technische universität
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Lecture 6a:
Wage Inequality

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Empirical Economics

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Introduction

- As we discussed previously, wages account for 60–70% of GDP (factor shares) in the long run. Therefore, countries with high GDP also have high average wages. In the long term, GDP growth determines average wages.
- However, it also very important how unequally income is distributed. In the following, we will discuss fundamental facts and determinants related to this.

Agenda

I. Facts on (labor) income inequality

II. Determinants of labor income inequality

a. Skill-biased technical change

   Acemoglu/Autor (2011): Skills, Tasks and Technologies: Implications for Employment and Earnings, Handbook of Labor Economics (4b).

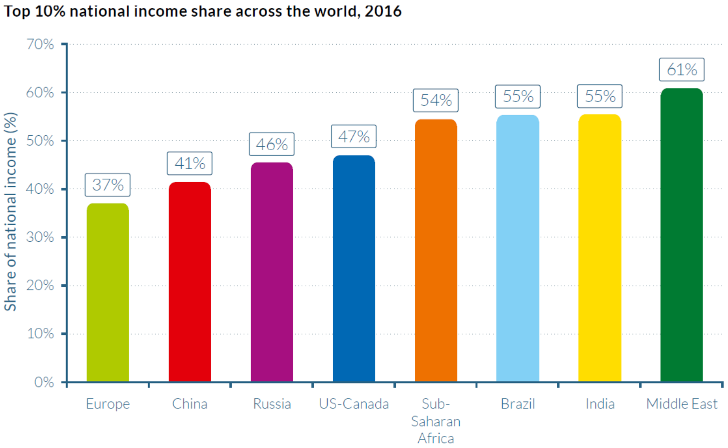
b. Employer-specific wage differentials

   Card/Kline/Heining (2013): Workplace Heterogeneity And The Rise Of The West German Wage Inequality, QJE.

c. *Domestic outsourcing*

   Goldschmidt/Schmieder (2017): The Rise of Domestic Outsourcing and the Evolution of the German Wage Structure, QJE.

Inequality from a global perspective

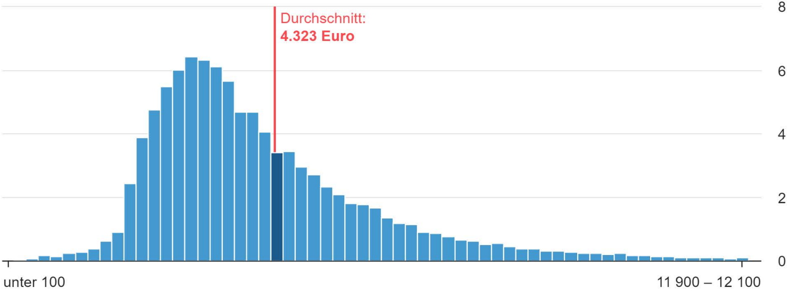


Source: World Inequality Report (2018), World Inequality Lab.

Income is widely distributed within Germany

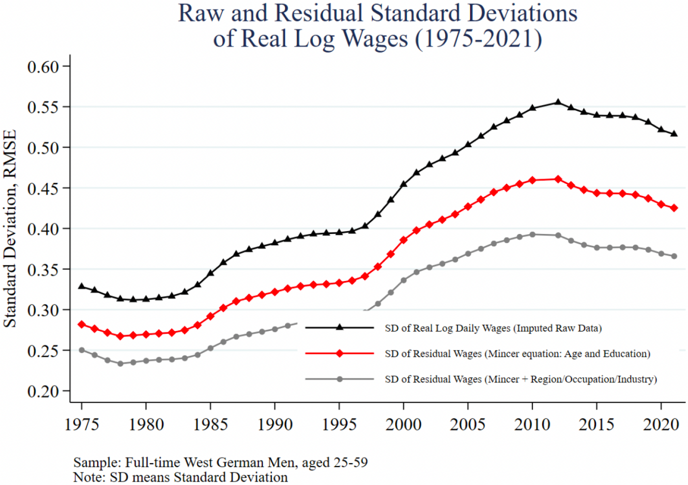
Verteilung der Bruttomonatsverdienste von Vollzeitbeschäftigten im April 2023

Bruttomonatsverdienste in Schritten à 200 EUR von ... bis unter ... , relative Häufigkeit in %



Durchschnittlicher Bruttomonatsverdienst 4.323 EUR. Rundungsbedingte Abweichung möglich.

Rising German wage inequality, 1980s–2010



- Similar increase in other countries (and even stronger in US)

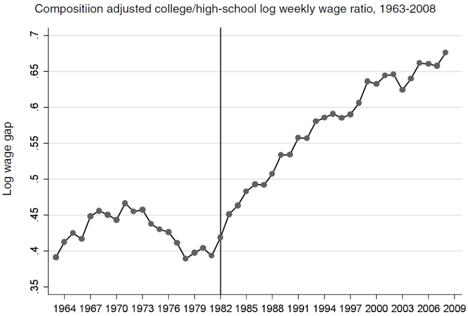
Causes of inequality: Skill-biased technical change

Tinbergen (1974):

- Skill-biased technical change exceedingly $\uparrow$ the demand for skilled labor
- Additional demand for skills to raise relative wages of skilled workers

Causes of inequality: Skill-biased technical change

The “returns to skills in the US” (1964–2009)



Source: Acemoglu/Autor (2011): Skills, Tasks and Technologies: Implications for Employment and Earnings.

