Accounting for the Evolution of U.S. Wage Inequality

Lutz Hendricks

UNC

Preliminary
May 24, 2013

Motivation

- Wage inequality has increased in the U.S. since the 1970s
  - standard deviation of log wages, college wage premium, "residual" wage inequality, ...
- A vast, most non-structural literature has investigate explanations.
- A structural model allows to investigate shocks and their indirect effects.

The Questions

- How far can a standard human capital model go towards accounting for changing wage inequality?
- What are the (proximate) causes of rising inequality?
- What happened to lifetime inequality?

Approach

- Calibrate a stochastic Roy / Ben-Porath model to match CPS wage moments, $1964-2010$, men
  - building on Heckman / Lochner / Taber (1998 RED)
- Discrete school choice
- Heterogeneity in "abilities," human capital endowments, shocks
- Rising inequality is due to
  - diverging skill prices (demographics + SBTC)
  - rising schooling
  - rising shock variances

Result Preview

- The model accounts for trends in several inequality statistics
- Rising "overall wage inequality" is 50% skill prices / 50% rising shock variances
- Rising "between group" inequality is almost 100% skill prices
- Rising "within group" inequality is almost 100% shock variances
- Lifetime earnings inequality rises nearly as much as overall wage inequality

Guvenen and Kuruscu

- How does it differ from Guvenen and Kuruscu's "A Quantitative Analysis of the Evolution of the U.S. Wage Distribution, 1970-2000"?
- GK argue that single shock (acceleration of SBTC) accounts for everything
    - There is no role for labor supply / demographics
- I run with the Katz and Murphy view that demographics + SBTC drive the college wage premium
- Other differences:
    - stochastic model
    - discrete school choice and skill prices

Model

Model Outline

- General equilibrium
- Overlapping generations
- "Small open economy" - no capital, fixed interest rate
- Individuals
  - draw endowments: ability a, human capital h_1
  - choose schooling s: HSD, HSG, CD, CG (Roy model)
  - work and produce human capital (Ben-Porath)

Demographics, Endowments, Preferences

- N_c: size of cohort born in $\tau = c$
- T: fixed lifetime
- t: age
- $\ell_{s,c,t}$: time endowment, used for work and studying
- Endowments: $a, h_1 \sim$joint Normal
- Preferences: maximize expected lifetime earnings

Human Capital Production

In school:

- duration T_s
- $h_{T_s+1} = F(h_1, a, s)$

On the job:

$$h_{t+1} = (1 - \delta_s) h_t + A(a,s)(h_t l_t)^{\alpha_s} \quad (1)$$

$$A(a,s) = e^{A_s + \theta a} \quad (2)$$

Labor Supply

Labor supply in efficiency units

$$e_{i,s,c,t} = \underbrace{q_{i,s,c,t}\zeta_{i,s,c,t}}_{\text{shocks}}\underbrace{h_{i,s,c,t}(\ell_{s,c,t} - l_{i,s,c,t})}_{\text{Ben-Porath}} \tag{3}$$

ζ: transitory shock or measurement error

- Normal distribution

q: persistent shock:

- AR(1) with linear trend in shock variance

Aggregate output and skill prices

Aggregate production function

$$Y_\tau = \left[G_\tau^{\rho_{CG}} + (\omega_{CG,\tau} L_{CG,\tau})^{\rho_{CG}}\right]^{1/\rho_{CG}} \quad (4)$$

where

$$G_\tau = \left[\sum_{s=HSD}^{CD} (\omega_{s,\tau} L_{s,\tau})^{\rho_{HS}}\right]^{1/\rho_{HS}} \quad (5)$$

Skill prices equal marginal products:

$$w_{s,\tau} = \partial Y_\tau / \partial L_{s,\tau} \quad (6)$$

$L_{s,\tau}$: labor supply in efficiency units

Constant SBTC: ω_s/ω_{HSG} grows at a constant rate.

Household Problem: Work

Maximizes the expected value of lifetime earnings

$$V(h_{T_s+1}, a, s, c) = \max \mathbb{E} \sum_{t=T_s+1}^{T} R^{-t} \underbrace{w_{s,\tau(c,t)} e_{s,c,t}}_{\text{earnings}} \tag{7}$$

subject to

- law of motion for h
- time constraint $0 \leq l_t \leq \bar{l}\ell_{s,c,t}$.

The model has a closed form solution.

Solution: Work

Human capital investment is chosen before the current transitory shock, ζ_t, is realized.

