Automation and Work

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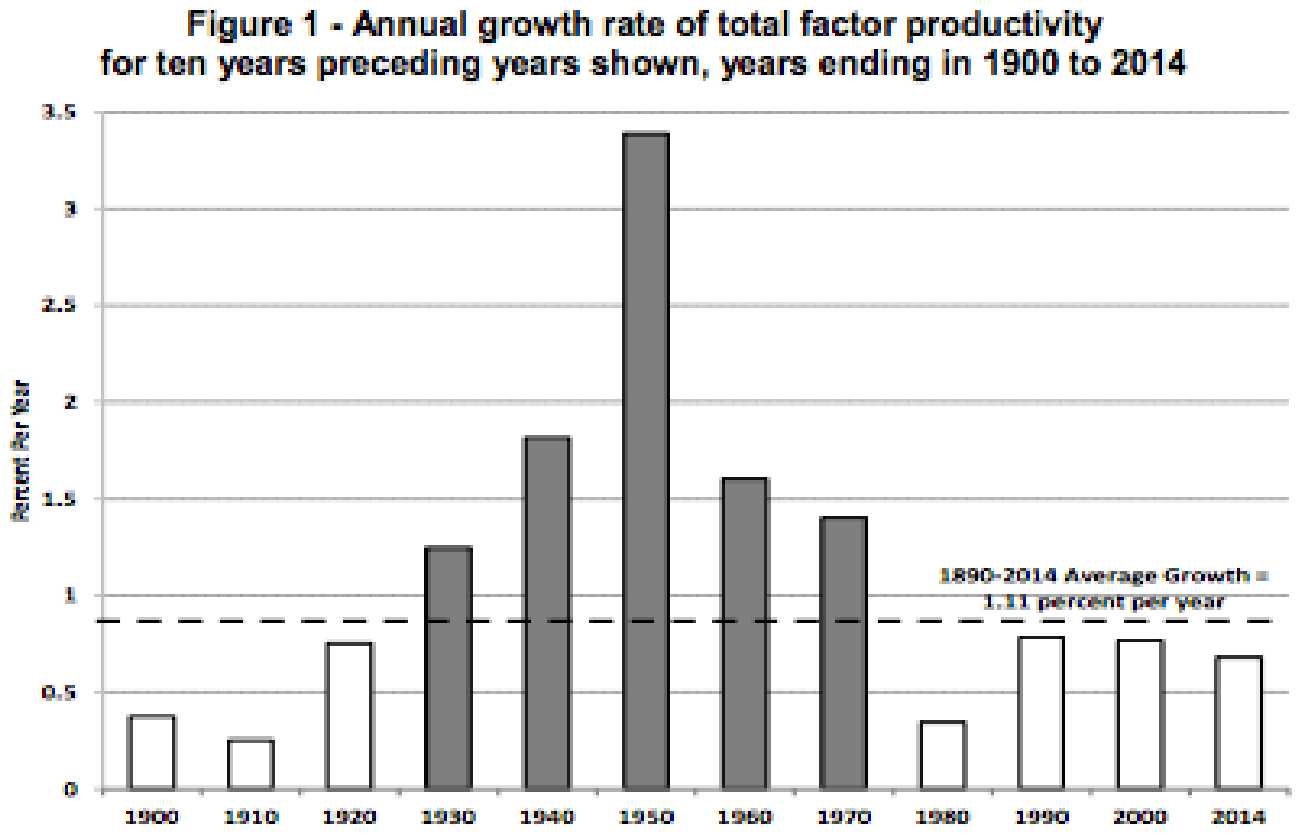
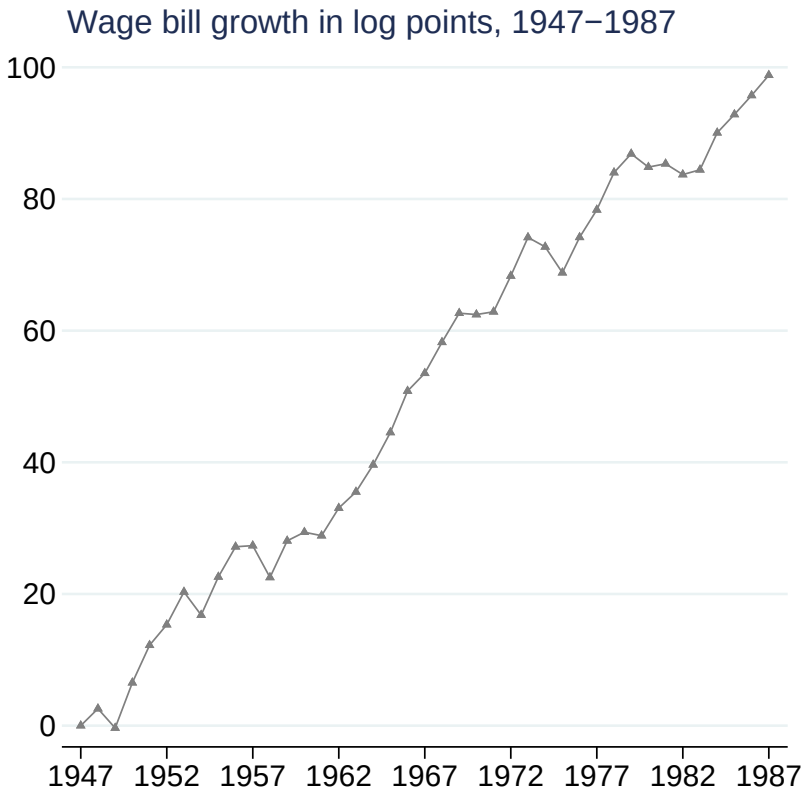
A Bleak Record

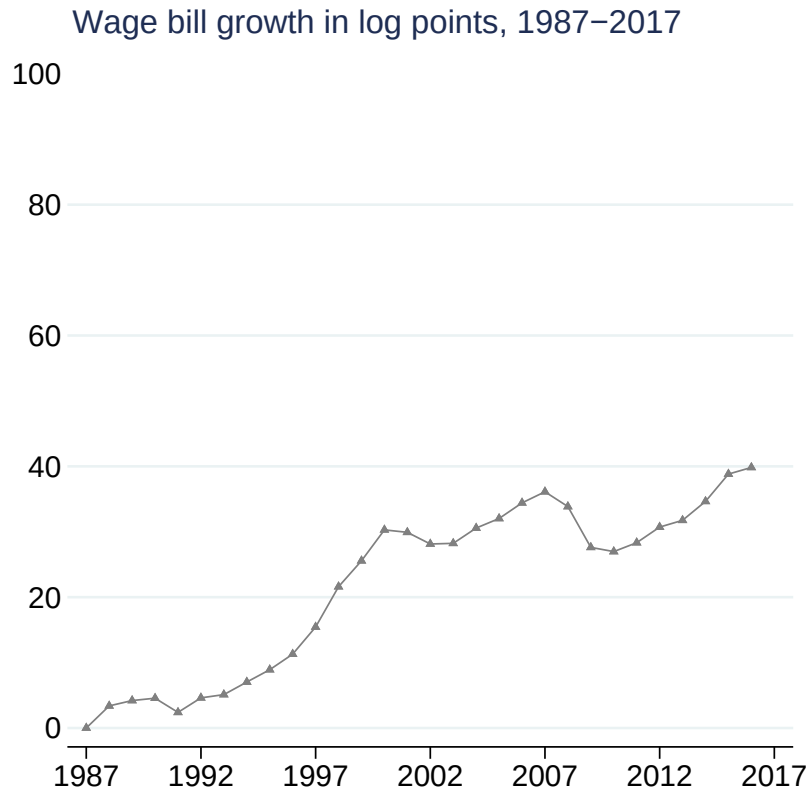


(Gordon, 2016)

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

Even Worse in the Labor Market

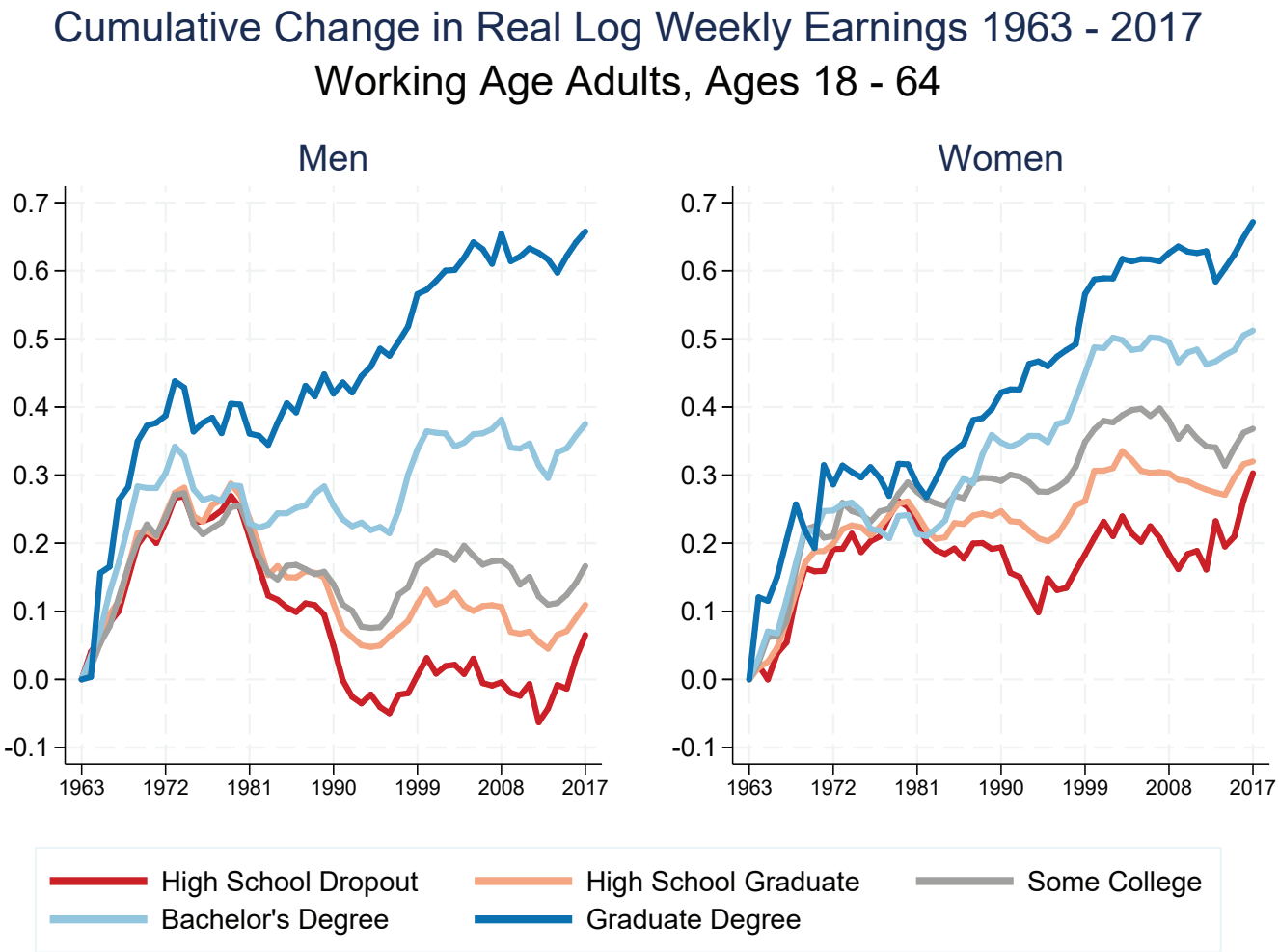




- The data points to anemic growth of labor demand from 1987 to 2017.
- Labor demand roughly stagnant since 2000.

