The Insurance Value of Public Insurance Against Idiosyncratic Income Risk

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Motivation

- Households face unexpected income changes (**income *risk***)
  - only partially self-insurable
  - cyclical: more $(-\Delta)$ in recessions and more $(+\Delta)$ in expansions

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- Here: can we answer these questions with *only* income data?

Background: What Does Tax and Transfer System Do?

From Busch, Domeij, Guvenen, Madera 2022

1. Reduce overall dispersion (variance) of $\Delta \log y$

2. Reduce cyclicality of asymmetry (Skewness) of $\Delta \log y$ (BDGM'22)

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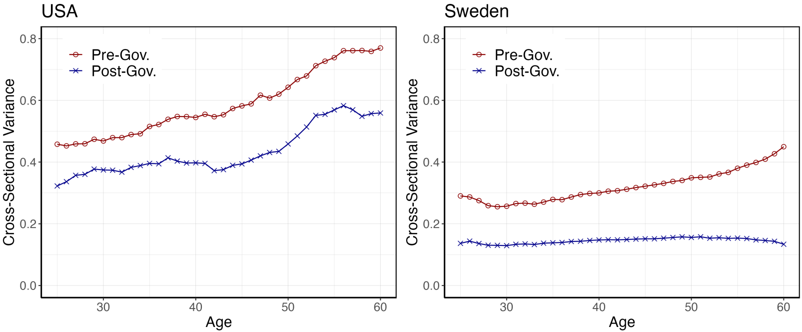

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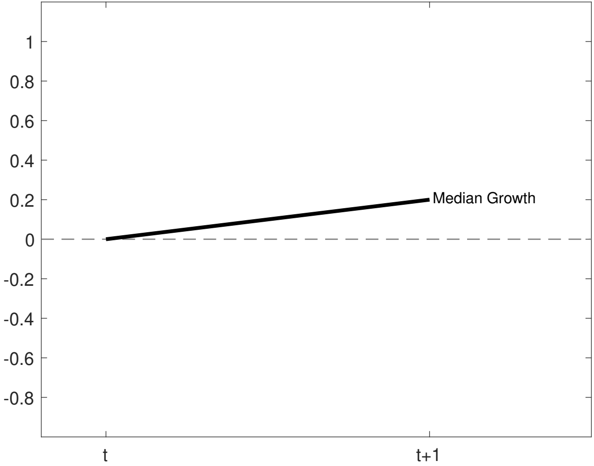
Corr($\Delta \log GDP_t$,m)		Dispersion	Skewness	Upper Tail	Lower Tail
US	Pre-Gov	0.04	**1.91*** **	0.81***	−0.78***
	Post-Gov	0.34	**1.09*** **	0.55***	−0.21
Sweden	Pre-Gov	−0.02	**2.24*** **	0.50***	−0.52*
	Post-Gov	−0.41*	**0.94** **	−0.03	−0.38**

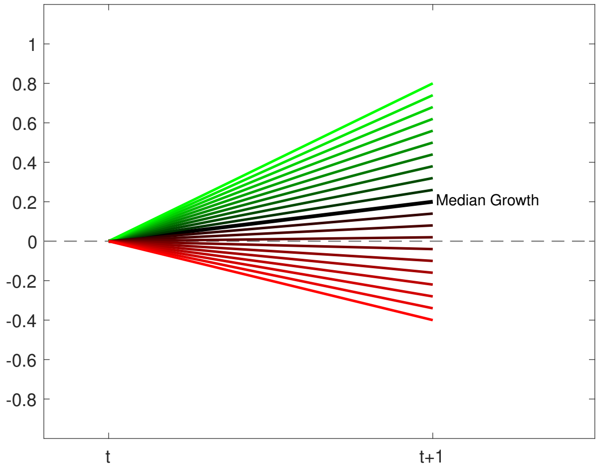
Cyclical Variation in Distribution of Income Changes

