Tasks and Technological Change

UniTo, Labor Economics Part II
Christoph Albert

Lecture 3

Agenda

Tasks and Technological Change

A Task Model with Comparative Advantage

- Setup + three equilibrium conditions
- Inequality implications: Comparative statics

Task Displacement, Productivity, and Real & Relative Wages

- Real wage levels and technological change
- Labor replacing technologies and inequality

More Inequality

- Top incomes and "superstars"
- Wealth inequality

Cross-sectional and Intergenerational Inequality

Skill Differentials, Inequality and Intergenerational Mobility

(1) Cross-sectional inequality

- skill-biased technological change
- **task-biased technological change**

(2) Intergenerational inequality

- parent-child evidence

Other factors

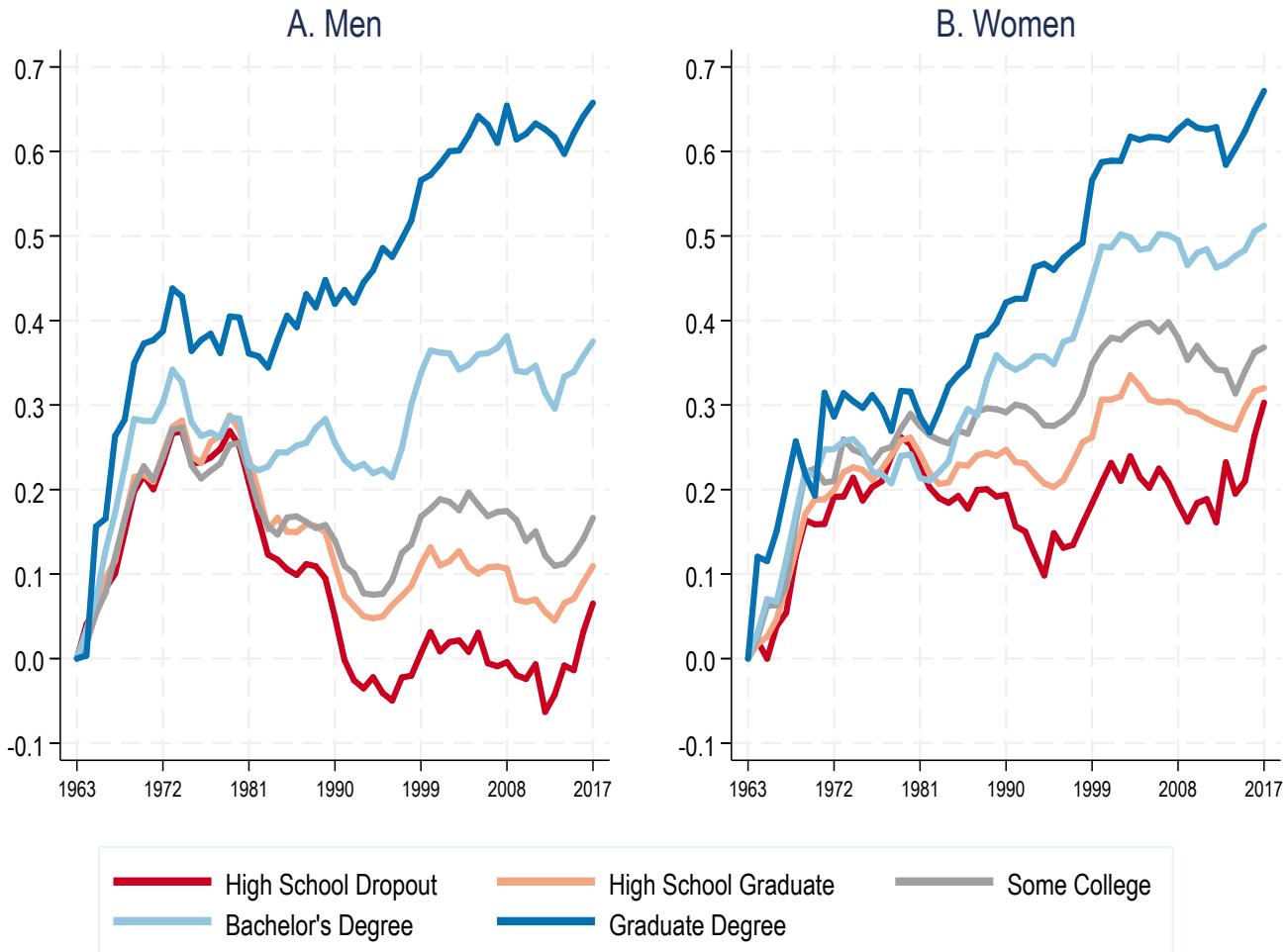
The canonical 'factor proportions' model is intuitive and explains earlier trends and some cross-country pattern in inequality.

However, it cannot explain:

- Decline in wages for low-skilled workers
- Job and wage polarization since the 1990s
- Decline in labor share

We focus on a model of tasks and automation (task-biased technological change), which could explain these pattern, as well as the recent fall in the labor share.

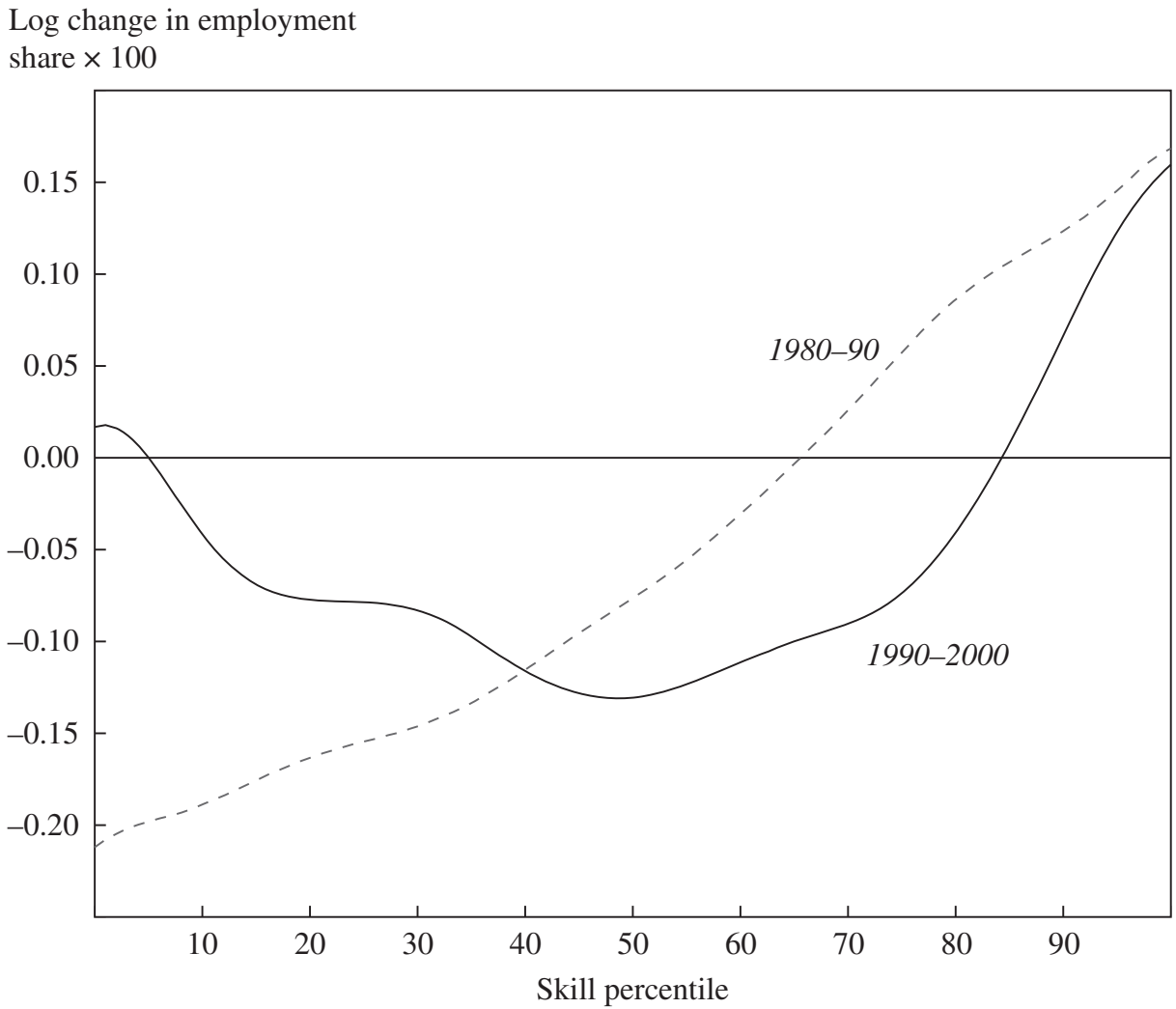
U.S. Real Hourly Wages by Education Level



Autor (2019)

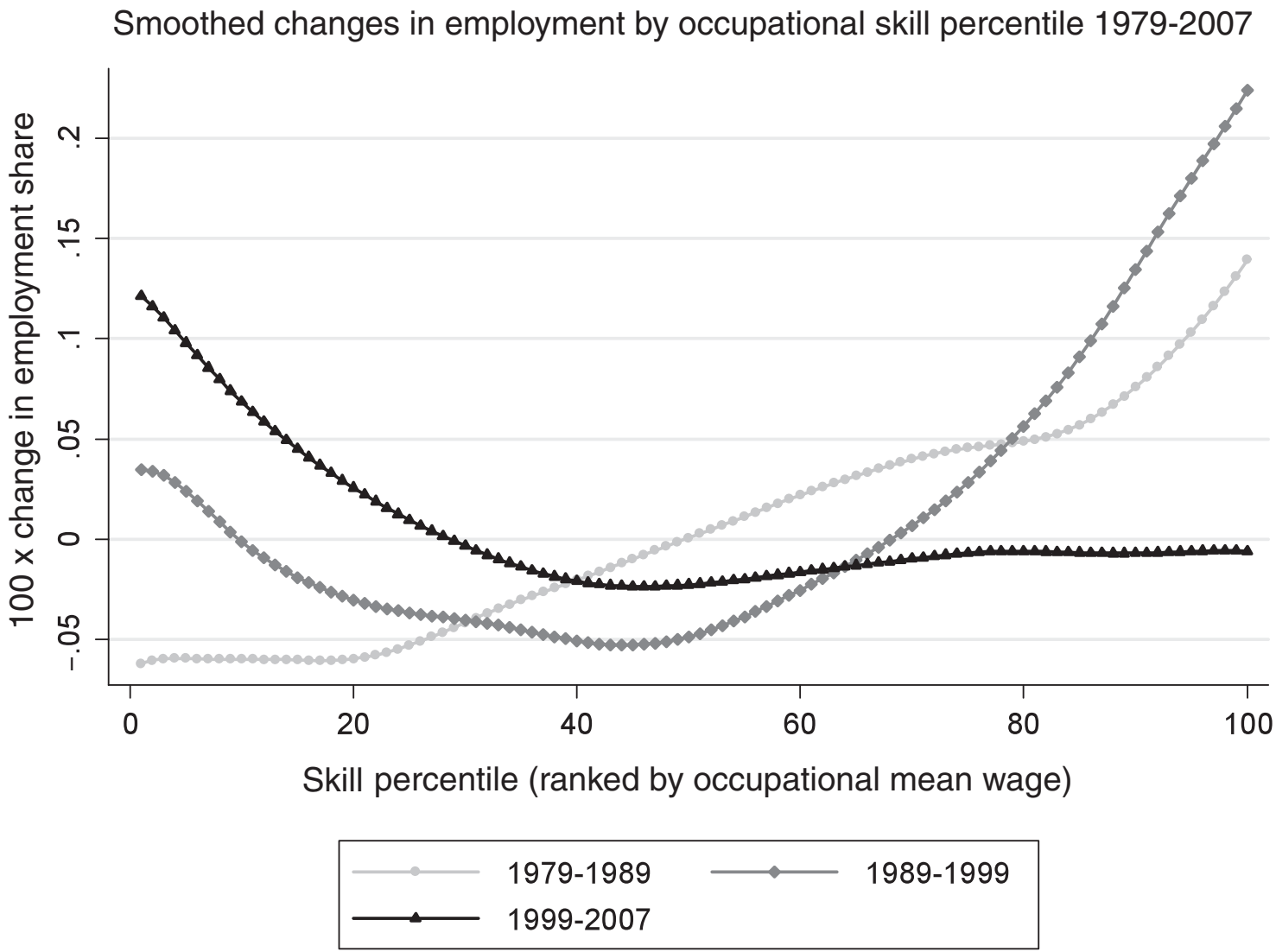
Job Polarization U.S.