Causes of inequality: Skill-biased technical change

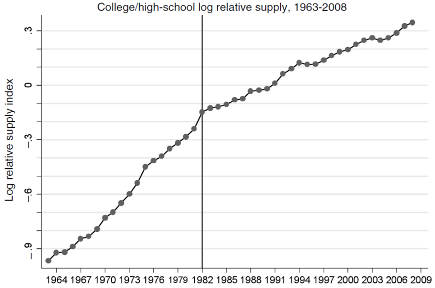
Key insights:

- Wage premium for college graduates increased substantially over time
- Non-monotone increase → wage premium declines during 1971–78

Causes of inequality: Skill-biased technical change

↑ in skill premium along with increase of college-educated workers

- Given supply and demand framework: increase of wage premium even more remarkable



Source: Acemoglu/Autor (2011): Skills, Tasks and Technologies: Implications for Employment and Earnings.

Causes of inequality: Skill-biased technical change

Tinbergen (1974) and Katz & Murphy (1992):

- Returns to skills determined by a *race* between the supply of skills and skill-biased technical change raising the demand for skilled labor

Skill-biased technical change: The canonical model

The model's set-up:

- Environment with low and high skill workers
- Both types of workers as imperfect substitutes in production
- Within worker groups, individuals differ in productivity:

  Low-skilled worker $i \in \mathcal{L}$ supplies l_i *efficiency units* of low-skilled labor

  High-skilled worker $i \in \mathcal{H}$ supplies h_i *efficiency units* of high-skilled labor
- Workers supply their efficiency units inelastically
- Total labor supply

  $L = \int_{i \in \mathcal{L}} l_i d_i$ and $H = \int_{i \in \mathcal{H}} h_i d_i$

Skill-biased technical change: The canonical model

Output Y produced by means of a CES production function:

$$Y = \left[(A_L L)^{\frac{\sigma-1}{\sigma}} + (A_H H)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

- $\sigma \in [0, \infty)$: elasticity of substitution between low and high skill labor
- A_L/A_H: factor-augmenting technologies increasing productivity of certain skill

$\rightarrow$ model does not explicitly allow for “skill-replacing” technologies

$\downarrow$

Key message: Effect of skill-biased technical change ($d(A_H/A_L) > 0$) on the wage premium of skilled workers to depend on sign and size of σ.

Skill-biased technical change: The canonical model

Competitive market: wage per efficiency unit = marginal product of labor

$$w_L = \frac{dY}{dL} = A_L^{\frac{\sigma-1}{\sigma}} \left[A_L^{\frac{\sigma-1}{\sigma}} + A_H^{\frac{\sigma-1}{\sigma}} (H/L)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{1}{\sigma-1}}$$

$$w_H = \frac{dY}{dH} = A_H^{\frac{\sigma-1}{\sigma}} \left[A_L^{\frac{\sigma-1}{\sigma}} (H/L)^{\frac{-\sigma-1}{\sigma}} + A_H^{\frac{\sigma-1}{\sigma}} \right]^{\frac{1}{\sigma-1}}.$$

Using these expressions, it follows that

- $\frac{dw_L}{d(H/L)} > 0$: due to imperfect substitution between H and L workers
- $\frac{dw_H}{d(H/L)} < 0$: the more abundant a group of workers, the lower its wage
- $\frac{dw_L}{dA_L} > 0; \frac{dw_L}{dA_H} > 0$: either kind of factor-augmenting technical change $\uparrow w_L$
- $\frac{dw_H}{dA_H} > 0$; $\frac{dw_H}{dA_L} > 0$: either kind of factor-augmenting technical change $\uparrow w_H$

Skill-biased technical change: The canonical model

Given our description of wage rates per efficiency unit, write skill premium as

$$\omega = \frac{w_H}{w_L} = \left(\frac{A_H}{A_L}\right)^{\frac{\sigma-1}{\sigma}} \left(\frac{H}{L}\right)^{-\frac{1}{\sigma}},$$

or in logs as

$$\ln \omega = \frac{\sigma - 1}{\sigma} \ln \left(\frac{A_H}{A_L}\right) - \frac{1}{\sigma} \ln \left(\frac{H}{L}\right).$$

$\rightarrow$ Log-linear relationship between the skill premium and the two forces of Tinbergen's race (skill-biased technical change & the rel. supply of skills)

Skill-biased technical change: The canonical model

Comparative statics:

1. Holding $\frac{A_H}{A_L}$ constant, how does an increase in $\frac{H}{L}$ affect ω?

$$\frac{d\ln\omega}{d\ln(H/L)} = -\frac{1}{\sigma};\ \text{strength of effect subject to size of } \sigma$$

2. Holding $\frac{H}{L}$ constant, how does an increase in $\frac{A_H}{A_L}$ affect ω?

$$\frac{d\ln\omega}{d\ln(A_H/A_L)} = \frac{\sigma-1}{\sigma};\ \text{direction of effect subject to sign and size of } \sigma$$

$\rightarrow$ Are L and H substitutes ($\sigma > 1$) or complements ($\sigma < 1$)?

Skill-biased technical change: The canonical model

Empirical evidence: L and H as substitutes in production; $\sigma = [1.5; 2]$

1. For $\sigma > 1$, $\frac{d \ln \omega}{d \ln(H/L)} = -\frac{1}{\sigma} < 0$:

- If $\frac{A_H}{A_L}$ stayed constant, a relative increase in H would reduce ω

2. For $\sigma > 1$, $\frac{d \ln \omega}{d \ln(A_H/A_L)} = \frac{\sigma - 1}{\sigma} > 0$

- If $\frac{H}{L}$ stayed constant, a relative increase in A_H would increase ω

$\rightarrow$ Given the observed increase in ω, skill biased technical change has outpaced rising educational attainment in recent decades.

