Osher Lifelong Learning Institute, Fall 2005

Contemporary Economic Policy

Northwestern University

Host: Geoffrey Woglom, Ph.D.
National Economic Education Delegation

NATIONAL ECONOMIC EDUCATION DELEGATION

Course Schedule

Inequality and Public Policy

- Week 1 (10/14): The New Inequality, Geoffrey Woglom, Amherst College
- Week 2 (10/21): Economics of Immigration, Robert Gitter, Ohio Wesleyan University
- Week 3 (10/28): Trade and Inequality Geoffrey Woglom, Amherst College
- Week 4 (11/04): The Black-White Wealth Gap, Jon Haveman, Exec. Director, NEED
- Week 5 (11/11): Climate Change Economics Sarah Jacobson, Williams College
- **Week 6 (11/18): AI and Inequality Geoffrey Woglom, Amherst College**

NATIONAL ECONOMIC EDUCATION DELEGATION

Artificial Intelligence and Inequality

November 18, 2025

Geoffrey Woglom,
Emeritus Professor, Amherst College

NATIONAL ECONOMIC EDUCATION DELEGATION

Outline

1. **Lessons from 2 episodes Technological Changes during the 20th Century.**
2. **What is the current state of AI?**
3. **How will the adoption of this technology affect inequality.**

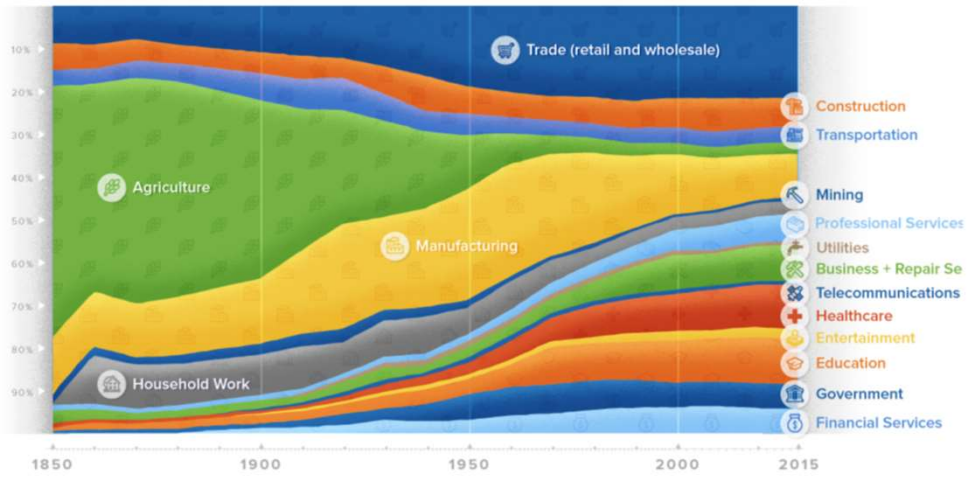
Spoiler Alert: No One Really Knows?

4. **Recent Evidence on the Effects of AI.**
5. **Implications for our grandchildren's future.**

I will not discuss the possibility of an "AI Takeover" of humanity

NATIONAL ECONOMIC EDUCATION DELEGATION

Two Major Shifts in Employment



NATIONAL ECONOMIC EDUCATION DELEGATION

https://www.visualcapitalist.com/visualizing-150-years-of-u-s-employment-history/

Out of Agriculture

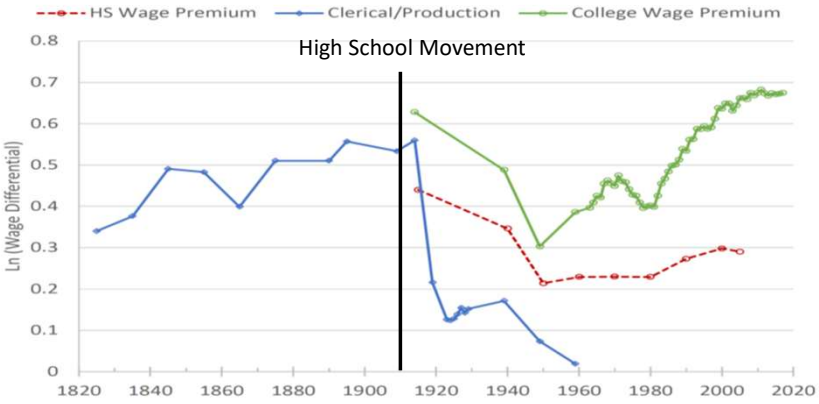
- **D. Autor, C. Goldin, and L. Katz, Extending the Race between Education and Technology"** *AEA Papers and Proceedings 2020, 110: 347–351*
- **Technology increase the demand for skilled workers tending into raise their wages.**
- **Education increases the supply of skilled workers tending to lower their wages.**

Example: Shift from agriculture to manufacturing in the late 19th and early 20th centuries: Increasing demand for high school graduates

NATIONAL ECONOMIC EDUCATION DELEGATION

Historical Returns to Education

Figure 1: Educational and Occupational Wage Differentials: 1825 to 2017



Autor, Goldin and Katz

Early 20th Century Technology Adjustment

Four Keys to Success:

1. **New technology created jobs in new sectors where labor was more productive. (e.g., Model T).**
2. **Wealthier nation could afford the new schooling and afford to buy the new goods.**
3. **Farm workers were geographically mobile to move to the new jobs.**
4. **Increase in educational attainment increased the supply of workers for new jobs.**

Lessons of the Effects of Technology

1. Some of the new technologies substituted for existing labor ***automating*** jobs (cotton picking machines, 1943).
2. Some of the new technologies ***augmented*** labor increasing jobs (Black & Decker mass produced pistol grip electric drills in 1917).
3. Some new technologies created new goods and more new jobs (electrical engineers with the development of the electric grid).
4. New technologies increased wealth and increased the demand for all types of labor; GDP per capita increased by 80% between 1900 and 1929).