Figure 8. Changes in Share of Employment by Percentile of the Occupational Skill Distribution, 1980–90 and 1990–2000[a]



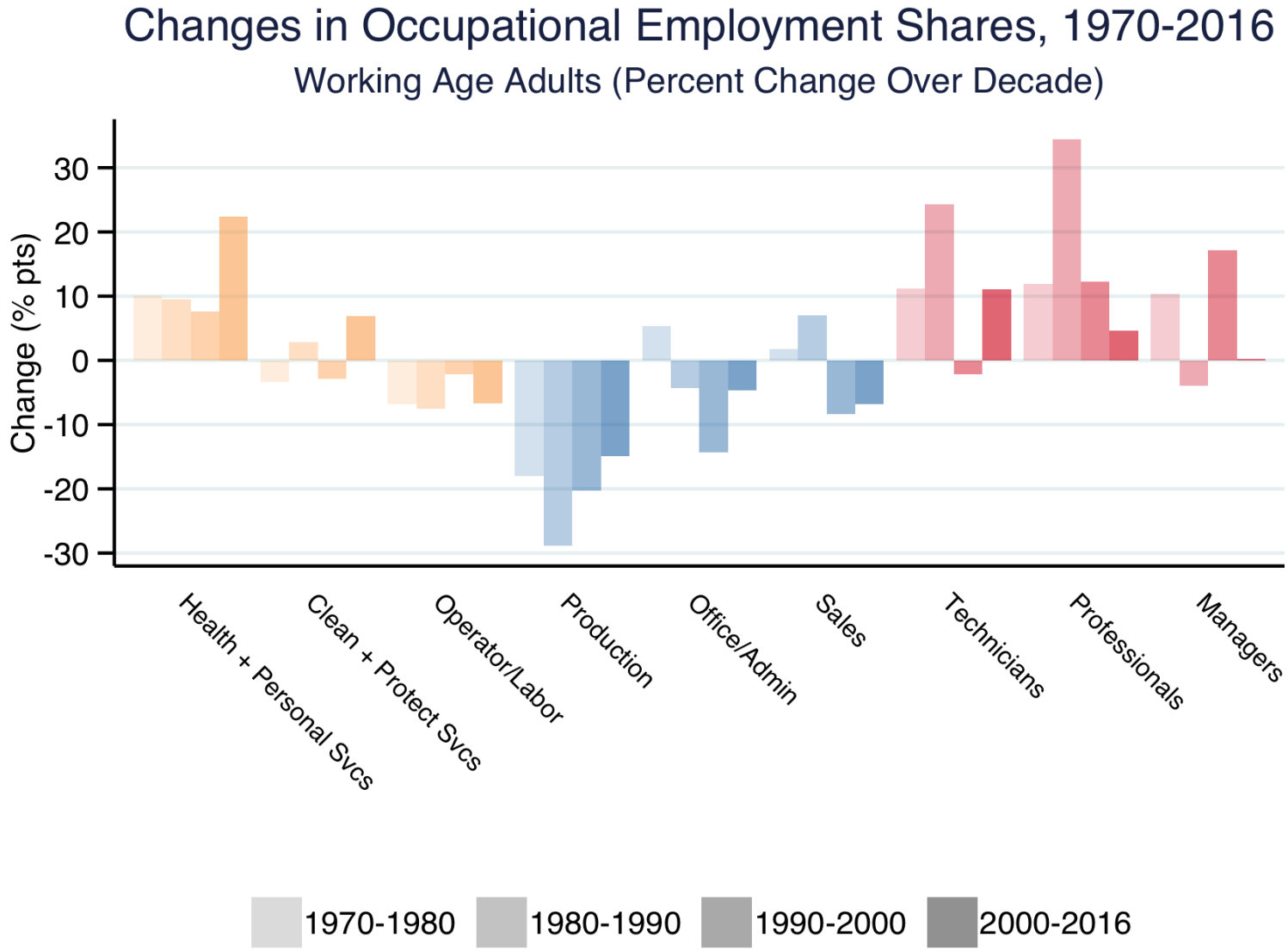
Goldin and Katz (2007)

Job polarization U.S.



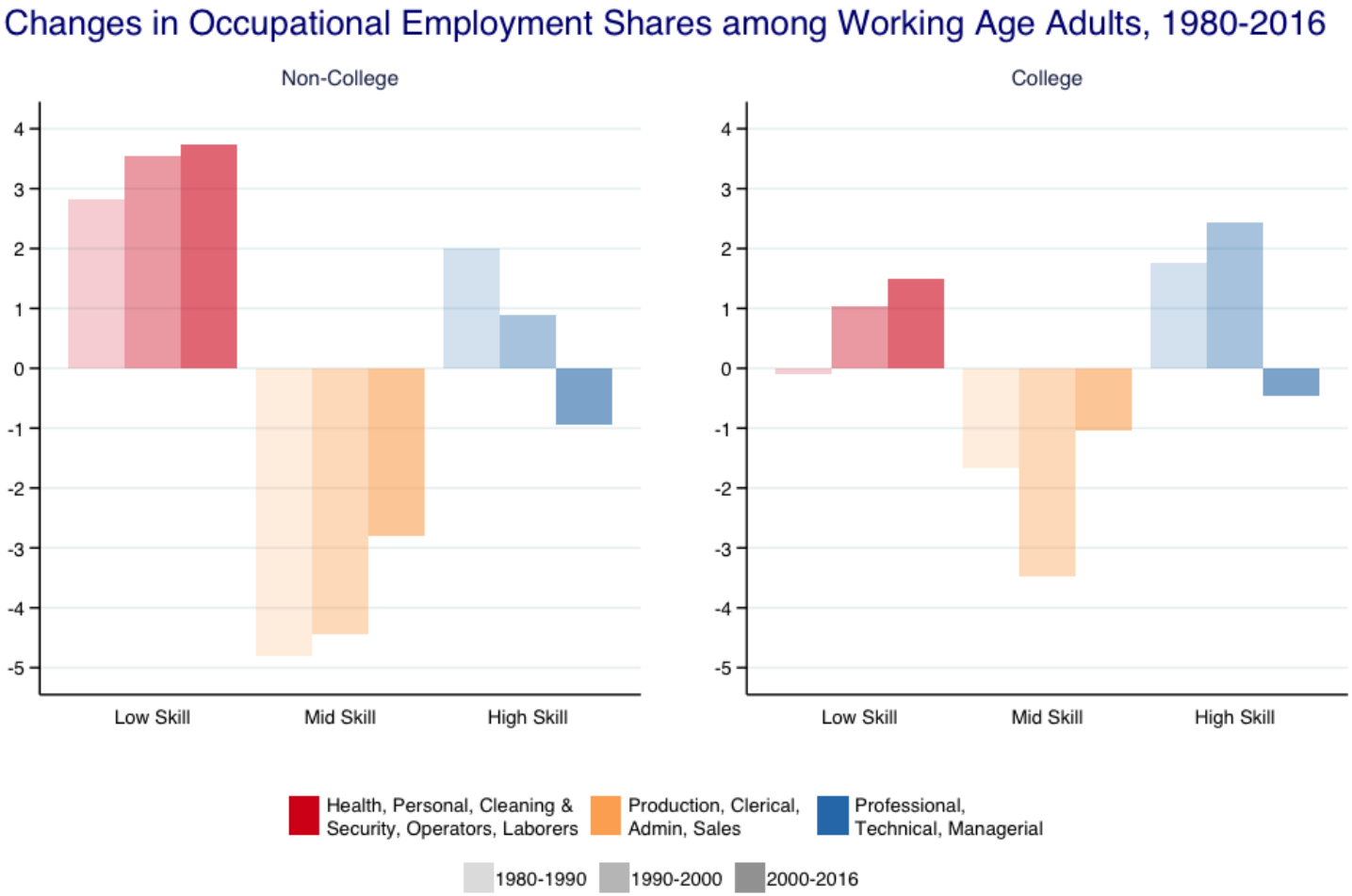
Acemoglu and Autor (2011)

Occupational Polarization, 1970-2016



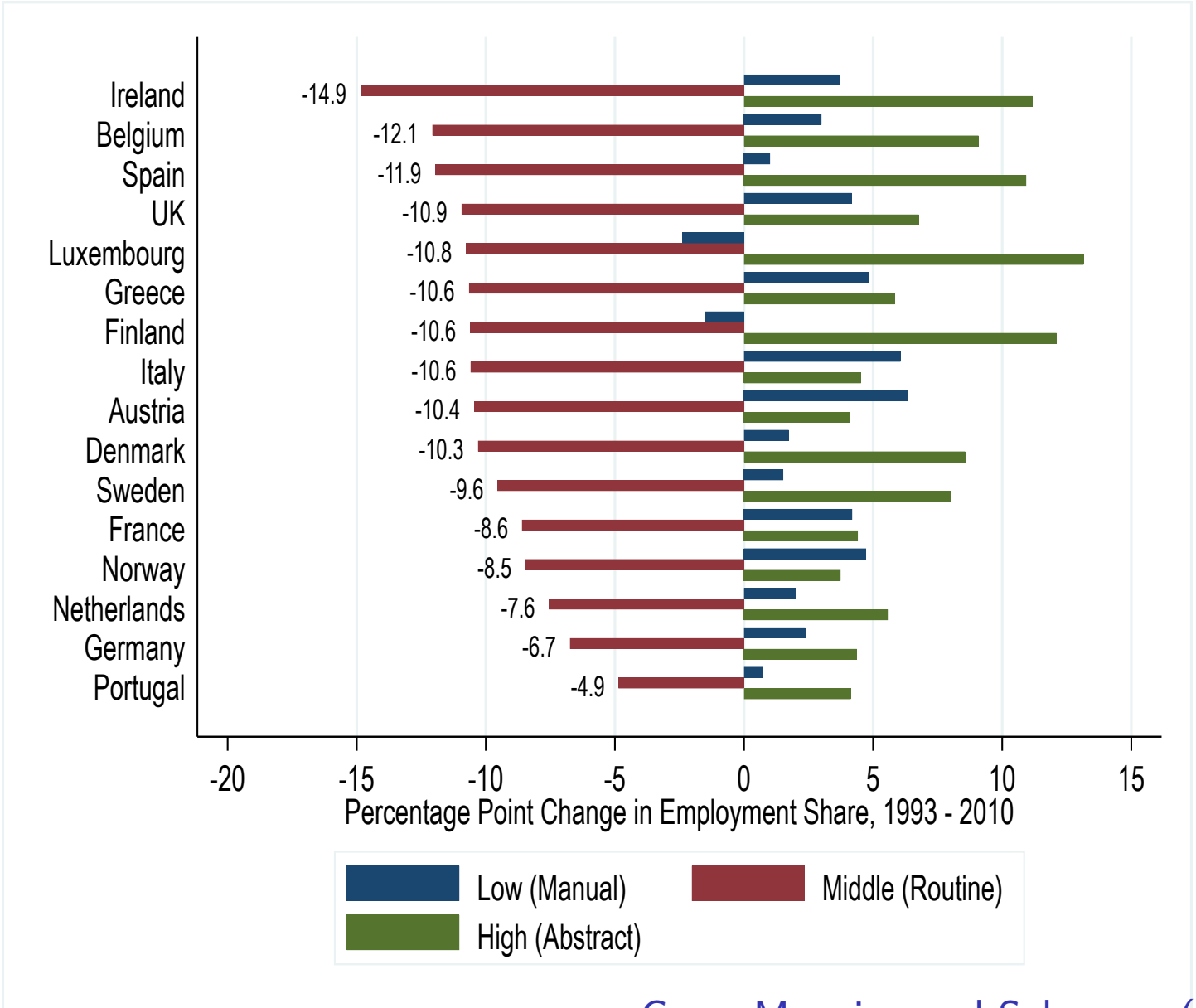
Autor (2019)

by Broad Category: Non-College and College Workers



Autor (2019)

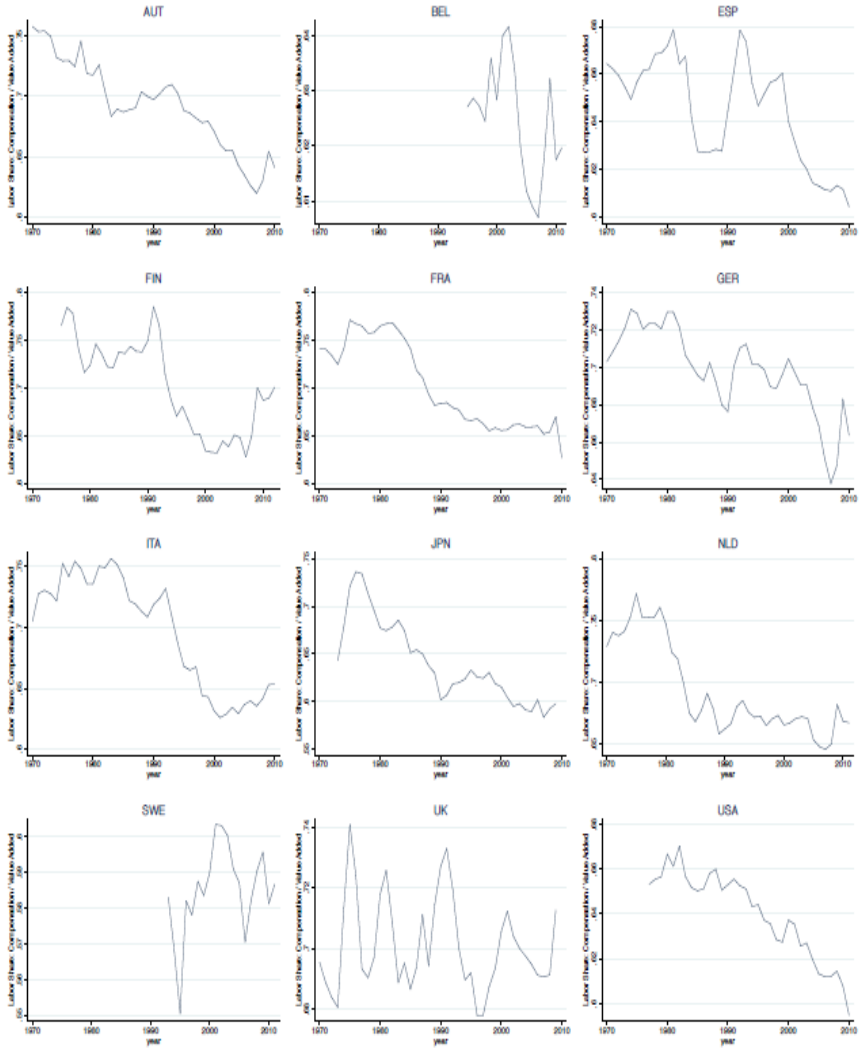
Occupational Polarization in EU Countries, 1993-2010



Goos, Manning and Salomons (2014)

Labor's Falling Share of National Income

Figure 1: International Comparison: Labor Share by Country



Notes: Each panel plots the ratio of aggregate compensation over value-added for all industries in a country based on KLEMS data.