Wages

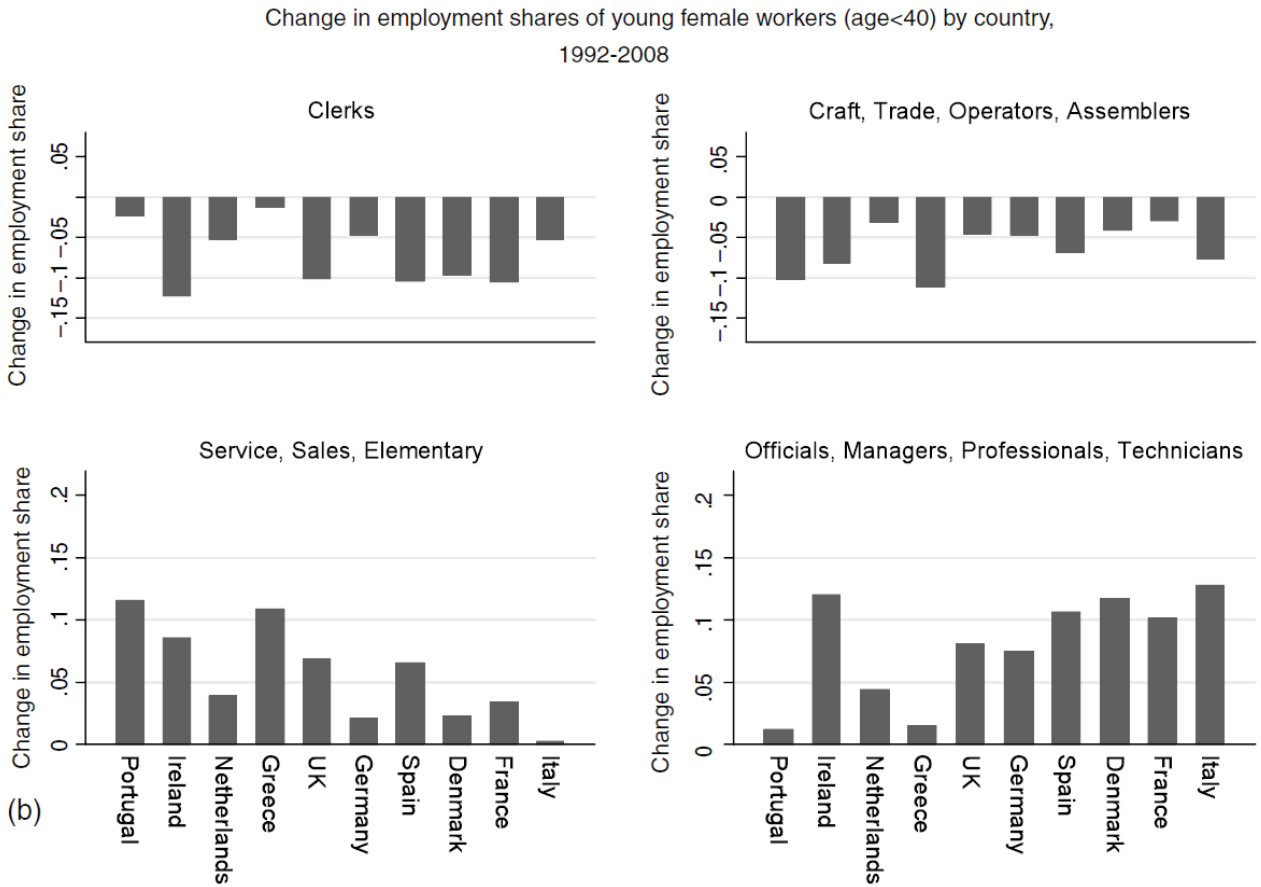
- Technology of the last several decades, as opposed to what we used to have, looks nothing like a tide lifting all boats.



(Autor, 2019)

Displacement: Not Just a US Phenomenon

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

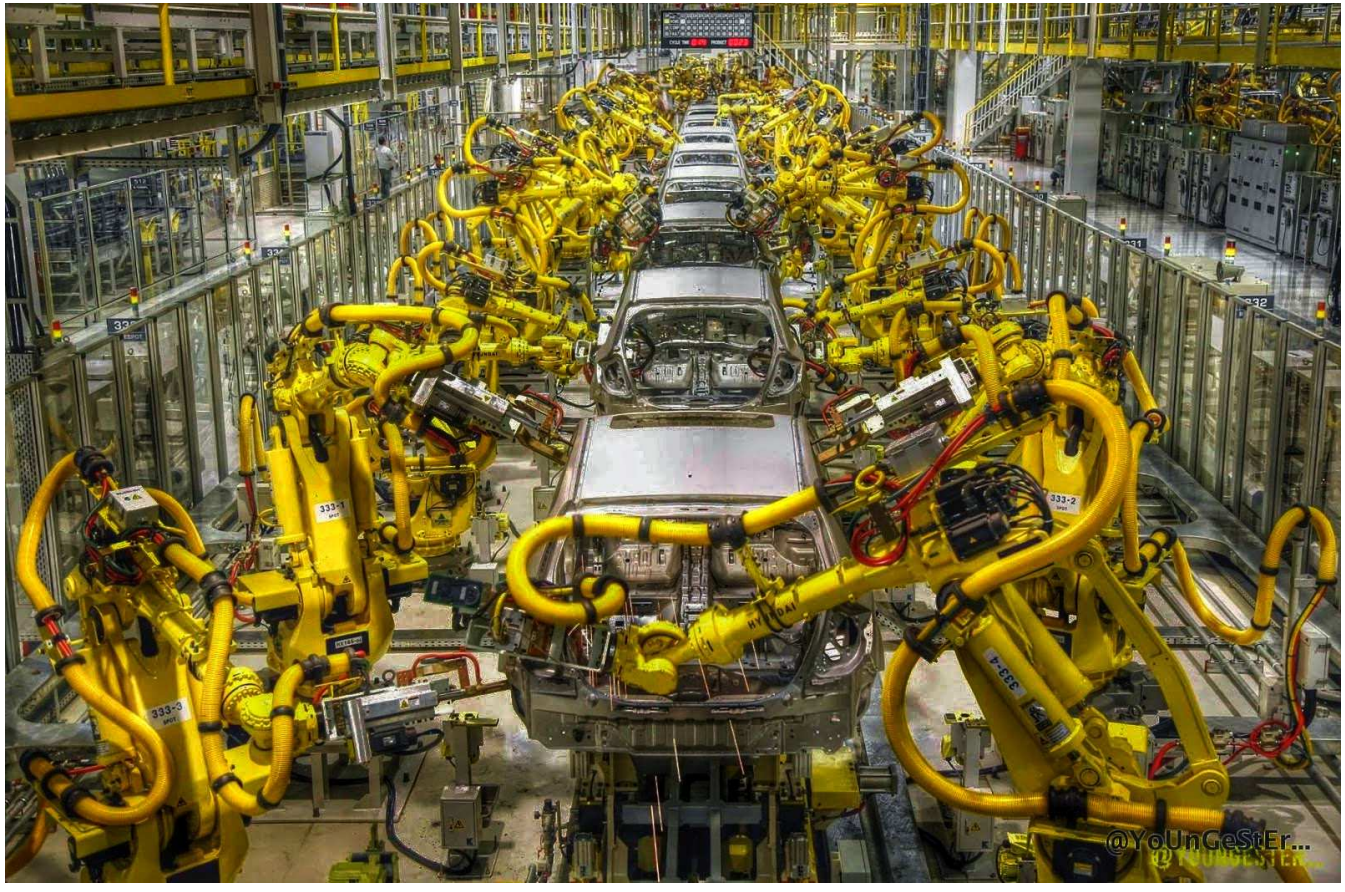


(Acemoglu and Autor, 2011)

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.

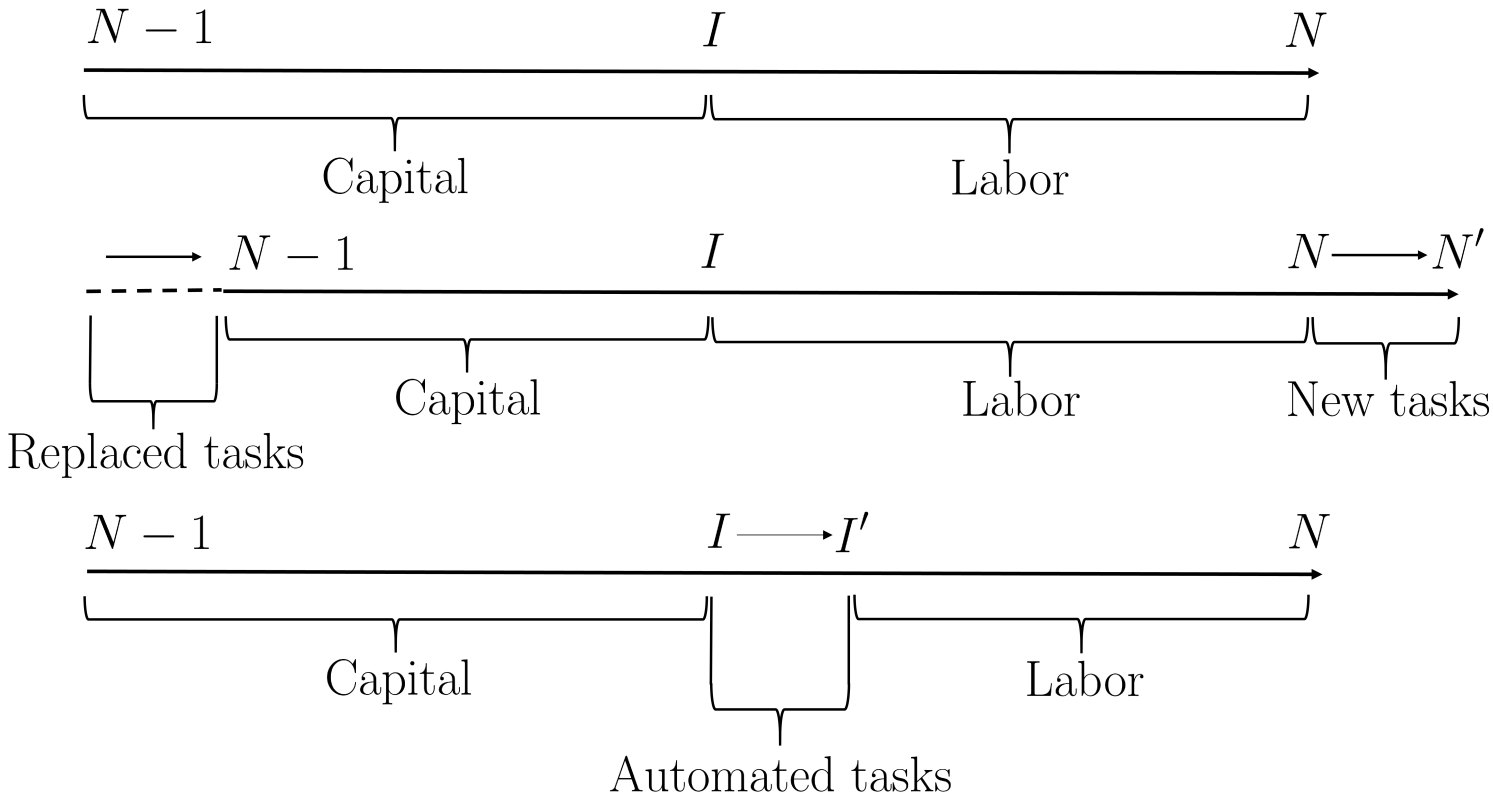
- Tasks can be produced using capital or labor:

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

- 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.

$$\text{Effect of new tasks on labor demand} = \text{Productivity effect} + \text{Reinstatement}$$

- 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:

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

Patterns in Labor Share 1947-1987

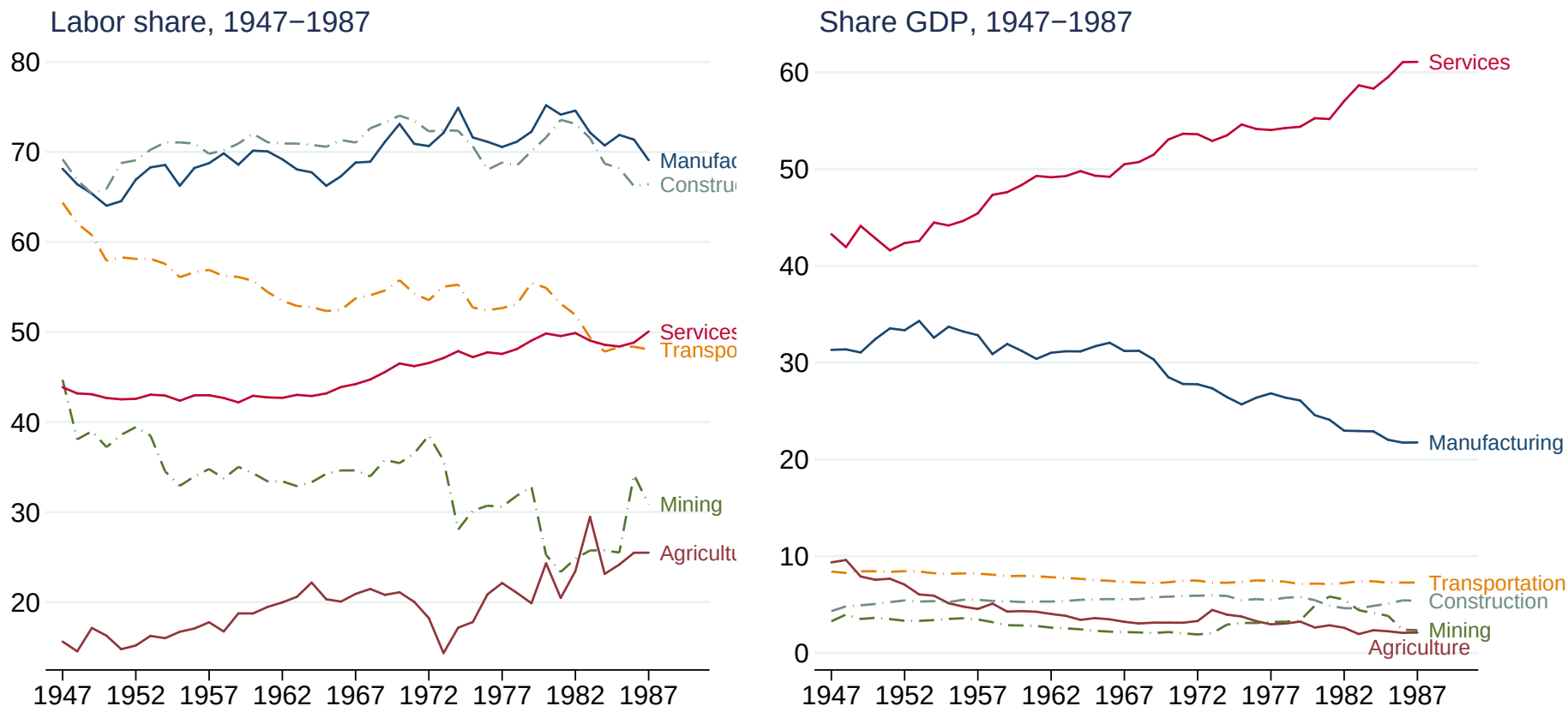


Figure: The labor share and sectoral evolutions, 1947-1987.

Decomposing Labor Demand, 1947-1987

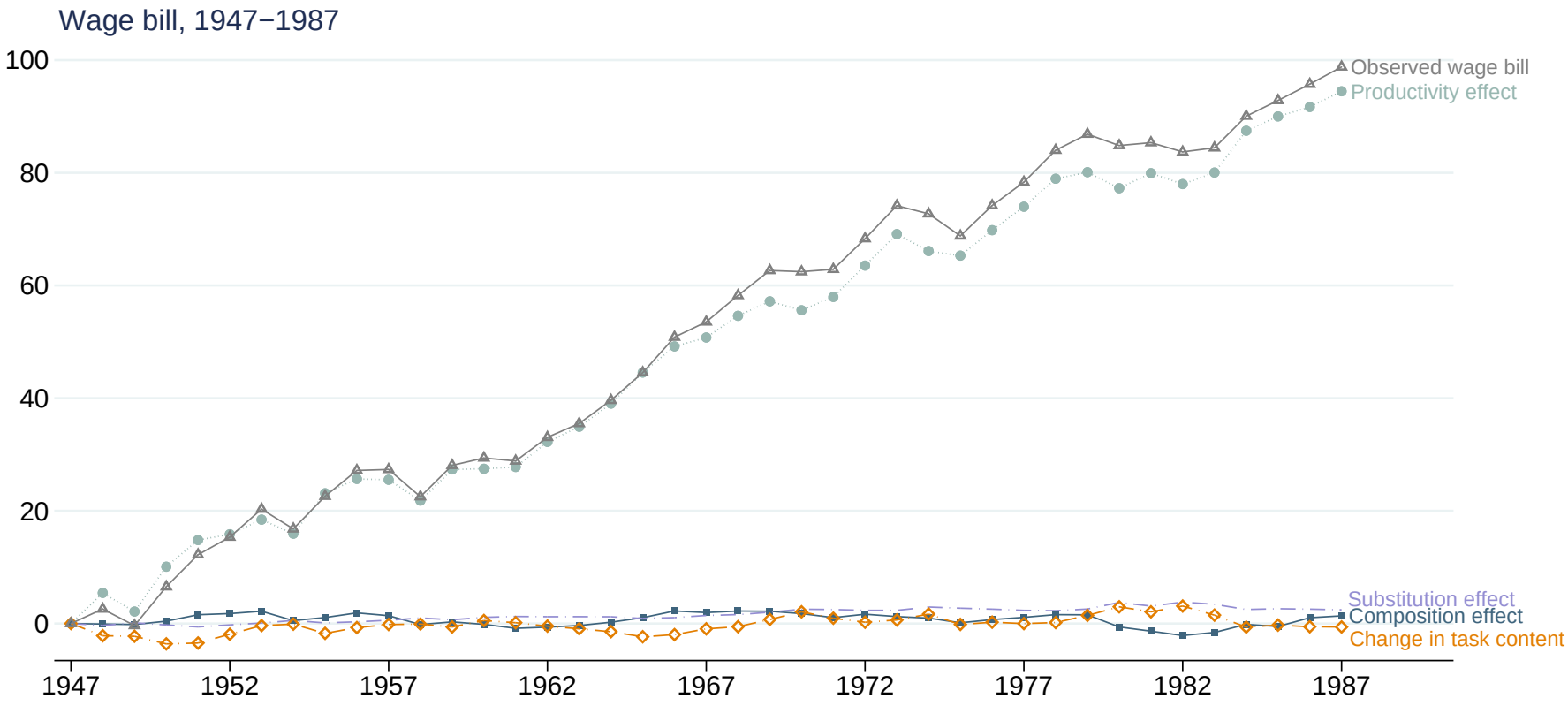


Figure: Sources of changes in labor demand, 1947-1987.

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

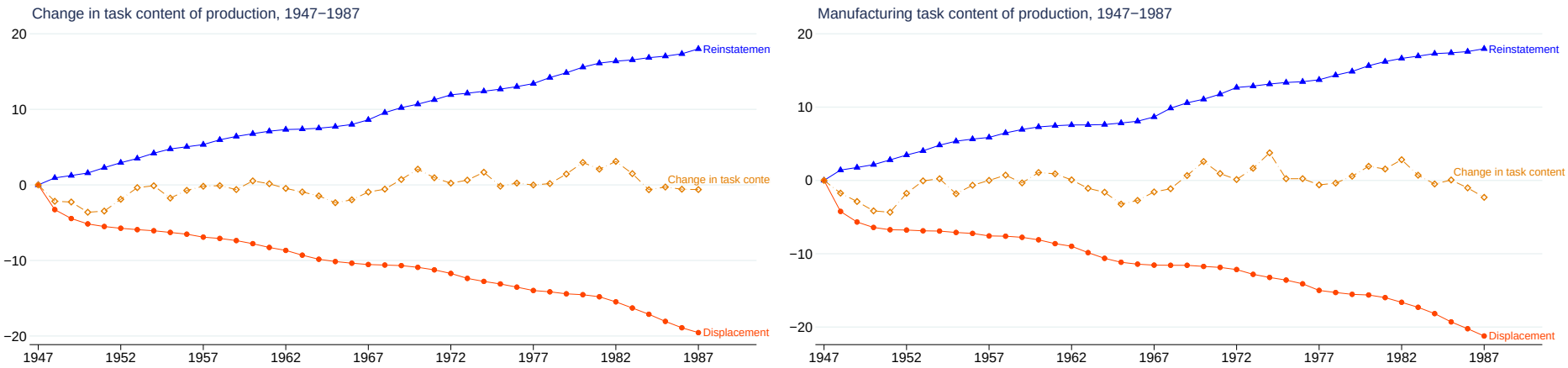
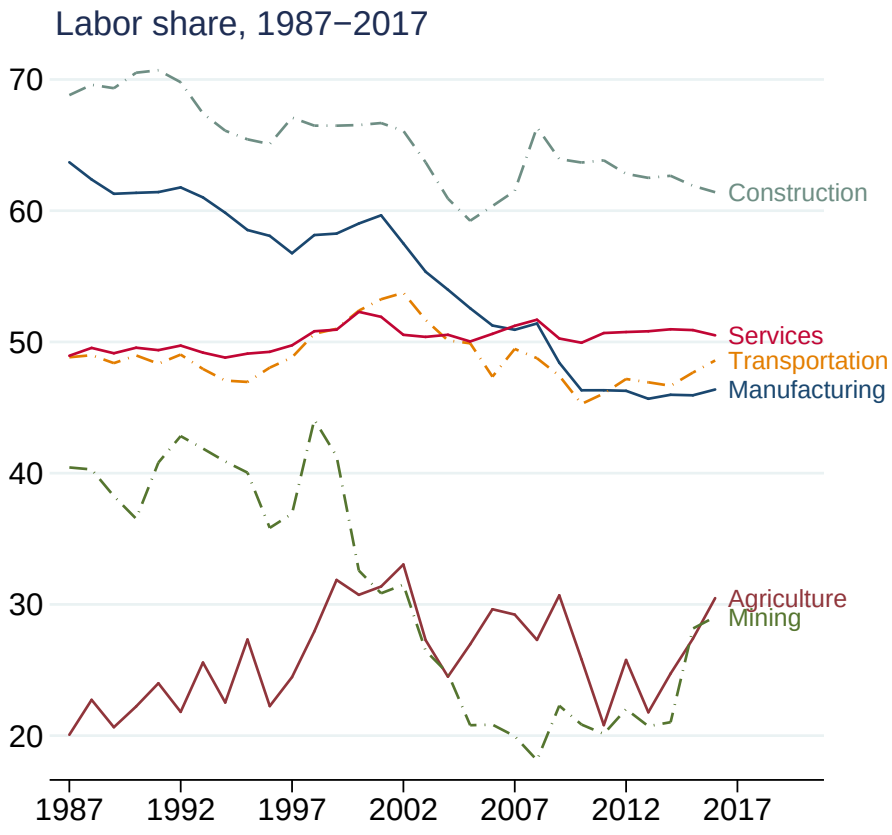
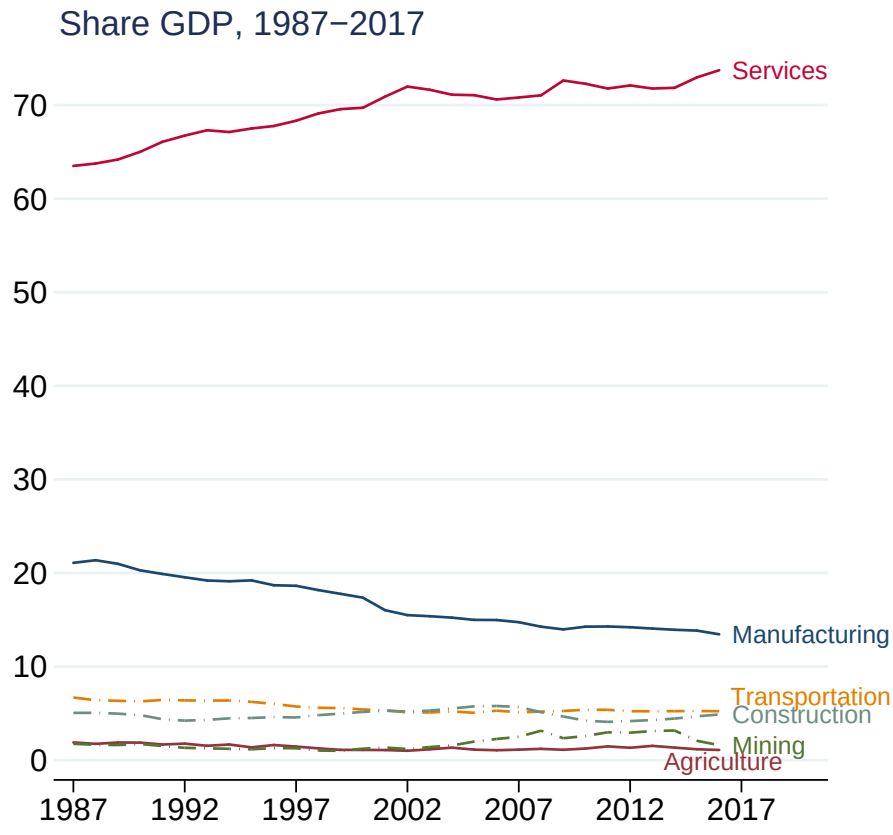


Figure: Estimates of the displacement and reinstatement effects, 1947-1987.

