From Wages to Welfare:
Decomposing Gains and Losses From Rising Inequality

Jonathan Heathcote

Federal Reserve Bank of Minneapolis and CEPR

Kjetil Storesletten

Federal Reserve Bank of Minneapolis and CEPR

Gianluca Violante

New York University, CEPR, and NBER

UCL, March 3 2011

Rising wage inequality

Major transformation in the structure of relative wages in the U.S.

1. Increase in the education wage premium

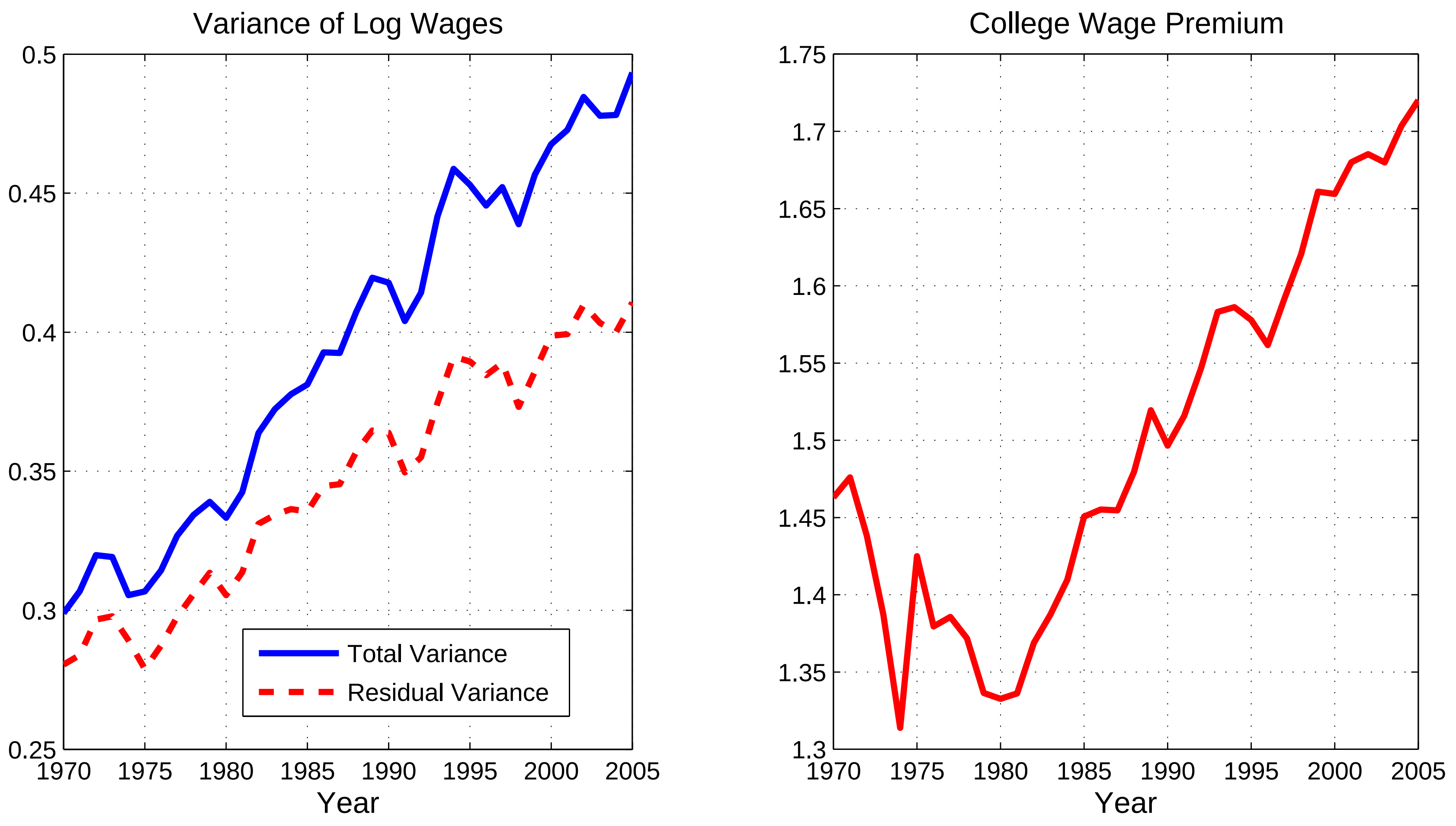
2. Increase in wage dispersion within education groups