Backward induction leads to

$$(h_{i,s,c,t} l_{i,s,c,t})^{1-\alpha_s} = \frac{\alpha A(a,s)}{(1-\delta_s)} \sum_{j=1}^{T-t} X_{s,c,t,j} \frac{\mathbb{E}(q_{i,s,c,t+j}|t)}{q_{i,s,c,t}} \tag{8}$$

where

$$X_{s,c,t,j} = \left(\frac{1-\delta_s}{R}\right)^j \frac{w_{s,\tau(c,t+j)}}{w_{s,\tau(c,t)}} \ell_{s,c,t+j} \tag{9}$$

Recursive solution: Solve for $l_t(h_t)$, compute h_{t+1}, and iterate forward.

Household Problem: Schooling

Choose schooling to maximize

$$W_s(p_s, h_1, a, s, c) = \underbrace{\ln V(F[h_1, a, s], a, s, c)}_{\text{lifetime earnings}} + \mu_{s,c} + \underbrace{\pi p_s + \pi_a (T_s - T_1) a}_{\text{"psychic cost"}}$$

The household values:

- lifetime earnings V
- school "costs" $\mu_{s,c}$: common; allow the model to match cohort schooling
- "psychic costs" generate imperfect ability sorting

With Type I Extreme Value shocks p_s: school choice has a closed form solution.

Cognitive Test Scores

- IQ as a proxy for unobserved ability.
- Helps with identification of ability dispersion (θ) and school choice

$$IQ = a + \sigma_{IQ}\varepsilon_{IQ} \tag{10}$$

$$\varepsilon_{IQ} \sim N(0,1) \tag{11}$$

Calibration

Data Moments

Mean and standard deviation of log wage by (s, c, t):

- March CPS, $1964 - 2011$
- Men born between 1935 and 1968.

Test scores (IQ):

- mean scores of high school and college students
- selected cohorts
- Taubman and Wales (1972) and NLSY79

Shocks:

- PSID: covariance matrix of log wages

Assumptions

- schooling technology = job training technology
- for aggregation:
    - cohorts born before 1935 look like 1935 cohort
    - cohorts born after 1968 look like 1968 cohort

Fixed Parameters

Parameter	Description	Value
T	Lifespan	65
τ	Birth cohorts	1935, 1938, 1941, ..., 1962, 1965, 1968
T_s	School duration	2, 3, 5, 7
$\ell_{t,s,\tau}$	Market hours	CPS data
n/a	Nodes of skill price spline	1950, 1957, 1964, ..., 2010, 2021, 2032
R	Gross interest rate	1.04

Calibration Approach

- Simulate $1,000$ individuals in each cohort.
- Choose school costs $\mu_{s,c}$ to match the fraction of persons choosing each school level in each cohort.
- Choose variance of transitory shocks to best fit variance of wages across ages (for each s, τ)
- Minimize sum of squared deviations from calibration targets.

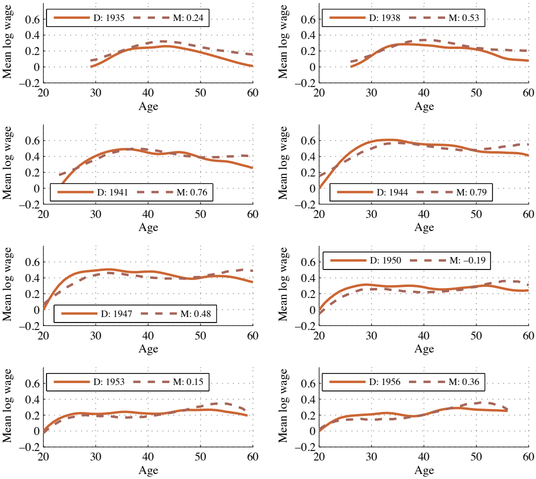
Calibrated Parameters

- 36 calibrated parameters governing endowments, technologies, shocks
- 36 parameters governing skill prices
  - unrestricted skill weight on HSG labor by year
  - for all other school groups: skill weight in 1964 and rate of SBTC
- Of note: Ben-Porath curvature parameters α_s near 0.4
  - much lower than most previous estimates (> 0.8)