- Median Growth



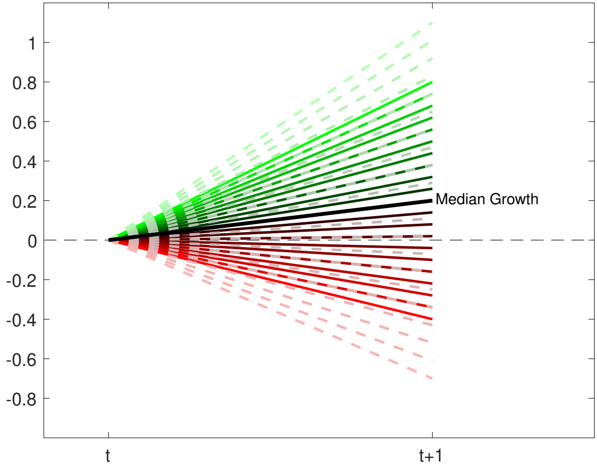
Cyclical Variation in Distribution of Income Changes

- Distribution in normal times



Cyclical Variation in Distribution of Income Changes

- Symmetric increase in income risk



Cyclical Variation in Distribution of Income Changes

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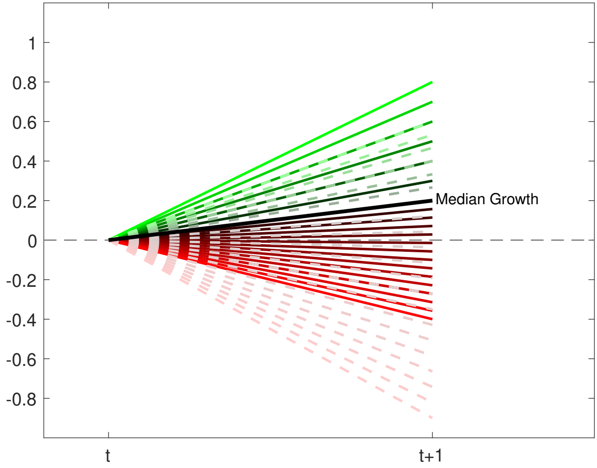

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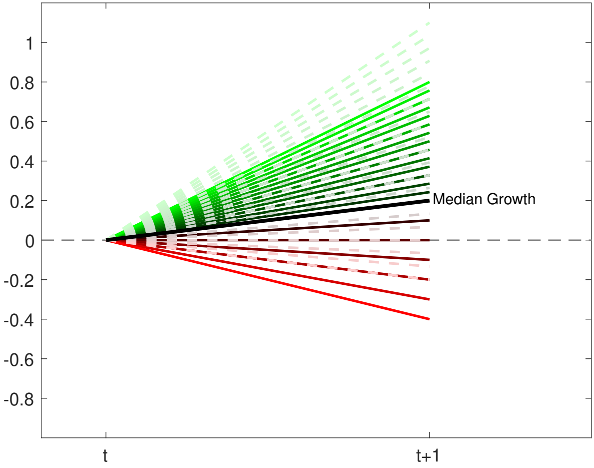

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  2. write cons. as function of variances + insurance parameter
  3. get insurance that makes agents indifferent between both streams

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- Answer (for Sweden): **43%** variation smoothed (CEV of 14.3%)
  - after adjusting for initial dispersion: **6%** (CEV of 1.3%)
  - extra gains from further removing cyclicality: **27%** (CEV of 5.9%)

Outline

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Measurement Tool: Intuition

$$\Delta \textit{Income} \underset{1-\lambda\ (\textit{insurance})}{\longrightarrow} \Delta \textit{Consumption}$$

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- $0 < \lambda < 1$: partial insurance
- λ : captures total insurance by taxes/transfers & other sources
- Blundell et al. (2008): empirical application with disp. income:

$$\lambda = 1 - \frac{Cov(\Delta \log y^{post}, \Delta \log c)}{Var(\Delta \log y^{post})}$$

