

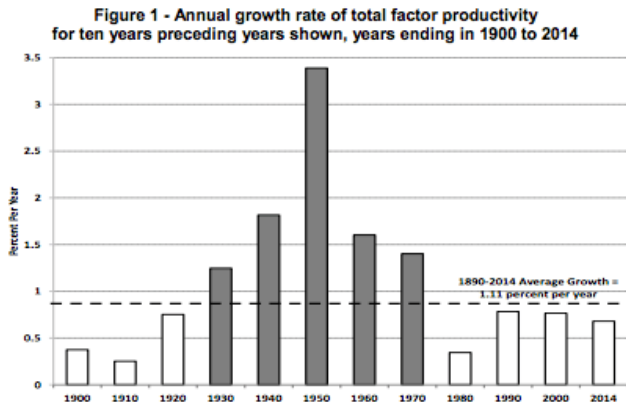
Automation and Work

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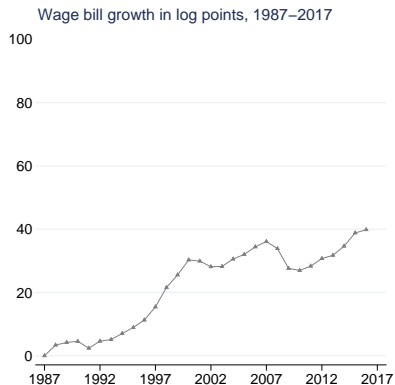
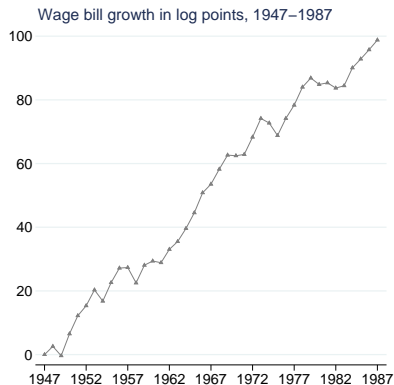
A Bleak Record



(Gordon, 2016)

Difficult to explain these trends with mismeasurement of productivity.
What is going on?

Even Worse in the Labor Market

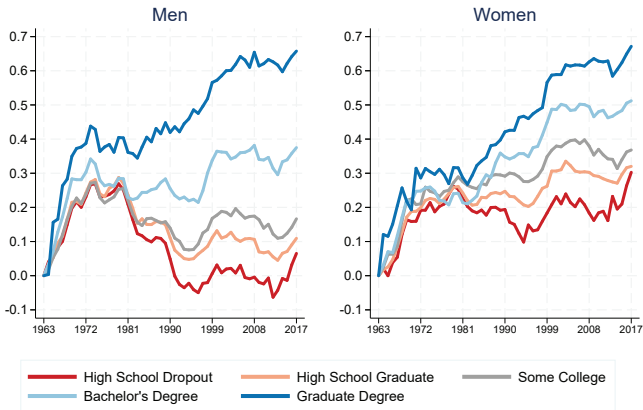


The data points to anemic growth of labor demand from 1987 to 2017. Labor demand roughly stagnant since 2000.

Wages

Technology of the last several decades, as opposed to what we used to have, looks nothing like a tide lifting all boats.

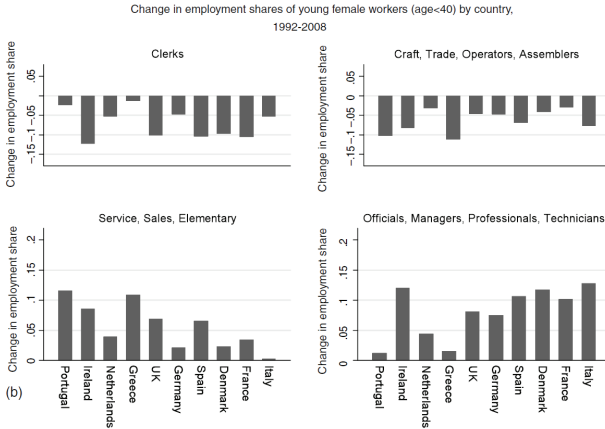
Cumulative Change in Real Log Weekly Earnings 1963 - 2017
Working Age Adults, Ages 18 - 64



(Autor, 2019)

Displacement: Not Just a US Phenomenon

Similar polarization of employment— but not of wages, indicating an important role for labor market institutions.