Skill-biased technical change: The canonical model

The key equation of the canonical model: $\omega = \frac{\sigma-1}{\sigma} \ln\left(\frac{A_H}{A_L}\right) - \frac{1}{\sigma} \ln\left(\frac{H}{L}\right)$

- links the skill premium to the relative supply of skills & technological change
- In reality, former term not observable

To derive estimable model, $\frac{A_H}{A_L}$ assumed to grow linearly over time:

$$\ln\left(\frac{A_{H,t}}{A_{L,t}}\right) = \gamma_0 + \gamma_1 t$$

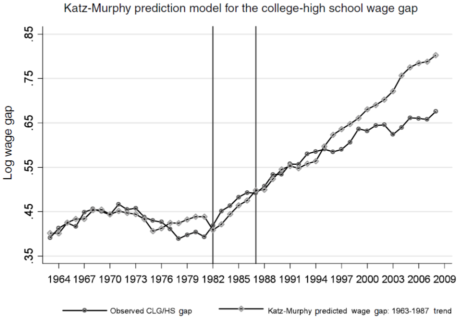
$$\ln \omega_t = \frac{\sigma-1}{\sigma}\gamma_0 + \frac{\sigma-1}{\sigma}\gamma_1 t - \frac{1}{\sigma} \ln\left(\frac{H_t}{L_t}\right)$$

$\rightarrow \omega$ changes if the growth rate of skills differs from the pace of $\frac{A_H}{A_L}$

Skill-biased technical change: The canonical model

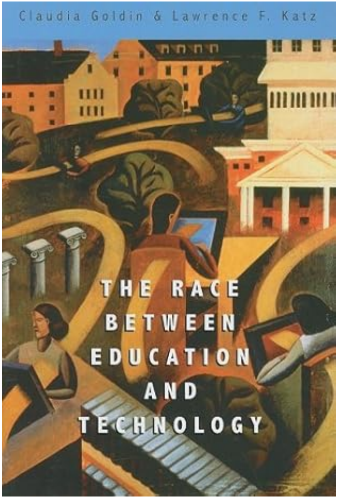
An empirical test of the canonical model (Katz & Murphy)

- Using time-series data for the college wage premium in the US



- Model's predictions close to actual evolution b/w 1960s and early 90s
- From mid-1990s onwards, model has less predictive power

Understanding the rising value of education

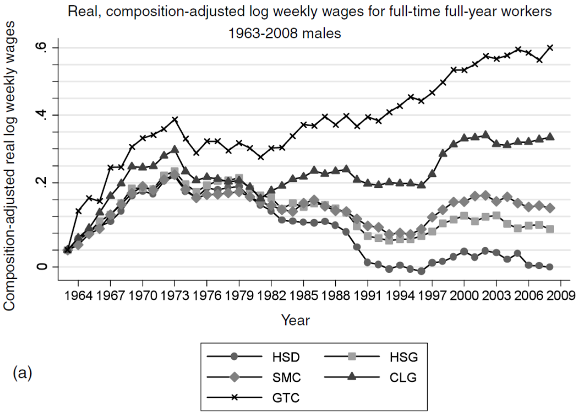


- Claudia Goldin (Nobel Prize 2023) and Larry Katz refer to this as "The Race Between Education and Technology."
- Argue that the insufficient expansion of university education is responsible for part of the increase in inequality.

Goldin, Claudia, and Lawrence F. Katz. *The Race Between Education and Technology.* Harvard University Press, 2009.

Drawbacks of the canonical model

I. Model predicts technical change ($A_H > 0, A_L > 0$) to raise w_L and w_H

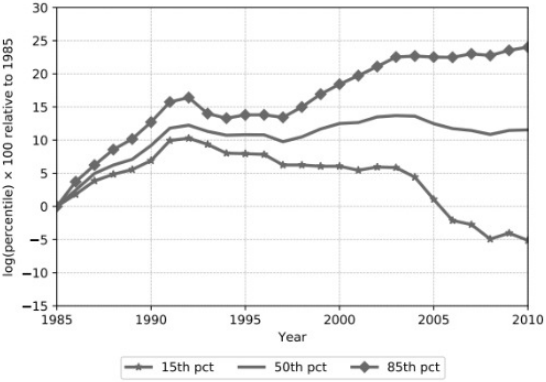


Source: Acemoglu/Autor (2011): Skills, Tasks and Technologies: Implications for Employment and Earnings.

Yet, for some workers, real wages actually declined (esp. during 1980/90s)

Drawbacks of the canonical model

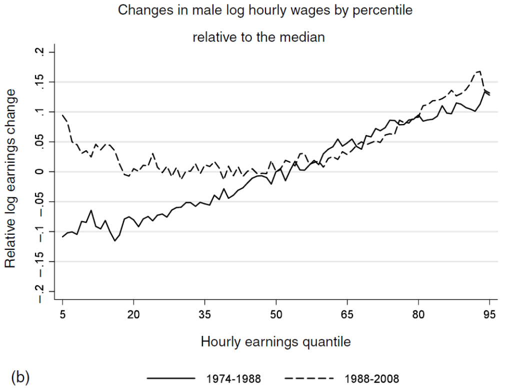
Also in Germany, inflation-adjusted wages of lower-percentile earners declined:



Source: Böhm, von Gaudecker and Schran (2024, Journal of Labor Economics) using Data from the IAB

Drawbacks of the canonical model

II. Model misses *polarization* of earnings distribution (only in US)

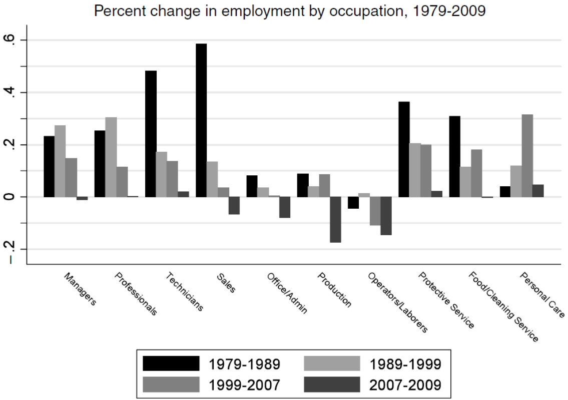


Source: Acemoglu/Autor (2011): Skills, Tasks and Technologies: Implications for Employment and Earnings.

