

# How Do New Technologies Affect Workers?

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# I'll summarize three papers

1. Information and Communication Technologies (ICT) shift demand from middle-skilled workers to high-skilled workers
  - with Van Reenen and Natraj (Review of Economics and Statistics 2014)
2. Industrial robots increase labour productivity and wages, & reduce output prices. But they reduce low skilled workers' employment
  - with Graetz (Working paper 2015, updated 2017)
3. Modern technology does not appear to be responsible for “Jobless Recoveries” in developed economies outside the US
  - with Graetz (American Economic Review Papers and Proceedings 2017)

# Methodology & cautionary notes

- We study changes within industries in different countries over time, as exposure to new technology changes
  - As much as possible, we use harmonized definitions of technology and skill
  - But we control for differential changes across countries
- Advantage: can look across industries in 10-20 countries over time
  - Drawback: we do what we can, but there are limits to the causal inference
- Further, we should be cautious because what happens in the future may differ from what happened, even in the recent past

# Main data sources

- Value added, hours & wages for different skill groups, capital, ICT:
  - OECD, EUKLEMS, World Input-Output Database (WIOD)
- Task use:
  - US Dictionary of Occupational Titles
- Recession dates:
  - Economic Cycle Research Institute, OECD
- Industrial robots:
  - International Federation of Robotics

# 1. ICT and Skill Demand

- Middle skilled workers (high school graduates or those with some college) perform more routine cognitive tasks than others
  - Following Autor, Levy, Murnane (2003) and others we expect them to be more susceptible to replacement by modern ICT
- We study US, Japan, and nine European countries from 1980-2004
- Industries with faster growth of ICT shifted demand from middle skilled workers towards high skill workers (college graduates)
- The effect of ICT adoption is similar to that of R&D
- International trade seems less important in explaining the patterns

## 2. Robots' effect on workers

- Modern robots are autonomous, flexible, versatile machines
- Three dimensional movement was challenging → largely solved
- We study 17 industries in 14 countries (EU, US, S. Korea, Australia) from 1993-2007
- Quality-adjusted robot prices fell by about 80% from 1990-2005
- Robot density (#robots per million hours worked) increased by 150 percent in developed countries from 1993-2007

