

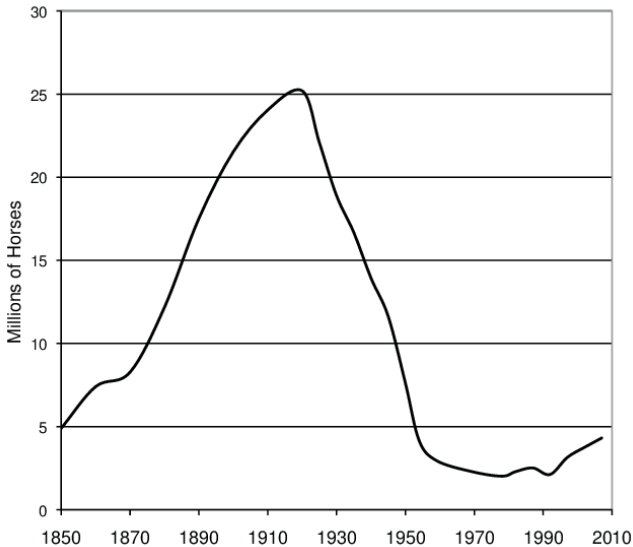
ROBOTS—A MINI LECTURE

Trevor Gallen

INTRODUCTION

- ▶ Some of you have expressed an interest in robots/robocalypse
- ▶ Not much time, but worth giving an overview of the research
- ▶ Primarily relevant to fiscal policy—where are we going as regards labor supply?

HORSES V. AUTOMOBILES

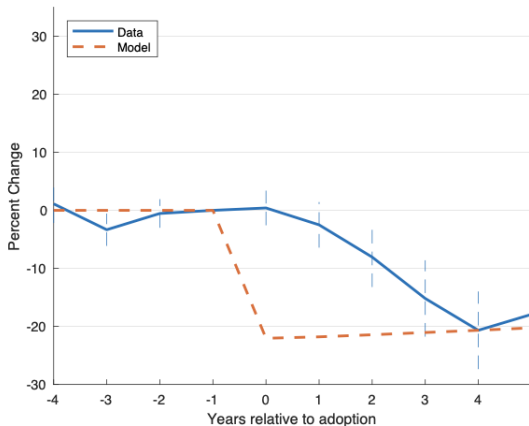


HUMLUM 2019

- ▶ Look at when firms adopt robots (highly granular)
- ▶ What happens to these firms relative to others?
- ▶ Firms expand production, lay off production workers, hire tech workers
- ▶ Estimate robots increase average real wages by 0.8% and reduce production worker wages by 6% (inequality)

HUMLUM 2019

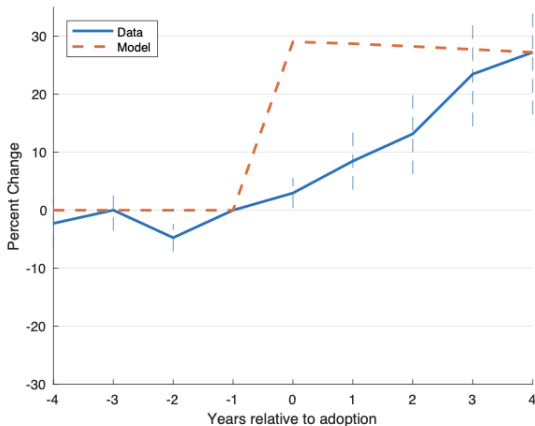
(a) Production Workers



Within firm, clear loss for production workers from roboticization

HUMLUM 2019

(b) Tech Workers



Within firm, clear gain for production workers from roboticization

WITHIN FIRM IS NOT TOTAL

- ▶ Just because workers within a firm (and especially job!) gain or lose doesn't mean that robots negatively affect workers on average
- ▶ Even if replaces workers at a task within an occupation:
 - ▶ May increase productivity in other tasks (increases within occupation)
 - ▶ But may increase productivity in other occupations and industries (increases other occupations)
 - ▶ But may increase demand for other occupations or industries (increases other industries)
 - ▶ If workers free to move, losses within firm no different than industry (no differential increase by firm)

- ▶ Look at french manufacturing
- ▶ When foreign machine suppliers increase in productivity, some French firms are differentially exposed to changes in prices
- ▶ Or, look before and after adoption (both give similar results)
Results:
 - ▶ Automation \uparrow 1%, employment \uparrow 0.3%.
 - ▶ Automation \uparrow 1%, sales \uparrow 0.4%
 - ▶ Automation \uparrow 1%, prices \downarrow 0.28%
- ▶ Note the significant “income” effect of the price change.

