

Job Levels and West German Wage Growth

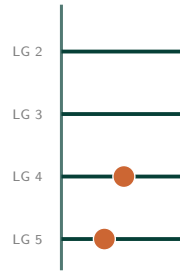
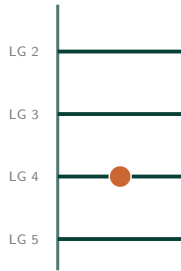
Wages, productivity, and gender along the Leistungsgruppen ladder, 1958–2021

Luis Calderon

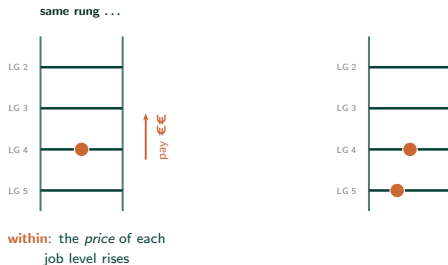
July 23, 2026

University of Bonn

When mean wages rise, two things can happen

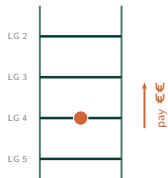


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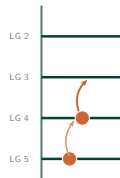
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same rung ...



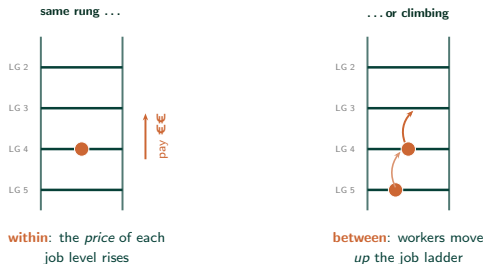
within: the *price* of each
job level rises

...or climbing



between: workers move
up the job ladder

When mean wages rise, two things can happen



This project asks, for West Germany over six decades across sectors,

- *Wages*: how much of real wage growth was prices, how much was climbing?
- *Productivity*: does the climbing show up in measured output (TFP)?
- *Gender*: did women close the gap by climbing faster?

Motivation & literature

The German wage literature: two anchors, one missing margin

why

how

result

reading

- **Dustmann–Ludsteck–Schönberg (QJE 2009).** — Inequality focus
 - Composition margin: *education, age, tenure*
 - Method: **DiNardo–Fortin–Lemieux reweighting**
 - “what would today’s wages look like at yesterday’s workforce composition?”

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- **Bayer–Kuhn (2023)**
 - Composition Margin: a worker’s **job level**, an official five-rung ladder graded by the **complexity, autonomy, and responsibility** of the job
 - explains $\approx 47\%$ of cross-sectional wage variation and most life-cycle wage growth

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 - All use worker cross sections.

This paper provides the long-run macro counterpart.

The project in one slide: three results on one new panel

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1. Job levels inside the Solow residual

$\approx 10\%$ of measured
sectoral TFP growth
1975–2006 is workers
climbing the ladder
(30% in Finance)

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3. Gender convergence is compositional

women's wage growth is $\approx 2\times$ as composition-driven as men's — within blue- *and* white-collar work

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- the **accounting spine**: real wage growth splits $\approx 86\%$ **within** / **14% between** — and this split **replicates across the 2007 survey break** in two unconnected surveys;

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Plan: go slowly — each result gets *why* $\rightarrow$ *how* $\rightarrow$ *result* $\rightarrow$ *should it motivate a model of job levels?*

Data:

A new long-run job level panel

What is a Job Level?

why

how

result

reading

- An **official Destatis classification**.
- Every covered worker is assigned a **job level**;
- graded by the job's **complexity**, **autonomy**, and **responsibility** (Bayer–Kuhn);
- *not* education, occupation, or firm.
- Recorded **quarterly since 1958** in the earnings survey — 17 years before the admin data begin.

LG	definition
1	<i>leitende Stellung</i> (managerial)
2	<i>herausgehobene Fachkräfte</i>
3	<i>Fachkräfte</i> (vocationally trained)
4	<i>angelernete</i> (trained on the job)
5	<i>ungelernte</i> (no formal training)

- **Vierteljährliche Verdiensterhebung (VVE)**, 1958–2006: firm-reported quarterly survey of industry, trade, finance (West Germany).
 - Variables: # of employees*, wages*, hours*
 - Variation: **industry** $\times$ **sex** $\times$ **job level**.

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Some Pre-2007 caveats

- two separate ladders: Arbeiter (blue-collar) LG 1–3, Angestellte (white-collar) LG 2–5;
- LG 1 (managers) never recorded for Angestellte;
- wages monthly (Ang) / weekly (Arb) sums, *no bonuses*;

Construction of Panel

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- **Sectoral results** restricted to seven **consistently-defined** WZ08 sections: B, C, D, E, G, J, K (same sub-industries throughout, to avoid "cliffs" in time series). ▶ which sections are excluded, and why?