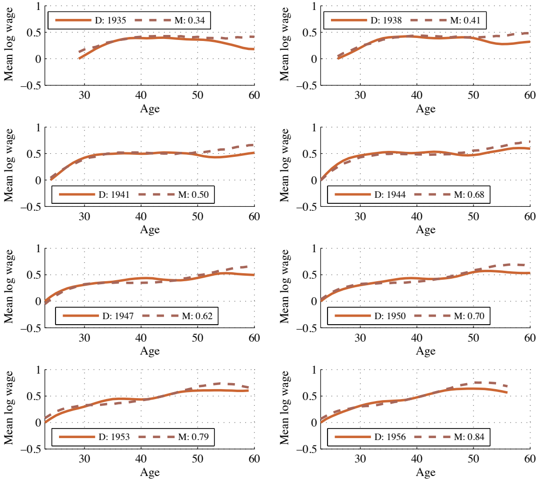
Calibrated Parameters

Parameter	Description	Value
On-the-job training		
A_s	Productivity	0.14, 0.12, 0.15, 0.23
α_s	Curvature	0.49, 0.40, 0.38, 0.46
δ_s	Depreciation rate	0.050, 0.040, 0.048, 0.088
Endowments		
σ_{h1}	Dispersion of h_1	0.290
θ	Ability scale factor	0.098
π_1	Psychic cost scale factor	0.257
γ_{ap}	Ability weight in psychic cost	0.111
γ_{ah}	Governs correlation of $\ln h_1$ and a	0.328
σ_{IQ}	Noise in IQ	0.610
Shocks		
$\sigma(q_1)$	Std dev of first shock	0.03, 0.01, 0.29, 0.29
ρ_s	Shock persistence	0.98, 0.97, 0.99, 0.98
$\sigma(\zeta)$, 1964	Std deviation of shocks	0.12, 0.11, 0.08, 0.08
$\sigma(\zeta)$, 2010	Std deviation of shocks	0.12, 0.16, 0.11, 0.14
Other		
Δw_s	Skill price growth rate, 1964-2010 [pct]	-1.27, -0.69, -0.61, -0.02
$(1+\rho_{HS})^{-1}$, $(1+\rho_{CG})^{-1}$	Substitution elasticities	6.03, 4.09

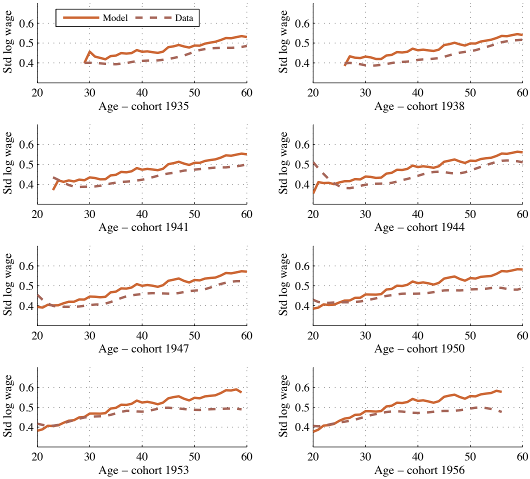
Model Fit: Mean Log Wages (HSG)



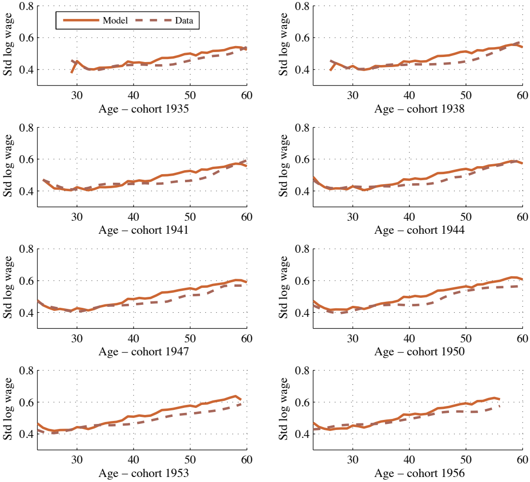
Model Fit: Mean Log Wages (CG)



Model Fit: Standard Deviation (HSG)



Model Fit: Standard Deviation (HSG)



Results

Questions

1. How far can a simple human capital model go towards accounting for wage distribution facts?
2. What is the contribution of various "shocks" to changing wage inequality?
3. Limetime earnings inequality?