Early 20th Century Technologies Were GPT

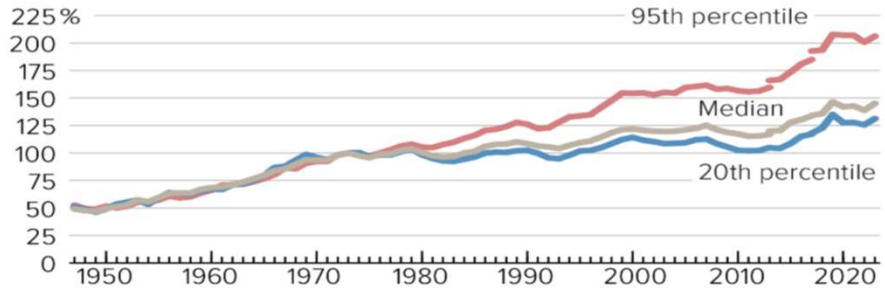
- General Purpose Technologies (GPT) are foundational innovations that affect many sectors of the economy.
  1. Electricity.
  2. Automobiles.
  3. Transistors.
- These GPTs did substitute for some labor, but augmented most labor and created many new occupations and industries.

The Abrupt Increase in Inequality

FIGURE 1

Income Gains Widely Shared in Early Postwar Decades — But Not Since Then

Real family income between 1947 and 2023, as a percentage of 1973 level



Note: Breaks indicate implementation of a redesigned questionnaire (2013) and an updated data processing system (2017).

Source: CBPP calculations based on U.S. Census Bureau Data

CENTER ON BUDGET AND POLICY PRIORITIES | CBPP.ORG

Source: Arloc Sherman, Danilo Trisi, and Joseph Cureton, "A Guide to Statistics on Historical Trends in Income Inequality," Center on Budget and Policy Priorities, Policy Futures, Dec. 11, 2024.

Recent Experience of Technology & Wage Inequality

Acemoglu (Nobel 2024) & Restrepo:

- **"We document that between 50% and 70% of changes in the U.S. wage structure over the last four decades are accounted for by relative wage declines of worker groups specialized in routine tasks in industries experiencing rapid automation."**
- **What Characterized industries experiencing rapid automation?**

Econometrica, Vol. 90, No. 5 (September, 2022), 1973–2016

David Autor and Labor Market Polarization

FIGURE 3

Percentage point change in employment by occupation, 1979–2009

https://www.hamiltonproject.org/wp-content/uploads/2023/01/The_Polarization_of_Job_Opportunities_in_the_US_Labor_Market-_Implications_for_Employment_and_Earnings.pdf

Causes of Polarization in the Early 21st Century

- **Automation substituted machines for labor for *routine* work; e.g., bookkeeping, clerical work and repetitive production work – middle skill jobs. Thereby lowering the demand for these workers.**
- **As a result, the relative demand for two kinds of *nonroutine* work rose;**
  1. Abstract tasks such as problem solving, intuition and persuasion; many of these jobs, but not all require formal training and/or a college degree.
  2. Manual tasks requiring little formal education such as janitors, home health aide workers, construction laborers.

Polarization and Wage Inequality

- High-skilled jobs requiring a college education increased as well as wages.
- Conversely, middle-skilled jobs fell along with wages.
- Low-skilled jobs demand rose, but the supply of workers also rose as displaced middle skilled workers found low skill jobs.

- How will this story change with the introduction of AI?

What is Artificial Intelligence?

- Definition: The capacity of machines to simulate intelligent behavior. Such as learning, problem solving, reasoning, perception and decision making.
- Machine Learning (ML): Train computer to do a specific task by *reinforcement*.
- Alpha-Go and Alpha-Go Zero: 2016 beats World Champ. https://deepmind.google/research/projects/alphago/
- Reading Mammograms "…urgent efforts should be made to integrate AI-supported mammography into screening guidelines and to promote the widespread adoption of AI in mammography screening programs. (https://www.nature.com/articles/s41591-024-03408-6)

Generative AI: ChatGPT et. al.

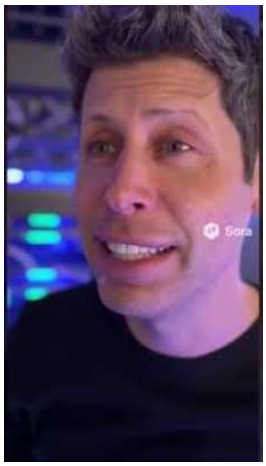
- **Generative AI and Large Language Models (LLM): Train computers on massive amounts of data to predict patterns, and use these predictions to generate "new" content.**
- **It is still a kind of reinforcement, but the "game" is to predict what word, image, music comes next.**
- **You play the "game" by providing a prompt in natural language; e.g.**
  - "What is a neural network?
  - "Perplexity:"A neural network is a computational system inspired by the structure and function of biological brains, designed to recognize patterns and learn from data by adjusting connections between artificial "neurons" arranged in layers.

