Technological revolutions and the triangle between firms, government and civil society

Philippe Aghion

Patinkin Lecture

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CREATIVE DESTRUCTION…

- Process whereby new innovations displace old technologies
  - Joseph Schumpeter in *Capitalism, Socialism et Democracy (1942)*

PETER HOWITT

BASIC "SCHUMPETERIAN GROWTH" PARADIGM

- Long-run growth driven by cumulative process of innovation
- Innovations result from entrepreneurial activities motivated by prospect of innovation rents
- Creative destruction: new innovations displace old technologies

AT THE HEART OF THE PARADIGM

- Contradiction :
  - The innovator is motivated by prospect of monopoly rents
  - But those rents can be used ex post to prevent future innovations and to block new entry

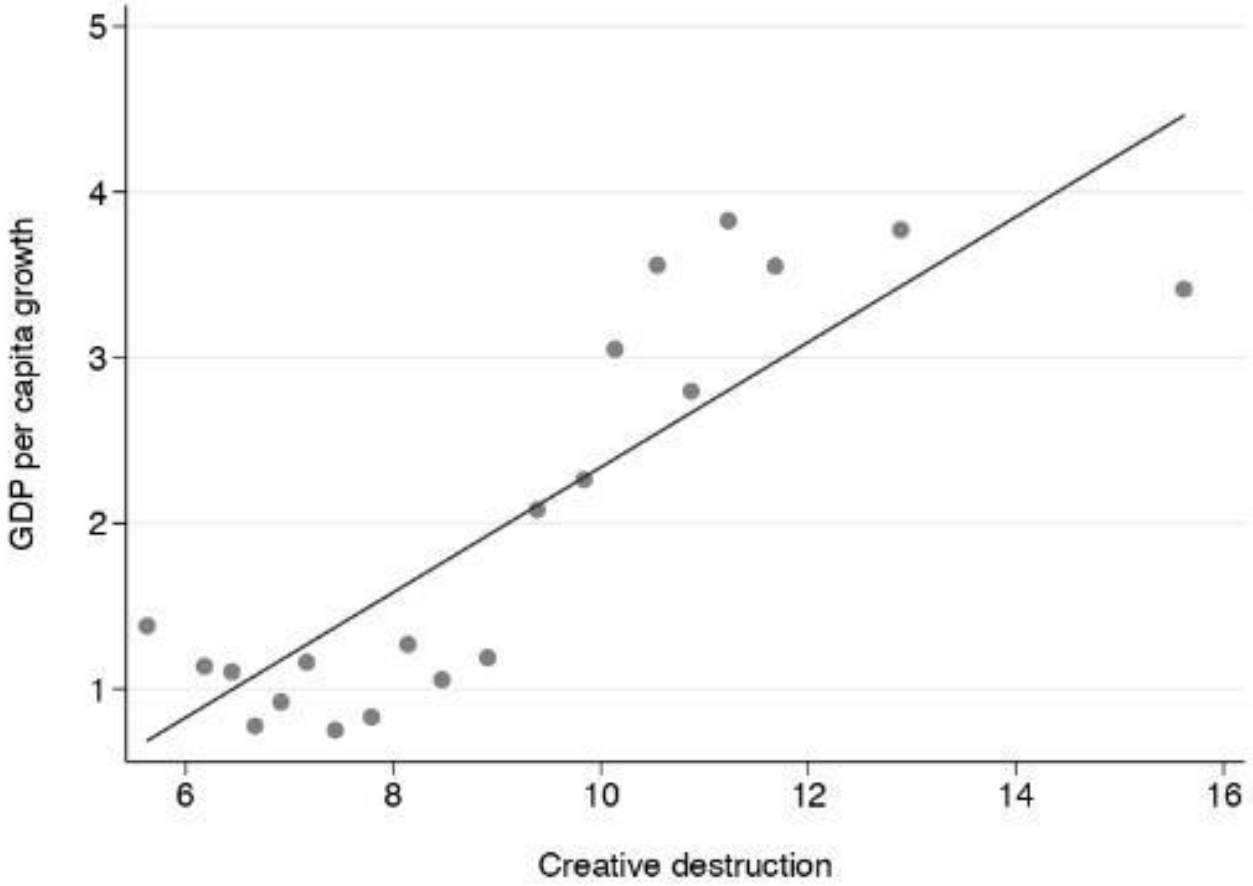
- Regulating capitalism is largely about how to manage this contradiction

SOME DISTINCTIVE PREDICTIONS

- Growth is positively correlated with firm turnover
- More intense competition enhances innovation in « frontier » firms but discourages it in « non-frontier » firms

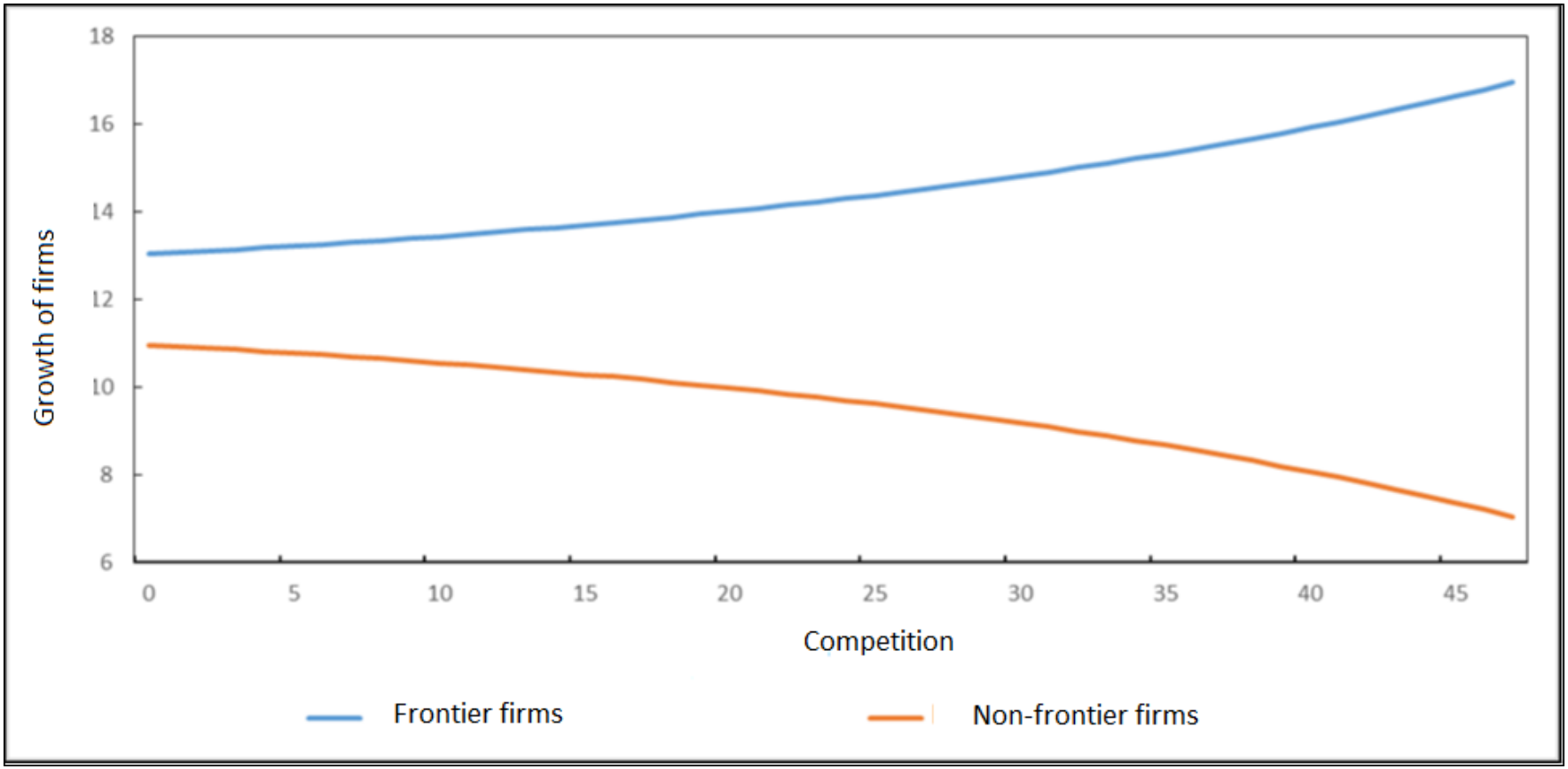
GROWTH AND TURNOVER

- Firm and job turnover



Positive correlation between GDP per capita growth and the rate of creative destruction.
Source: Eurostat.

COMPETITION, GROWTH AND DISTANCE TO FRONTIER



IN THIS LECTURE, WE USE THE LENS OF CREATIVE DESTRUCTION TO…

- ***Think about two major technological revolutions currently at work***
  - ***AI revolution***
  - ***Green transition***
- ***Rethink the future of capitalism***

PART 2A: THE AI REVOLUTION

INTRODUCTION

- The history of AI is over 70 years old.
- As early as 1950, the British mathematician and cryptologist Alan Turing was interested in the ability of a machine to imitate a conversation.

INTRODUCTION

- It was a few years later, in 1956, that the term ‘artificial intelligence’ first appeared.
- AI first developed in the form of deductive rules of the “if... then” type.
- This is the so-called symbolic approach, based on reasoning and instructions

INTRODUCTION

- Although this symbolic approach has not been abandoned, a statistical approach to AI has been gaining ground since the 1990s: machine learning.
- Unlike the symbolic approach, the human does not determine a set of “if... then” rules. Instead, they ensure that the computer “learns” to identify statistical relationships between data.
- So there is no explicit human instruction: the machine is trained to recognize links from a set of training data. The machine then applies these links to new data to perform a task.

INTRODUCTION

- The success of this second approach relies on two essential ingredients: data and computing power, supported by the emergence of the cloud.
- The availability of these two ingredients has increased sharply over the last 30 years, under the triple effect of the digitization of our society (producing more data), improvements in semiconductor materials (increasing computing power) and technical progress.

GOUVERNEMENT
Liberté
Égalité
Fraternité

COMMISSION DE L'INTELLIGENCE ARTIFICIELLE

IA : NOTRE AMBITION POUR LA FRANCE

MARS 2024

INTRODUCTION

- The AI revolution affects all domains of activity: the economy, public services, the organization of work, media, culture, …

INTRODUCTION

- Pessimistic view: AI does not have much of a growth potential to begin with, and it is intrinsically detrimental to employment
- A cautiously optimistic view: AI has the potential of delivering on growth and employment provided the appropriate institutions and policies are put in place

AI AND GROWTH

AI AND GROWTH

AI should boost productivity growth as it automates both, the production of goods and services and the production of ideas (Aghion, Jones and Jones)

AI AND GROWTH

AI and ideas:

- Helps find solution to complex problems
- Facilitates imitation and learning
- Can become self-improving

AI AND GROWTH: A MICRO APPROACH

- *« Generative AI at Work »,* Erik Brynjolfsson, Danielle Li, and Lindsey R. Raymond, 2023, NBER working paper

BRYNJOLFSSON ET AL. (2023)

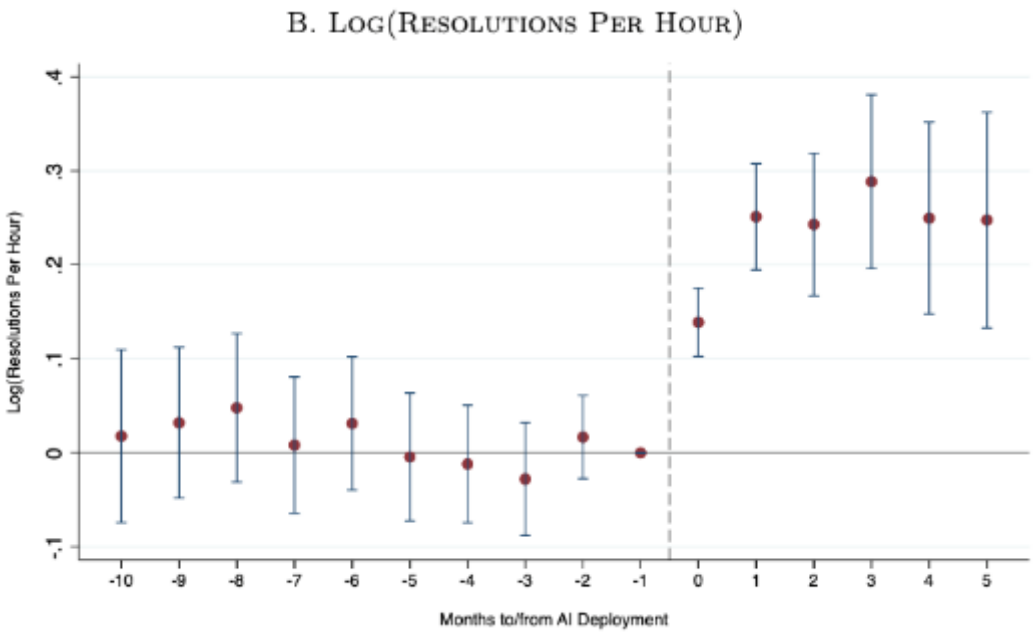
Focus

- Diffusion of a Generative AI system in a Fortune 500 company which advises SMEs on enterprise software
- The job mainly consists in answering SME managers' questions on how to install the software.

Measuring agents' productivity:

- Number of resolutions per hour

BRYNJOLFSSON ET AL. (2023) - RESULTS



Significant productivity boost already one month after AI adoption (+14%)

Further productivity increase thereafter (up to +25%)

AI AND GROWTH: FROM MICRO TO MACRO

Extrapolate from previous Technological Revolutions (Electricity, IT)

Adopt a task-based approach

AI AND GROWTH: EXTRAPOLATING FROM PREVIOUS GPTS

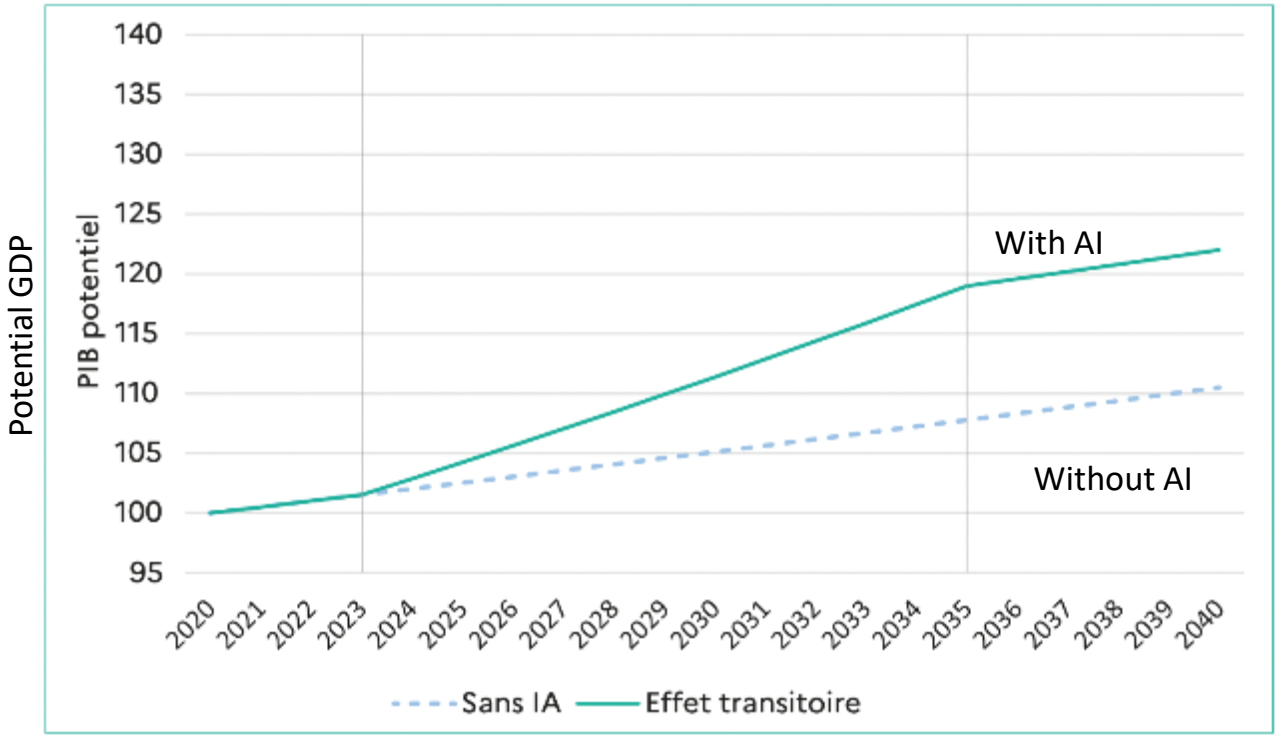
- Extrapolating from previous GPTs lead to anticipating an increase in productivity growth between 0.8 percentage points (IT revolution) and 1.3 percentage points (electricity revolution) over the next ten years.

- This in turn would induce an increase in GDP between 250 and 400 billion euros by 2034.

AI AND GROWTH: EXTRAPOLATION

Expected transitory effect of AI adoption on growth

(Report of Ministry of Economics, Finance and Industrial and Digital Sovereignty)



Graphique 2 : Effet transitoire attendu de l'adoption de l'IA sur la croissance.