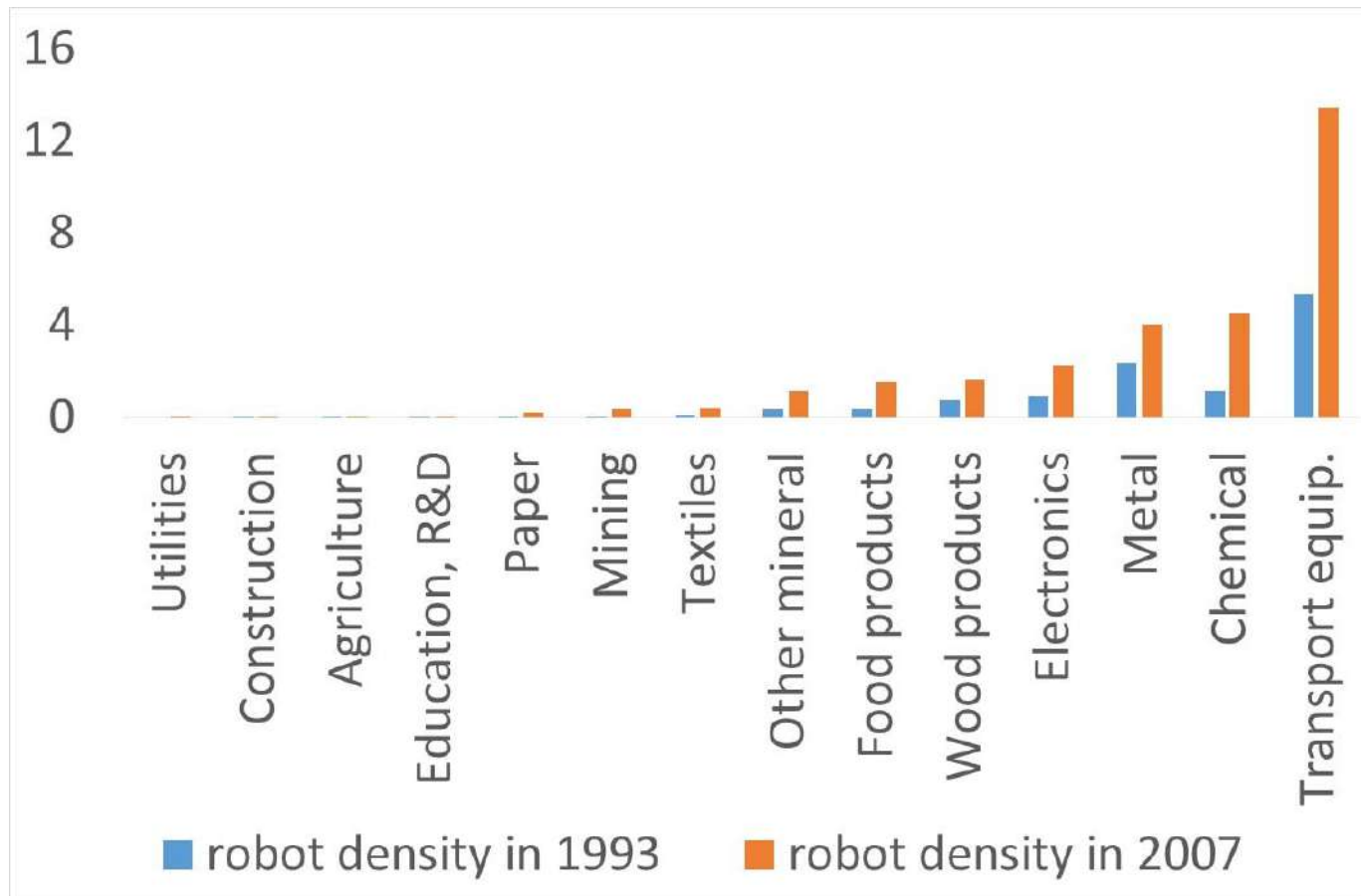
# Measuring industrial robot use

- Need unified definition across countries, industries, and time
- International Federation of Robotics follows International Organization for Standardization (ISO) definition:

*Industrial robots are automatically controlled, reprogrammable, multipurpose manipulators, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications*

