U.S. Wages and Salaries, 
A Decomposition of Wage and 

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Dept. of Ag. & Resource Ec. Seminar
UC Berkeley
Summary Slide

- Problem Definition
- Literature review
- The Theory
- Results and Interpretation
- Summary and Conclusions
Problem Definition

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Employment (thous.)</td>
<td>94,330</td>
<td>113,429</td>
<td>133,070</td>
</tr>
<tr>
<td>Per worker wages and salaries</td>
<td>$29,569</td>
<td>$29,666</td>
<td>$31,411</td>
</tr>
<tr>
<td>Per capita net earnings</td>
<td>$15,353</td>
<td>$16,522</td>
<td>$18,189</td>
</tr>
<tr>
<td>Per capita dividends, interest and rent</td>
<td>$2,890</td>
<td>$4,559</td>
<td>$5,147</td>
</tr>
<tr>
<td>Per capita total</td>
<td>$18,245</td>
<td>$21,081</td>
<td>$23,335</td>
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<thead>
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<tbody>
<tr>
<td>Employment</td>
<td>18.4%</td>
<td>16.0%</td>
<td>34.4%</td>
</tr>
<tr>
<td>Per worker wages and salaries</td>
<td>0.33%</td>
<td>5.72%</td>
<td>6.04%</td>
</tr>
<tr>
<td>Per capita net earnings</td>
<td>7.3%</td>
<td>9.6%</td>
<td>17.0%</td>
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<tr>
<td>Per capita dividends, interest and rent</td>
<td>45.6%</td>
<td>12.1%</td>
<td>57.7%</td>
</tr>
<tr>
<td>Per capita total</td>
<td>14.5%</td>
<td>10.2%</td>
<td>24.6%</td>
</tr>
</tbody>
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<td>Per worker wages and salaries</td>
<td>$29,569</td>
<td>29,666</td>
<td>$31,411</td>
</tr>
<tr>
<td>Standard dev.</td>
<td>$11,566</td>
<td>$15,974</td>
<td>$18,314</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.24</td>
<td>1.43</td>
<td>1.81</td>
</tr>
<tr>
<td>Thiel T'</td>
<td>0.058</td>
<td>0.071</td>
<td>0.079</td>
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<td>6.04%</td>
</tr>
<tr>
<td>Paired t-test, 1 tail</td>
<td>53%</td>
<td>92%</td>
<td>80%</td>
</tr>
<tr>
<td>N (no. of sectors)</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
</tbody>
</table>
Table Determining the Source of Lower Wages

<table>
<thead>
<tr>
<th>Explanations for low wages</th>
<th>High paying industries</th>
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<tbody>
<tr>
<td>High wages</td>
<td>&quot;past&quot;</td>
<td>conventional wisdom</td>
</tr>
<tr>
<td>Low wages</td>
<td>Power and Barrett</td>
<td>worst case</td>
</tr>
</tbody>
</table>
Interpreting the Wage & Industry Effects

• Wage effect
  - Movement of high quality factors toward or away from a region
    - Solow (convergence)
    - Romer & Lucas (divergence)

• Industry effect
  - Movement of high value industries toward or away from a region
    - Heckscher-Ohlin (convergence)
    - Krugman (divergence)
Growth and Trade Policies

• If wage effect is negative, then
  – Increase investment in physical and human capital, e.g., education and technology
  – Primary factors policies (labor vs capital?)

• If industry effect is negative, then
  – Increase competitive advantage by improving local resources and institutions
  – Place policies (urban vs rural?)
Literature Review
Hamermesh, Daniel S. and Grant, James.


- Physical and human capital are complements and are jointly substitutable with raw labor.

- Future research should concentrate on substitution among workers.
Bluestone, Barry and Harrison, Bennett


• The data suggest a rising low-wage share and growing wage polarization, at least after 1979.
  - The decline in unionization
  - The erosion in the real value of the minimum wage
  - The widespread existence of wage concession bargaining
  - Two-tier wage structures in a number of large industries.
  - The growing business practice of "outsourcing" to achieve lower labor costs
  - The secular shift of capital from directly productive to overtly speculative investment
Krueger, Alan B. and Summers, Lawrence H.