AI AND GROWTH: TASK-BASED APPROACH

- Acemoglu (2024) relies on a task-based model (Acemoglu and Restrepo, 2018) to estimate the effects of AI on TFP and concludes to an increase of 0.07 percentage point in annual TFP growth over the coming decade

  - More precisely :

$$\begin{aligned}\text{TFP gains over 10 years} = {} & \text{GDP share of tasks that are exposed to AI} \\ & \text{x Share of exposed tasks for which AI would be profitable} \\ & \text{x Labor cost savings enabled by AI} \\ & \text{x Labor Share adjusted for AI exposure}\end{aligned}$$

$$\text{Annual TFP gains} = \underbrace{ExpAI}_{0.199} \text{ x } \underbrace{ProfitableAI}_{0.23} \text{ x } \underbrace{LaborCostSavingsAI}_{0.27} \text{ x } \underbrace{LaborShareAI}_{0.57} \text{ x10} = 0.07\%$$

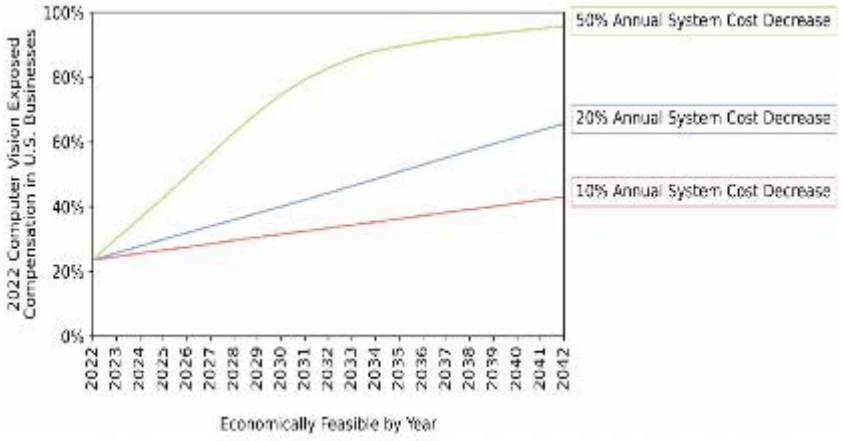
GDP SHARE OF TASKS THAT ARE EXPOSED TO AI

- **Daron** - Eloundou et al., 2023 : 19,9%
- BIT - Gmyrek et al. (2023) : 18,5% in developed countries
- IMF – Pizzinelli et al. (2023) : 60% in the US and on average in developed economies, 68% in the UK
- **Interval to consider: [18,5%; 68%]**

SHARE OF EXPOSED TASKS FOR WHICH AI WOULD BE PROFITABLE

- **Daron :** « at today's costs », **<u>23%</u>** of visual tasks exposed to AI would be profitable to automate for American firms (Svanberg et al. 2024)
- However that share is likely to increase over time:

    - Svanberg et al. (2024) proposes 3 scenarios: annual cost reduction of 10%, 20%, and 50%, leading respectively to 30%, 50% and 80% of visual tasks exposed to AI that would be profitable to automate in the long run



LABOR COST SAVINGS ENABLED BY AI

- +55.8% for programmers (Peng et al. 2023)
- +40% for analysts (Noy and Zhang 2023)
- +14% for customer service employees in the first month following AI tool introduction, then +25% after 5 months (Brynjolfsson et al. 2023)

Acemoglu (2024): 27% as an average of Noy and Zhang's (2023) effect and Brynjolfsson et al.'s (2023) short-term effect of 14% magnitude

Interval to consider: [33%; 40%]

TFP GAINS OVER 10 YEARS

- Given the existing literature, we conclude that annual productivity growth should be in the **interval [0.07pp; 1.24pp] over 10 years**

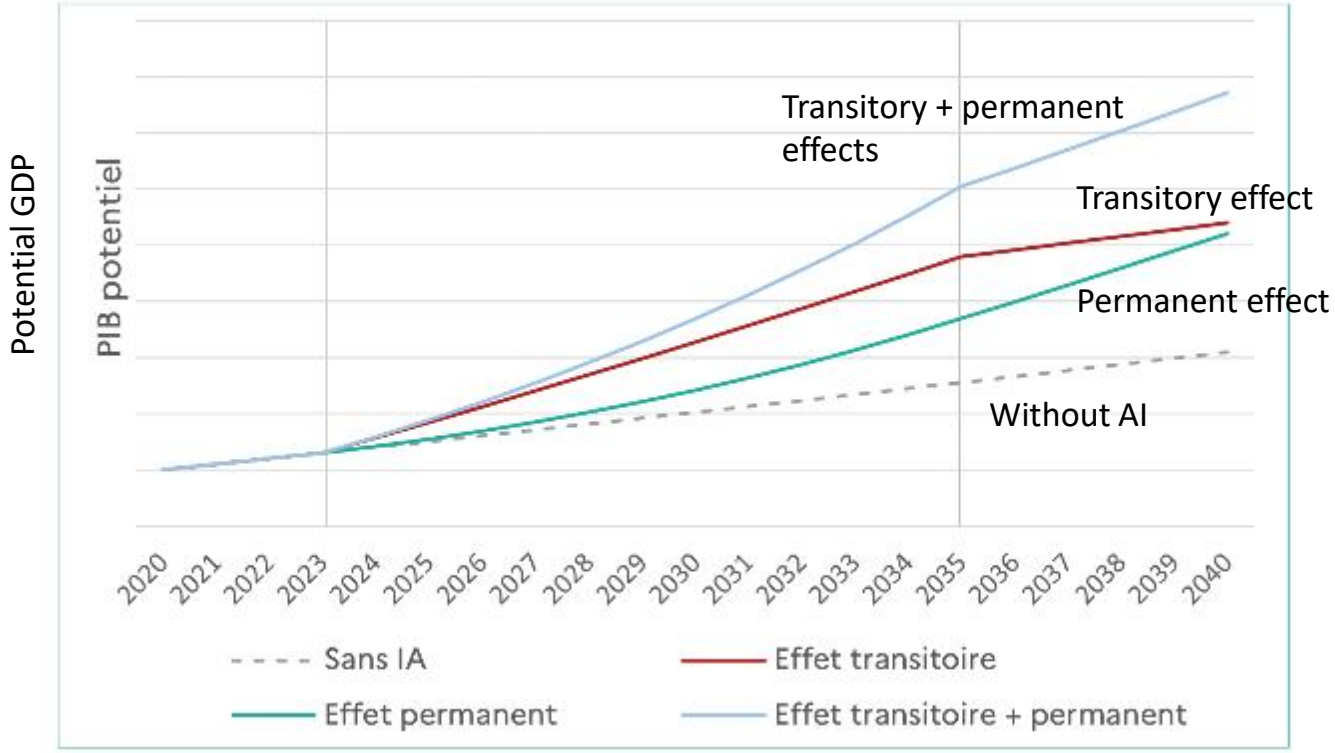
Median scenario:

- **Increase in productivity growth of 0.68pp/year over 10 years**, an effect of the same magnitude as what the extrapolation from previous GPTs would predict

AI AND GROWTH: AI MAKES IDEAS EASIER TO FIND

Total expected effects of AI adoption on growth

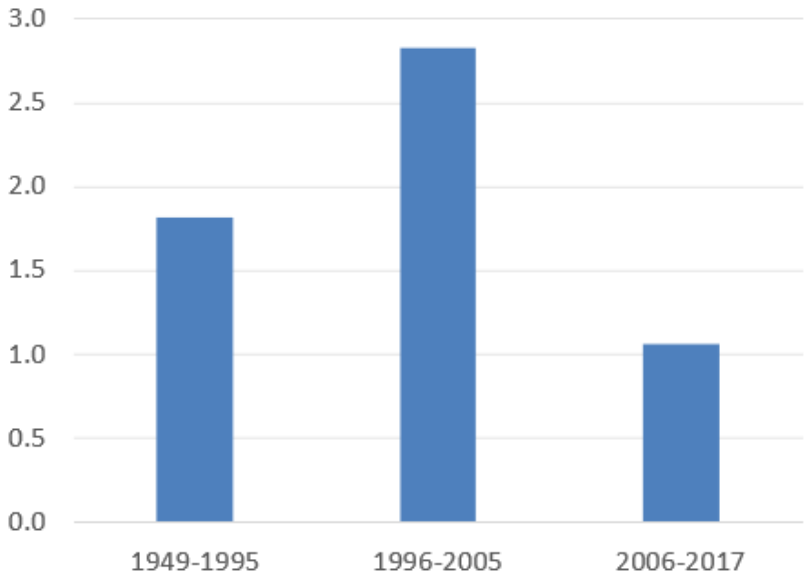
(Report of Ministry of Economics, Finance and Industrial and Digital Sovereignty)



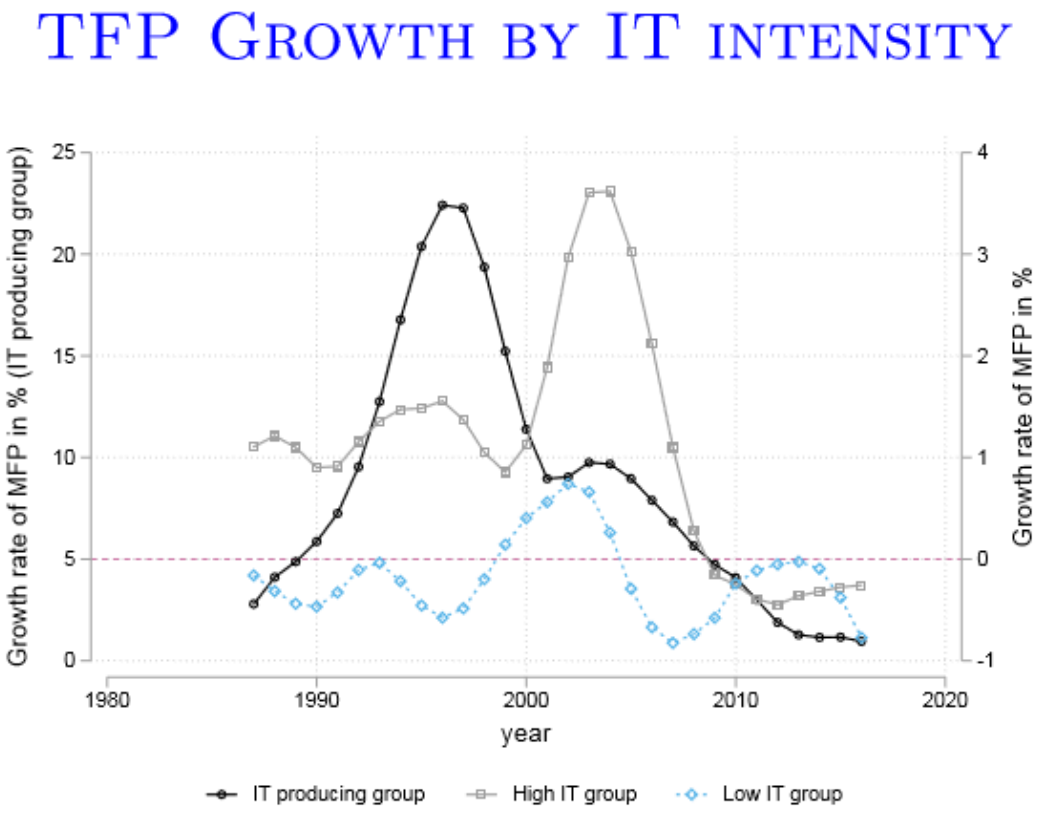
Graphique 3 : Effets totaux attendus de l'adoption de l'IA sur la croissance.

BUT LACK OF COMPETITION IS AN OBSTACLE

Rise and Decline in TFP Growth

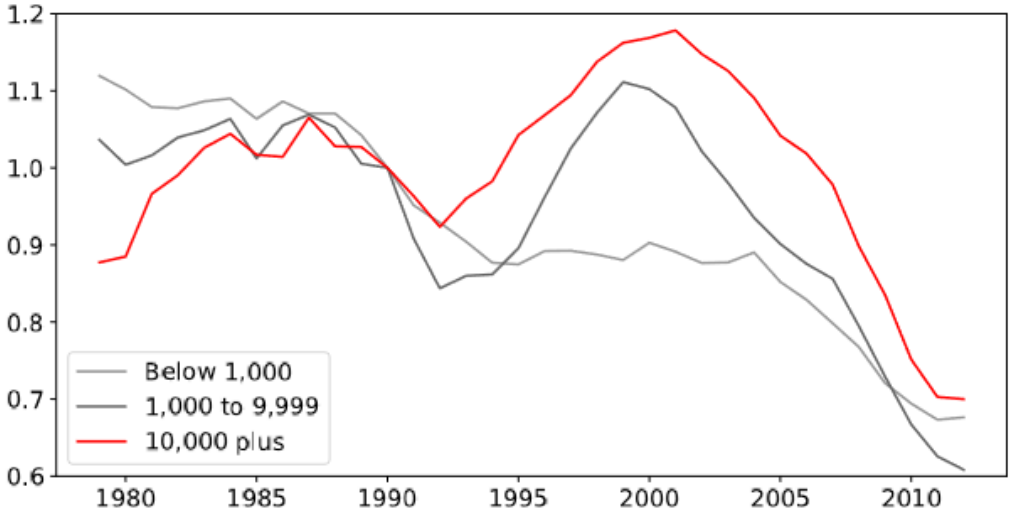


BUT LACK OF COMPETITION IS AN OBSTACLE



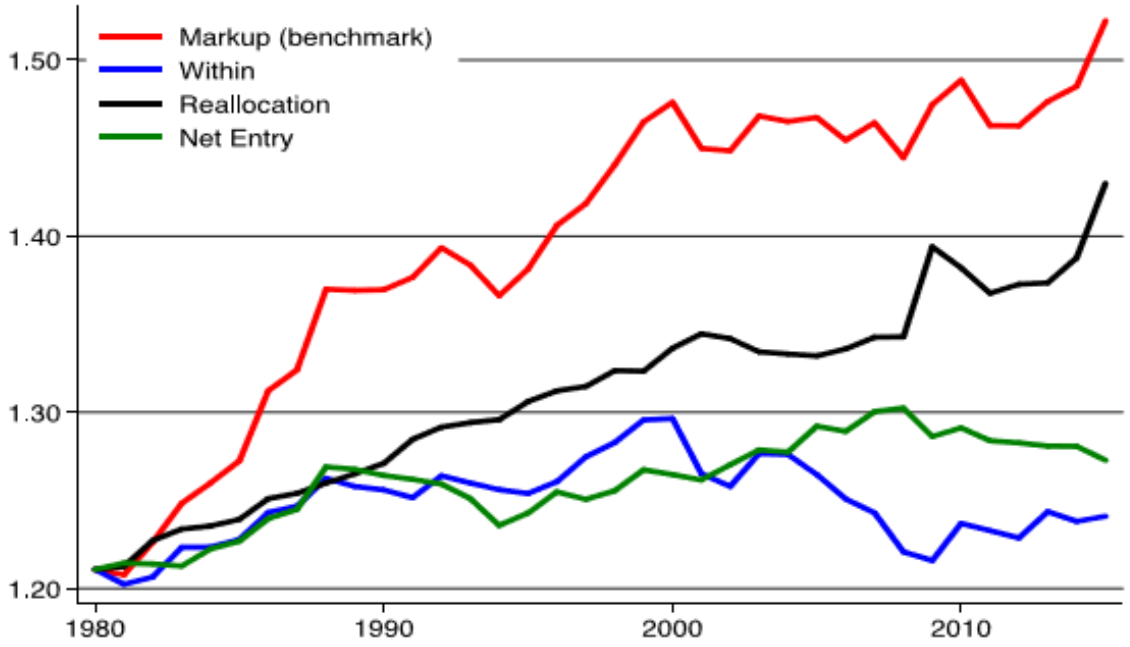
BUT LACK OF COMPETITION IS AN OBSTACLE

Rise and decline in employment-weighted plant entry rate



Source: U.S. Census Bureau's *Business Dynamics Statistics*. Job creation by birth over total employment by firm size bins. 5-year centered moving average.

Within firm markups



Source: De Loecker, Eeckhout and Unger (2018).

CONCLUSION SO FAR

- AI has a high growth potential

- But inappropriate competition policy may hamper it
  - In particular the Cloud is dominated by three superstar firms: Amazon, Google, Microsoft
  - Only one big actor (GPU) on the market for graphic processes

  Hence, need to reform competition policy!!

  But this in turn requires both, Government and Civil Society!!

