOMICS WITH HETEROGENEITY

IDIOSYNCRATIC INCOME RISK

Serdar Ozkan

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Standard Incomplete Markets (SIM) Model

Models with Heterogenous Agents

- Currently, the main workhorse for studying household heterogeneity in macroeconomics is what we will call the "standard incomplete markets" (SIM) model.
- In the SIM model, a large number of agents draw idiosyncratic realizations for productivity, and make independent choices for consumption, savings, and, in some versions, labor supply.
- In aggregate, their choices determine the total amount of capital and effective labor available for production and, thus, equilibrium prices.

Standard Incomplete Markets Model

- All variants of SIM share two common characteristics.
  1. They feature imperfect insurance (incomplete markets)
  2. They incorporate the risk-sharing mechanisms observed in actual economies.
- If preferences are homethetic and **the markets are complete**, agents may differ by initial tastes, skills, or wealth, and are subject to idiosyncratic shocks, the economy aggregates do not depend on the wealth distribution (Constantinides, 1982).

Environment-SIM

- **Income fluctuation problem:** Characterizing the optimal consumption sequence for a household facing stochastic income fluctuations.

- Discrete time, infinitely lived households: $t = 0, 1, 2....\infty$
  - Could be life cycle model as well (Imrohoroglu et al. (1995); Rios-Rull (1995); Huggett (1996)).

- Stochastic income endowment, y_t, with bounded support.

- No state-contingent securities to insure idiosyncratic risk.
  - Data shows imperfect (partial) insurance. (Deaton and Paxson (1994) and Blundell et al (2008))

Environment-SIM

- Save and borrow only risk-free a_t up to some exogenous limit (which could be zero), but no default is allowed.
  - risk-free asset, a_t, yields exogenous $1 + r$ (Bewley 1983).
  - r can be endogenized by bond markets (Huggett 1993) or by production with capital input (Aiyagari 1994)
  - Krusell and Smith 1998 introduce aggregate shocks (business cycle fluctuations)

- Households discount future with $\beta < 1$
  - time-separable preferences derives utility from streams of consumption $\{c_t\}_{t=0}^{\infty}$.
  - Period utility, $u(c_t)$, is strictly concave, strictly increasing, and differentiable, usually CRRA.

SIM Model

$$
\begin{aligned}
V(a, y) &= \max_{a', c} u(c) + \beta \mathbb{E} V(a', y') \\
a' + c &= a(1+r) + y \\
a' &\geq -\bar{a}
\end{aligned}
$$

- Euler equation:

$$u'(c) \geq \beta\,(1+r)\,\mathbb{E}[u'(c')], = \text{ if } a' > -\bar{a}$$

- Precautionary saving motive when $u''' > 0$ ("prudence"); i.e., a rise in future income uncertainty leads to a rise in current savings (as in CRRA, $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$).

- Properties of $F[y' \mid y]$ is crucial for precautionary saving motive.

Precautionary saving motive: 2-Period Model

$$\max_{a_1,c_0,c_1} u(c_0) + \beta \mathbb{E} u(c_1)$$

$$\begin{aligned} a_1 + c_0 &= y_0 \\ c_1 &= \tilde{y}_1 + (1+r)a_1 \\ & y_0 \text{ is given and } \tilde{y}_1 \text{ is stochastic.} \end{aligned}$$

- Euler equation: $\underbrace{u'(y_0 - a_1)}_{\text{LHS}} = \beta\,(1+r)\,\underbrace{\mathbb{E}[u'(\tilde{y}_1 + (1+r)a_1)]}_{\text{RHS}}$

  LHS is increasing and RHS is decreasing in a_1 since $u'' < 0$, so we have a unique a_1^*.

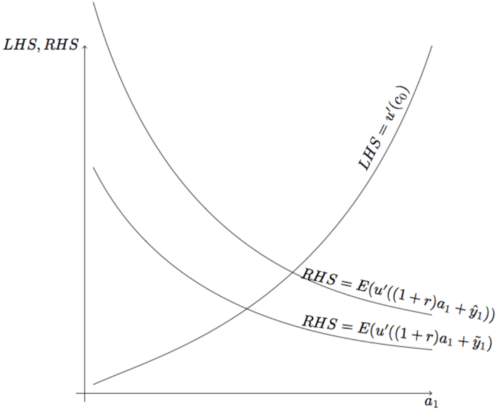
- Consider a mean preserving spread of $\tilde{y}_1$, $\hat{y}_1 = \tilde{y}_1 + \varepsilon$; ε is a random variable with zero mean and positive variance.

$$\begin{aligned} u'(y_0 - \tilde{a}_1) &= \beta\,(1+r)\,\mathbb{E}[u'(\tilde{y}_1 + (1+r)\tilde{a}_1)] \\ u'(y_0 - \hat{a}_1) &= \beta\,(1+r)\,\mathbb{E}[u'(\hat{y}_1 + (1+r)\hat{a}_1)] \end{aligned}$$

  Because of the precautionary motive $\hat{a}_1 > \tilde{a}_1$.

Intuition

- When we increase income risk, by Jensen's inequality, RHS shifts up for any a:
  $\mathbb{E}[u'(\hat{y}_1 + (1+r)a)] = \mathbb{E}_{\tilde{y}_1}\left[\mathbb{E}_\varepsilon[u'(\tilde{y}_1 + \varepsilon + (1+r)a) \mid \tilde{y}_1]\right] >$
  $\mathbb{E}_{\tilde{y}_1}\left[u'\left(\mathbb{E}_\varepsilon[\tilde{y}_1 + \varepsilon + (1+r)a \mid \tilde{y}_1]\right)\right] = \mathbb{E}\left[u'\left(\tilde{y}_1 + (1+r)a\right)\right]$



Source: Perri's notes.

Idiosyncratic Income Risk

1. The precise nature of idiosyncratic risk, $F[y' \mid y]$ matters for:
    - effectiveness self insurance through asset accumulation.
        - transitory shocks can be mostly insured whereas persistent shocks are only partially insured.
    - Wealth and consumption inequality.
    - Optimality of redistributive policies; e.g. progressive taxation, social security.
    - Welfare costs of business cycle.

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   - Wealth and consumption inequality.
   - Optimality of redistributive policies; e.g. progressive taxation, social security.
   - Welfare costs of business cycle.
2. $F[y' \mid y]$ is informative about the underlying theory of wages, hours, job latter, etc.

   Up until recently labor economists have estimated income processes (Lillard and Willis 1978; MaCurdy 1982; Abowd and Card 1989; Meghir and Pistaferri 2004) and macroeconomists used them.

Income Process

$$
\begin{aligned}
\tilde{y}^i_{t,h} &= \underbrace{g(t,h,cohort,gender,education...)}_{\text{common systemtic component}} \\
&\quad + \underbrace{\underbrace{[\alpha^i + \beta^i h]}_{\text{profile heterogenity}} + \underbrace{[z^i_{t,h} + \varepsilon^i_{t,h}]}_{\text{stochastic component}}}_{y^i_{t,h}\text{,idiosyncratic component or residual income}} \\
z^i_{t,h} &= \rho z^i_{t,h} + \eta^i_{h,t}
\end{aligned}
$$

$y^i_{t,h}$: log earnings of individual i in period t at age h.

$g(.)$: deterministic component common to all individual.

α^i: Individual fixed effect.

β^i: individual income growth rate over the life cycle.

$z^i_{h,t}$: persistent AR(1) component with $\eta^i_{h,t} \sim F(0, \sigma^\eta_{i,h,t})$.

$\varepsilon^i_{h,t}$: transitory component with $\varepsilon^i_{h,t} \sim F(0, \sigma^\varepsilon_{i,h,t})$ or a low order MA (e.g., MA(2)).

Nature of Idiosyncratic Income Risk

Questions

1. Shocks versus initial conditions in earnings dynamics?
2. How much of risk is forecastable (advanced information)?
3. How persistent are shocks?
4. What does the distribution of shocks look like?
    - And how does idiosyncratic risk vary over lifecycle and the income distribution?
5. Long run trends in idiosyncratic risk?
6. How does idiosyncratic risk vary over business cycle?
7. Micro-foundations of labor income risk?
8. Idiosyncratic risk after public insurance?

Shocks vs Heterogeneity

- Keane and Wolpin (1997) estimate a structural model of schooling, work, and occupational choice
  - argue that 90% of lifetime earnings dispersion is due to unobserved endowment heterogeneity as measured at age 16.
- Karahan, Ozkan and Song (2017) estimate a life cycle job-ladder model with heterogeneity in ability to accumulate human capital and climb up the ladder as well as ex-post risk.
  - Very little role for ex-post risk.
  - Above median heterogeneity in ability to accumulate human capital
  - Below median heterogeneity in job-ladder risk.

Nature of Idiosyncratic Income Risk

1. Shocks versus initial conditions in earnings dynamics?✓
2. **How much of risk is forecastable (advanced information)?**
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Advanced information

How much of risk is forecastable?

- This cannot be done using earnings data in isolation.
- Blundell, Pistaferri and Preston (2008): With advance information, future earnings growth should be correlated with current consumption growth, which is not seen in the data.
- Jappelli and Pistaferri (2000) use survey data and find that subjective income expectations is correlated with consumption growth.
- Primiceri and van Rens (2009) estimate a structural model of consumption and saving using CEX data and argue that consumption inequality has not increased as much as income inequality in 1990s because households knew their permanent income "shocks" in advance.

Advanced information

Inferring Risk versus Heterogeneity from Economic Choices

- Identification: agents act on all forecastable information and rely on a fully specified economic model.
- Cunha, Heckman, and Navarro (2005) find that more than 50% of idiosyncratic returns to education are predictable before college decision.
- Guvenen and Smith (2009) study the joint dynamics of consumption and labor income (using PSID data) in order to disentangle "known heterogeneity" from income risk. They find that individuals have substantial amounts of information about their income growth rates.

Nature of Idiosyncratic Income Risk

1. Shocks versus initial conditions in earnings dynamics?✓
2. How much of risk is forecastable (advanced information)?✓
3. **How persistent are shocks?**
4. What does the distribution of shocks look like?
   - And how does idiosyncratic risk vary over lifecycle and the income distribution?
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How persistent are shocks?

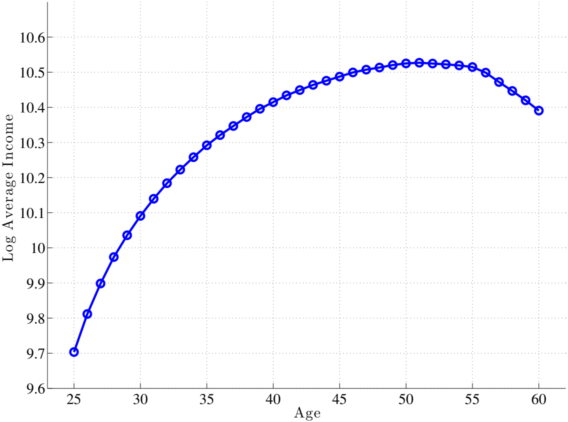
Linear ARMA(p,q) representation

$$
\begin{aligned}
y_{t,h}^{i} &= \underbrace{[\alpha^{i} + \beta^{i} h]}_{\text{profile heterogenity}} + [\underbrace{z_{t,h}^{i}}_{AR(p)} + \underbrace{\varepsilon_{t,h}^{i} + \varepsilon_{t,h-1}^{i} + \ldots + \varepsilon_{t,h-q}^{i}}_{MA(q)}] \\
z_{t,h}^{i} &= (\rho_1 L + \rho_2 L^2 + \ldots + \rho_p L^p) z_{t,h}^{i} + \eta_{h,t}^{i}
\end{aligned}
$$

- $y_{t,h}^{i}$: log residual earnings of individual i in period t at age h.
- $\sigma_{\beta}^{2} > 0$?: HIP vs RIP
- $z_{h,t}^{i}$: very persistent AR(1) component with $\eta_{h,t}^{i} \sim F(0, \sigma_{i,h,t}^{\eta})$.
- transitory component with $\varepsilon_{h,t}^{i} \sim F(0, \sigma_{i,h,t}^{\varepsilon})$ or a low order MA (e.g., MA(2)).
- How do we identify the parameters?
  - Exploit the error term structure in the data or covariance matrix estimation.

Covariance Matrix Estimation

1. Regress log income on a subset of observables (year, age, cohort, etc.) to estimate $g(.)$ and get the residuals, $y^i_{t,h}$.