(Acemoglu and Autor, 2011)

Thinking in Terms of Tasks: Motivation

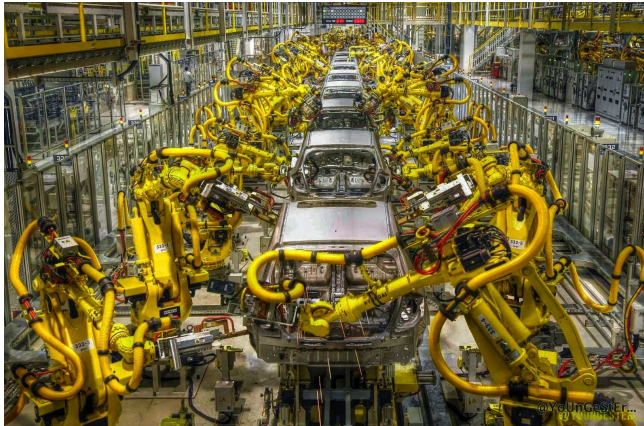
Production requires a range of tasks or industrial processes.

Automation in history: **machines and computers used to substitute for human labor in an expanding range of tasks:**

1. In agriculture, horse-powered reapers, harvesters, and threshing machines replaced manual labor working with rudimentary tools.
2. Machine tools, such as lathes and milling machines, replaced labor-intensive production techniques relying on skilled artisans.
3. Industrial robotics automated remaining labor-intensive processes in some industries: welding, machining, assembly, and packaging.
4. Software automated routine tasks performed by white-collar workers in clerical and sales jobs.

But at the same time, **new tasks in which labor has a comparative advantage** have created employment opportunities.

Thinking in Terms of Tasks: Automation



Examples of automated tasks: assembly, switchboard operation, mail sorting, packing, stock trading, dispensing cash, operating machines.

Thinking in Terms of Tasks: Just a Tiny Bit of Math

Output produced according to

$$Y = \left(\int_{N-1}^N Y(z)^{\frac{\sigma-1}{\sigma}} dz \right)^{\frac{\sigma}{\sigma-1}},$$

where $Y(z)$ denotes the output of task z for $z \in [N-1, N]$ and $\sigma \geq 0$ is the elasticity of substitution between tasks.

Tasks can be produced using capital or labor:

$$Y(z) = \begin{cases} A^L \gamma^L(z) l(z) + A^K \gamma^K(z) k(z) & \text{if } z \in [N-1, I] \\ A^L \gamma^L(z) l(z) & \text{if } z \in (I, N]. \end{cases}$$

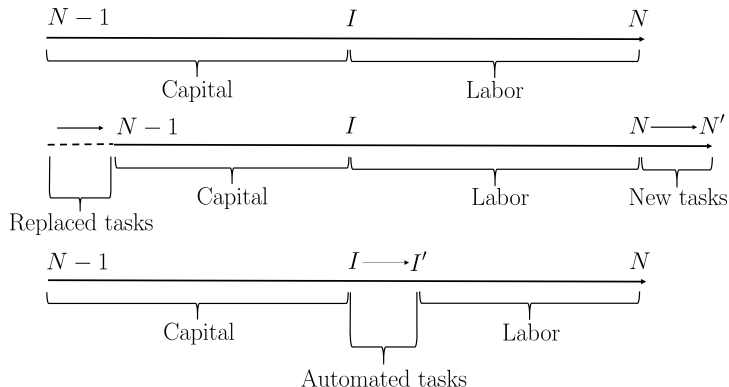
I = automation; N = new tasks.

$\gamma^L(z)/\gamma^K(z)$ is increasing in z , so that labor has a *comparative advantage* in higher-indexed tasks, and that $\gamma^L(z)$ increasing in z .

Assume new tasks are used immediately and capital used up to task I .

Thinking in Terms of Tasks: Automation and New Tasks

Capital, K , used on tasks $[N - 1, I]$; labor, L , used on tasks (I, N) .



Automation squeezes labor into a smaller set of tasks.

The creation of new tasks in which labor has a comparative advantage expands the set of tasks for labor.

Thinking in Terms of Tasks: Automation

Effect of automation on the labor demand:

Effect of automation on labor demand = Productivity effect + Displacement

The displacement effect is always negative.

Without the displacement effect, the labor share would remain constant. With the displacement effect, the labor share declines.

If the displacement effect is large, labor demand declines even though we have technological progress.

Worst-case scenario for labor: “so-so technologies,” large displacement effect and small productivity gains.