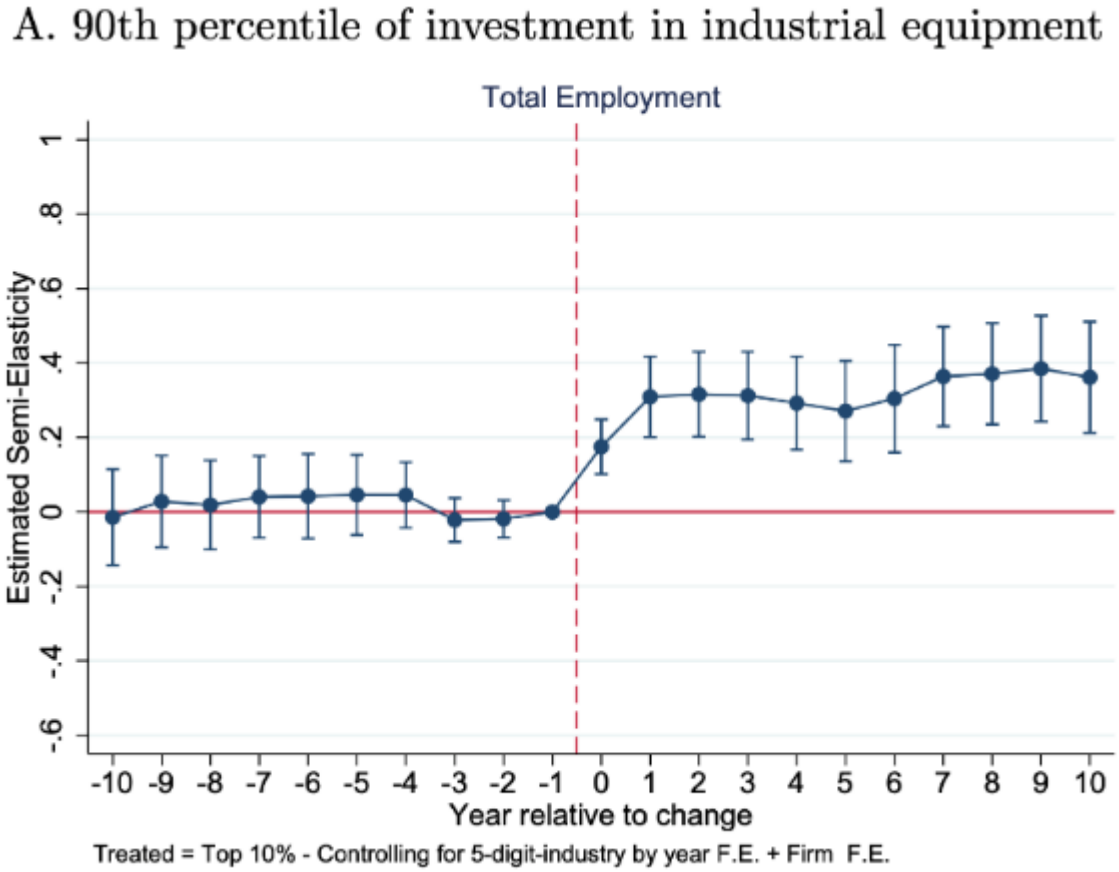
AI AND EMPLOYMENT

AI AND EMPLOYMENT

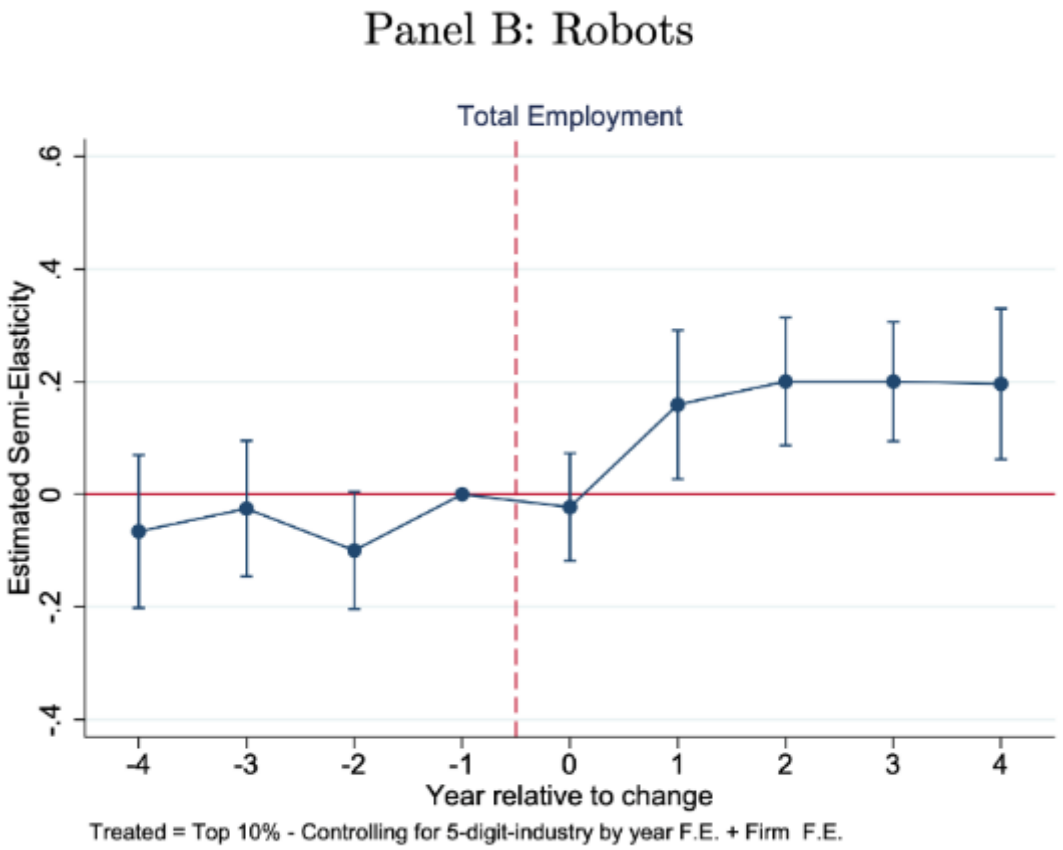
-With Celine Antonin, Simon Bunel and Xavier Jaravel on Automation and Employment, using French firm-level data

-With Simon Bunel, Xavier Jaravel et Alexandra Roulet on AI and Employment, again using French firm-level data

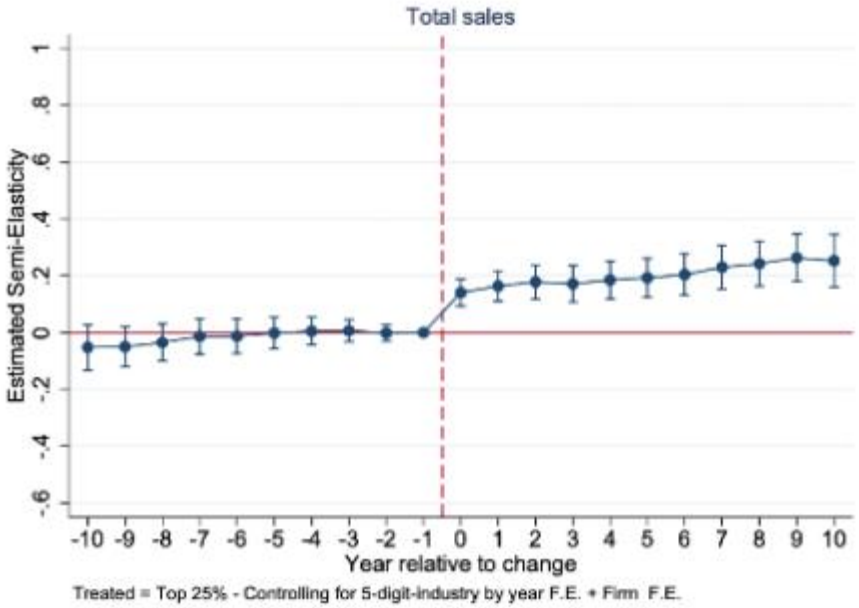
AUTOMATION AND EMPLOYMENT

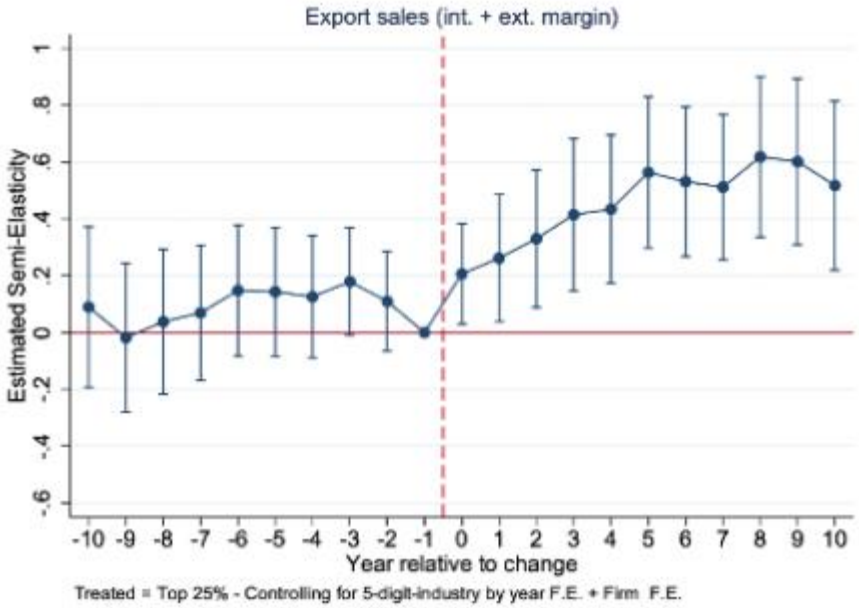


ROBOTS AND EMPLOYMENT

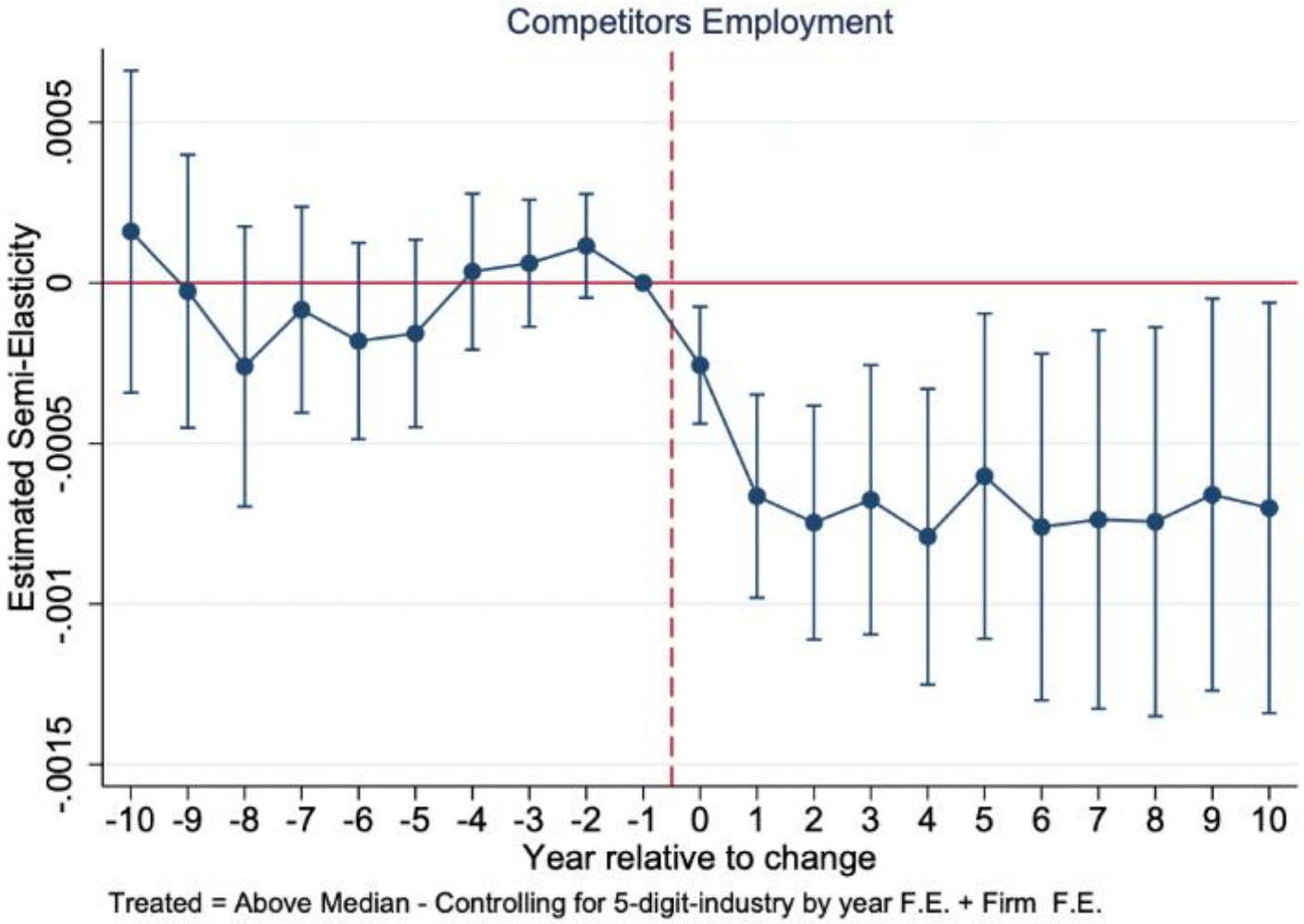


AUTOMATION AND EMPLOYMENT





BUSINESS STEALING



AI AND EMPLOYMENT

Are things different for AI ?

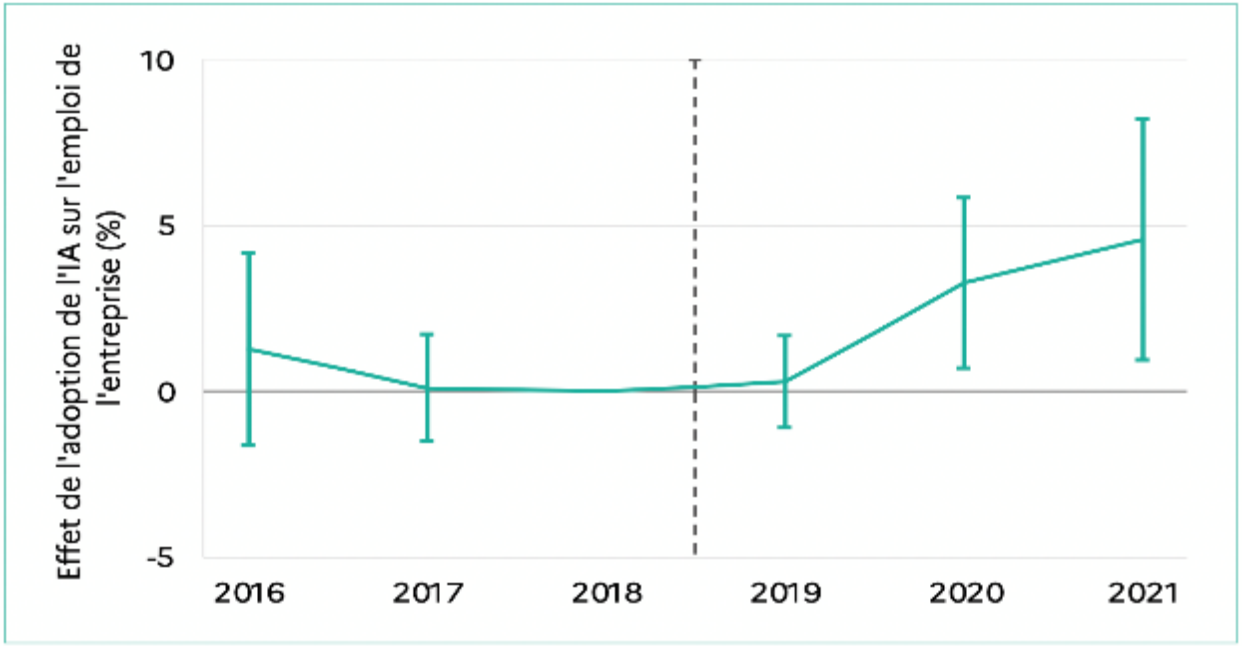
AI AND EMPLOYMENT

- « Enquête annuelle de l'Insee » = ICT French firm-level annual survey
- Specific questions on AI adoption in 2019 and 2021 surveys
- Random survey covering 9000 representative firms with more than 50 employees
- Event studies comparing between firms that adopt « some » AI between 2018 and 2020, and similar firms that do not adopt AI at all before 2020
- 321 firms in treatment group: adopt AI before 2020
- 897 firms in control group: do not adopt AI before 2020

AI AND EMPLOYMENT

Effect of adopting AI on total employ within companies in France

(Report of Ministry of Economics, Finance and Industrial and Digital Sovereignty)



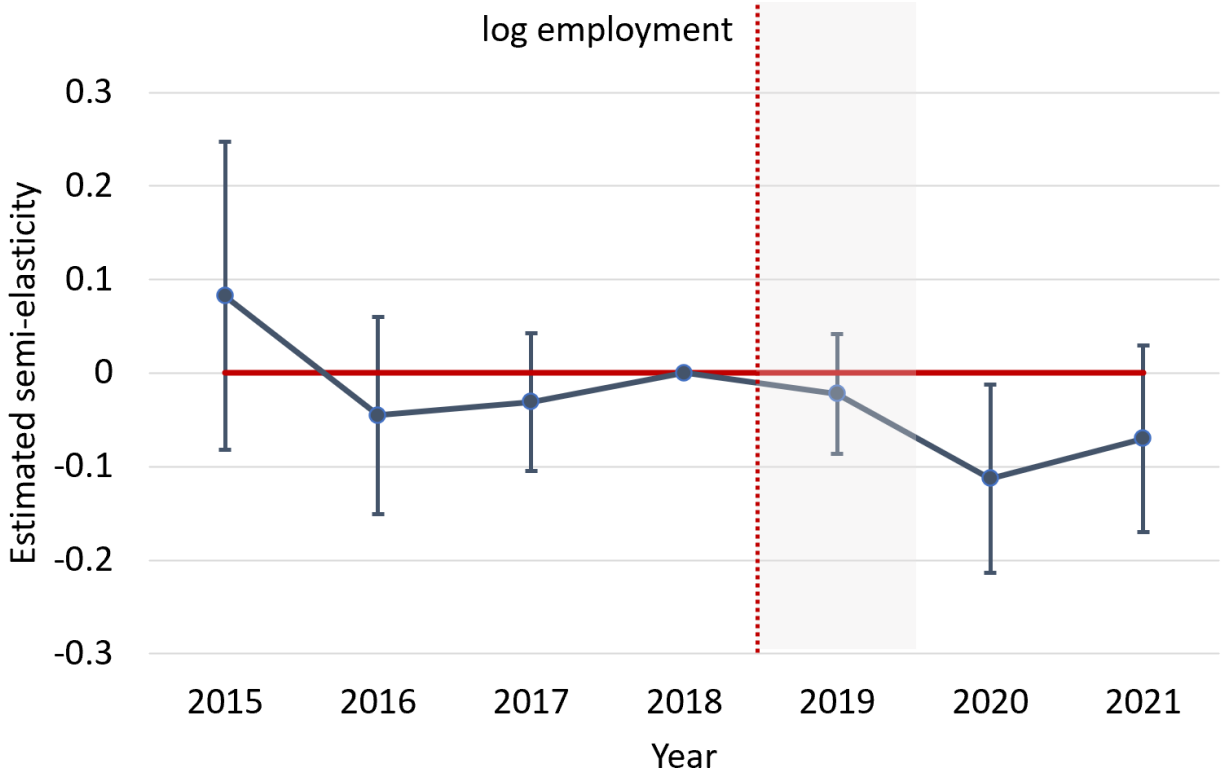
Graphique 5 : Effet de l'adoption de l'IA sur l'emploi total au sein des entreprises en France

Source : Commission IA.

