Past Trends and Projections in Wage, Work and Occupations in the United States

David Autor
MIT and NBER

Federal Reserve Bank of Chicago
Strategies for Improving Economic Mobility of Workers
November 15 – 16, 2007
A Historic Rise in Earnings Inequality: Change in Real Weekly Wages by Percentile, 1963 –2005
Less Well Known: An Ongoing Polarization of Earnings Inequality from 1988 to Present

Figure 2. Changes in Real Male & Female Log Hourly Wages by Pctile: CPS MORG
Figure 4. Smoothed Changes in Employment by Occupation 1980-2000
A Striking Correspondence...

Real Wage Growth by Earnings Pctile 1973-88 and 1988-04

Changes in Employment by Occs’ Educt’n Pctile, 1980-90 & 1990-00

Figure 2. Changes in Real Male & Female Log Hourly Wages by Pctile: CPS MORG

Figure 4. Smoothed Changes in Employment by Occupation 1980-2000
What Explains Polarization of Employment Growth?

• **A hypothesis:**
  • Autor, Levy, Murnane (2003) ‘task’ view of computerization
  • Conceptualize work from “computer’s point of view:”
    • Which tasks does computerization substitute/replace?
    • Which tasks does it complement?

• **Two defining traits of Computers:**
  2. Actions deterministically specified by explicit procedures (‘programs’).
The First Computer

Jacquard Loom of 1801

Since 1800s, 1 to 5 Trillion-Fold Decline in Price of Computing

Figure 2. The cost of computer power for different technologies
What do Computers do? ‘Routine’ Tasks

• A task can’t be computerized unless we ‘know the rules’
  • That is, there is a well-specified procedure for accomplishing the task.

• For a large set of tasks, this is not a constraint:
  • Clerical tasks: Sorting, filing, storing, copying, calculating
  • Control tasks: Monitoring, measuring, controlling

• Refer to these rules-based activities as ‘Routine’ tasks:
  • Routine tasks are readily automated/computerized.
  • Note: What is ‘routine’ for computers is not necessarily routine for people. Adding a column of 1,000 numbers is routine for computers—not people.
Plate 1. Comparison of Manual Calculation with Manual Calculator

This photograph shows a comparison of manual calculators and computations by a clerk in adding up a column of numbers such as might be found in a ledger. The calculator has an advantage of a factor of six. (Source: Burroughs Adding Machine Company, *A Better Day’s Work at a Less Cost of Time, Work and Worry to the Man at the Desk in Three Parts Illustrated*, Third Edition, Detroit, Michigan, 1909, pp. 153-154.)
What don’t Computers do? ‘Non-Routine’ Tasks

- But ‘knowing the rules’ not a trivial requirement.
  - “We can know more than we can tell…” Michael Polanyi, The Tacit Dimension, 1966)

- Two broad sets of tasks where we don’t ‘know the rules’:
  1. ‘Abstract’ tasks: Demand problem-solving, creativity:
     - Solving novel/unstructured problems.
     - Developing and testing hypotheses.
     - Exercising discretion, managing other people.
  2. ‘Manual’ tasks: Requiring environmental or interpersonal adaptability:
     - Driving a truck through city traffic.
     - Conversing in spoken language.
     - Serving a meal.
     - Dusting a room.
“Warning Will Robinson! Danger”
<table>
<thead>
<tr>
<th>Task Description</th>
<th>Example Occupations</th>
<th>Potential Computer Impact</th>
</tr>
</thead>
</table>
| **Routine Tasks** | • ‘Rules-based’  
• Repetitive  
• Procedural | • Bookkeepers  
• Assembly line workers | • Direct Substitution |
| **Abstract Tasks** | • Abstract problem-solving  
• Mental flexibility | • Scientists  
• Attorneys  
• Managers  
• Doctors | • Strong Complementarity |
| **Manual Tasks** | • Environmental Adaptability  
• Interpersonal Adaptability | • Truck drivers  
• Security guards  
• Waiters  
• Maids/Janitors | • Limited Complementarity or Substitution |
Google: The Ultimate Routine Cognitive Task
Delegating Non-Routine Manual Tasks to Workers

Computerized Warehouse
- Computer is the brain
- Worker is hands and eyes
- **Computer’s tasks:**
  - Maps quickest route to item
  - Direct worker to bins
  - Manage inventory
- **Worker’s tasks:**
  - Walk to bins
  - Retrieve items
  - Scan items so computer can verify correct pickup
- **If asked by computer:**
  - Count what’s left in bin
  - Tell computer via microphone
Delegating Non-Routine Manual Tasks to Workers

- **Worker is hands and eyes**
- **Worker’s tasks:**
  - Interpret spoken language
  - Walk to bins, retrieve items
  - Pour drinks
  - Handle cash
  - Verify signatures
- **Computer’s tasks:**
  - Accounting
  - Inventory and order management
  - Workflow: Coordination of production
Facilitating Outsourcing: ‘Kiss Your Cubicle Goodbye’

THE NEW FACE OF THE SILICON AGE
Tech jobs are fleeing to India faster than ever. You got a problem with that?
Representative Evidence:

![Graph showing trends in U.S. job task content from 1960 to 2002. The graph displays the percentiles of task distribution for abstract, routine, and manual tasks over time.]
What does this Have to do with Skill Demands?