"New" Content

Exan

- **"W**
- **"C**
- **De**

Funny, but Scary Too

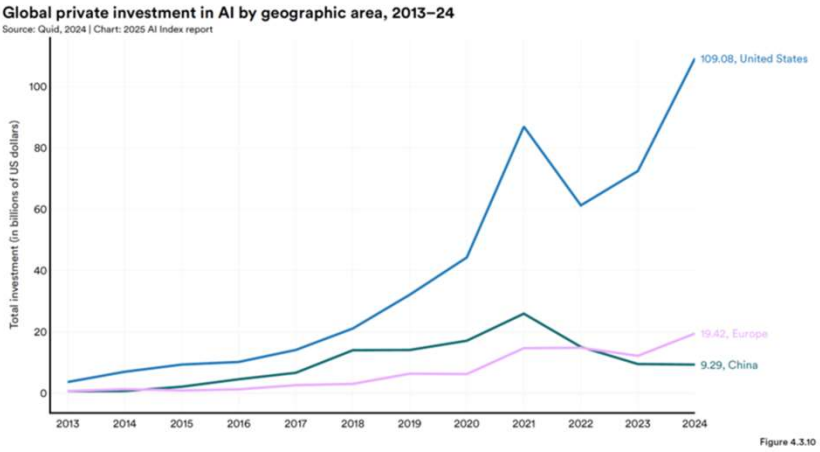


Augmentation or Automation?

AI Actress Tilly Norwood

NATIONAL ECONOMIC EDUCATION DELEGATION

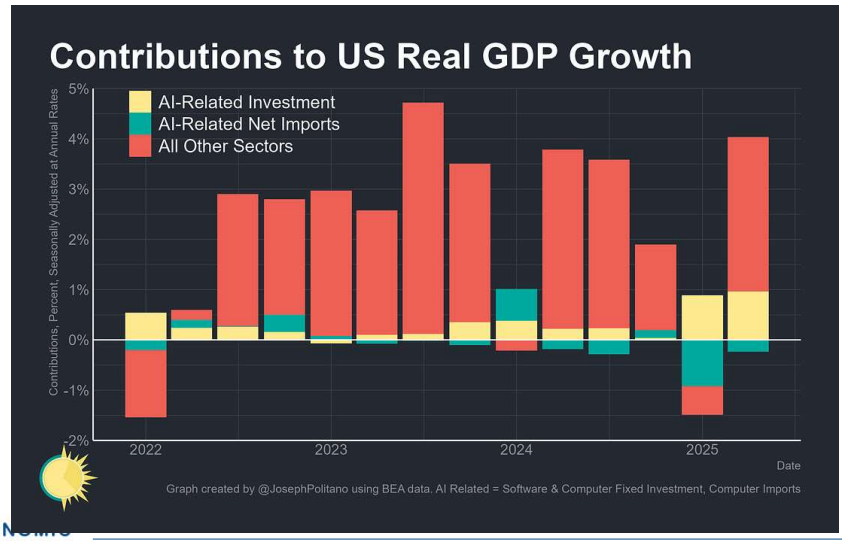
US Investment in AI is Exploding



NATIONAL ECONOMIC EDUCATION DELEGATION

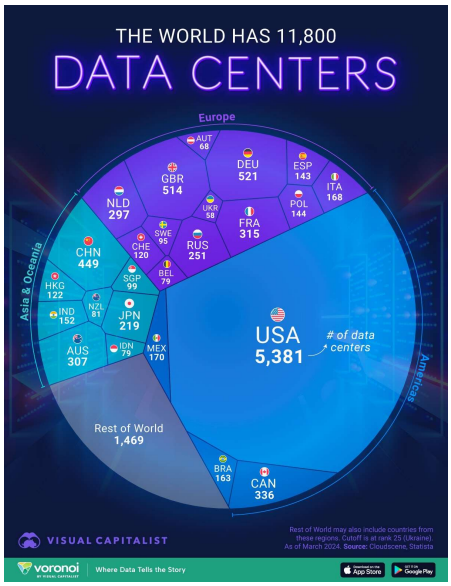
https://hai.stanford.edu/ai-index/2025-ai-index-report