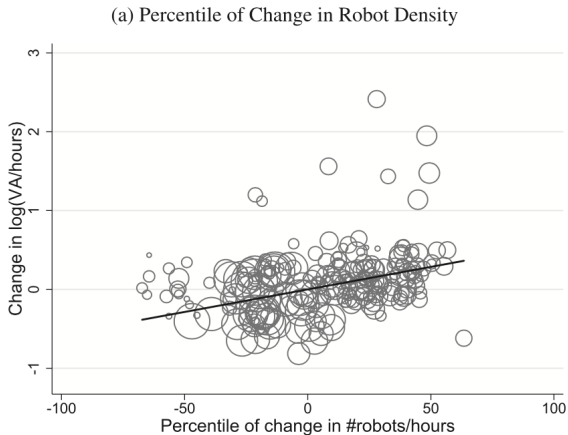
INCOME EFFECTS

- ▶ As with many things in life, something can be big bad for you but small good for many
- ▶ Everyone benefits from everyone doing it, but you wish you didn't
- ▶ Robots are *potential* example:
 - ▶ Let's say all industries are 1/100th labor and consumption bundle
 - ▶ Stipulate: 1% increase in roboticization reduces my wages by 1%(!)
 - ▶ Stipulate: 1% increase in roboticization reduces prices by 2%
- ▶ If I roboticize, I'm out 1% of earnings, prices go down by -0.02%.
- ▶ If everyone roboticizes, I'm out 1% of earnings, but real wage increases by 1%, I'm happier (other price decreases worth more than my wage loss)!
- ▶ This phenomenon comes up a lot (unions, housing/NIMBY, monopolies and competition, trade)

GRAETZ MICHAELS 2018

- ▶ Map robots to tasks by industry, try to measure labor productivity effect
- ▶ Shocking: increased robot use produces 0.36%/year labor productivity gains
- ▶ But may have lowered low-skilled workers share

GRAETZ MICHAELS 2018

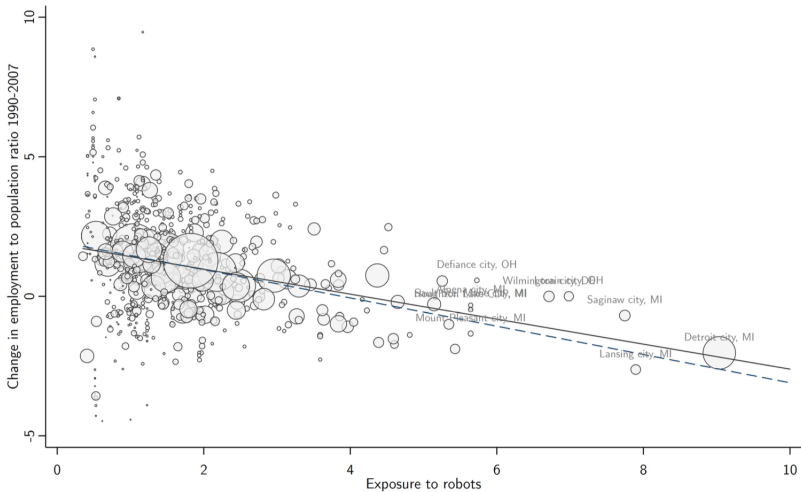


VA=“value added” (think revenue-cost)

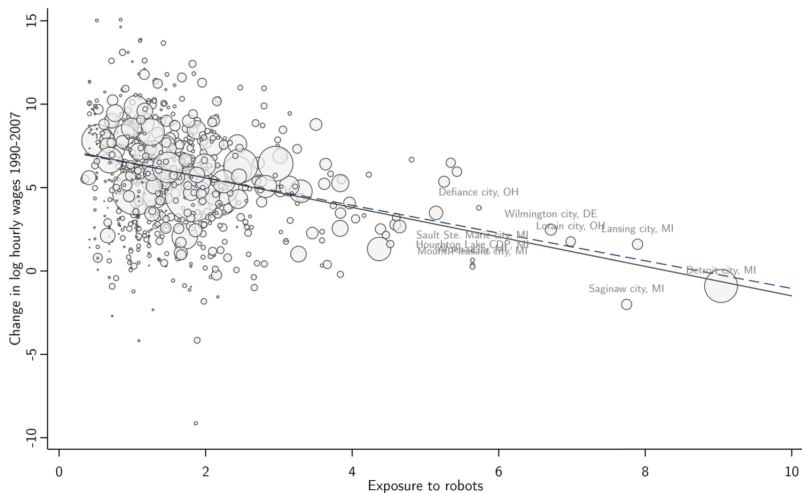
ACEMOGLU AND RESTREPO 2019

- ▶ Look at robot adoption in Europe by industry
- ▶ See how exposed U.S. cities are to roboticization based on industrial mix
- ▶ Wages and employment go down!