→ 1988–2008: Low-earners with relative increases in wages compared to medium-earners

Drawbacks of the canonical model

III. Model misses key trends in *job polarization*



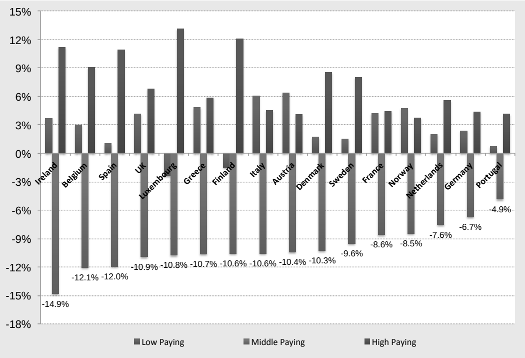
Source: Acemoglu/Autor (2011): Skills, Tasks and Technologies: Implications for Employment and Earnings.

→ Employment growth in high skill and low skill jobs at expense of medium skill jobs

Drawbacks of the canonical model

Figure: Job polarization in Europe 1993–2010

Change in Occupational Employment Shares in Low, Middle and High Wage Occupations in 16 EU Countries, 1993 - 2010



Alternative: think harder what IT revolution did

Polarization as consequence of rapid improvements in computer technologies

- Technical advances rapidly lowered the costs of automating *standardized* tasks.
- Cost reduction created incentives for substituting technology for workers
- Standardized, routine tasks are characteristic of many medium-skilled jobs
- In contrast, low and high skill jobs are usually non-routine (abstract or manual)
- Non-routine tasks require problem-solving, creativity or personal interactions

↓

Canonical model cannot distinguish skills from tasks

What are computers good at? (up to circa 2015)

- Obviously these capabilities have drastically changed with machine learning and artificial intelligence. (How) will this transform the labour market and inequality?
- But, for now, let's stick with the technology pre-AI ...

What are computers good at? (up to circa 2015)

Its not clear, that computers will always hurt the low-skilled workers. Moravec's famous paradox states that:
"...*it is comparatively easy to make computers exhibit adult level performance on intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility.*"

- Hard to invent computers or robots to be servers in a restaurant.
- Computer programs that do companies' accounts or robots on the assembly line commonplace for more than 30 years.

Points to the importance of tacit knowledge. Polanyi's paradox: "*We can know more than we can tell*".

What are computers good at? (up to circa 2015)

	Routine tasks	Nonroutine tasks
	Analytic and interactive tasks	
Examples	• Record-keeping • Calculation • Repetitive customer service (e.g., bank teller)	• Forming/testing hypotheses • Medical diagnosis • Legal writing • Persuading/selling • Managing others
Computer impact	• Substantial substitution	• Strong complementarities
	Manual tasks	
Examples	• Picking or sorting • Repetitive assembly	• Janitorial services • Truck driving
Computer impact	• Substantial substitution	• Limited opportunities for substitution or complementarity

Source: Autor, Levy, Murnane (2003): The Skill Content of Recent Technological Change: An Empirical Exploration.

Task Models

Most task models are variants of the following setup

- Tasks (occupations) are inputs into final good production.
- A given task can be done by workers of different skill levels, and sometimes by machines.
- Each worker performs the task that maximizes her wage income.
- Frictionless environment where agents are price takers.
- They switch occupations at zero cost, worker attributes are public information, there is market clearing.

The Ricardian model of the labor market

Model by Acemoglu (Nobel Prize 2024) and Autor allows clear distinction between skills & tasks

- Task: unit of work activity that produces output
- Skill: worker's endowment of capabilities to perform various tasks
- Workers apply their skills to tasks in exchange for wages
- Occupations are defined as bundles of tasks to fulfill

Distinction b/w skills & tasks becomes relevant if

- Workers of given skill may perform variety of different tasks, but cannot perfectly substitute each other
- Workers may change tasks in light of technical change/shifts in labor supply

The Ricardian model of the labor market

Cobb-Douglas production function:

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

- Y: final output good - y(i): "production level" of task i - tasks given by interval $[0, 1]$

Each task contributes to final output Y by:

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

- where indices L, M, H refer to low, medium and high skill workers
- A_L, A_M, A_H: factor-augmenting technologies
- $\alpha_L(i)$, $\alpha_M(i)$, $\alpha_H(i)$: productivity of workers in task i
- $l(i), m(i), h(i)$: number of workers allocated to task i

The Ricardian model of the labor market

Given set-up, every task may be performed by every worker type (L,M,H)

- However, there are comparative advantages of skill groups across tasks

The following structure of the comparative advantage is assumed

- $\alpha_L(i)/\alpha_M(i)$ and $\alpha_M(i)/\alpha_H(i)$ are differentiable and strictly decreasing
- Higher indices of i correspond to more complex tasks
- Comparative advantage as a function of a task's complexity

The Ricardian model of the labor market

Equilibrium:

Allocation of workers to tasks s.t. max! profits & labor markets clear:

$$\int_0^1 l(i)di \leq L, \quad \int_0^1 m(i)di \leq M, \quad \int_0^1 h(i)di \leq H$$

- Firm cannot assign, e.g., more high-skilled workers to tasks than available
- Workers supply labor inelastically

The Ricardian model (equilibrium)

Given the comparative advantage, there are threshold tasks I_L & I_H

- Tasks less complex than I_L will be performed by low skill workers
- Tasks more complex than I_H will be performed by high skill workers
- Average tasks ($I_L < i > I_H$) will be performed by medium skill workers

Threshold tasks are endogenous and respond to skill supply & technology

- I.e., tasks can be performed by different types of workers
- Firms choose allocation of tasks to skill groups (s.t. supply & technology)

The Ricardian model (equilibrium)

The law of one price

- Workers of identical skill receive the same wage irrespective of their task
- Otherwise, workers would not perform tasks yielding lower pay

Given the law of one price, wages can be expressed as

$$
\begin{aligned}
w_L &= p(i)A_L\alpha_L(i) \quad \text{for any} \quad i < I_L \\
w_M &= p(i)A_M\alpha_M(i) \quad \text{for any} \quad I_L < i < I_H \\
w_H &= p(i)A_H\alpha_H(i) \quad \text{for any} \quad i > I_H.
\end{aligned}
$$

- p(i): price of task (i)

The Ricardian model (equilibrium)

Intuition: Price difference between two tasks by same worker type has to offset productivity differential of a worker in these tasks

$$p(i)\alpha_L(i) = p(i')\alpha_L(i') = P_L \text{ for any two tasks } i, i' < I_L$$

- P_L: price index of tasks performed by low skill workers

The Ricardian model (equilibrium)

Given Cobb-Douglas function, expenditures for each task should be equal

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

Given our definition of (e.g., L-workers') productivity, this translates to

$$p(i)\alpha_L(i)l(i) = p(i')\alpha_L(i')l(i')$$

→ same number of low-skilled workers assigned to each low skill task

→ as markets clear, it follows that $l(i) = \frac{L}{I_L}$

Of course, the same is true for *M* and *H* workers, such that

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

The Ricardian model (equilibrium)

Across skill groups, expenditures per task must equal as well; e.g.:

$$p(i)A_M\alpha_M(i)m(i) = p(i')A_H\alpha_H(i')h(i')$$

Using that $p(i)\alpha_M = P_M$, $p(i)\alpha_H = P_H$, and definitions of $m(i)$ & $h(i)$:

$$\frac{P_M A_M M}{I_H - I_L} = \frac{P_H A_H H}{1 - I_H} \quad \text{or} \quad \frac{P_H}{P_M} = \left(\frac{A_H H}{1 - I_H}\right)^{-1}\left(\frac{A_M M}{I_H - I_L}\right)$$

A similar expression can be derived for $\frac{P_M}{P_L}$:

$$\frac{P_L A_L L}{I_L} = \frac{P_M A_M M}{I_H - I_L} \quad \text{or} \quad \frac{P_M}{P_L} = \left(\frac{A_M M}{I_H - I_L}\right)^{-1}\left(\frac{A_L L}{I_L}\right)$$

The Ricardian model (equilibrium)

Threshold tasks I_L and I_H of key interest in the model

- No arbitrage, by equalizing production costs for threshold tasks using different skills

I_H must be defined s.t. it can be profitably pursued by H and M workers

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

Equivalently, I_L must be profitably produced by either L or M workers:

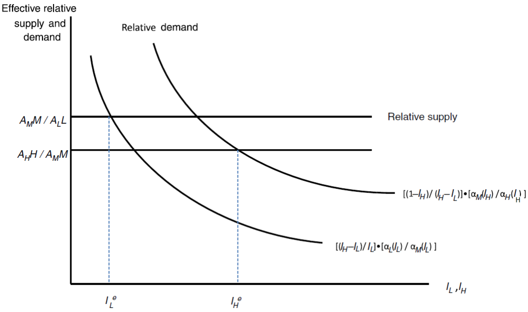
$$\frac{A_L \alpha_L(I_L) L}{I_L} = \frac{A_M \alpha_M(I_L) M}{I_H - I_L}.$$

Effective demand for and supply of tasks by re-writing above conditions

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

The Ricardian model (equilibrium)

Graph: Allocation of skills to tasks (keeping one threshold fixed)



Example: Allocation of tasks to medium vs. high skill workers

- Demand curve downward sloping as $\alpha_M(I_H)/\alpha_H(I_H)$ decreasing in I_H
- Threshold task I_H determined at intersection of demand and supply curve

The Ricardian model (equilibrium)

Given threshold tasks I_L/I_H, wage levels/differences can be derived

$$\frac{w_H}{w_M} = \frac{P_H A_H}{P_M A_M} \quad \text{or} \quad \frac{w_H}{w_M} = \left(\frac{1 - I_H}{I_H - I_L}\right)\left(\frac{H}{M}\right)^{-1}$$

or

$$\frac{w_M}{w_L} = \frac{P_M A_M}{P_L A_L} \quad \text{or} \quad \frac{w_M}{w_L} = \left(\frac{I_H - I_L}{I_L}\right)\left(\frac{M}{L}\right)^{-1}.$$

$\rightarrow$ Relative wages as a function of supply and equilibrium task assignment

$\rightarrow$ Allocation of tasks central for determining wage differential across skills

The Ricardian model (equilibrium)