AI Investment is Driving GDP Growth



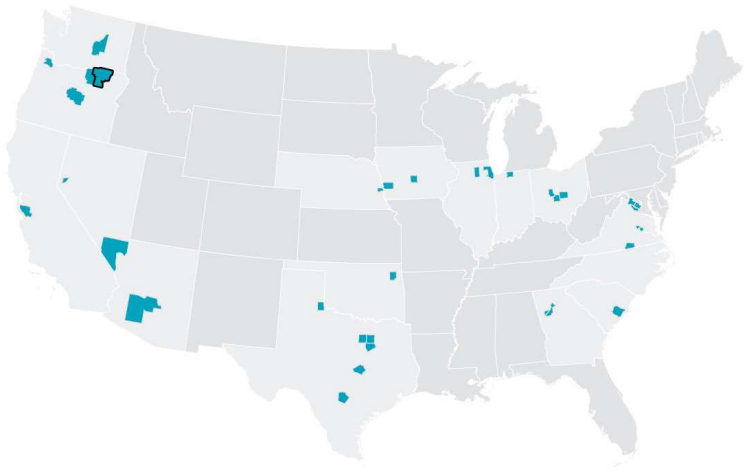
NATIONAL ECONOMIC EDUCATION DELEGATION

Data Centers



NATIONAL ECONOMIC EDUCATION DELEGATION

33 Counties Account for 72% of Data Centers

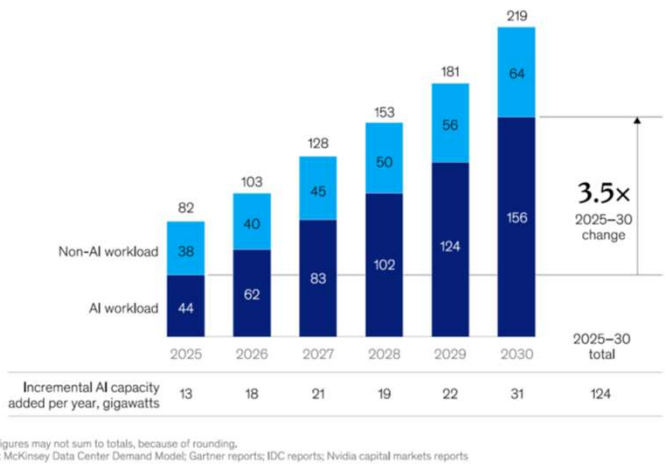


NATIONAL ECONOMIC EDUCATION DELEGATION

Source: Goldman Sachs from the *WSJ*,1/4/2025

And, It Has Only Just Begun

Estimated global data center capacity demand, 'continued momentum' scenario, gigawatts



Note: Figures may not sum to totals, because of rounding.
Source: McKinsey Data Center Demand Model; Gartner reports; IDC reports; Nvidia capital markets reports

McKinsey & Company

NATIONAL ECONOMIC EDUCATION DELEGATION

https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/the-cost-of-compute-a-7-trillion-dollar-race-to-scale-data-centers#/

One Nuclear power plant adds about 1 Gigawatt in electric capacity

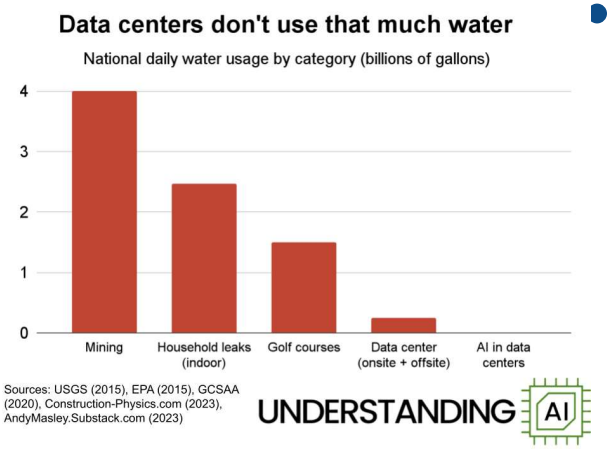
https://www.eia.gov/energyexplained/nuclear/us-nuclear-industry.php

Data Centers & Fresh Water?

"Data center developers are increasingly tapping into freshwater resources to quench the thirst of data centers, which is putting nearby communities at risk.
Large data centers can consume up to 5 million gallons *per day*, equivalent to the water use of a town populated by 10,000 to 50,000 people."

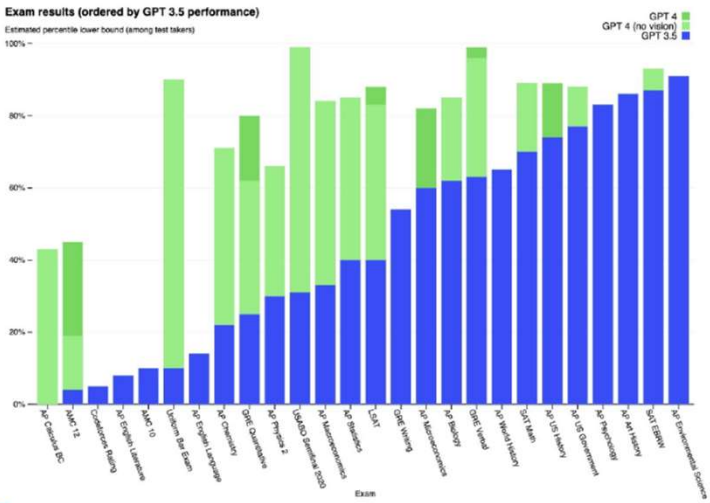
https://www.eesi.org/articles/view/data-centers-and-water-consumption

.



https://escholarship.org/uc/item/32d6m0d1

AI Is Getting "Smarter"



Eloundo, Manning, Mishkin, Rock (2023) https://ar5iv.labs.arxiv.org/html/2303.10130

How Is ChatGPT Used?

