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

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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

Trend in wage inequality from CPS

Male workers aged 25-60. Hourly wage = annual earnings/annual hours
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
Equivalized consumption expenditures = nondurables, services, small durables and estimated flow from vehicles and housing

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

Trend in leisure/hours inequality from CPS

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

\[ \text{Leisure} = 1 - h^{market} - h^{home}, \quad \text{but } h^{home} \text{ is poorly measured} \]

Social welfare function

• Assume stationary distribution over age, consumption and hours

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

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

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

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

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

- 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 $\omega$ of moving from stationary distribution $(c^*, h^*)$ to $(c^{**}, h^{**})$

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

Period utility function:

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

Initial distribution $(c^*, h^*)$: CEX 1980-1984

Final distribution $(c^{**}, h^{**})$: CEX 2001-2005
In the log case ($\gamma = 1$), $\omega \approx -2\%$ of lifetime consumption

A Lucas-style calculation

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

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

\( \ast \) Battistin-Blundell-Stoker (2010)

Following the derivations in Lucas (1987):

\[
\omega_L \approx -\frac{\gamma}{2} \Delta v_c
\]

\( \gamma = 1 \) and \( \Delta v_c = 0.036 \) \( \Rightarrow \) \( \omega_L = -1.8\% \)

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 $\pi$ 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 $\chi_i$ 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

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


- Empirical fit of this tax/transfer system quite good on U.S. data
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
  - \( \alpha \) follows a unit root process
  - \( \varepsilon \) uncorrelated with \( \alpha \) (could be forecastable)
• Agents can save and borrow a risk-free bond (age 0 bonds = 0)

• Additional insurance against $\varepsilon$ (financial markets, family)

• Equilibrium outcome: no bond trade $\Rightarrow \alpha$ uninsurable, $\varepsilon$ 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

Summary of the model

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

- Four key channels of adjustment/insurance:
  1. education: $q$
  2. flexible labor supply: $\sigma$
  3. progressive taxation: $\tau$
  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 \((p_e, \alpha)\) mediated by progressivity
- Consumption invariant to insurable shock \(\varepsilon\)

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

- Hours respond to \(\varepsilon\) in proportion to tax-modified Frisch elasticity
- Hours invariant to skill price \(p_e\) and uninsurable shocks \(\alpha\)
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

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

solve for \(\omega\) in closed form as function of structural parameters
Analytical expression for $\omega$

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

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

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

(very beautiful)
Interpreting each component of $\omega$

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

$$\Delta var^{bet}(\log c)$$

$$\Delta var^{with}(\log c)$$

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

$$\Delta var(\log h)$$

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

$$\frac{\partial \log(Y/N)}{\partial \varepsilon}$$

$$\Delta \log \mathbb{E}[P_e]$$

$$- (1 - \pi) \Delta (\bar{\chi} q)$$

$$\Delta \text{edu cost}$$
Interpreting each component of $\omega$

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

Welfare cost from rise in consumption inequality

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

Welfare cost from rise in hours inequality

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

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


<table>
<thead>
<tr>
<th>Model parameter</th>
<th>Value</th>
<th>Empirical moment</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Delta \zeta)</td>
<td>0.11</td>
<td>(\Delta (p_H - p_L))</td>
</tr>
<tr>
<td>(\Delta v_\alpha)</td>
<td>0.05</td>
<td>(\Delta \text{var} \text{with} \ (\log c))</td>
</tr>
<tr>
<td>(\Delta v_\varepsilon)</td>
<td>0.03</td>
<td>(\Delta \text{var} \text{with} \ (\log w) - \Delta \text{var} \text{with} \ (\log c))</td>
</tr>
<tr>
<td>((\mu_\chi, v_\chi))</td>
<td>(3.26, 6.20)</td>
<td>((q^*, \Delta q))</td>
</tr>
<tr>
<td>(\tau)</td>
<td>0.31</td>
<td>(\text{var} \ (\log \tilde{y}) / \text{var} \ (\log y))</td>
</tr>
</tbody>
</table>

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

Welfare calculation

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

\[-2.2\%\]

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

\[-0.3\%\]

\[+ \left( \frac{1 - \tau}{\sigma + \tau} \right) \Delta v_\varepsilon \]

\[+ \Delta \log E[P_e] - (1 - \pi) \Delta (\bar{\chi} q) \]

\ [+3.0\%\]

Gains \(+3.9\%\) minus losses \(-2.5\%\) \(\Rightarrow\) \(\omega = +1.4\%\) of lifetime consumption
We can also compute the welfare gain for a newborn agent across the two steady states: $\omega^0$

Two differences between the expressions for $\omega$ and $\omega^0$

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?

<table>
<thead>
<tr>
<th>Indiv. type</th>
<th>$\chi_i$</th>
<th>Fraction of pop.</th>
<th>$\omega^0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H^* \rightarrow H^{**}$</td>
<td>0.220</td>
<td>+12.3%</td>
<td></td>
</tr>
<tr>
<td>$L^* \rightarrow L^{**}$</td>
<td>0.713</td>
<td>−2.4%</td>
<td></td>
</tr>
<tr>
<td>$L^* \rightarrow H^{**}$</td>
<td>0.067</td>
<td>+5.6%</td>
<td></td>
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</tbody>
</table>

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

Shut down one insurance mechanism at a time and recompute $\omega$

<table>
<thead>
<tr>
<th>Model</th>
<th>Insurance channel missing</th>
<th>$\omega$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>None</td>
<td>+1.4%</td>
</tr>
<tr>
<td>$\sigma = \infty$</td>
<td>Flexible labor supply</td>
<td>+0.8%</td>
</tr>
<tr>
<td>$\varepsilon \rightarrow \alpha$</td>
<td>Private risk-sharing</td>
<td>+0.1%</td>
</tr>
<tr>
<td>$\tau = 0$</td>
<td>Public insurance</td>
<td>+0.1%</td>
</tr>
<tr>
<td>$\Delta q = 0$</td>
<td>Rise in college enrollment</td>
<td>−6.0%</td>
</tr>
</tbody>
</table>

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