Automation and the Future of Work.

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Based on joint work with Daron Acemoglu.
3. New tasks and reinstatement.
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Tasks and Technology

- Production requires tasks, produced by machines (productivity $\gamma$) or labor.
- Over time, more tasks automated.
Automation and the displacement effect

- If tasks are combined via a Cobb-Douglas aggregator
  \[ Y = A \cdot L^\alpha K^{1-\alpha}, \]

- Allocation of tasks linked to factor shares and productivity
  \[ \alpha = \text{Labor share} = \text{Share of tasks performed by labor} \]

- Automation has an ambiguous effect on labor demand:
  \[ \text{Wages} = \alpha \times \frac{Y}{L}. \]

- \( \alpha \downarrow \) displacement effect and \( Y/L \uparrow \) productivity effect.
Concerns about Single-minded Focus on Automation

- The displacement effect:
  - Automation could reduce employment and/or wages.
  - Suppose the labor share goes down from 65% to 45%. One needs output to expand by 44% (=65/45-1) to sustain employment and wages.
  - Automation reduces the labor share and decouples $W$ from $Y/L$.
  - Distributional consequences: capital income becomes more relevant.

- By itself, automation brings limited productivity gains:
  - Productivity gains depend on $\gamma \cdot W/R$.
  - Alone, automation runs out of steam.
  - Worst case for productivity and labor: replacement by mediocre robots and machines!
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Empirical evidence: Industrial robots

- Automatic and multipurpose machines with several axis suitable for industry.
- Robots perform tasks that used to be labor intensive (machining, welding, assembling, inspecting, packaging).
- Large increase between 1993 and 2014: in the US, fivefold increase from 2 to 10 robots per thousand industry workers.
Industries exposure to robots

- Data on stock of robots from the *International Federation of Robotics* for the 1993-2007 period.
- Measure of *exposure to robots* based on adoption of robots among European industries.
- Adoption highly correlated across industries, which suggest it is driven by technology.
Exposure to robots and the labor share

Figure: Change in the labor share and exposure to robots. Data from the BEA.
Exposure to robots and output

Figure: Change in the log of quantities produced and exposure to robots. Data from the BEA.
A broader transformation of manufacturing

- Broader transformation of manufacturing starting in the late 80s.
- Labor share of the sector declined from 65% to 45% in 20 years.
- Consistent with an increased emphasis in industrial automation.

![Graph showing labor share in manufacturing](chart.png)
Estimating the impact of exposure to robots on US labor markets.

Adjustment of local-labor markets.

Exposure to robots between 1993-2007 for commuting zones, $c$:

$$\sum_i \text{Baseline Employment share}_{ci} \times \text{Robot Exposure}_i$$

What happened to exposed labor markets during the 1990-2007 period?
Exposed labor markets

- One robot per thousand workers:
  - Epop falls by 0.4pp
  - Wages fall by 0.7%
  - No evidence of migration or expansion of services.
  - People drop out of labor force
- Aggregate estimates: 300-600K jobs and 0.25-0.5% decline in wages.
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New tasks and the reinstatement effect

- Technology is not just about automation and displacement.
- Over time, we have also created new tasks and improve existing machinery.
- These technologies *reinstate* labor and interact with automation.
New job titles and employment

![Graph showing employment growth (annualized) against the share of new job titles in each occupation. Data from Jeffrey Lin (2011).](image)

**Figure:** Employment growth (annualized) against the share of new job titles in each occupation. Data from Jeffrey Lin (2011).
Even if the economy keeps creating new tasks, the adjustment may be difficult:

- New jobs take time to appear.
- New jobs require different skills.
- New jobs are in other regions.
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Looking ahead

Future of labor depends on technologies invented and adopted:

- Automation is an ongoing process, but we have found ways to counteract it in the past through technologies that reinstate labor.

- Concerns:
  - Single-minded focus on automation.
  - Possibility that new tasks and ideas about products and services that can generate a demand for labor are in turn getting harder to find.

- If concerns materialize, we are left with automation, but not the successful combination of new tasks and automation that spurred growth in productivity and labor demand in the past.