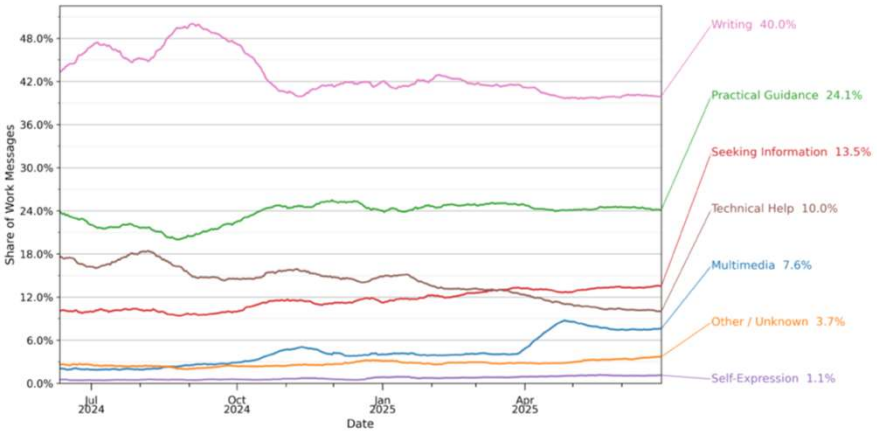
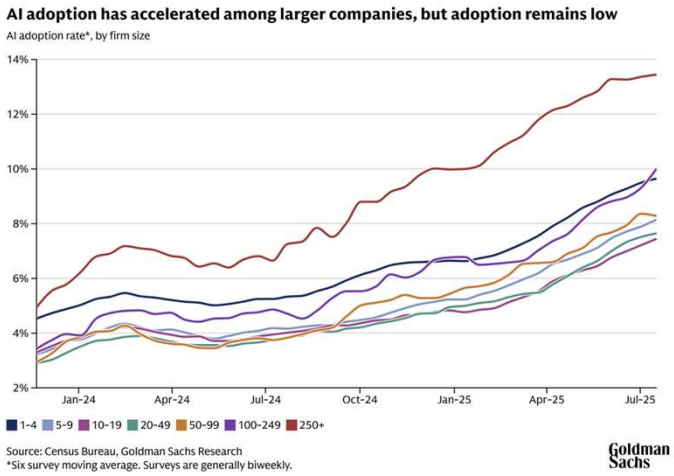


Figure 8: Share of **work related** consumer ChatGPT messages broken down by high level conversation topic, according to the mapping in Table 3. Values are averaged over a 28 day lagging window. Shares are

ChatGPT and Tasks

AI is Making it into the Workplace (slowly)



NATIONAL ECONOMIC EDUCATION DELEGATION

https://www.goldmansachs.com/insights/articles/how-will-ai-affect-the-global-workforce

Cautionary Tale: "The Internet Changes Everything"

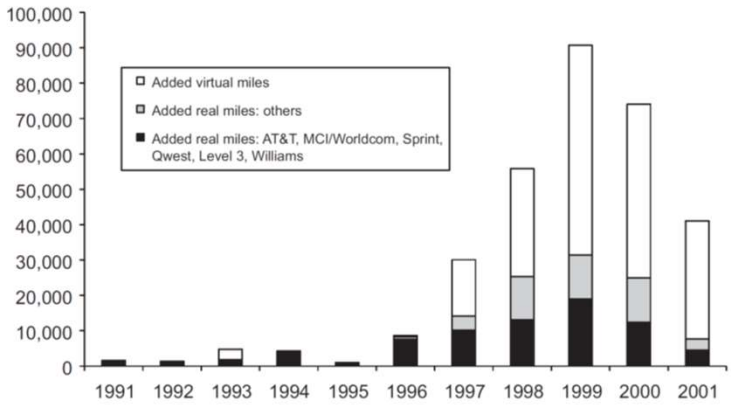
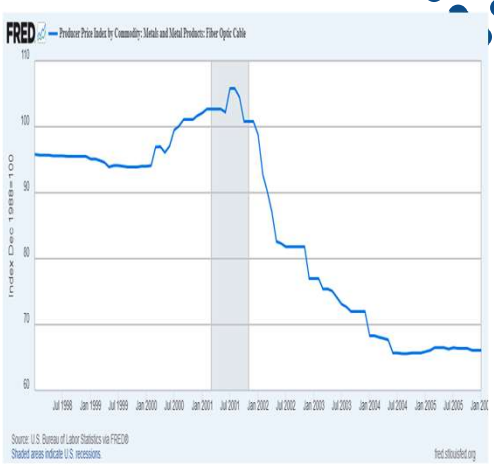


Fig. 1. Yearly additions to total route miles, 1990–2001.



NATIONAL ECONOMIC EDUCATION DELEGATION

What is the Big Deal?

- Robert Solow Paradox, 1987: "You can see the computer age everywhere but in the productivity statistics."
- *The Economist* May 2025 Echo: "Why AI hasn't taken my job?"
- But the resolution of the Solow Paradox occurred in the late 1990s with a surge of productivity growth!

How Will AI Automation Be Different?

Polyani 's Paradox: "We can know more than we can tell"

- Tacit knowledge: Tasks humans accomplish effortlessly yet cannot be explained by a set of rules: How do we recognize a piece of furniture as a chair?
- In contrast to codified knowledge or "book learning:" Instruction Manual.

Do ML models have tacit knowledge.