Lecture : Les entreprises adoptant l'IA augmentent leur emploi davantage que celles ne l'adoptant pas, alors qu'elles évoluaient de façon similaire dans les 3 années précédentes.

AI AND EMPLOYMENT

• Effect on employment in “administrative and commercial intermediate professions” (executive secretary, administrative service, legal service, sales, etc.)



AI AND EMPLOYMENT: THE « TASKS » APPROACH (ILO)

- *Generative AI and jobs: A global analysis of potential effects on job quantity and quality,* Paweł Gmyrek, Janine Berg, David Bescond, ILO Working Paper 96, 2023

Idea :

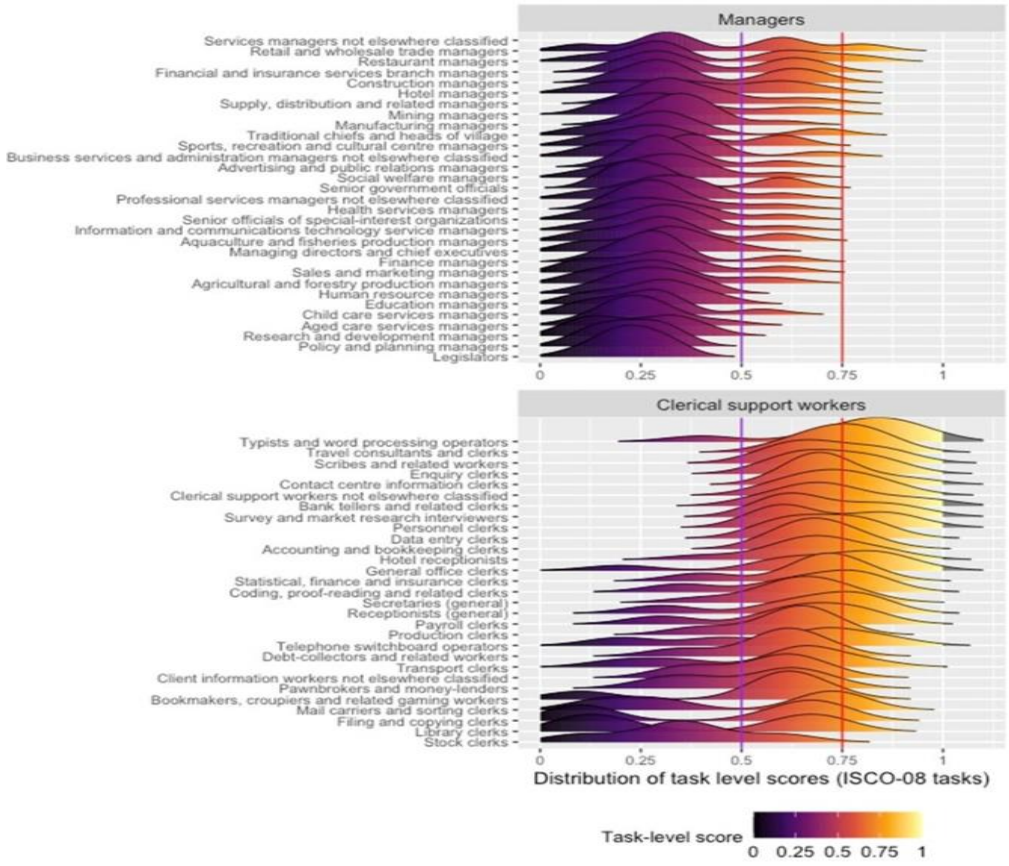
- Analyze the exposure of various tasks and jobs to *generative AI*, more precisely to *Generative Pre-Trained Transformers* (GPTs)

REPLACEMENT SCORE

- For each task :
  - Score less than 0.5 : small replacement risk
  - Score between 0.5 and 0.75 : medium replacement risk
  - Score above 0.75 : high replacement risk

AI AND EMPLOYMENT: THE « TASKS » APPROACH (ILO)

► **Figure 3. Box plot of task-level scores by ISCO 4d, grouped by ISCO 1d**



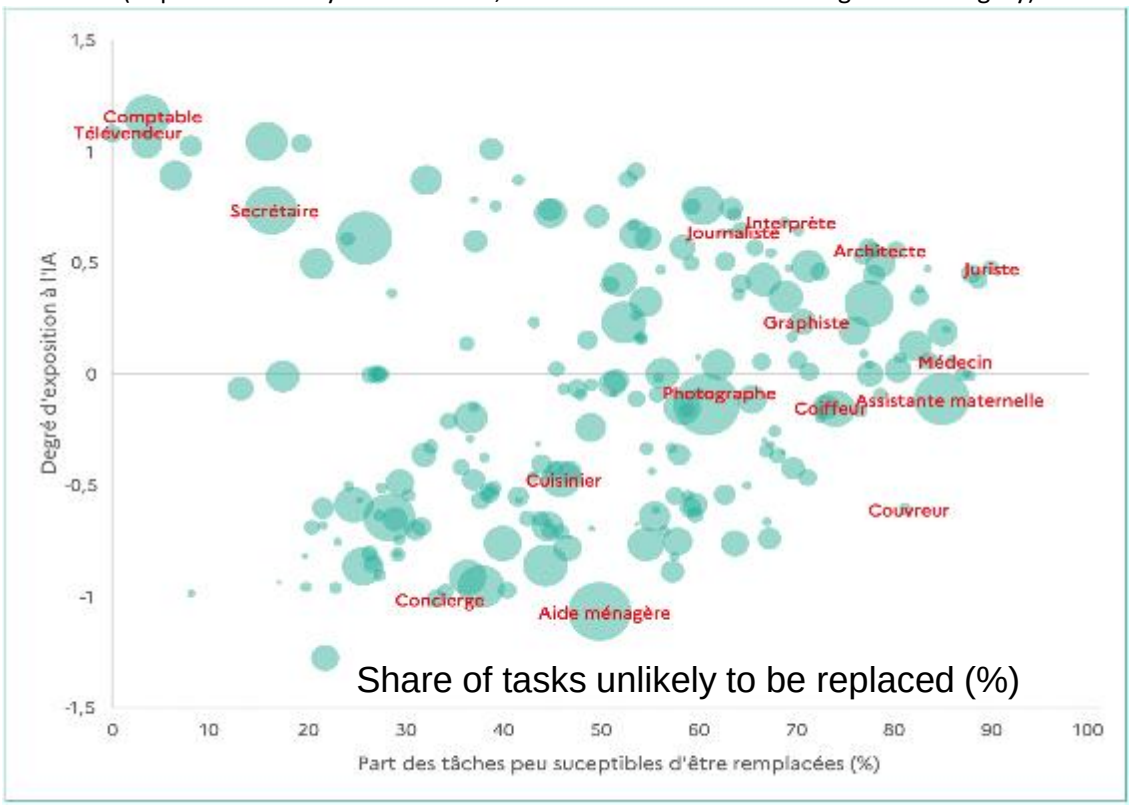
- Managers
- Clerks

AI AND EMPLOYMENT: THE « TASKS » APPROACH IN FRANCE

Expected effect of AI on professions in France

(Report of Ministry of Economics, Finance and Industrial and Digital Sovereignty)

Degree of exposure to AI (%)

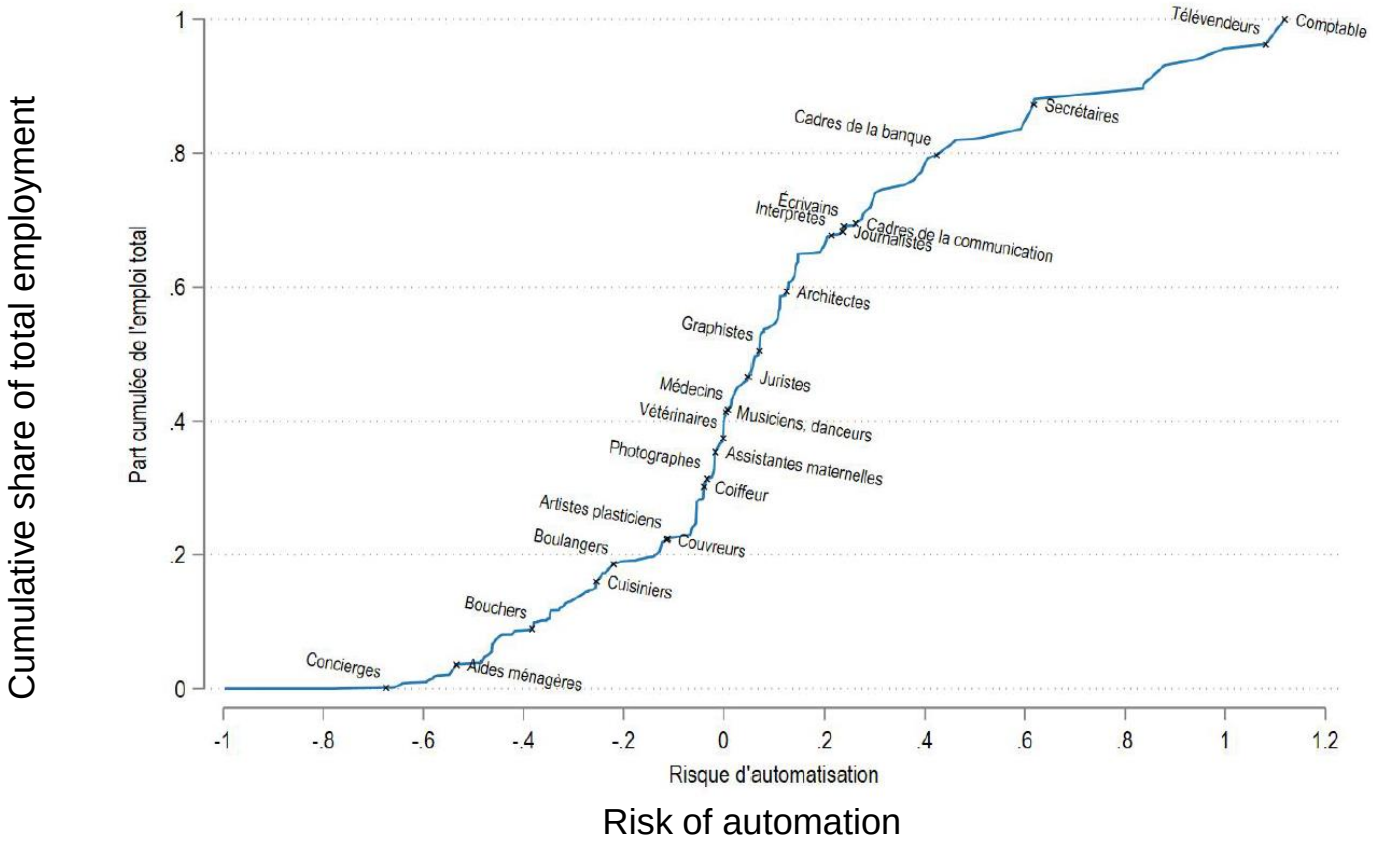


Share of tasks unlikely to be replaced (%)

Graphique 7 : Effet attendu de l'IA sur les métiers en France.

Source : Bergeaud (2024)

AI AND EMPLOYMENT



CONCLUSION

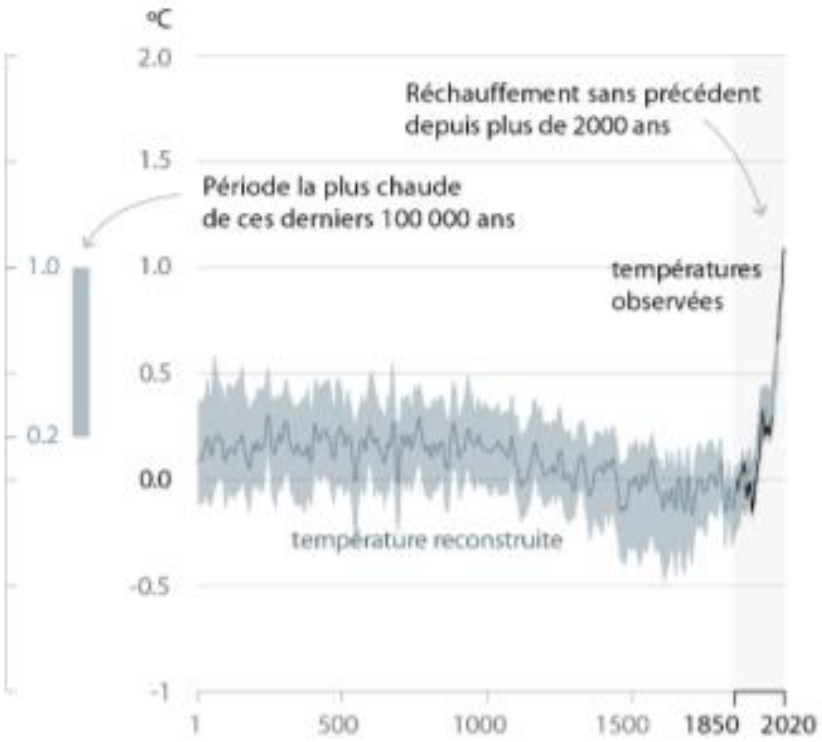
- No existential risk of AI
  - AI should not generate mass unemployment!

- Yet, need appropriate institutions and policies for AI to boost growth and employment
  - Adequate competition policy reform
  - Education and labor market policies

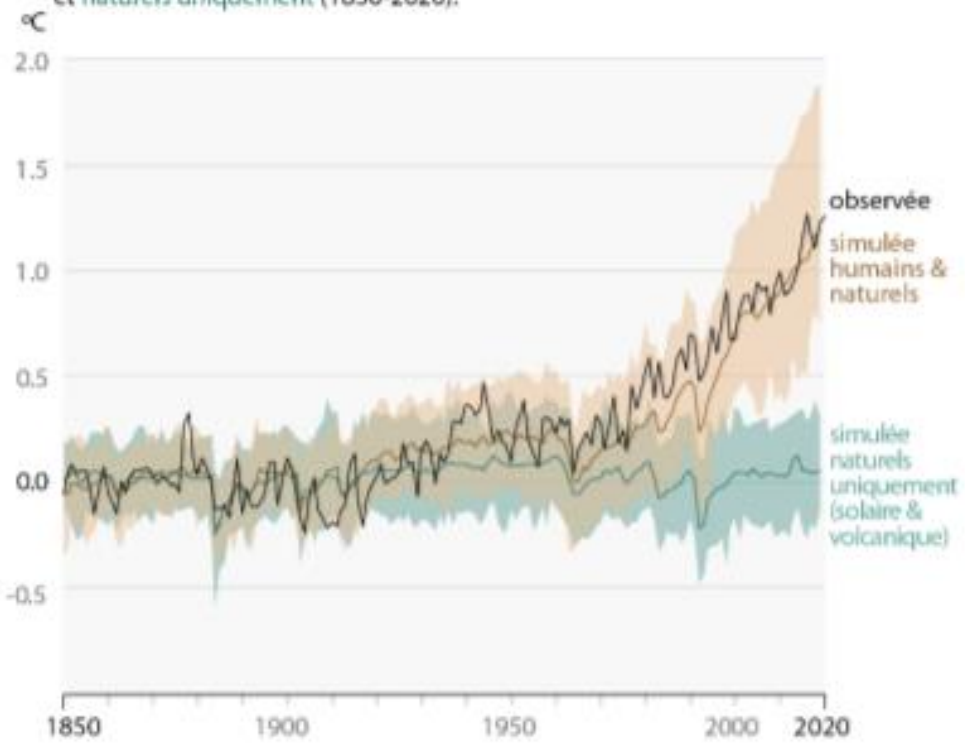
  And these require both, Government and Civil Society

PART 2B: THE GREEN TRANSITION

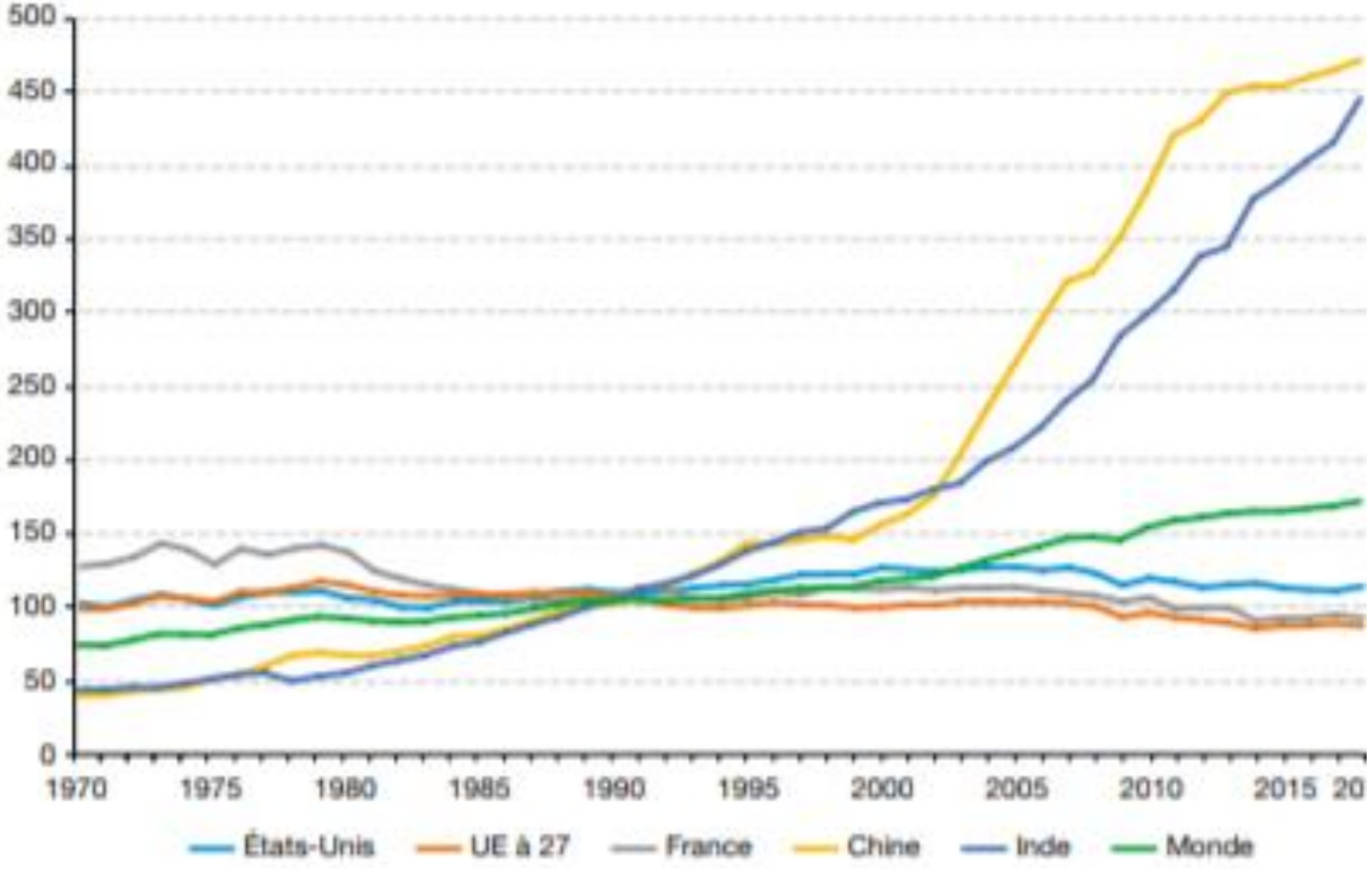
a) changement de la température de surface mondiale (moyenne décennale) reconstruite (1-2000) et observée (1850-2020)



b) changement de la température de surface mondiale (moyenne annuelle) observée et simulée utilisant les facteurs humains et naturels, et naturels uniquement (1850-2020).