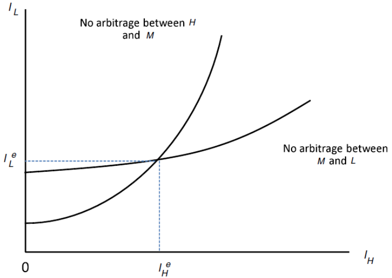
Given the full description of the environment, focus on comparative statics

Therefore, express no-arbitrage conditions in logs:

$$\ln A_M - \ln A_H + \beta_H(I_H) + \ln M - \ln H - \ln(I_H - I_L) + \ln(1 - I_H) = 0$$
$$\ln A_L - \ln A_M + \beta_L(I_L) + \ln L - \ln M - \ln(I_H - I_L) + \ln(I_L) = 0$$

- $\beta_H = \ln \alpha_M(I) - \ln \alpha_H(I)$ - $\beta_L = \ln \alpha_L(I) - \ln \alpha_M(I)$

Both curves are upward sloping in $[I_L, I_H]$ space



The Ricardian model (comparative statics)

The allocation of tasks in response to changes in technology and skills

- Totally differentiating the no-arbitrage conditions w.r.t. variable of interest
- $A_H \uparrow (H \uparrow) \rightarrow I_H \downarrow; I_L \downarrow; (I_H - I_L) \downarrow$
- $A_L \uparrow (L \uparrow) \rightarrow I_L \uparrow; I_H \uparrow; (I_H - I_L) \downarrow$
- $A_M \uparrow (M \uparrow) \rightarrow I_H \uparrow; I_L \downarrow; (I_H - I_L) \uparrow$

Example: Rise in A_H, i.e. high-skill biased technical change

- A rise in A_H makes high skill workers uniformly more productive
- Number of tasks in which H hold comparative advantage over M increases
- Consequently, tasks get shifted away from M to H workers
- If I_L remained constant, excess supply of M workers
- Therefore, *indirect effect*: reduce I_L to shift tasks from L to M
- Note: Direct effect always dominates indirect effect

The Ricardian model (comparative statics)

Changes in wages (differentials) in response to shifts in skill supplies

- $H \uparrow \rightarrow \frac{w_H}{w_L} \downarrow$ $\quad$ $L \uparrow \rightarrow \frac{w_H}{w_L} \uparrow$ $\quad$ $M \uparrow \rightarrow \frac{w_H}{w_L}?$
- $H \uparrow \rightarrow \frac{w_H}{w_M} \downarrow$ $\quad$ $L \uparrow \rightarrow \frac{w_M}{w_L} \uparrow$ $\quad$ $M \uparrow \rightarrow \frac{w_H}{w_M} \uparrow$

Example 1:

- An increase in the relative supply of H workers makes H less scarce
- Additional supply of H reduces the wage premium for the high skilled

Example 2:

- An increase in the relative supply of M raises I_H and lowers I_L $\rightarrow$ expanding set of tasks performed by M
- Wage effects for w_H and w_L in similar direction; effect unknown

The Ricardian model (comparative statics)

Changes in wages (wage differentials) in response to technical change

- $A_H \uparrow \rightarrow \frac{w_H}{w_L} \uparrow$ $\quad A_H \uparrow \rightarrow \frac{w_M}{w_L} \downarrow$ $\quad A_H \uparrow \rightarrow \frac{w_H}{w_M} \uparrow$
- $A_L \uparrow \rightarrow \frac{w_H}{w_L} \downarrow$ $\quad A_L \uparrow \rightarrow \frac{w_M}{w_L} \downarrow$ $\quad A_L \uparrow \rightarrow \frac{w_H}{w_M} \uparrow$
- $A_M \uparrow \rightarrow \frac{w_H}{w_L} ?$ $\quad A_M \uparrow \rightarrow \frac{w_M}{w_L} \uparrow$ $\quad A_M \uparrow \rightarrow \frac{w_H}{w_M} \downarrow$

Example 1:

- As in the canonical model, increase in A_H raises both $\frac{w_H}{w_L}$ and $\frac{w_H}{w_M}$

Example 2:

- Importantly, A_H unambiguously reduces $\frac{w_M}{w_L}$
- Direct effect of $\uparrow A_H$: reallocation of tasks from M to H workers
- Indirect effect: reallocation of jobs from L to M workers
- Yet, direct effect $>$ indirect effect, such that $\frac{w_M}{w_L} < 0$

The Ricardian model (task replacing technology)

Suppose now there is also capital available for production:

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

Productivity $\alpha_K(i)$ increases such over time that now $[I', I''] \in [I_L, I_H]$ profitably produced by capital.

Leads to new equilibrium with new threshold tasks $\hat{I}_L$ and $\hat{I}_H$ s.t.

- Threshold ranks: $0 < \hat{I}_L < I' < I'' < \hat{I}_H < 1$
- Skill allocations:
  - for any $i < \hat{I}_L$ we have $l(i) = L/\hat{I}_L$
  - for any $i \in (\hat{I}_L, I') \cup (I'', \hat{I}_H)$ we have $m(i) = \frac{M}{\hat{I}_H - I'' + I' - \hat{I}_L}$
  - for any $i > \hat{I}_H$ we have $h(i) = H/(1 - \hat{I}_H)$
- Relative wages: $\frac{w_H}{w_M} \uparrow$, $\frac{w_L}{w_M} \uparrow$, $\frac{w_H}{w_L}$?