The Coming Disruption: The View from Microsoft

AI is Most Applicable

Job Title (Abbrv.)	Coverage	Cmpltn.	Scope	Score	Employment
Interpreters and Translators	0.98	0.88	0.57	0.49	51,560
Historians	0.91	0.85	0.56	0.48	3,040
Passenger Attendants	0.80	0.88	0.62	0.47	20,190
Sales Representatives of Services	0.84	0.90	0.57	0.46	1,142,020
Writers and Authors	0.85	0.84	0.60	0.45	49,450
Customer Service Representatives	0.72	0.90	0.59	0.44	2,858,710
CNC Tool Programmers	0.90	0.87	0.53	0.44	28,030
Telephone Operators	0.80	0.86	0.57	0.42	4,600
Ticket Agents and Travel Clerks	0.71	0.90	0.56	0.41	119,270
Broadcast Announcers and Radio DJs	0.74	0.84	0.60	0.41	25,070
Brokerage Clerks	0.74	0.89	0.57	0.41	48,060
Farm and Home Management Educators	0.77	0.91	0.55	0.41	8,110
Telemarketers	0.66	0.89	0.60	0.40	81,580
Concierges	0.70	0.88	0.56	0.40	41,020
Political Scientists	0.77	0.87	0.53	0.39	5,580
News Analysts, Reporters, Journalists	0.81	0.81	0.56	0.39	45,020
Mathematicians	0.91	0.74	0.54	0.39	2,220
Technical Writers	0.83	0.82	0.54	0.38	47,970
Proofreaders and Copy Markers	0.91	0.86	0.49	0.38	5,490
Hosts and Hostesses	0.60	0.90	0.57	0.37	425,020
Editors	0.78	0.82	0.54	0.37	95,700

AI is Least Applicable

Job Title (Abbrv.)	Coverage	Cmpltn.	Scope	Score	Empl.
Phlebotomists	0.06	0.95	0.29	0.03	137,080
Nursing Assistants	0.07	0.85	0.34	0.03	1,351,760
Hazardous Materials Removal Workers	0.04	0.95	0.35	0.03	49,960
Helpers–Painters, Plasterers, ...	0.04	0.96	0.38	0.03	7,700
Embalmers	0.07	0.55	0.22	0.03	3,380
Plant and System Operators, All Other	0.05	0.93	0.38	0.03	15,370
Oral and Maxillofacial Surgeons	0.05	0.89	0.34	0.03	4,160
Automotive Glass Installers and Repairers	0.04	0.93	0.34	0.03	16,890
Ship Engineers	0.05	0.92	0.39	0.03	8,860
Tire Repairers and Changers	0.04	0.95	0.35	0.02	101,520
Prosthodontists	0.10	0.90	0.29	0.02	570
Helpers–Production Workers	0.04	0.93	0.36	0.02	181,810
Highway Maintenance Workers	0.03	0.96	0.32	0.02	150,860
Medical Equipment Preparers	0.04	0.96	0.31	0.02	66,790
Packaging and Filling Machine Op.	0.04	0.91	0.39	0.02	371,600
Machine Feeders and Offbearers	0.05	0.89	0.36	0.02	44,500
Dishwashers	0.03	0.95	0.30	0.02	463,940
Cement Masons and Concrete Finishers	0.03	0.92	0.39	0.01	203,560
Supervisors of Firefighters	0.04	0.88	0.39	0.01	84,120
Industrial Truck and Tractor Operators	0.03	0.94	0.28	0.01	778,920
Ophthalmic Medical Technicians	0.04	0.89	0.33	0.01	73,390

NATIONAL ECONOMIC EDUCATION DELEGATION

https://www.microsoft.com/en-us/research/publication/working-with-ai-measuring-the-occupational-implications-of-generative-ai/

The Coming Disruption: The View from Microsoft

Table 5: SOC Major groups sorted by AI Applicability Score

Major Group	Coverage	Completion	Scope	Score	Employment
Sales and Related	0.56	0.89	0.51	0.32	13,266,370
Computer and Mathematical	0.64	0.86	0.48	0.30	5,177,390
Office and Administrative Support	0.56	0.89	0.49	0.29	18,163,760
Community and Social Service	0.51	0.88	0.44	0.25	2,216,930
Arts, Design, Entertainment, Sports, Media	0.59	0.80	0.49	0.25	2,039,830
Business and Financial Operations	0.49	0.89	0.47	0.24	10,087,850
Educational Instruction and Library	0.46	0.89	0.46	0.23	8,328,920
Architecture and Engineering	0.49	0.84	0.46	0.22	2,523,090
Personal Care and Service	0.39	0.90	0.45	0.20	2,959,620
Life, Physical, and Social Science	0.39	0.88	0.46	0.20	1,381,930
Food Preparation and Serving Related	0.32	0.91	0.43	0.18	13,142,870
Management	0.27	0.90	0.45	0.14	10,445,050
Protective Service	0.33	0.84	0.40	0.14	3,484,710
Legal	0.33	0.89	0.42	0.13	1,196,870
Healthcare Practitioners and Technical	0.25	0.91	0.39	0.12	9,251,930
Installation, Maintenance, and Repair	0.22	0.92	0.41	0.11	5,979,150
Production	0.23	0.91	0.41	0.11	8,419,460
Transportation and Material Moving	0.21	0.92	0.38	0.11	13,664,940
Building, Grounds Cleaning, Maintenance	0.15	0.94	0.38	0.08	4,403,350
Construction and Extraction	0.16	0.92	0.40	0.08	6,188,720
Farming, Fishing, and Forestry	0.11	0.92	0.39	0.06	422,740
Healthcare Support	0.13	0.90	0.38	0.05	7,063,540

NATIONAL ECONOMIC EDUCATION DELEGATION

https://www.microsoft.com/en-us/research/publication/working-with-ai-measuring-the-occupational-implications-of-generative-ai/

But is It Augmentation or Substitution?

- **Specific Occupations:**
  - Interpreters with the highest applicability score of .49?
  - Substitution.
  - How about Writers and Authors with a sore of .45?
  - Technical Writers, probably substitution.
  - Creative Writers, possibly augmentation.

