



AI and the Future of Work: Lessons from History

Carl Benedikt Frey
Dieter Schwarz Associate Professor of AI & Work

NEW YORK LIGHTS NOW ROBOTIZED

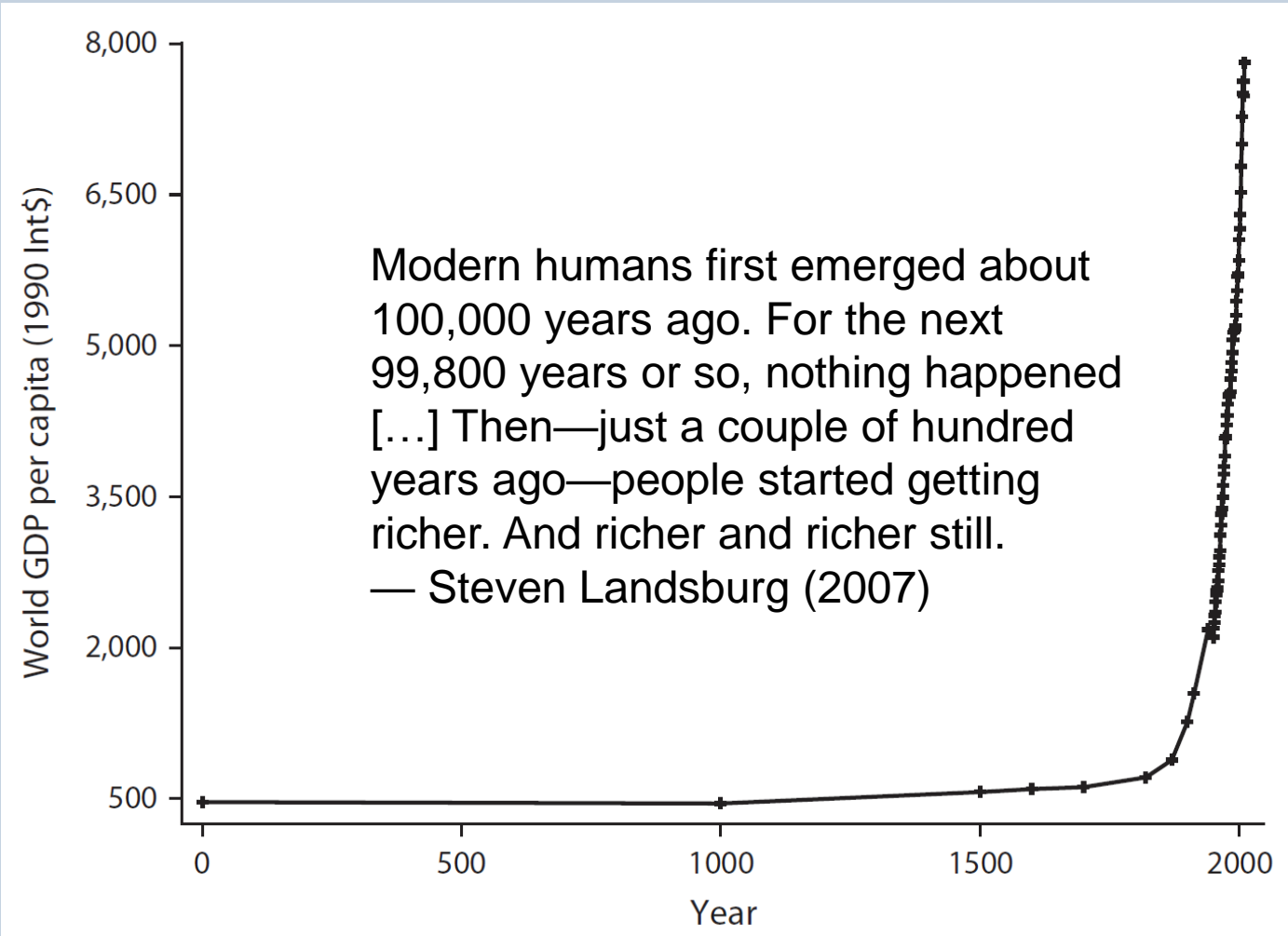
Delicate Electrical Devices in Control Stations
Carry On the Work That the Lamp-
lighters of Other Days Performed



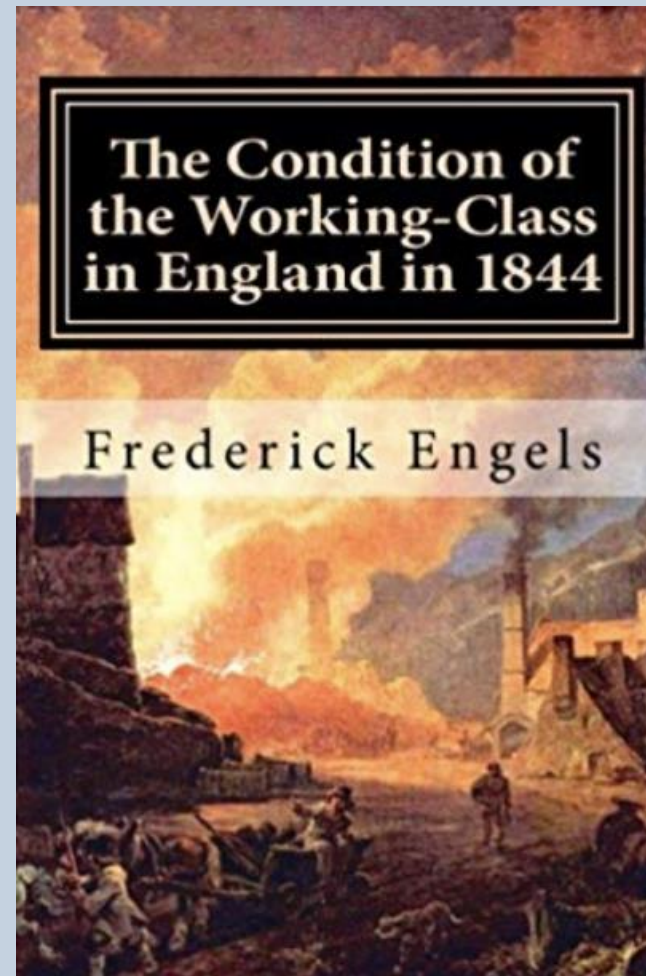
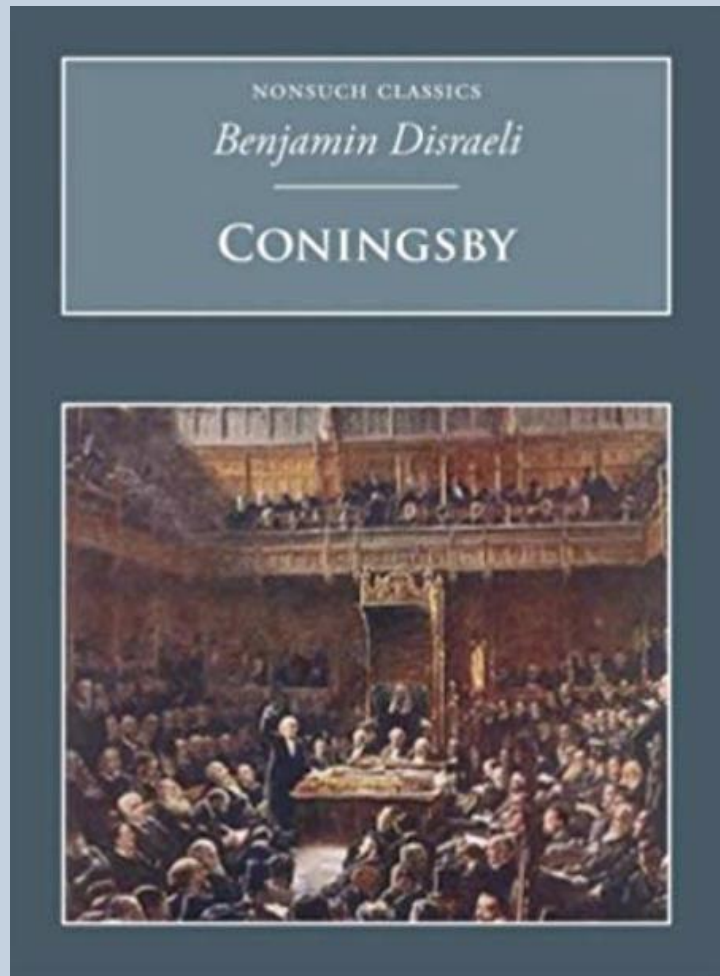
THE NEW YORK TIMES, SUNDAY, 'APRIL' 28, 1929.



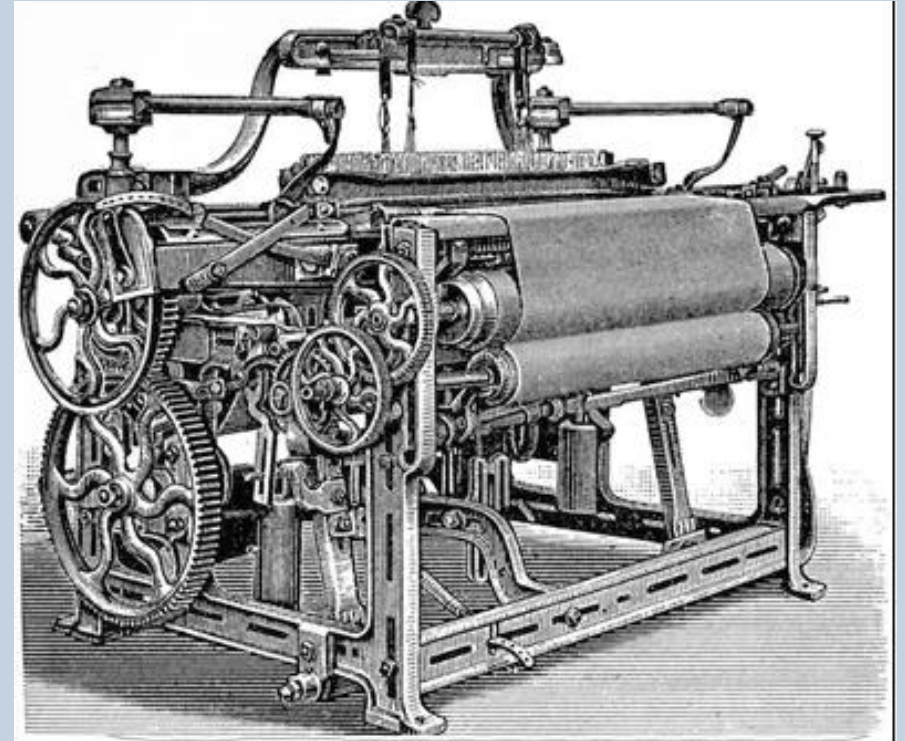
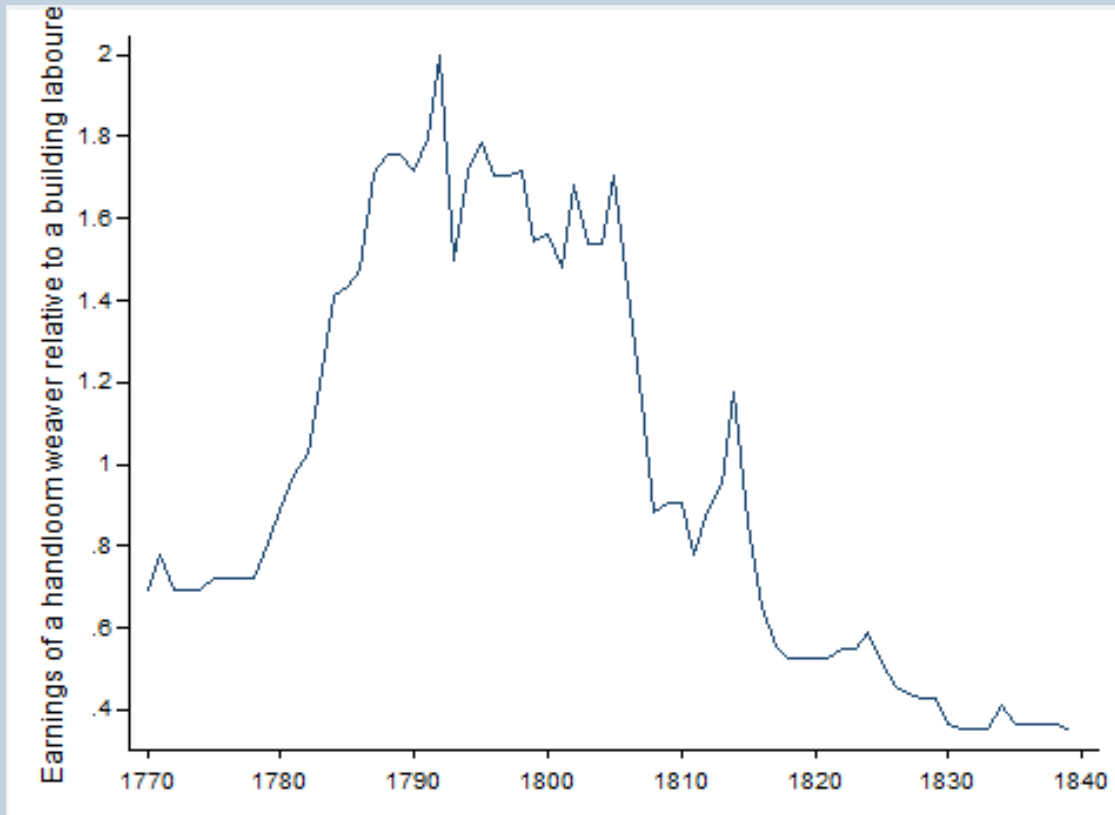
The “Great” Enrichment