EVOLUTION OF CO2 EMISSIONS WORLDWIDE BETWEEN 1970 AND 2018 – BASE 100 INDEX IN 1990



Source : *EDGAR, 2019*

INTRODUCE INNOVATION IN THE CLIMATE DEBATE

Innovation versus de-growth

Implications of introducing endogenous and directed innovation for the climate debate?

PATH-DEPENDENCE IN GREEN VERSUS DIRTY INNOVATION

DATA

World Patent Statistical Database (PATSTAT) at European Patent Office (EPO) over period 1978-2005

- All triadic patents filed in 80 patent offices in world

Extracted all patents pertaining to "clean" and "dirty" technologies in the automotive industry (following OECD IPC definition)

Tracked applicants and extracted all their past patents.

INTERNATIONAL PATENT CLASSES (IPC)

Description	IPC code	
Electric vehicles		
Electric propulsion with power supplied within the vehicle	B60L 11	
Electric devices on electrically-propelled vehicles for safety purposes; Monitoring operating variables, e.g. speed, deceleration, power consumption	B60L 3	
Methods, circuits, or devices for controlling the traction- motor speed of electrically-propelled vehicles	B60L 15	
Arrangement or mounting of electrical propulsion units	B60K 1	
Conjoint control of vehicle sub-units of different type or different function / including control of electric propulsion units, e.g. motors or generators / including control of energy storage means / for electrical energy, e.g. batteries or capacitors	B60W 10/08, 24, 26	
Hybrid vehicles		
Arrangement or mounting of plural diverse prime-movers for mutual or common propulsion, e.g. hybrid propulsion systems comprising electric motors and internal combustion engines	B60K 6	"Clean"
Control systems specially adapted for hybrid vehicles, i.e. vehicles having two or more prime movers of more than one type, e.g. electrical and internal combustion motors, all used for propulsion of the vehicle	B60W 20	
Regenerative braking		
Dynamic electric regenerative braking	B60L 7/1	
Braking by supplying regenerated power to the prime mover of vehicles comprising engine -driven generators	B60L 7/20	
Fuel cells		
Conjoint control of vehicle sub-units of different type or different function; including control of fuel cells	B60W 10/28	
Electric propulsion with power supplied within the vehicle - using power supplied from primary cells, secondary cells, or fuel cells	B60L 11/18	
Fuel cells; Manufacture thereof	H01M 8	
Combustion engines		"Dirty"
Combustion engines	F02 (excl. C/G/ K)	

ESTIMATION

Number of clean triadic patents by firm *i* in year *t*

Clean and dirty spillovers

$$PAT_{CLEAN,it} = \exp(\beta_{C,P} \ln FP_{it} + \beta_{C,1} \ln SPILL_{C,it} + \beta_{C,2} \ln SPILL_{D,it}$$

$$+ \beta_{C,3} \ln K_{C,it} + \beta_{C,4} \ln K_{D,it}$$

Lagged firm's own innovation stocks

$$+ \beta_{C,w} w_{it} + \ln \eta_{C,i} + T_{C,t}) + u_{C,it}$$

Other controls (GDP, GDP/capita, other policies)

Firm fixed effect

Time dummies

Random error

TABLE 3: MAIN RESULTS

	Clean	Dirty
Fuel Price	0.886**	-0.644***
ln(FP)	(0.362)	(0.143)
Clean Spillover	0.266***	-0.058
$SPILL_C$	(0.087)	(0.066)
Dirty Spillover	-0.160*	0.114
$SPILL_D$	(0.097)	(0.081)
Own Stock Clean	0.303***	0.016
K_C	(0.026)	(0.026)
Own Stock Dirty	0.139***	0.542***
K_D	(0.017)	(0.020)
#Observations	68,240	68,240
#Units (Firms and individuals)	3,412	3,412

Notes: Estimation by Conditional fixed effects (CFX), all regressions include GDP, GDP per capita & time dummies. SEs clustered by unit.

THUS

Bad news is that path-dependence implies that under laissez-faire the economy may get stuck with dirty technologies

Good news is that government can avoid disaster by redirecting innovation towards clean technologies and early action now can become self-sustaining later due

THE ROLE OF CIVIL SOCIETY

Competition and Social Values

- Above analysis suggests a role for the State in directing firms' production and innovation
- Question: Is there also a role for "Civil Society"?

Environmental Values and Technological Choices: Is Market Competition Clean or Dirty?

Philippe Aghion [1] Roland Bénabou [2]
Ralf Martin [3] Alexandra Roulet [4]

[1]College de France [2]Princeton University

[3]Imperial College London [4]INSEAD

POSITIVE EFFECT OF CONSUMERS VALUATION OF THE ENVIRONMENT

Firms innovate green to cater to their consumers' demand for green

VARIABLES	(1)	(2)	(3)	(4)
	Log (1+#clean)- Log (1+#dirty)			
Values	0.170***	0.229***	0.233***	0.594***
	(0.0397)	(0.0500)	(0.0524)	(0.144)
Competition	0.189***	0.161***	0.325**	-0.0223
	(0.0614)	(0.0605)	(0.139)	(0.0305)
ValuesXCompetition	0.109***	0.0703***	0.0875***	0.0620**
	(0.0370)	(0.0234)	(0.0231)	(0.0243)
Log fuel price	0.766***	0.601**	0.151	0.856
	(0.235)	(0.244)	(0.236)	(0.663)
Competition measure	OECD	OECD	World Bank	Lerner
Values measure	Higher tax	Index	Higher tax	Higher tax
Observations	17,124	17,124	17,124	2,706
R-squared	0.121	0.122	0.121	0.199
Number of xbvdid	8,562	8,562	8,562	1,854

TWO OPPOSITE EFFECTS OF COMPETITION

More competition:

- **Scale effect**: it increases output, thereby increasing emissions (« Chinese » effect)
- **Innovation effect**: if consumers value the environment, then more competition induces more green innovation, thereby reducing emissions

VARIABLES	(1)	(2)	(3)	(4)
	Log (1+#clean)- Log (1+#dirty)			
Values	0.170***	0.229***	0.233***	0.594***
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	(0.0370)	(0.0234)	(0.0231)	(0.0243)
Log fuel price	0.766***	0.601**	0.151	0.856
	(0.235)	(0.244)	(0.236)	(0.663)
Competition measure	OECD	OECD	World Bank	Lerner
Values measure	Higher tax	Index	Higher tax	Higher tax
Observations	17,124	17,124	17,124	2,706
R-squared	0.121	0.122	0.121	0.199
Number of xbvdid	8,562	8,562	8,562	1,854

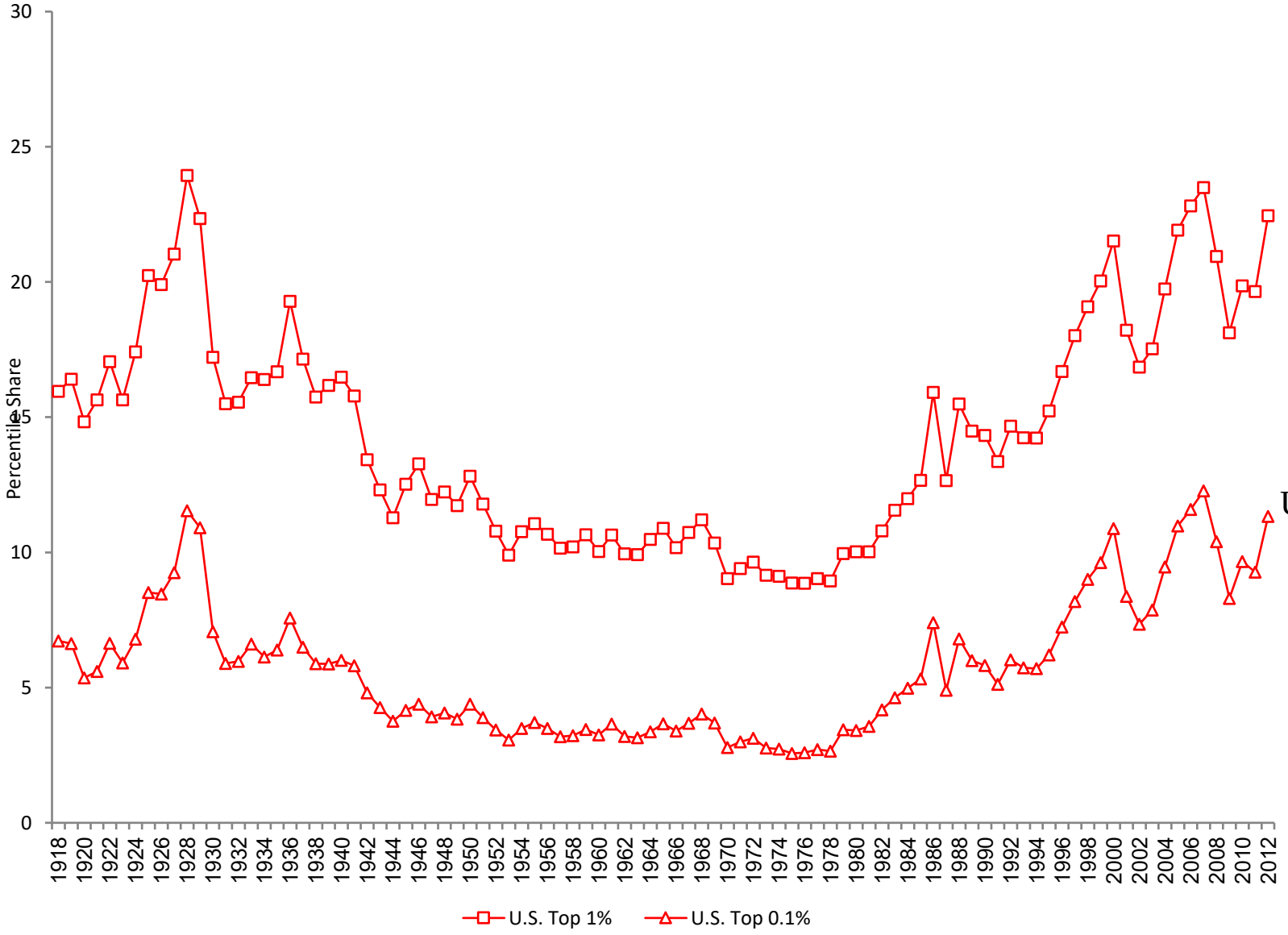
CONCLUSION OF THIS PART

Innovation-based climate models suggest that Government and Civil Society are both needed to redirect firms' innovation towards green.

PART 3: RETHINKING CAPITALISM

PRELIMINARIES ON INEQUALITY AND INNOVATION

Income shares at the very top over last 100 years: US top 1% increases from 9% in 1978 to 22% in 2012



Source: Atkinson, Piketty & Saez; High Income Database

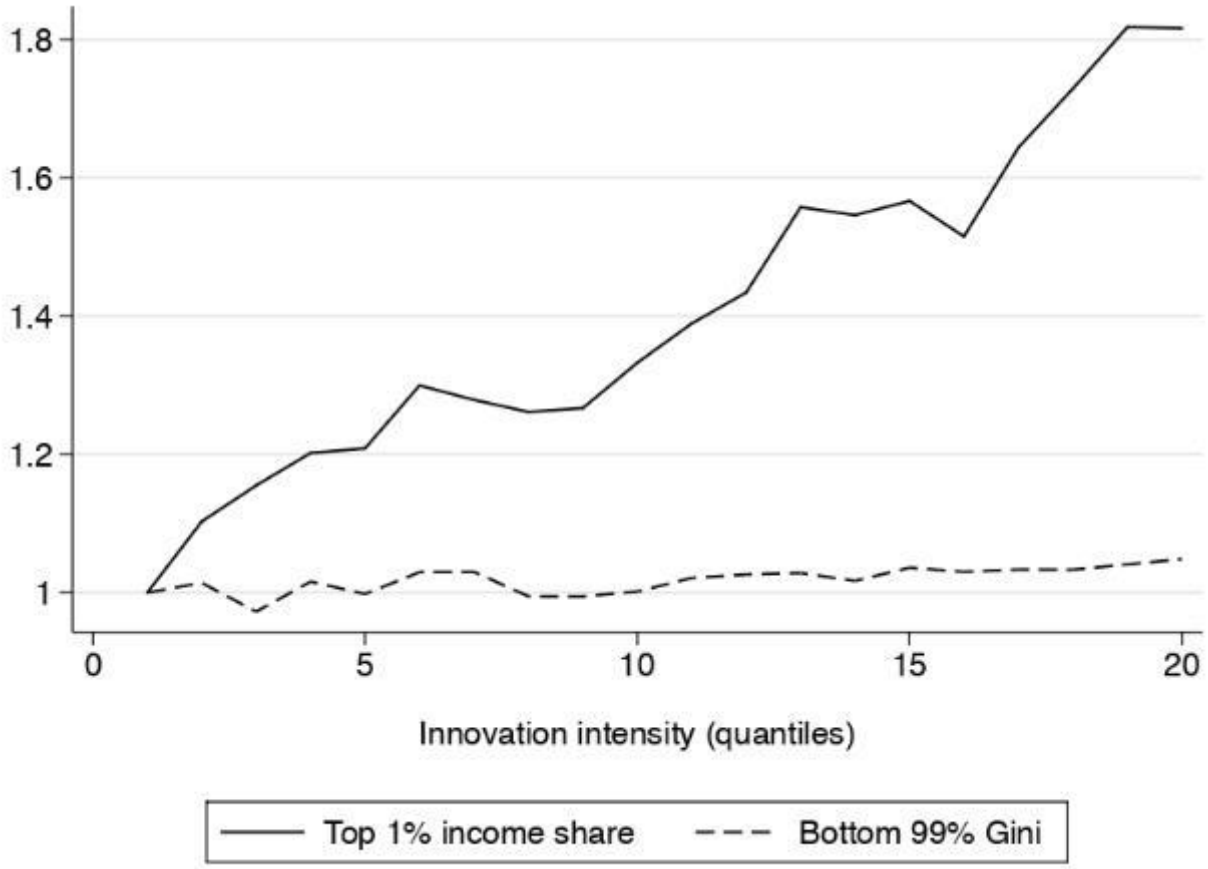
INNOVATION:

Innovation increases top income inequality

(Entrant) Innovation increases social mobility

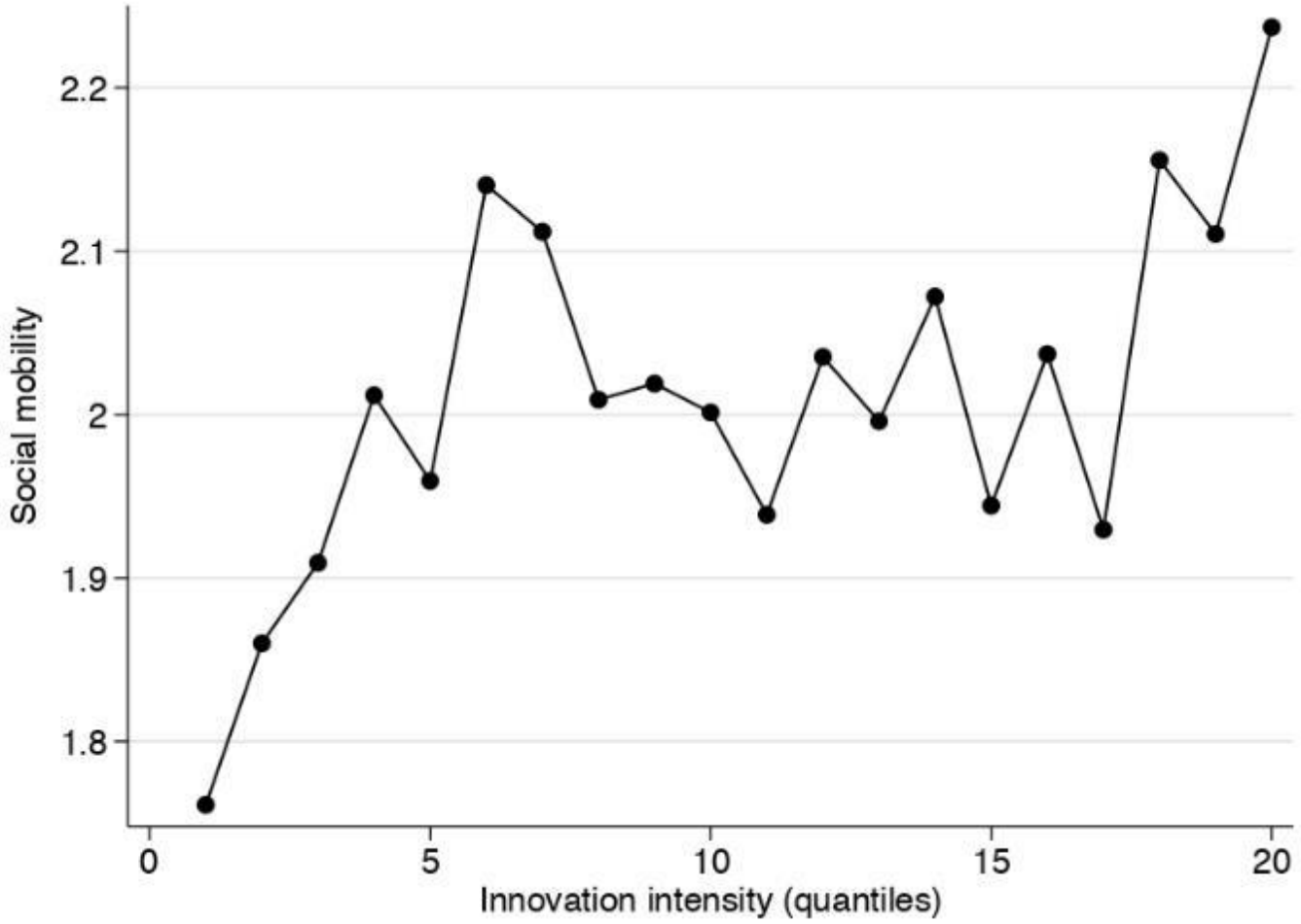
Innovation does not increase broad inequality

INNOVATION AND INEQUALITY



Innovation, top 1% income share and Gini coefficient.
Source: Aghion, Akcigit, Bergeaud, Blundell, Hemous (2018)

INNOVATION AND SOCIAL MOBILITY



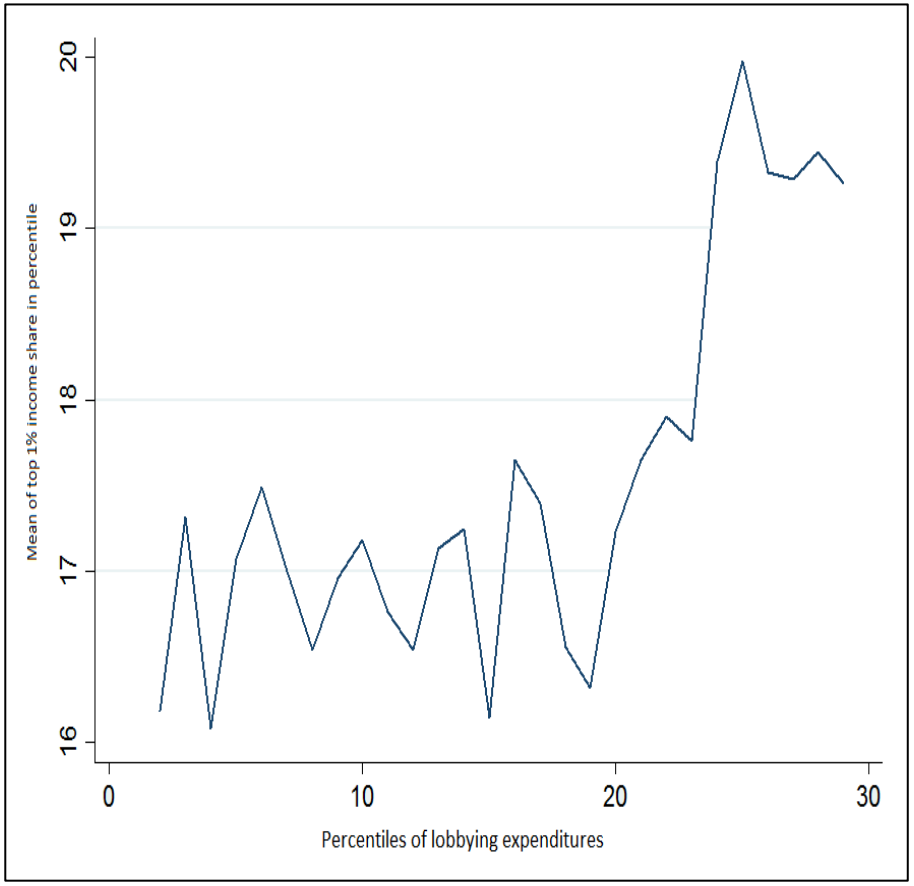
Innovation and Social Mobility
Source: Aghion, Akcigit, Bergeaud, Blundell, Hemous (2018)

BY CONTRAST, LOBBYING..

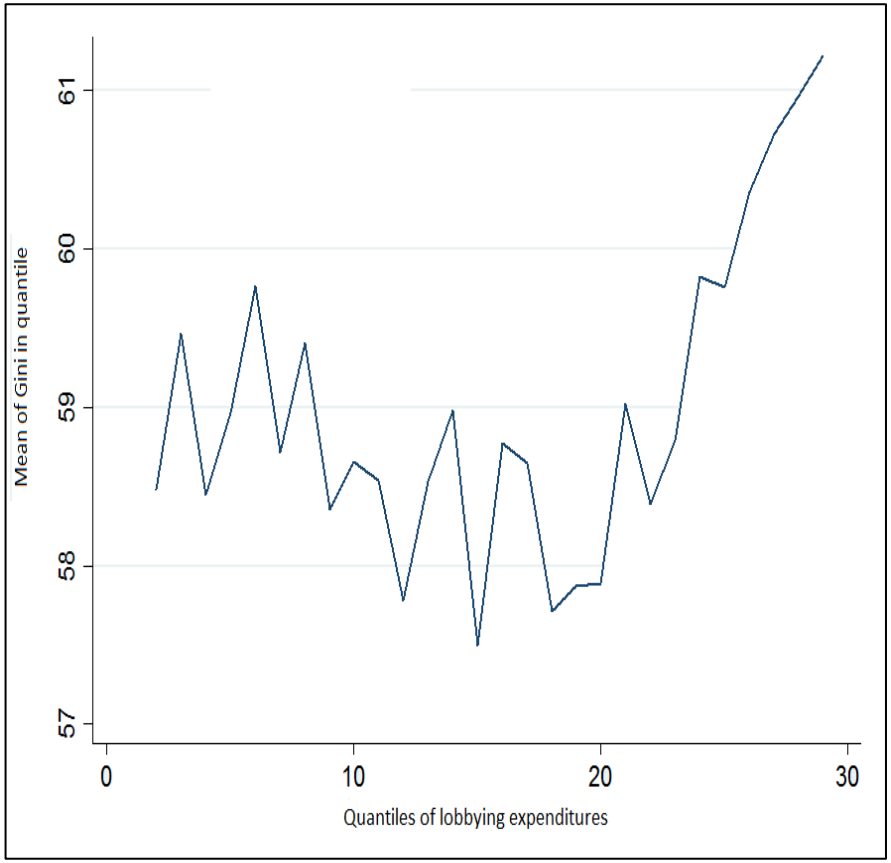
Reduces social mobility

Increases broad inequality

Lobbying VS Top1% (USA)



Lobbying VS GINI (USA)



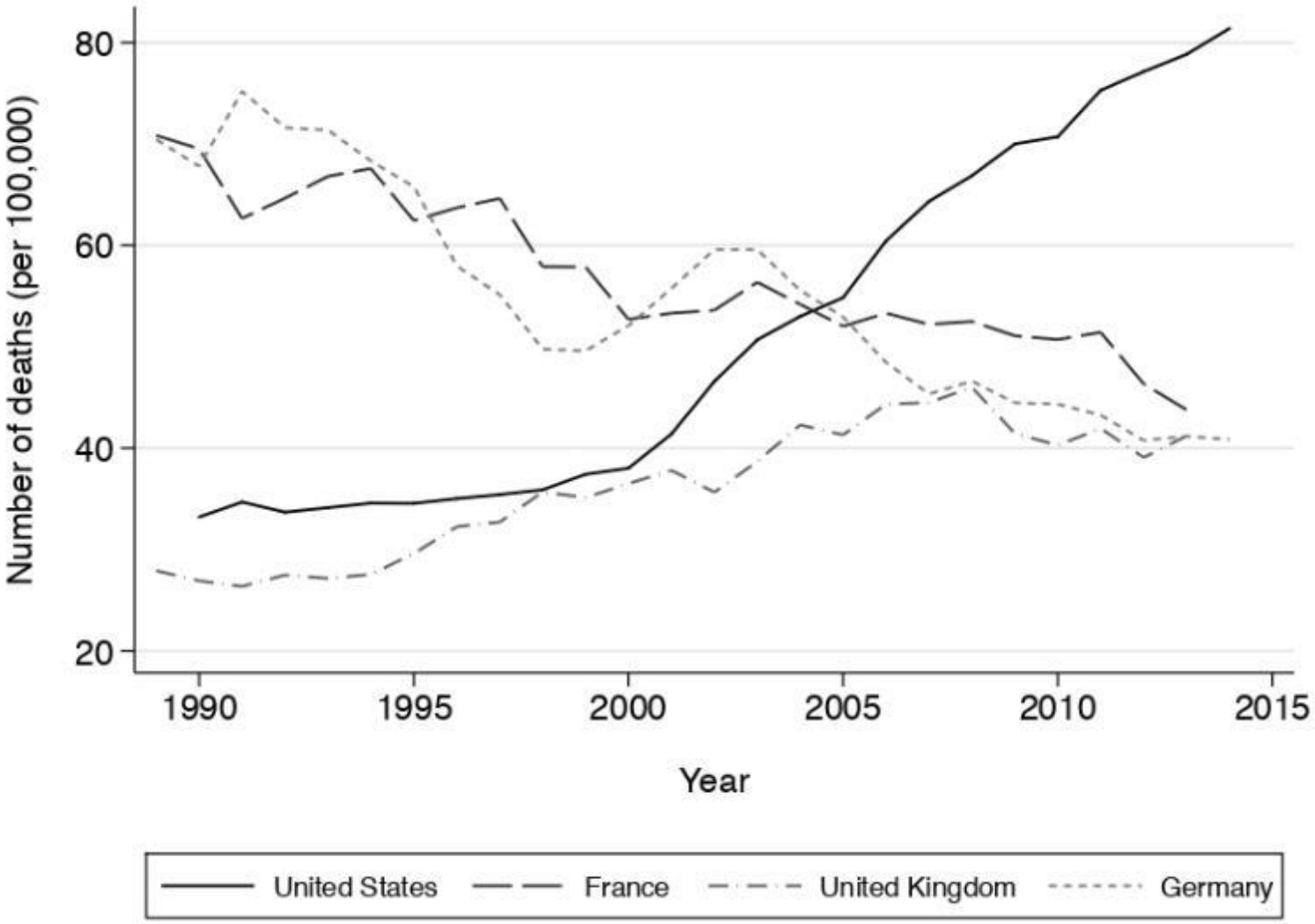
RETHINKING CAPITALISM

RETHINK CAPITALISM : COVID AS A REVELATOR

- US does poorly on inequality and social protection
- Europe does poorly on innovation

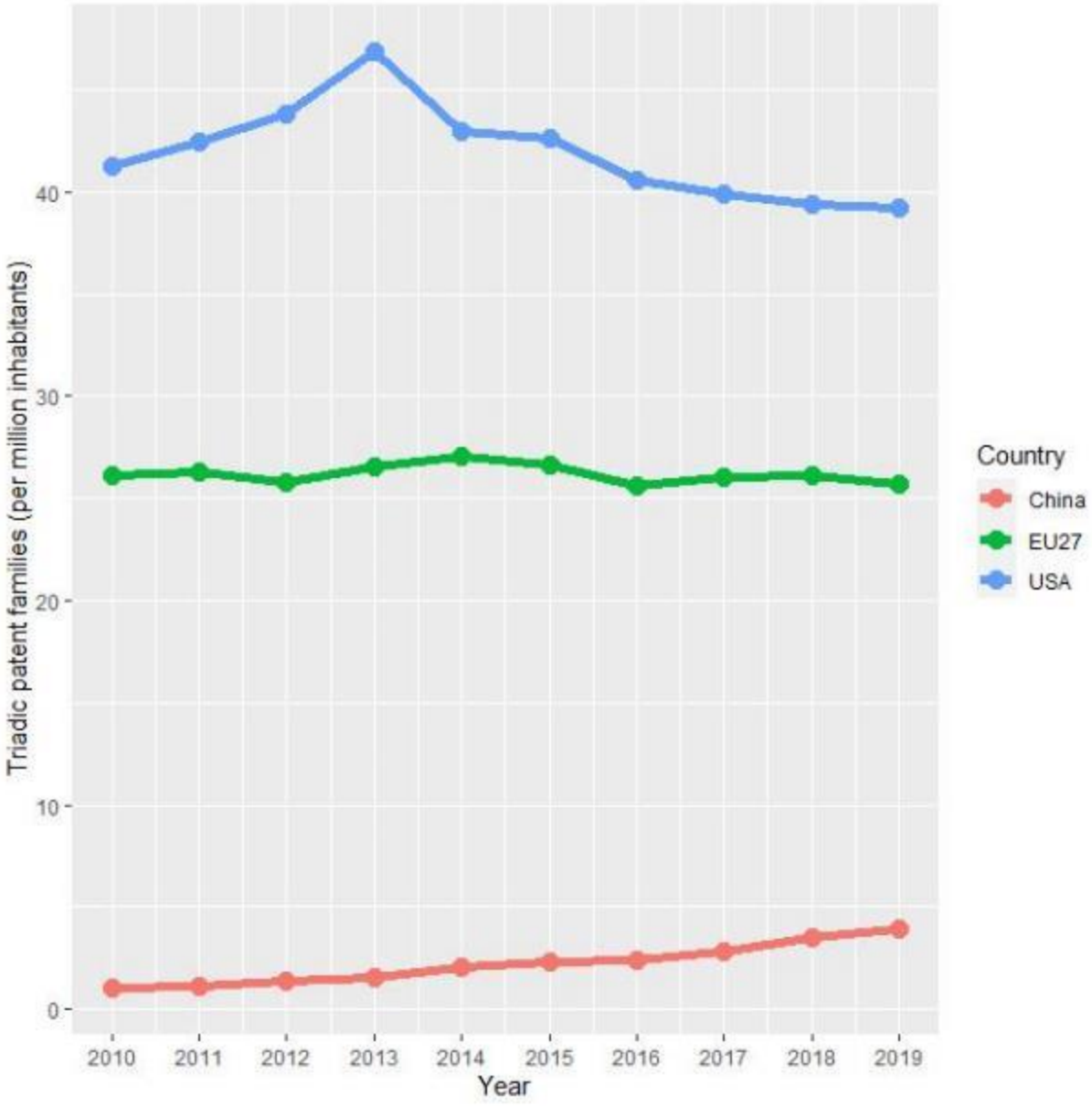
COVID AS REVELATOR

	Gini Index	Poverty Rate
United States	0.390	0.178
Germany	0.289	0.104
Sweden	0.282	0.093
Norway	0.262	0.084
France	0.292	0.081
Denmark	0.261	0.058



Source: Case and Deaton (2017).