Thinking in Terms of Tasks: New Tasks

The effects of creation of new tasks in which labor has a competitive advantage—an expansion in N —can be determined similarly.

Effect of new tasks on labor demand = **Productivity effect** + **Reinstatement**

The reinstatement effect is always positive.

Without the reinstatement effect, the labor share in value added would remain constant.

With the reinstatement effect, the labor share always increases.

Multi-Sector Economy: Summary

Consider a multi-sector economy.

Changes in economy-wide labor demand, WL , can be decomposed as:

$$\begin{aligned} \text{Overall change in labor demand} &= \text{Productivity effect} \\ &+ \text{Composition effect} \\ &+ \text{Substitution effects} \\ &+ \text{Change in task content} \end{aligned}$$

Patterns in Labor Share 1947-1987

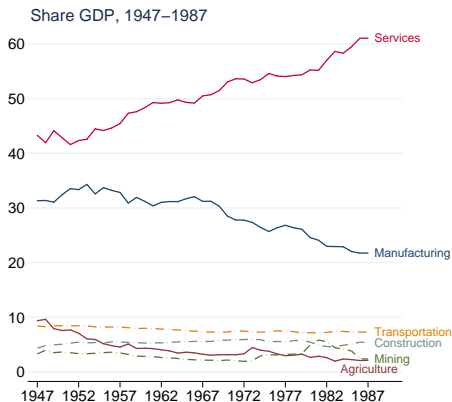
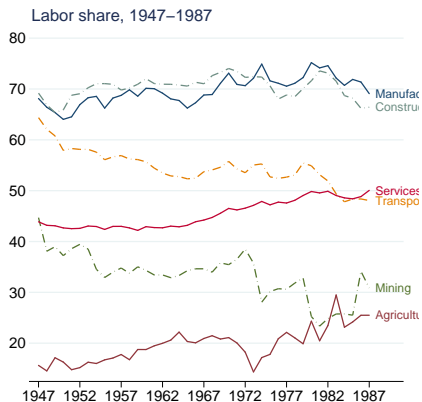


Figure: The labor share and sectoral evolutions, 1947-1987.

Decomposing Labor Demand, 1947-1987

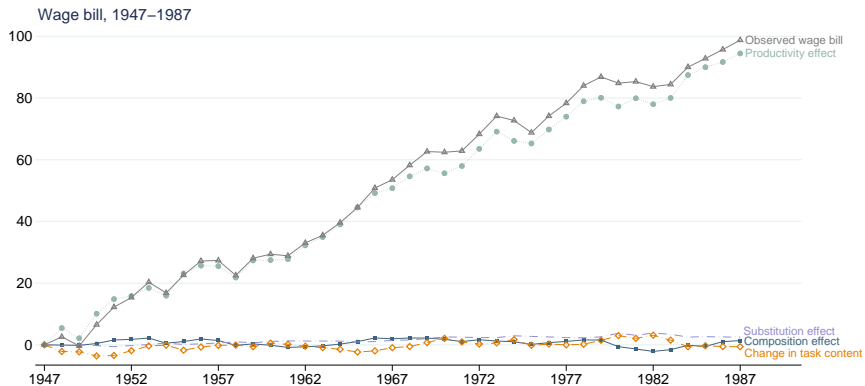


Figure: Sources of changes in labor demand, 1947-1987.

Displacement and Reinstatement, 1947-1987

Change in task content = **displacement** + **reinstatement**.

Requires two additional assumptions:

1. no technological regress
2. at a point in time, an industry either automates or creates new tasks

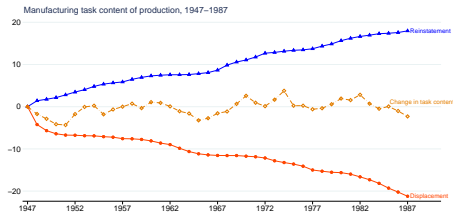
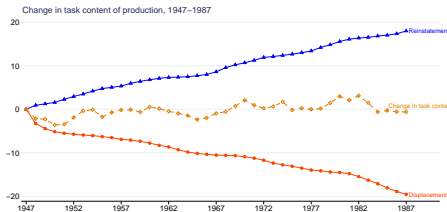


Figure: Estimates of the displacement and reinstatement effects, 1947-1987.