  Needs
  - identification strategy (Panel IV in BPP)
  - Income and consumption panel data
- Our goal: measure the role of taxes/transfers alone

Measurement Tool: Illustration with Tax Function

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- Tax function in the style of Benabou (2000,2002), HSV (2017)
- Post-gov. income can be written as: $y^{post} = \phi y^{1-\tau}$ and
- progressivity τ = elast. of disp. income wrt gross income, $1-\tau$:

$$\Delta \log y^{post} = (1-\tau)\Delta \log y,$$

and thus

$$\frac{\text{cov}(\Delta \log c, \Delta \log y^{post})}{\text{var}(\Delta \log y^{post})} = \frac{(1-\tau)\text{cov}(\Delta \log c, \Delta \log y)}{(1-\tau)^2 \text{var}(\Delta \log y)},$$

$$\iff \lambda = 1-(1-\tau)(1-\lambda^{disp}).$$

Measurement Tool: Illustration with Tax Function

- some bounds for common reference values:

$$\lambda = \begin{cases} \mathbf{1} & \text{if } \lambda^{post} = 1 \text{ (full self-insurance)} \\ \tau & \text{if } \lambda^{post} = 0 \text{ (no self-insurance)} \end{cases}$$

- if agents can **fully** self-insure $\rightarrow$ public insurance is irrelevant
- If agents **cannot** self-insure (hand-to-mouth) $\rightarrow$
  total insurance = public insurance = degree of progressivity

Measurement Tool: Our Exercise

→ Given some λ^{post}, find λ^{pre} s.t. indifferent between worlds

- earn *PRE* with insurance λ and
- earn *POST* with insurance λ^{post}

Advantages

- No need for mechanical link between pre and post-gov income
- No need for consumption panel data

Need Two Things

1. Income processes PRE and POST government
2. Model:
   - Link income to consumption
   - Control degree of partial insurance by a parameter

Outline

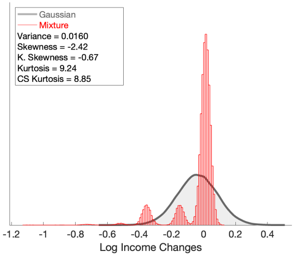
Estimation of Income Process

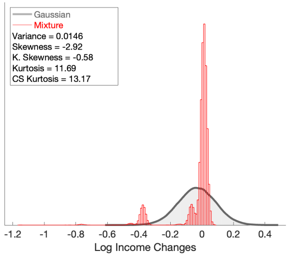
- Estimate flexible process using SMM ▸ Specification
  - Transitory + permanent components
  - Shock distributions: mixtures of 3 Normals
  - Distributions vary over the BC (as in McKay (2017))
- Targets:
  - Timeseries of L9050, L5010, of 1-, 3-, 5-year Δy
  - Average of Crow-Siddiqui Kurtosis of 1-, 3-, 5-year Δy
  - Age profile of cross-sectional variance
- Data:
  - Swedish tax register sample LINDA 1979–2010
  - Household income from wages and salaries
  - Taxes and transfers