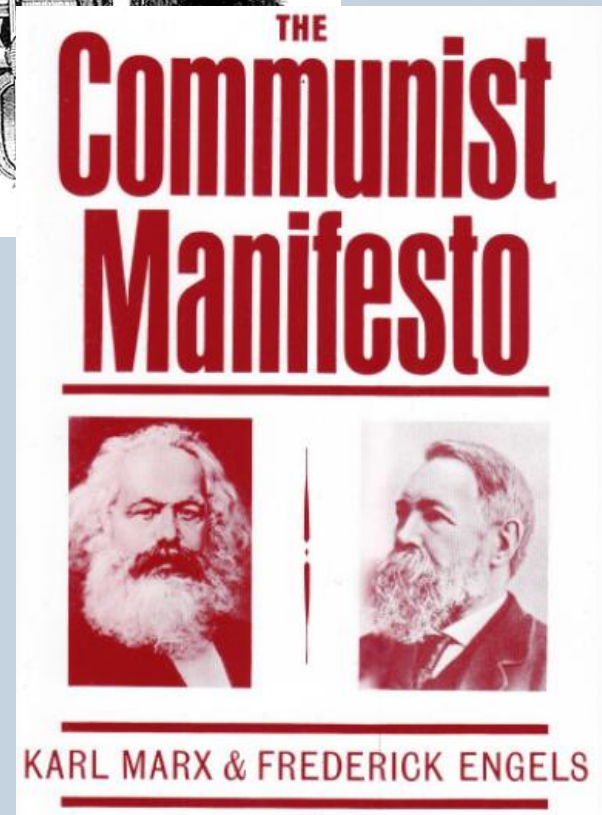
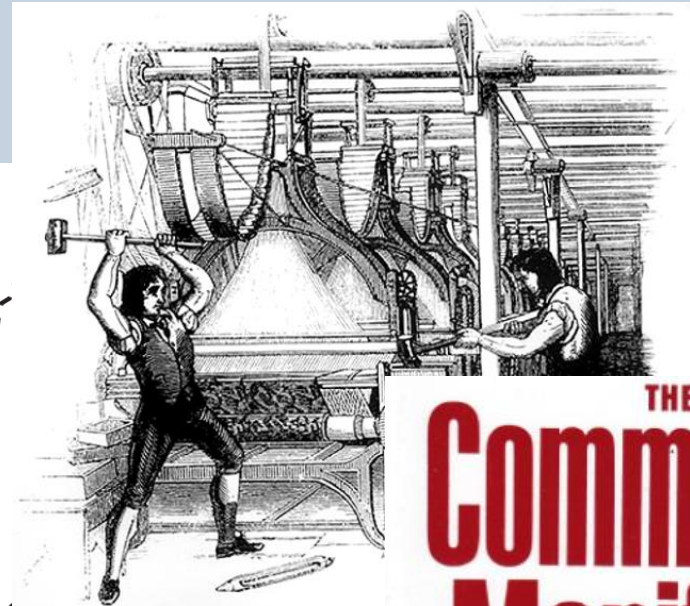
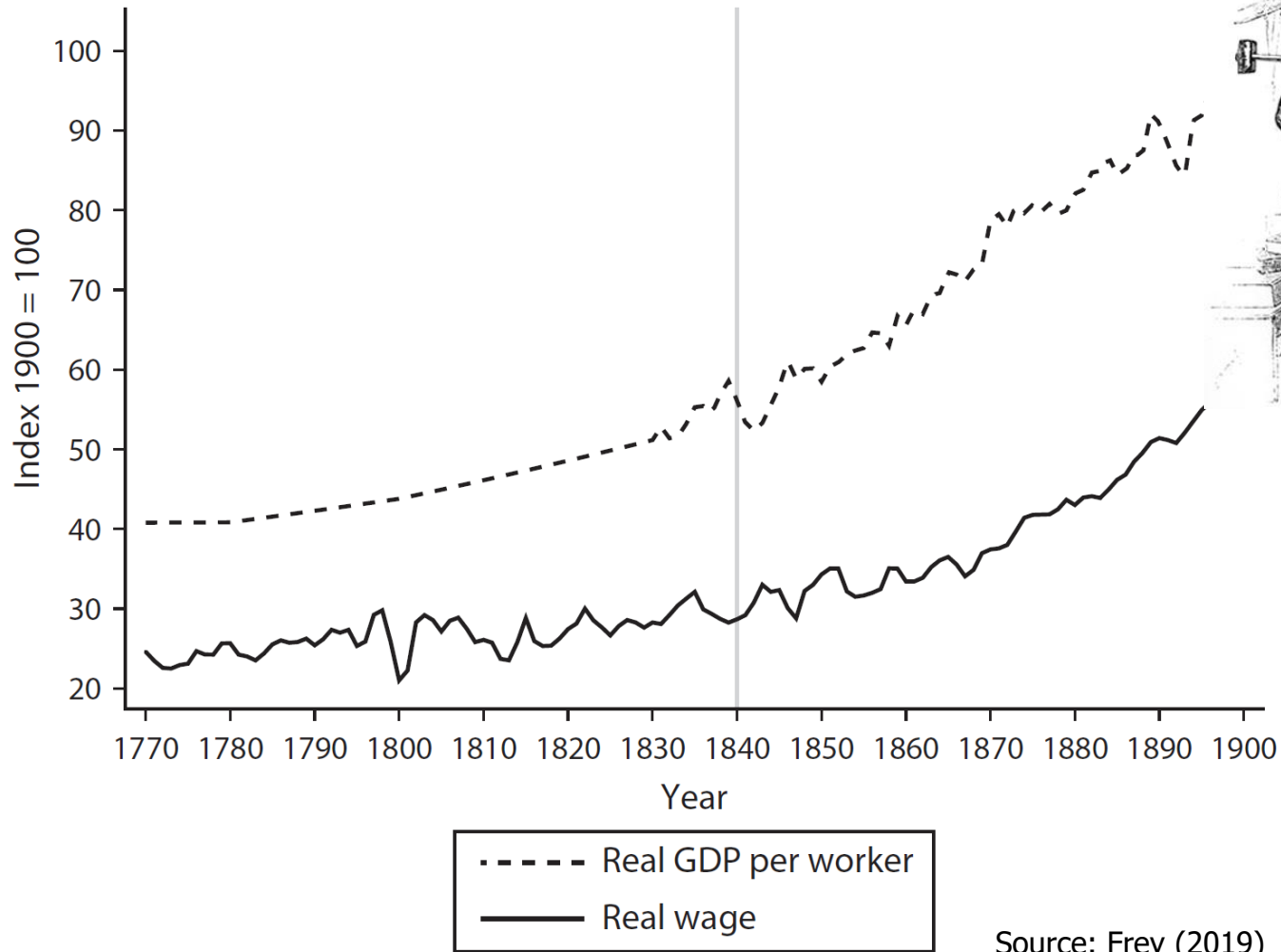
What did people say during the Industrial Revolution?