   - Both permanent and transitory components ↑

Among sources of this trend: skill-biased demand shift (technology, trade/offshoring), deunionization, shift in contractual arrangements

⊛ Katz-Murphy (1992), Krusell et al. (2000), Acemoglu (2002), Acemoglu-Autor (2010), Feenstra-Hanson (1996), Burstein-Vogel (2010), DiNardo-Fortin-Lemieux (1996), Acemoglu-Aghion-Violante (2001), Lemieux-Mcleod-Parent (2009)

Trend in wage inequality from CPS



Male workers aged 25-60. Hourly wage = annual earnings/annual hours

The question

WHAT ARE THE WELFARE IMPLICATIONS

OF THIS SHIFT IN THE WAGE STRUCTURE?

Contrasting views of rising inequality

- Implies lower expected welfare for U.S. households

  (i) Higher permanent wage risk and imperfect risk sharing

- Presents new opportunities to U.S. households

  (ii) Higher returns to education and investment in human capital

  (iii) Higher transitory wage volatility and flexible labor supply

Challenge: quantifying the relative importance of these three channels

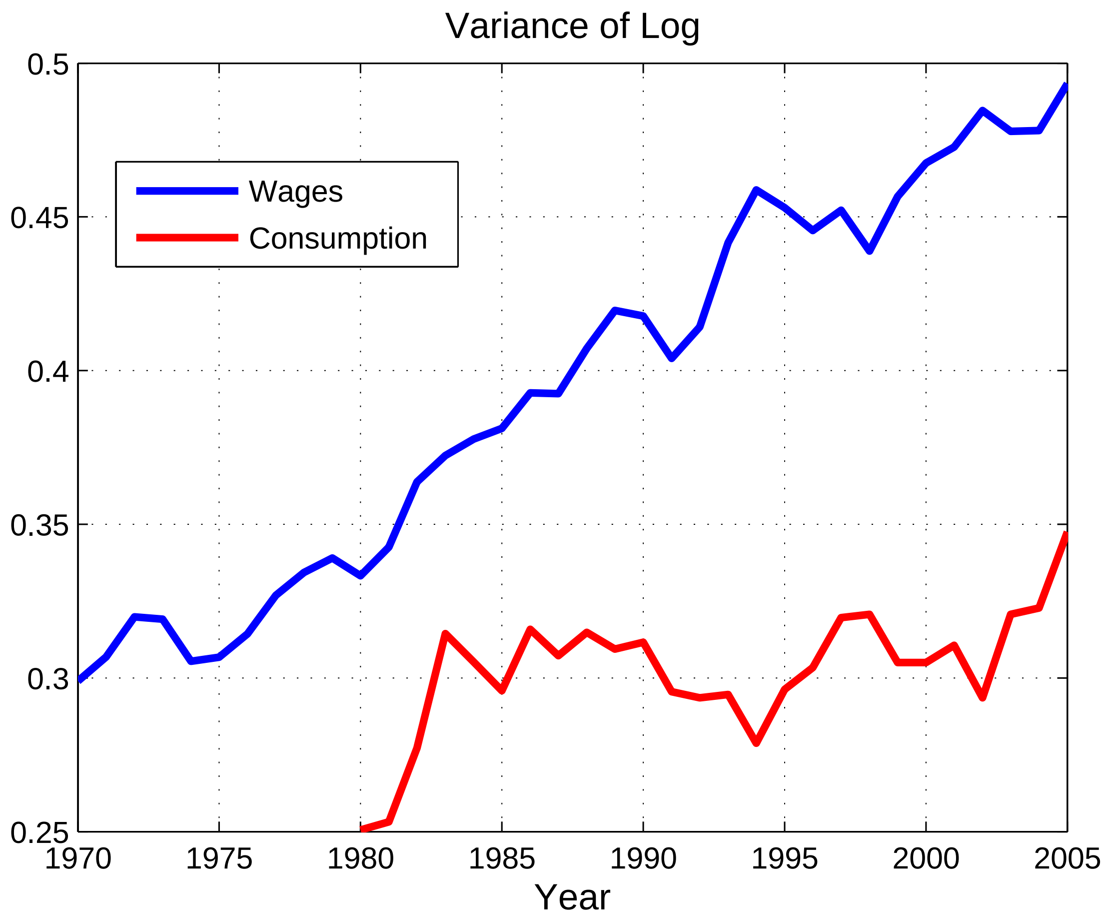
Two alternative methodologies

Welfare is a function of consumption and leisure, not of wages

1. Empirical approach
   - Looks directly at shifts in the empirical distribution of consumption and leisure through a social welfare function
   - In comparing distributions, data are demeaned
2. Structural approach
   - Uses a model to draw mapping from shift in wage distribution to shift in the distribution of consumption and leisure
   - Allows for relative wage movements to affect mean consumption and mean leisure (“level effects")