Patterns in Labor Share, 1987-2017





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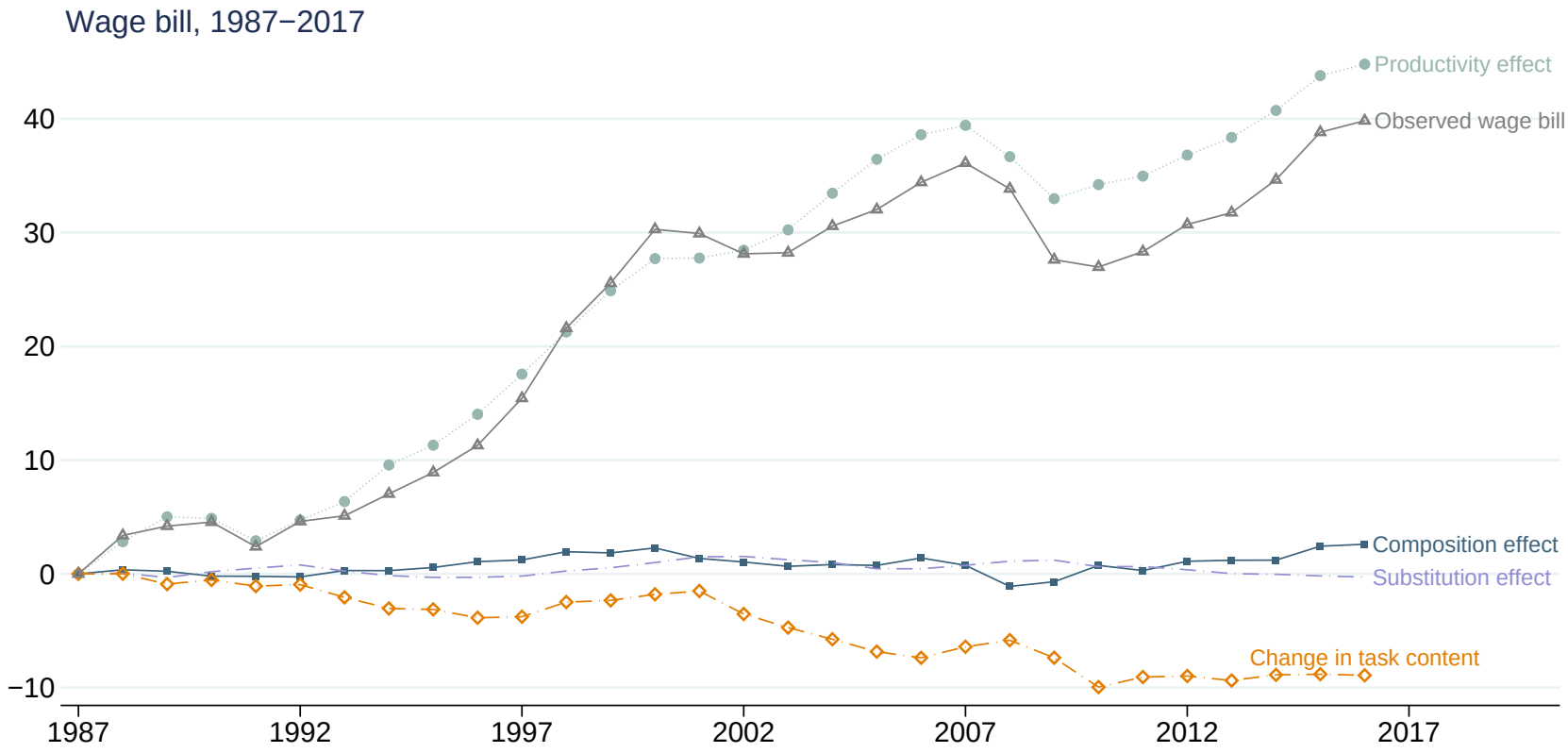

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Displacement and Reinstatement, 1987-2017

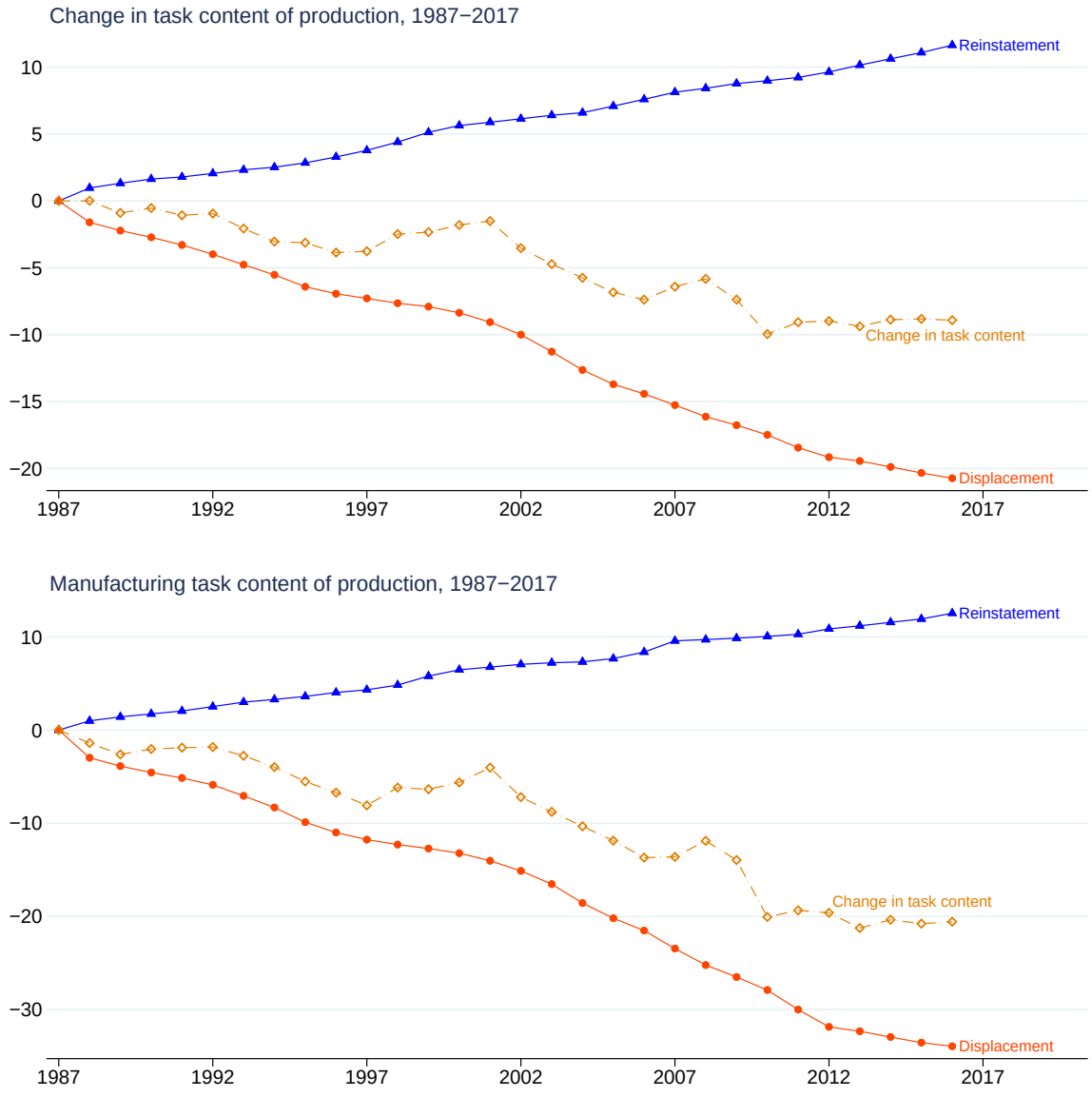
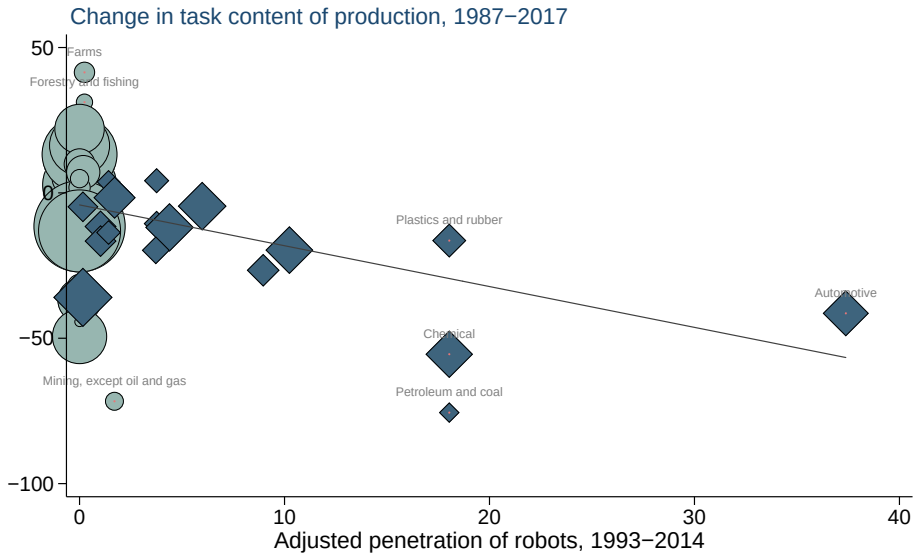
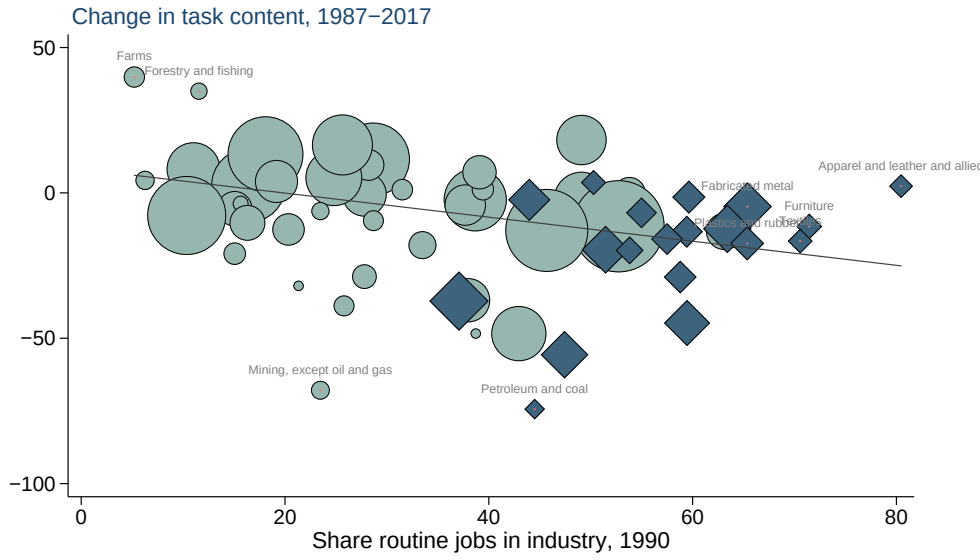
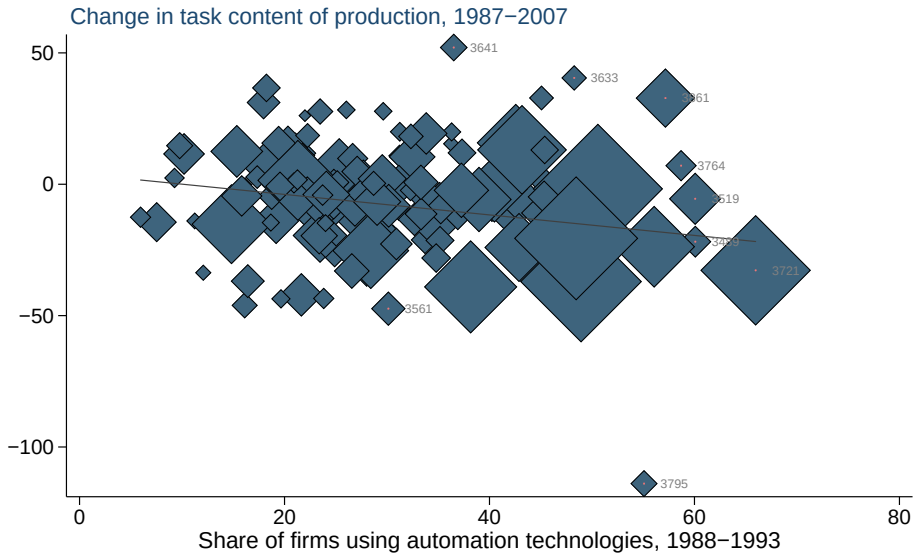


Figure: Estimates of the displacement and reinstatement effects, 1987-2017.