The Ricardian model (task replacing technology)

In words, change in the productivity of capital leads to:

- job polarization: employment growth at the fringes of the task distribution.
- wage polarization: middle-skill workers' relative wages decline.
- effect on low- versus high-skill workers' wages ambiguous. Depends on the substitutability (comparative advantage schedules) around the thresholds: $\alpha_L(I_L)/\alpha_M(I_L)$ versus $\alpha_M(I_H)/\alpha_H(I_H)$

Rising inequality in the data suggests:

- Suggests low-skill workers closer substitutes to middle-skilled at the low threshold. Put differently, stronger comparative advantage of high relative to middle skill workers than of low relative to middle.
- And / or additionally factor-biased technical change $A_H \uparrow$ (e.g. due to complementarity with the capital).

Causes of inequality: Employer-specific wage differentials

Finding we saw in “firm heterogeneity” lecture: Some firms pay higher wages for equally skilled workers

- I.e. there is a workplace component of wage inequality

Case study by Card/Heining/Kline (2013, QJE): “Workplace Heterogeneity And The Rise Of The West German Wage Inequality‘”

- Has the importance of this *firm component* changed over time?
- Did the distribution of the component contribute to the rise in wage inequality?

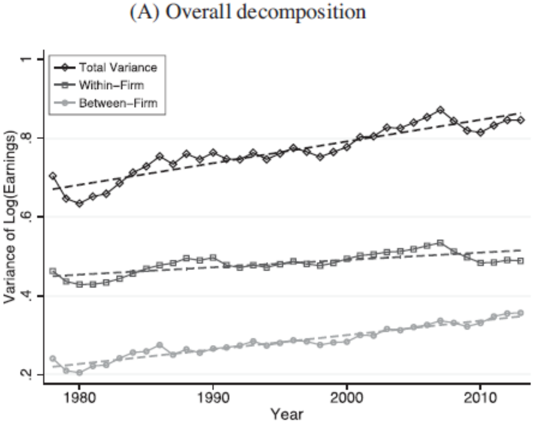
Related study in the US by Song et al (2019, QJE): “Firming up Inequality‘”

Causes of inequality: Employer-specific wage differentials

Key findings of Card/Kline/Heining (2013):

I. Workers who tend to earn more at any job are increasingly concentrated at those firms that offer above-average wages to all employees
II. Rise in the variance of the worker component contributes about 40% to the overall rise in the variance of wages; rise in the firm component about 25%
III. Importantly, increasing "match quality" between workers and firms (the rising covariance between worker and firm fixed effects) explains about 33%.

Causes of inequality: Employer-specific wage differentials



Source: Song et al (2019): “Firming up Inequality”

Causes of inequality: Domestic outsourcing

Increasing domestic outsourcing as additional source of inequality

- In recent years, firms re-shifted focus on their “core competencies”
- Outsourcing of food, cleaning, security or logistic (FCSL) services
- May reduce costs by lowering the direct number of employees, hiring service contractors who fiercely compete for contracts
- Competition to reduce wages of workers pursuing service tasks

Case study: *Goldschmidt/Schmieder (2017): The Rise of Domestic Outsourcing and the Evolution of the German Wage Structure, QJE.*

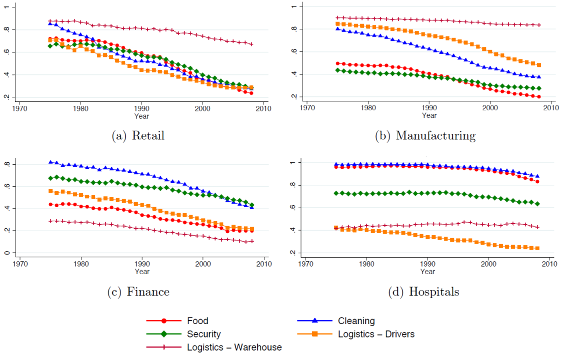
Study based on universe of GER social security records (1975-2009)

- Information on employees’ occupation, duration of employment with specific employer, characteristics of the firm (industry, etc.), wages

Domestic outsourcing - Goldschmidt/Schmieder

Evidence for increased domestic outsourcing by firms

- Share of large firms that employ at least one worker in a FCSL occupation

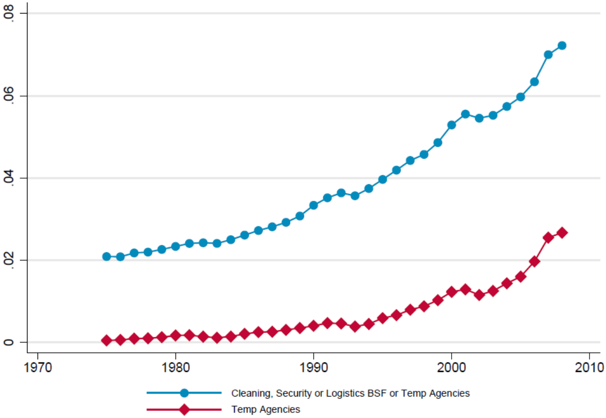


- In 1975, 80% of large retail firms employed at least one cleaning worker. In 2000, only 20% of the retail firms did.

Domestic outsourcing - Goldschmidt/Schmieder

Evidence for rising domestic outsourcing by firms

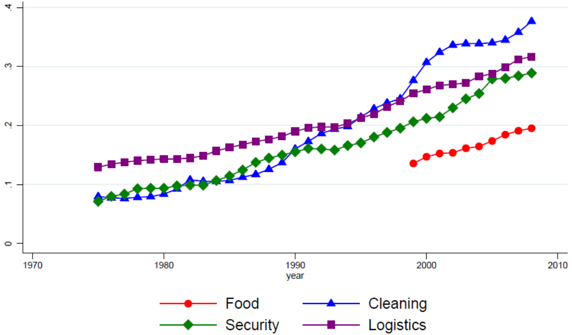
- Share of workers employed in service firms or temp agencies



Domestic outsourcing - Goldschmidt/Schmieder

Evidence for rising domestic outsourcing by firms

- Share of FCSL workers in FCSL firms over time



(b) Workers in Food / Cleaning / Security / Logistics Occupations

- In 1975, 10% of cleaners employed by cleaning firms; today: 40%

Domestic outsourcing - Goldschmidt/Schmieder

Why should wages differ for outsourced and non-outsourced workers?