Estimated Process: Permanent Component

2008: *GDP growth* -5.04%

Pre-Government Income	Post-Government Income

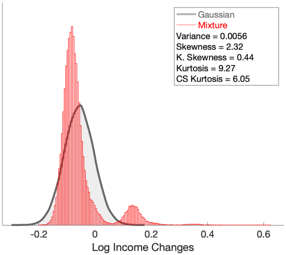




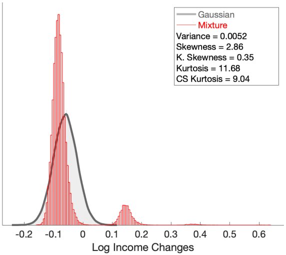
Estimated Process: Permanent Component

2009: *GDP growth* 6.59%

Pre-Government Income



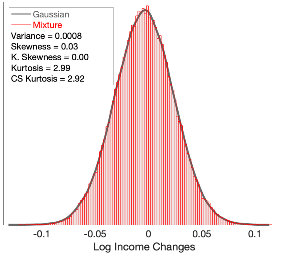
Post-Government Income



Estimated Process: Permanent Component

2010: *GDP growth* 2.49%

Pre-Government Income



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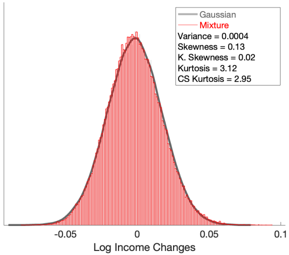

Main Features of Earnings Changes in Sweden

Taxes and transfers

- reduce overall dispersion of income changes
- reduce the cyclicality of dispersion and skewness (ϕs)
- increase concentration of income changes

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The Model Framework

- Island economy inspired by Heathcote/Storesletten/Violante *(AER'14)*
- no-trade equilibrium

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→ **Incomplete Markets** model with:

- Partial insurance against income risk
- Key feature: analytical link from income shocks to consumption
- Obtained through (hypothetical) split into 2 shocks:
  - Fully insurable vs. fully uninsurable
- yet isomorphic to *Bewley* models

Model: Stochastic Endowment Economy

- Discrete time
- Continuum of islands
- On each island: continuum of agents
- Perpetual youth: survival prob. δ

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- Two types of shocks to income:
  1. Idiosyncratic shocks (hitting individual on island)
     (wash out within island)
  2. Island-level shocks (hitting whole island)
     (wash out across islands: no aggregate uncertainty)

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     (wash out within island)
  2. Island-level shocks (hitting whole island)
     (wash out across islands: no aggregate uncertainty)
- Island=group of agents with same history of island-level shocks

i.e. **Islands capture insurance mechanisms** available to households

Model

(Heterogeneous) Endowments and Preferences

- Endowment process: Permanent and transitory components

$$
\begin{aligned}
y_t &= y_t^{island} + y_t^{idio} \\
y_t^i &= z_t^i + \varepsilon_t^i, && \varepsilon_t^i \sim F_{\varepsilon,t}^i, && \text{for } i \in \{island, idio\} \\
z_t^i &= z_{t-1}^i + \eta_t^i, && \eta_t^i \sim F_{\eta,t}^i, && \text{for } i \in \{island, idio\}
\end{aligned}
\tag{1}
$$

where $\int \exp\left(x_t^i\right) dF_{x,t}^i = 1$ for $i \in \{island, idio\}$ and $x \in \{\varepsilon, \eta\}$

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- Preferences (standard)
  - max present-value lifetime utility
  - Time- and state-separable utility
  - Per-period utility: $U(c) = \log(c)$

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Asset Market Structure and Equilibrium

→ No-(across-island)-trade equilibrium:

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- Equilibrium log consumption:

$$\log c_t \left(\mathbf{x}_t, y_t^{idio}\right) = y_t^{island} + \log \int \exp\left(y_t^{idio}\right) dF^a_{y^{idio},t} \tag{2}$$

where $\mathbf{x}_t$: age a and island-income y_t^{island}

- Gives (log) consumption change:

$$\Delta \log c_t = \eta_t^{island} + \Delta\varepsilon_t^{island}$$

Measure of Partial Insurance in Model

- Consider cons. response to total permanent/transitory shocks
  - Total permanent: $\eta_t = \eta_t^{idio} + \eta_t^{island}$
  - Total transitory: $\varepsilon_t = \varepsilon_t^{idio} + \varepsilon_t^{island}$

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- Consumption response to permanent component:

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1 - \lambda_{perm} &= \frac{\text{cov}(\Delta \log c_t, \eta_t)}{\text{var}(\eta)} \qquad (3) \\
&= \frac{\text{cov}(\eta_t^{island} + \Delta\varepsilon_t^{island}, \eta_t)}{\text{var}(\eta_t)} = \frac{\text{cov}(\eta_t^{island}, \eta_t^{island} + \eta_t^{idio})}{\text{var}(\eta_t)} \\
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- λ_{perm}: % of variance accounted for by idio. component

Model as Measurement Device

- Earnings process is fundamental
- Tax and transfer system: alters the endowment stream
- We do not explicitly model the tax system
- Degree of partial insurance λ exogenous

  (= fraction of shocks accounted for by idio. vs. island shocks)

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- Consider two separate worlds:

1. Households face income process *POST* (post-government)
2. Households face income process *PRE* (pre-government)

Exercise

- fix insurance under POST: $\lambda_{perm}^{post} = 0$
  - $\rightarrow$ Assume no further insurance beyond T&T system
- find λ_{perm}^{pre} s.t. indifferent between (ex ante)
  - facing PRE stream with compressed distribution given by λ_{perm}^{pre}
  - facing POS stream as is

$\rightarrow$ Measure of insurance provided by tax and transfer system

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Notice:

- Focus: direct redistribution/insurance
  - T&T system that cross-sectionally redistributes endowments
- Endogeneity of PRE to taxes not captured
- Silent on government expenditures and financing

Bridging Estimated and Model Process

- Data: we have estimated $var(\eta_t^{pre})$ and $var(\eta_t^{pos})$
- Model: overall permanent shocks $\eta_t = \left(\eta_t^{idio} + \eta_t^{island}\right)$
  - For given λ_{perm}: scale estimated parameters of permanent shocks s.t. $\text{var}(\eta_t^{idio}) = \lambda_{perm}\text{var}(\eta_t)$
  - Adjust means s.t. $E\left[exp\left(\eta^{island}\right)\right] = E\left[exp\left(\eta^{idio}\right)\right] = 1$
- Simulated income process→simulated consumption process

$$\log c_t\left(\mathbf{x}_t, y_t^{idio}\right) = y_t^{island} + \log\int \exp\left(y_t^{idio}\right) dF^a_{y^{idio},t}$$

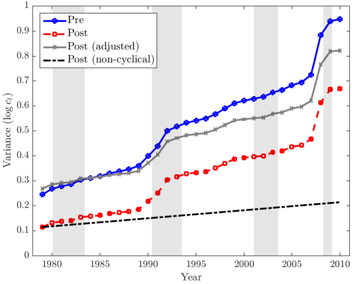
Outline

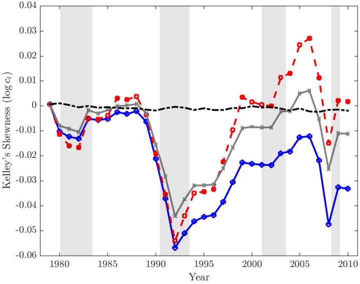
Exercise

- Take ex-ante perspective of cohort born into Swedish economy at beginning of sample period
- Get $var(\eta^{island}) = (1-\lambda)var(\eta^{pre})$, $var(\eta^{idio}) = \lambda var(\eta^{pre})$
- Simulate z shocks series, starting from η_0 (age 25)
- Get consumption from model

Consumption Paths

- Stochastic paths of consumption (with $\lambda = 0$)





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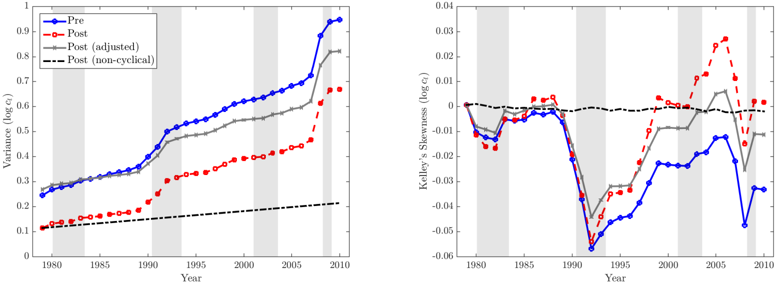