Explaining Changes in Task Content: Automation







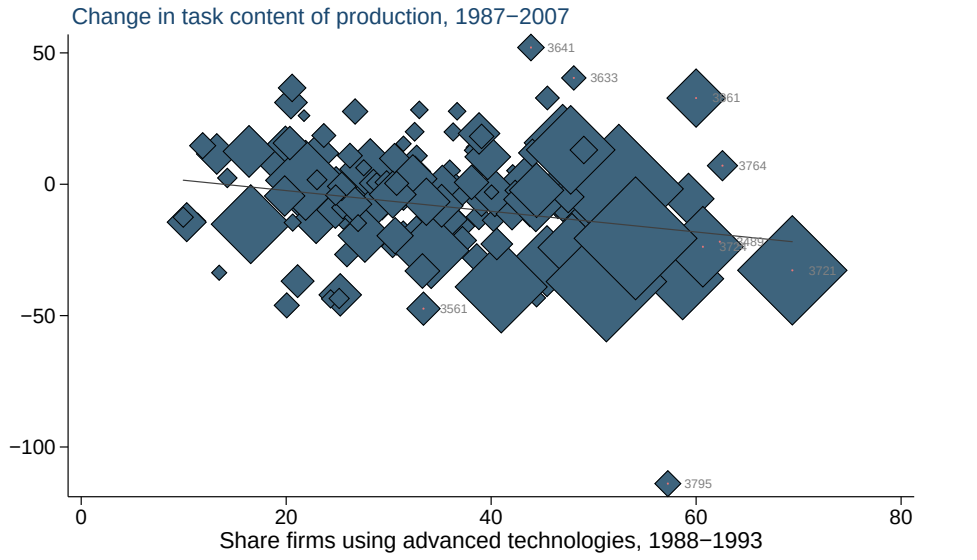
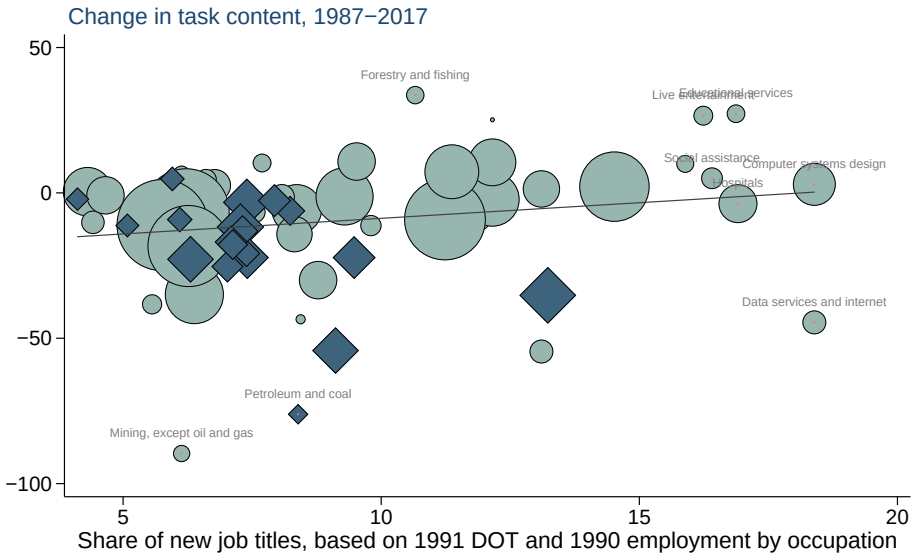
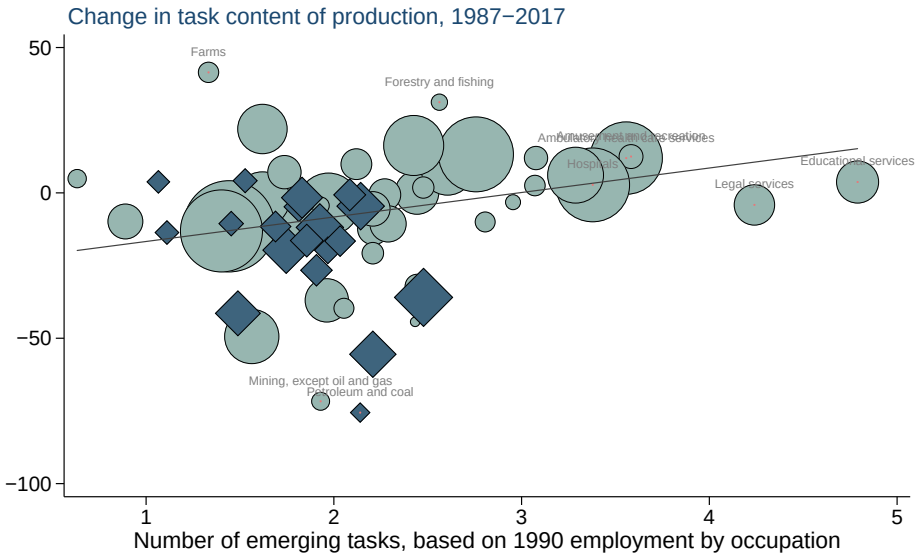
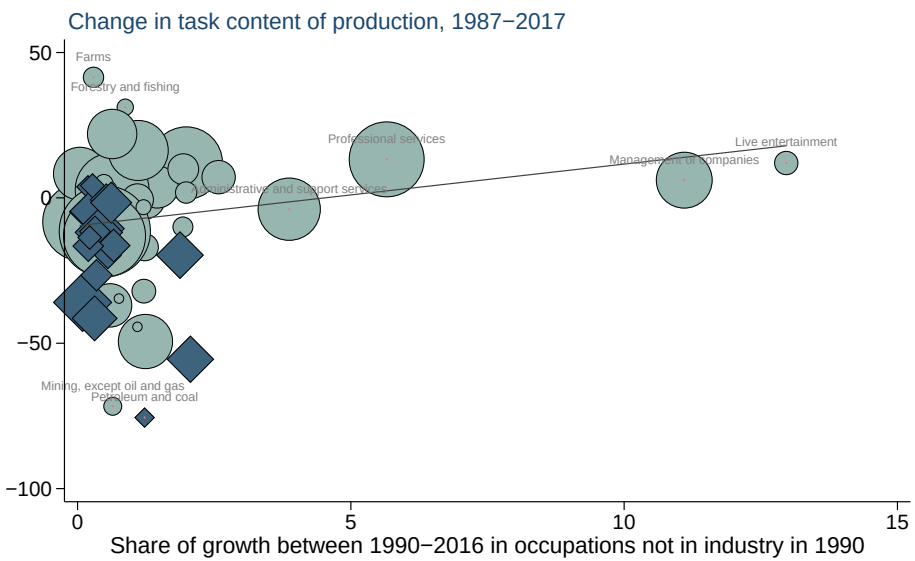


Figure: Automation technologies and change in the task content of production.

Explaining Changes in Task Content: New Tasks







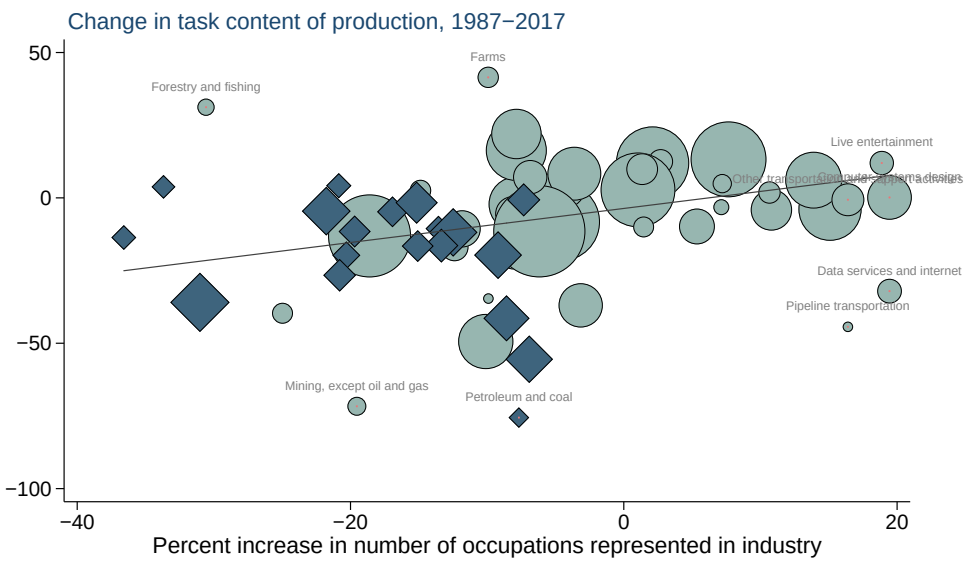
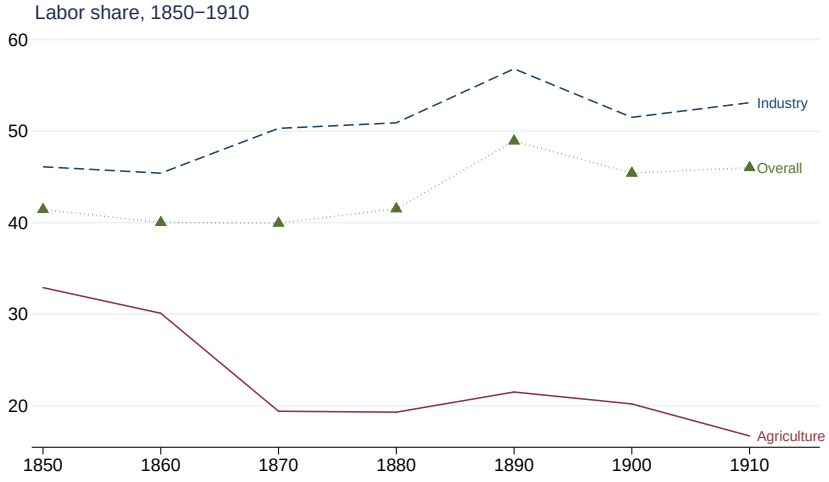
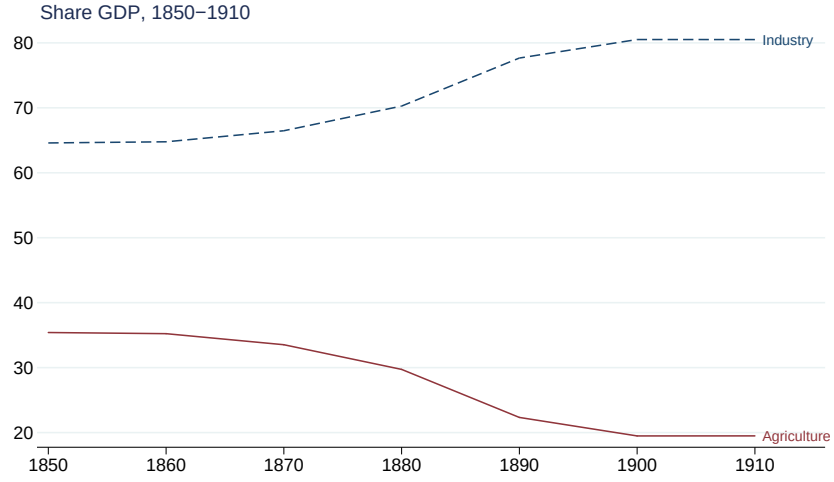
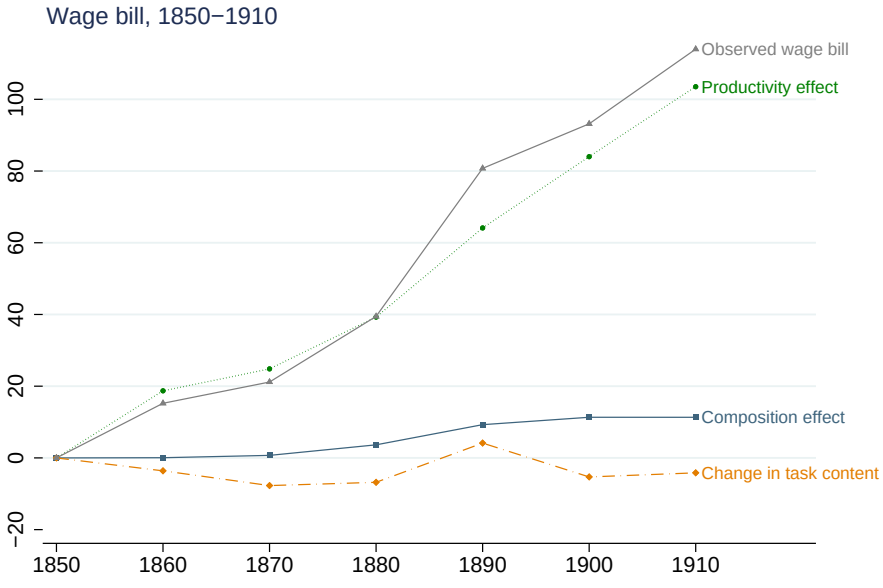


Figure: New tasks and change in task content of production.