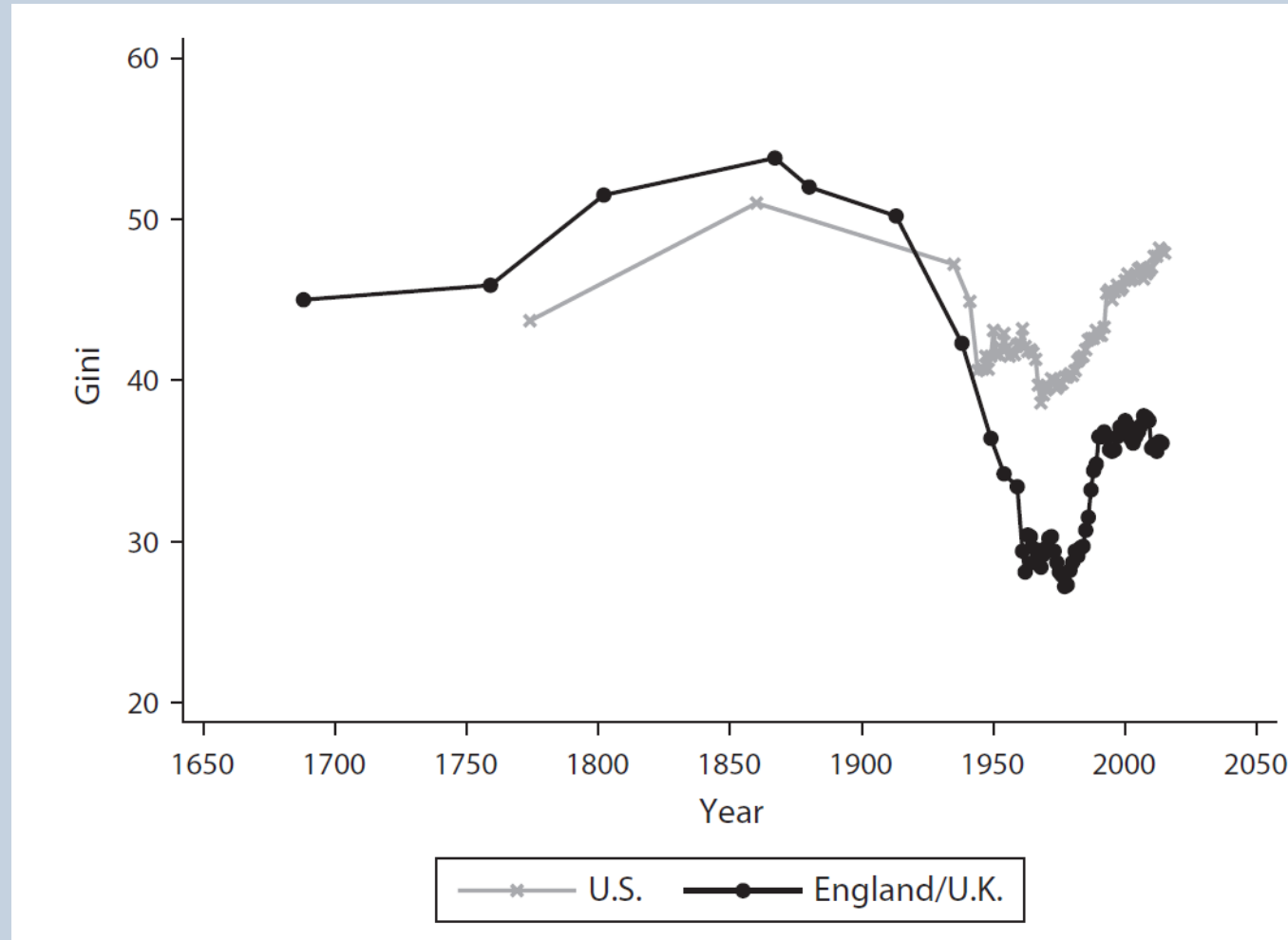
The Fates of Weavers – 1770 to 1840



Engels Pause

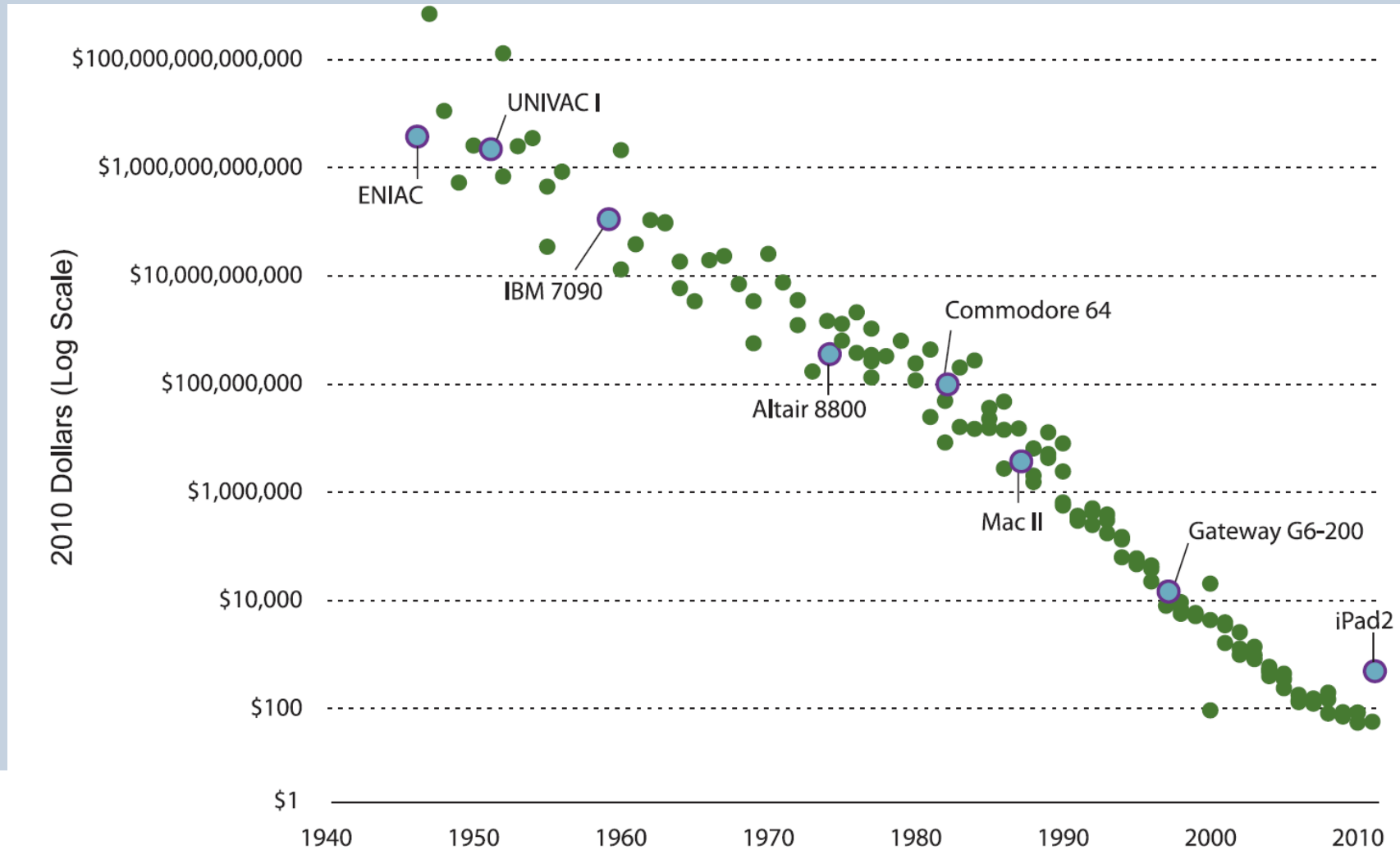


A Tale of Two Technological Revolutions

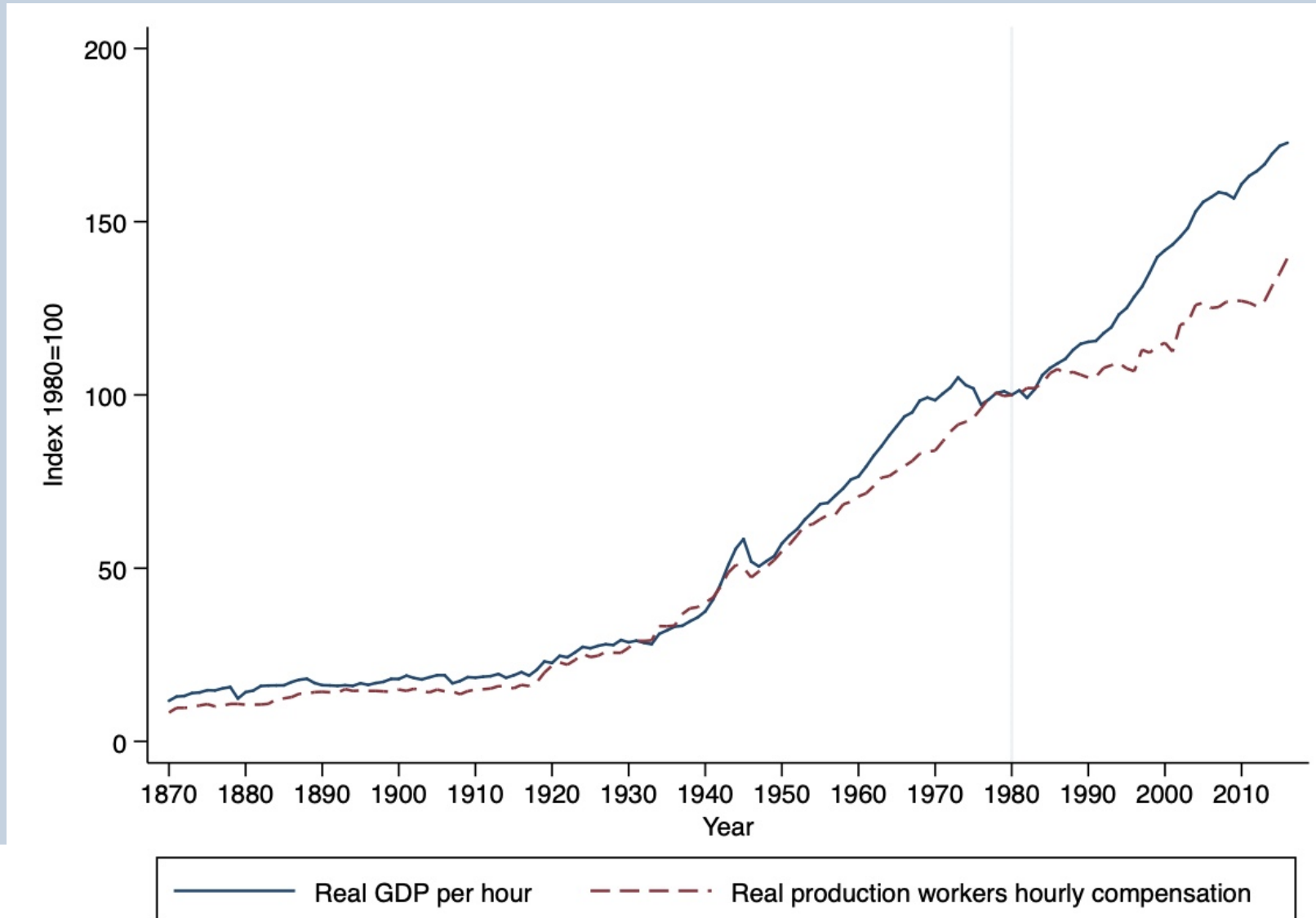


Source: Frey (2019). See also Milanovic 2019.

The Cost of Computing

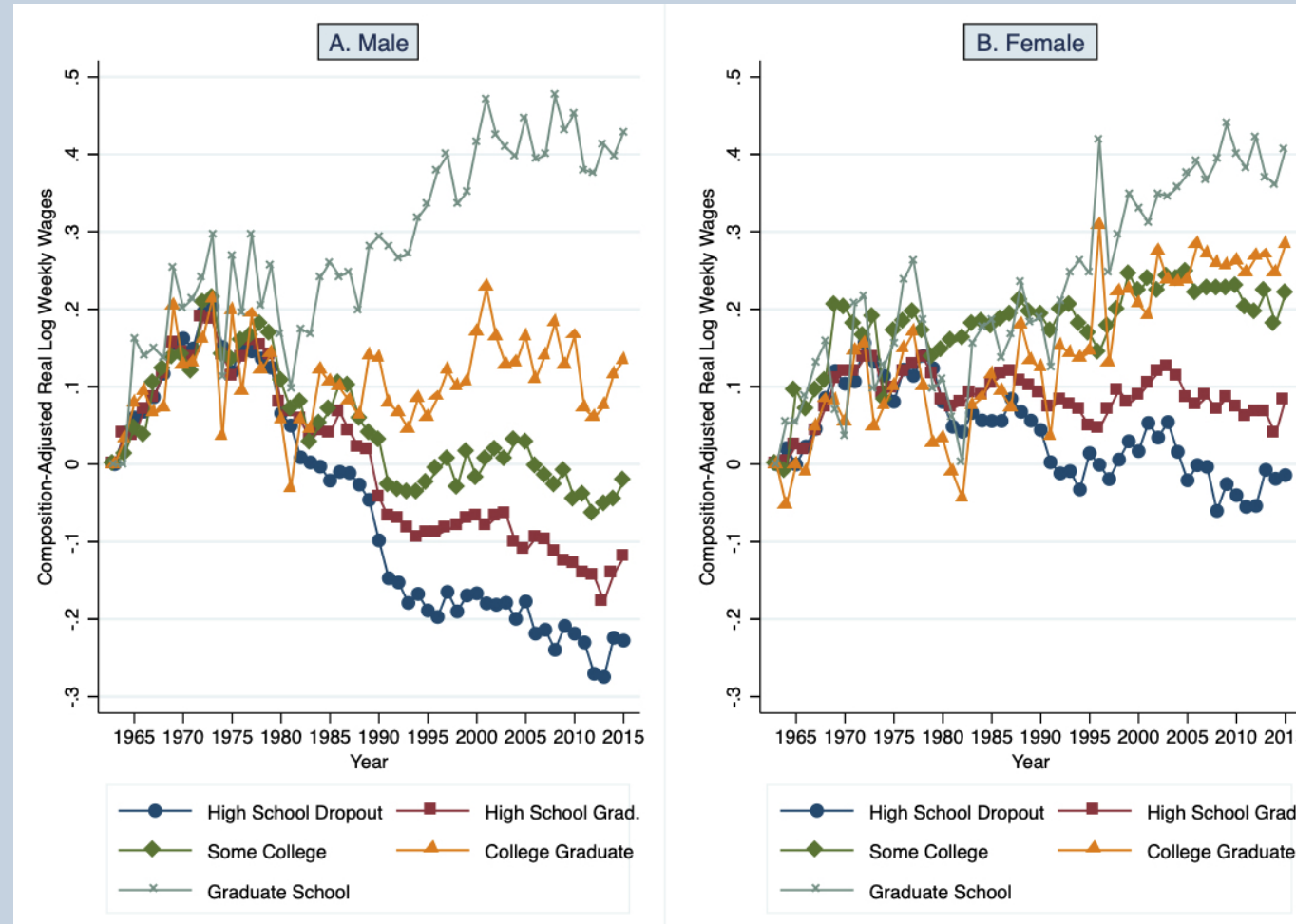


Productivity and Compensation



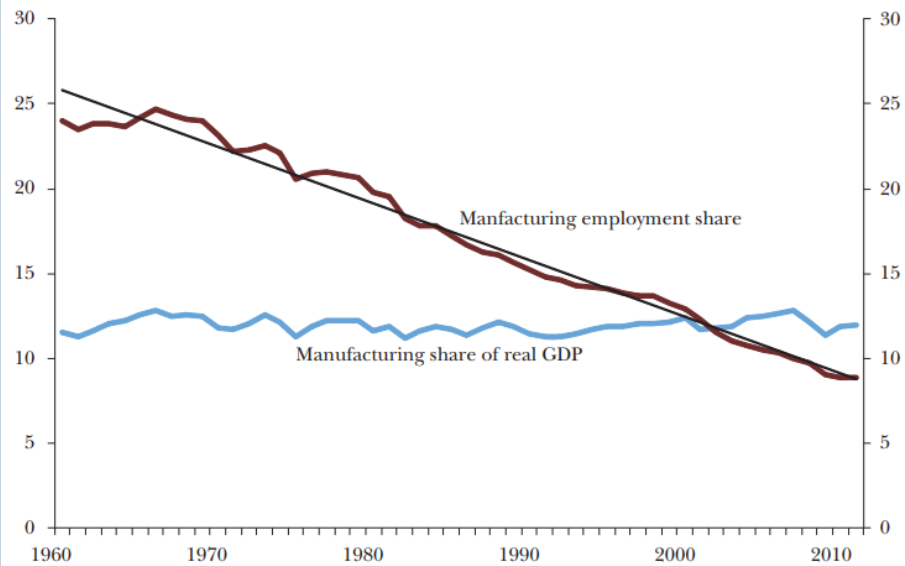
Source: Frey (2019). See also Gordon (2016).