Autor, Dorn, Katz, Patterson and Van Reenen (2020)

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A Model of Skills, Tasks and Technologies

We consider a model with:

1. Explicit distinction between *skills* and *tasks*
   - Skill: Worker's capability at performing various tasks
   - Tasks: Unit of work activity that produces output
2. *Comparative advantage* and self-selection of workers to tasks
   - Assignment of workers to tasks is endogenous (as in Roy '51)
3. Technology as a substitute or complement for specific tasks
   - may displace workers from tasks; increase productivity; augment or reduce labor demand; affect labor's share of output

Task Framework: Motivation

Framework builds on

- Autor, Levy, Murnane (2003)
- Grossman, Rossi-Hansberg (2008)
- Acemoglu and Autor (2011)
- Acemoglu and Restrepo (2016+)

Baseline model: Acemoglu-Autor (2011)

- Interplay among skill supplies, task assignments, wages

Other interesting models and evidence [for self-study]:

- Acemoglu and Restrepo '18, AER (see also A-R '19 *JEP*)
- Acemoglu and Restrepo '20, JPE

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A Ricardian Model of Skills, Tasks and Technologies

Production technology: Tasks into goods

- Static environment with a unique final good, Y
- Y produced with continuum of *tasks* on the unit interval, $[0,1]$
- Cobb-Douglas technology mapping tasks the final good:

$$\ln Y = \int_0^1 \ln y(i) di,$$

  where $y(i)$ is the "service" or production level of task i
- Price of the final good, Y, is numeraire

Task Framework: Historical Context

Key idea—tasks are complements

- Automating a subset does not make the remainder redundant
- Extreme example: O-Ring Production Function (Kremer '93)

Technological progress (or importing/offshoring) may replace labor:

- **Textiles**: weaving machines replaced manual labor
- **Machine tools**: lathes and milling machines replaced skilled artisans
- **Agriculture**: horse-powered reapers and harvesters replaced manual labor
- **Robotics**, **software** and **AI** automate labor intensive tasks

Need not assume that task space is fixed/static

- Creation of new tasks will be important

Supply of skills to tasks

Three types of labor: High, Medium and Low

- Fixed, inelastic supply. Supplies are L, M and H

Each task on continuum has production function

$$y(i) = A_L \alpha_L(i)\, l(i) + A_M \alpha_M(i)\, m(i) + A_H \alpha_H(i)\, h(i)$$

- A terms are factor-augmenting technologies
- $\alpha_L(i)$, $\alpha_M(i)$ and $\alpha_H(i)$ are *task productivity schedules*
- For example, $A_L \alpha_L(i)$ is the productivity of low skill workers and $l(i)$ is the number of low skill workers in task i

Comparative advantage

All tasks can be performed by low, medium or high skill workers

$$y(i) = A_L \alpha_L(i) l(i) + A_M \alpha_M(i) m(i) + A_H \alpha_H(i) h(i)$$

Assumption (comparative advantage): $\alpha_L(i)/\alpha_M(i)$ and $\alpha_M(i)/\alpha_H(i)$ are continuously differentiable and strictly decreasing

Higher indices correspond to "more complex" tasks, in which high-skill workers are better

- Note 1: No assumption made about *absolute* advantage (i.e., the level of $\alpha_J(i)$ vs. $\alpha_{J'}(i)$)
- Note 2: Which skill group performs which tasks in equilibrium depends on *both* relative productivity ($A_J \alpha_J(i) \gtrless A_{J'} \alpha_{J'}(i)$) *and* relative wages

A Ricardian Model of Skills, Tasks and Technologies

Equilibrium objects: Task thresholds, I_L, I_H

- In any equilibrium there exist I_L and I_H such that $0 < I_L < I_H < 1$ and for any $i < I_L$, $m(i) = h(i) = 0$, for any $i \in (I_L, I_H)$, $l(i) = h(i) = 0$, and for any $i > I_H$, $l(i) = m(i) = 0$

Allocation of tasks to skill groups determined by I_H, I_L

- Tasks $i > I_H$ will be performed by high skill workers (Abstract)
- Tasks $i < I_L$ will be performed by low skill workers (Manual)
- Middle tasks $I_L \leq i \leq I_H$ will be performed by medium skill workers (Routine)

Boundaries of these sets are endogenous (decide by firms and workers) $\rightarrow$ *Substitution of skills across tasks*

Solution concept: Three equilibrium conditions

1. Law of one price for skills
2. Equal division of labor among tasks within a skill group
3. No arbitrage between tasks

Three eq. conditions: Law of one price for skill

1. Law of one price for skills

- Let $p(i)$ denote the price of services of task i. In equilibrium all tasks employing L workers must pay them the same wage, w_L, and similarly for H and L:

$$w_L = p(i)A_L\alpha_L(i) \text{ for any } i < I_L.$$

$$w_M = p(i)A_M\alpha_M(i) \text{ for any } I_L < i < I_H.$$

$$w_H = p(i)A_H\alpha_H(i) \text{ for any } i > I_H.$$

- Thus, workers of each skill level are indifferent among tasks that are exclusively performed by their own skill group.

Three eq. conditions: Law of one price for skill

1. Law of one price for skills

- This has a convenient implication:
  - $p(i)\alpha_L(i) = p(i')\alpha_L(i') \equiv P_L$ for any $i, i' < I_L$
  - $p(i)\alpha_M(i) = p(i')\alpha_M(i') \equiv P_M$ for any $I_H > i, i' > I_L$
  - $p(i)\alpha_H(i) = p(i')\alpha_H(i') \equiv P_H$ for any $i, i' > I_H$
- Note that we are using the Cobb-Douglas property that:
  - $p_i \times q_i$ for a factor i is equal to its factor share in the CD production function
  - share of output paid to each task is identical

Three eq. conditions: Equal division of labor

2. Equal division of labor among tasks within a skill group

- The Cobb-Douglas technology implies:

$$p(i)y(i) \quad = \quad p(i')y(i')$$

- Noting that

$$y(i) = A_L \alpha_L(i) l(i) \text{ for any } i < I_L$$
$$P_L = p(i)\alpha_L(i) \text{ for any } i < I_L$$
$$\Rightarrow p(i)y(i) = P_L A_L l(i)$$

- Substituting

$$P_L A_L l(i) = P_L A_L l\left(i'\right)$$
$$\Rightarrow l(i) = l\left(i'\right) \text{ for any } i, i' < I_L$$

Three eq. conditions: Equal division of labor

2. Equal division of labor among tasks within a skill group

$$l(i) = l\left(i'\right)$$

- which implies

$$l(i) = \frac{L}{I_L} \text{ for any } i < I_L,$$
$$m(i) = \frac{M}{I_H - I_L} \text{ for any } I_H > i > I_L,$$
$$h(i) = \frac{H}{1 - I_H} \text{ for any } i > I_H.$$

- Any two tasks performed exclusively by workers of a skill group must use identical amounts of labor—group's labor supply divided by the fraction of tasks performed by group

Three eq. conditions: No arbitrage across skill groups

3. No arbitrage between tasks

- Start with observation that wages equal marginal products:

$$w_L = P_L A_L = A_L p(i)\,\alpha_L(i) \text{ for } i < I_L$$

$$w_M = P_M A_M = A_M p(i)\,\alpha_M(i) \text{ for } I_L < i < I_H$$

$$w_H = P_H A_H = A_H p(i)\,\alpha_H(i) \text{ for } i > I_H$$

Three eq. conditions: No arbitrage across skill groups

3. No arbitrage between tasks

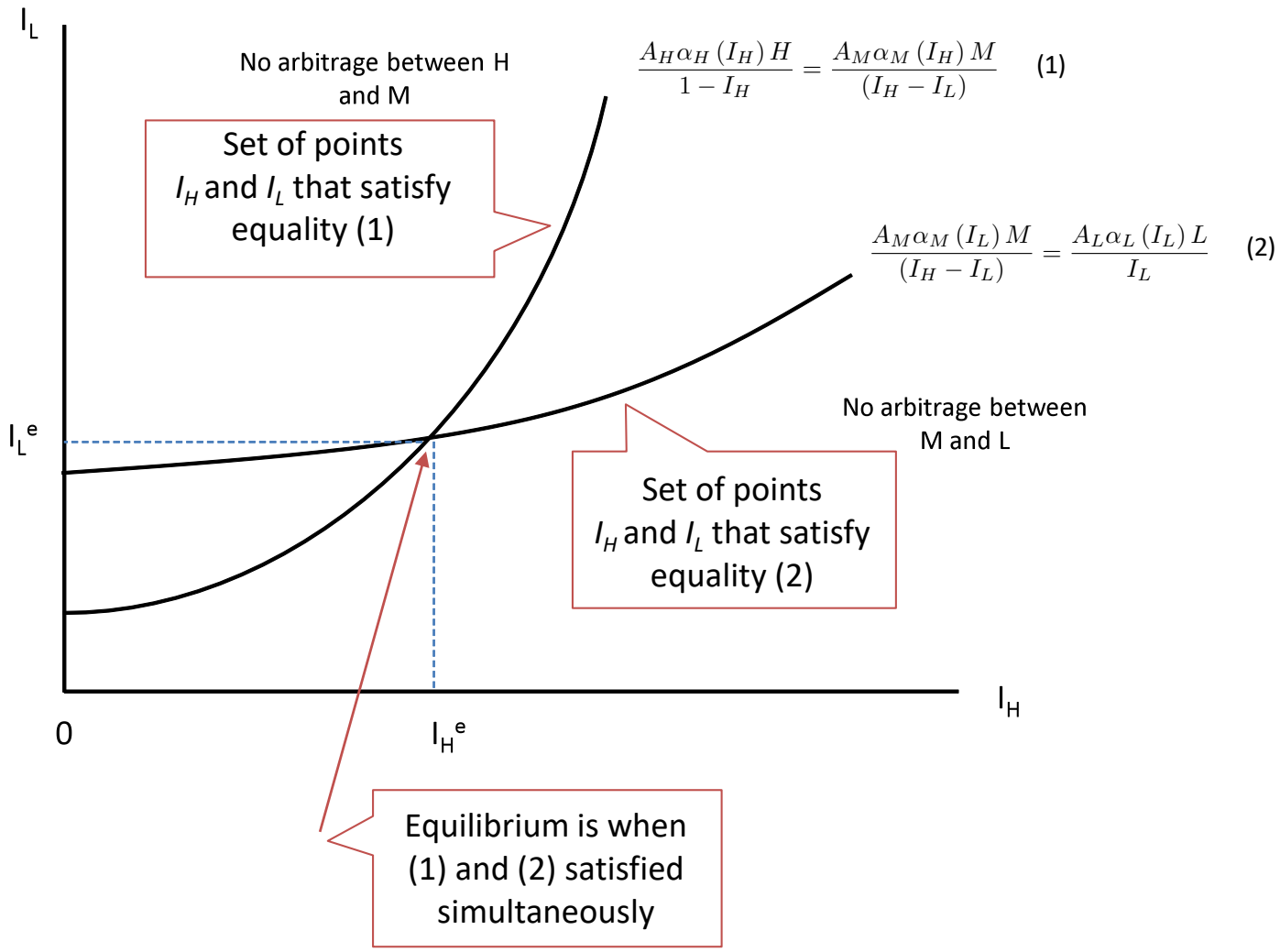
- The threshold task I_H must be such that it can be profitably produced using either H or M workers (similar for I_L):

$$\frac{A_H \alpha_H(I_H) H}{1 - I_H} = \frac{A_M \alpha_M(I_H) M}{I_H - I_L}$$
$$\frac{A_M \alpha_M(I_L) M}{I_H - I_L} = \frac{A_L \alpha_L(I_L) L}{I_L}$$

- Since $P_L A_L I(i) = P_L A_L I(i')$ for all $i < I_L$, and similarly for M and H, we have:

$$\frac{P_H A_H H}{1 - I_H} = \frac{P_M A_M M}{I_H - I_L}$$
$$\frac{P_M A_M M}{I_H - I_L} = \frac{P_L A_L L}{I_L}$$

No Arbitrage Across Skill Groups: Relative Cost of Producing Marginal Task(s) Rising in Task Threshold(s)



Three equilibrium conditions

3. No arbitrage between skill groups across tasks

$$P_H A_H H/(1-I_H) = P_M A_M M/(I_H - I_L)$$
$$P_M A_M M/(I_H - I_L) = P_L A_L L/(I_L)$$

- Substituting

$$w_H = P_H A_H,\ w_M = P_M A_M,\ w_L = P_L A_L$$

$$w_H H/(1-I_H) = w_M M/(I_H - I_L)$$
$$w_M M/(I_H - I_L) = w_L L/(I_L)$$

$$\Rightarrow \frac{w_H}{w_M} = \left(\frac{1-I_H}{I_H - I_L}\right)\frac{M}{H},\ \frac{w_M}{w_L} = \left(\frac{I_H - I_L}{I_L}\right)\frac{L}{M},\ \frac{w_H}{w_L} = \left(\frac{1-I_H}{I_L}\right)\frac{L}{H}$$

Relative Wages

- These three conditions [law of one price, equal shares, no arbitrage] imply that relative wages are solely a function of labor supplies and task thresholds:

$$\begin{aligned} \frac{w_H}{w_M} &= \left(\frac{1-I_H}{I_H-I_L}\right)\left(\frac{M}{H}\right), \\ \frac{w_M}{w_L} &= \left(\frac{I_H-I_L}{I_L}\right)\left(\frac{L}{M}\right) \end{aligned}$$

- So, labor supplies L, M, H plus compare adv. $\alpha(L)$, $\alpha(M)$, $\alpha(L)$ determine task allocation, I_L and I_H, and hence wages.
- It's that simple!