Patterns in Labor Share, 1987-2017

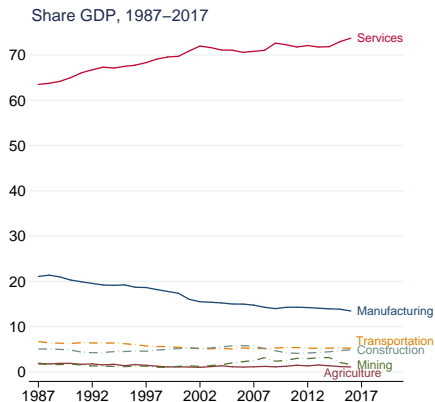
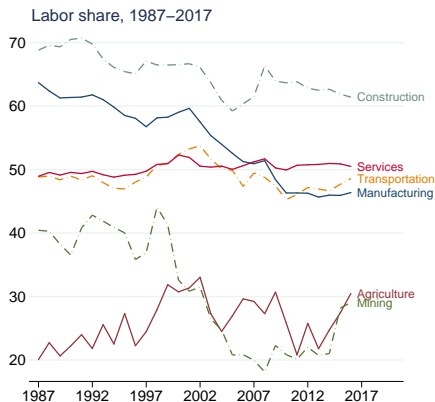


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Decomposing Labor Demand, 1987-2017

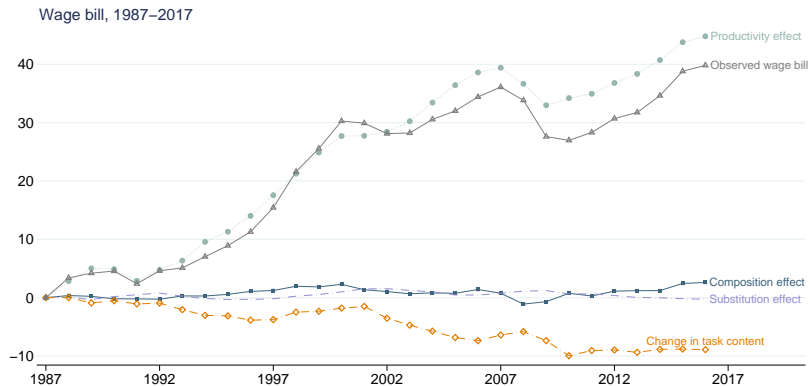


Figure: Sources of changes in labor demand, 1987-2017.

Displacement and Reinstatement, 1987-2017

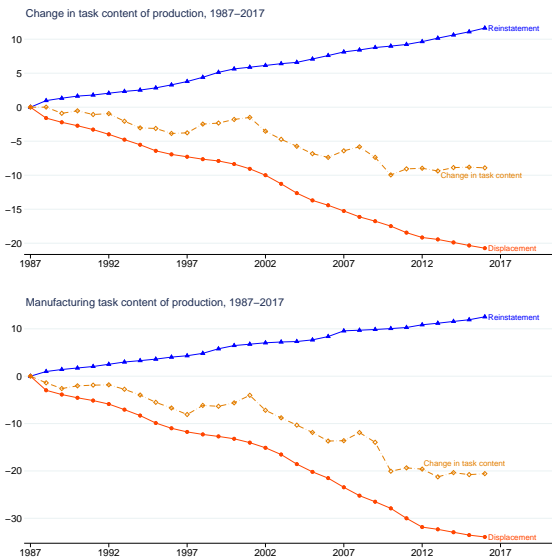


Figure: Estimates of the displacement and reinstatement effects, 1987-2017.