- Empirically tests and rejects classical competitive theories of wage determination by examining differences in wages for equally skilled workers across industries.

- These findings suggest that workers in high wage industries receive noncompetitive rents.
Bound, John and Johnson, George


• During the 1980's, there were large changes in the structure of relative wages, most notably a huge increase in the relative wages of highly educated workers.

• Our conclusion is that their major cause was a shift in the skill structure of labor demand brought about by biased technological change.
DiNardo, John; Fortin, Nicole M. and Lemieux, Thomas.


• De-unionization and supply and demand shocks were important factors in explaining the rise in wage inequality from 1979 to 1988.

• The decline in the real value of the minimum wage explains a substantial proportion of this increase in wage inequality, particularly for women.
Valletta, Robert G.


• Earlier analyses revealed that average earnings are lower, and earnings inequality is higher for service-producing workers than for goods-producing workers.

• During the period 1979-1995 the results show at most a small effect of industry employment shifts on growing inequality in male hourly earnings.
Calmon, Paulo Du Pin; Conceicao, Pedro; Galbraith, James K.; Cantu, Vidal Garza and Hibert, Abel.


• Mexico and Brazil show increases in wage dispersion over time, and a strong negative correlation is found with the rate of real economic growth.
The Theory
Hanna and LaCroix Wage and Industry Indices

\[
Hanna \text{ _ Wage } = \frac{W_n^1 N_n^1}{W_n^0 N_n^1}
\]

\[
LaCroix \text{ _ Wage } = \frac{W_n^1 N_n^0}{W_n^0 N_n^0}
\]

\[
Hanna \text{ _ Industry } = \frac{W_n^0 N_n^1}{W_n^0 N_n^0}
\]

\[
LaCroix \text{ _ Industry } = \frac{W_n^1 N_n^1}{W_n^1 N_n^0}
\]
Hanna and La Croix Wage Indices
Contradictory Results

• For both Hanna and La Croix indices:

\[(\text{Wage index})(\text{Industry index}) = \text{Total index}\]

• Hanna total index = La Croix total index

• However:

  Hanna wage index \neq \text{La Croix wage index}
  Hanna industry index \neq \text{La Croix industry index}

• Sometimes they are contradictory!

• Needed: a consistent and defensible wage index
Avg. wages as a function of avg. sector wages
Wage index derivation

• Assume a continuous, twice-differentiable, concave quadratic average wage function in which the region’s industrial structure is constant
  \[ W = \sum_i (a_{i0} + a_{i1} w_i - a_{i2} w_i^2) \]

• This functional form implies that skilled and less skilled labor are imperfect substitutes in all industries.

• Then apply a second-order Taylor series expansion to \( W = f(w_i) \)

• Adapt Shepherd’s lemma in which the 1st derivative of a logarithmic Cobb-Douglas cost function equals the factor share

• Diewert’s quadratic lemma: the geometric mean of two 1st order approximations equals a second order measure
Wage decomposition equation and the Theil inequality index (T’)

Total effect = wage effect + industry effect

\[
\ln(\frac{W^1}{W^0}) = \sum_i \frac{1}{2}(s_i^0 + s_i^1) \ln(\frac{w_i^1}{w_i^0}) + \ln(1 + \mu)
\]

Theil inequality index (T’)

\[
T' = \sum_i s_i \ln(\frac{w_i}{W})
\]

W: avg. overall wage/job
w: avg. sector wage/job
s: share sector’s wage bill
u: industry effect
i: sector; time: 0..1
Wage and Industry Effects as Substitution and Output Effects

E^0E^1: Total effect (+)
E^0A: Wage Effect (+)
AE^1: Industry Effect (-)
Change in the Theil Inequality index
(overall between sectors, $T'$ and wage effect, $T_{F'}$)