Source: Guvenen, Karahan, Ozkan, and Song (2015)

Covariance Matrix Estimation

2. For the residual income $y^i_{t,h}$ specify a parametric income process, e.g.:

$$
\begin{aligned}
y^i_h &= \alpha^i + z^i_h + \varepsilon^i_h,\ \varepsilon^i_h \sim N(0,\sigma^2_\varepsilon) \\
z^i_h &= \rho z^i_{h-1} + \eta^i_h,\ \eta^i_h \sim \mathrm{N}(0,\sigma^2_\eta) \\
\Delta y^i_h &= y^i_h - y^i_{h-1} = \eta^i_h + (\rho - 1) z^i_{h-1} + \varepsilon^i_h - \varepsilon^i_{h-1} \\
\Delta y^i_{h,h-2} &= \eta^i_h + \rho\eta^i_{h-1} + (\rho^2 - 1) z^i_{h-1} + \varepsilon^i_h - \varepsilon^i_{h-1} \\
&\vdots \\
\Delta y^i_{h,h-k} &= \sum_{j=0}^{k-1} \rho^j \eta^i_{h-j} + (\rho^k - 1) z^i_{h-1} + \varepsilon^i_h - \varepsilon^i_{h-k}
\end{aligned}
$$

For $\rho \sim 1 \Rightarrow \Delta y^i_{h,h-k} = \underbrace{\sum_{j=0}^{k-1} \eta^i_{h-j}}_{\text{k persistent shocks}} + \underbrace{\varepsilon^i_h - \varepsilon^i_{h-k}}_{\text{2 transitory shocks}}$

Covariance Matrix Estimation

3. Derive the theoretical autocovariances of income *levels*:

$$\mathrm{var}(y_h^i) = \sigma_\alpha^2 + \mathrm{var}(z_h^i) + \sigma_\varepsilon^2,$$

$$\mathrm{var}(z_h^i) = \sum_{s=1}^{h} \rho^2 \sigma_\eta^2,$$

$$\mathrm{cov}(y_h^i, y_{h+n}^i) = \sigma_\alpha^2 + \rho^n \mathrm{var}_i(z_h^i).$$

or autocovariances of income *growth*

$$\mathrm{var}(\Delta y_{h,h-1}^i) = \mathrm{var}(\Delta y_h^i) = (\rho-1)^2 \mathrm{var}(z_{h-1}^i) + \sigma_\eta^2 + 2\sigma_\varepsilon^2,$$

$$\mathrm{cov}(\Delta y_h^i, \Delta y_{h+1}^i) = (\rho-1)^2 \rho \mathrm{var}_i(z_{h-1}^i) - \sigma_\varepsilon^2$$

$$\mathrm{cov}(\Delta y_h^i, \Delta y_{h+2}^i) = (\rho-1)^2 \rho^2 \mathrm{var}_i(z_{h-1}^i) \sim 0 \text{ if } \rho \sim 1.$$

Covariance Matrix Estimation

4. Construct the empirical counterpart of the covariance matrix:

$$\begin{bmatrix} \text{var}_i(y_1^i \text{ or } \Delta y_1^i) & & & & & \\ \vdots & \text{var}_i(y_2^i) & & & & \\ \vdots & \cdots & \ddots & & & \\ \text{cov}(y_1^i, y_t^i) & \cdots & & \text{var}_i(y_t^i) & & \\ \vdots & & & & \ddots & \\ \text{cov}(y_1^i, y_T^i) & & & & & \text{var}_i(y_T^i) \end{bmatrix}$$

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5. Choose $(\rho, \sigma_\alpha^2, \sigma_\eta^2, \sigma_\varepsilon^2)$ to bring the theoretical covariance matrix as close to its empirical part as possible.

Covariance Matrix Estimation

4. Construct the empirical counterpart of the covariance matrix:

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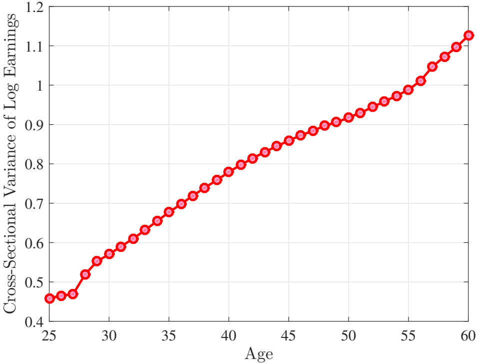
5. Choose $(\rho, \sigma_\alpha^2, \sigma_\eta^2, \sigma_\varepsilon^2)$ to bring the theoretical covariance matrix as close to its empirical part as possible.

- CME developed for a data-constrained environment
  - Use small survey-based data sets, e.g., the PSID, between 500 to 2000 individuals per year

Variance Profile

$$\mathbf{var}(y_h^i) = \sigma_\alpha^2 + \sum_{s=1}^{h} \rho^2 \sigma_\eta^2 + \sigma_\varepsilon^2,$$



Source: Guvenen, Karahan, Ozkan, and Song (2015)

- Almost linear increase in within cohort inequality implies $\rho \sim 1$.

Autocovariances of Earnings Growth, $\Delta y_{h,h+n}$

TABLE I

THE AUTOCOVARIANCES OF THE UNEXPLAINED GROWTH OF EARNINGS[a]

Order	Pooled Sample	High School Dropout	High School Graduate	College Graduate
0	0.109	0.164	0.103	0.065
	(0.0051)	(0.014)	(0.0068)	(0.0058)
1	−0.0303	−0.0535	−0.028	−0.0105
	(0.0021)	(0.0055)	(0.0027)	(0.0018)
2	−0.0079	−0.0134	−0.0077	−0.0025
	(0.0014)	(0.0046)	(0.0015)	(0.0013)
3	−0.0024	−0.0018	−0.0026	−0.0024
	(0.0011)	(0.0034)	(0.0014)	(0.0011)
4	0.0007	0.0074	−0.0015	−0.0017
	(0.0011)	(0.0035)	(0.0013)	(0.0012)

[a]Asymptotic standard errors are reported under the coefficient estimate. Values are pooled over all years and individuals.

Source: Meghir and Pistaferri (2004)

- Autocovariances are significant for order up to 2 $\Rightarrow$ MA(2) transitory shocks and very persistent ($\rho \sim 1$) persistent component.
- $\sigma^2_{\eta,C} = 0.044$, $\sigma^2_{\eta,HS} = 0.03$, $\sigma^2_{\eta,HSD} = 0.033$.

RIP vs HIP or $\sigma^2_\beta \gg 0$?

$$y^i_{t,h} \quad = \quad \alpha^i + \beta^i h + z^i_{t,h} + \varepsilon^i_{t,h} \Rightarrow \underbrace{\sigma^2_\beta \gg 0 \text{ and } \rho \ll 1}_{\text{HIP}} \text{ vs. } \underbrace{\sigma^2_\beta = 0 \text{ and } \rho \simeq 1}_{\text{RIP}}$$

MaCurdy's (1982) Test: $cov(\Delta y^i_h, \Delta y^i_{h+n}) = \sigma^2_\beta - \rho^{n-1}\left(\frac{1-\rho}{1+\rho}\sigma^2_\eta\right)$

- For sufficiently large n, the second term vanishes ($\rho^{n-1} \sim 0$) and $cov(\Delta y^i_h, \Delta y^i_{h+n}) \simeq \sigma^2_\beta \gg 0$.
- MaCurdy's (1982) used the first 5 lags from the PSID data and concluded that $cov(\Delta y^i_h, \Delta y^i_{h+n}) \simeq \sigma^2_\beta \simeq 0$.

Guvenen (2009) raises 2 issues:

- For $\rho \simeq 0.80$ the autocovariances do not even turn positive before the 13th lag.
- Weak power: cannot reject the false null hypothesis of $\sigma^2_\beta = 0$ for any sample size smaller than 500,000 observations.

RIP vs HIP or $\sigma_\beta^2 \gg 0$?

Guvenen (2009) investigates autocovariance of *levels* of earnings:

$$\text{var}(y_h^i) = \underbrace{\left[\sigma_\alpha^2 + 2\sigma_{\alpha\beta}h + \sigma_\beta^2 h^2\right]}_{\text{HIP component}} + \underbrace{\sum_{s=1}^{h} \rho^2 \sigma_\eta^2}_{\text{AR(1) component}} + \sigma_\varepsilon^2$$

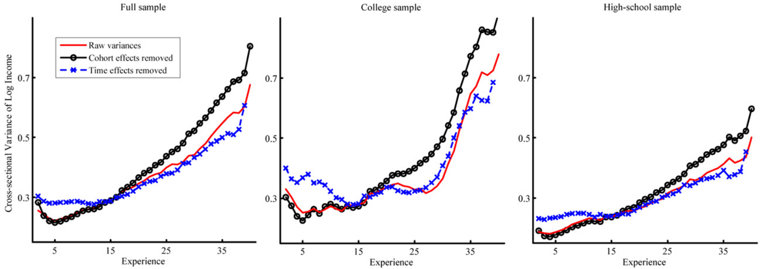


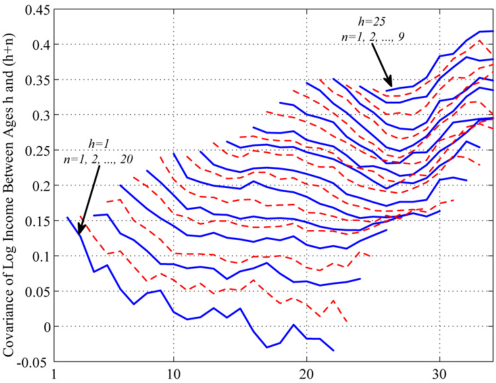
Fig. 4. Age–variance profile of log income in PSID.

Source: Guvenen (2009)

- Convex pattern in within cohort inequality implies $\beta \gg 0$.

RIP vs HIP or $\sigma_\beta^2 \gg 0$?

$$\mathrm{covar}(y_h^i, y_{h+n}^i) = \underbrace{\left[\sigma_\alpha^2 + \sigma_{\alpha\beta}(2h+n) + \sigma_\beta^2 h(h+n)\right]}_{\text{Convex in } h \text{ and } \uparrow \text{ or } \downarrow \text{or non-monotonic in } n} + \underbrace{\rho^n \mathrm{var}(z_h^i)}_{\text{decay at rate } \rho}$$



Source: Guvenen (2009). Covariance structure of log income for college.

Guvenen 2009

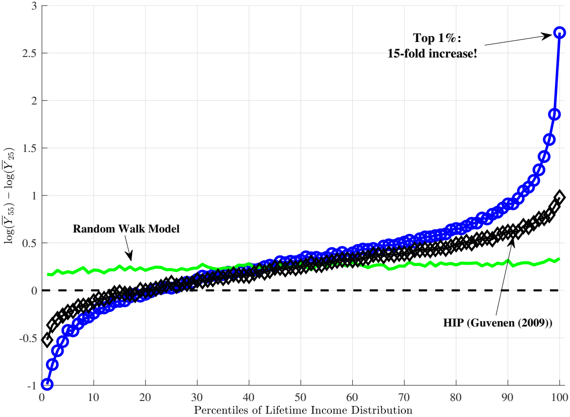
Table 1
Estimating the parameters of the labor income process

	Sample	ρ	σ_α^2	σ_β^2	$corr_{\alpha\beta}$	σ_η^2	σ_ε^2
				Panel A: σ_β^2 *restricted* to be zero (RIP process)			
(1)	All	.988	.058	–	–	.015	.061
		(.024)	(.011)			(.007)	(.010)
(2)	College	.979	.031	–	–	.0099	.047
		(.055)	(.021)			(.013)	(.020)
(3)	High-school	.972	.053	–	–	.011	.052
		(.023)	(.015)			(.007)	(.008)
				Panel B: σ_β^2 *unrestricted* (HIP process)			
(4)	All	.821	.022	.00038	−.23	.029	.047
		(.030)	(.074)	(.00008)	(.43)	(.008)	(.007)
(5)	College	.805	.023	.00049	−.70	.025	.032
		(.061)	(.112)	(.00014)	(1.22)	(.015)	(.017)
(6)	High-school	.829	.038	.00020	−.25	.022	.034
		(.029)	(.081)	(.00009)	(.59)	(.008)	(.007)
(7)	All (large sample)	.842	.072	.00043	−.33	.032	.044
		(.024)	(.055)	(.00007)	(.40)	(.006)	(.008)
(8)	All (first 10 cov.)	.899	.055	.00055	−.73	.016	.047
		(.042)	(.060)	(.00013)	(.38)	(.010)	(.009)

Notes. Standard errors are in parentheses. Time effects in the variances of persistent and transitory shocks are included in the estimation in all rows. The estimated time effects for rows 1 and 4 are reported in Table 5, others are omitted to save space. The reported variances are averages over the sample period.

Source: Guvenen (2009).

Guvenen, Karahan, Ozkan and Song (2017)



- Random walk model (RIP) is not even close to capturing the heterogeneity in earnings growth seen in the data.
- HIP performs better but still falls short of fully capturing the differences.

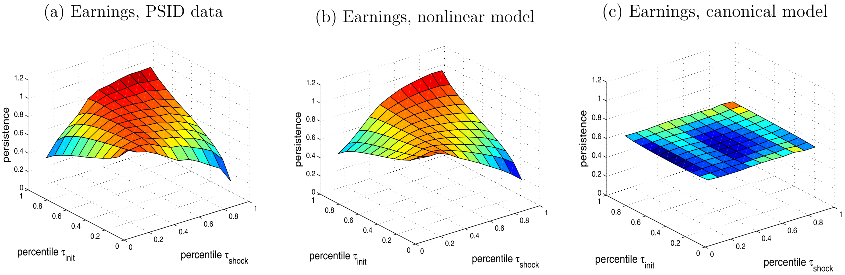
Non-Linear Earnings Dynamics

- The canonical model rules out asymmetric persistence and nonlinear transmission of shocks.
  - persistence may differ with the sign and size of shocks as well as for different income groups.
  - e.g.,unusual shocks (like job or health loss) may wipe out the memory of past shocks.
  - e.g., positive growth may be more persistent than negative growth.
- Arellano, Blundell and Bonhomme (2017 ECMA) (ABB) and Guvenen, Karahan, Ozkan and Song (2017) (GKOS) study nonlinear dynamics of earnings.
  - ABB allows shocks/innovations to not only change the size of the persistent component but also its persistence.
  - GKOS allows for multiple AR(1) components so that shocks differ in their persistence.