THE EMPIRICAL APPROACH

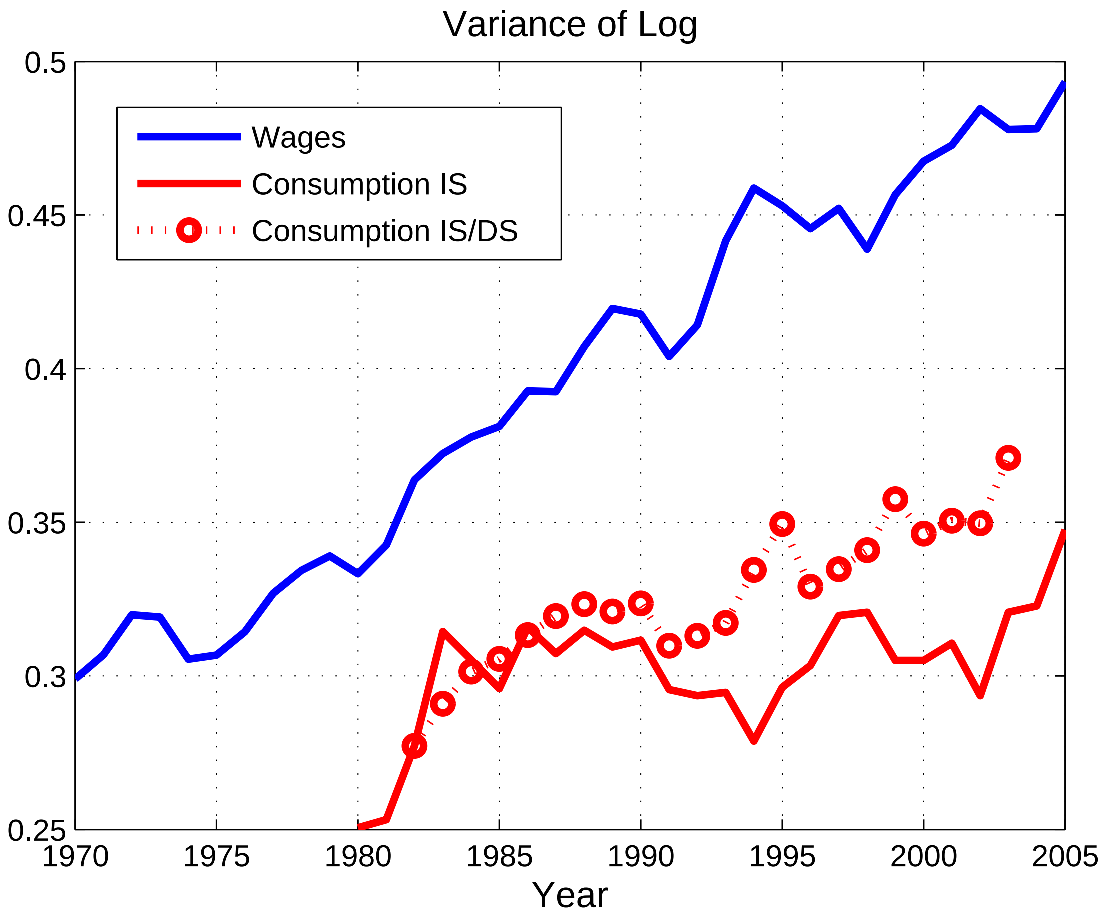
Trend in consumption inequality from CEX



Equivalized consumption expenditures = nondurables, services, small durables and estimated flow from vehicles and housing

⊛ Cutler-Katz (1991, 1992), Slesnick (1994, 2001), Krueger-Perri (2003, 2006)