Explaining Changes in Task Content: Automation

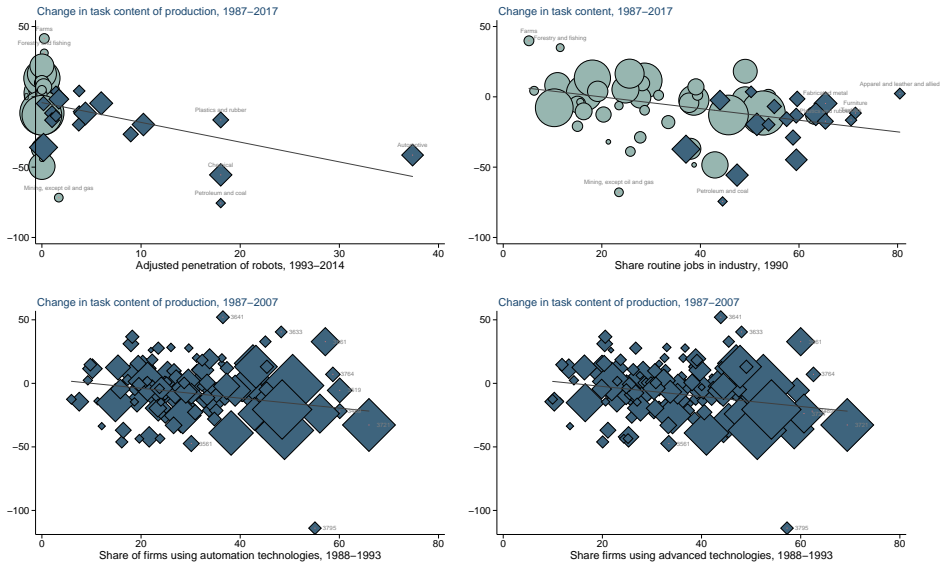


Figure: Automation technologies and change in the task content of production.

Explaining Changes in Task Content: New Tasks

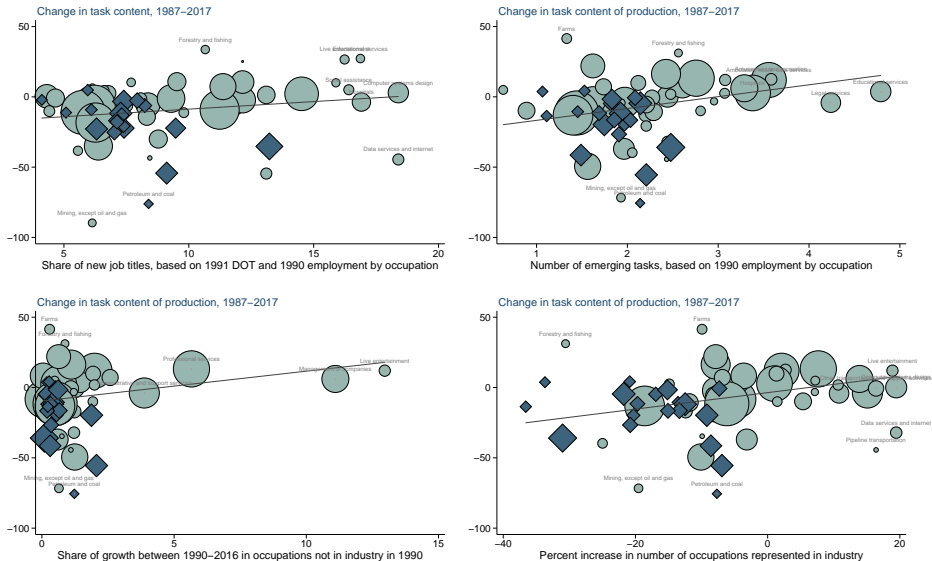


Figure: New tasks and change in task content of production.

Decomposing Labor Demand: Decomposition, 1850-1910

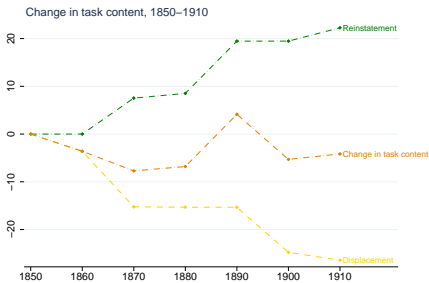
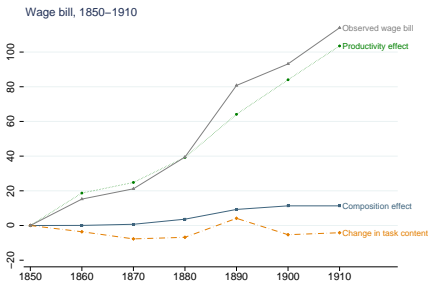
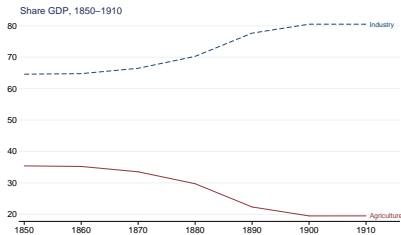
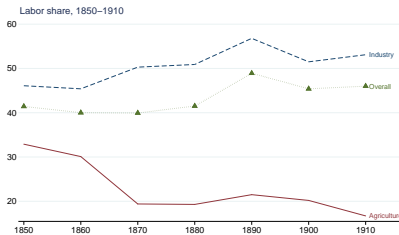
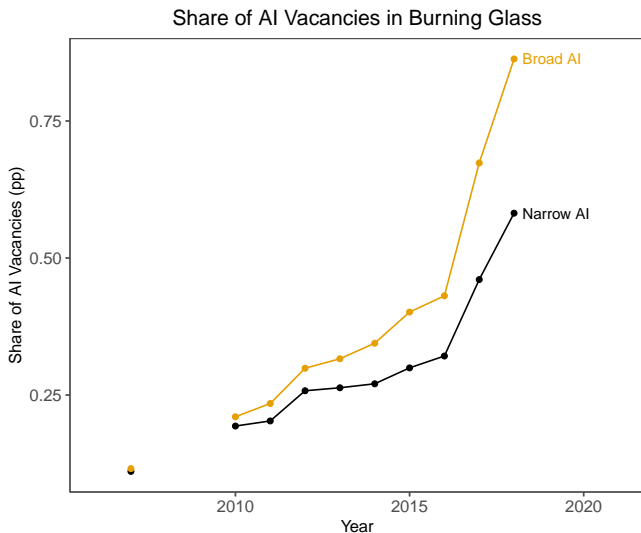