Equations for Wage Levels May Make this (Even) Clearer

- Output is

$$Y = B \times \underbrace{L^{I_L} M^{I_H - I_L} H^{1-I_H}}_{\text{Cobb-Douglas labor aggregate}}$$

where

$$B = \underbrace{\exp\left(\int_0^{I_L} \ln A_l \alpha(i)\, di + \int_{I_L}^{I_H} \ln A_m \alpha(i)\, di + \int_{I_H}^{1} \ln A_h \alpha(i)\, di \right)}_{\text{TFP}}$$

- Wages equal

$$\begin{aligned} w_L = \frac{\partial Y}{\partial L} &= B \times I_L \times L^{I_L - 1} M^{I_H - I_L} H^{1-I_H} \\ &= \frac{I_L}{L} \times \left(B L^{I_L} M^{I_H - I_L} H^{1-I_H} \right) \\ &= I_L \times \frac{Y}{L} \end{aligned}$$

and similarly, $w_M = Y(I_H - I_L)/M$ and $w_H = Y(1 - I_H)/H$.

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More Inequality

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Inequality in the task model

1. A rise in A_H (SBTC)
2. A rise in high-skilled labor supply H
3. Analogous comparative statics for rise in A_L or L
4. What about the effect of a rise in A_M or M on w_H/w_L?

The effect of $\Delta's$ in technology and skill supplies

An increase in supply H or an H-augmenting technical change A_H

1. $H's$ own task share

$$\frac{dI_H}{d\ln A_H} = \frac{dI_H}{d\ln H} \quad \lessgtr \quad 0 \quad ?$$

2. $L's$ task share:

$$\frac{dI_L}{d\ln A_H} = \frac{dI_L}{d\ln H} \quad \lessgtr \quad 0 \quad ?$$

3. $M's$ task share:

$$\frac{d\left(I_H - I_L\right)}{d\ln A_H} = \frac{d\left(I_H - I_L\right)}{d\ln H} \quad \lessgtr \quad 0 \quad ?$$

The effect of changes in skill supplies on wage inequality

Impact of an increase in the supply of labor on own relative wages

1. High skill supply:

$$\frac{d\ln(w_H/w_L)}{d\ln H} < 0, \frac{d\ln(w_H/w_M)}{d\ln H} < 0$$

2. Medium skill supply:

$$\frac{d\ln(w_H/w_M)}{d\ln M} > 0, \frac{d\ln(w_M/w_L)}{d\ln M} < 0$$

3. Low skill supply:

$$\frac{d\ln(w_M/w_L)}{d\ln L} > 0, \frac{d\ln(w_H/w_L)}{d\ln L} > 0$$

Factor-augmenting technical change and wage inequality

Impact of technological changes on relative wages

1. H augmenting:

$$\frac{d\ln(w_H/w_L)}{d\ln A_H} > 0,\ \frac{d\ln(w_H/w_M)}{d\ln A_H} > 0,\ \frac{d\ln(w_M/w_L)}{d\ln A_H} < 0;$$

2. M augmenting:

$$\frac{d\ln(w_H/w_M)}{d\ln A_M} < 0,\ \frac{d\ln(w_M/w_L)}{d\ln A_M} > 0$$

3. L augmenting:

$$\frac{d\ln(w_H/w_L)}{d\ln A_L} < 0,\ \frac{d\ln(w_H/w_M)}{d\ln A_L} > 0,\ \frac{d\ln(w_M/w_L)}{d\ln A_L} < 0$$

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Can a technological advance lower wages?

Reminder: wage levels in task model

$$Y = B \times \underbrace{L^{I_L} M^{I_H - I_L} H^{1-I_H}}_{\text{Cobb-Douglas labor aggregate}}$$

where

$$B = \underbrace{\exp\left(\int_0^{I_L} \ln A_l \alpha(i)\, di + \int_{I_L}^{I_H} \ln A_m \alpha(i)\, di + \int_{I_H}^{1} \ln A_h \alpha(i)\, di\right)}_{\text{TFP}}$$

- Wages equal

$$\begin{aligned} w_L = \frac{\partial Y}{\partial L} &= B \times I_L \times L^{I_L - 1} M^{I_H - I_L} H^{1-I_H} \\ &= \frac{I_L}{L} \times \left(B L^{I_L} M^{I_H - I_L} H^{1-I_H}\right) \\ &= I_L \times \frac{Y}{L} \end{aligned}$$

and similarly, $w_M = Y(I_H - I_L)/M$ and $w_H = Y(1 - I_H)/H$.

Can a technological advance lower wages?

Consider a task-replacing tech Δ, embodied in K, that displaces workers from some M tasks

Assume initially that there are some tasks performed by K that have crowded out some previously $M-$using tasks

$$Y = \underbrace{\exp\left(\int_0^{I_L} \ln A_l \alpha(i)\, di + \int_{I_L}^{I_K} \ln A_k \alpha(i)\, di + \int_{I_K}^{I_H} \ln A_m \alpha(i)\, di + \int_{I_H}^{1} \ln A_h \alpha(i)\, di\right)}_{\equiv B_K}$$

$$\times L^{I_L} K^{I_K - I_L} M^{I_H - I_K} H^{1 - I_H}$$

How does w_M respond to a further invasion of K into into $M's$ task space?

$$w_M = \frac{\partial Y}{\partial M} = (I_H - I_K) \times \frac{Y}{M}$$

$$\frac{\partial \ln w_M}{\partial I_K} = \underbrace{\frac{-1}{I_H - I_K}}_{\lessgtr 0\ ?} + \underbrace{\frac{\partial \ln Y/M}{\partial I_K}}_{\lessgtr 0\ ?}$$

Can a technological advance lower wages?

How does W_M respond to a further encroachment of K into into $M's$ task space?

$$w_M = \frac{\partial Y}{\partial M} = (I_H - I_K) \times \frac{Y}{M}$$

$$\frac{\partial \ln w_M}{\partial I_K} = \underbrace{\frac{-1}{I_H - I_K}}_{\textbf{Displacement Effect}} + \underbrace{\frac{\partial \ln Y/M}{\partial I_K}}_{\textbf{Productivity Effect}}$$

Two offsetting forces at work

1. Task displacement – Technology displaces workers from a subset of tasks, lowers labor share
2. Productivity effect — Technology increases output, thereby raises wages

Net effect — Depends on which dominates

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How labor-replacing technologies affect inequality

Example: Routine Task Replacing technology

- Capital that out-competes M in a subset of tasks i' in the interval $I_L < i' < I_H$
- Own wage effects
  - Immediately lowers relative wage of M by narrowing set of M tasks

  $\rightarrow$ **Can explain job and wage polarization**
- Cross-price effects on w_L and w_H?
  - Depend on $\left|\beta_L'(I_L)\, I_L\right| \gtreqless \left|\beta_H'(I_H)(1-I_H)\right|$

    where $\beta_H(I) \equiv \ln \alpha_M(I) - \ln \alpha_H(I)$, $\beta_L(I) \equiv \ln \alpha_L(I) - \ln \alpha_M(I)$
  - If M workers better suited to L than H tasks, then w_H/w_L rises

Routine task replacing technology

Focal case

- Task replacing technology concentrated in middle-skill/routine tasks
- Strong comparative advantage of H relative to L at respective margins with M

Leads to wage and employment 'polarization'

1. Wages:
   - Middle wages fall relative to top and bottom.
   - Top rises relative to bottom
2. Employment:
   - Middle-skill/routine tasks mechanized
   - Declining labor input in Routine tasks
   - Given comparative advantage, middle-skill workers move disproportionately downward in task distribution.

Ricardian Model: Summary

Model's inputs

1. Explicit distinction between *skills* and *tasks*
2. *Comparative advantage* among workers in different tasks
3. Multiple sources of competing task 'supplies'

What the model delivers

- A natural concept of occupations (bundles of tasks)
- An endogenous mapping from skill to tasks via comparative advantage
- Technical change (offshoring) that can raise and *lower* wages
- Migration of skills across tasks as technology changes
- Polarization of wages and employment as *one possible outcome*

Task-biased technological change

Autor, Levy and Murnane (2003), "The Skill Content of Recent Technological Change: An Empirical Exploration", Quarterly Journal of Economics

Autor, Levy and Murnane distinguish:

1. Routine tasks
   Typically middle-income
2. Non-routine cognitive tasks
   Typically high-income
3. Non-routine manual tasks
   Typically low-income

Task-biased technological change

Main hypothesis:

- The introduction of computers and other forms of automation replace routine tasks
- Routine-task intensive occupations tend to be in the middle of the wage distribution (Goos and Manning, 2007; Autor and Dorn 2013)
- Implies job and wage polarization

Related empirical literatures:

- Computerization and Robotization, Trade, Offshoring, ...

Autor and Dorn (2013)

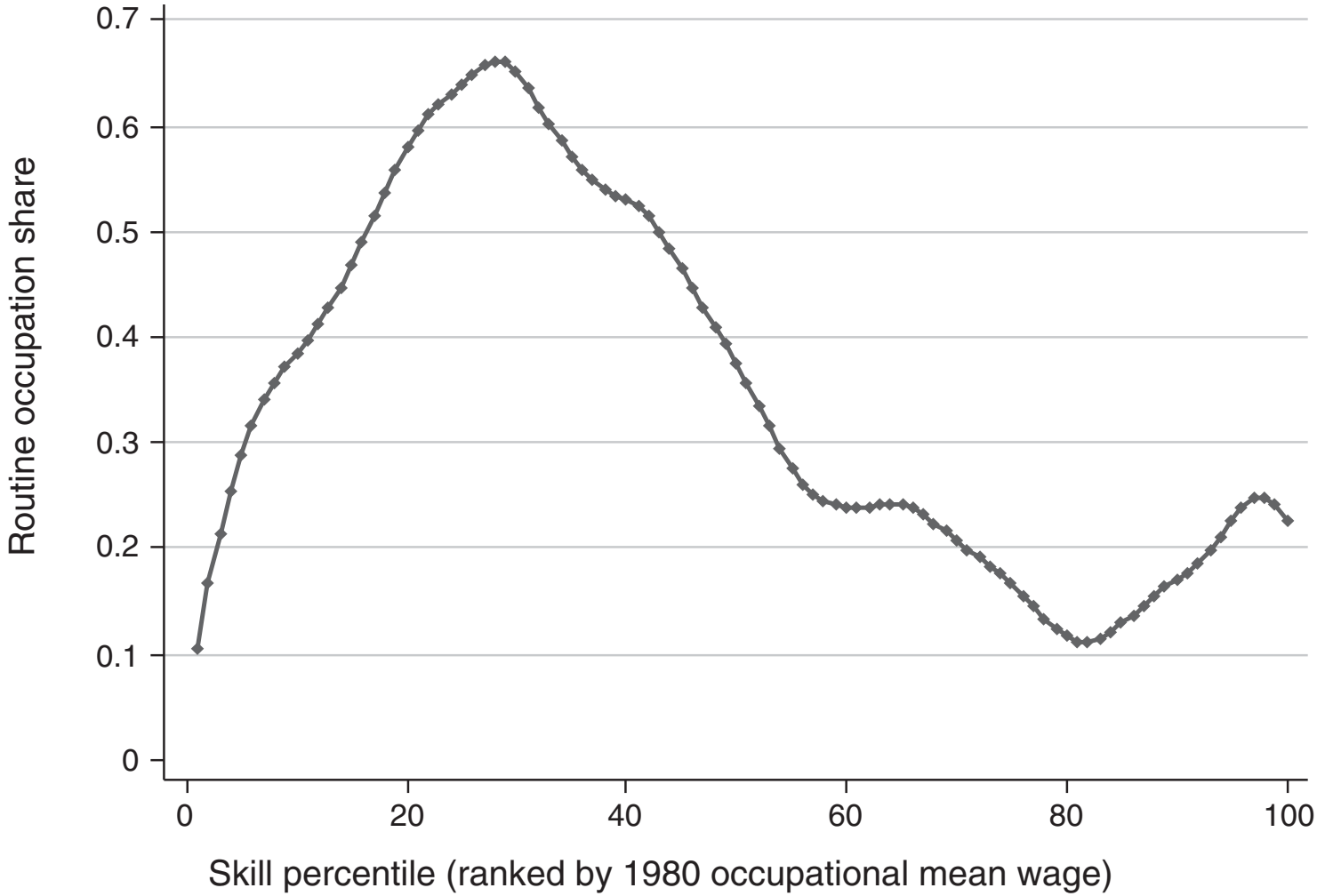

FIGURE 4. SHARE OF ROUTINE OCCUPATIONS BY OCCUPATIONAL SKILL PERCENTILE

Other contributions

Beaudry, Green, and Sand (2014) on life-cycle effects of recent college graduates:

- Argue that in the US, demand for cognitive-task intensive occupations declined after 2000
- Study if cohorts with lower initial share in cognitive tasks (post-2000) eventually reach similar higher share as earlier cohorts.