Trend in consumption inequality from CEX

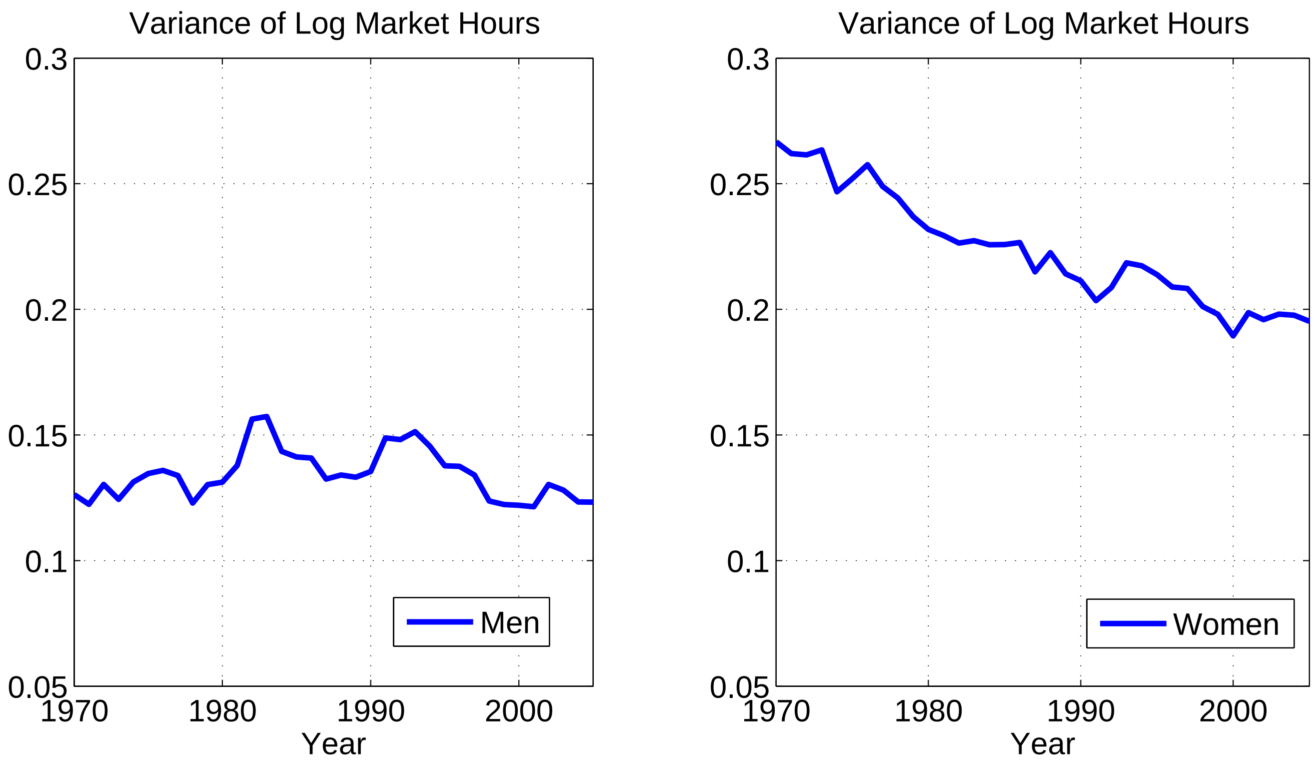


Combining CEX Interview Survey (IS) and Diary Survey (DS), one finds larger increase in consumption inequality

⊛ Attanasio-Battistin-Ichimura (2007), Attanasio-Battistin-Padula (2010), Aguiar-Bils (2010)

Trend in leisure/hours inequality from CPS

If leisure is valued, then the distribution of hours worked affects welfare



$$Leisure = 1 - h^{market} - h^{home},$$ but h^{home} is poorly measured

⊛ Aguiar-Hurst (2006), Ramey (2006), Knowles (2009)

Social welfare function

- Assume stationary distribution over age, consumption and hours

$$U_j = \sum_{t=j}^{J} \beta^t \frac{s_t}{s_j} \mathbb{E}\left[u\left(c_t, h_t\right)\right]$$

$$\mathcal{W} = \sum_{j=0}^{J} \mu_j s_j U_j + \sum_{j=-\infty}^{-1} \mu_j s_0 U_0$$

- U_j is lifetime utility for an age j household
- s_j is the population share of age-group j
- $\mathcal{W}$ is social welfare
- μ_j is the weight in the SWF on an agent of age j ($j < 0$ denotes future generations)