Arellano, Blundell and Bonhomme (2017)

- $y_{i,h} = \alpha_i + \eta_{i,h} + \varepsilon_{i,h}$
  - $\varepsilon_{i,h}$ is iid and $\eta_{i,h}$ follows a general first order Markov process.
- $\eta_{i,h} = Q_h(\eta_{i,h-1}, \tau)$, Q_h is the τth conditional quantile of η_{it} given η_{it-1}.
  - $\eta_{i,h} = Q_h(\eta_{i,h-1}, u_{ih})$, $u_{ih} \sim U(0,1)$ represents the rank τ.
  - The distribution of η_{i1} is left unrestricted.
  - The function $Q_h(\eta, u)$ is age-specific.
- $\rho_h(\eta_{i,h-1}, \tau) = \frac{\partial Q_h(\eta_{i,h-1}, \tau)}{\partial \eta}$
  - the persistence of $\eta_{i,h-1}$ when hit by a shock u_{ih} of rank τ.
  - in the canonical model $\rho_h(\eta_{i,h-1}, \tau) = 1$ for all $\eta_{i,h-1}$ and τ.

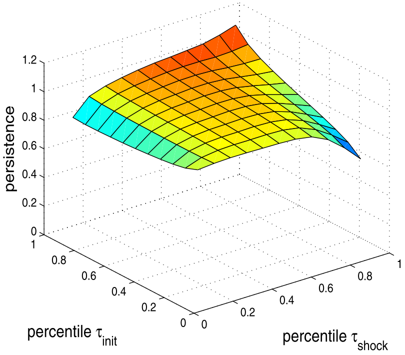
Arellano, Blundell and Bonhomme (2017)



- nonlinear model can capture the nonlinear persistence pattern of the data well.
- canonical model (random walk+iid transitory) is in contrast with the data.

Arellano, Blundell and Bonhomme (2017)

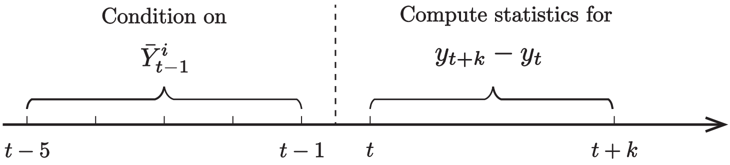
(d) Persistent component η_{it}, nonlinear model



- ρ is close to 1 for high (low)-earners hit by good (bad) shocks
- ρ is lower (0.6–0.8), when bad (good) shocks hit high (low)-earners.

Impulse Response Function–GKOS (2017)

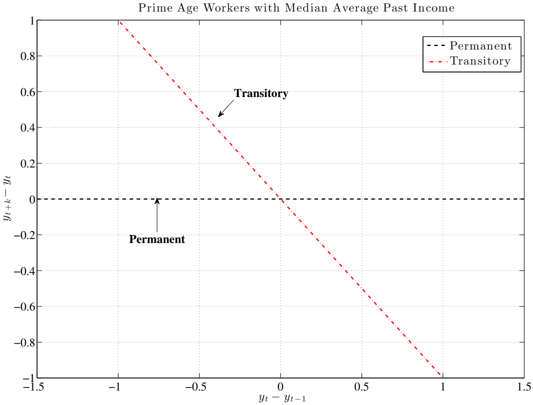
Figure: Timeline For Rolling Panel Construction



Source: Guvenen, Karahan, Ozkan, and Song (2017)

1. Condition workers on age at $t-1$ and past income between $t-1$ and $t-5$.
2. Within each age and past income bin, fix a group of workers who have experienced *similar growth* between t and $t-1$.
3. Follow this group over the next 1, 2, 3, 5, and 10 years.

Impulse Response Function–GKOS (2017)



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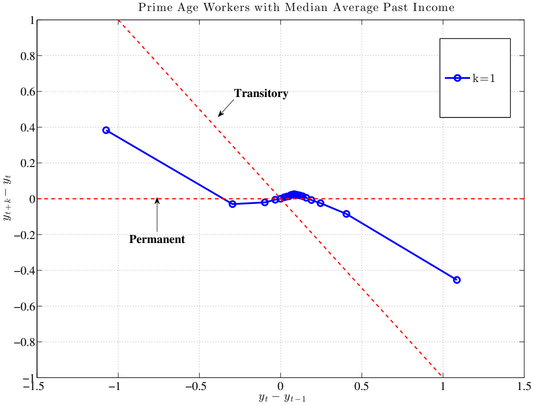
Impulse Response Function–GKOS (2017)



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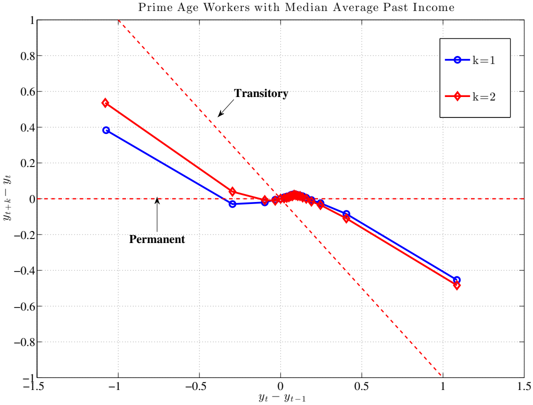
Impulse Response Function–GKOS (2017)



Source: Guvenen, Karahan, Ozkan, and Song (2017)

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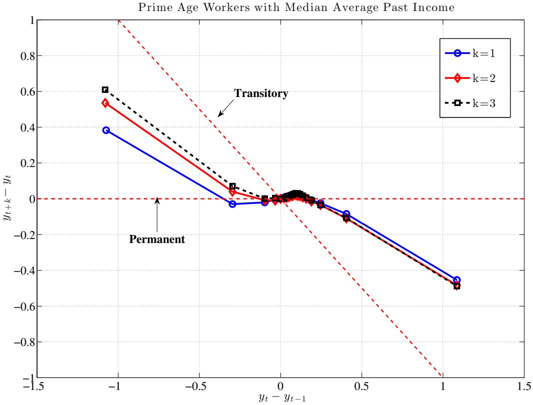

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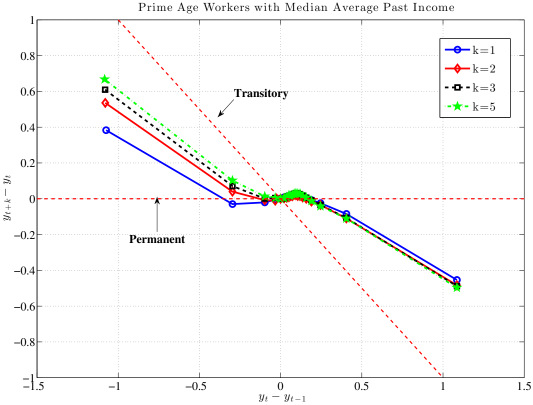

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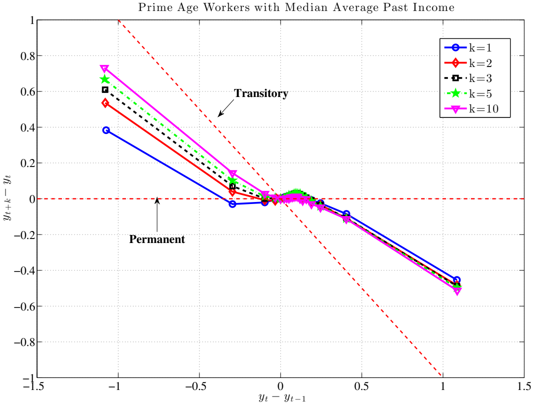
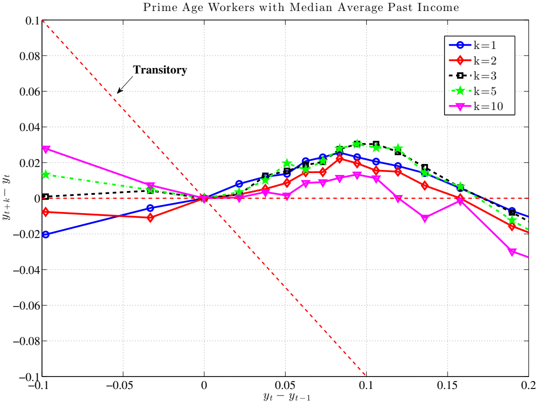


Source: Guvenen, Karahan, Ozkan, and Song (2017)

- Large declines are less persistent than large positive growth.

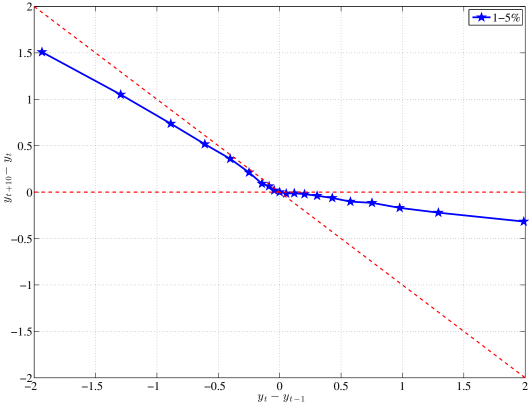
Impulse Response Function–GKOS (2017)



Source: Guvenen, Karahan, Ozkan, and Song (2017)

- Small changes are more persistent.
- Upward slope suggests HIP.

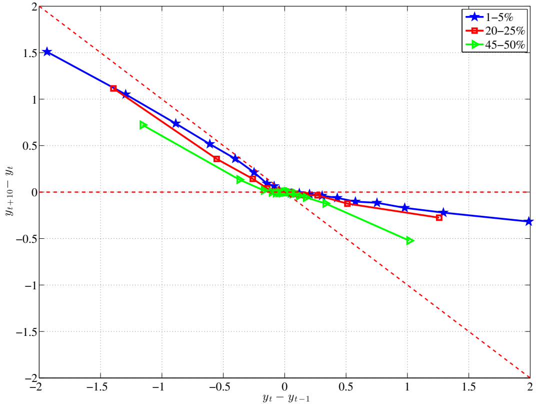
Asymmetric Mean Reversion–GKOS (2017)



Source: Guvenen, Karahan, Ozkan, and Song (2017)

- Low income: Negative changes are more transitory than positive changes.

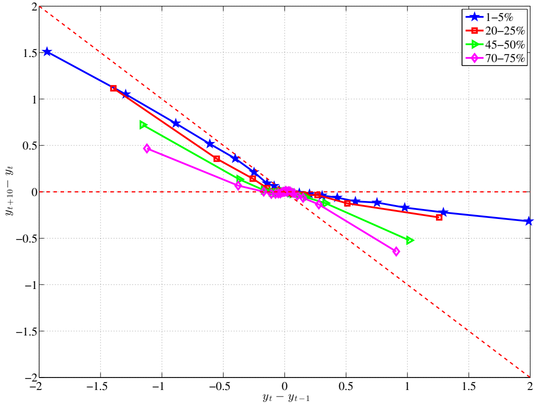
Asymmetric Mean Reversion–GKOS (2017)



Source: Guvenen, Karahan, Ozkan, and Song (2017)

- As we move to higher income: positive (negative) changes become more transitory (persistent).

Asymmetric Mean Reversion–GKOS (2017)



Source: Guvenen, Karahan, Ozkan, and Song (2017)

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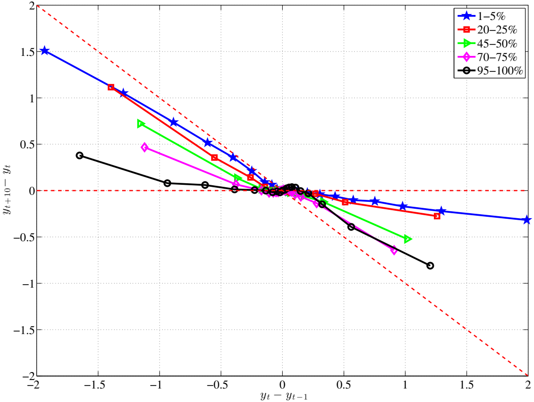
Asymmetric Mean Reversion–GKOS (2017)



Source: Guvenen, Karahan, Ozkan, and Song (2017)

- High income: Positive changes are more transitory than negative changes.

Nature of Idiosyncratic Income Risk

1. Shocks versus initial conditions in earnings dynamics?✓
2. How much of risk is forecastable (advanced information)?✓
3. How persistent are shocks?✓
4. **What does the distribution of shocks look like?**
   - **And how does idiosyncratic risk vary over lifecycle and the income distribution?**
5. Long run trends in idiosyncratic risk?
6. How does idiosyncratic risk vary over business cycle?
7. Micro-foundations of labor income risk?
8. Idiosyncratic risk after public insurance?

Distribution of Earnings Shocks

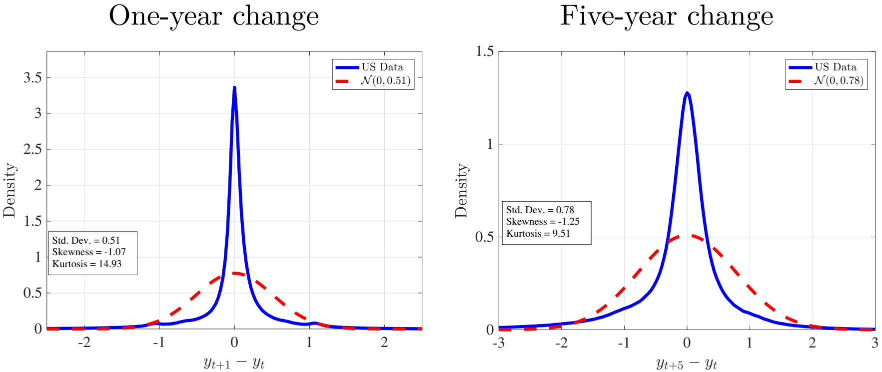
1. What does the distribution of earnings shocks look like?