Martinez (2019) on transitional and life-cycle effects of job polarization:

- Job polarization has different impact across cohorts, as young workers respond more strongly to demand effects
- Interacts with returns to experience $\rightarrow$ suggests that job polarization has larger impact in transition than in long run

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More inequality

We briefly cover two other forms of inequality:

1. Top income shares
2. Wealth inequality
3. Assignment and "superstar" models

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Tasks and Technological Change

A Task Model with Comparative Advantage

- Setup + three equilibrium conditions
- Inequality implications: Comparative statics

Task Displacement, Productivity, and Real & Relative Wages

- Real wage levels and technological change
- Labor replacing technologies and inequality

More Inequality

- Top incomes and "superstars"
- Wealth inequality

Top incomes in history

Why focus specifically on top incomes?

Large share of income held by top earners, and mechanisms might be different:

- For labor income: Skill demand and supply, labor market institutions, assignment and superstar models, ...
- For capital income: Capital accumulation, credit constraints, inheritance law and taxation, ...

See Atkinson, Piketty, and Saez (2011) and Alvaredo, Atkinson, Piketty, and Saez (2013). APS-11:

> *While we agree that [the literature on wage inequality] offers important insights about the premium to college education (see, for example, Acemoglu 2002 and Katz and Autor 1999), we do not feel that it has a great deal to say about what is happening at the very top of the earnings distribution because dramatic changes have taken place within the top decile of the earnings distribution, i.e., within college educated workers.*

Top incomes in history

Severe data limitations:

- Survey data? Very few top earners ($\rightarrow$ Imputation)
- e.g. tax data unreliable because of tax avoidance; only gross incomes before tax; etc
- definition of income varies across countries and over time

Some researchers have worked on these measurement problems for a long time...

Top incomes in history

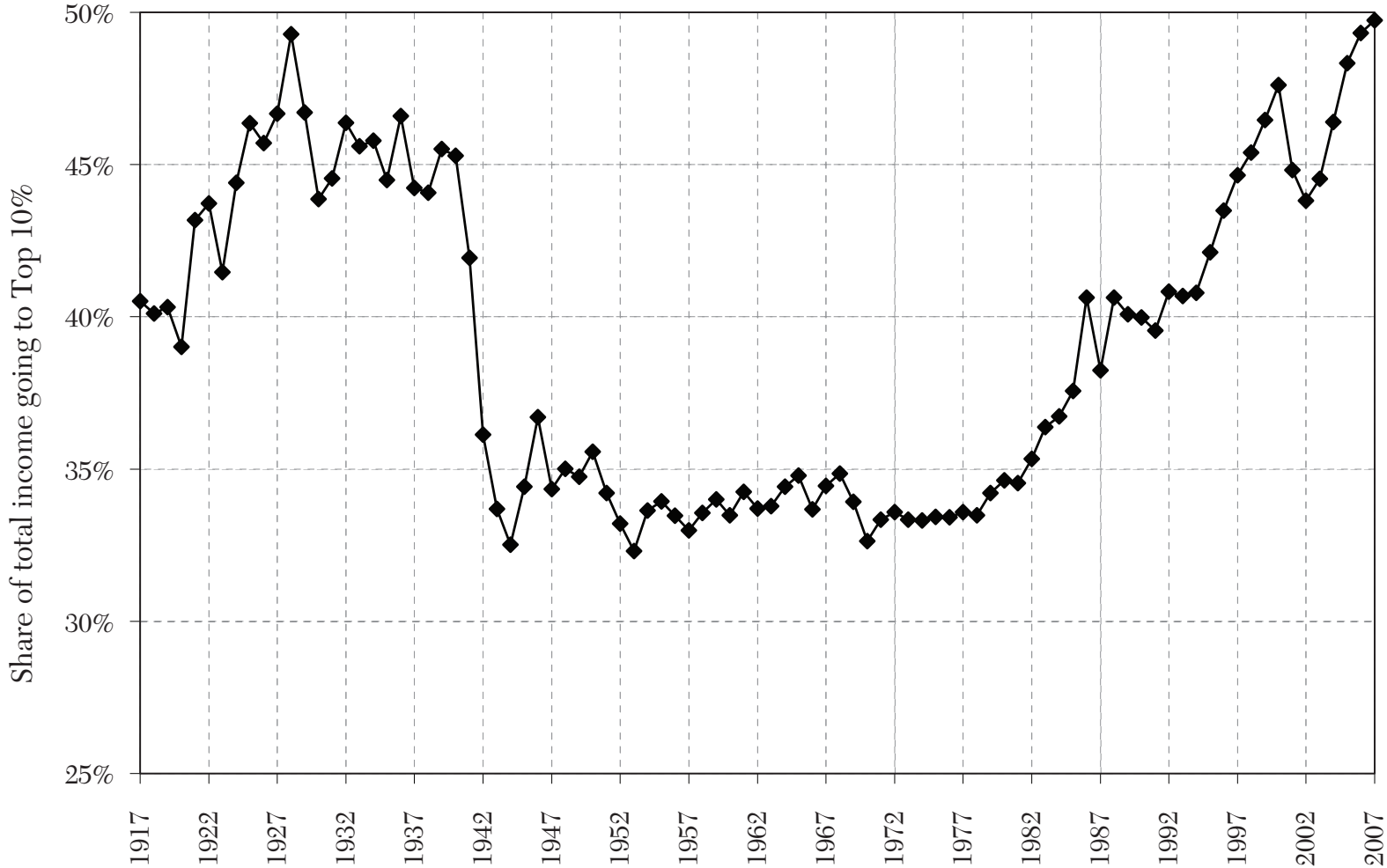


Figure 1. The Top Decile Income Share in the United States, 1917–2007.

Top incomes in history

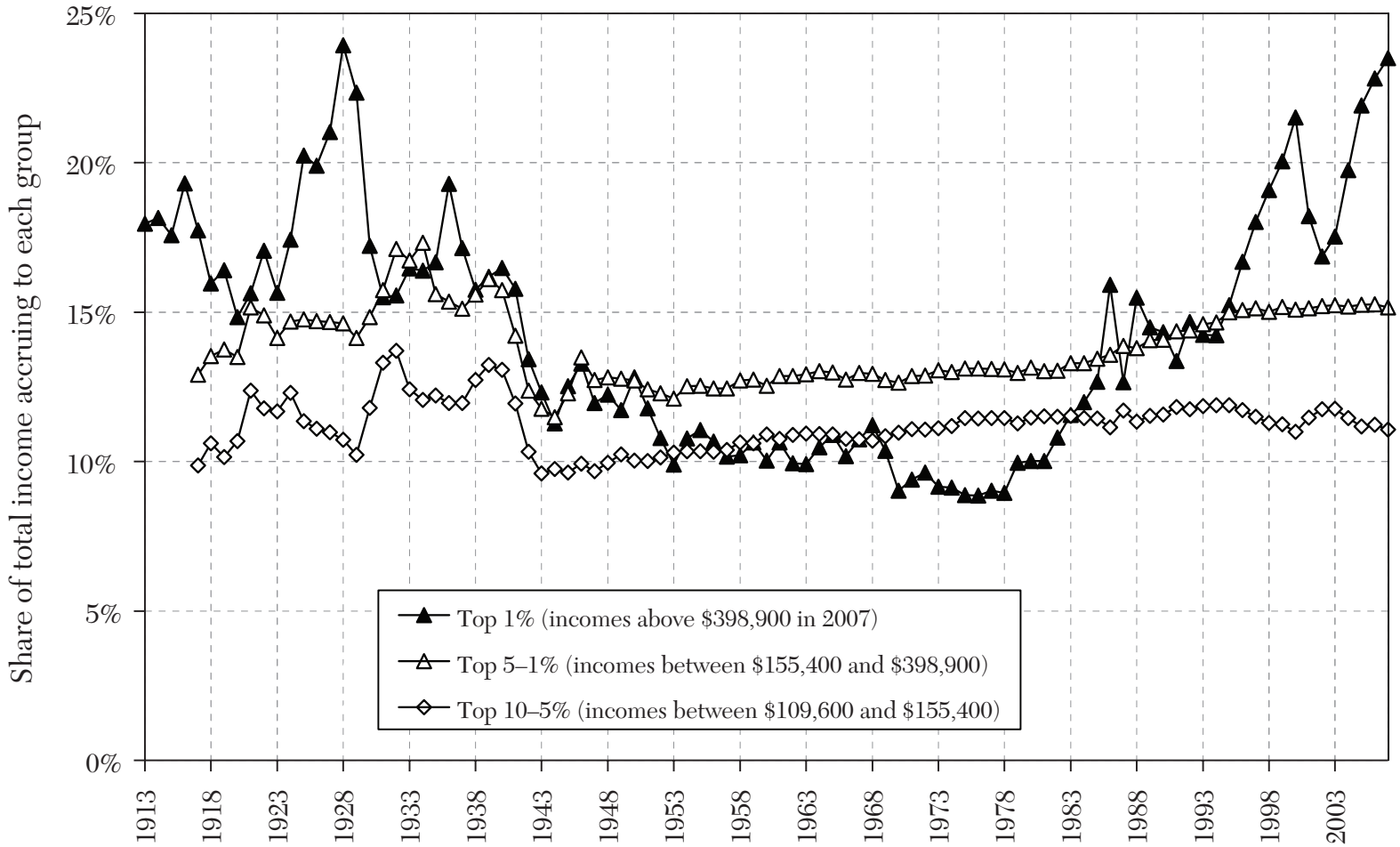


Figure 2. Decomposing the Top Decile US Income Share into three Groups, 1913–2007

Top incomes in history

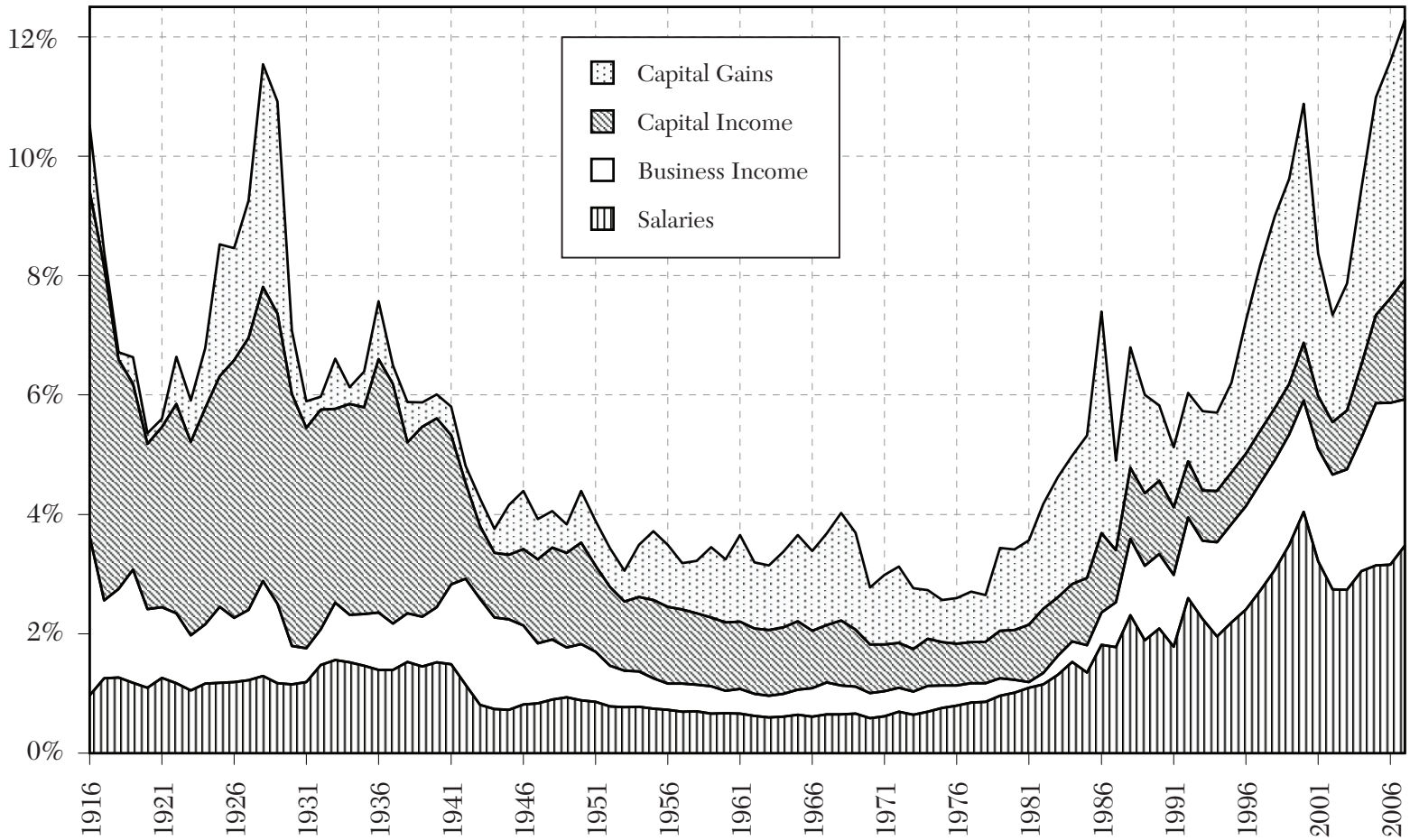


Figure 3. The Top 0.1 Percent Income Share and Composition, 1916–2007

Top incomes in history

TABLE 1
Top Percentile Share and Average Income Growth in the United States

	Average income real annual growth (1)	Top 1% incomes real annual growth (2)	Bottom 99% incomes real annual growth (3)	Fraction of total growth captured by top 1% (4)
Period				
1976–2007	1.2%	4.4%	0.6%	58%
Clinton expansion				
1993–2000	4.0%	10.3%	2.7%	45%
Bush expansion				
2002–2007	3.0%	10.1%	1.3%	65%

Notes: Computations based on family market income including realized capital gains (before individual taxes). Incomes are deflated using the Consumer Price Index (and using the CPI-U-RS before 1992). Column (4) reports the fraction of total real family income growth captured by the top 1 percent. For example, from 2002 to 2007, average real family incomes grew by 3.0 percent annually but 65 percent of that growth accrued to the top 1 percent while only 35 percent of that growth accrued to the bottom 99 percent of U.S. families.