Examples of Augmentation and Substitution

- **Augmentation: Air Traffic Controller. AI processes flight data while leaving decisions to humans, keeping wages high.**
- **Substitution: AI can increase the number of cases where a customers' problem can be solved without human involvement, lowering demand for humans and their wages.**

https://www-economist-com/finance-and-economics/2025/02/13/how-ai-will-divide-the-best-from-the-rest

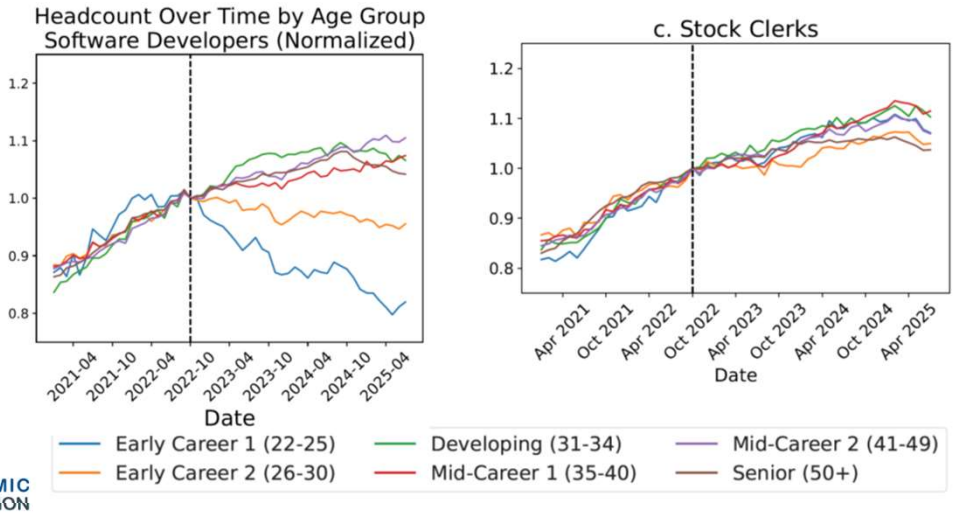
How will AI Disruption Be Different

- **Pre AI Technological Disruption to:**
  - Low and Middle-Skill workers, routine tasks.
  - Correlated with education.
- **AI will affect jobs requiring book learning, not tacit knowledge**
  - Some High Skill: computer programmers, highly affected.
  - Most Low Skill: Blue collar, not highly affected.

So, AI will likely affect more high-income, college-educated workers, who will be displaced into lower paying jobs.

Canaries in the Coal Mine?

Brynjolfsson, Chandar and Chen, August 26, 2025. Stanford economists systematic investigation of employment effects of AI using detailed payroll data from 1/21 to 7/25 https://digitaleconomy.stanford.edu/wp-content/uploads/2025/08/Canaries_BrynjolfssonChandarChen.pdf



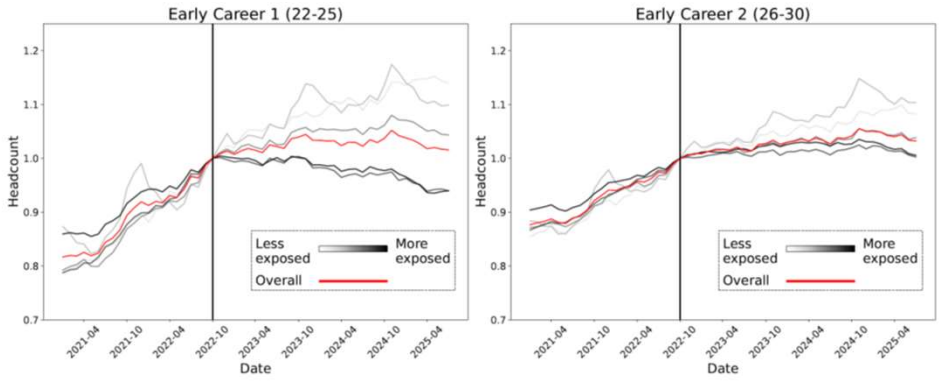
What Explains The Difference?

- **Remember Two Kinds of Knowledge?**
  - Codified knowledge: "book learning" from formal education
  - Tacit Knowledge: idiosyncratic tips and tricks that accumulate with experience.
- **What kind of knowledge is AI better at?**
- **What kind of knowledge is more important for a programmer; for a stock clerk?**
- **What kind of knowledge is more likely to be *augmented* by AI?**

Wage Polarization with AI

- **Early 21st Century Technology: Machines substitute for humans in *routine* work.**
- **AI Technology: AI substitutes for humans in work that requires *codified* skills.**
- **What is the difference?**
- **Ask a computer programmer.**
- **AI polarization will displace workers further up the traditional levels of skill.**

Evidence of AI Substitution



NATIONAL ECONOMIC EDUCATION DELEGATION

And, It is Apparently Becoming Importanty

***WSJ*, Headline, 10/28**

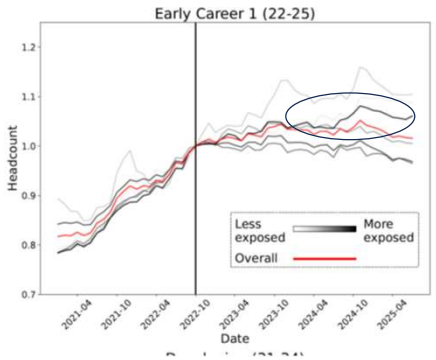
"Tens of Thousands of White-Collar Jobs Are Disappearing as AI Starts to Bite"

"Layoffs at companies from Amazon to Target are sending young and experienced workers alike into unwelcoming market."