Real Wages by Skill Group



Premature Deindustrialization

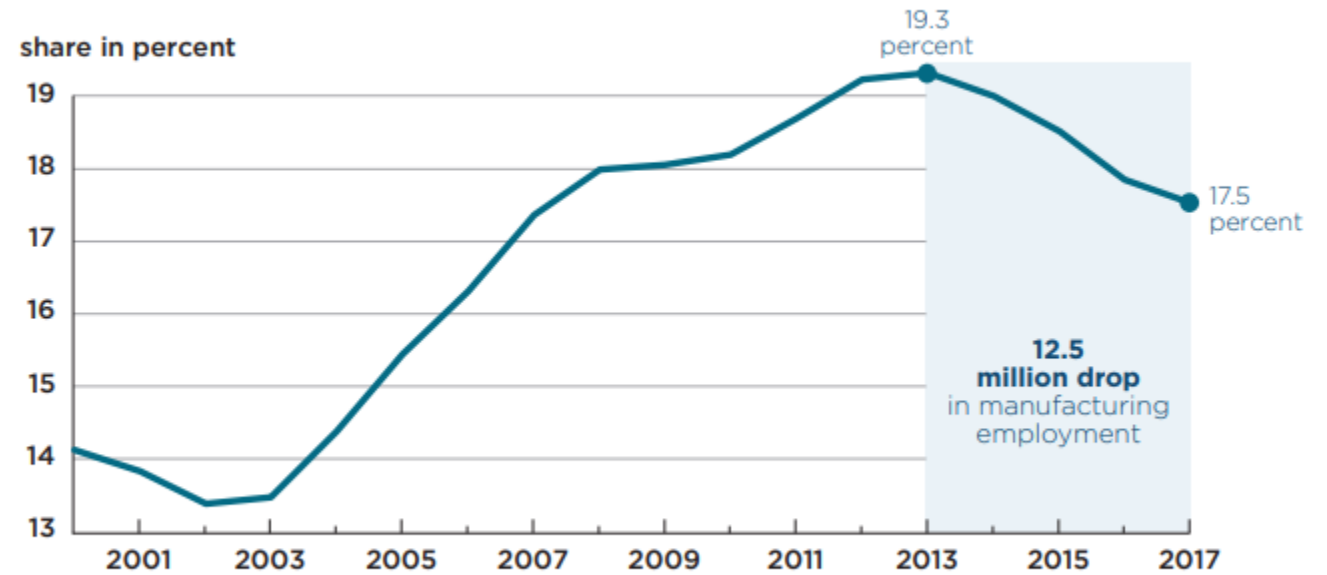
Figure 1
Manufacturing Value Added and Employment as a Share of the Total US Economy, 1960–2011
(in 2005 prices)



Source: Industry Accounts of the Bureau of Economic Analysis.
 Note: Output is measured as value added in 2005 prices, and employment is reported as persons engaged in production (full-time equivalent employees plus the self-employed).

Source: Baily and Bosworth (2014)

Figure 4
Share of manufacturing in total Chinese employment, 2000–17



Sources: Conference Board Total Economy Database (TED) and International Labor Comparisons (ILC) Databases.

Source: Lawrence (2019)

Robots and Jobs

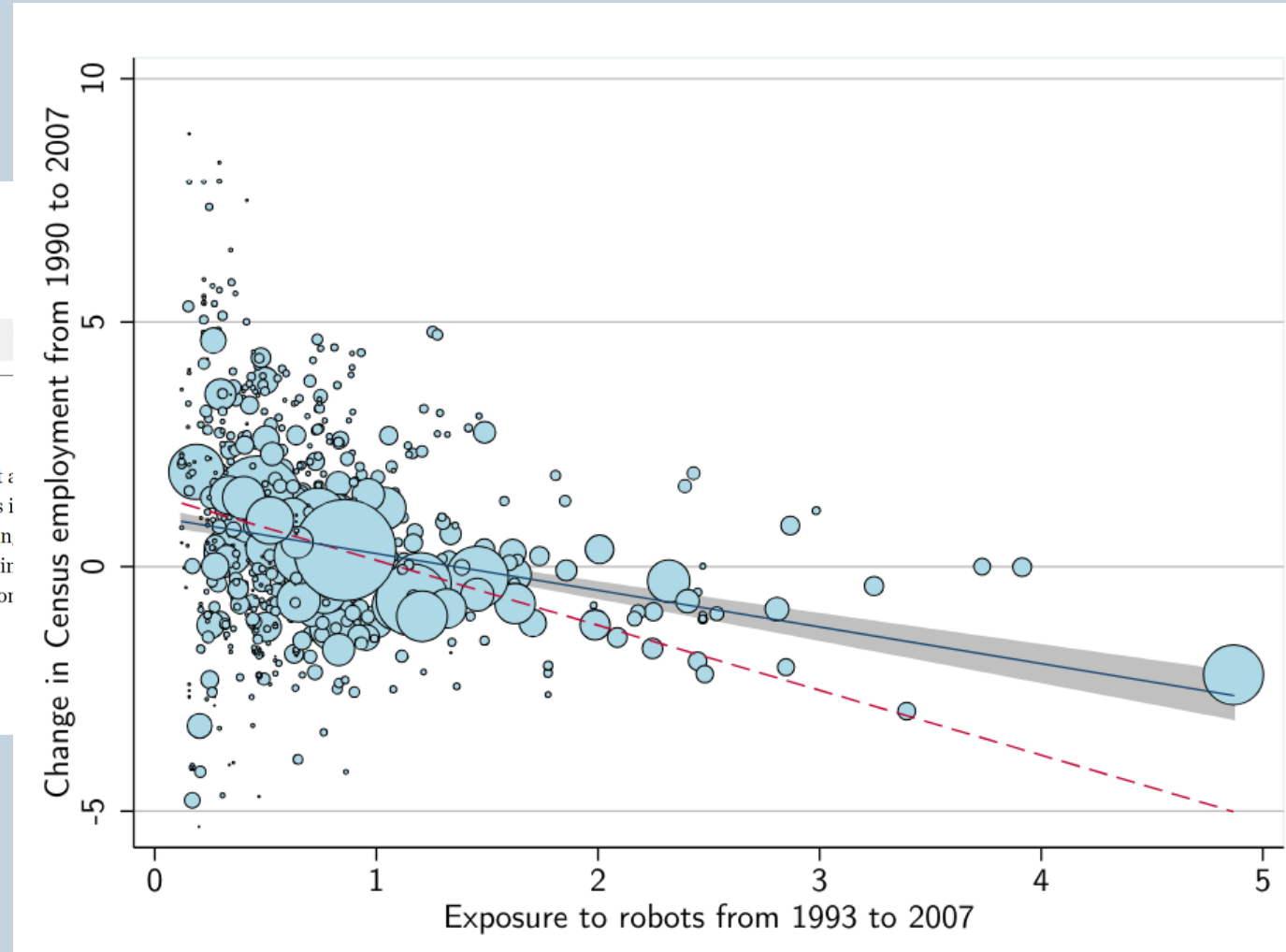
Robots and Jobs: Evidence from US Labor Markets

Daron Acemoglu and Pascual Restrepo

[PDF](#) [PDF PLUS](#) [Abstract](#) [Full Text](#) [Supplemental Material](#)

Abstract

We study the effects of industrial robots on US labor markets. We show theoretically that robots may reduce employment and that their local impacts can be estimated using variation in exposure to robots—defined from industry-level advances in robotics and local industry employment. We estimate robust negative effects of robots on employment and wages across commuting zones. We also show that areas most exposed to robots after 1990 do not exhibit any differential trends before then, and robots' impacts are distinct from other capital and technologies. One more robot per thousand workers reduces the employment-to-population ratio by 0.2 percentage points and wages by 0.42%.



Automation and Social Mobility

Labor Market Prospects:

- Future job opportunities for children.

Early Life-Course Impact:

- Family's ability to invest in children's development.

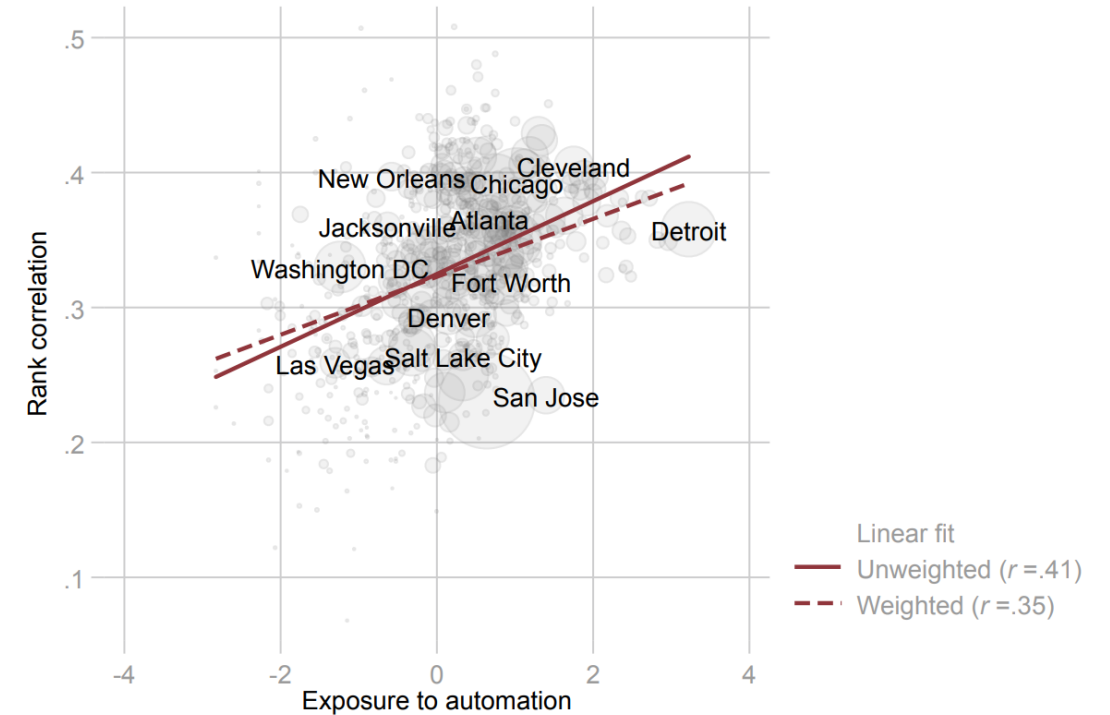


Figure 4: Automation and Intergenerational Persistence in Income Rank across Commuting Zones.

Source: Berger and Engzell (2020)

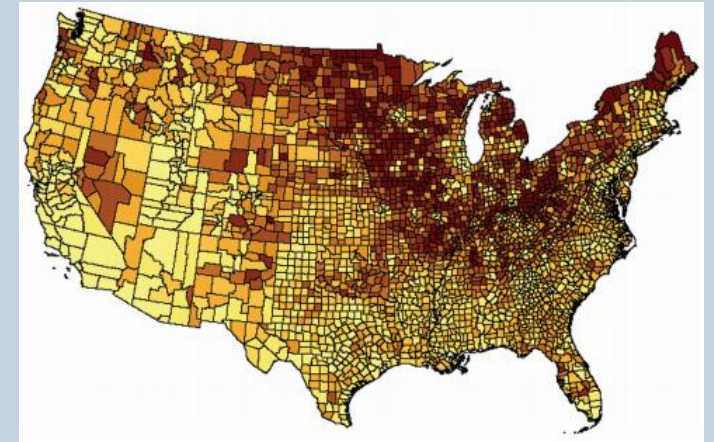
Political machinery: did robots swing the 2016 US presidential election?