Approach

Use counterfactual experiments to shut down one shock at a time

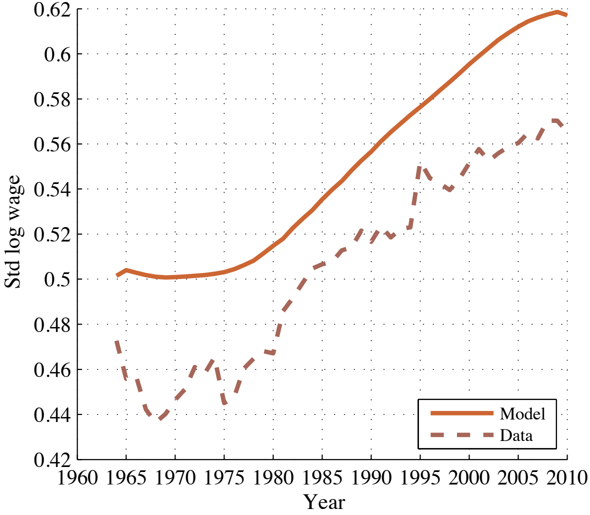
1. fixed wages: $w_{s,\tau} = w_{s,1964}$
2. fixed schooling at level of 1935 cohort
3. fixed shock variances: $\sigma_{\xi,s,\tau} = \sigma_{\xi,s,1964}$

Two cases:

1. Direct effect: holding human capital investments and school choices constant
2. Total effect: allowing human capital investments to adjust

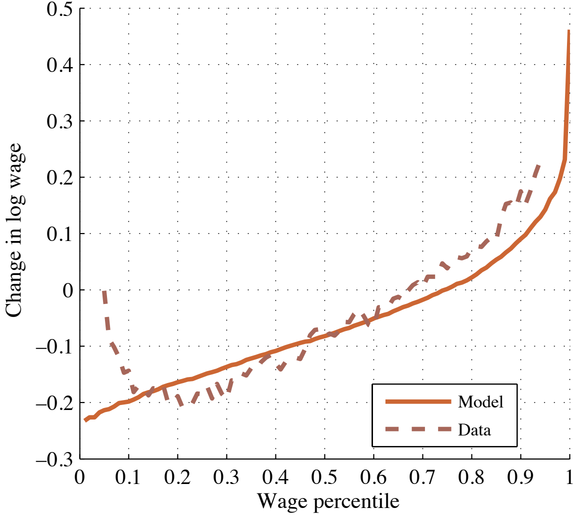
All inequality statistics hold population composition constant at cross-year average.