Social welfare function

- Assume $\mu_j \propto \beta^{-j}$

$$\mathcal{W} = \frac{1}{1-\beta}\sum_{j=0}^{J} s_j \mathbb{E}\left[u\left(c_j, h_j\right)\right]$$

- Can compute welfare effects of changing wage structure by comparing cross-sectional distributions of (c, h) before and after the shift

Welfare Calculation Inputs

Compute consumption equivalent welfare change ω of moving from stationary distribution $(\mathbf{c}^*, \mathbf{h}^*)$ to $(\mathbf{c}^{**}, \mathbf{h}^{**})$

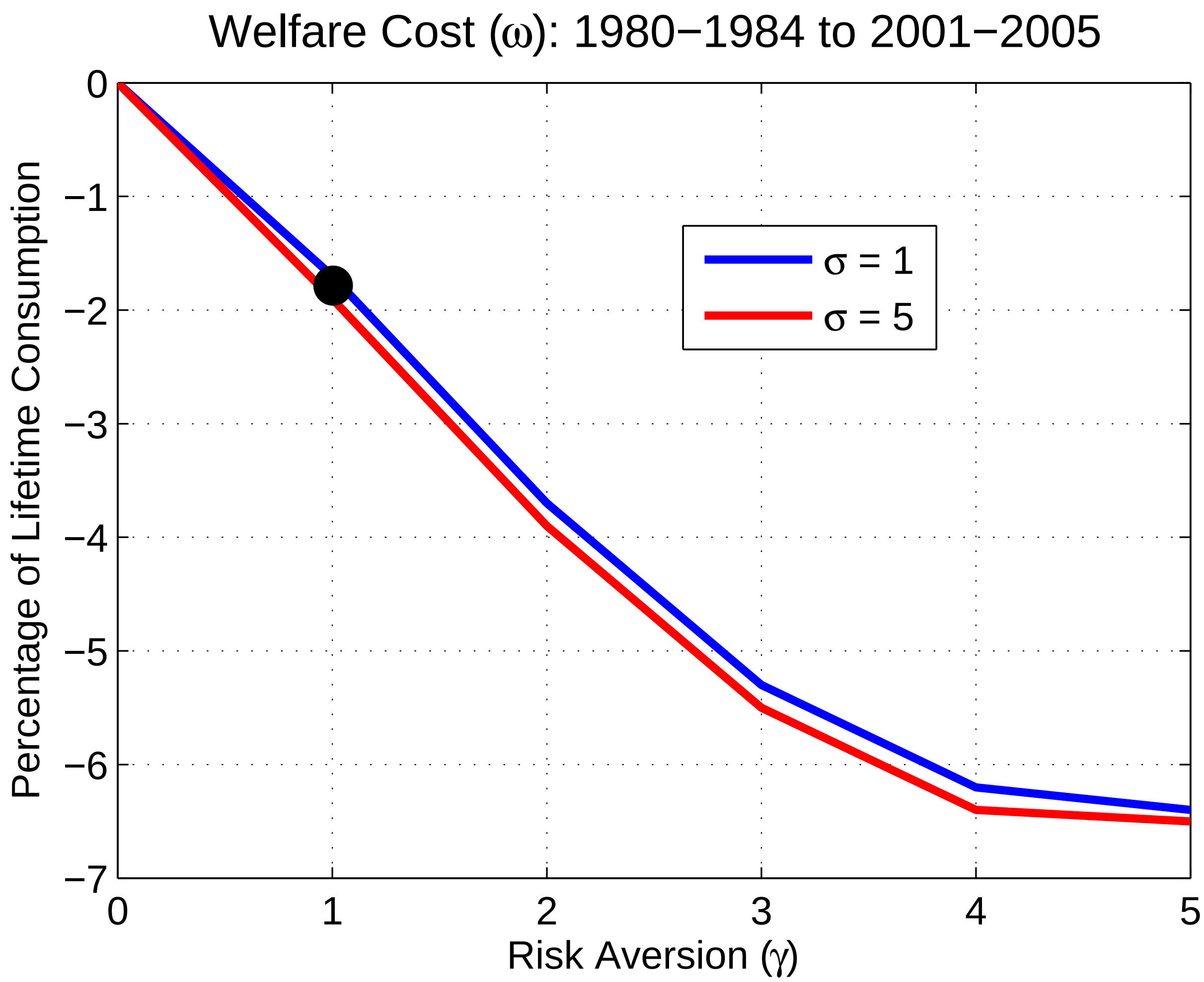
$$\mathcal{W}_t\left(\left(1+\omega\right)\mathbf{c}^*, \mathbf{h}^*\right) = \mathcal{W}_t\left(\mathbf{c}^{**}, \mathbf{h}^{**}\right)$$