Carl Benedikt Frey ✉, Thor Berger ✉, Chinchih Chen ✉

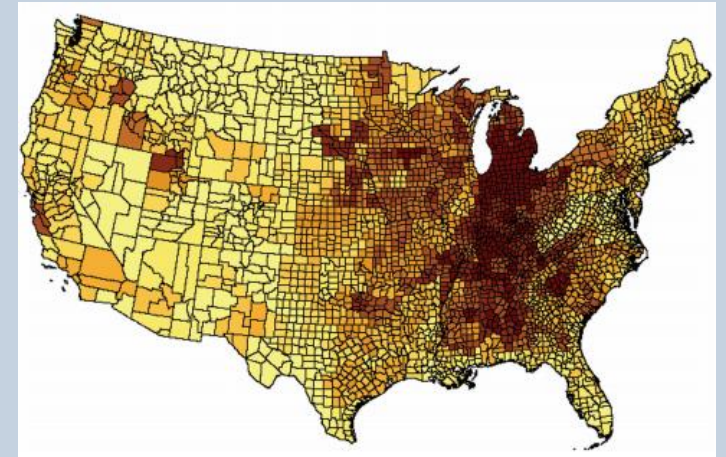
Oxford Review of Economic Policy, Volume 34, Issue 3, Autumn 2018, Pages 418–442,
<https://doi.org/10.1093/oxrep/gry007>

Published: 02 July 2018

Changes in the Republican vote share, 2012-2016



Changes in robot exposure, 2012-2016



Source: Frey, Berger, and Chen (2018)

DISCUSSION PAPER SERIES

IZA DP No. 12485

We Were the Robots: Automation and Voting Behavior in Western Europe

Massimo Anelli
Italo Colantone
Piero Stanig

JULY 2019

Presentation title, edit in head
and footer (view menu)

Generative AI

- Exposure to Generative AI (e.g. Felten et al. (2023); Eloundou et al. 2023)
- Generative AI boosts productivity of coders, writers, and costumer support agents (Noy and Zhang, 2023; Brynjolfsson et al., 2023)
- Novices and low-ability workers benefit most

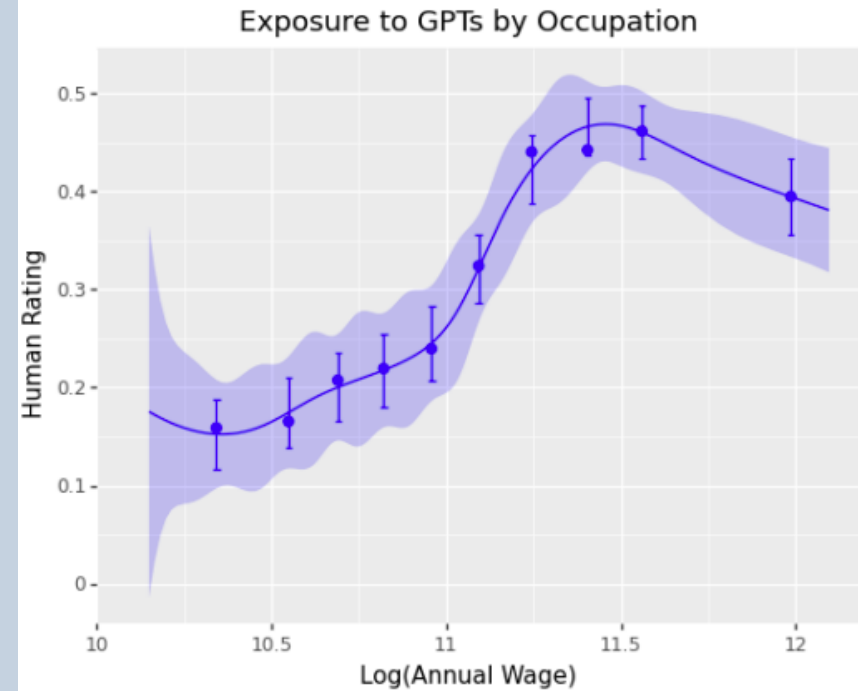
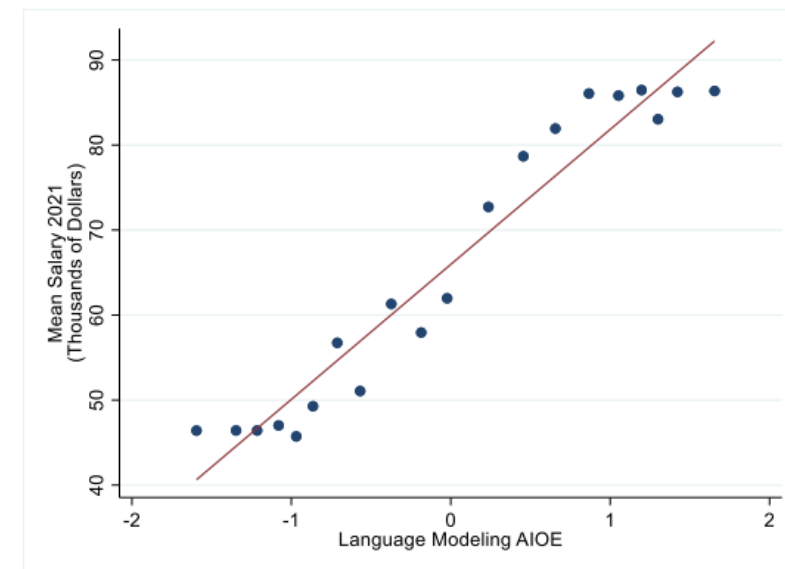


Figure 2: Relationship between Language Modeling AIOE and Mean Occupational Wages



The Uber Effect



Drivers of disruption? Estimating the Uber effect ☆

Thor Berger^{a, b}, Chinchih Chen^b, Carl Benedikt Frey^b

Show more

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<https://doi.org/10.1016/j.eurocorev.2018.05.006>

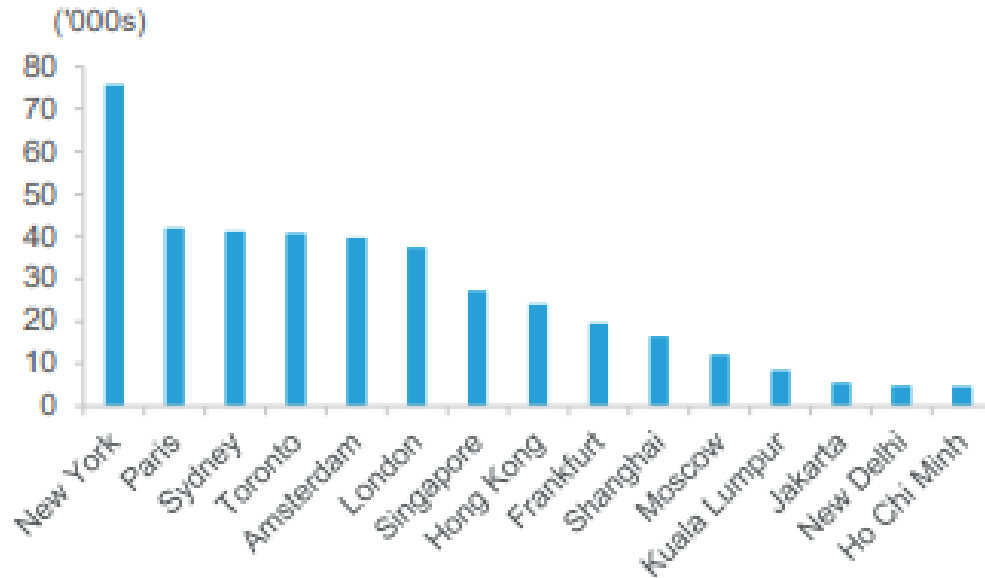
Get rights and content

Abstract

A frequent belief is that the rise of so-called “gig work” has led to the displacement of workers in a wide range of traditional jobs. This paper examines the impacts of the flagship of the gig economy—Uber—on workers employed in conventional taxi services. Our analysis exploits newly collected data on the staggered rollout of Uber across metropolitan areas in the United States and a difference-in-differences design to document that incumbent taxi drivers experienced a relative earnings decline of about 10 percent subsequent to Uber’s entry into a new market, while there are no significant effects on their labor supply. Additional evidence from a battery of placebo tests, event study estimates, and specifications using Google Trends data to capture differences in treatment intensity underlines these findings. A triple-differences design that compares changes among taxi drivers relative to bus, tractor, and truck drivers that were unaffected by the arrival of Uber, provides further supporting evidence that the diffusion of Uber has reduced the earnings potential of incumbent drivers in conventional taxi services in the United States.

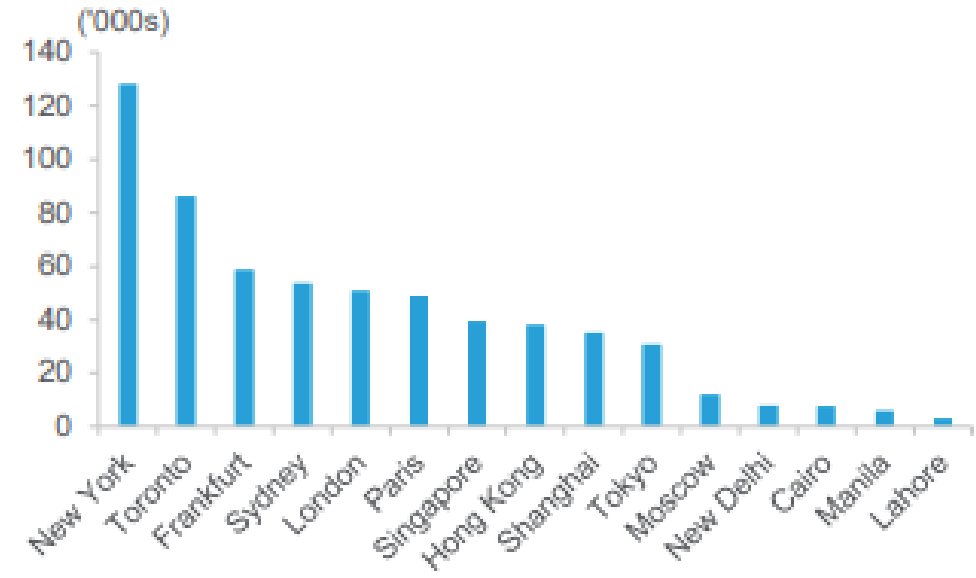
Wage Arbitrage

Figure 10. Average Annual Salary for Big 4 Auditors (0-1 Year Experience) Across Cities (US\$)



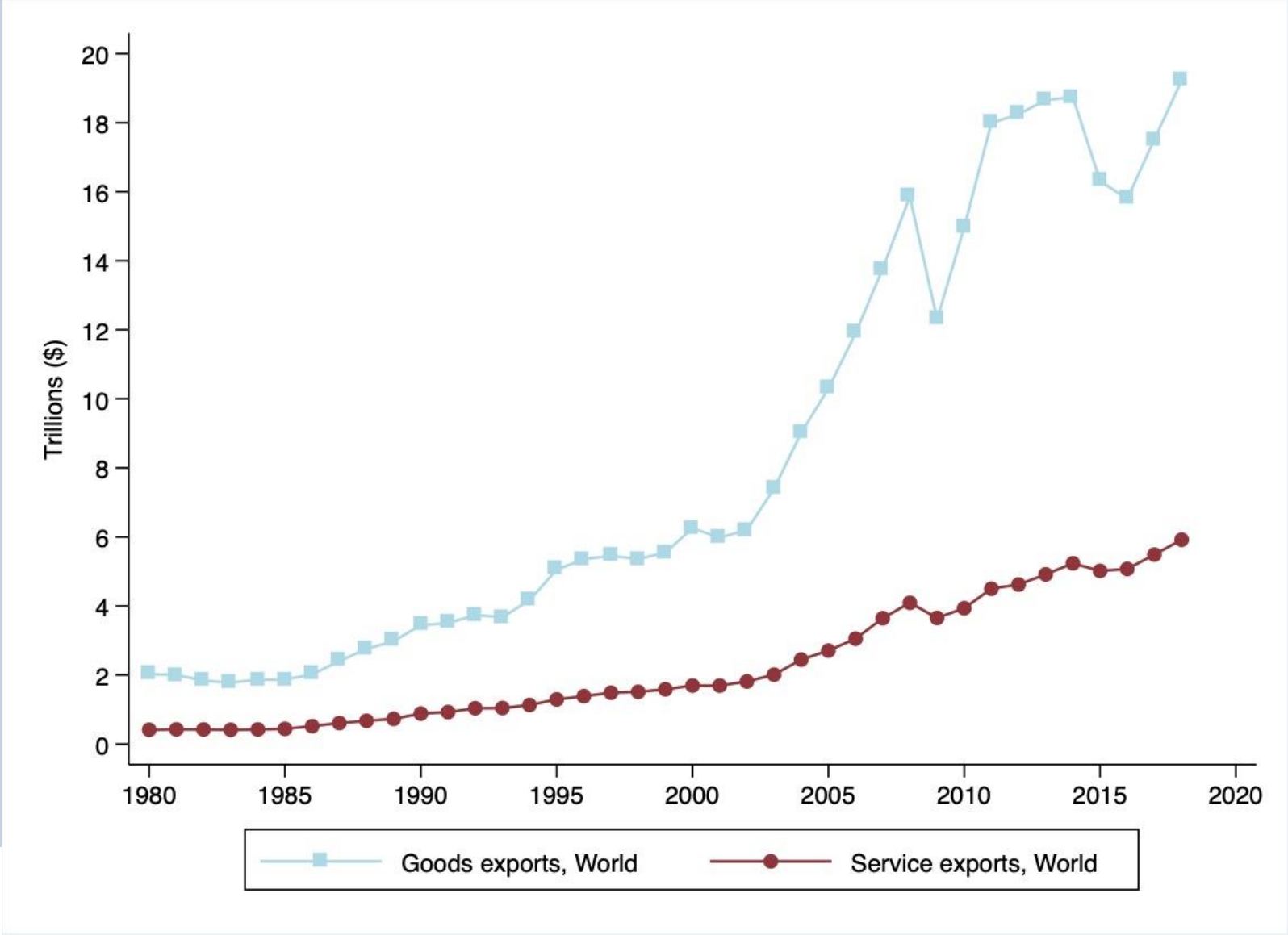
Source: Glassdoor

Figure 11. Average Annual Salary for Google Software Engineers (0-1 Year Experience) Across Different Cities (US\$)