Figure: The labor share, sectoral evolutions, and the sources of labor demand, 1850-1910.

Will AI Make Things Even Worse?

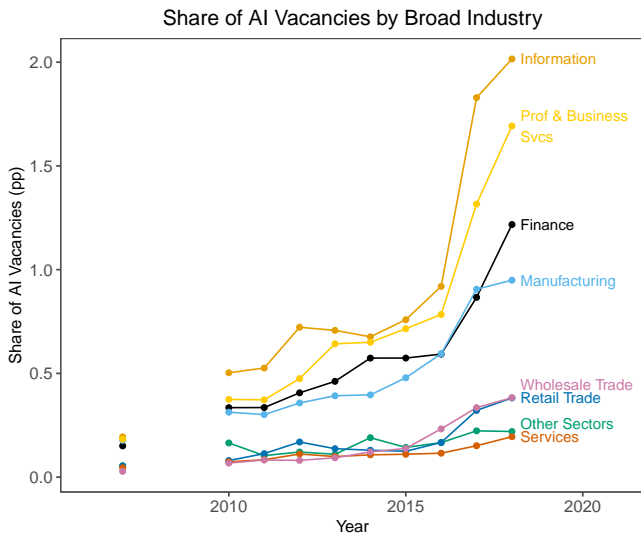
- ▶ Perhaps. Automation is one of the things AI technologies are targeting.
- ▶ But AI is a general technological platform, and it can be used in many different ways (for example, in education and health care).
- ▶ The study of AI is hampered by the fact that it is just getting going and there are no good datasets of AI adoption.
- ▶ But we can get the first glimpse of the implications of AI from online vacancy postings, which show a surge in AI-related postings.

AI Vacancies Over Time



- narrow AI vacancies up from 0.1% to 0.6%

AI Vacancies Over Time



- AI vacancies rising in retail, wholesale, manufacturing, finance, information technologies, business services

Exposure to Opportunities for AI

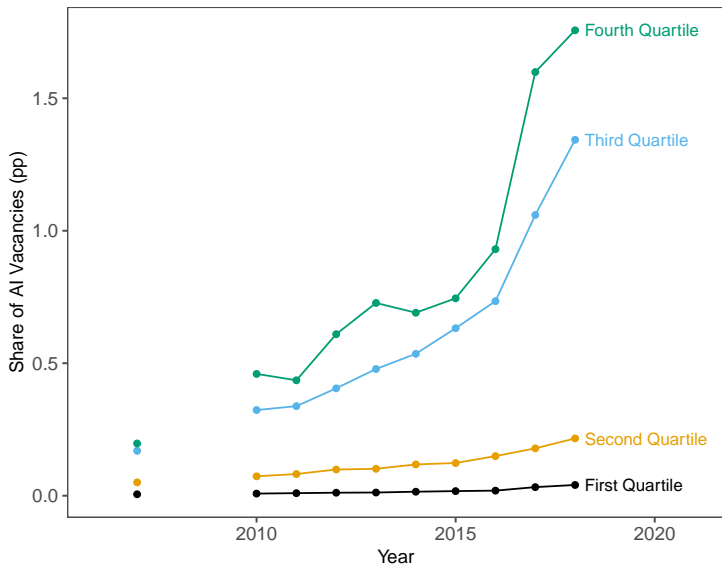
- **AI exposure measure** at the establishment level, s :

$$\text{AI exposure}_{st_0} = \sum_j \text{Share postings}_{jst_0} \times \text{AI Occupational Impact}_j$$