Theil ($T'$) effect = industry + wage effects

\[ T' = \sum_i \left[ \left( \frac{w_i}{\bar{W}} \right) \log \left( \frac{w_i}{\bar{W}} \right) \right] n_i + \left( n_i \log \left( \frac{w_i}{\bar{W}} \right) + n_i \right) \left( \frac{w_i}{\bar{W}} \right) \]

\[ T' = \sum_i \left[ \left( \frac{w_i}{\bar{W}} \right) \log \left( \frac{w_i}{\bar{W}} \right) \right] n_i^0 \log \frac{n_i^1}{n_i^0} + \left( n_i^1 \log \left( \frac{w_i}{\bar{W}} \right) + n_i^1 \right) \left( \frac{w_i}{\bar{W}} \right)^0 \log \left( \frac{w_i}{\bar{W}} \right)^1 \]

Theil wage effect ($T_{F'}$)

\[ T_{F'} = \sum_i n_i \left( \log \left( \frac{w_i}{\bar{W}} \right) + 1 \right) \left( \frac{w_i}{\bar{W}} \right) \]

\[ T_{F'} = \sum_i n_i^1 \left( \log \left( \frac{w_i}{\bar{W}} \right) + 1 \right) \left( \frac{w_i}{\bar{W}} \right)^0 \log \left( \frac{w_i}{\bar{W}} \right)^1 \]

Conceicao & Galbraith, 2000, pp. 65, 68

\[ \left( \frac{w_i}{\bar{W}} \right)^1 \]

w,/W. ratio of avg. sector wage per job to overall average

\[ n_i: \text{ratio of labor in sector } i \text{ to overall labor} \]

\[ T \in \{0, \log(n)\} \]

Outline_USA_7898_Rev.ppt
Results and Interpretation: U.S. Wages and Salaries
### U.S. Wages and Salaries (cpi 1998=100)

<table>
<thead>
<tr>
<th>Year/ index</th>
<th>growth rate</th>
<th>real avg. W/J</th>
<th>A. diff. W/J</th>
<th>A. Change in W</th>
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</thead>
<tbody>
<tr>
<td>1988/78 cpi</td>
<td>40.0%</td>
<td>$29,666</td>
<td>-20</td>
<td>-2.37%</td>
</tr>
<tr>
<td>Wage</td>
<td>1.69%</td>
<td>$30,074</td>
<td>$25</td>
<td>$2,863,401,134</td>
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<tr>
<td>Industry</td>
<td>-1.37%</td>
<td>$29,666</td>
<td>-$20</td>
<td>-2,314,081,551</td>
</tr>
<tr>
<td>Total</td>
<td>0.33%</td>
<td>$29,666</td>
<td>$5</td>
<td>$549,319,582</td>
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</tbody>
</table>

| 1998/88 cpi | 72.6%       | $29,666       | -18          | -1.37%         |
| Wage        | 6.85%       | $31,771       | $105         | $14,004,517,272|
| Industry    | -1.14%      | $31,411       | -$38         | -2,398,457,563 |
| Total       | 5.72%       | $31,411       | $87          | $11,611,059,709|

| 1998/78 cpi | 40.0%       | $29,666       | -38          | -2.37%         |
| Wage        | 8.41%       | $32,164       | $130         | $17,265,637,642|
| Industry    | -2.37%      | $31,411       | -$38         | -5,010,139,942 |
| Total       | 6.04%       | $31,411       | $92          | $12,255,497,700|

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<tr>
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<tbody>
<tr>
<td>Wage decomposition (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-effect</td>
<td>0.3</td>
<td>5.7</td>
<td>6.0</td>
</tr>
<tr>
<td>W-effect</td>
<td>1.7</td>
<td>6.8</td>
<td>8.4</td>
</tr>
<tr>
<td>l-effect</td>
<td>-1.4</td>
<td>-1.1</td>
<td>-2.4</td>
</tr>
<tr>
<td>Theil inequality index (T’ between industries only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T’-total</td>
<td>.012</td>
<td>.007</td>
<td>.016</td>
</tr>
<tr>
<td>T’-wage</td>
<td>.031</td>
<td>.021</td>
<td>.049</td>
</tr>
<tr>
<td>T’-industry</td>
<td>-.019</td>
<td>-.014</td>
<td>-.033</td>
</tr>
</tbody>
</table>
The Fat Epidemic: He says it’s an illusion