A. Is it approximately lognormal?

B. How about higher-order moments?

> Symmetric or skewed? any excess kurtosis?

Distribution of Earnings Shocks



Source: Guvenen, Ozkan and Song 2013 JPE

Distribution of Earnings Shocks

1. **What does the distribution of earnings shocks look like?**

2. **How do the properties of shocks vary?**

   A. across "different income groups" GKOS (2017)?

   B. over the life cycle? Karahan and Ozkan (2013, RED)

Earlier Work

1. Small survey-based data sets, e.g., the PSID
    - between 500 to 2000 individuals per year

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   - between 500 to 2000 individuals per year

2. Employ covariance matrix estimation (CME), developed for a data-constrained environment

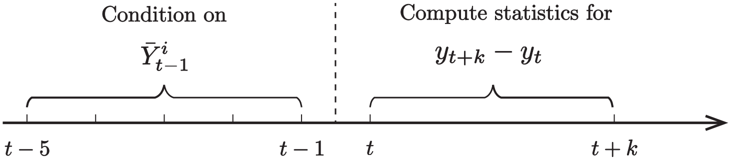
   - Ignores higher order moments, which is a very important feature of data.
   - Selecting among rejected models is very hard:
     - moments that are missed do not have clear economic interpretations.
   - *Notable exceptions:* Meghir and Pistaferri (2004), Browning et al (2010), and Altonji et al (2013)

Data: 10% Random Sample from SSA

- Data contains all individuals in the US with a Social Security number.
- Labor income data from W-2 forms for salaried/wage workers.
  - For self-employed workers from IRS tax forms (Schedule SE).
- A representative sample of US males aged 25–60 covering 34 years: 1978 to 2011
- Compared to survey data:
  - Very large sample size: important for higher order moments.
  - Less measurement error (possible under-reporting).
  - No sample attrition: Allows to control for compositional changes.
  - No top-coding: income observations in tens of millions of $ per year.
  - Drawback: Lack of hours data and no information on hourly wages!!

Moments of $F(y_{t+1} - y_t | \bar{Y}^i_{t-1}, age_{t-1})$

Figure: Timeline For Rolling Panel Construction



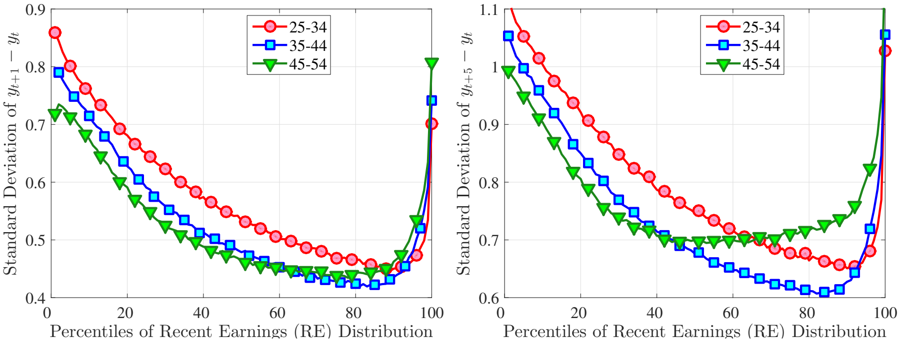
Source: Guvenen, Karahan, Ozkan, and Song (2017)

- Condition workers on age at $t-1$ and past income between $t-1$ and $t-5$.

$$
\begin{aligned}
y_{t+1} - y_t &= \left(\alpha^i + z^i_{t+1} + \varepsilon^i_{t+1}\right) - \left(\alpha^i + z^i_t + \varepsilon^i_t\right) \\
&= \eta^i_{t+1} + \varepsilon^i_{t+1} - \varepsilon^i_t \text{ (assuming that } \rho = 1) \\
y_{t+5} - y_t &= \sum_{j=1}^{5} \eta^i_{t+j} + \varepsilon^i_{t+5} - \varepsilon^i_t
\end{aligned}
$$

Variance

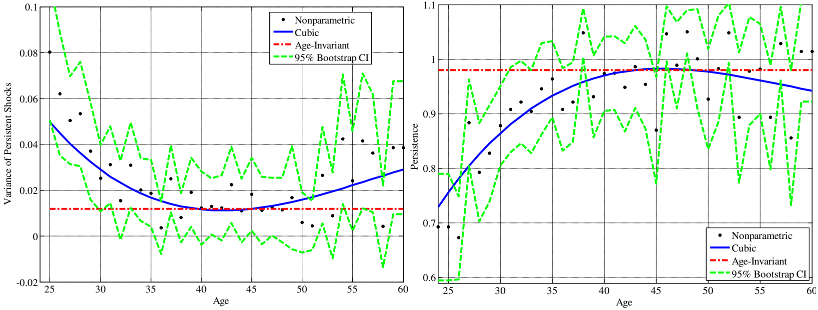
I. Standard Deviation of $y_{t+k} - y_t$



Source: Guvenen, Karahan, Ozkan and Song 2017

- Low income and top income workers face a larger variance of shocks.
- Shocks follow a U-shaped pattern over the lifecycle.

Life Cycle Variation–Karahan and Ozkan 2013

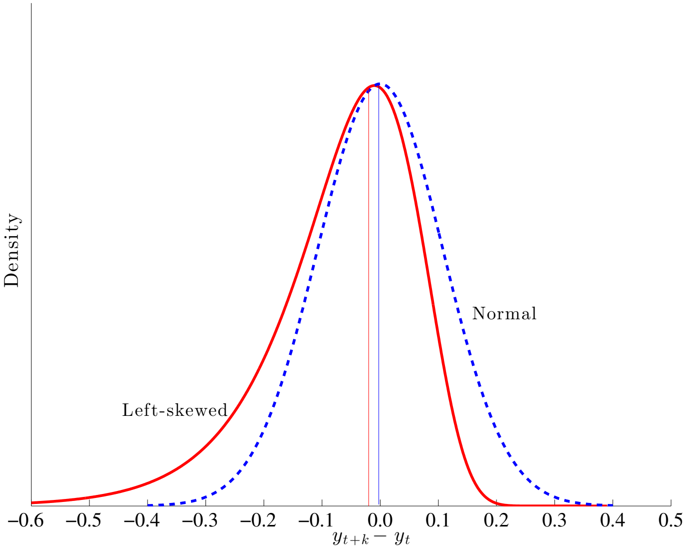


Source: Karahan and Ozkan 2013 RED

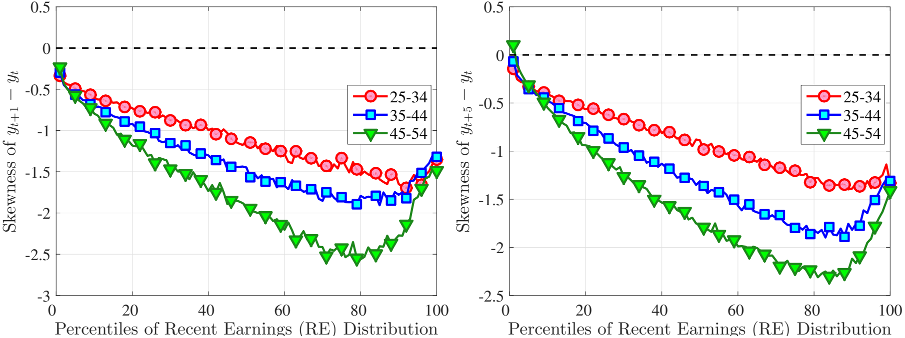
- Persistence is moderate early in life and rises up to 1 by age 25-40.
- Variance of persistent shocks follow a U shaped pattern over the lifecycle.

Skewness

Left-Skewness



II. Skewness of $y_{t+k} - y_t$

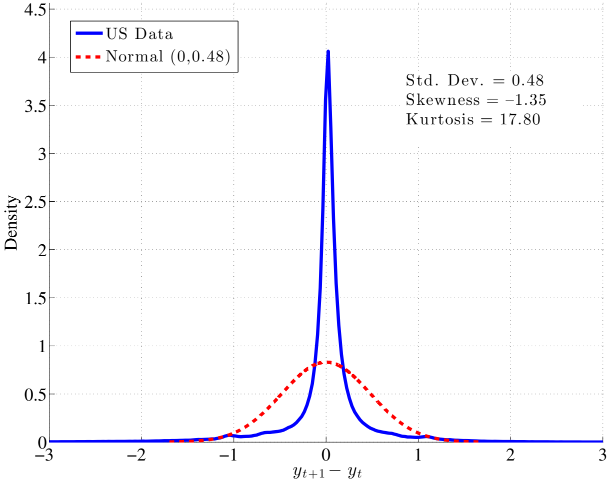


Source: Guvenen, Karahan, Ozkan and Song 2017

- Higher income and older workers face a more left skewed distribution.
- As workers get older and climb up the ladder there is more room to fall down.

Kurtosis

Kurtosis



US Data
Normal (0,0.48)
Std. Dev. = 0.48
Skewness = −1.35
Kurtosis = 17.80
Density
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
−3
−2
−1
0
1
2
3
$y_{t+1} - y_t$

Kurtosis

x :	Prob($\lvert y^i_{t+1} - y^i_t \rvert < x$) Data*	$\mathcal{N}(0, 0.48^2)$	Ratio
0.05	0.35	0.08	4.38
0.10	0.54	0.16	3.38
0.20	0.71	0.32	2.23
0.50	0.86	0.70	1.22
1.00	0.94	0.96	0.98
$\lvert y^i_{t+1} - y^i_t \rvert > 1.5$	0.023	0.002	11.5

Kurtosis

	$\text{Prob}(\lvert y^i_{t+1} - y^i_t \rvert < x)$		
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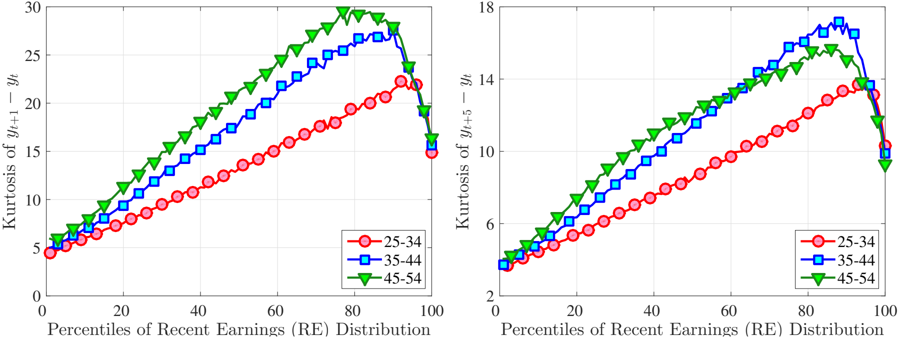
III. Kurtosis of $y_{t+k} - y_t$



Source: Guvenen, Karahan, Ozkan and Song 2017

- Higher income and older workers face a more leptokurtic distribution.

Risk Premium: Skewness and Kurtosis

Let $\tilde{\delta}$ be a static gamble. And π is the risk premium to avoid it:

$$U(c \times (1 - \pi)) = \mathbb{E}\left[U(c \times (1 + \tilde{\delta}))\right].$$

	Risk Premium (π)		
Gamble:	$\tilde{\delta}^A$	$\tilde{\delta}^B$	$\tilde{\delta}^C$
Mean	0.0		
Standard Deviation	0.10		
Skewness	0.0		
Excess Kurtosis	0.0		
Premium	**4.88%**		

Risk Premium: Skewness and Kurtosis

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	Risk Premium (π)		
Gamble:	$\tilde{\delta}^A$	$\tilde{\delta}^B$	$\tilde{\delta}^C$
Mean	0.0	0.0	0.0
Standard Deviation	0.10	0.10	0.10
Skewness	0.0	0.0	**–2.0**
Excess Kurtosis	0.0	**27.0**	27.0
Premium	4.9%	**18.8%**	**22.2%**

A Flexible Income Process

GKOS (2017)

Econometric Specification

$$\widetilde{y}_t^i = \overbrace{(1-\nu_t^i)}^{Unemp.}\, exp(\overbrace{\alpha^i + \beta^i t}^{HIP} + \overbrace{z_t^i}^{AR(1)} + \overbrace{\varepsilon_t^i}^{i.i.d.})$$

$$z_t^i = \rho_z z_{t-1}^i + \eta_{zt}^i$$

$$\text{Innovations for } z: \quad \eta_t^i \sim \begin{cases} \mathcal{N}(\mu_{z,1}, \sigma_{z,1}) & \text{with pr. } p_z \\ \mathcal{N}(\mu_{z,2}, \sigma_{z,2}) & \text{with pr. } 1-p_z \end{cases}$$

$$\text{Transitory shock:} \quad \varepsilon_t^i \sim \begin{cases} \mathcal{N}(\mu_{\varepsilon,1}, \sigma_{\varepsilon,1}) & \text{with pr. } p_\varepsilon \\ \mathcal{N}(\mu_{\varepsilon,2}, \sigma_{\varepsilon,2}) & \text{with pr. } 1-p_\varepsilon \end{cases}$$

$$\text{Nonemployment shock:} \quad \nu_t^i \sim \begin{cases} 0 & \text{with prob } 1-p_\nu^i \\ \min(1, \mathcal{E}(\lambda)) & \text{with prob } p_\nu^i \end{cases}$$

$$p_\nu^i(y_{t-1}^i, t) = a_j + b_j \times t + c_j \times z_{t-1}^i + d_j \times z_{t-1}^i \times t$$

Estimation

- Simulated Method of Moments (SMM) is employed.
    - Simulate earnings histories for 100K individuals and compute the model counterparts of data moments from the SSA sample.