Top incomes in history

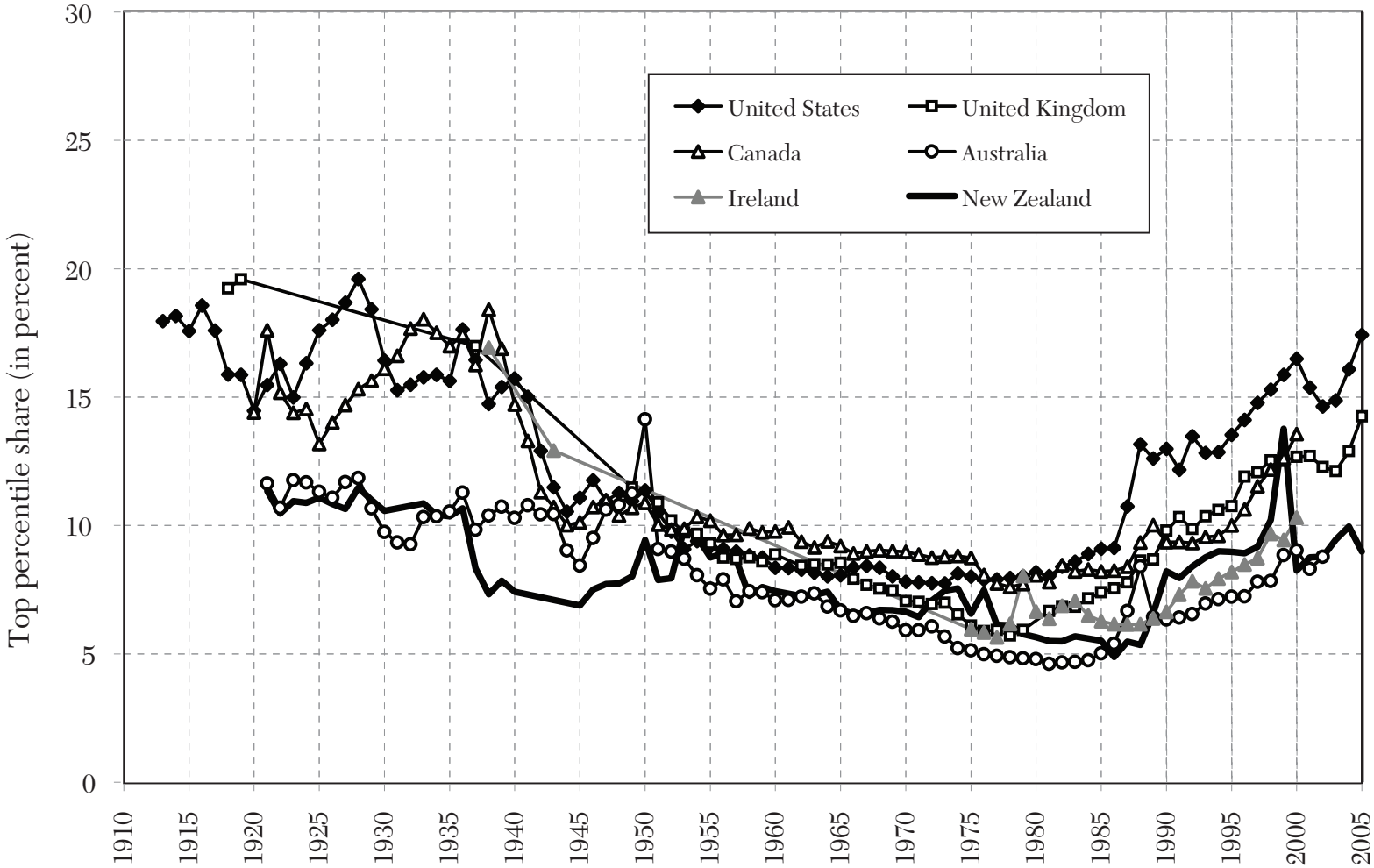


Figure 8. Top 1 Percent Share: English Speaking Countries (*U*-shaped), 1910–2005

Top incomes in history

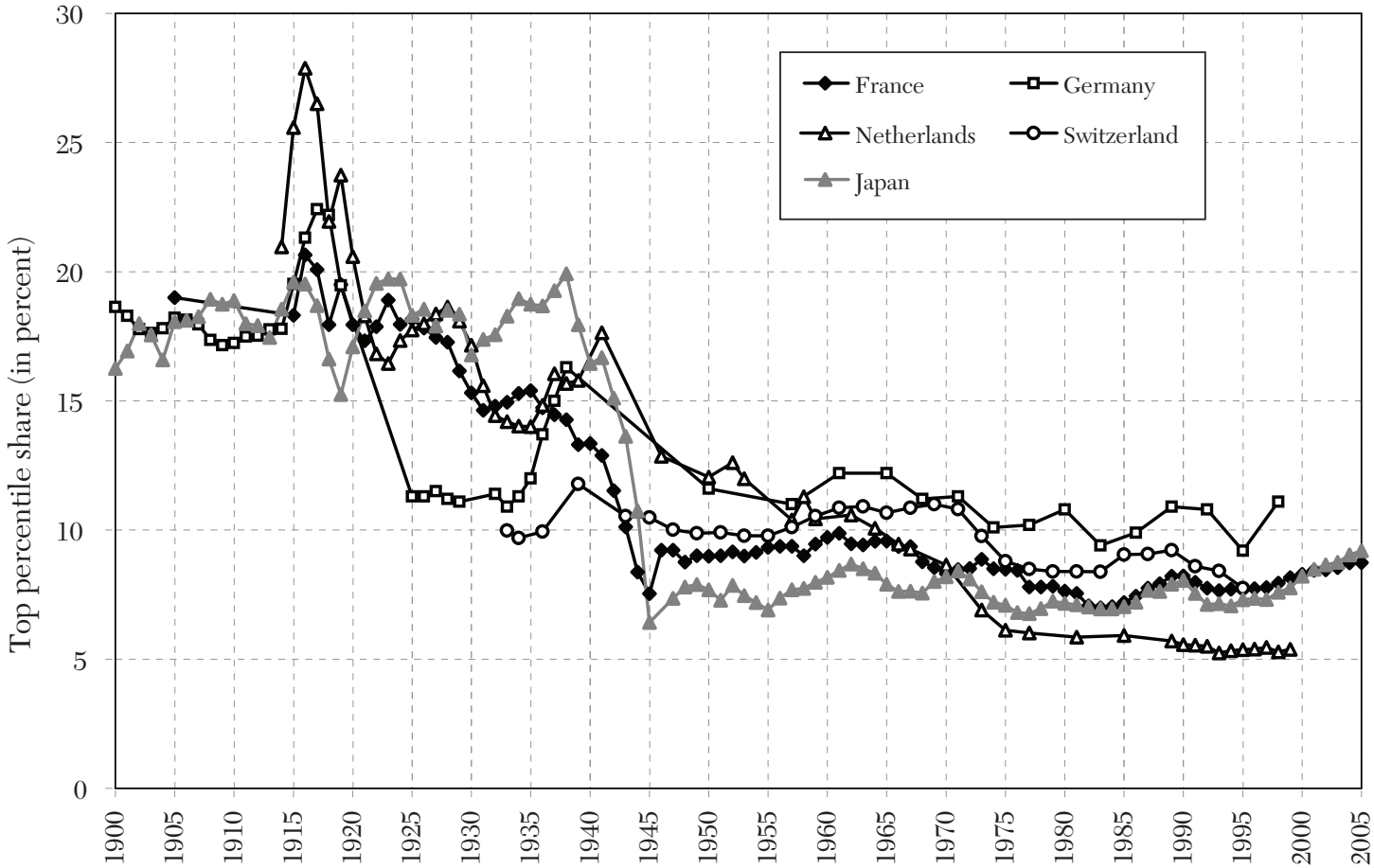


Figure 9. Top 1 Percent Share: Middle Europe and Japan (*L*-shaped), 1900–2005

Source: Atkinson and Picketty (2007, 2010).

- But, top income shares rising more recently (Bartels, 2019)?

Top incomes in history

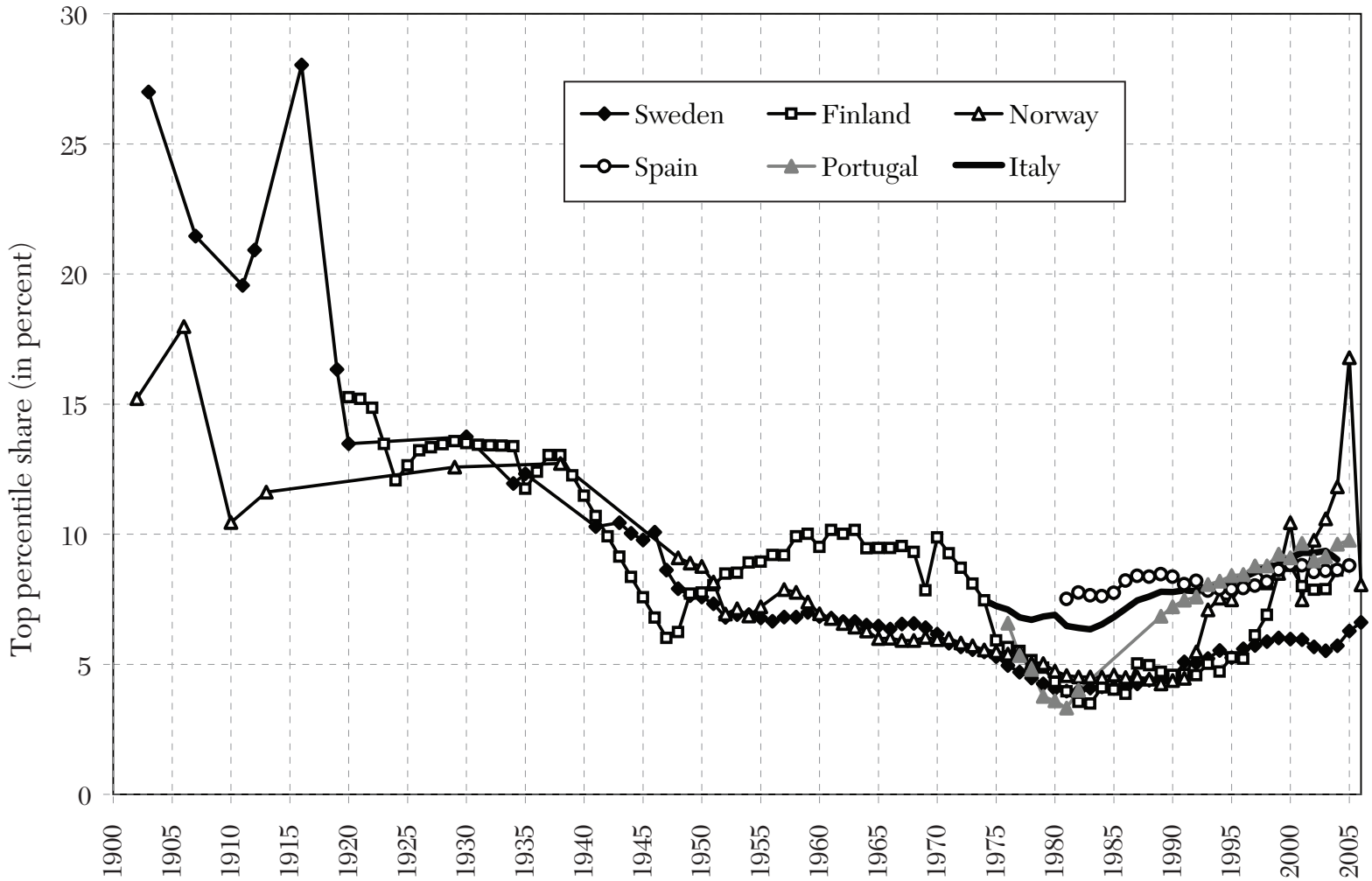


Figure 10. Top 1 Percent Share: Nordic and Southern Europe (*U*/*L*-shaped), 1900–2006

Source: Atkinson and Picketty (2007, 2010).