Decomposing Labor Demand: Decomposition, 1850-1910







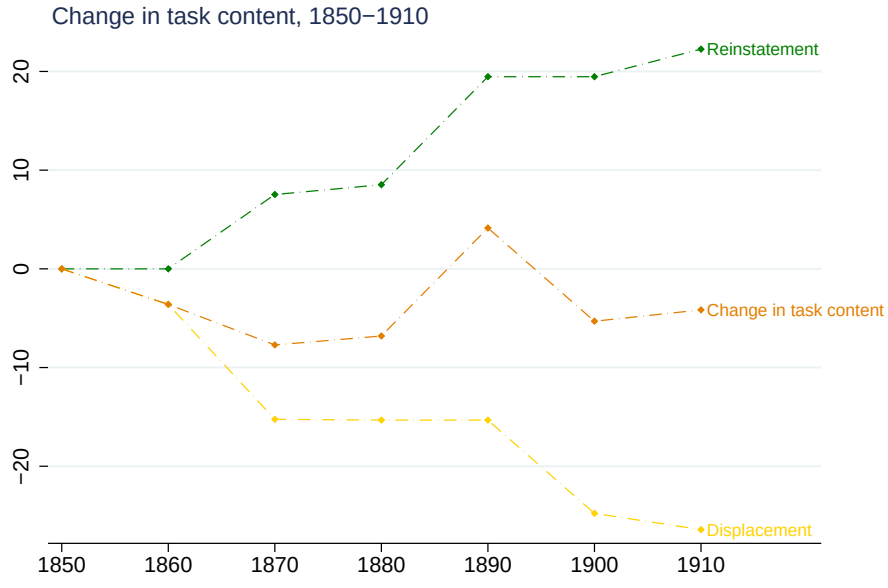
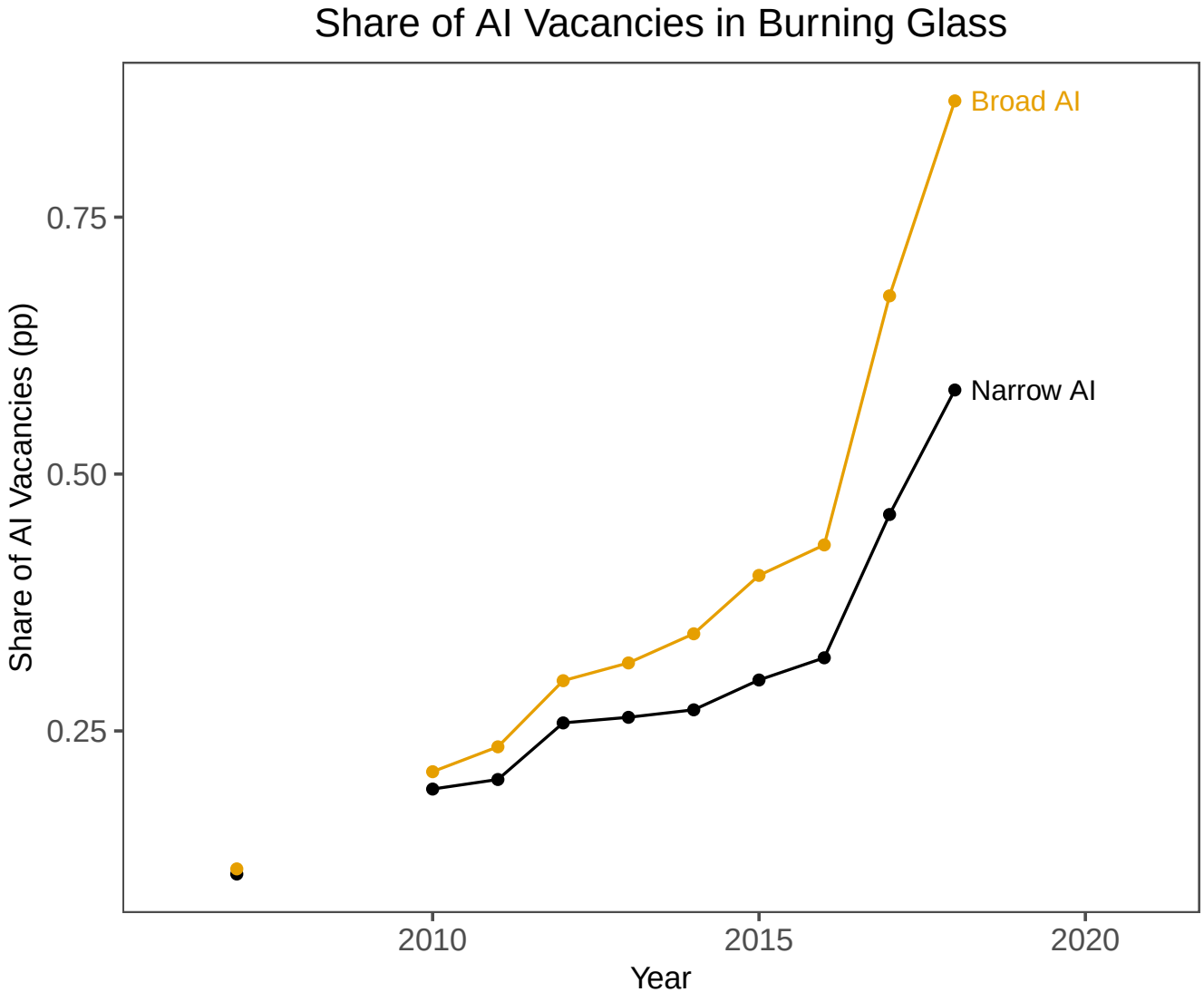


Figure: The labor share, sectoral evolutions, and the sources of labor demand, 1850-1910.

Will AI Make Things Even Worse?

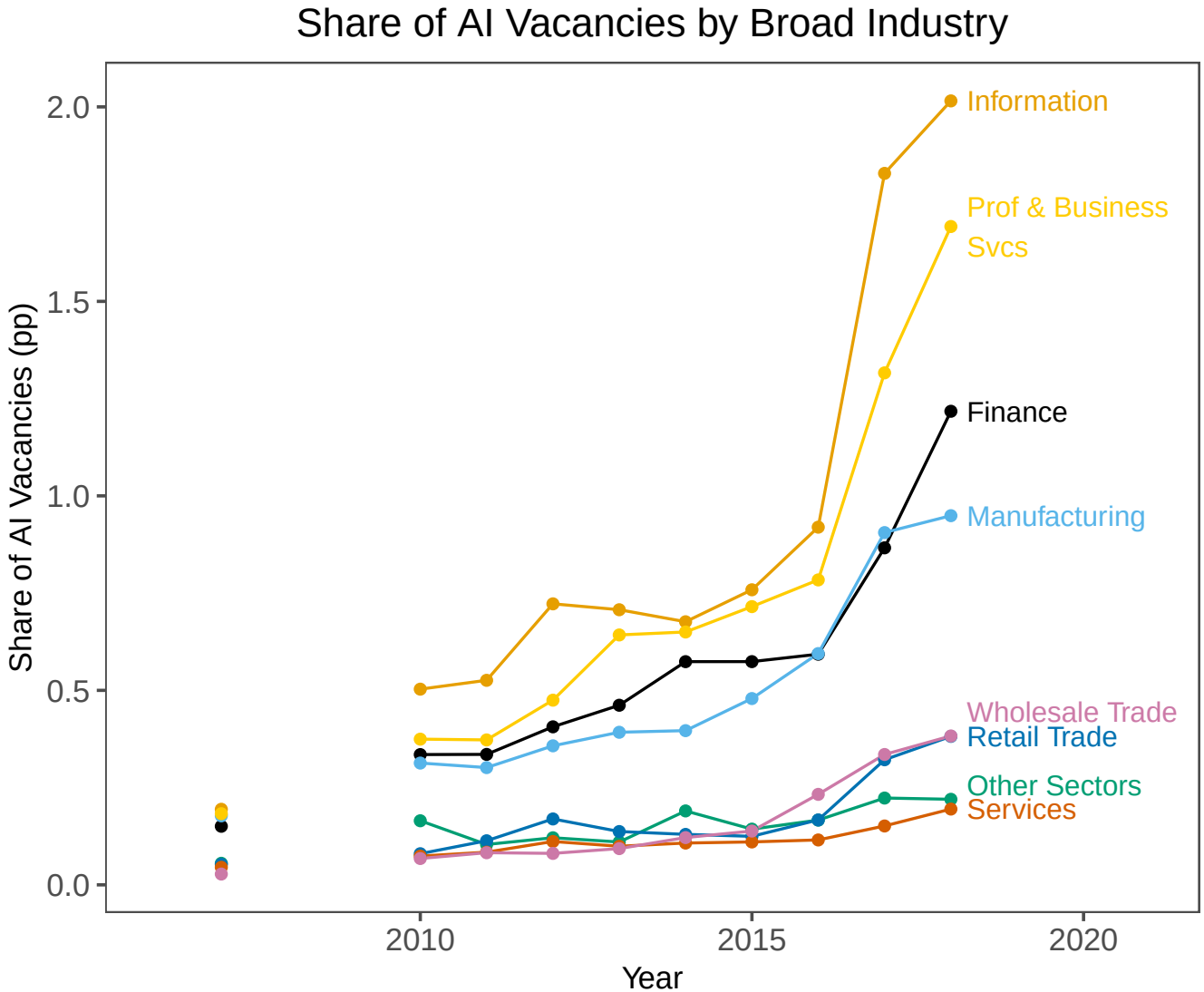
- Perhaps. Automation is one of the things AI technologies are targeting.
- But AI is a general technological platform, and it can be used in many different ways (for example, in education and health care).
- The study of AI is hampered by the fact that it is just getting going and there are no good 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