- Typical tasks: packaging; picking & placing; painting; welding

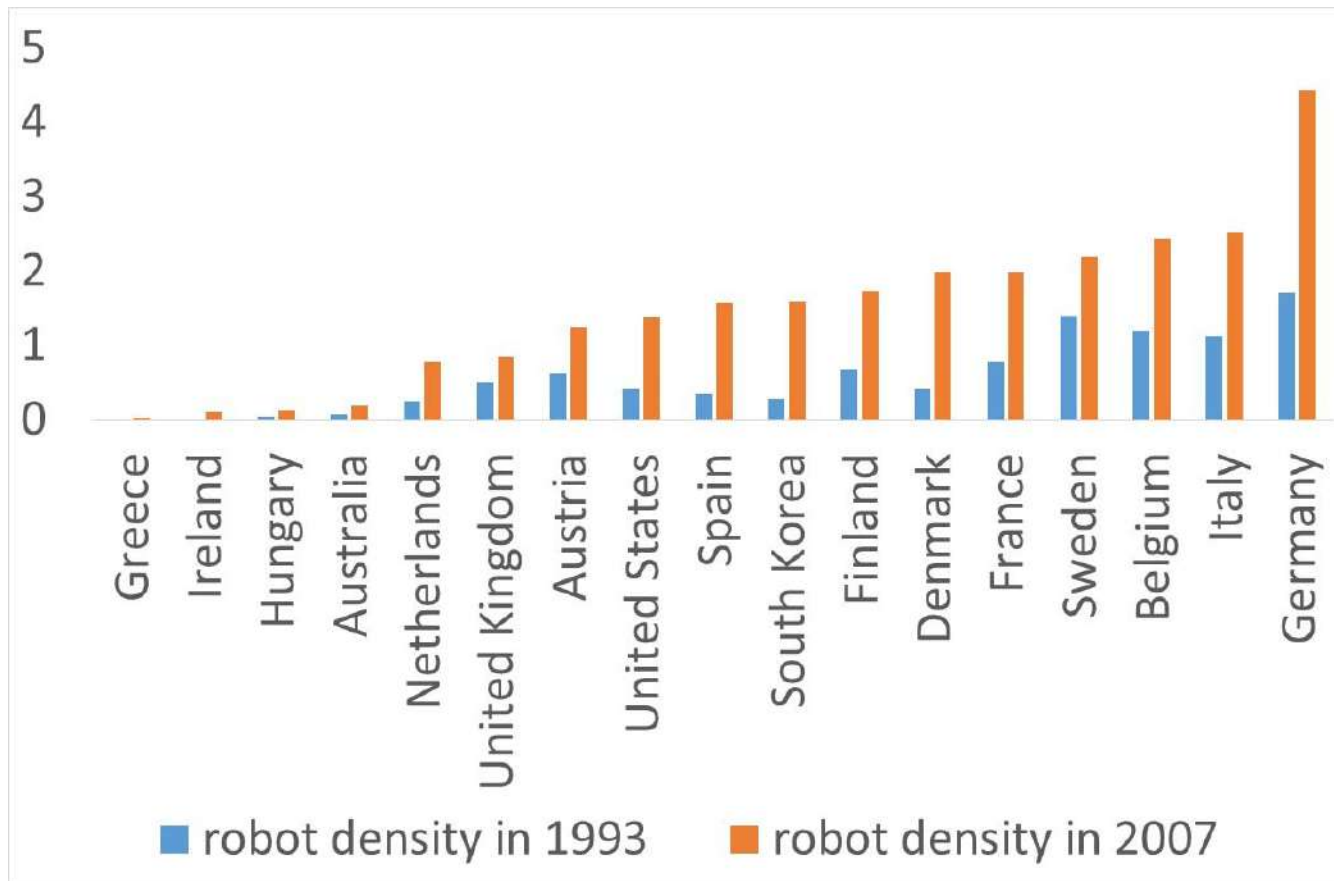
# Robots per million hours worked by industry in 1993 and 2007





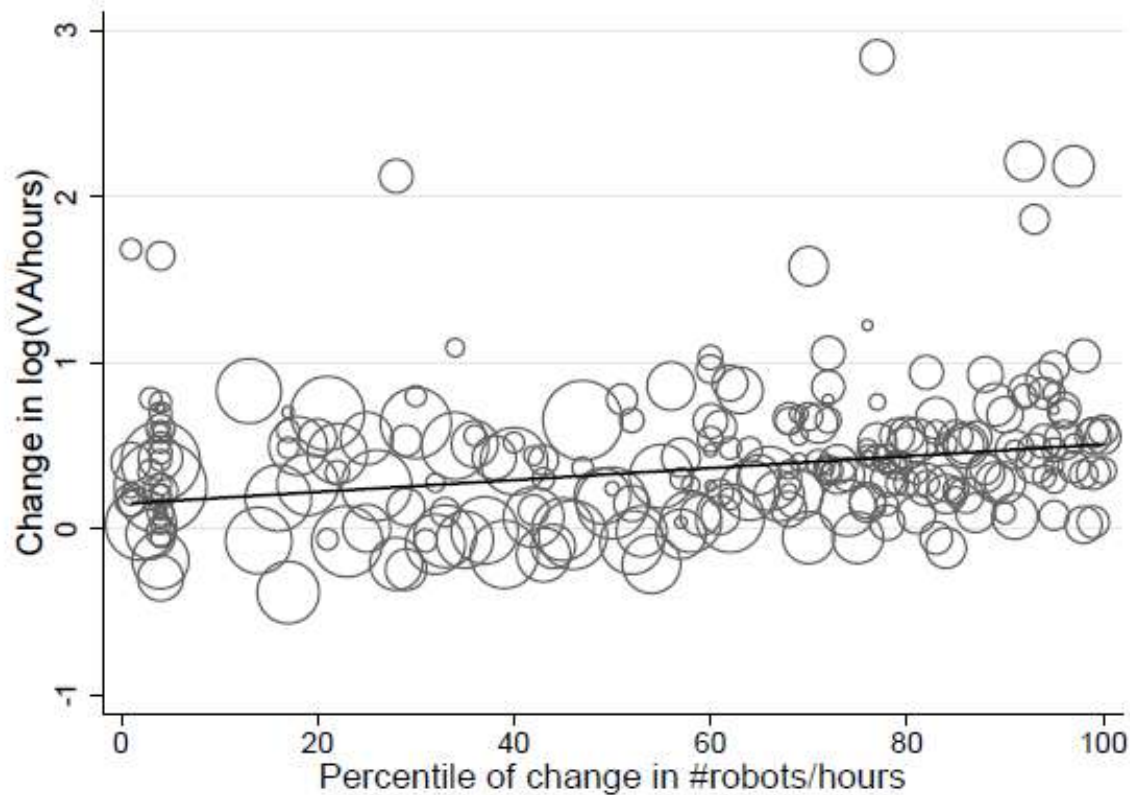
# Robots per million hours worked by country in 1993 and 2007