Period utility function:

$$u\left(c,h\right) = \frac{c^{1-\gamma}}{1-\gamma} - \varphi\frac{h^{1+\sigma}}{1+\sigma}$$

Initial distribution $(\mathbf{c}^*, \mathbf{h}^*)$: CEX 1980-1984

Final distribution $(\mathbf{c}^{**}, \mathbf{h}^{**})$: CEX 2001-2005



In the $\log$ case $(\gamma = 1)$, $\omega \approx -2\%$ of lifetime consumption

⊛ Attanasio-Davis (1996), Krueger-Perri (2006), Storesletten (2006)

A Lucas-style calculation

Since shift in hours distribution has small effect, ignore it for now

Assume log-normality of consumption: $\log c \sim N(\frac{-v_c}{2}, v_c)$

⊛ Battistin-Blundell-Stoker (2010)

Following the derivations in Lucas (1987):

$$\omega_L \approx -\frac{\gamma}{2}\Delta v_c$$

$\gamma = 1$ and $\Delta v_c = 0.036 \quad \Rightarrow \quad \omega_L = -1.8\%$

Caveat: If the "revisionists" are correct and true rise in the variance of log consumption is twice as big $\Rightarrow \omega_L = -3.6\%$

THE STRUCTURAL APPROACH

Demographics, preferences, and education choice

- Demographics: Continuum of individuals indexed by i facing constant survival probability π from age j to $j+1$

- Preferences over sequences of consumption and hours worked:

$$U = \mathbb{E}_0 \sum_{j=0}^{\infty} (\beta\pi)^j \left[\log(c_{ij}) - exp(\overline{\varphi} + \varphi_i) \frac{h_{ij}^{1+\sigma}}{1+\sigma} \right]$$

- Two education levels $e \in \{L, H\}$ denoting high-school and college
    - Idiosyncratic utility cost χ_i of attending college
    - Fraction q of individuals with $\chi_i < U_H - U_L$ chooses college

Technology and labor market

- CES aggregate technology:

$$Y = Z\left[\zeta N_H^{\frac{\theta-1}{\theta}} + (1-\zeta)N_L^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}$$

- Competitive labor markets: $P_e = MPL_e$, with $e \in \{L, H\}$

$$\log\left(\frac{P_H}{P_L}\right) \equiv p_H - p_L = \log\left(\frac{\zeta}{1-\zeta}\right) - \frac{1}{\theta}\log\left(\frac{N_H}{N_L}\right)$$

  - Rise in $\frac{\zeta}{1-\zeta}$ represents skill-biased demand shifts

⊛ Katz-Murphy (1992), Krusell et al. (2000), Acemoglu (2002), Johnson-Keane (2008)

Government

- Runs a progressive tax/transfer scheme to redistribute and to finance (non-valued) expenditures

- Balances the budget every period

- Relationship between pre-tax ($y_i = w_i h_i$) and disposable ($\tilde{y}_i$) earnings:

$$\tilde{y}_i = \lambda y_i^{1-\tau}$$

- $\tau \geq 0$ is the progressivity parameter of the system

  $\circledast$ Benabou (2002), HSV (2009, 2010)

- Empirical fit of this tax/transfer system quite good on U.S. data

Individual wages

Log individual wage is the sum of three orthogonal components

$$\log w_i = p_{e(i)} + \alpha_i + \varepsilon_i$$

- $p_{e(i)}$ is the log price per efficiency unit of labor of type e
- $(\alpha_i, \varepsilon_i)$ two components determining within-group wage dispersion
  - α follows a unit root process
  - ε uncorrelated with α (could be forecastable)

Private risk-sharing

- Agents can save and borrow a risk-free bond (age 0 bonds = 0)
- Additional insurance against ε (financial markets, family)
- Equilibrium outcome: no bond trade $\Rightarrow \alpha$ uninsurable, ε insurable

Connection to Constantinides and Duffie (1996)

- CRRA prefs, unit root shocks to log disposable income, zero initial wealth $\Rightarrow$ existence of a no trade equilibrium
- Our environment micro-founds unit root disposable income:

1. Start from richer process for individual wages
2. Labor supply: exogenous wages $\rightarrow$ endogenous earnings
3. Non-linear taxation: pre-tax earnings $\rightarrow$ after-tax earnings
4. Private risk sharing: earnings $\rightarrow$ gross income
5. No bond trade: disposable income = consumption

$\circledast$ Constantinides-Duffie (1996), Krebs (2003), HSV (2008, 2009, 2010)

Summary of the model

- Three sources of shift in the wage structure:
  1. education differentials: $\Delta\zeta$
  2. uninsurable within-group differentials: Δv_α
  3. insurable within-group differentials: Δv_ε

- Four key channels of adjustment/insurance:
  1. education: q
  2. flexible labor supply: σ
  3. progressive taxation: τ
  4. private risk-sharing: $\frac{v_\varepsilon}{v_\alpha}$

Equilibrium allocations for consumption and hours

Individual allocations depend on $(e, \varphi, \alpha, \varepsilon)$, but not on wealth $\Rightarrow$ tractability

$$\log c(e, \varphi, \alpha) = \kappa_c + (1 - \tau)\,(p_e + \alpha) - \frac{1-\tau}{1+\sigma}\varphi$$

- Consumption's response to (p_e, α) mediated by progressivity
- Consumption invariant to insurable shock ε

$$\log h(\varphi, \varepsilon) = \kappa_h - \frac{\varphi}{1+\sigma} + \tfrac{1-\tau}{\sigma+\tau}\,\varepsilon$$

- Hours respond to ε in proportion to tax-modified Frisch elasticity
- Hours invariant to skill price p_e and uninsurable shocks α

Welfare analysis

- Neutrality conditions: normalizations s.t. absent change in agents' behavior, $(\Delta\zeta, \Delta v_\alpha, \Delta v_\varepsilon)$ leave average wage level unaffected

- Assume Normal distributions for $(\alpha, \varepsilon, \varphi, \log\chi)$

- Compare two steady-states, pre $(*)$ and post $(**)$ shift in wage structure ($* = 1980 - 1984$, $** = 2001 - 2005$)

- Plug (c, h) allocations into social welfare function $\mathcal{W}$, and from

$$\mathcal{W}\left((1+\omega)\,\mathbf{c}^*, \mathbf{h}^*\right) = \mathcal{W}\left(\mathbf{c}^{**}, \mathbf{h}^{**}\right)$$

solve for ω in closed form as function of structural parameters

Analytical expression for ω

$$\omega \approx -\frac{(1-\tau)^2}{2}\Delta\left[q(1-q)(p_H-p_L)^2\right] \quad -\frac{(1-\tau)^2}{2}\Delta v_\alpha$$

$$-\frac{\sigma}{2}\left(\frac{1-\tau}{\sigma+\tau}\right)^2\Delta v_\varepsilon$$

$$+\left(\frac{1-\tau}{\sigma+\tau}\right)\Delta v_\varepsilon \quad +\Delta\log\mathbb{E}\left[P_e\right] \quad -(1-\pi)\Delta(\bar{\chi}q)$$

(very beautiful)

Interpreting each component of ω

$$\omega \approx -\underbrace{\frac{1}{2}(1-\tau)^2 \Delta\left[q(1-q)(p_H - p_L)^2\right]}_{\Delta var^{bet}(\log c)} - \underbrace{\frac{1}{2}(1-\tau)^2 \Delta v_\alpha}_{\Delta var^{with}(\log c)}$$

$$-\underbrace{\frac{\sigma}{2}\left(\frac{1-\tau}{\sigma+\tau}\right)^2 \Delta v_\varepsilon}_{\Delta var(\log h)}$$

$$+\underbrace{\left(\frac{1-\tau}{\sigma+\tau}\right)\Delta v_\varepsilon}_{\frac{\partial \log(Y/N)}{\partial v_\varepsilon}} + \underbrace{\Delta \log \mathbb{E}\left[P_e\right]}_{\frac{\partial \log(Y/N)}{\partial \zeta}} - \underbrace{(1-\pi)\,\Delta(\bar{\chi} q)}_{\Delta \text{ edu cost}}$$