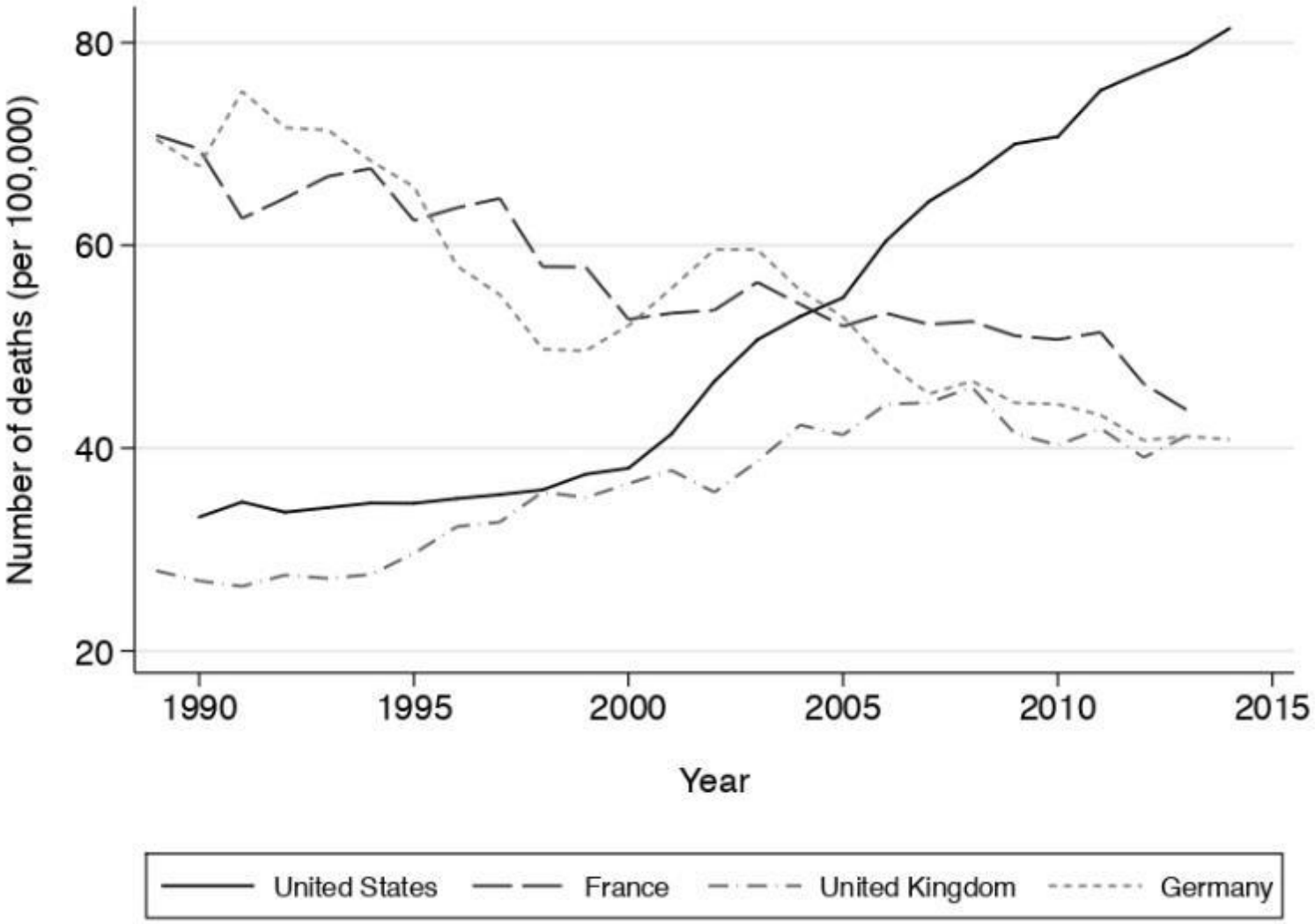
COVID AS REVELATOR



Triadic patents (per million inhabitants)

RETHINK CAPITALISM

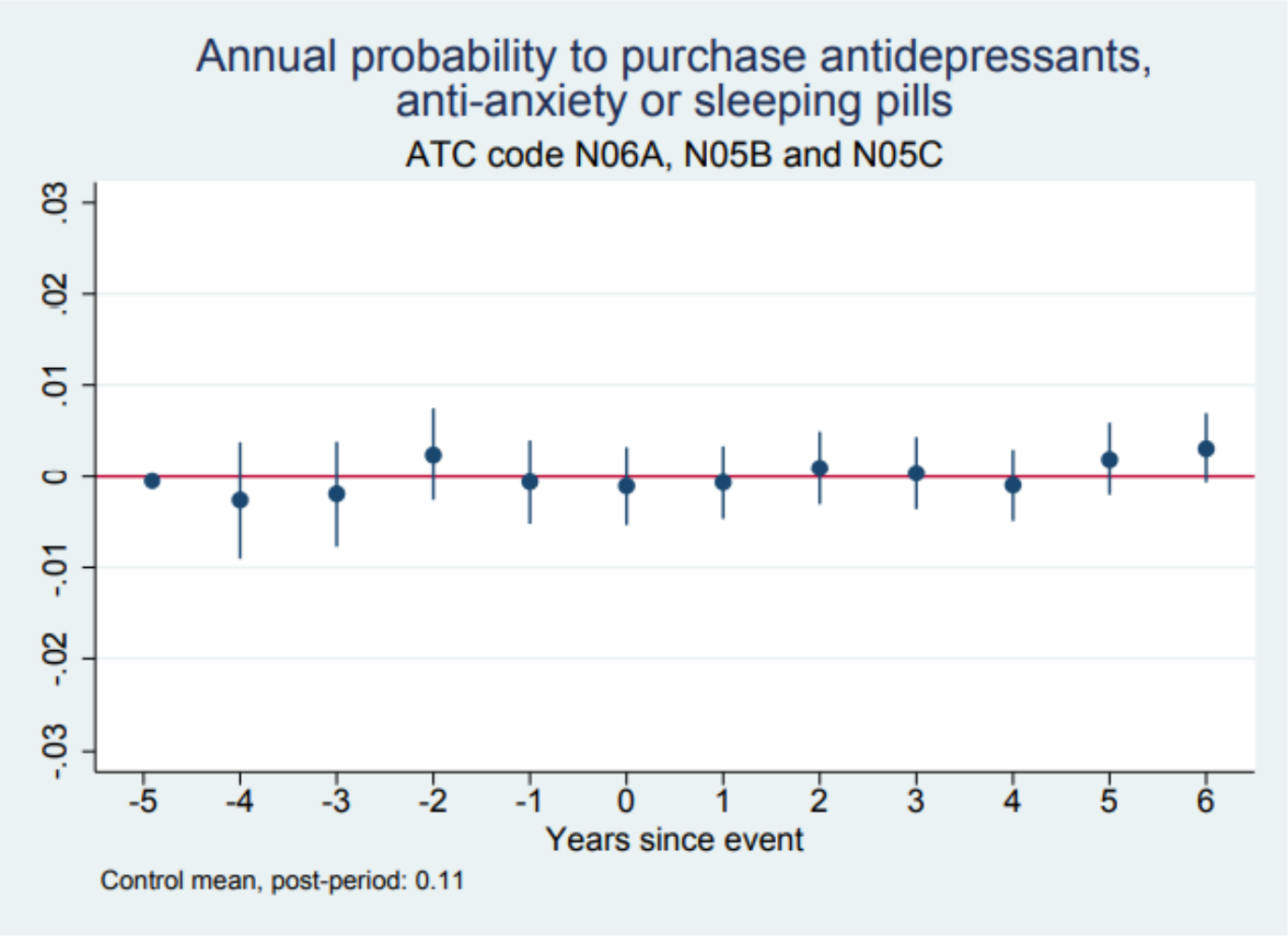
- Combine good side of American model (innovation) with good side of European model (protection)
- No trade off, rather, complementarity!!
  - Flexsecurity
  - Education and lost Einsteins
  - Competition



Source: Case and Deaton (2017).