- In competitive labor markets, wages should be equal
- Wage differences if service contractors have monopsony power
- If large, highly productive firms outsource service workers, outsourced workers do not benefit from rent sharing or collective bargaining ("firm fixed effect")

Empirical design

$$\ln(w_{ijt}) = \delta Outsourced_{it} + Z'_{jt}\rho + X'_{it}\beta + \epsilon_{ijt}$$

- $\ln(w_{ijt})$: log daily wage of worker i working in job j at time t

- $Outsourced_{it}$: dummy taking value 1 if worker is outsourced (employed by service firm)

- Z'_{jt}: job-specific characteristics, X_{it}: individual-specific characteristics

Domestic outsourcing - Goldschmidt/Schmieder

Simple OLS may yield biased estimates

- Outsourcing likely correlated with unobservable job/worker characteristics

Event study design

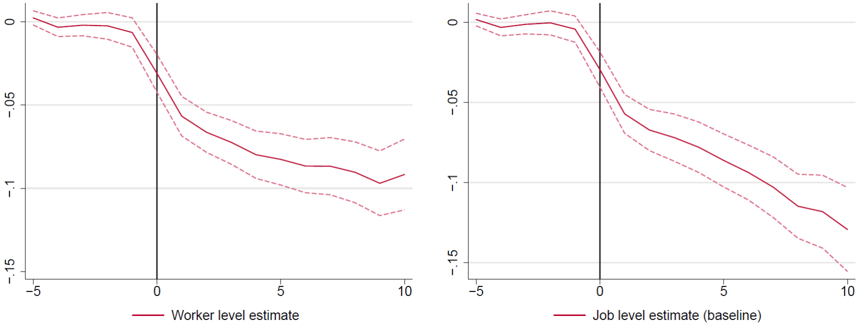
- Focus on workers doing same job before and after an outsourcing event
- Compare these workers with non-outsourced similar workers
  $\rightarrow$ using matching techniques

$$y_{ijt} = \sum_{k=-5}^{10} d_k I(t = t^* + k) Outsourced_i + \alpha_i + \gamma_j + \theta_t + X'_{it}\beta + \epsilon_{ijt}$$

- Empirical model as expansion of DiD approach
- Identifying assumption: Treatment and control group would have followed same evolution absent outsourcing event
- Identifying assumption tested via inspection of pre-trends

Domestic outsourcing - Goldschmidt/Schmieder

Effects of outsourcing on wages (event-study estimates)

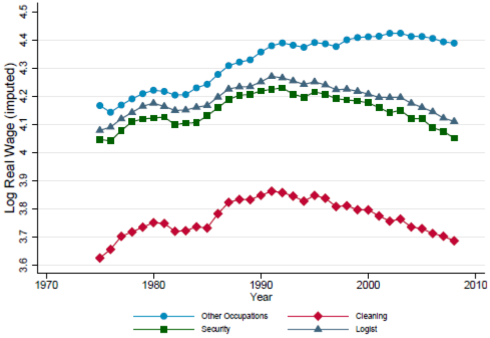


- Being outsourced leads to an immediate drop in workers' wages
- Wages further decline over time; ∼ 10% lower 10 years after outsourcing

Domestic outsourcing - Goldschmidt/Schmieder

Wage effects relative to other occupations

- Workers in cleaning, security & logistic saw substantial decline in wages
- On average, log real wages increased for all other occupations



→ Outsourcing of service jobs one driver of wage inequality
→ May partly result from firms "circumventing" wage premia

Conclusion

Economic research identified various causes of *labor* income inequality

I. Different waves of technological changes (also causing the polarization of labor markets)
II. Employer-specific wage differentials and employer–employee sorting
III. Organisational adjustments to above factors (e.g. domestic outsourcing of service occupations)
IV. Minimum wages and unions (reduce inequality; see e.g. DiNardo et al. 1996, ECTA)

The Current Revolution: Artificial Intelligence

Early studies indicate that artificial intelligence could make workers and companies more productive. Examples:

- The productivity of software developers increases by 26% (Cui, Z. et al., The Effects of Generative AI on High Skilled Work: Evidence from Three Field Experiments with Software Developers, 2024).
- Call center employees become 14% more productive, especially entry-level workers (Brynjolfsson, Erik et al., Generative AI at Work. No. w31161. NBER, 2023).
- AI performs as well as radiologists, but radiologists do not trust AI and do not become more productive (Agarwal, N., et al., Combining Human Expertise with Artificial Intelligence: Experimental Evidence from Radiology. No. w31422. NBER, 2023).

It is still unclear how artificial intelligence will change the labor market. Research is currently underway on this topic. However, it seems clear that workers who effectively utilize AI will achieve wage gains.

Further reading

- Acemoglu/Autor (2011): Skills, Tasks and Technologies: Implications for Employment and Earnings, Handbook of Labor Economics (4b).
- Card/Kline/Heining (2013): Workplace Heterogeneity And The Rise Of The West German Wage Inequality, QJE.
- Goldschmidt/Schmieder (2017): The Rise of Domestic Outsourcing and the Evolution of the German Wage Structure, QJE.
- DiNardo/Fortin/Lemieux (1996): Labor Market Institutions and the Distribution of Wages, Econometrica