ACEMOGLU AND RESTREPO 2019



ACEMOGLU AND RESTREPO 2019



FRAMING OUR THINKING

- ▶ How should we think about robots?
- ▶ Robots replace workers with machines—capital/labor substitution
- ▶ But there are countervailing effects! (Robots replace *tasks* not *workers*)
- ▶ Example: there used to be around 500,000 bank tellers in U.S. in 1995, and 100,000 ATMs
- ▶ By 2020, there were 400,000 ATMs: how many tellers?

FRAMING OUR THINKING

- ▶ How should we think about robots?
- ▶ Robots replace workers with machines—capital/labor substitution
- ▶ But there are countervailing effects! (Robots replace *tasks* not *workers*)
- ▶ Example: there used to be around 500,000 bank tellers in U.S. in 1995, and 100,000 ATMs
- ▶ By 2020, there were 400,000 ATMs: how many tellers?
- ▶ 550,000(!) (Autor 2015)

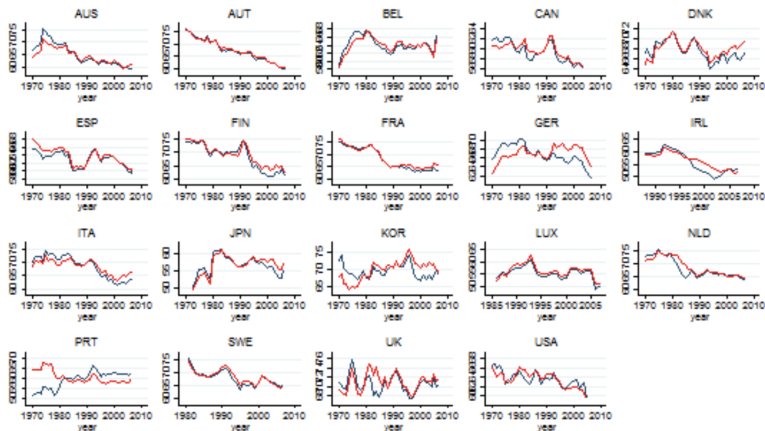
FRAMING OUR THINKING

- ▶ Autor 2015: three important factors
 1. Are robots are complement, or a substitute? Frequently, when substitutes for task, complements for job
 2. How elastic is labor supply? If elastic, wages don't rise/fall, quantities do. If inelastic, quantities don't change, wages do
 3. "Output" vs "income" elasticity. Robots→productivity, and:
 - ▶ Productivity→ fewer workers needed per good
 - ▶ Productivity→ income→ more demand for good

AUTOR AND SALOMONS 2018

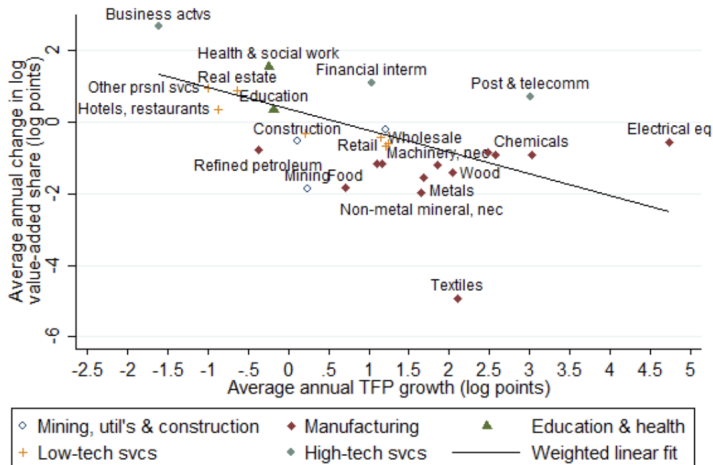
- ▶ Will robots displace labor? Decompose industry-level effect of roboticization into four factors
 1. Robots in industry i change output
 2. Robots in industry j 's effect on output j may effect inputs in industry i
 3. Robots in industry i may shift output across industries
 4. Robots in industry i may shift final demand
- ▶ Estimate effects of own and other industry TFP on industry/country/time period level data
- ▶ Result: broadly increases employment, but decreases labor share (productivity reduces employment, but supplier TFP and final good demand offset)