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Result: a quarterly panel of wages and employment by year $\times$ quarter $\times$ industry $\times$ sex $\times$ job level, 1958–2021.

Results

Exercise #1: Decompose wage as in motivation

why

how

result

reading

Mean wage $W(t) = \sum_g s_g(t) w_g(t)$:

- job levels $g \in \{2, \dots, 5\}$
- shares s_g
- level wages w_g

The symmetric (Stuart) Oaxaca–Blinder split of growth:

$$\Delta \log W \approx \underbrace{\sum_g \bar{s}_g \Delta \log w_g}_{\text{within (prices)}} + \underbrace{\sum_g \Delta s_g \overline{\log w_g}}_{\text{between (composition)}}$$

with $\bar{s}_g$, $\overline{\log w_g}$ period-averaged weights.

- **Detail:** Attribution of the share $\times$ wage *covariance* doesn't matter (robustness, appendix).

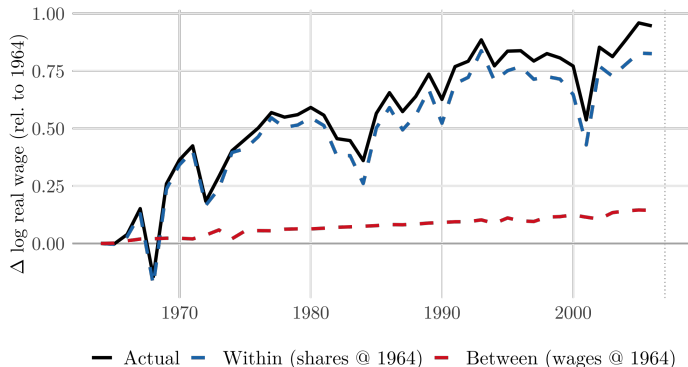
The headline plot: prices carry the mean

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Over **1975–2006** — the window of every table, quoted here for comparability:

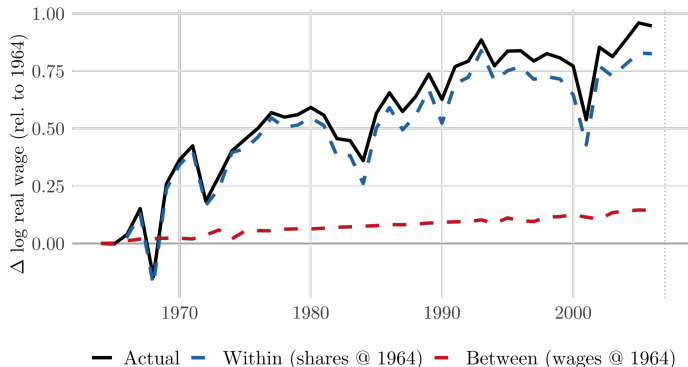
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Over **1975–2006** — the window of every table, quoted here for comparability:

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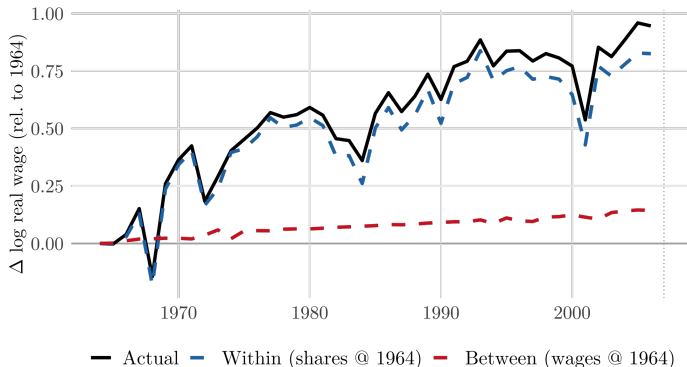
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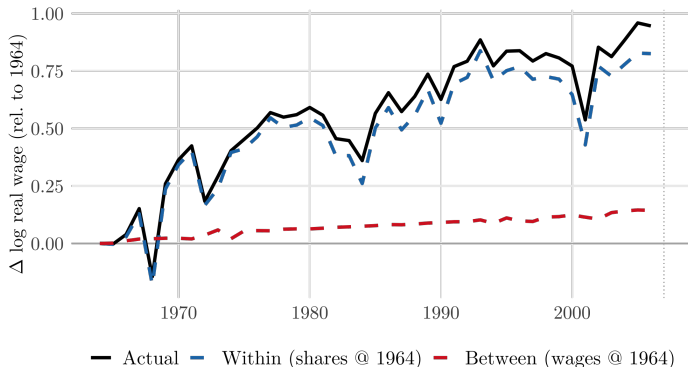
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- actual real wage: **+62%**;
- **within-only** (1964 shares): **+51%** — tracks the actual;
- **between-only** (1964 wages): **+9%** — steady, slow.

Plot base 1964 = first clean year (1958 lacks blue-collar data; 1960–63 wages contaminated).