Overall Wage Dispersion

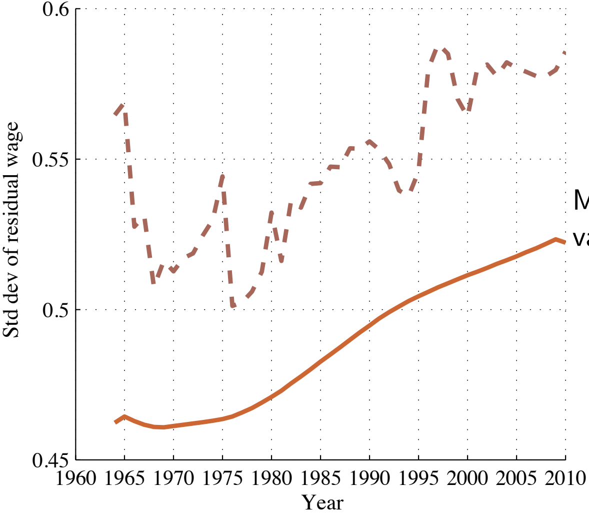


Roughly 50% due to diverging skill prices, 50% due to rising shock variances

Fanning Out of the Wage Distribution



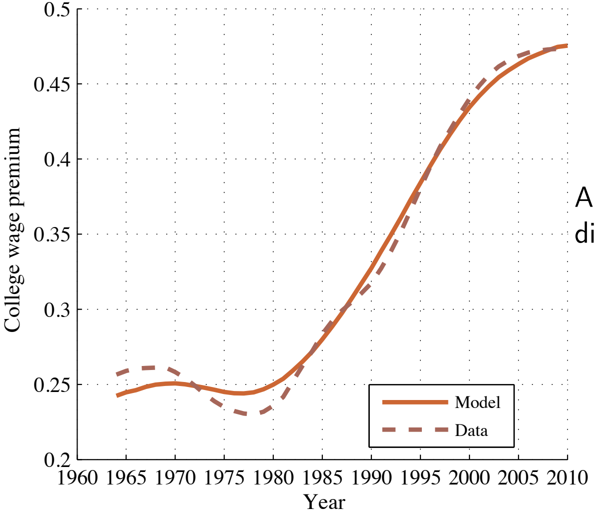
Residual Wage Inequality



Mostly due to rising shock variances

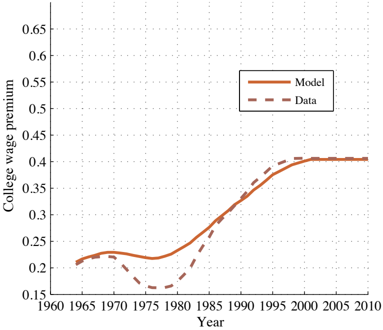
Wage Dispersion and Schooling

College Premium

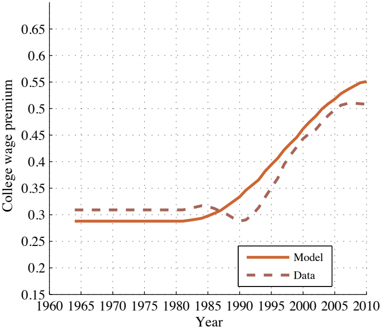


Almost entirely due to diverging skill prices

College Premium: Young and Old



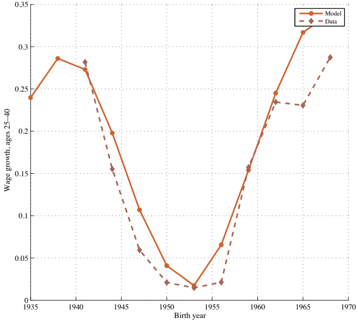
Ages 26-35



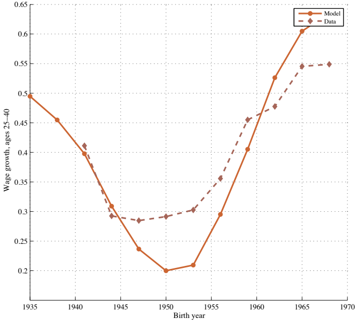
Ages 46-55

Early decline in the young college premium is due to falling human capital investment of high school graduates in the 1970s.

Returns to Experience



High school graduates



College graduates

Changes are 50% skill prices / 50% human capital investment.

Summary

1. Overall wage inequality: 50% due to diverging skill prices / 50% due to rising shock variances
2. Within group inequality: due to rising shock variances
3. College wage premium: due to diverging skill prices
   Human capital investment plays a role for the divergent behavior of young / old.
4. Returns to experience: 50% skill prices; 50% human capital investment.
5. Rising education matters only for skill prices.
6. Secondary effects are generally small.

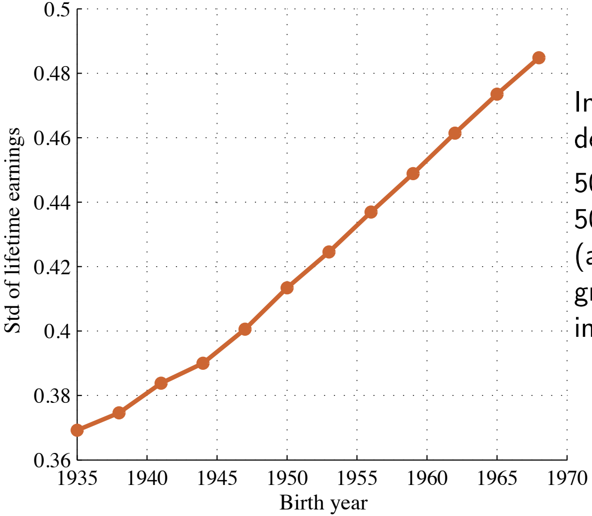
Why Are Indirect Effects Small?

- Optimal human capital investment:

$$(h_{i,s,c,t} l_{i,s,c,t})^{1-\alpha_s} = \frac{\alpha A(a,s)}{(1-\delta_s)} \sum_{j=1}^{T-t} X_{s,c,t,j} \frac{\mathbb{E}(q_{i,s,c,t+j}|t)}{q_{i,s,c,t}}$$

- Changing skill prices affect $X_{s,c,t,j}$.
  - Investment response is the same for all individuals in a [school, age] cell (except for interaction with expected shock growth term)
  - Small effect on within group inequality
- Rising shock variances affect $\mathbb{E}(q_{i,s,c,t+j}|t)/q_{i,s,c,t}$
  - Investment response is the same for all individuals in a [school, age] cell
  - Small amplification of within group inequality
  - Since $Var(q)$ rises by similar amounts for CG and HSG: small effect on college premium.

Lifetime Earnings Inequality



Increase similar to standard deviation of log wages.

50% diverging skill prices.

50% rising shock variances (accounts for within school group rise in lifetime earnings inequality).

Predictability of Lifetime Earnings

- Predictability = [var of lifetime earnings without shocks] / [var of lifetime earnings]
- Huggett / Ventura / Yaron (2011 AER): 0.6
- This model: 0.25
  - 0.1 for college educated workers
  - 0.25 for high school educated workers
- Why so much smaller than HVY?

The End