Interpreting each component of ω

$$\omega \approx \underbrace{-\frac{1}{2}(1-\tau)^2 \Delta\left[q(1-q)(p_H - p_L)^2\right] - \frac{1}{2}(1-\tau)^2 \Delta v_\alpha}_{\text{Welfare cost from rise in consumption inequality}}$$

$$\underbrace{-\frac{\sigma}{2}\left(\frac{1-\tau}{\sigma+\tau}\right)^2 \Delta v_\varepsilon}_{\text{Welfare cost from rise in hours inequality}}$$

$$\underbrace{+\left(\frac{1-\tau}{\sigma+\tau}\right)\Delta v_\varepsilon + \Delta \log \mathbb{E}\left[P_e\right] - (1-\pi)\Delta(\bar{\chi}q)}_{\text{Additional level effects from structural approach}}$$

Parametrization

- Use data on skill premium, enrollment, and (co-)variances of joint distribution of (w, c, h) to recover values for structural parameters

  ⊛ Blundell-Preston (1998), Cunha-Heckman-Navarro (2005), Primiceri-van Rens (2007), Blundell-Pistaferri-Preston (2008), HSV (2009), Guvenen-Smith (2010)

Model parameter	Value	Empirical moment
$\Delta\zeta$	0.11	$\Delta\ (p_H - p_L)$
Δv_α	0.05	$\Delta var^{with}(\log c)$
Δv_ε	0.03	$\Delta var^{with}(\log w) - \Delta var^{with}(\log c)$
(μ_χ, v_χ)	$(3.26, 6.20)$	$(q^*, \Delta q)$
τ	0.31	$var(\log \tilde{y}) / var(\log y)$

- $\sigma = 2 \Rightarrow$ tax-modified Frisch elasticity $\frac{1-\tau}{\sigma+\tau} = 0.30$

  ⊛ Altonji (1986), Blundell-MaCurdy (1999), Pistaferri (2003), Domeij-Floden (2008)

Welfare calculation

$$\omega \approx \underbrace{-\frac{1}{2}(1-\tau)^2 \Delta\left[q(1-q)(p_H - p_L)^2\right] - \frac{1}{2}(1-\tau)^2 \Delta v_\alpha}_{-2.2\%}$$

$$\underbrace{-\frac{\sigma}{2}\left(\frac{1-\tau}{\sigma+\tau}\right)^2 \Delta v_\varepsilon}_{-0.3\%}$$

$$\underbrace{+\left(\frac{1-\tau}{\sigma+\tau}\right)\Delta v_\varepsilon}_{+0.9\%} \quad \underbrace{+\Delta \log \mathbb{E}\left[P_e\right] - (1-\pi)\Delta(\bar{\chi} q)}_{+3.0\%}$$

Gains $(+3.9\%)$ minus losses $(-2.5\%) \Rightarrow \omega = +1.4\%$ of lifetime consumption

Alternative welfare function

- We can also compute the welfare gain for a newborn agent across the two steady states: ω^0

- Two differences between the expressions for ω and ω^0

  1. Loss associated with widening consumption inequality is smaller: $-2.2\% \rightarrow -1.3\%$

  2. Gain associated with rising enrollment is smaller: $+3.0\% \rightarrow +2.0\%$

- Total welfare gain is slightly smaller: $\omega = 1.4\%$, $\omega^0 = 1.3\%$

Distribution of welfare gains and losses

- Our welfare calculation is a cross-sectional average

- How are welfare gains and losses distributed in the population?

Indiv. type χ_i	Fraction of pop.	ω^0
$H^* \to H^{**}$	0.220	$+12.3\%$
$L^* \to L^{**}$	0.713	-2.4%
$L^* \to H^{**}$	0.067	$+5.6\%$

- Over 70% of households (all HS + some switchers) lose

Role of insurance mechanisms

Shut down one insurance mechanism at a time and recompute ω

Model	Insurance channel missing	ω
Baseline	None	$+1.4\%$
$\sigma = \infty$	Flexible labor supply	$+0.8\%$
$\varepsilon \to \alpha$	Private risk-sharing	$+0.1\%$
$\tau = 0$	Public insurance	$+0.1\%$
$\Delta q = 0$	Rise in college enrollment	-6.0%

Private and public insurance equally important

Education choice paramount to take advantage of new wage structure

What did we learn?

- Empirical approach too pessimistic on the welfare consequences of the recent shift in the U.S. wage structure $(\omega = -2\%)$
- With model-based approach which quantifies "level effects", average losses turn into average gains $(\omega = +1.4\%)$
- Qualifier: majority of individuals experienced significant losses (choice of welfare function matters!)
- Policy: promoting human capital investment vs. progressive taxes