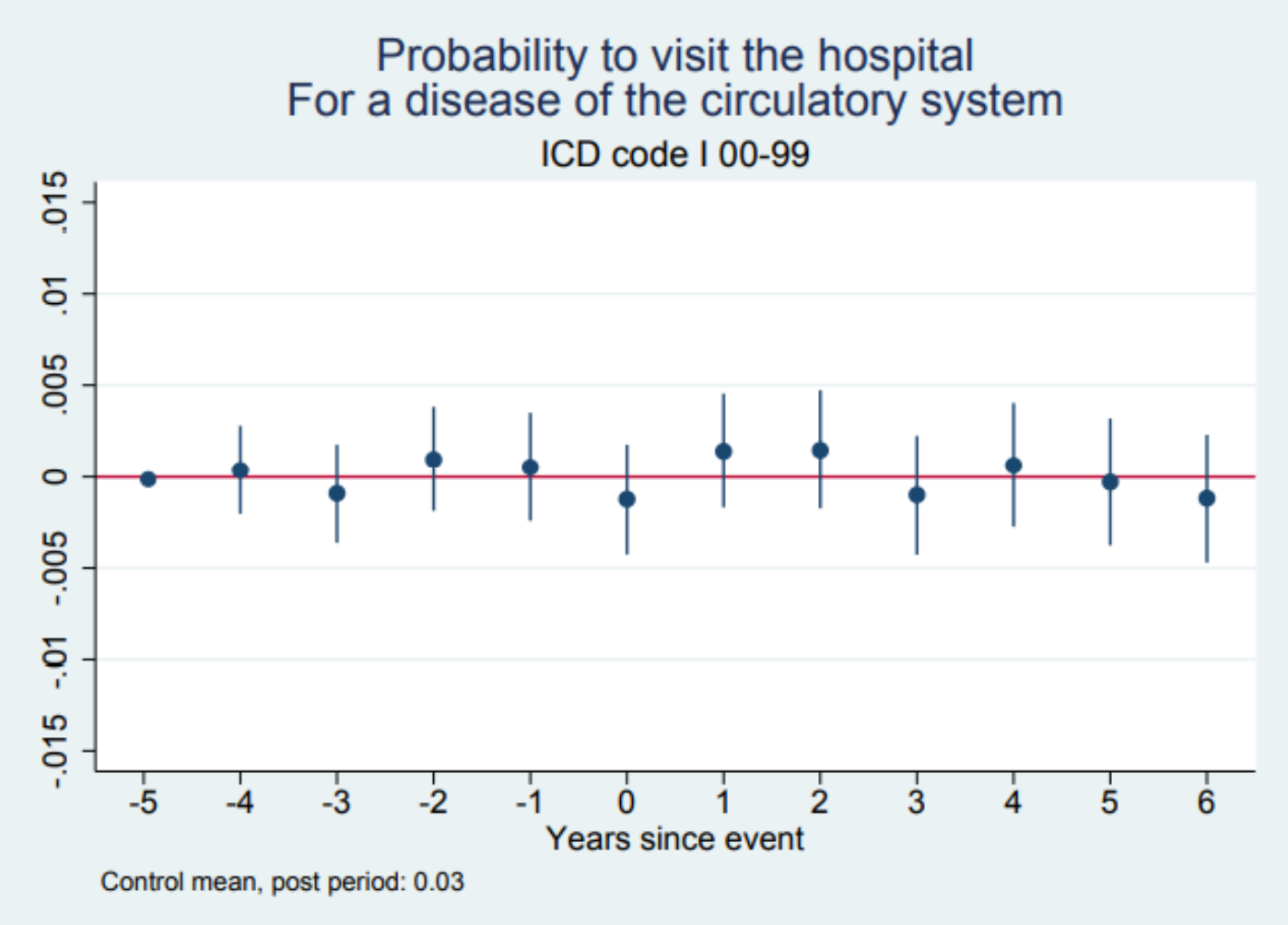
FLEXSECURITY: DENMARK

Moving to health: Antidepressants and related drugs

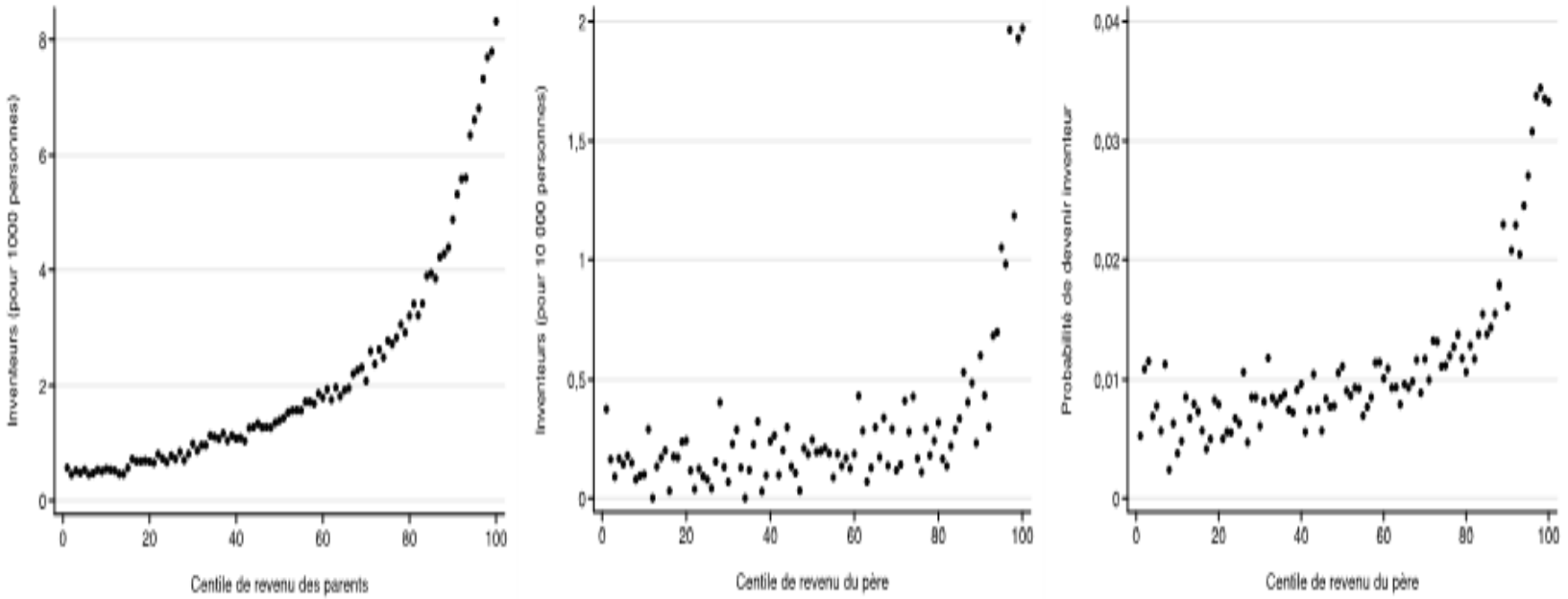


FLEXSECURITY: DENMARK

Heart attacks

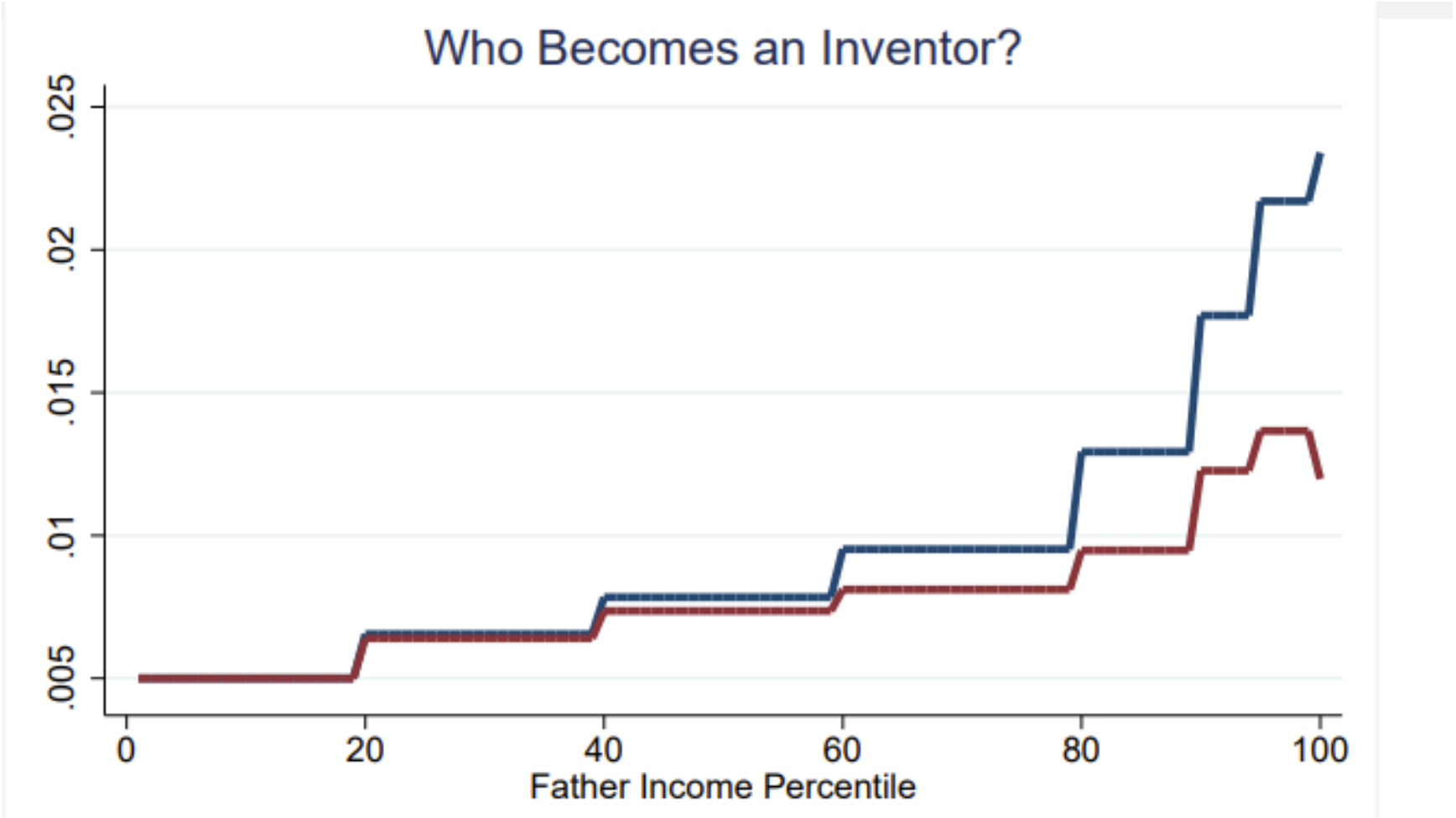


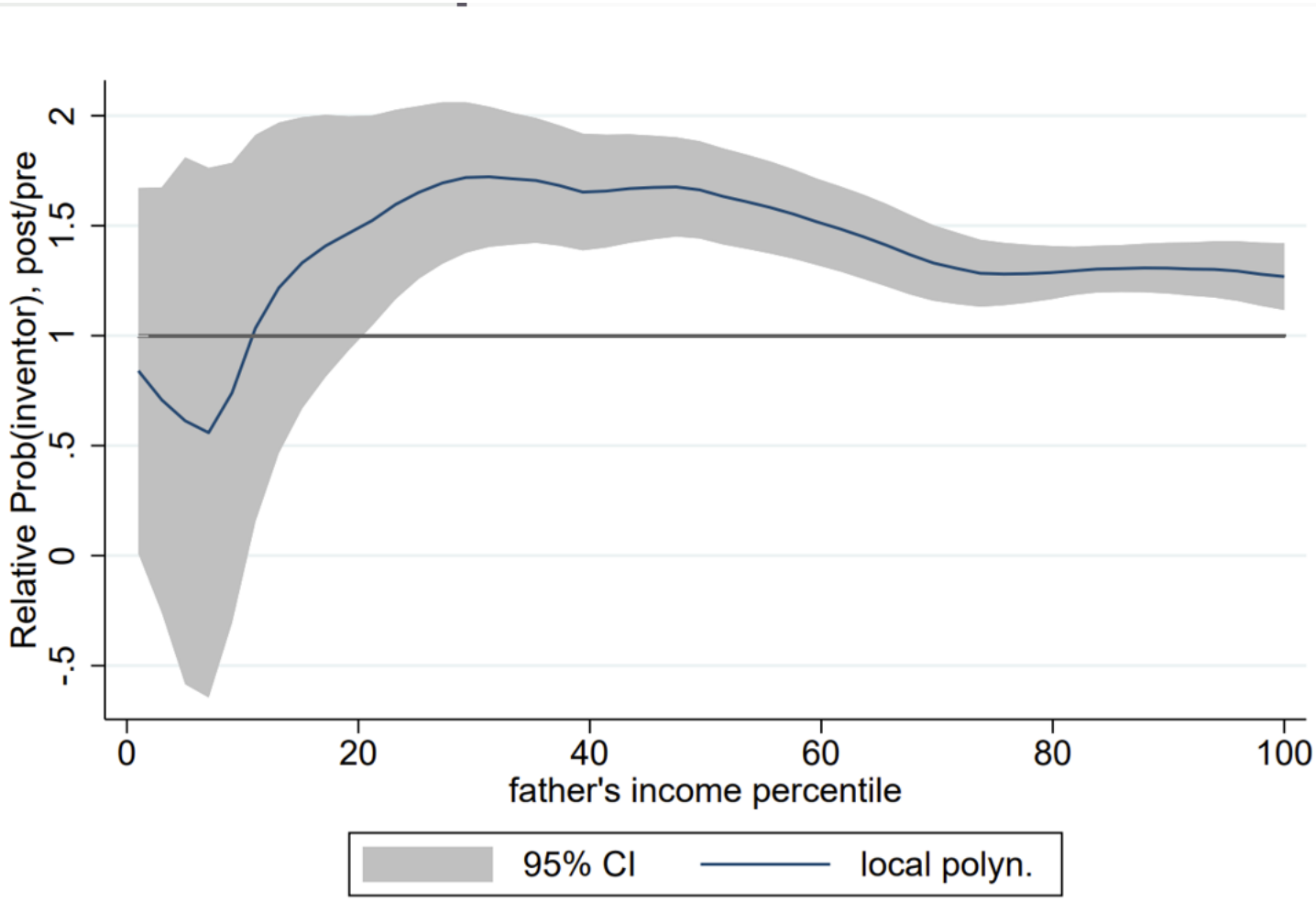
EDUCATION



Sources : Bell, Chetty, Jaravel, Petkova et Van Reenen (2019) ; Akcigit, Grigsby et Nicholas (2017) ; Aghion, Akcigit, Hyytinen et Toivanen (2017).

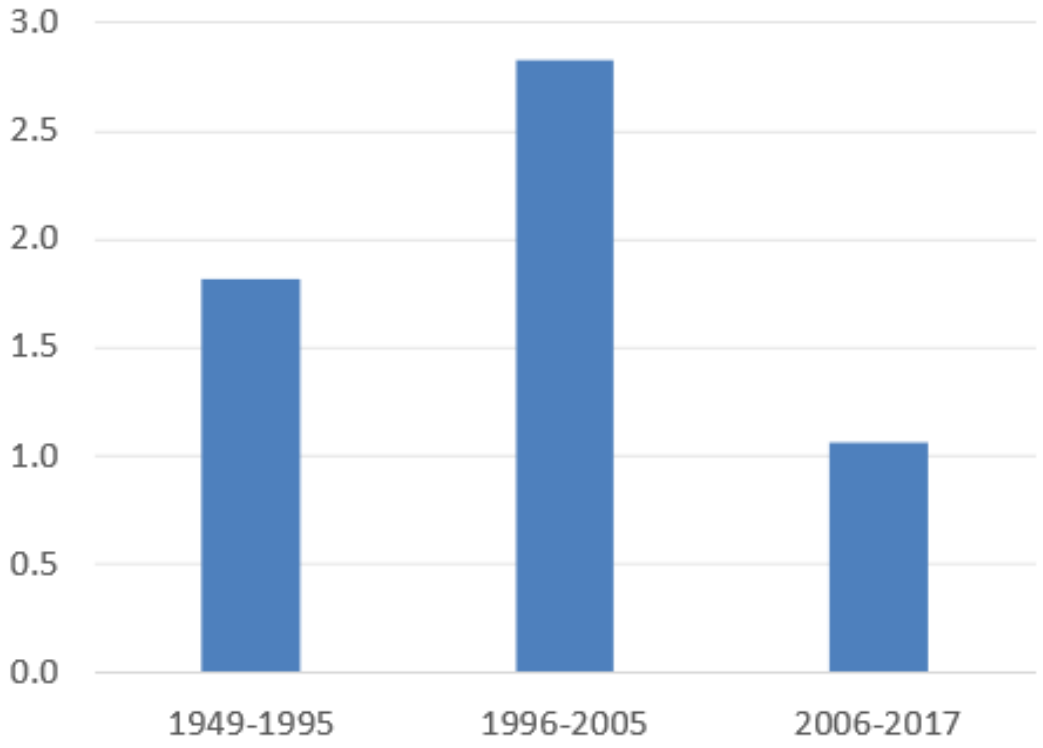
EDUCATION


Who Becomes an Inventor?
.025
.02
.015
.01
.005
0
20
40
60
80
100
Father Income Percentile


Relative Prob(inventor), post/pre
-.5
0
.5
1
1.5
2
0
20
40
60
80
100
father's income percentile
95% CI
local polyn.

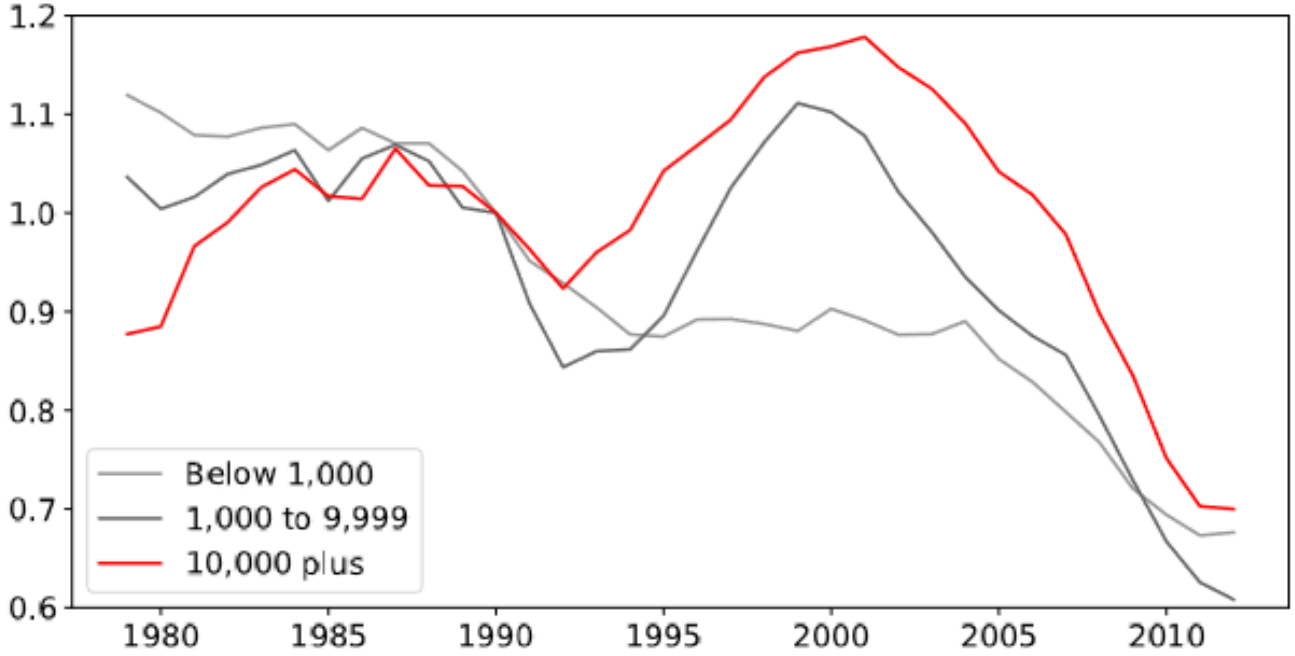
COMPETITION

Rise and Decline in TFP Growth



COMPETITION

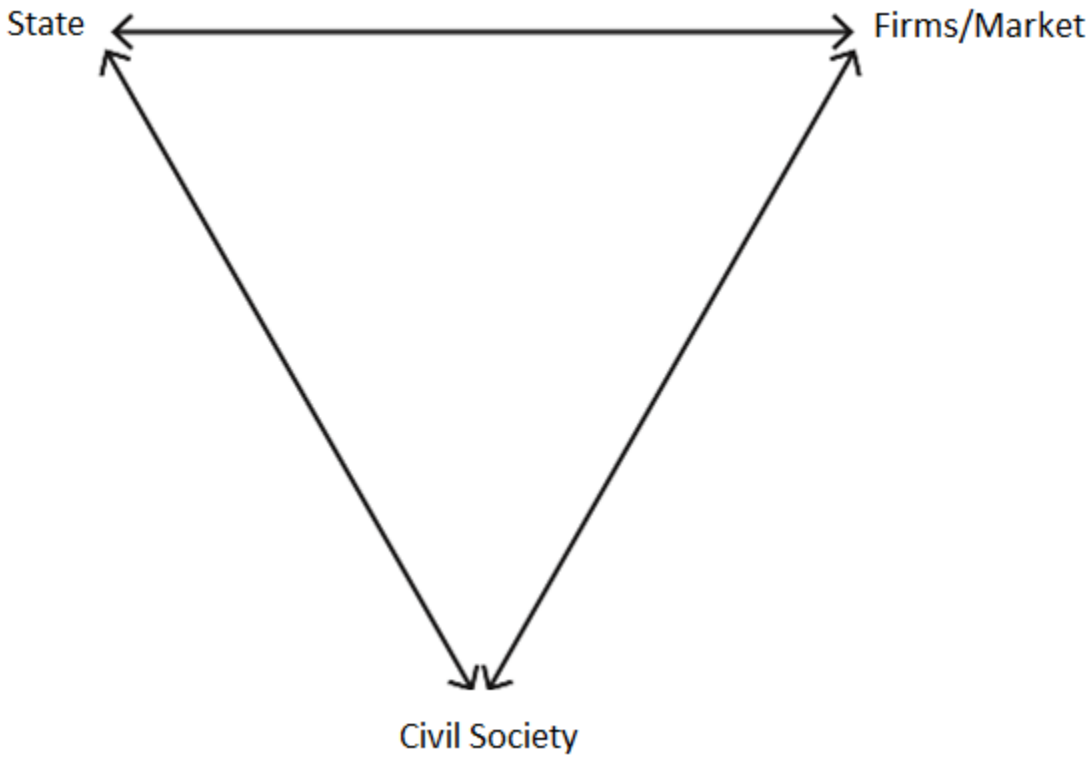
Rise and decline in employment-weighted plant entry rate



Source: U.S. Census Bureau's *Business Dynamics Statistics*. Job creation by birth over total employment by firm size bins. 5-year centered moving average.

RETHINK CAPITALISM

- Magic triangle: Firms/Market – State – Civil Society (Bowles and Carlin)

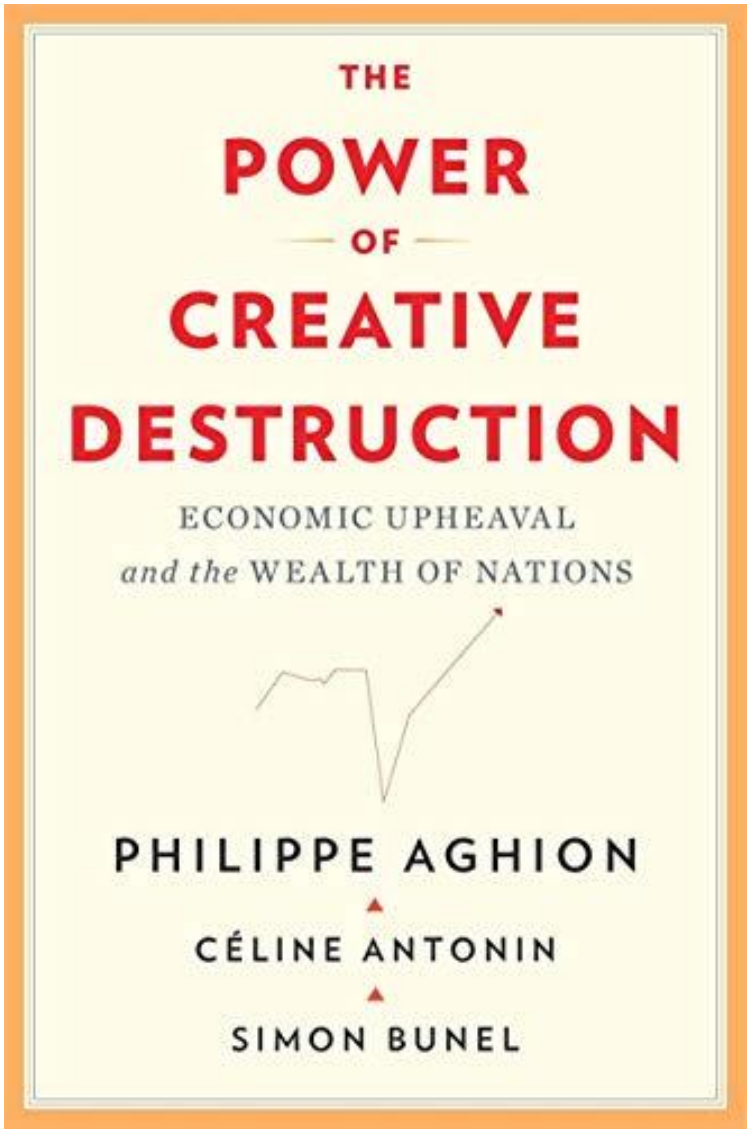


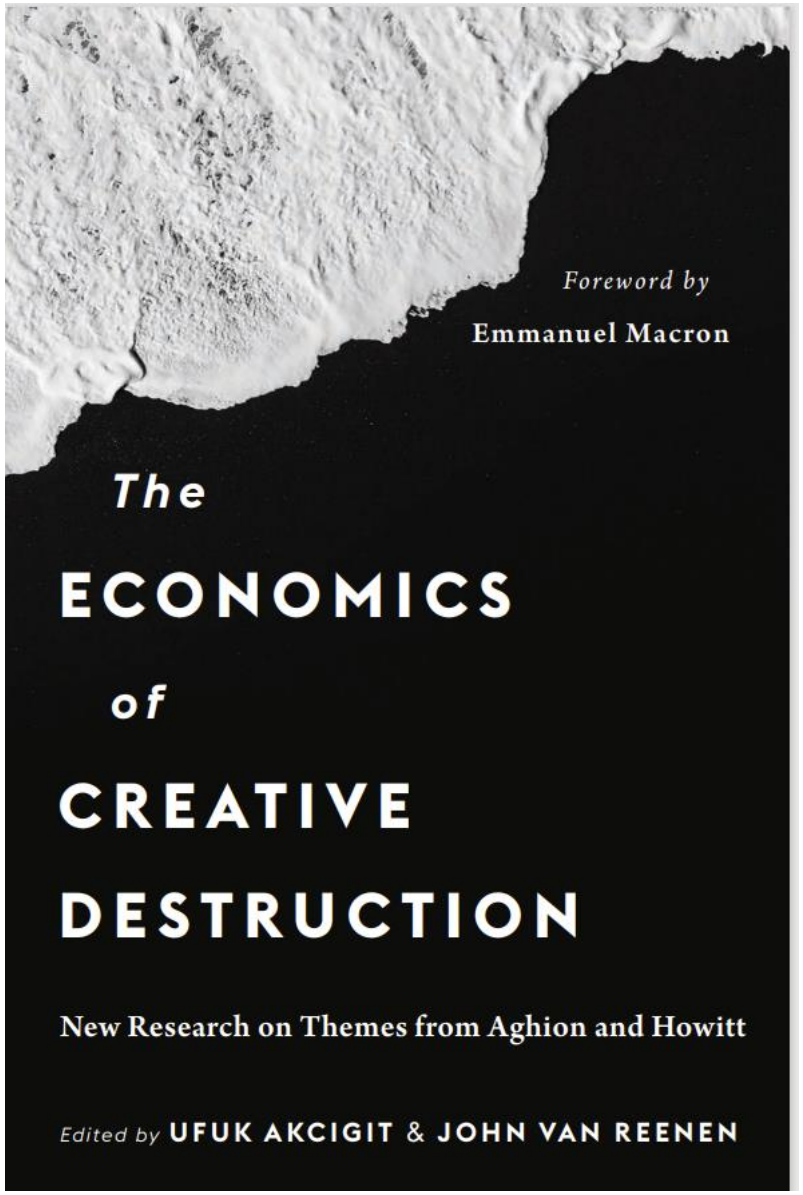
RETHINK CAPITALISM

- Constitutions are incomplete contracts (Aghion-Bolton, 2003; Aghion-Alesina-Trebbi, 2004)
- Civil society plays a crucial role as a means of ensuring the effective implementation of these contracts

RETHINK CAPITALISM

- Example:
  - The Fight for Civil Rights in the US
  - Israel’s demonstrations?


THE
POWER
OF
CREATIVE
DESTRUCTION
ECONOMIC UPHEAVAL
and the WEALTH OF NATIONS
PHILIPPE AGHION
CÉLINE ANTONIN
SIMON BUNEL


Foreword by
Emmanuel Macron
The
ECONOMICS
of
CREATIVE
DESTRUCTION
New Research on Themes from Aghion and Howitt
Edited by UFUK AKCIGIT & JOHN VAN REENEN

Thank you!