- Exercise: find λ that makes households indifferent between:
  - facing the post-gov. income cons. stream (red) with $\lambda^{post} = 0$ and
  - facing the pre-gov. income stream (blue) with $\lambda > 0$

Consider Four Worlds

From (cyclical) pre- to (acyclical) post-government:

1. **Pre**-government income (**estimated**)
2. **Post**-government income (**estimated**)
3. **Post**-government **adjusted** for initial dispersion (**hypothetical**)
4. **Post**-gov. income **adjusted** and **removing cyclicality** (**hypothetical**)

Degree of Insurance and Welfare

Baseline Measure (log utility, $\beta = 0.95$, survival $\delta = 0.996$)

Scenario	λ_{perm}^{pre}	CEV	λ_{perm}^{pre} (adj.)	CEV (adj.)
Pre to Post	**43%**	**14.26%**	**6%**	**1.28%**
Pre to Post*	64%	17.53%	27%	5.91%

- *PRE*$\longrightarrow$*POST*:
  - Degree of partial insurance: **43%**
  - Implied CEV: **14.26%**

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- *PRE*$\longrightarrow$*POST* adjusted for init. dispersion:
  - Degree of partial insurance: **6%**
  - Implied CEV: **1.28%**
- *PRE*$\longrightarrow$*POST* adjusted for init. dispersion + removing cyclicality:
  - Degree of partial insurance: **27%**
  - Implied CEV: **5.91%** $\rightarrow$ Sizable further gain of smoothing cycles

Degree of Insurance and Welfare

The Role of **Risk Attitudes**

Scenario	λ_{perm}^{pre}	CEV	λ_{perm}^{pre} (adj.)	CEV (adj.)
	log utility			
Pre to Post	**43%**	**14.26%**	**6%**	**1.28%**
Pre to Post*	**64%**	**17.53%**	**27%**	**5.91%**
	$CRRA\ w/\ Risk\ Aversion = 2$			
Pre to Post	**36%**	**32.65%**	**5%**	**3.03%**
Pre to Post*	**66%**	**46.34%**	**34%**	**19.13%**

- Lower smoothing but higher value with risk aversion = 2
- Notice: this is conditional on $\lambda^{post} = 0$

Degree of Insurance and Welfare

The Role of **Additional Self-Insurance Channels**

- Anchoring of model measure by fixing λ_{perm}^{post}
- Baseline: $\lambda_{perm}^{post} = 0$
- Redo for $\lambda_{perm}^{post} > 0$
  - Capture additional insurance channels
  - Resulting λ_{perm}^{pre}: insurance through government + other channel
  - Back out insurance part coming from government:

$$\lambda^{gov} = 1 - \frac{1 - \lambda_{perm}^{pre}}{1 - \lambda_{perm}^{post}} = \frac{\lambda_{perm}^{pre} - \lambda_{perm}^{post}}{1 - \lambda_{perm}^{post}}$$

Degree of Insurance and Welfare

The Role of **Additional Self-Insurance Channels**: $\lambda_{perm}^{pos} = 0.1$

Scenario	λ^{gov}	λ_{perm}^{pre}	CEV	λ^{gov}(adj.)	λ_{perm}^{pre} (adj.)	CEV (adj.)
			log utility			
Pre to Post	**43%**	49%	15.13%	**7%**	16%	3.29%
Pre to Post*	**64%**	68%	18.09%	**28%**	35%	7.53%

- λ_{perm}^{pre} now combines both:
  - the partial insurance provided by the tax and transfer system,
  - additional partial insurance from other insurance channels.
- Obtained λ^{gov} basically unchanged