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# Increases in robot density and labour productivity over time



# Looking beyond correlations

- Where robot density grew faster, labour productivity also grew faster. This pattern is robust to controlling for:
  - Country-specific and industry-specific factors that affect growth
  - Other changes over time in capital and labour composition
- Instrumental variable : measure share of hours in 1980 in tasks that later became (potentially) replaceable by robots
  - This predicts later productivity growth, via increased robot use

# We similarly examine effect of robots on range of outcomes



- Robots increased value added and labour productivity
  - Contributed 0.36 percentage points to annual labour productivity growth
  - Contribution is similar to that of information & communication technology, post-war US highway construction, and nineteenth century steam engine
- Robots increased the wages of workers
- Robots reduced price of output (gains to consumers)
- Robots had no significant overall effect on hours worked
- But robots did crowd out workers with lower levels of education (mostly high school dropouts), so effect is different from ICT

# 3. Technology and “Jobless” Recoveries



- Since 1990, recoveries from recessions in US have become “jobless” (slower employment growth in 2 years after recession trough)
- Jaimovich & Siu (2014): technology – replacement of middle-skill/routine jobs during recessions – could be a cause
- But we see routine replacement by technology in other countries
- So could technology be responsible for jobless recoveries outside US?

# New technology doesn't seem to cause recent “jobless” recoveries

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- We study 71 recessions and recoveries in 17 countries (28 industries):
  - Little evidence that recoveries have become “jobless” since mid-1980s
  - Routine-intensive industries, with more scope for technological replacement of workers, had slower recoveries before mid-1980s, but this has not changed
    - We find similar results using our measure of replaceability by robots
  - Middle skilled workers, who are more susceptible to replacement (do more routine work), saw employment recoveries similar to other skill groups
  - US is an exception: recent recoveries are more “jobless”, and we cannot rule out that technology has a different effect there
  - But in developed countries outside the US technology doesn't seem to have worsened recent recoveries

# Summary of main points

- New technologies bring productivity benefits, which can benefit workers (wages $\uparrow$ ) and consumers (output prices $\downarrow$ )
- But there are costs, especially for workers whose jobs get replaced
- Different technologies replace different jobs, but generally speaking (so far) better educated workers seem to be benefitting more from technological change
- There is also suggestive evidence that new technologies may be more costly for employment in the US than in Europe, so institutions may matter for technology adoption

To conclude, how do we achieve the following?

1. Keep tech growth running in era of slow growth?
2. Help both young and old get right set of skills?
3. Avoid dangerous tech turns when private & public incentives are misaligned