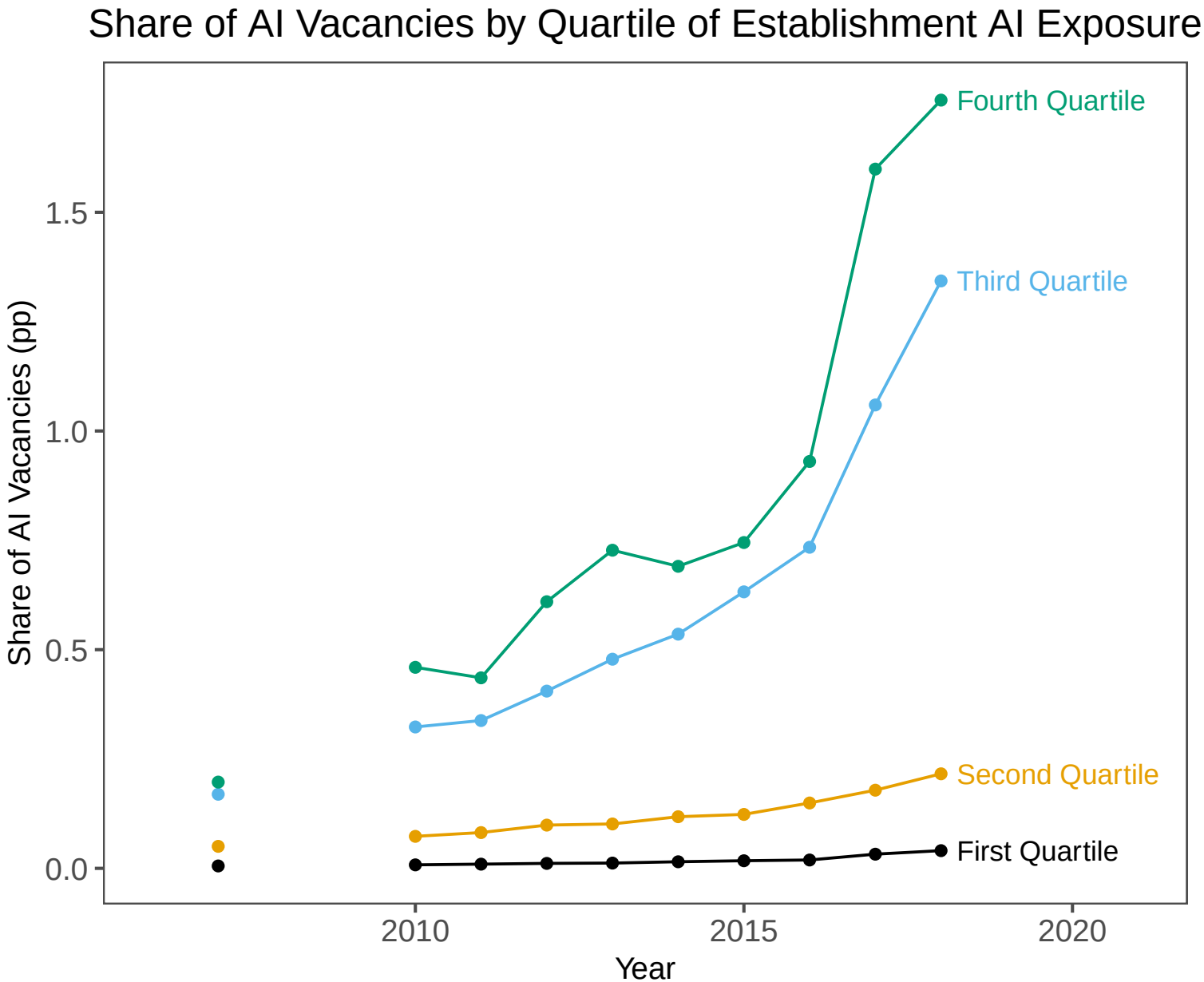
Exposure to Opportunities for AI

- **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.
- $\text{AI Occupational Impact}_j$ 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 $\text{AI exposure}_{st_0}$ 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



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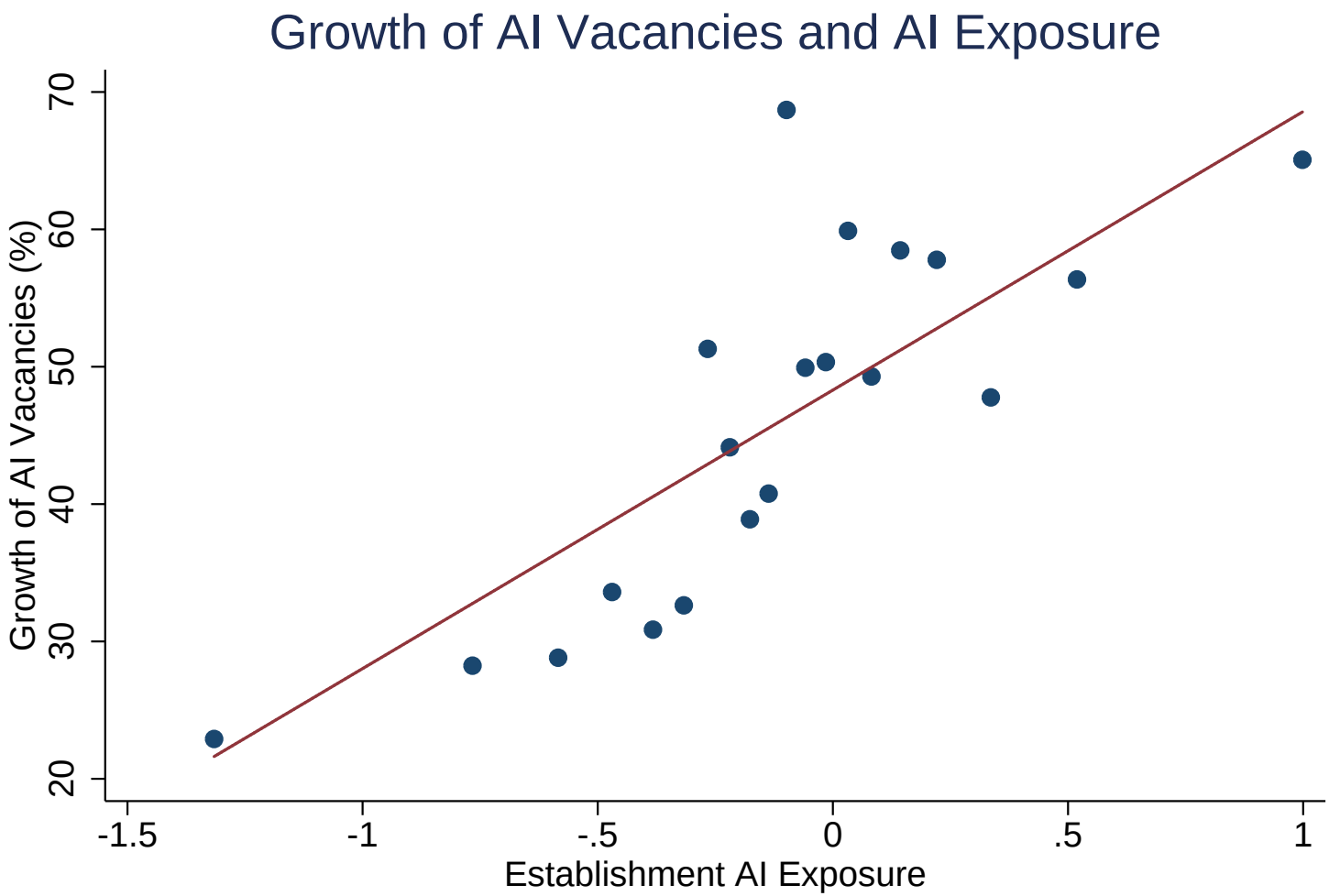
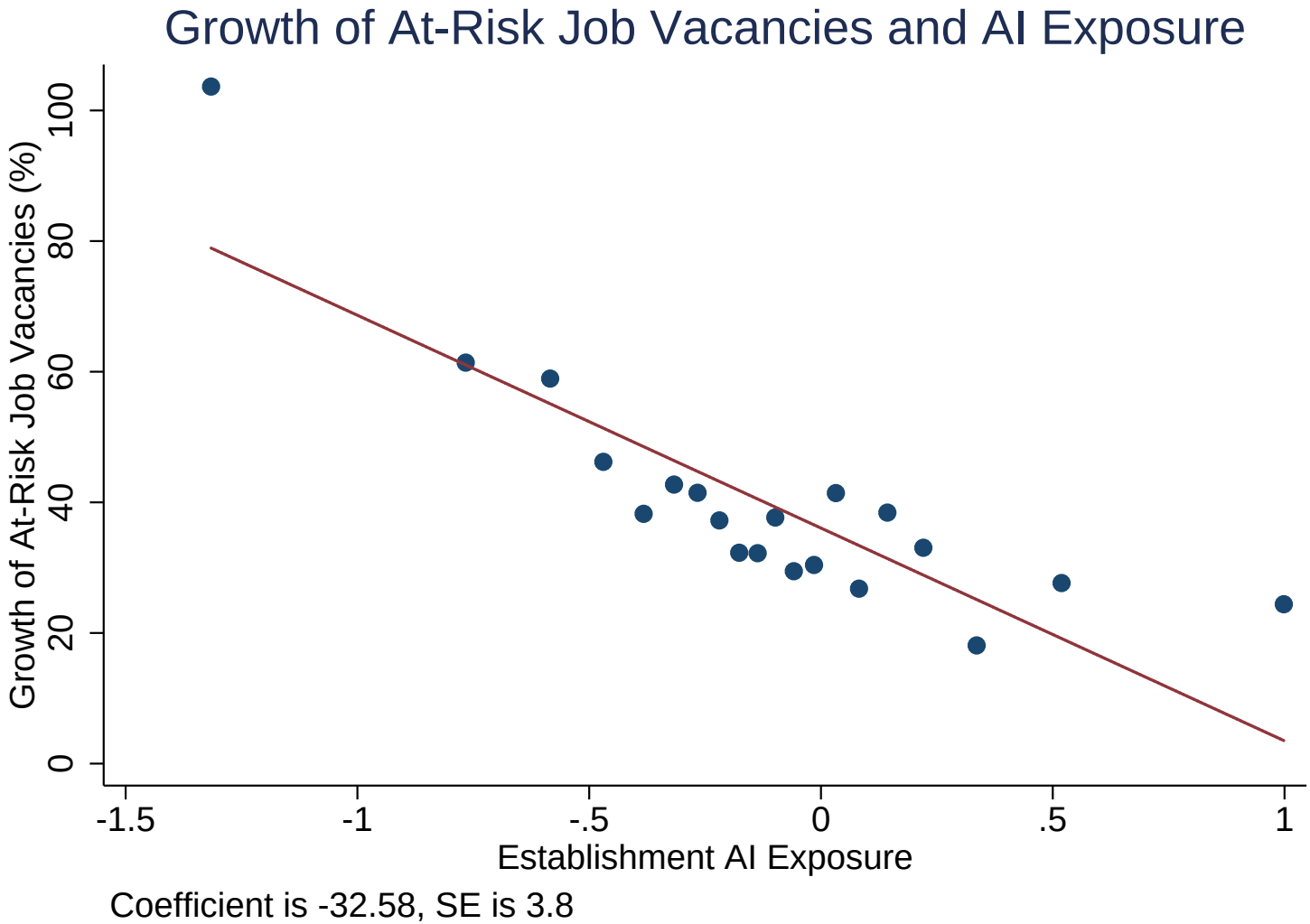