Degree of Insurance and Welfare

Role of **Higher-Order Moments**

Scenario	λ^{pre}_{perm}	CEV	λ^{pre}_{perm} (adj.)	CEV (adj.)
		log utility		
Pre to Post	**43%**	**14.26%**	**6%**	**1.28%**
Gaussian	*43%*	*15.52%*	*7%*	*2.97%*
Pre to Post*	**64%**	**17.53%**	**27%**	**5.91%**
	65%	*20.60%*	*29%*	*11.15%*

- agents exposed to Gaussian processes with same 1 and 2 mom
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- agents exposed to Gaussian processes with same 1 and 2 mom
- variance still co-moves with the aggregate state of the economy
- similar results, with larger welfare values
  - → not taking into account HO moments, overestimate the insurance value of the existing tax and transfer system

Outline

Summary

- Post-government earnings dynamics $\neq$ pre-government
- Question: What is the value?
- We: construct simple model-based measure
- By-product: illustrate how to use HSV framework
- Answer:
    1. Sizable partial insurance
    2. Still potential gain of smoothing cycle!

Summary

- Post-government earnings dynamics $\neq$ pre-government
- Question: What is the value?
- We: construct simple model-based measure
- By-product: illustrate how to use HSV framework
- Answer:
  1. Sizable partial insurance
  2. Still potential gain of smoothing cycle!
- Ongoing: apply to PSID based measures
  - Include consumption measure

  $\rightarrow$ Allows to estimate λ^{post}

Estimated Income Processes

$$y_t = z_t + \varepsilon_t \tag{4}$$

$$z_t = z_{t-1} + \eta_t$$

- ε_t follows mixture of two normals:

$$\varepsilon_t \sim \begin{cases} \mathcal{N}(\bar{\mu}_\varepsilon, \sigma^2_{\varepsilon,1}) & \text{with prob. } p_{\varepsilon,1} \\ \mathcal{N}(\bar{\mu}_\varepsilon, \sigma^2_{\varepsilon,2}) & \text{with prob. } 1 - p_{\varepsilon,1} \end{cases}$$

- η_t follows mixture of three normals

$$\eta_t \sim \begin{cases} \mathcal{N}(\bar{\mu}_{\eta,t} + \mu_{\eta,1} + \phi_1 x_t, \sigma^2_{\eta,1}) & \text{with prob. } p_{\eta,1} \\ \mathcal{N}(\bar{\mu}_{\eta,t} + \mu_{\eta,2} + \phi_2 x_t, \sigma^2_{\eta,2}) & \text{with prob. } p_{\eta,2} \\ \mathcal{N}(\bar{\mu}_{\eta,t} + \mu_{\eta,3} + \phi_3 x_t, \sigma^2_{\eta,3}) & \text{with prob. } p_{\eta,3} \end{cases}$$

- x_t: standardized log GDP growth
- $\bar{\mu}_\varepsilon$ and $\bar{\mu}_{\eta,t}$ such that $\mathbb{E}[\exp(\varepsilon)] = 1$ and $\mathbb{E}[\exp(\eta_t)] = 1$

Parameters to Estimate

- Parameters:

$$\chi_{trans} = \left\{\sigma_{\varepsilon,1}, \sigma_{\varepsilon,2}, p_{\varepsilon,1}\right\} \tag{5}$$

$$\chi_{perm} = \left\{\mu_{\eta,2}, \mu_{\eta,3}, \sigma_{\eta,1}, \sigma_{\eta,2}, p_{\eta,1}, p_{\eta,2}, \phi_2, \phi_3\right\} \tag{6}$$

- Estimate $\chi = \{\chi_{trans}, \chi_{perm}\}$ using SMM
  - Timeseries of L9050, L5010, of 1-, 3-, 5-year Δy
  - Average of Crow-Siddiqui Kurtosis of 1-, 3-, 5-year Δy
  - Age profile of cross-sectional variance

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