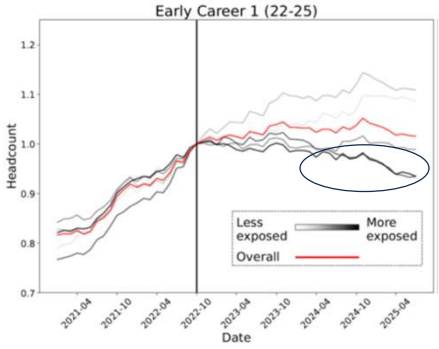
NATIONAL ECONOMIC EDUCATION DELEGATION

Evidence of Augmentation?

AI Searches "Augmentative"



AI Searches "Automative"



Brynjolfsson et.al., "Entry-level employment has declined in applications of AI that *automate* work, with muted changes for *augmentation.*

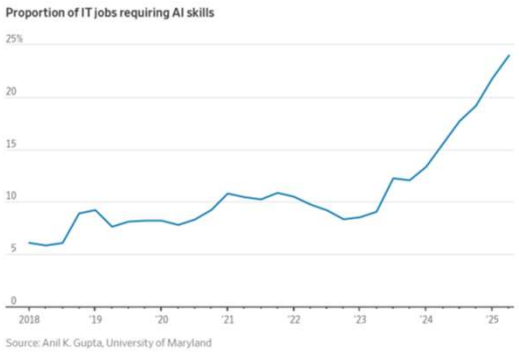
But, There is Some Evidence of AI Augmentation

These AI-Skilled 20-Somethings Are Making Hundreds of Thousands a Year

Companies are snapping up 'AI native' grads; 'under 25, you can be making a million'

By Katherine Bindley Follow

Aug. 26, 2025 8:00 pm ET



Brynjolfsson et.al. Conclusion

"The adoption of new technologies typically leads to heterogeneous effects across workers, resulting in an adjustment period as workers reallocate from displaced forms of work to new forms with growing labor demand (Autor et al., 2024). Such endogenous adjustment may already be happening with AI, with emerging evidence of shifts in college majors away from AI-exposed categories such as computer science (Horowitch, 2025). Past transitions such as the IT revolution ultimately led to robust growth in employment and real wages following physical and human capital adjustments, with some workers benefiting more than others (Bresnahan et al., 2002; Brynjolfsson et al., 2021).

Tracking employment trends on an ongoing basis will help determine if the adjustment to AI follows a similar pattern."

Optimistic or Pessimistic?

The Future Assuming, AI is a "Big Deal"

- **Suppose computer expertise *substitutes* for human expertise, so that the only work left for humans is unskilled and low paying**
- **But, the productivity of computers is so great that we live in a world of abundance.**
- **Keynes (1930) *Economic Possibilities for our Grandchildren***
  - I draw the conclusion that, assuming no important wars and no important increase in population [climate change?], the *economic problem* [scarcity] may be solved [in 100 years].
  - Thus, for the first time …man will be faced with his real, his permanent problem-how to use his freedom from pressing economic cares, how to occupy the leisure…, to live wisely and agreeably and well.

Problems with Keynes' Vision

- How do people lead meaningful lives without meaningful work?
- Given that the value of human skill is eliminated, how do we manage to share the abundance? Will the owners of AI resources be more like Bill Gates or Elon Musk?
- David Autor on a podcast has described the Musk case as a Mad Max scenario: "The more likely scenario to me looks much more like Mad Max: Fury Road, where everybody is competing over a few remaining resources that aren't controlled by some warlord somewhere." (https://podcasts.apple.com/us/podcast/david-autor-on-ais-impact-on-jobs-expertise-and-labor/id1677184070?i=1000715406677)

A Better Path:

- AI becomes a General Productivity Technology that *augments* human skills and leads to
  1. Meaningful work done by humans, without requiring education emphasizing codified knowledge.
  2. Generally shared prosperity of workers and owners
  3. New products and services.
- Great, but how do we get there?

Blueprint of Acemoglu, Autor and Johnson (10/23)

At this time, the five most important federal policies should be:

1. Equalize tax rates on employing workers and on owning equipment/algorithms to level the playing field between people and machines.

2. Update Occupational Safety and Health Administration rules to create safeguards (i.e. limitations) on the surveillance of workers. Finding ways to elevate worker voice on the direction of development could also be helpful.

NATIONAL ECONOMIC EDUCATION DELEGATION

https://cepr.org/voxeu/columns/how-ai-can-become-pro-worker#:~:text=The%20automation%20of%20blue%2Dcollar,onto%20this%20human%2Dcomplementary%20path.

Blueprint (Cont.)

3. Increase funding for human-complementary technology research, recognizing that this is not currently a private sector priority.

4. Create an AI center of expertise within the government, to help share knowledge among regulators and other officials.

5. Use that federal expertise to advise on whether purported human complementary technology is appropriate to adopt in publicly provided education and healthcare programmes, including at the state and local level.

NATIONAL ECONOMIC EDUCATION DELEGATION

Also, Well Worth a Read

Can we shape the Future of AI?

https://sites.google.com/view/macro-current-issues/ai-inequality

Let's Hear from You!

Geoffrey Woglom
grwoglom@amherst.edu

Contact NEED: Info@NEEDEcon.org

Submit a testimonial:
www.NEEDEcon.org/testimonials.php

Support NEED: www.NEEDEcon.org/donate.php