- Dr. Jeffrey Friedman (Rockefeller U.)
  - Obesity researcher at Howard Hughes Medical Institute
  - “national data do not show Americans growing uniformly fatter” (NYT 6/8/04, p. D5)
  - “from 1991 to present … the lower end of the weight distribution, nothing has changed, not even by a few pounds … only the massively obese, the very top of the distribution is there a substantial increase in weight, about 25 to 30 pounds”
Wage Effects on Avg. Wages

- An across the board proportionate change in wages per job (sign - or +) regardless of the distribution
Negative Industry Effects Cause a Decrease in the Mean

C. Low value industries that expand \((\uparrow)(L) = (+)(-)\)

(skewed to the right, \(\mu_3 > 0\))

D. High value industries that contract \((\downarrow)(H) = (-)(+)\)
1978 U.S. Frequency of Jobs by Wage (cpi 1998=100)
1978 U.S. Frequency of Jobs by Wage (cpi 1998=100)
1978 Frequency of jobs by salary (cpi 1998=100)
Per Worker Wages and Salaries by Industry: 1978
Per Worker Wages and Salaries by Industry: 1988
Per Worker Wages and Salaries by Industry: 1998
Gaussian probability density function

\[ f(x) = \frac{1}{h} \left( \sum_{i} \frac{n_i}{N} e^{-\frac{5}{2} \left( \frac{x-w_i}{h} \right)^2} \right) \sqrt{2\pi\sigma^2} \]

Silverman, B. W. *Density Estimation for Statistics and Data Analysis*. 1986
Gaussian Kernels with Wage & Industry Effects: 1978
Gaussian Kernels w/ Wage & Industry Effects: 1988
Gaussian Kernels w/ Wage & Industry Effects: 1998

Freq

Wages/job
Gaussian Kernels w/ Wage & Industry Effects: 1978 to 1998 (t-effect: 6.04%)
Gaussian Kernels w/ Industry Effects: 1978 to 1998 (i-effect: -2.37)
Gaussian Kernels w/ Wage Effects: 1978 to 1998 (w-effect: 8.41%)
Gaussian Kernel w/ Total Effect: 1978 to 1988 (avg. wages & shares) (t-effect: 0.39%)
Gaussian Kernel w/ Wage Effects: 1978 to 1988 (avg. shares) (w-effect: 1.69%)
Gaussian Kernel w/ Total Effect: 1988 to 1998 (avg. wages & shares) (t-effect=5.72%)
Gaussian Kernel w/ Industry Effects: 1988 to 1998 (avg. wages) (i-effect = -1.14%)
Gaussian Kernel w/ Wage Effects: 1988 to 1998 (avg. change) (w-effect=6.85%)
Summary and Conclusions
Summary

• I developed a CES average wage function
  – Derived 2nd order approximation using Taylor series
  – CES is exact

• Industry effect seems more important than it is because the wage effect has industry effect characteristics
  – Technology bias
  – Substitution of skilled for unskilled labor and vice versa within industries
  – High skill – high wage industries becoming more or less so compounds the perception of actual industry effect

• Thiel index shows that the negative industry effect can result in greater wage equality and conversely for the wage effect
Table Determining the Source of Wage Change

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"Worst case" and "past" are terms used to describe the conventional wisdom associated with wage changes. High paying industries are contrasted with low paying industries, and explanations for low wages are presented alongside these wage categories.
Growth and Trade Policies

• If industry effect is negative, then
  – Increase competitive advantage by improving local resources and institutions
  – Place policies (urban vs rural?)
References