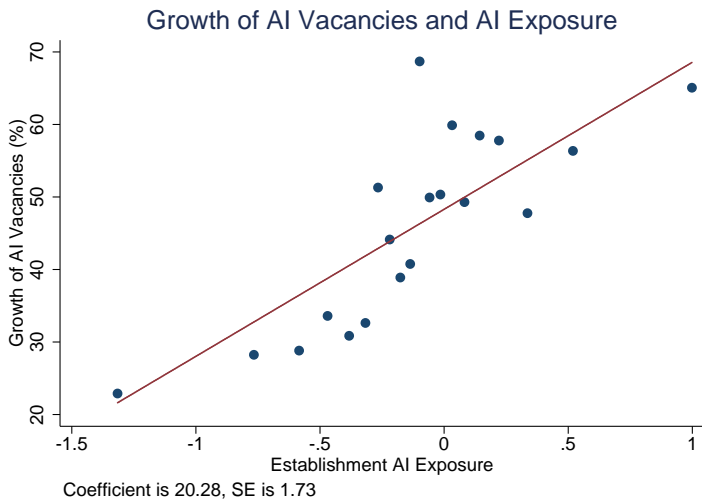
- Summation runs over 815 detailed occupations, j .
- AI Occupational Impact $_j$ stands for Felten et al.'s measure.
- AI exposure measure based on $t_0 = 2010 - 2012$ job postings or $t_0 = 2007$ in robustness exercises.
- Establishments with a higher AI exposure $_{st_0}$ have greater opportunities to replace some of their current workers with AI software as these algorithms improve.
- We standardize exposure measure across establishments to ease interpretation.

Opportunities for Substitution and AI Postings

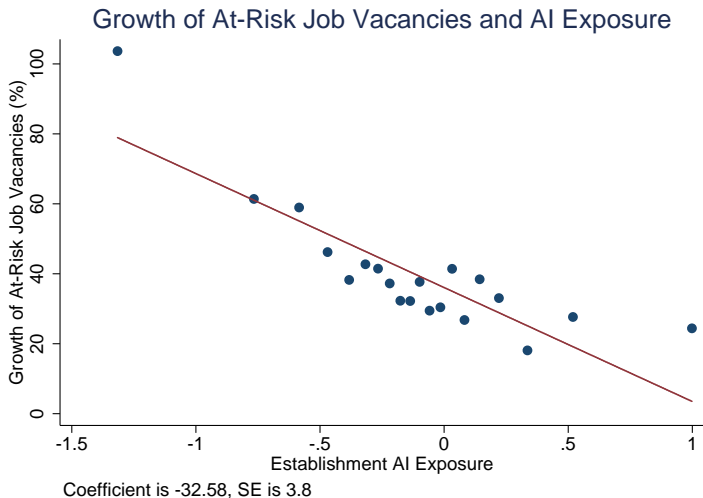
Share of AI Vacancies by Quartile of Establishment AI Exposure



Opportunities for Substitution and AI Postings

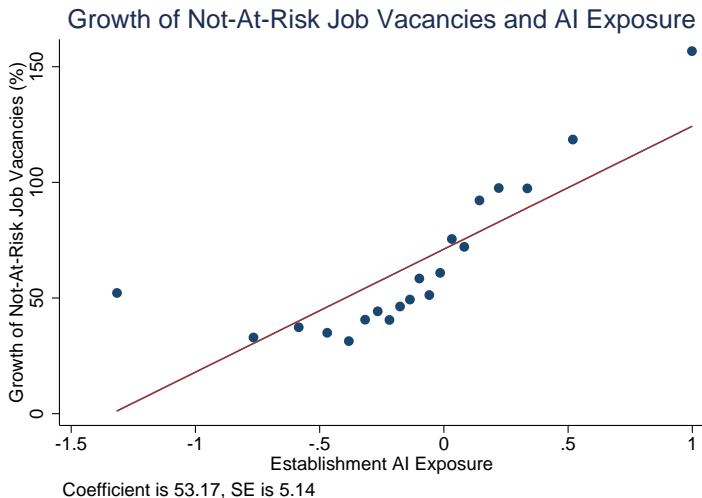


At-Risk Jobs Decline



- **At-risk jobs:** top 50% occupations with the highest AI impact according to Felten et al.