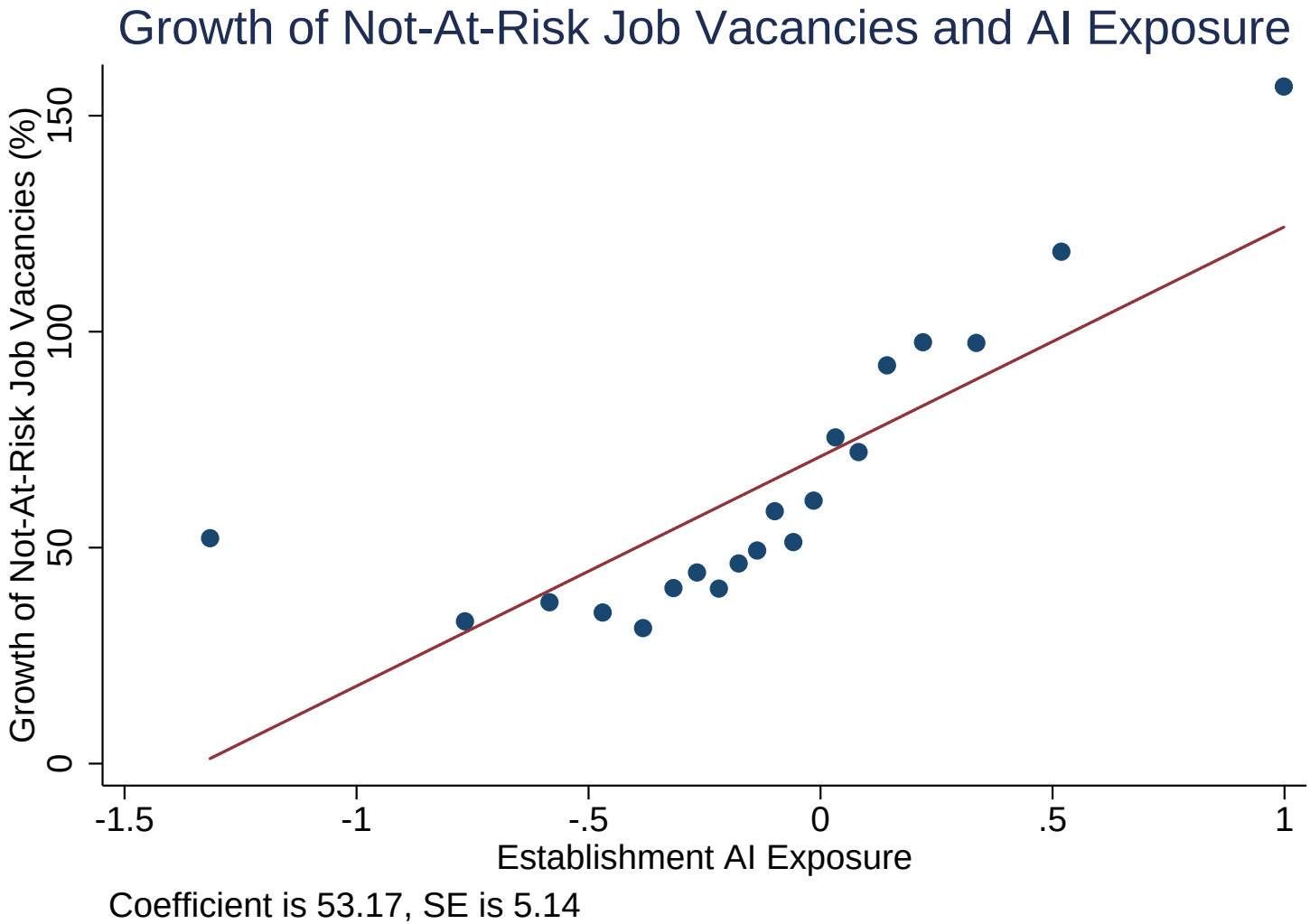
Coefficient is 20.28, SE is 1.73

At-Risk Jobs Decline



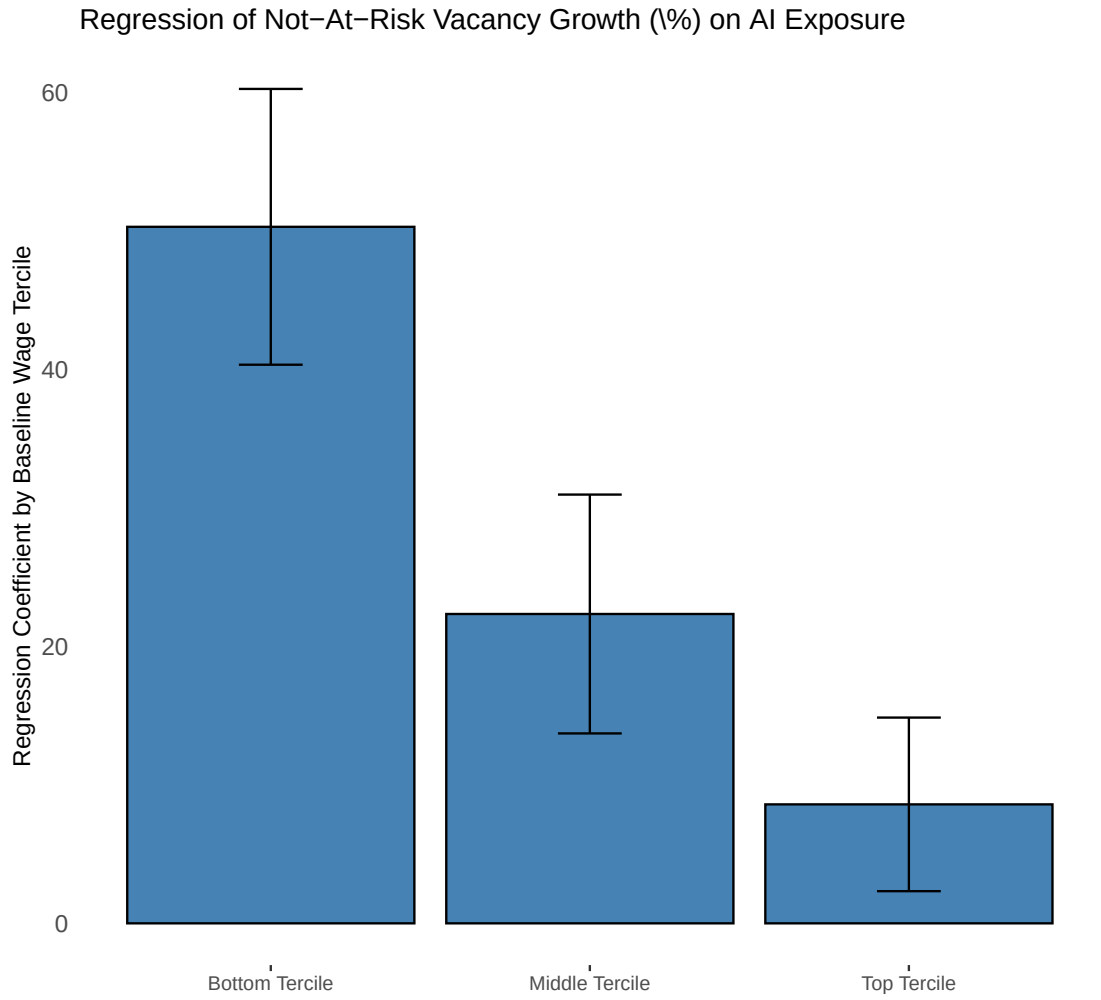
- **At-risk jobs:** top 50% occupations with the highest AI impact according to Felten et al.

Not-At-Risk Jobs Expand



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

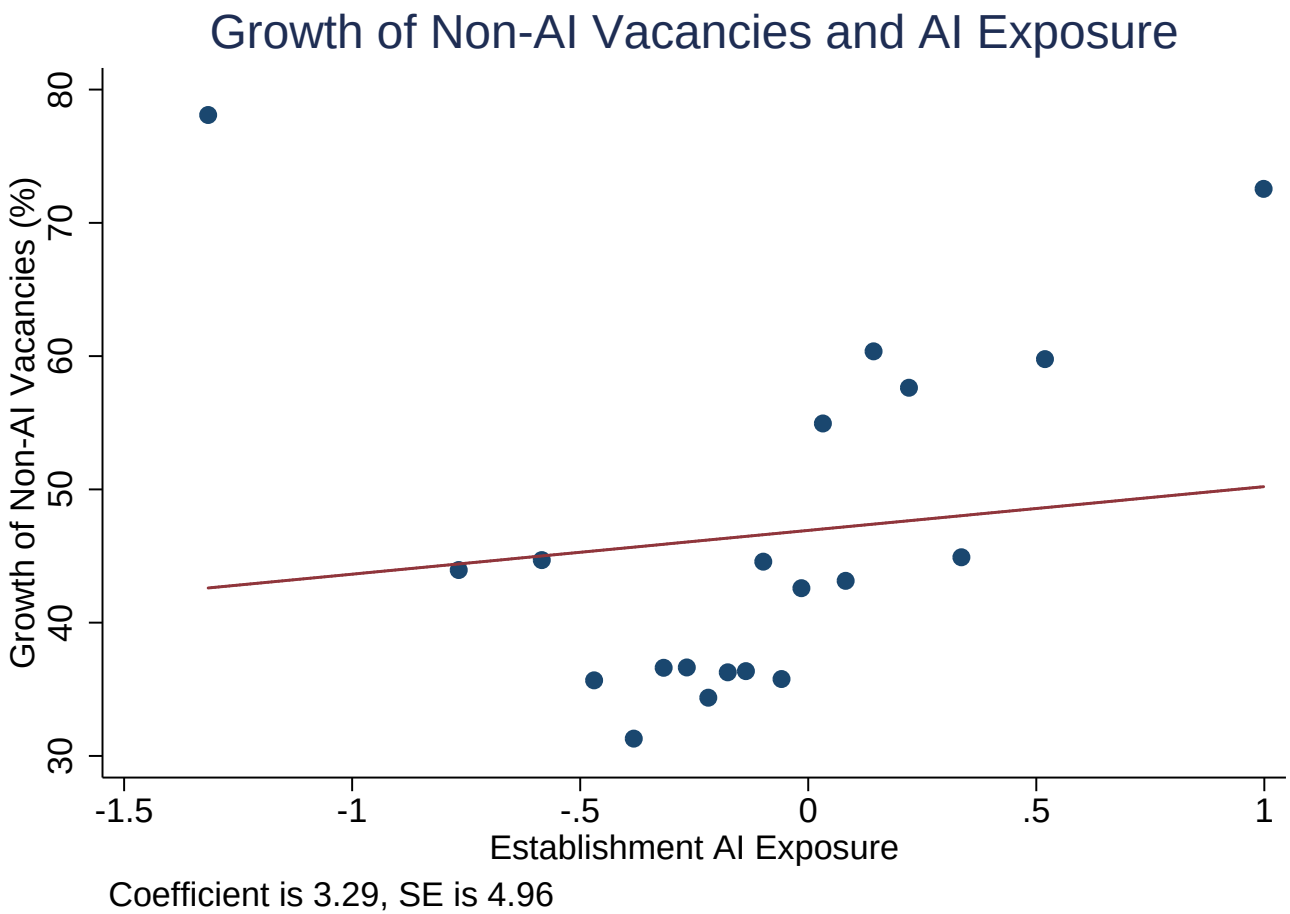
Explaining Rise in Postings of Not-at-risk Jobs



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?

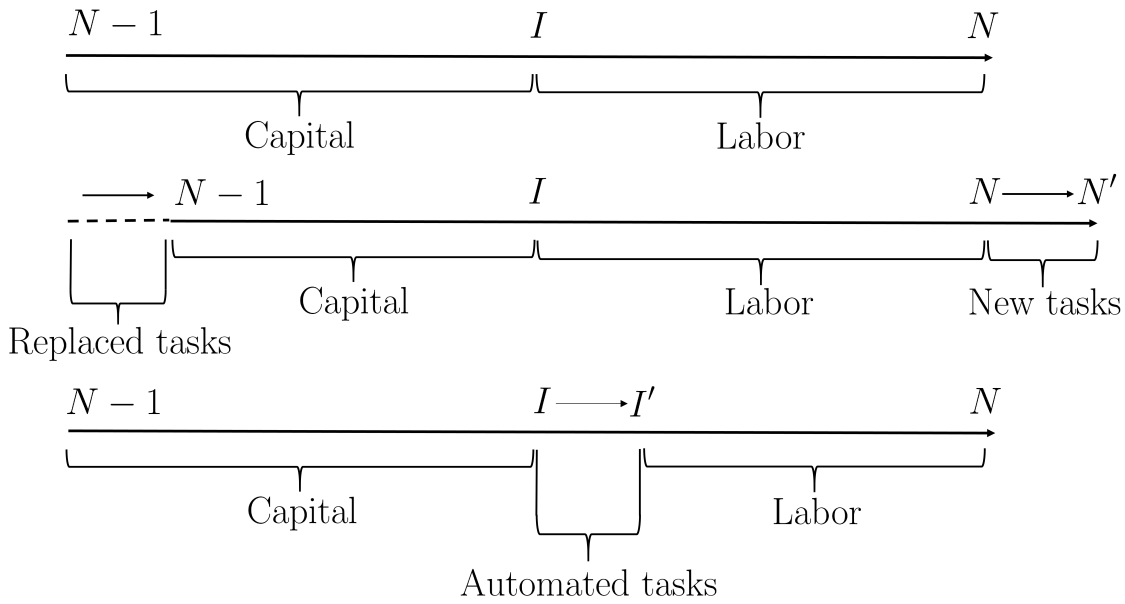
- Prospects for future productivity growth?
- The pessimistic view: because the new technologies are not worth that much (e.g., Gordon).

  ...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?