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  1. Higher order moments of 1- and 5-year earnings growth.
     - conditional on past income and age,
  2. Impulse response moments,
  3. Life cycle earnings profile of workers by LE groups,
  4. Within cohort variance profile,
  5. CDF of number of years of employment over the lifecycle.

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  2. Impulse response moments,
  3. Life cycle earnings profile of workers by LE groups,
  4. Within cohort variance profile,
  5. CDF of number of years of employment over the lifecycle.
- Income process can match the above features of the data fairly well.

Key Takeaways I

- The canonical income process is severely at odds with the above features of the data.
  - Does not generate any non-Gaussian features (negative skewness or excess kurtosis).
  - In order to capture the significant full-year nonemployment incidence seen in the data it has to feature very large (probably unrealistic) fixed effects and shocks.
  - No asymmetric mean reversion.
- To generate left skewness and excess kurtosis, need
  - innovations to persistent component and transitory shocks to be drawn from a mixture of normal and/or,
  - persistent nonemployment shocks
- In order to capture age and income variation in cross-sectional moments, need mixture/nonemployment probabilities to depend on age and past income.

Key Takeaways II

- Incorporating nonemployment shocks whose probability is *uniform* across workers does not help.
    - Nonemployment is very concentrated in the data (among low income and young workers).

- A ***heterogeneous*** nonemployment shock whose probability depends on past income and age can much better fit the data.

- Nonemployment shock without any persistence or scarring effect does not help generate left skewness.
    - Fully transitory shocks cannot generate left skewness in earnings growth distribution.

$$y_{t+1} - y_t \quad = \quad \eta^i_{t+1} + \varepsilon^i_{t+1} - \varepsilon^i_t$$

No matter what the shape of ε^i_t is $(\varepsilon^i_{t+1} - \varepsilon^i_t)$ is always symmetric.

Key Takeaways III

- Data requires a linear HIP component but not because of income growth heterogeneity moments.
  - very large, very persistent shocks along with nonemployment shocks can generate enough income growth heterogeneity.
- HIP allows for low persistence in the AR(1) component.
  - leads to a better fit to the impulse response moments, which exhibit large neither fully transitory nor permanent shocks.
- Second AR(1) component with mixture probabilities dependent on age and income also helps a much better fit to the impulse response moments.

Shock over the Life Cycle

Table: Probability of Nonemployment Shock

Age groups		
25–34	35–49	45–59
0.071	0.061	0.055

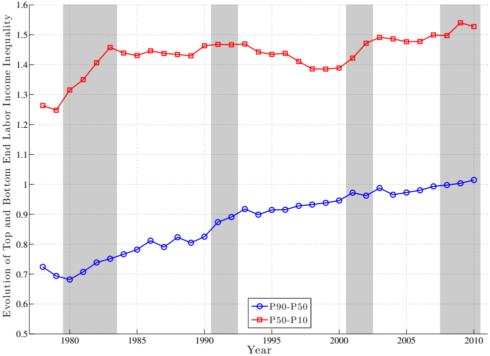
RE (Percentile) groups				
1–10	21–30	41–60	71–80	91–100
0.178	0.088	0.049	0.023	0.006

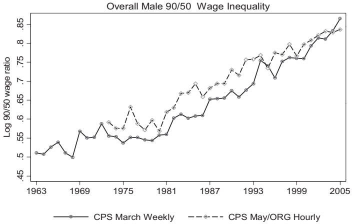
Nature of Idiosyncratic Income Risk

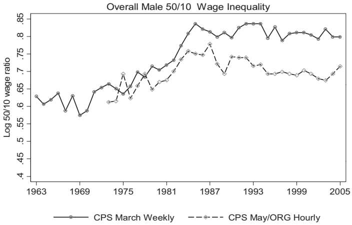
1. Shocks versus initial conditions in earnings dynamics?✓
2. How much of risk is forecastable (advanced information)?✓
3. How persistent are shocks?✓
4. What does the distribution of shocks look like?✓
   - And how does idiosyncratic risk vary over lifecycle and the income distribution?✓
5. **Long run trends in idiosyncratic risk?**
6. How does idiosyncratic risk vary over business cycle?
7. Micro-foundations of labor income risk?
8. Idiosyncratic risk after public insurance?

Earnings Inequality over Time

Figure A.2: Top and Bottom Ends of Labor Earnings Distribution







Source: Left: Guvenen, Ozkan, and Song 2013 SSA data. Right: Autor, Katz, and Kearney 2008 CPS.

- Income inequality has risen since 1970s. Sources?

Time Varying Factor Loadings

$$
\begin{aligned}
y^{i,c}_{t,h} &= p_t(\alpha^{i,c} + \beta^{i,c} h) + z^i_{t,h} + \lambda_t \varepsilon^i_{t,h} \\
z^i_{t,h} &= \rho_t z^i_{t-1,h-1} + \gamma_t \eta^i_{t,h} \\
(\alpha^{i,c}, \beta^{i,c}) \sim F(\Sigma_c), &\qquad \varepsilon^i_{t,h} \sim F(0, \sigma^\varepsilon),\ \eta^i_{h,t} \sim F(0, \sigma^\eta)
\end{aligned}
$$

The increase in inequality ($\text{var}(y^i_{t,h})$) may be due to:

1. Increase in volatility of shocks: $\lambda_t \uparrow$ and/or $\gamma_t \uparrow$ (Moffitt and Gottschalk 1995).
2. Increase in factor price of skills: $p_t \uparrow$ (Haider 2001)
3. new cohorts enter labor market more unequal: $\sigma^c_\alpha \uparrow$ and/or $\sigma^c_\beta \uparrow$ (Guvenen, Kaplan, Song, and Weidner 2017)
4. persistence of shocks increase over time or higher for newer cohorts: $\rho_t \uparrow$

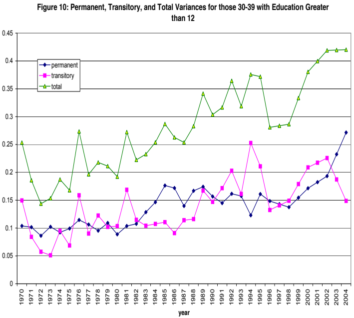
Has Volatility Increased?

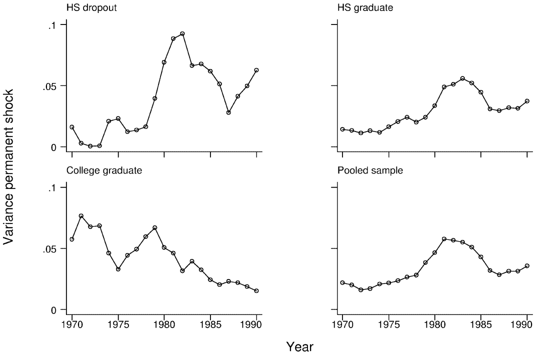
- Using the PSID, Moffitt and Gottschalk (1995) documented that volatility of shocks has risen, and it has been confirmed by a large subsequent literature.
- Opening quote from Ljungqvist and Sargent (2008, ECMA):

  A growing body of evidence points to the fact that the world economy is more variable and less predictable today than it was 30 years ago... [There is] more variability and unpredictability in economic life

  Heckman (2003).

Trend in Volatility: Evidence from the PSID





Source: Left: Moffitt and Gottschalk 2012. Right: Meghir and Pistaferri 2004.

- The volatility of income shocks has increased significantly over the past 40 years.

Trend in Volatility: Administrative Data

- Administrative data: the opposite conclusion emerges robustly. (Sabelhaus and Song 2010; Guvenen, Ozkan and Song 2014)
  - "The great moderation in micro labor earnings"
  - volatility of earnings has been declining within most industries, age groups, gender groups, U.S. regions, etc. (Bloom, Guvenen, Pistaferri, Sabelhaus, Salgado, Song 2017)

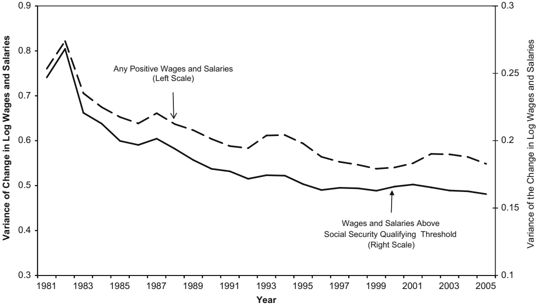
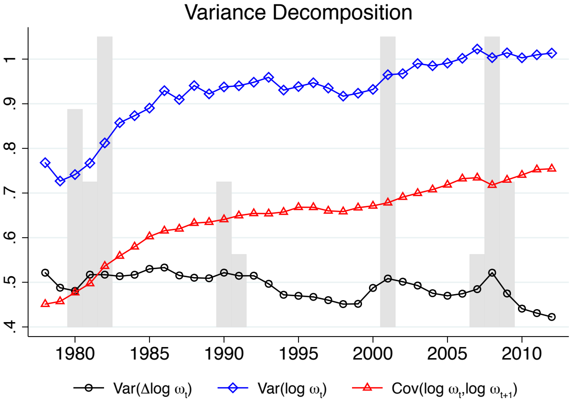


Fig. 1. Variability of changes in log annual wage and salary earnings, 1980–2005 (all earners ages 25–55).

Source: Sabelhaus and Song 2010

How Can Volatility ↓ and Inequality ↑?

$$\underbrace{\text{var}(\Delta y_t^i)}_{\text{volatility}\downarrow} = \underbrace{\text{var}(y_t^i) + \text{var}(y_{t-1}^i)}_{\text{Inequality}\uparrow} - \underbrace{2 \times \text{covar}(y_t^i, y_{t-1}^i)}_{\text{persistence must}\uparrow}$$



Source: Guvenen lecture on "Income Inequality And Income Risk: Old Myths Vs. New Facts"

What is Driving Persistence Up?

$$y_{t,h}^{i,c} = p_t(\alpha^{i,c} + \beta^{i,c} h) + z_{t,h}^{i} + \lambda_t \varepsilon_{t,h}^{i}$$

We don't know exactly but it'd be consistent with:

What is Driving Persistence Up?

$$y_{t,h}^{i,c} = p_t(\alpha^{i,c} + \beta^{i,c} h) + z_{t,h}^i + \lambda_t \varepsilon_{t,h}^i$$

We don't know exactly but it'd be consistent with:

- Increase in factor price of skills,$p_t \uparrow$ (Haider 2001)

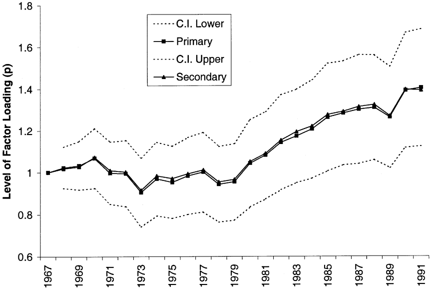


FIG. 2.—Times series of the factor loading (p_t). Data for this figure come from table 4. Point-wise confidence bands are calculated as 2 standard deviations from the primary sample results.

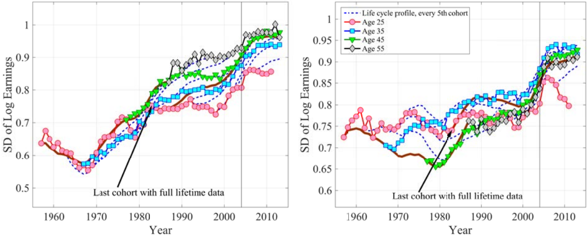
Source: Haider 2001

What is Driving Persistence Up?

$$y^{i,c}_{t,h} \quad = \quad p_t(\alpha^{i,c} + \beta^{i,c} h) + z^i_{t,h} + \lambda_t \varepsilon^i_{t,h}$$

We don't know exactly but it'd be consistent with:

- Increase in factor price of skills, $p_t \uparrow$ (Haider 2001)
- new cohorts enter labor market more unequal $\sigma^c_\alpha \uparrow$ and a modest rise in steepening of the life cycle profile (Guvenen et al 2017)



(a) Std Dev. of logs, Men

(b) Std Dev. of logs, Women

Source: Guvenen, Kaplan, Song, and Weidner 2017

What is Driving Persistence Up?

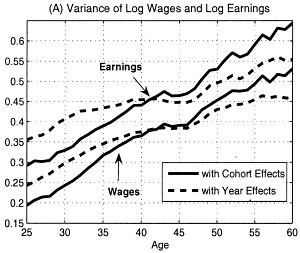
$$y^{i,c}_{t,h} \quad = \quad p_t(\alpha^{i,c} + \beta^{i,c} h) + z^i_{t,h} + \lambda_t \varepsilon^i_{t,h}$$

We don't know exactly but it'd be consistent with:

- Increase in factor price of skills,$p_t \uparrow$ (Haider 2001)
- new cohorts enter labor market more unequal $\sigma^c_\alpha \uparrow$ and a modest rise in steepening of the life cycle profile (Guvenen et al 2017)
- persistence of shocks increase over time or higher for newer cohorts, $\rho_t \uparrow$. May be?

Time vs Cohort Effects

- Deaton and Paxson (1994): Regress variance of log earnings on age and time or cohort effects.
  - Time, cohort and age are collinear: $t = a + c$. Choose to control for time or cohort effects.
- **Time effects**: changes in the economic environment that have increased wage inequality within every age group
- **Cohort effects**: younger cohorts were more unequally endowed with labor market skills than older cohorts.