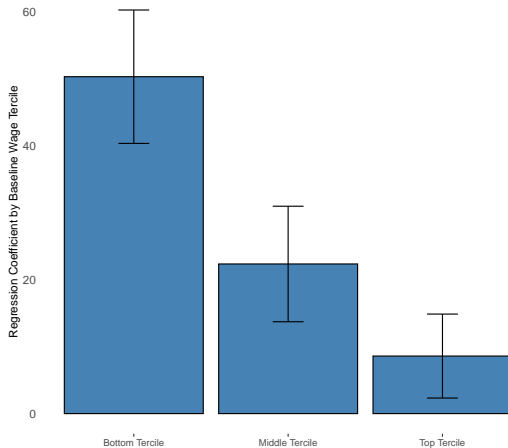
Not-At-Risk Jobs Expand



- **Not-at-risk jobs:** bottom 50% occupations with the lowest AI impact according to Felten et al.

Explaining Rise in Postings of Not-at-risk Jobs

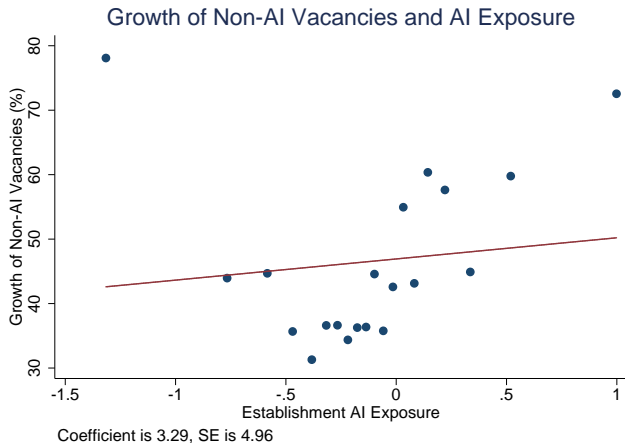
Regression of Not-At-Risk Vacancy Growth (%) on AI Exposure



Note: Controls for deciles of firm size, sales + admin baseline shares, CZ and 4 digit industry FEs

- But rise more pronounced among low-wage occupations.

No Effect on Overall Postings



- Bin-scatterplot for the model in column 1, using AI exposure based on Felten et al. measure.

Will AI Make Things Even Worse? What We Know so Far

- ▶ Evidence that AI is displacing some jobs, but also some job creation.
- ▶ However, new jobs seem to come from the lower end of the skill and wage distribution.
- ▶ Still early days.
- ▶ Critical may be the impact of AI on productivity.

Why Has Productivity Growth Been so Bad Lately?

Prospects for future productivity growth?

The pessimistic view: because the new technologies are not worth that much (e.g., Gordon).

...But then why are firms adopting them and shedding labor?

The optimistic view: it's all temporary.

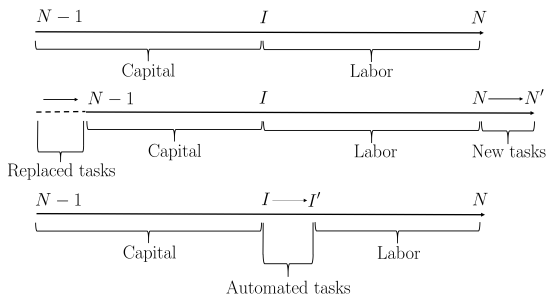
...But this has been going on for quite a while as we have seen.

Three possibilities in a world of **replacing technologies**:

1. **so-so technologies;**
2. **the wrong kinds of innovation;**
3. **bottlenecks.**

The Wrong Kinds of Innovation

New tasks: source of comparative advantage for labor and productivity growth:



But if we are devoting too much resources to replace tasks and not enough for creating new tasks, both labor and productivity will suffer.

- ▶ Most evident in the area of AI, which can be used not just for replacement but for creating new tasks and functions.

Engel's Pause: Bottlenecks Again?

Parallels to “Engel's pause”: No wage growth from the beginning of the Industrial Revolution around 1760 to about 1850 despite very rapid technological change and technology adoption in Britain.

- ▶ Why? Partly because the demand for labor did not build up sufficiently or new technologies were not properly implemented while employers were experimenting with the new technologies.
- ▶ But all of the above bottlenecks were important also — the real productivity gains were not fully realized until many sectors started improving together; organizations changed; there was an institutional revolution, including major democratizations and bureaucratic reforms and the beginnings of the fiscal state; and **mass schooling**.

Perhaps our progress will be as in the case of Engel's pause, or will it?