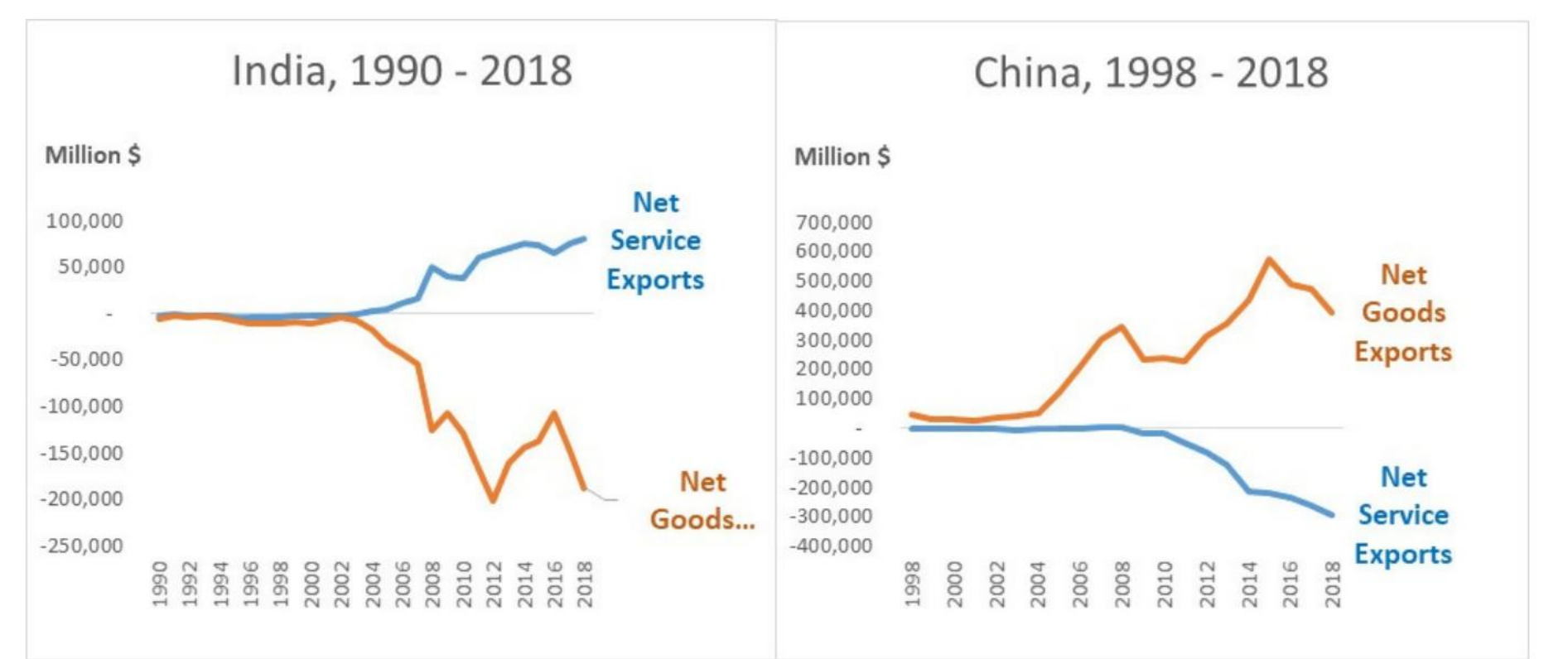


Source: Glassdoor

The Next Wave of Globalization - Goods and service exports

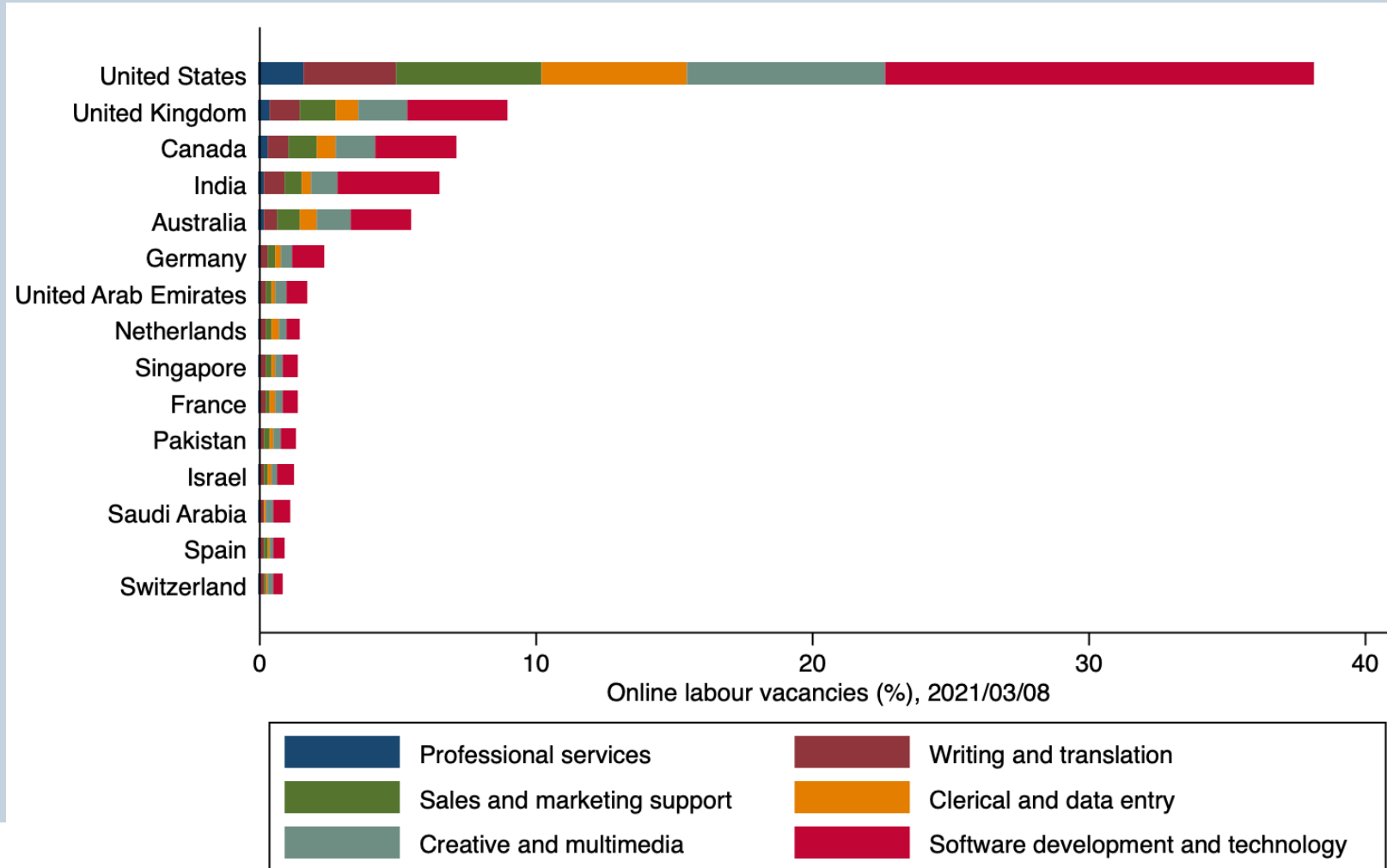


The future looks more like India

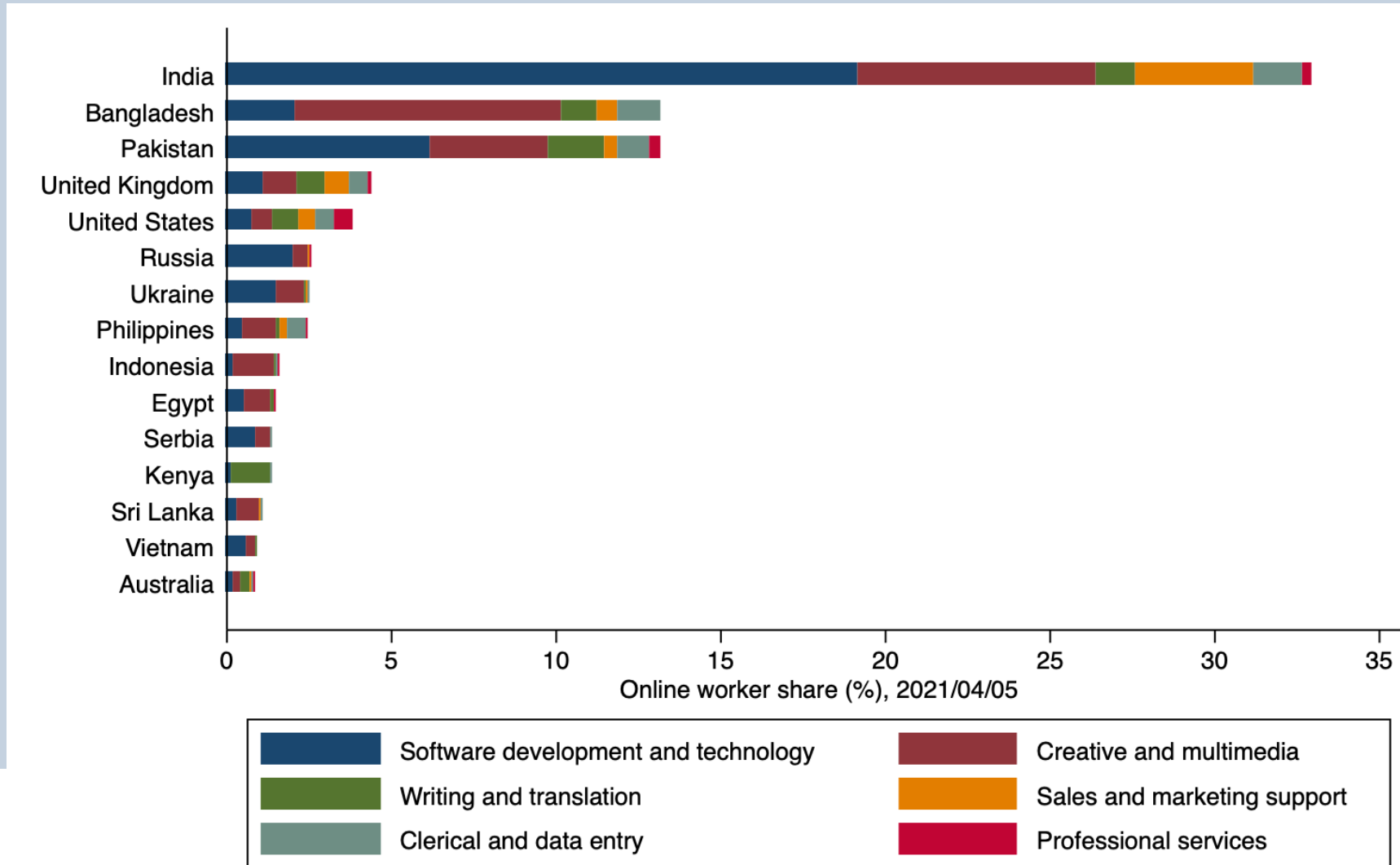


Source: Elaboration by authors based on online World Bank Data.