Source: Heathcote, Storesletten and Violante 2005 JEEA

Nature of Idiosyncratic Income Risk

1. Shocks versus initial conditions in earnings dynamics?✓
2. How much of risk is forecastable (advanced information)?✓
3. How persistent are shocks?✓
4. What does the distribution of shocks look like?✓
   - And how does idiosyncratic risk vary over lifecycle and the income distribution?✓
5. Long run trends in idiosyncratic risk?✓
6. **How does idiosyncratic risk vary over business cycle?**
7. Micro-foundations of labor income risk?
8. Idiosyncratic risk after public insurance?

Income Risk Over the Business Cycle

Questions

1. How does the distribution of idiosyncratic earnings shocks change over the business cycle?
   - Countercyclical variance (Storesletten, Telmer and Yaron 2004) vs countercyclical skewness (Guvenen, Ozkan and Song 2013)?

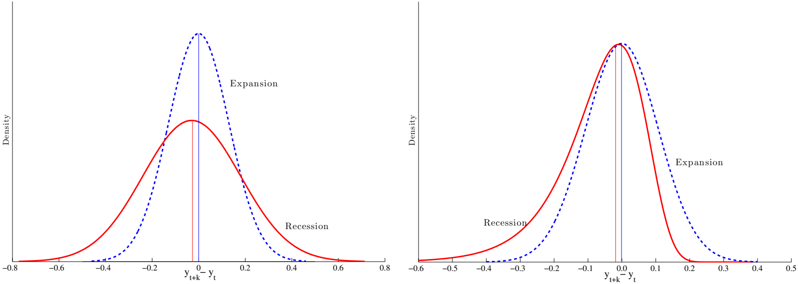
2. Are there any observable (potentially time-varying) characteristics of a worker that can help us predict his fortunes during a business cycle episode?

3. Are top earners largely immune to business cycle risk?

Distribution of Shocks in Recessions

- **Storesletten, Telmer and Yaron 2004** used the PSID data to estimate the variance of persistent shocks in recessions.
- $ARMA(1,1)$ model with business cycle variation in variance of innovations to persistent component.
- Identification: Cohorts that lived through more recessions exhibit larger within cohort inequality.
- Finding: Variance of persistent shocks are 3 times larger in recession than in expansions.

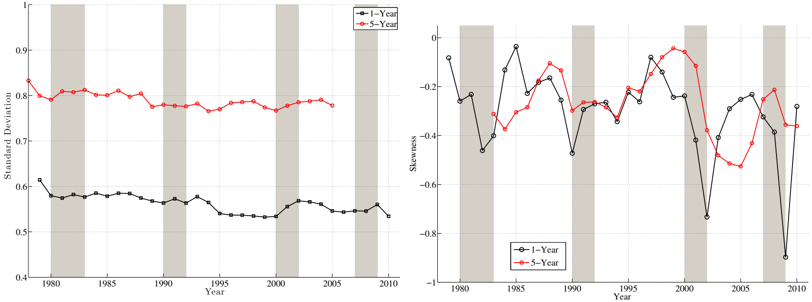
Countercyclical Variance vs Skewness?



Source: Guvenen, Ozkan and Song 2013 JPE

- **Guvenen, Ozkan and Song** use administrative data to argue that distribution of income shocks do not exhibit countercyclical variance but cyclical left skewness.

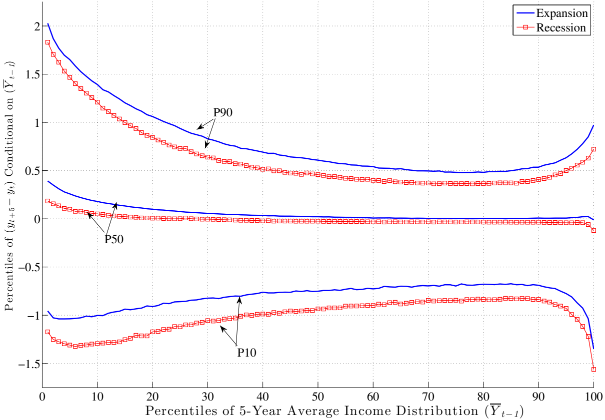
Guvenen, Ozkan and Song 2013



Source: Guvenen, Ozkan and Song 2013 JPE

- Variance of 1-year and 5-year annual earnings growth doesn't vary significantly over the business cycle.
- Both the 1- and 5-year earnings growth distributions become more left-skewed during recessions and the magnitude of change is large.

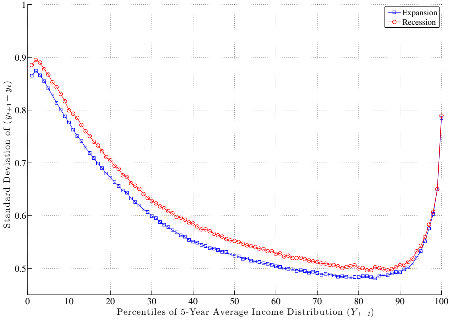
Distributions of Persistent Shocks

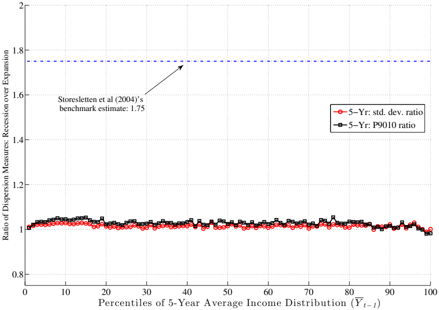


Source: Guvenen, Ozkan and Song 2013 JPE

- Median is quite stable over the business cycle.
- In recessions large positive shocks become less likely and large negative shocks become more likely.

Countercyclical Variance?

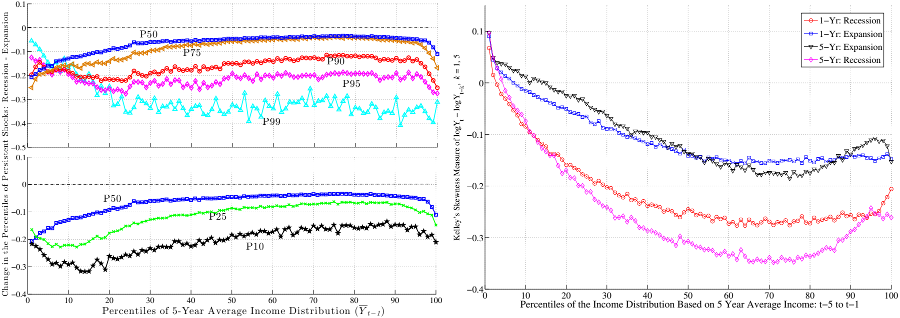




Source: Guvenen, Ozkan and Song 2013 JPE

- Variance is NOT countercyclical.

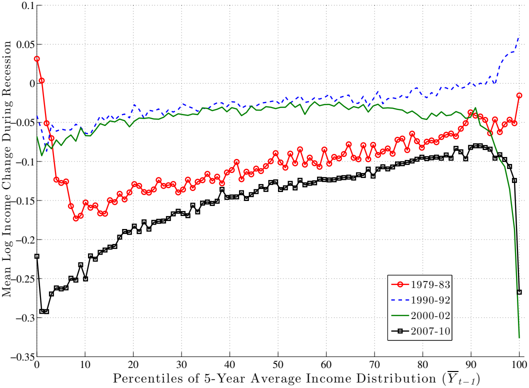
Countercyclical Skewness



Source: Guvenen, Ozkan and Song 2013 JPE

- Distribution of shocks become more left skewed during the recessions.

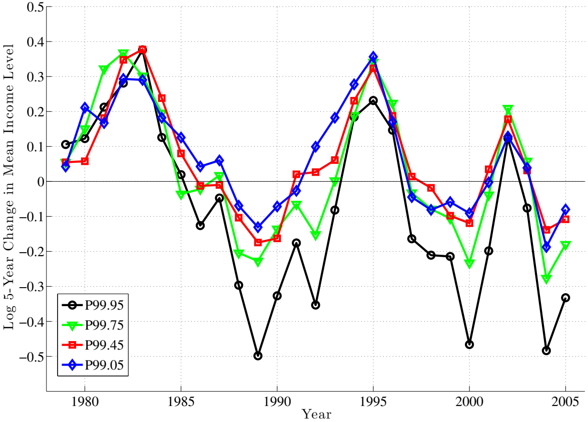
Systematic Business Cycle Risks



Source: Guvenen, Ozkan and Song 2013 JPE

- Except for top earners, earnings loss during a recession decreases with the pre-recession earnings.
- The slope of this relationship also varies with the severity of the recession.

Business Cycle Risk for Top Earners



Source: Guvenen, Ozkan and Song 2013 JPE

- Within the top 1% higher quantiles become more cyclical than lower ones.

Nature of Idiosyncratic Income Risk

1. Shocks versus initial conditions in earnings dynamics?✓
2. How much of risk is forecastable (advanced information)?✓
3. How persistent are shocks?✓
4. What does the distribution of shocks look like?✓
   - And how does idiosyncratic risk vary over lifecycle and the income distribution?✓
5. Long run trends in idiosyncratic risk?✓
6. How does idiosyncratic risk vary over business cycle?✓
7. **Micro-foundations of labor income risk?**
8. Idiosyncratic risk after public insurance?

Micro Foundations of Annual Earnings Risk

- What derives individual annual earnings fluctuations?
  - Wages vs hours?
- What derives fluctuations in wages or in hours?
  - Promotions, demotions, job loss, job switch, health shocks, etc?
- The answers to above questions are important for welfare costs of idiosyncratic risk, in turn, evaluating policy analysis.
  - Welfare consequences of policies such as unemployment insurance, employment regulations, wage subsidies, or earned income tax credits that insure against particular types of shocks to income.

Micro Foundations of Annual Earnings Risk

Two distinct paths (we'll focus on the first in this lecture):

1. Descriptive data or a statistical model with little attention to an underlying theory.
   - (1) an input for structural models of household decisions
   - (2) describe the data to guide to the structural model
   - the absence of theory limits what one can learn about how earnings are determined.

Micro Foundations of Annual Earnings Risk

Two distinct paths (we'll focus on the first in this lecture):

1. Descriptive data or a statistical model with little attention to an underlying theory.
   - (1) an input for structural models of household decisions
   - (2) describe the data to guide to the structural model
   - the absence of theory limits what one can learn about how earnings are determined.
2. Develop a structural model for household life cycle decisions.
   - e.g., human capital, job ladder, learning, occupation models, etc.
   - the difficulty of specifying and estimating a model that incorporates
     - human capital investment decisions,
     - labor supply choices, hours constraints,
     - job search decisions, voluntary separations, and involuntary job changes, etc.

Variance Profiles of Level

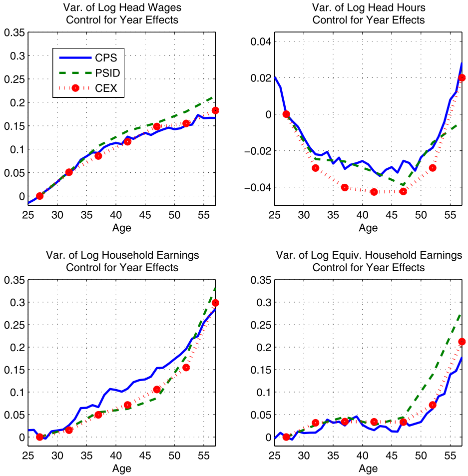


Fig. 15. Comparing life-cycle inequality across data sets.

Source: Heathcote, Perri, and Violante 2010

- Income processes for wages and annual earnings result in similar estimates (Karahan and Ozkan 2013).

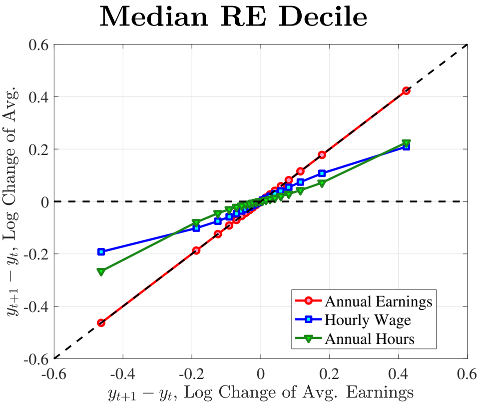
Norwegian Registry Data

- Administrative data covering the whole Norwegian population.
  - Derived from a combination of administrative registers such as annual tax records and employment register
- High quality because
  - Third-party reported: employers, banks, brokers, etc.
  - No attrition (unless someone emigrates).
- Family identifiers from the population register.
  - includes cohabitant couples.

Annual Hours vs Hourly Wage

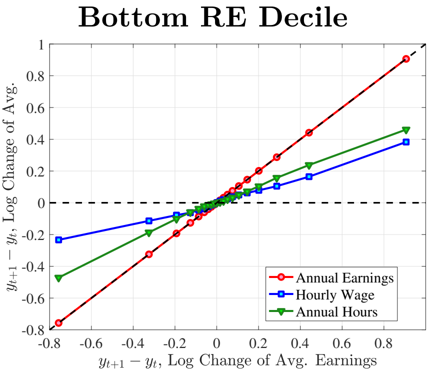
- Decompose changes in earnings to hourly wage or hours components.
- Group workers w.r.t. annual wage growth between $t-1$ and t, $\Delta e_{t,1}$ into 20 equally sized bins.
  - On top of conditioning on age in $t-1$ (young vs prime age) and past 5-year income (RE) deciles $\overline{Y}^{i}_{t-1}$.
  - e.g., a group of prime age men with median past income who experience 25 log points decline in earnings between $t-1$ and t.
- How much hourly wage and hours growth each group experience?