Task Input (Percentiles of 1960 Distribution)

- High School Dropouts
- High School Graduates
- Some College
- College Graduates

HSD, HSG, SMC, CLG
‘Polarization’ Framework Suggests

1. Growth of highly-educated professional and managerial jobs (i.e., those using abstract skills) – ‘Lovely jobs’
   - Not a controversial claim…

2. Growth of low-education jobs using ‘non-routine manual’ skills (i.e., those not readily automated) – ‘Lousy jobs’
   - Perhaps more novel…
Growth of High and Low Education Occupations

Employment Shares by Occupation 1980-2005
All Education Groups

Managerial & Professional Specialty Occs.
Technicians, Sales, & Administrative Support
Precision Prodn, Craft, & Repair Occs.
Operators, Fabricators, & Laborers
Farming, Fishery, & Forestry Occs.
Service Occs.

Employment Share

0 0.05 0.1 0.15 0.2 0.25 0.3 0.35

Occupational Change among Non-College Workers (High School or Lower)

Employment Shares by Occupation 1980-2005
Non-College Workers

- Managerial & Professional Specialty Occs.
- Technicians, Sales, & Administrative Support
- Precision Prodn, Craft, & Repair Occs.
- Operators, Fabricators, & Laborers
- Farming, Fishery, & Forestry Occs.
- Service Occs.

Employment Share

- 1980
- 1990
- 2000
- 2005
Composition of Employment in Service Occupations 2005

- Recreation and Hospitality Occupations
- Personal Appearance Occupations
- Child Care Workers
- Housekeeping, Cleaning and Laundry Workers
- Protective Service Occupations
- Food Preparation and Service Occupations
- Healthcare Support Occupations
- Building and Grounds Cleaning and Maintenance Occupations

*Note: Service occupations ≠ Service sector*
What is Special about Service Occupations?

1. **Difficult to automate:**
   - Demand environmental or interpersonal adaptability.
   - Examples: Waiting tables, caring for the elderly, childcare.

2. **Difficult to outsource/trade:**
   - Require in-person production.
   - Examples: House-cleaning, haircutting, childcare.

3. **Do not require extensive formal schooling – Extensive supply:**
   - Job tasks use ‘built-in’ skills: locomotion, visual recognition, fine motor coordination, spoken language.
   - Examples: Security guarding, lawn-mowing, cleaning.
The Growth of Low-Education Service Jobs in the US

- **Service occupations:** An exception to pattern of stagnant /falling employment and wages in low-education jobs:
  
  1. Since 1990, growth rate of Service occs as a share of all labor hours has equaled that of Professional and Managerial occs: growing at 2.1 percent per decade.

  2. Share of hours worked in Service occs among non-college rose 60 percent between 1980 and 2005: 12.8 to 20.3 percent.

  3. Real hourly wages in service occupations increased by more than 20 percent between 1980 and 2005.
Chart 6. Percent change in total employment by major occupational group, projected 2004-2014

- Professional and related
- Service
- Management, business, and financial
- Construction and extraction
- Installation, maintenance, and repair
- Transportation and material moving
- Sales and related
- Office and administrative support
- Production
- Farming, fishing, and forestry

Percent change
Predicted employment change (in thousands) by 2004 median annual wage quartile, projected 2004-14

- **Highest**: 6,489
- **Second**: 4,024
- **Third**: 3,487
- **Lowest**: 4,927
Conclusion

• A historic rise of earnings inequality over 25 years
• Rising returns to ‘skill’ are the central actor in this story
  • Secular demand shifts favoring highly educated workers
• But the story is not that simple…
  • Labor demand appears to be polarizing – Rising demand for high and low education jobs.
  • Computerization a key factor – Displacement of ‘routine tasks.’
  • Offshoring could be equally disruptive – Great unknown.
• Expect further polarization of work – ‘Lousy and Lovely Jobs’
• Policies issues worth discussing:
  1. Rising demand for highly-educated → Solid case for ‘brain gain’ policies.
  2. Rising demand for less-educated (at last) → Not a problem.
  3. Investing in human capital of young to preserve economic mobility.