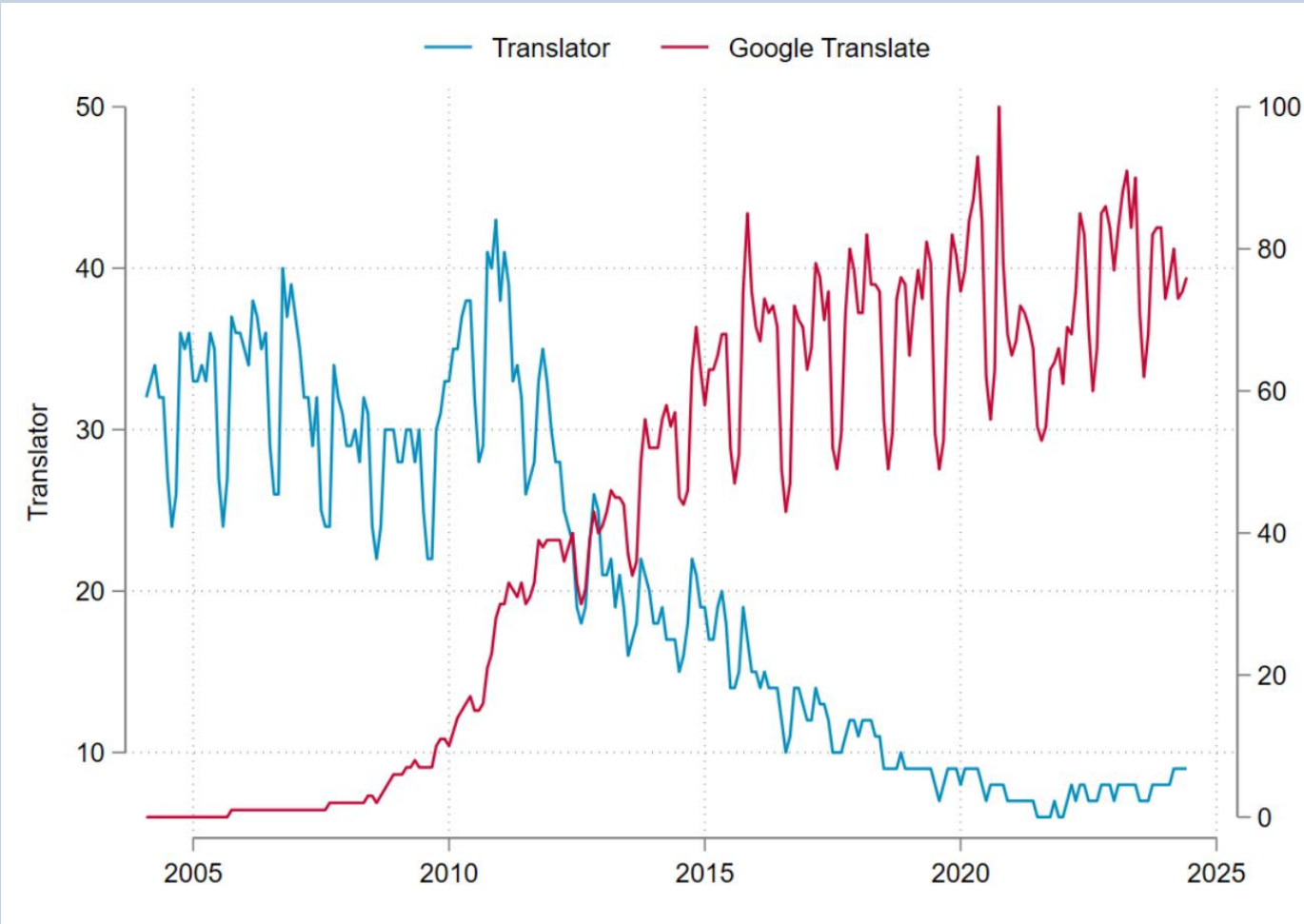
Digital labor - vacancies



Digital labor – worker location



Machine Translation and Language Skills



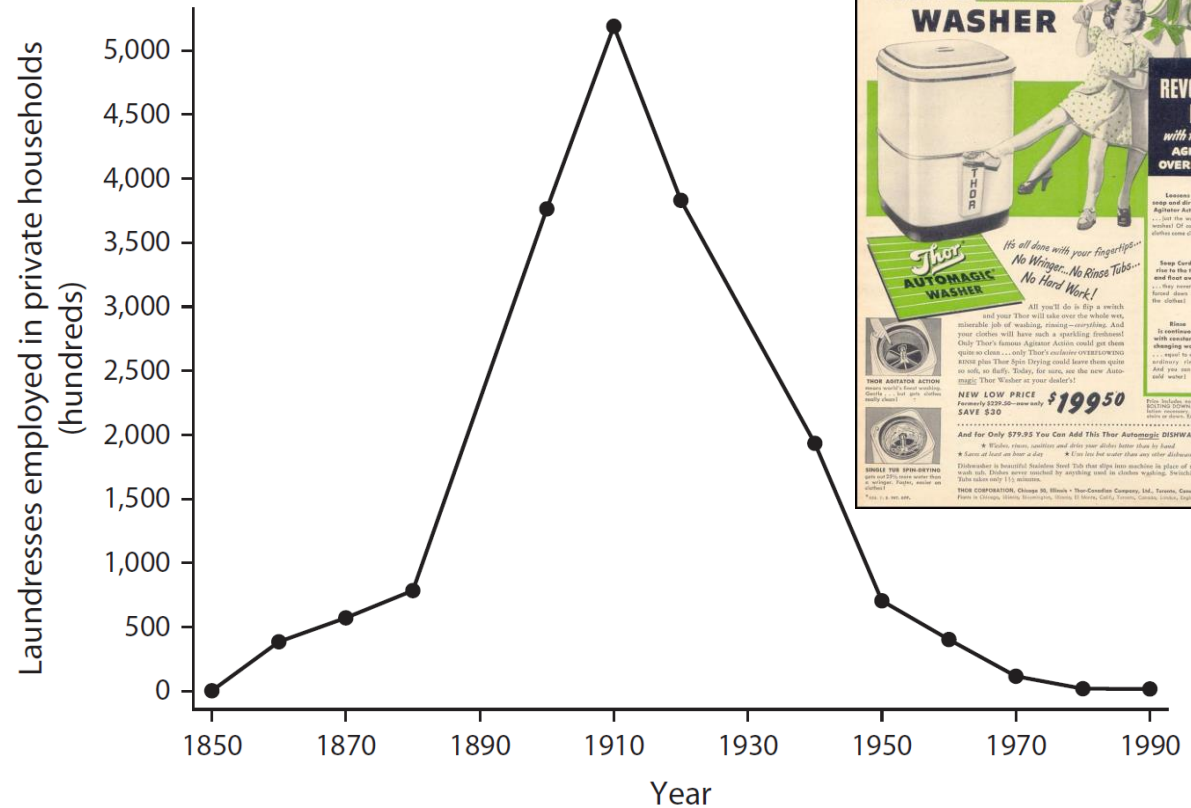
Lost in Translation: Artificial Intelligence and the Demand for Foreign Language Skills

Carl Benedikt Frey*†

Pedro Llanos-Paredes‡

June 2024

Task Simplification



The future of employment: How susceptible are jobs to computerisation? *

Carl Benedikt Frey ^a , Michael A. Osborne ^b

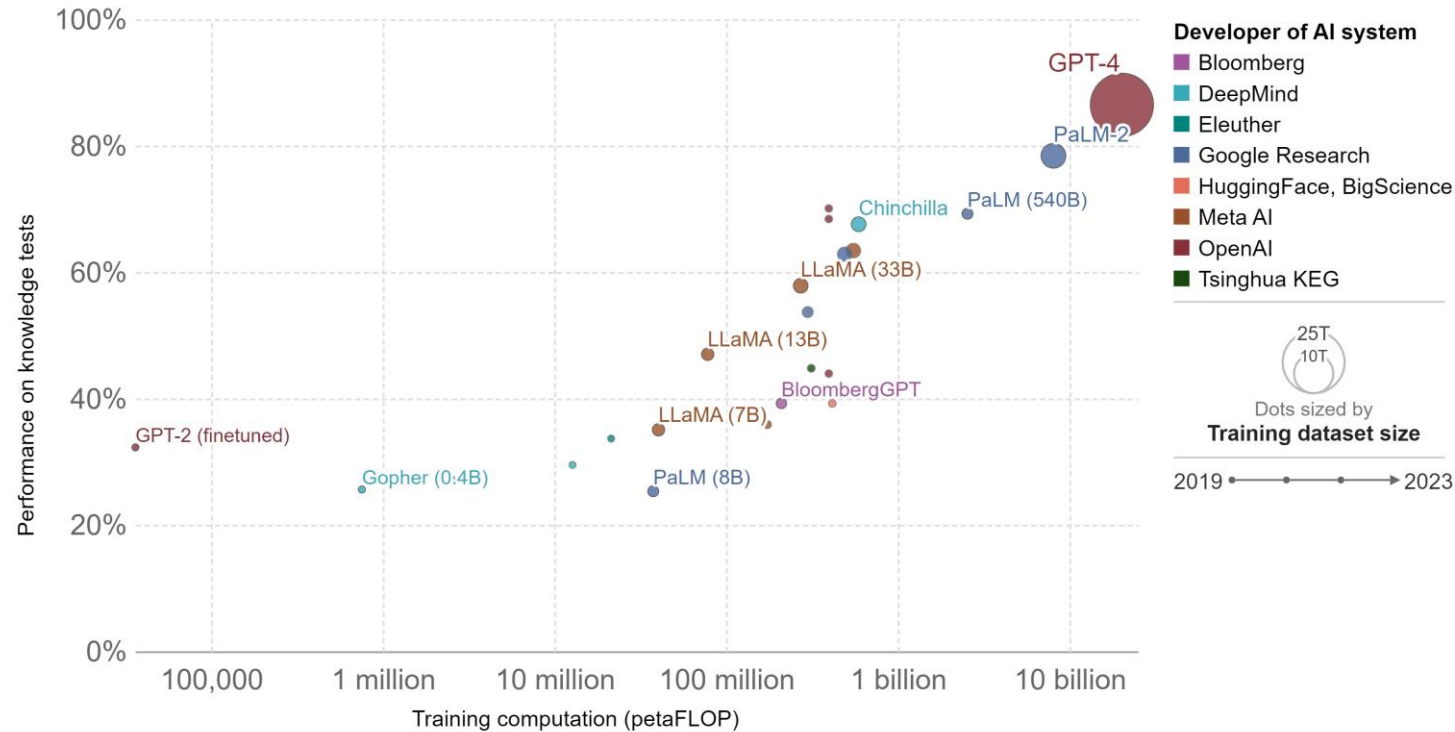


The Future of AI

Artificial intelligence: Performance on knowledge tests vs. training computation

Performance on knowledge tests is measured with the MMLU benchmark¹. Training computation is measured in total petaFLOP, which is 10^{15} floating-point operations².

Our World
in Data



- Moore's Law
- Training data
- Synthetic data
- Memorization vs generalization

Source: Epoch (2023)

OurWorldInData.org/artificial-intelligence • CC BY

Note: The values for training computation and dataset size are estimates and come with some uncertainty, especially for models for which only minimal information has been disclosed, such as GPT-4.

The Human Comeback

Financial Times US & Canadian companies + Add to myFT

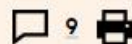
AlphaGo conquers Korean grandmaster Lee Se-dol

Google computer system seals 4-1 victory over player in landmark for AI



© AP

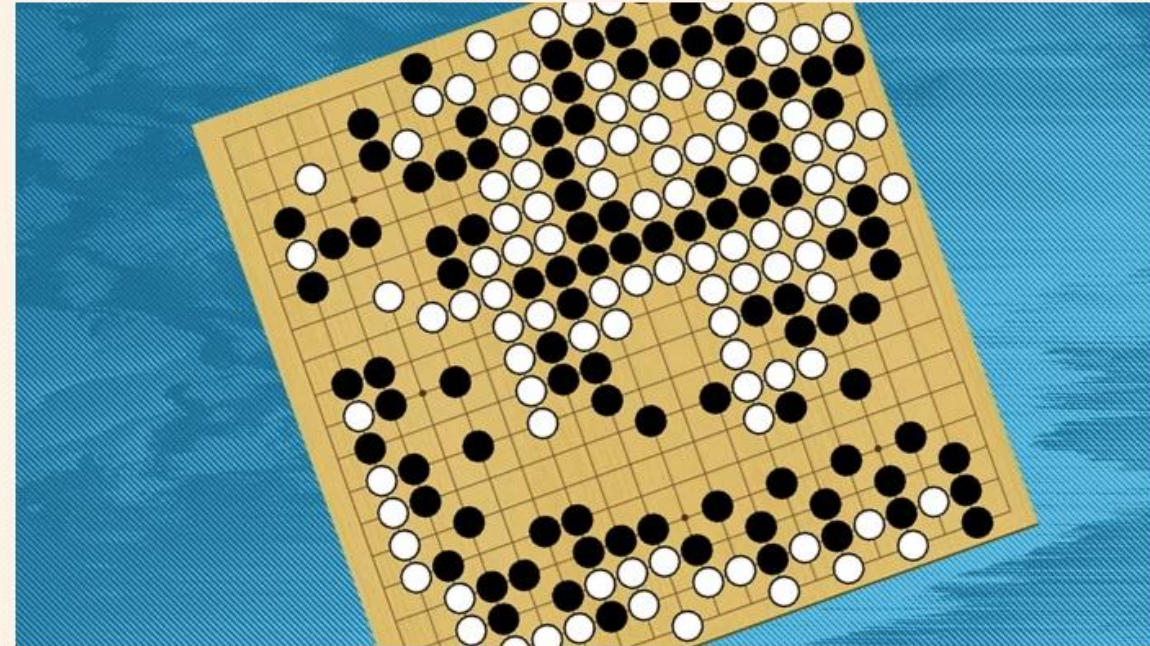
Simon Mundy in Seoul MARCH 15 2016



Artificial intelligence + Add to myFT

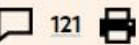
Man beats machine at Go in human victory over AI