AUTOR AND SALOMONS 2018

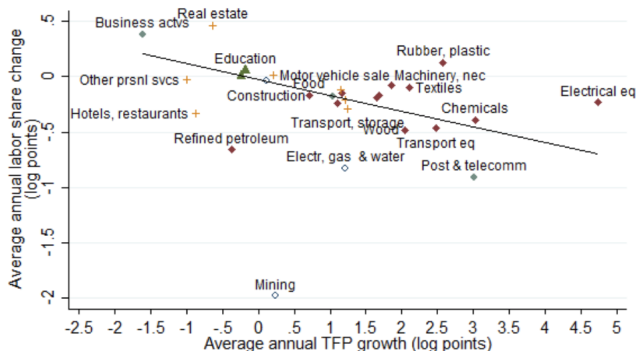


— Labor share — Reweighted labor share

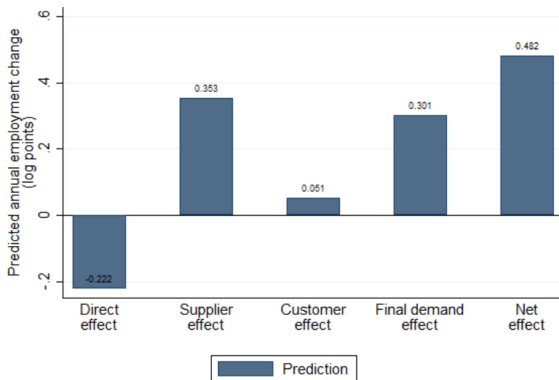
AUTOR AND SALOMONS 2018



AUTOR AND SALOMONS 2018

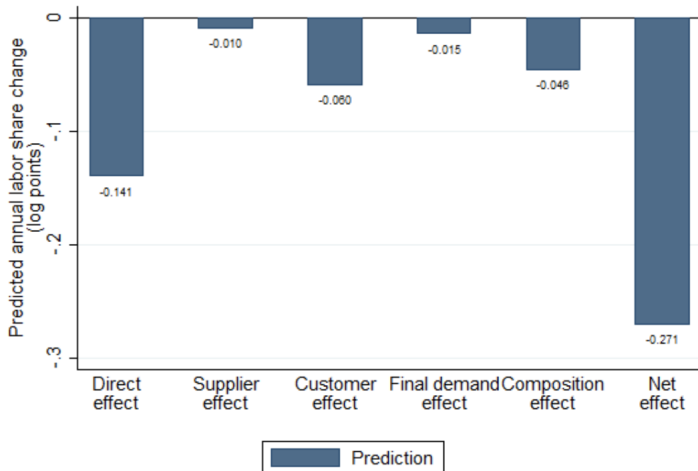


AUTOR AND SALOMONS 2018



Predictions based on Table 9.

AUTOR AND SALOMONS 2018



Predictions based on Table 9.

- ▶ My read of the state-of-the-art on roboticization
 1. Clear evidence robots increase average labor productivity (but why?)
 2. There's decent evidence within-industry roboticization reduces employment and wages, particularly of low-skilled workers
 - ▶ But may increase both for high-skilled workers in that industry
 3. However, there's also evidence that *other* industry roboticization *increases* employment and wages
 4. This is a big deal, and it appears large enough to outstrip own-industry effects
 5. However, while robots as a phenomenon have currently increased employment, it does appear to have decreased labor share
- ▶ None of this means next time will be different, but it should temper hyperbolic tendencies (is machine learning dramatically different from roboticization?)

My final read:

- ▶ There is some room to disagree about the effects of roboticization.
- ▶ Some evidence that low-skilled workers lose, and even that a population loses (Acemoglu & Restrepo)
- ▶ But also evidence that everyone gains more than they lose jointly (Autor & Salomons, Graetz & Michaels)
- ▶ My broad read is that it's hard to make the case that robotics have been anything but a minor nuisance for workers compared to gains
- ▶ Moreover, I am skeptical of doomsday predictions simply based on historical evidence that the “sky has been falling” for hundreds of years
- ▶ But! I might be a horse. The future is unknown and requires theory, could go either way. Next time might be different, and there's some (theoretical!) reason to think it could be