Top incomes in history

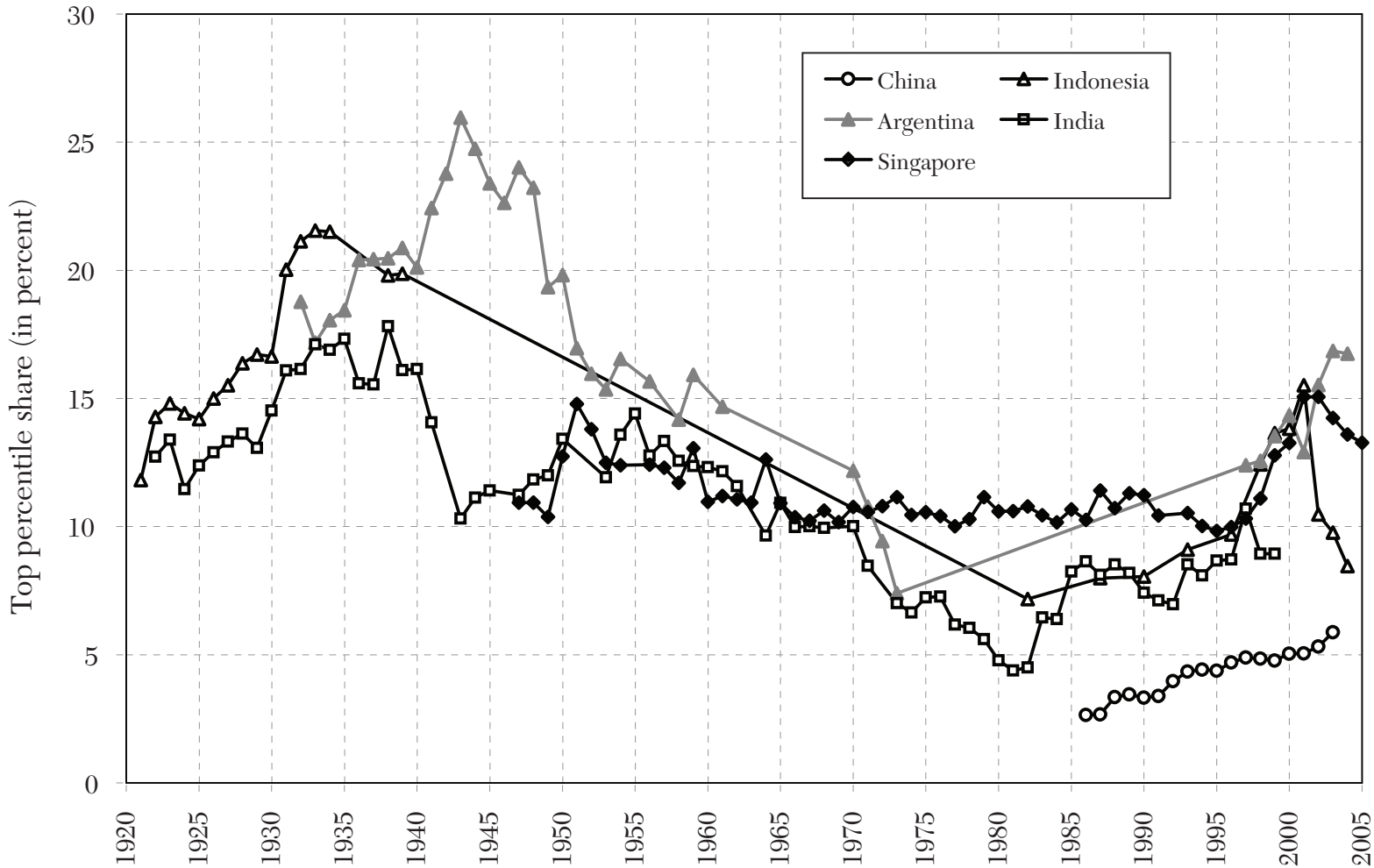


Figure 11. Top 1 Percent Share: Developing Countries, 1920–2005

Top incomes in history

Main findings in Atkinson, Piketty, and Saez (2011):

- In early 20th century, top incomes mainly due to *capital* income
- Sharp drop in top income shares in first half of 20th century
  - Drop around the World Wars and Great Depression ($\rightarrow$ Destruction of capital reduces wealth concentration?)
  - More gradual for countries that stayed out of WW II
- Rebound of top income shares in recent decades
  - Substantial increase in English-speaking countries, India and China (earliest: U.S.)
  - Less increase in Southern European and Nordic countries, flat in Continental European countries, Japan
- Recently, greater share of *labor* (vs. capital) income

Top incomes: Hypotheses

Potential explanations:

1. Same as for wage inequality (SBTC, TBTC, etc)?
2. Financial liberalization (Bell and van Reenen 2010)
3. Change in norms (Atkinson et al 2011)
4. Assignment (Sattinger 75) and "Superstar" models (Rosen 81)
   - For some tasks, can't interchange quantity and quality; talented workers earn a high premium
   - Improved communication and transportation $\rightarrow$ Larger market size, expansion of firms
   - Superstar theory attributes rising top incomes to expanding market reach

"Superstars" evidence

Example: Koenig (2018), "Superstar Earners and Market Size: Evidence from the Roll-Out of TV"

Test "superstar" theory using a quasi-experiment: an expansion in market reach during roll-out of TV in mid-20th century:

- Early TV stations filmed and broadcasted locally
- Sharp increase in income concentration at top of the distribution for performing artists
- Widening income differences at the top, decline in middle-income jobs, an increase in low-paid jobs. Fall in total employment of performing artists.
- Elasticity of pay at 99th percentile to market size is 0.16

Top incomes and bargaining power

Alvaredo, Atkinson, Piketty, and Saez (2013) on worker's bargaining power:

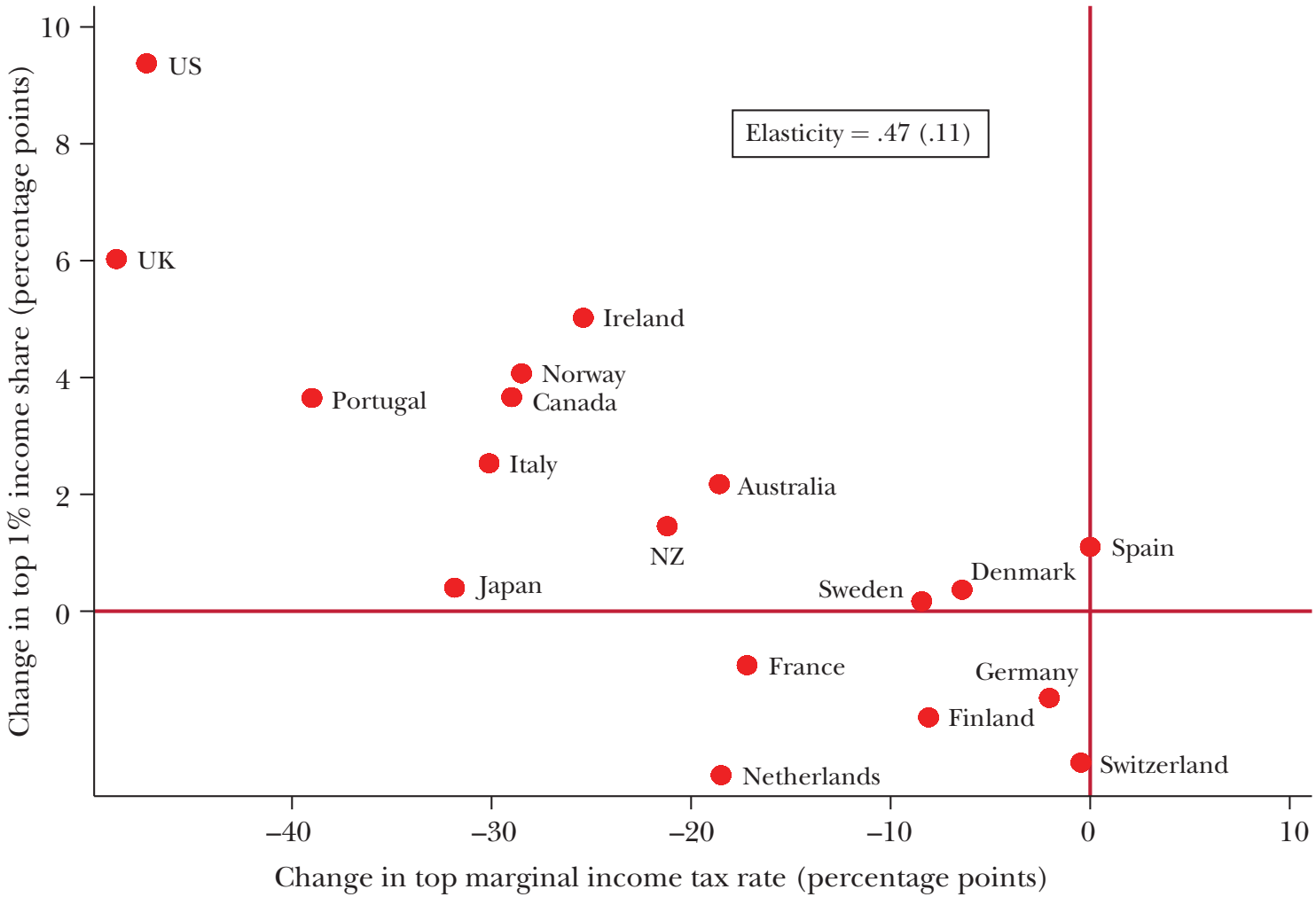
- Bargaining power of top earners and changes in tax system might interact. When top marginal tax rates are high, the net reward to bargaining for more compensation was modest. When top marginal tax rates fell, high earners started bargaining more aggressively to increase their compensation.
- Implies that cuts in tax rate for top incomes may increase top income shares

Top income shares and tax rates

Figure 4

Changes in Top Income Shares and Top Marginal Income Tax Rates since 1960

(combining both central and local government income taxes)



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Wealth inequality

Piketty and Zucman (2014), "Capital is Back: Wealth-Income Ratios in Rich Countries 1700–2010", QJE

- Q: How do wealth-income and capital-output ratios evolve in the long run, and why?
- Problem: National accounts used to be about flows, so difficult to estimate stocks

This literature requires detective work: How to value different types of capital (e.g., family-owned firm), in different data sources?

- National accounts record replacement value ($\neq$ market value)
- Wealth tax data often record cadastral value ($<$ market value)
- Survey data rely on respondents' estimate of market value

Wealth inequality: Piketty and Zucman (2014)

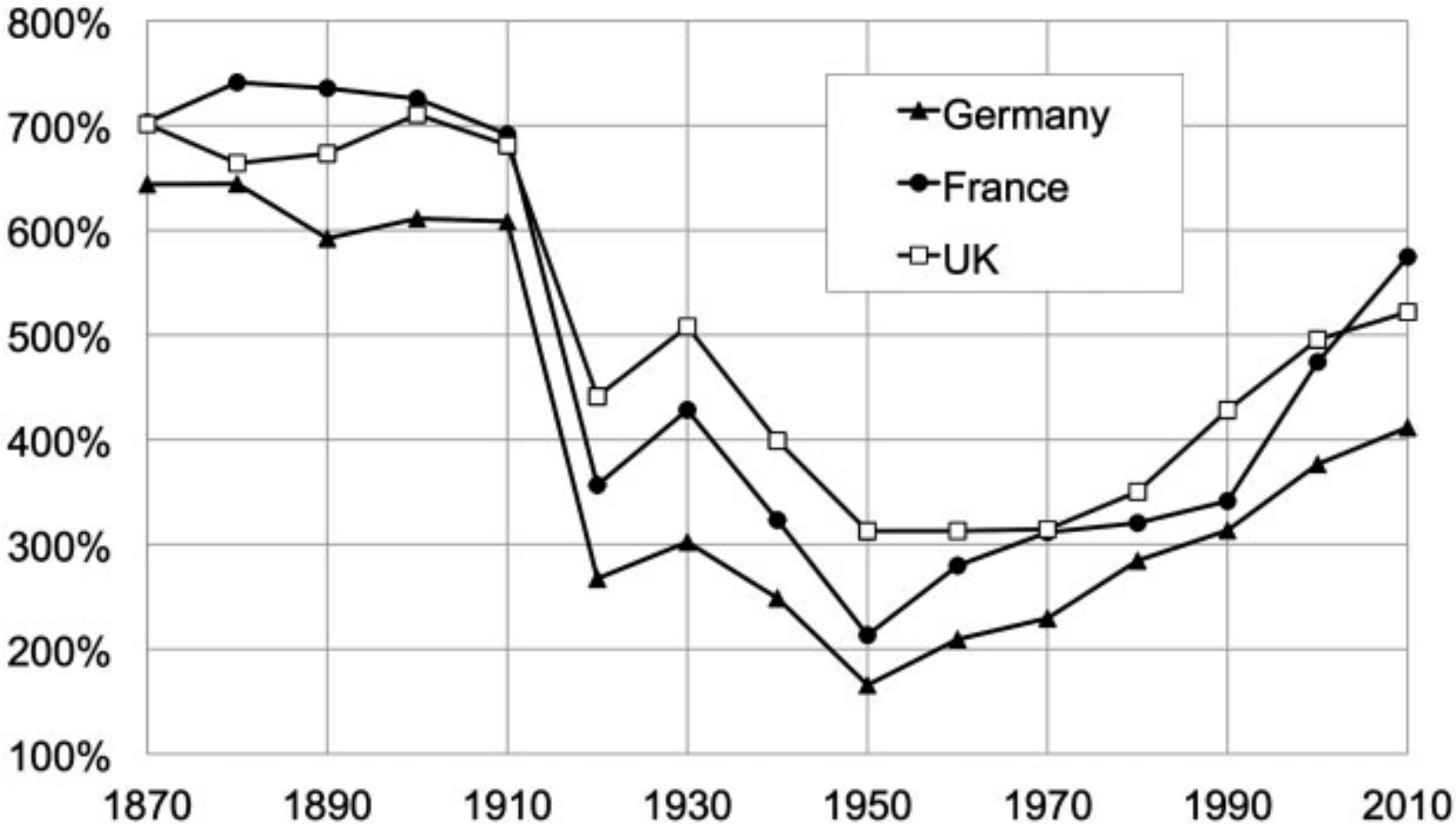
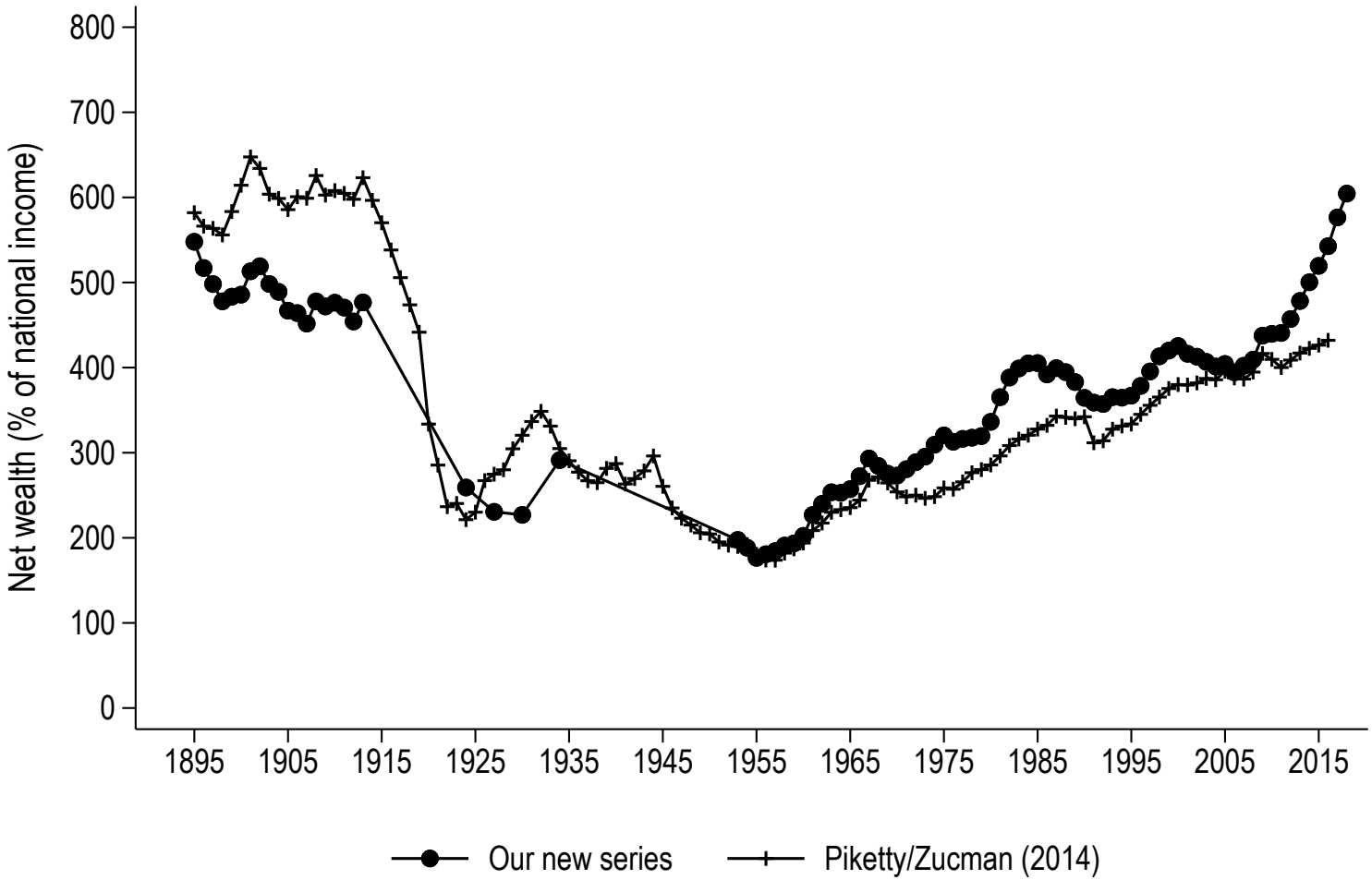