Amateur Kellin Pelrine exploited weakness in systems that have otherwise dominated board game's grandmasters



Kellin Pelrine won 14 of 15 games against one of the top Go-playing systems in January © FT montage

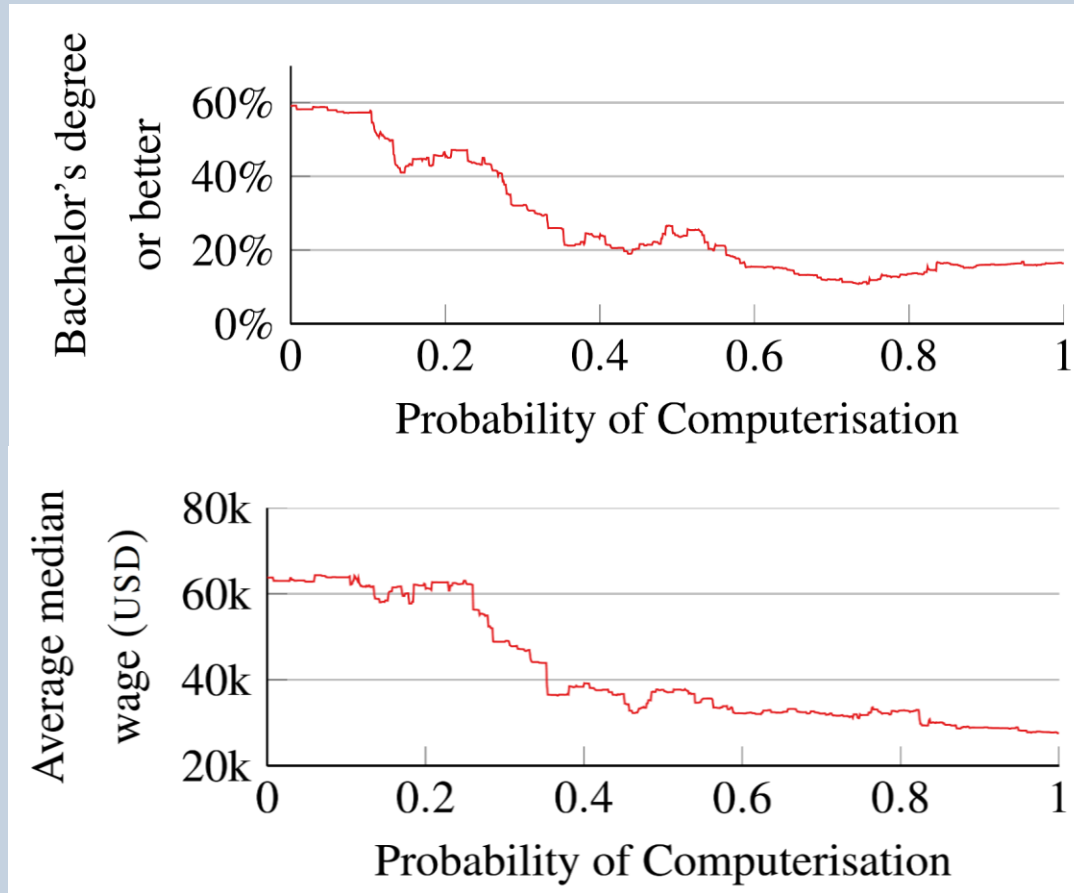
Richard Waters in San Francisco FEBRUARY 17 2023



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INSTITUTE



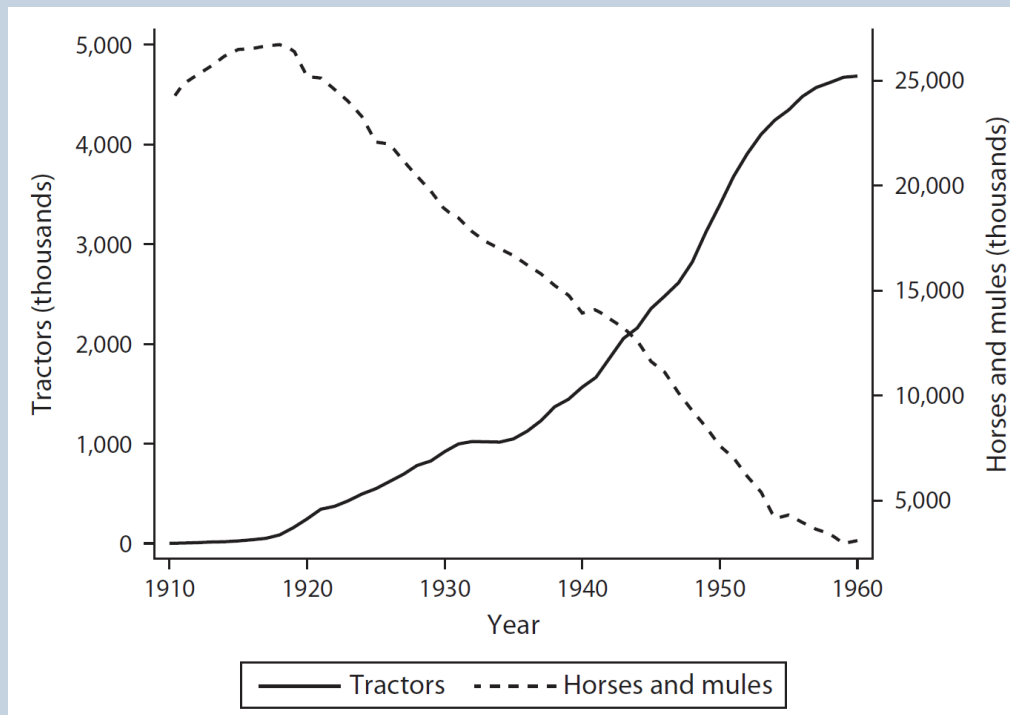
Automation and low-skilled jobs



Source: Frey & Osborne (2017)

“If horses could have joined the Democratic party and voted, what happened on farms might have been different.”

- Wassily Leontief



Source: Manuelli and Seshadri (2014)

...THE...
Horseless Age

VOLUME 11. JANUARY 7, 1903. NUMBER 1.

WATERLESS KNOX.
THE IDEAL DOCTOR'S CARRIAGE.



(TESTIMONIAL.)
Boston, Mass., August 27, 1902.
AUTOMOBILE HEADQUARTERS, Boston, Mass.:
Dear Sirs—The Knoxmobile which I purchased of you about three months ago has given perfect service, and I am entirely satisfied with it. I consider it the ideal carriage for a physician. The absence of water and its attendant troubles remove about half the amount of care necessary to keep it in good running order. I have not had any trouble of any kind with it, although I have run it about 1,000 miles since June. I have not even cleaned the spark plug once in that time. There is no overheating of the engine, in fact, the engine is so cool that I usually open the throttle and allow the engine to take in a charge of its momentum after removing the circuit making stop, and an am able to start the engine next time by simply pulling the crank over a quarter of a turn. The ease and quickness of the control make it a pleasure to run the carriage. I consider the Knox far ahead of any carriage on the market at the present time for the ease to which a physician would put it in his professional work. It is always ready at an instant's notice and I have found it thoroughly reliable.

Yours truly,
GEO. T. CUSHMAN, M. D.

One-quarter of our 1902 output was sold to Doctors.
SEND FOR CATALOG AND TESTIMONIALS.

KNOX AUTOMOBILE CO., Springfield, Mass.

NEW YORK: 152 West 38th Street.
February 1,
146 West 30th Street.

WESTERN AGENCY:
National Automobile and Mfrs. Company,
30 Fremont St., SAN FRANCISCO, CAL.

COPYRIGHT, 1903, BY E. F. INGERSOLL.

Redirecting Technology

- What if a team of engineers 3,500 years ago and had, built human-like machines that fully automated every work-related task that his fellow Greeks were doing.
 - Herding sheep
 - Making clay pottery
 - Weaving tunics
 - Repairing horse-drawn carts
 - Bloodletting victims of disease

The Turing Trap: The Promise & Peril of Human-Like Artificial Intelligence

[Erik Brynjolfsson](#)

In 1950, Alan Turing proposed an imitation game as the ultimate test of whether a machine was intelligent: could a machine imitate human intelligence has implicitly or explicitly been the goal of thousands of researchers, engineers, and entrepreneurs. The benefit: understanding of our own minds.

But not all types of AI are human-like. In fact, many of the most powerful systems are very different from humans. So an excessive workers lose economic and political bargaining power and become increasingly dependent on those who control the technology. In share of the value created. Furthermore, augmentation creates new capabilities and new products and services, ultimately generating incentives for automation rather than augmentation among technologists, business executives, and policymakers.

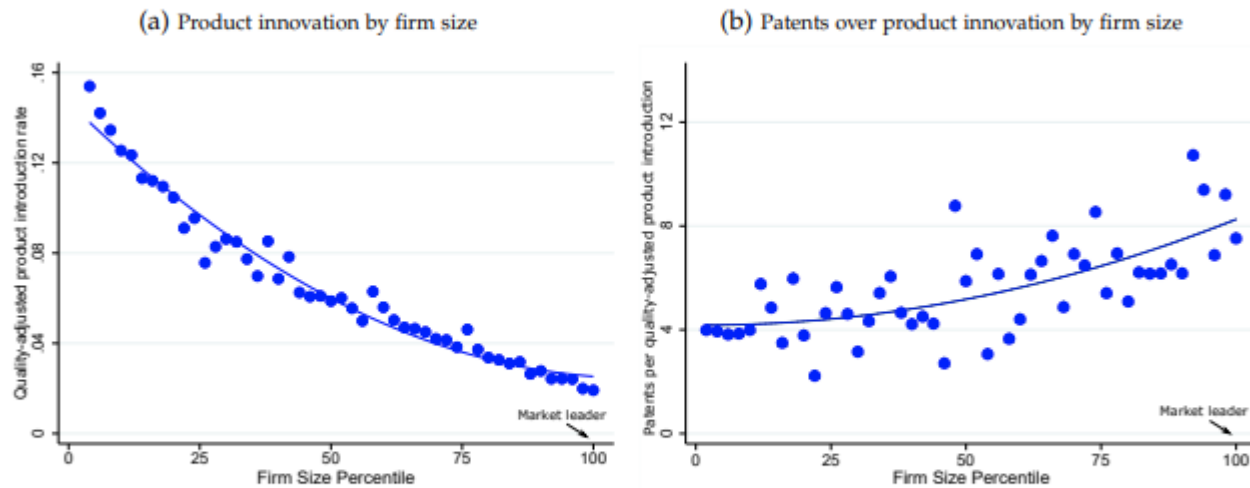
Redirecting Technology

- Oil price shocks or carbon taxes aiding the development of green technologies (Acemoglu et al., 2012; Hassler et al., 2021)
- Privacy regulation reducing the data-intensity of AI (Frey et al., 2021)
- Tax code aiding automation (Acemoglu et al. 2020)



Redirecting Technology

Figure 4: PRODUCT INNOVATION AND PATENTING OVER FIRM SIZE



Notes: Figures are reproduced from Argente et al. (2020). Panel (a) depicts the average quality-adjusted product introduction rate for firms in different size (sales) percentiles in the product category in a year. Panel (b) depicts the ratio of patent applications over quality-adjusted new products across the firm size percentile.

The Failure of Free Entry

Germán Gutiérrez & Thomas Philippon

WORKING PAPER 26001

DOI 10.3386/w26001

ISSUE DATE June 2019

We study the entry and exit of firms across U.S. industries over the past 40 years. The elasticity of entry with respect to Tobin's Q was positive and significant until the late 1990s but declined to zero afterwards. Standard macroeconomic models suggest two potential explanations: rising entry costs or rising returns to scale. We find that neither returns to scale nor technological costs can explain the decline in the Q- elasticity of entry, but lobbying and regulations can. We reconcile conflicting results in the literature and show that regulations drive down the entry and growth of small firms relative to large ones, particularly in industries with high lobbying expenditures. We conclude that lobbying and regulations have caused free entry to fail.