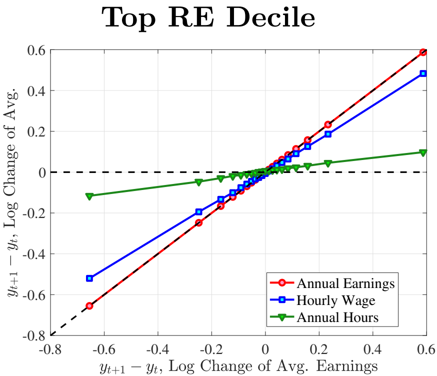
Hours vs Wage: Median RE



- Large earnings swings: hours and wage growth are equally important.
- Smaller earnings changes: wage growth is more important.

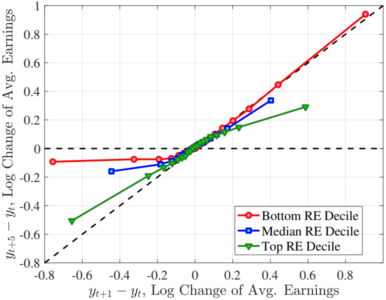
Hours vs Wage: Bottom vs Top RE





- For bottom RE group hours growth plays a more important role.
- For higher RE groups wage changes are main drivers of earnings growth. More RE Groups Average of Log Growth

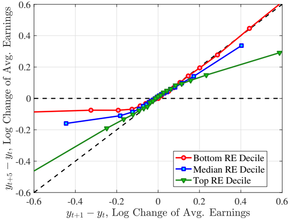
Asymmetric Mean Reversion: Dynamics of Earnings



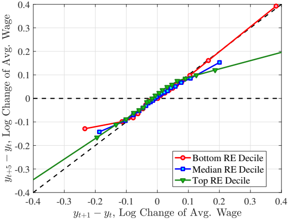
- For bottom (and median) RE group negative changes are transitory and positive changes are very persistent.
- The opposite is true for top RE group.

Asymmetric Mean Reversion: Hours vs Wages

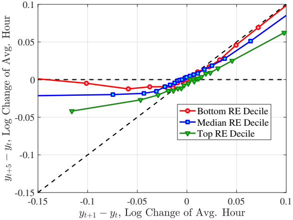
Earnings Growth



Wage Growth



Hours Change



- Wage changes are very persistent (except for top RE).
- Declines in hours are transitory and increases persistent (not so much for top RE).

Distribution of Hours vs Wage Growth

- Does hourly wage and annual hours growth distribution exhibit non-Gaussian/nonlinear features?
  - Plot their distributions and higher-order moments.
- How much of the left skewness and excess kurtosis of annual earnings growth are driven by changes in hourly wages vs hours?
  - Decompose skewness and kurtosis of earnings into hours and wage components.

Decomposing Higher-Order Moments

$$\underbrace{e_{t+k} - e_t}_{\Delta e_{t,k}} = \underbrace{w_{t+k} - w_t}_{\Delta w_{t,k}} + \underbrace{h_{t+k} - h_t}_{\Delta h_{t,k}}$$

- $\Delta e_{t,k}$: log annual wage growth between t and $t+k$
- $\Delta w_{t,k}$: log hourly wage growth between t and $t+k$
- $\Delta h_{t,k}$: log annual hours growth between t and $t+k$

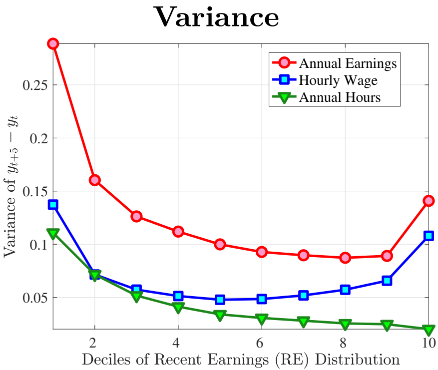
Skewness Decomposition

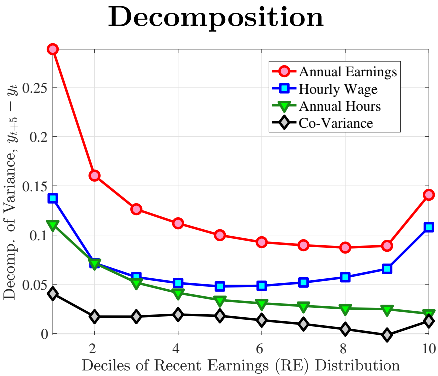
$$s_{\Delta e_{t,k}} = \left(\frac{\sigma_{\Delta w_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^3 \times s_{\Delta w_{t,k}} + \left(\frac{\sigma_{\Delta h_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^3 \times s_{\Delta h_{t,k}} + \text{co-}s_{\Delta w_{t,k},\Delta h_{t,k}}$$

Kurtosis Decomposition

$$\kappa_{\Delta e_{t,k}} = \left(\frac{\sigma_{\Delta w_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^4 \times \kappa_{\Delta w_{t,k}} + \left(\frac{\sigma_{\Delta h_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^4 \times \kappa_{\Delta h_{t,k}} + \text{co-}\kappa_{\Delta w_{t,k},\Delta h_{t,k}}$$

Variance of $y_{t+5} - y_t$ for Prime Age Male

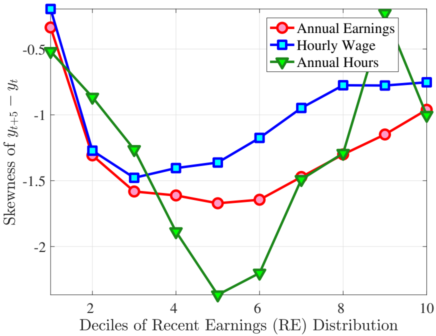




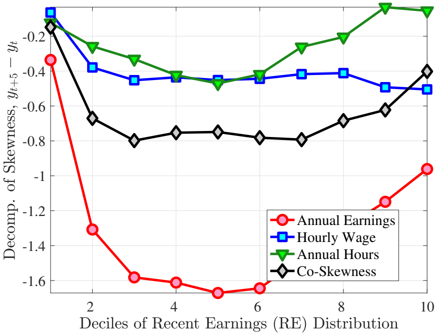
- Hourly wage is more volatile than hours especially above the median.
- Similar to the PSID.

Skewness of $y_{t+5} - y_t$ for Prime Age Male

Skewness

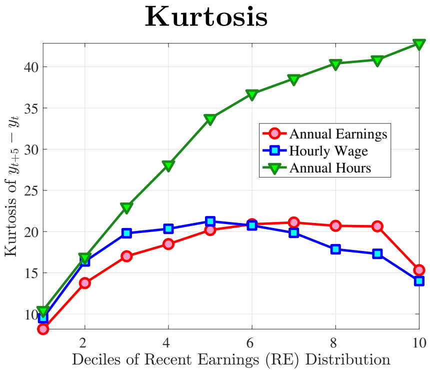


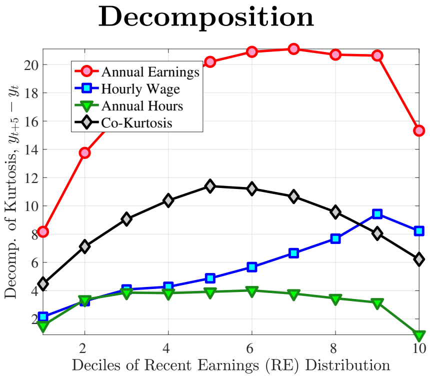
Decomposition



- Both hours and wage growth are left skewed.
- Wage growth and more importantly co-skewness are driving the left skewness of earnings growth.

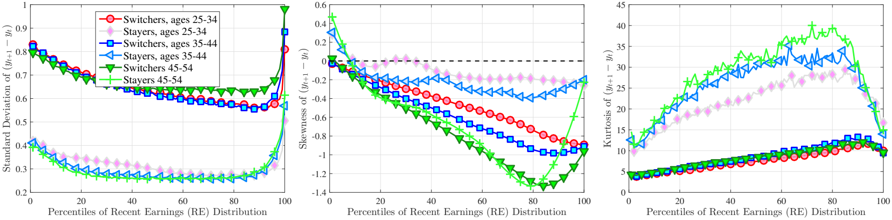
KURTOSIS OF $y_{t+5} - y_t$ FOR PRIME AGE MALE





- Wage and hours growth are both leptokurtic (especially hours growth).
- Excess kurtosis due to hourly wage dominates the hours.

Stayers vs Switchers



Source: Guvenen, Karahan, Ozkan and Song 2017, US SSA data.

- Job changes are an important source of annual earnings dispersion.
- Switchers are facing a more left skewed and leptokurtic distribution of earnings growth.

Joint Statistical Process

Joint Statistical Process

- Altonji, Smith, and Vidangos (2013 ECMA) (ASV 2013) estimate a joint model of earnings, employment, job changes, wage rates, and work hours over a career.
- **Structural model:** Not really but approximates the decision rules relating choices to state variables that would arise in a structural model based on utility maximization.
- **Auxiliary model:** Seemingly unrelated regressions (SUR) of 7 labor market variables on 25 independent variables.
- Estimate by employing Indirect Inference using the PSID data.
  - Simulate data from the structural model to run the SUR.
  - Minimize distance between data SUR parameter estimates and model SUR parameter estimates.
- Use model to study sources of inequality and wage growth over the life cycle.

ASV 2013 Structural Model

- Labor market transitions (EE, JC, EU, and UE), wages, and hours depend on:
  - three exogenous variables: race, education, and potential experience:
  - two permanent unobserved heterogeneity components.
    - unobserved productivity or ability, μ
    - propensity to move, η.
- Productivity and hours is sum of autoregressive "general" and "job specific" components.
- Employed worker receives a shock to the value of the current job and draw the job-specific wage and hours component for the new job.
- Unemployment spells reduce the autoregressive general-productivity component

ASV 2013 Wage Growth Profile

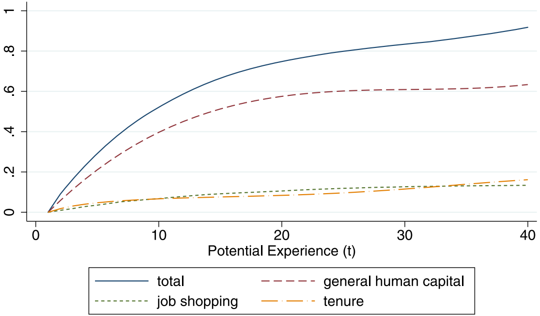


Figure 1.—Decomposing the experience profile of wages. Baseline model, full SRC sample. The figure displays the model's decomposition of wage growth over a career (or the experience profile of log wages) into the contributions of job shopping (the mean value of the job-specific wage component ν), the accumulation of tenure (the contribution of the mean value of tenure on the wage experience profile), and the accumulation of general human capital.

Source: Altonji, Smith, and Vidangos (2013)

- Most of the return to potential experience is due to general skill accumulation.

ASV 2013 Variance Decomposition

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
	Contribution to Variance							Breakdown of 'Composite'			
Variable	ε^e	ε^h	ε^ω	Composite	η	μ	EDUC	ξ	υ	E	JC
Lifetime Earnings	**5.9** (0.3)	**1.7** (0.1)	**9.5** (1.0)	**43.0** (3.3)	**−4.7** (2.0)	**15.9** (4.2)	**28.7** (2.2)	**8.4** (1.4)	**33.9** (3.3)	**1.5** (0.4)	**−0.7** (0.3)
Lifetime Wage	**0** (0.0)	**0** (0.0)	**15.4** (1.6)	**53.2** (3.4)	**−6.0** (2.3)	**4.7** (5.0)	**32.7** (3.3)	**0** (0.0)	**52.8** (3.5)	**1.2** (0.4)	**−0.8** (0.4)
Lifetime Hours	**0** (0.0)	**3.6** (0.2)	**0.5** (0.2)	**58.9** (10.1)	**1.5** (4.0)	**32.9** (11.3)	**2.6** (0.8)	**54.2** (9.8)	**1.2** (0.6)	**3.6** (0.6)	**−0.1** (0.1)

Source: Altonji, Smith, and Vidangos (2013), Table VI.A DECOMPOSITION OF CROSS-SECTIONAL VARIANCE IN LIFETIME EARNINGS, WAGE, AND HOURS (IN LEVELS)

- μ: unobserved productivity or ability; η: propensity to move.
- $\varepsilon^e, \varepsilon^h, \varepsilon^\omega$: AR(1) shocks to earnings, hours and wages, respectively.
- Composite: collective impact of shocks to job-specific hours and wage components, unemployment spells, and job changes.
- ξ and ν are job specific hours and wage shocks.
- E and JC are unemployment and job change shocks.