FIGURE II

Private Wealth-National Income Ratios in Europe, 1870–2010

→ See other graphs in paper (e.g. Figures 5 and 6)

Wealth inequality: Albers, Bartels and Schularick (2021)



→ Study impact of different historical episodes (including WWI, Great depression, WWII, reunification) on wealth concentration

Wealth inequality

Main findings from Piketty and Zucman (2014):

- Aggregate wealth has risen from about 200-300% of national income in 1970 to 400-600% today (in every country)
- Ratios appear to return to the high values observed in Europe in the eighteenth and nineteenth centuries (600–700%)
- Low ratios in postwar decades were a historical anomaly?

Explanations?

- Long-run asset price recovery (itself driven by changes in capital policies since the world wars) and slowdown in productivity and population growth
- "*Capital is back because low growth is back*" ($\rightarrow$ the $\beta = \frac{s}{g}$ formula and Piketty's "Capital in the 21st century")

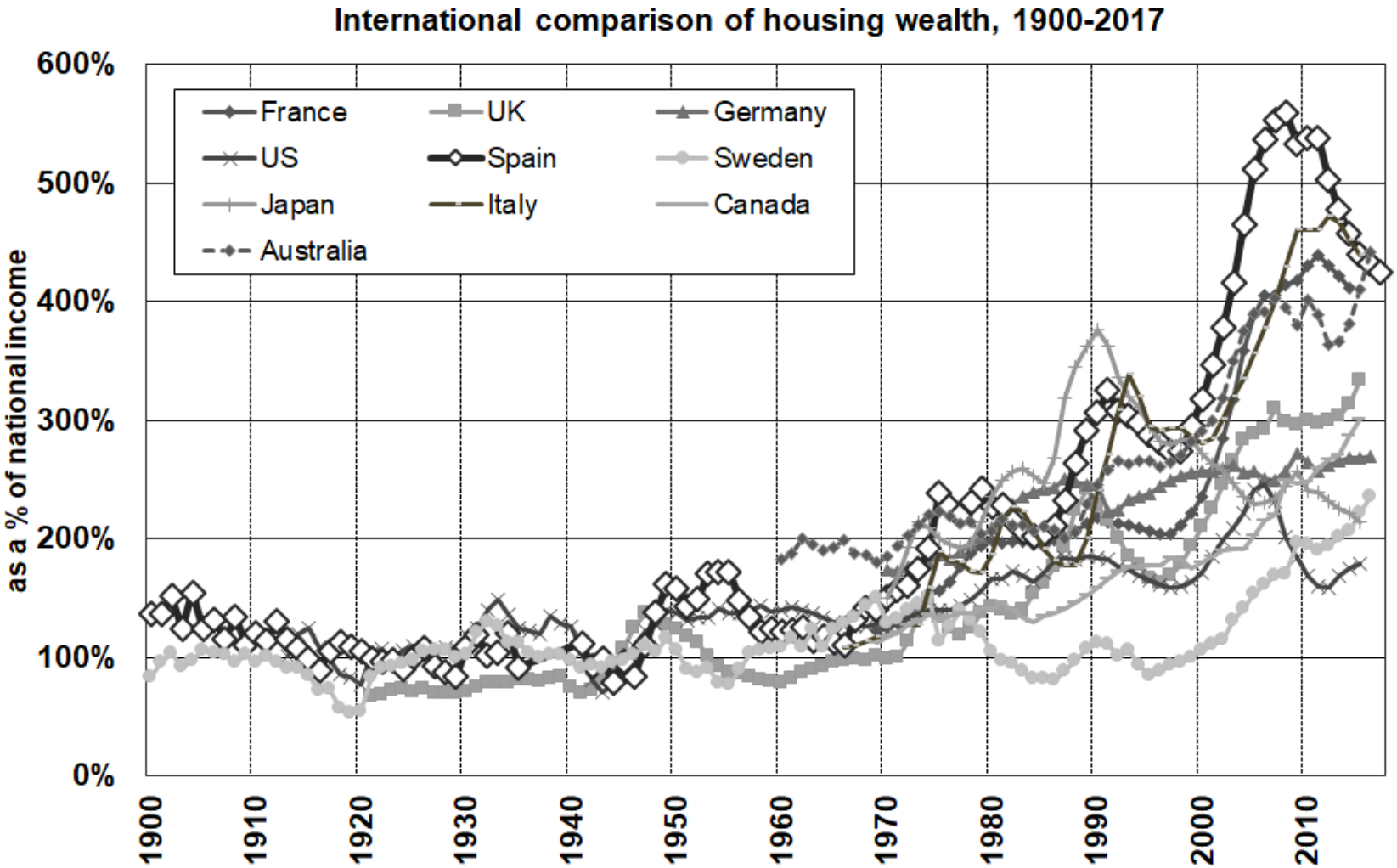
Wealth inequality

PZ-14 on production functions and rise in capital shares:

> *In the eighteenth and early nineteenth century, capital was mostly land, so that there was limited scope for substituting labor to capital. In the twentieth and twenty-first centuries, by contrast, capital takes many forms, to an extent such that the elasticity of substitution between labor and capital might well be larger than 1.*
>
> *With an elasticity even moderately larger than 1, rising capital-output ratios can generate substantial increases in capital shares, similar to those that have occurred in rich countries since the 1970s.*

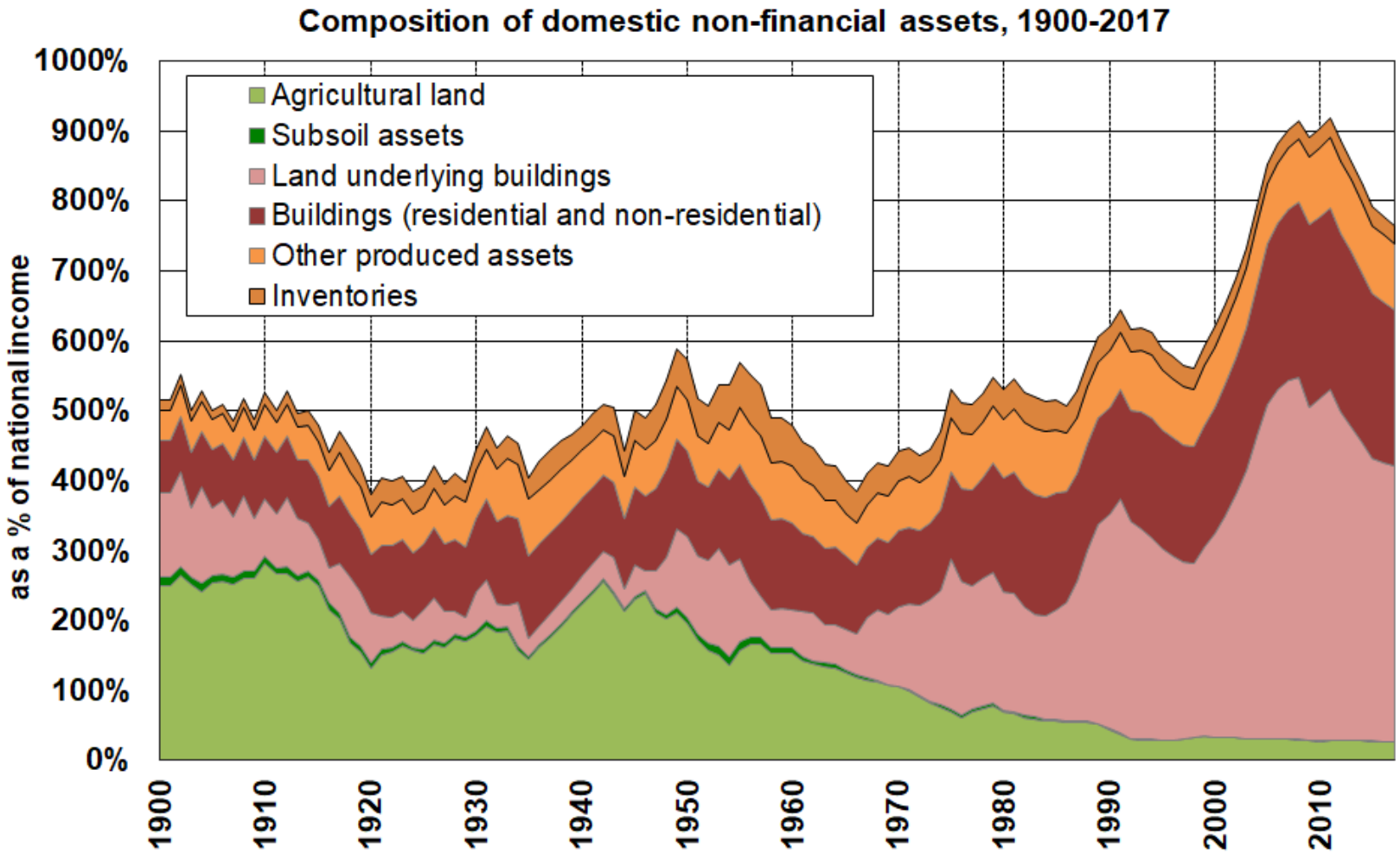
And on spot

Artola, Bauluz and Martínez-Toledano (2019)



(b) International comparison of housing wealth, 1900-2017

Artola, Bauluz and Martínez-Toledano (2019)



(b) Composition of domestic nonfinancial assets, 1900-2017

Readings

Interesting readings on automatization and (future) inequality:

- Autor (2015), "Why Are There Still So Many Jobs? The History and Future of Workplace Automation", *Journal of Economic Perspectives*
- Acemoglu and Restrepo (2019), "Automation and New Tasks: How Technology Displaces and Reinstates Labor", *Journal of Economic Perspectives*
- Acemoglu and Restrepo (2020), "Robots and Jobs: Evidence from US Labor Markets", *Journal of Political Economy*
- Caselli, and Manning (2019), "Robot Arithmetic: New Technology and Wages." *American Economic Review: Insights*

Appendix

Wealth inequality and bubbles

back On bubbles:

> *"According to our computations, the wealth-income ratio reached 700% at the peak of the Japanese bubble of the late 1980s, and 800% in Spain in 2008–2009. Housing and financial bubbles are potentially more devastating when the total stock of wealth amounts to six to eight years of national income rather than two to three years only."*

and

> *"In Japan and Spain, most observers had noticed that asset price indexes were rising fast. But in the absence of well-defined reference points, it is always difficult for policy makers to determine when such evolutions have gone too far and whether they should act."*