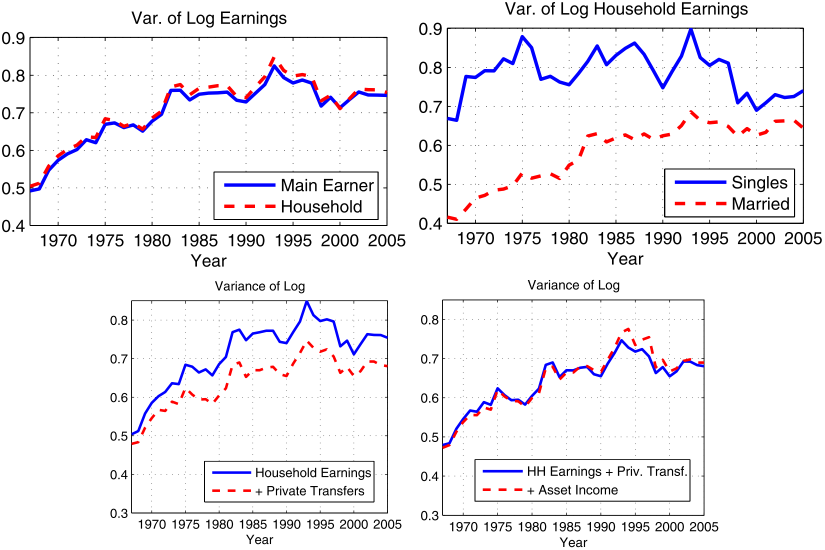
Nature of Idiosyncratic Income Risk

1. Shocks versus initial conditions in earnings dynamics?✓
2. How much of risk is forecastable (advanced information)?✓
3. How persistent are shocks?✓
4. What does the distribution of shocks look like?✓
    - And how does idiosyncratic risk vary over lifecycle and the income distribution?✓
5. Long run trends in idiosyncratic risk?✓
6. How does idiosyncratic risk vary over business cycle?✓
7. Micro-foundations of labor income risk?✓
8. **Idiosyncratic risk after public insurance?**

Idiosyncratic Risk After Public Insurance

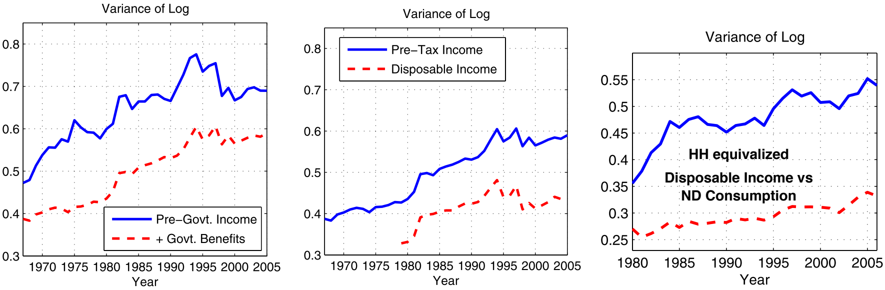
- How much insurance through family; e.g., spouse, parents, children, inter vivo transfers in cash, in kind, etc.
- How much public insurance against idiosyncratic earnings risk?
  - Progressive taxes and redistributive transfers
  - Unemployment insurance
  - Consumption floor via food stamps.
- For some questions idiosyncratic risk in disposable income is the key.
  - Individual income risk differ after public insurance.

Inequality after Private Transfers



Source: Heathcote, Perri, and Violante (2010)

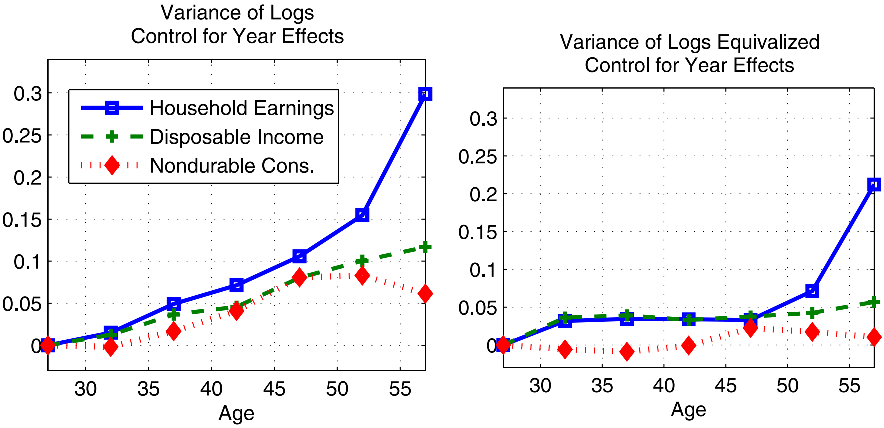
Inequality after Public Transfers



Source: Heathcote, Perri, and Violante (2010)

- Progressive taxes and redistributive transfers reduce inequality.
- Consumption inequality is lower than income inequality.
- Cons. ineq. has risen less than disp. income (Krueger and Perri 2006).
  - Aguiar and Bils (2011) show this is due to measurement error in luxury consumption.

Life-cycle Inequality

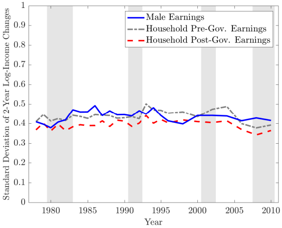


Source: Heathcote, Perri, and Violante (2010)

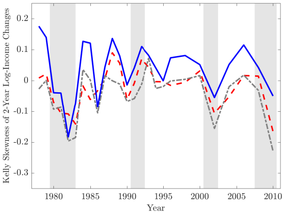
- **Cohort vs. time.** The precise magnitudes of the life-cycle increases in inequality are sensitive to whether one controls for year or cohort effects.

Distribution of Income Growth, US

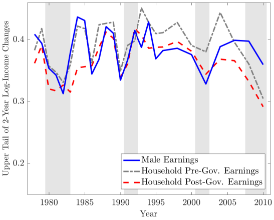
(a) United States, Std. Dev.



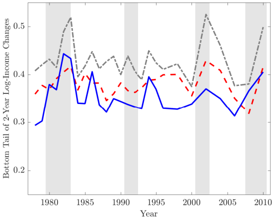
(b) United States, Kelly's Skewness



(a) United States, P90-50



(b) United States, P50-10

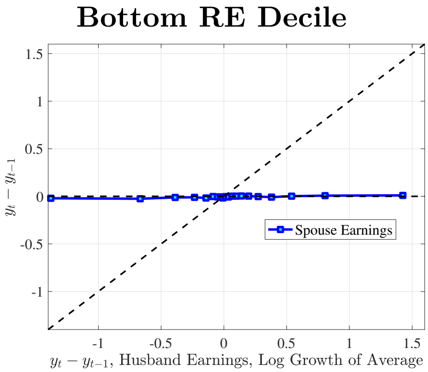


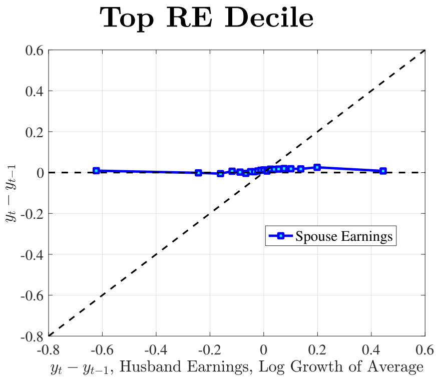
Source: Busch, Domeij, Guvenen and Madera 2015

Insurance Against Tail Shocks

- How much insurance against tail shocks from
  - Spousal income & Government tax and transfers
  - After 1 year? After 5 years?
- **Capital income** includes positive interests, dividends and realized capital gains and losses.
  - excludes unrealized capital gains.
- **Tax and transfers** include UI, DI, SS pension, sickness benefits, paid maternity leave, money received on government activity program.
  - No in kind transfers: health care, daycare subsidies, schools, etc.
- **Imputed consumption** using the budget constraint of the household.

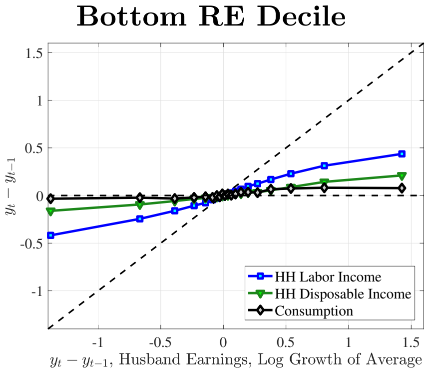
Norway: Spousal Insurance

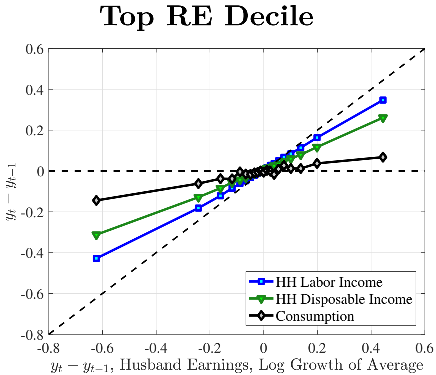




- No change in behavior of spouse or her earnings (not showing the SE income).

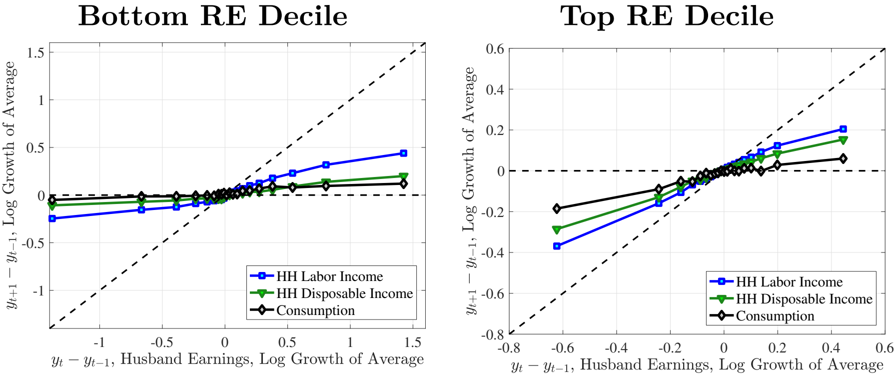
Norway: Public Insurance





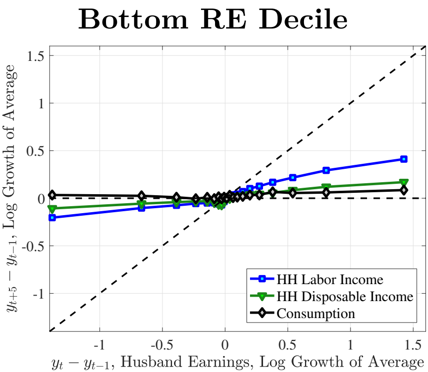
- Strong second earner effect (more so for low RE).
- Public insurance is much more helpful with tail shocks for low income.
- High RE can rely on self insurance for consumption.

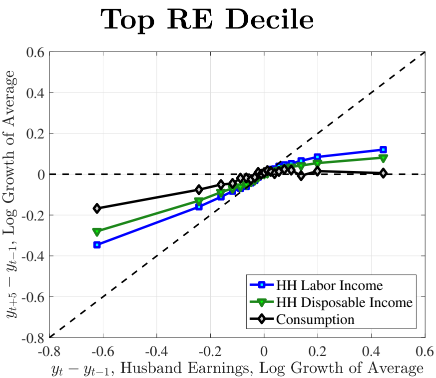
Norway: Public Insurance, 1 Year Later



- After 1 year bottom RE see a very small decline in consumption (larger for top RE).
- Earnings losses are more persistent for top RE.

Norway: Public Insurance, 5 Years Later



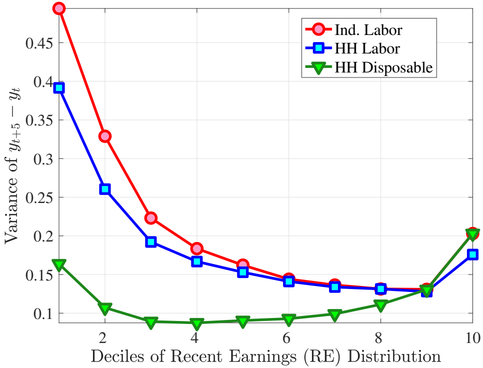


- Earnings changes are more persistent for top RE (especially negative changes).
- After 5 years, top RE still hasn't recovered the losses between t and $t-1$.

Distribution of Household Income Growth

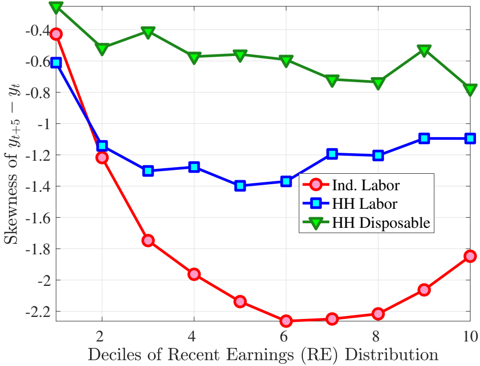
- Do non-Gaussian features of annual earnings growth distribution extend to
  - household (husband+wife) earnings?
  - After tax/after transfer disposable household income?
- For some questions nature of household income risk—before and after tax—is key.
- Plot their distributions and higher-order moments.

Variance of 5-Year Income Growth, $y_{t+5} - y_t$



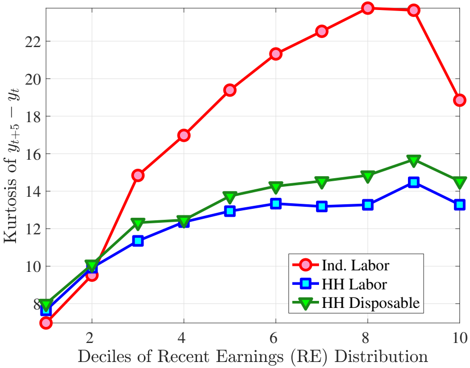
- HH labor is less volatile than individual labor.
- Taxes and transfers reduces variance substantially.

Skewness of 5-Year Income Growth, $y_{t+5} - y_t$



- Spousal income reduces negative skewness due to second earner effect (similar for the US, Pruitt and Turner (2018)).
- Public insurance reduces left tail further.

Kurtosis of 5-Year Income Growth, $y_{t+5} - y_t$



- HH labor and disposable income are still substantially leptokurtic, less so than individual earnings growth though.