Under the hood: Germany did climb the ladder — but premia stayed put

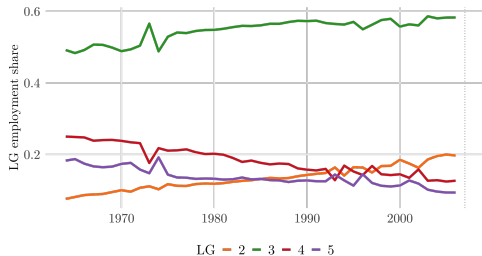
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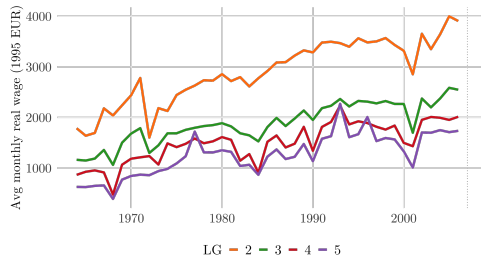
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LG employment shares



within-LG real wages



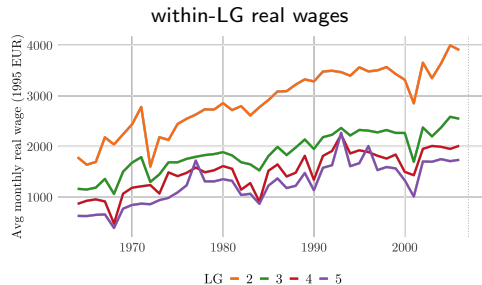
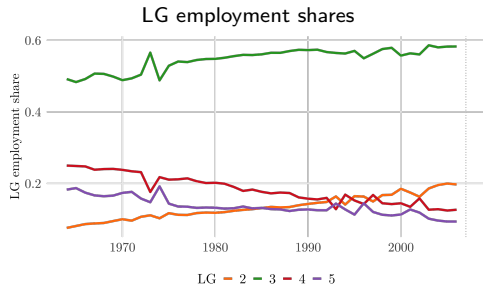
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 - LG 4 25% → 13%, LG 5 18% → 9%;
 - LG 3 49% → 58%, LG 2 8% → 20%.

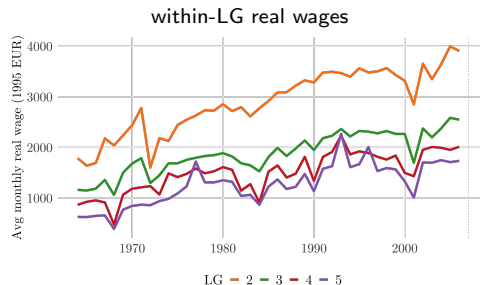
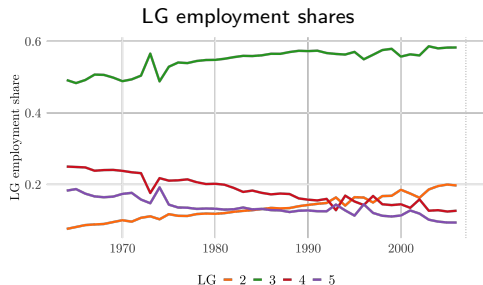
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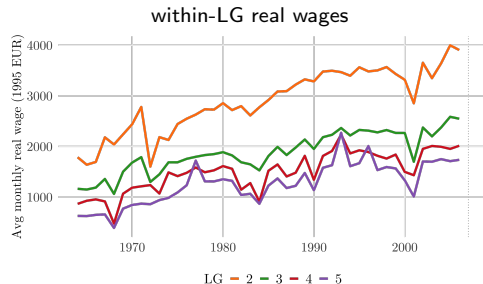
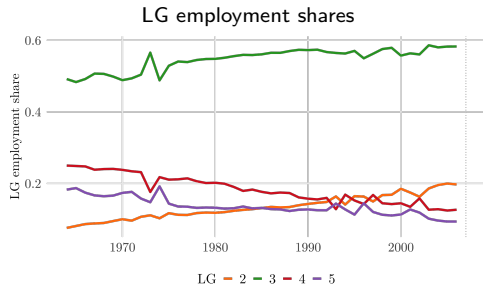
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- But **LG wage ratios are stable** — all four level wages grow at similar rates.
- The climb was real, premia widened little, and the shift took decades ⇒ between ends up at ≈ 14% of cumulative growth.

The split by decade: within dominates in every decade

[why](#)[how](#)[result](#)[reading](#)

Period	ΔW	within	between
1964–2006	+158%	86.5%	13.5%
1964–1975	+57%	90.1%	9.9%
1975–1985	+12%	84.3%	15.7%
1985–1995	+31%	90.4%	9.6%
1995–2006	+12%	75.0%	25.0%
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- By sector: between share highest in Information (29%), Finance (19%), Mining (17%). (appendix)

Is the 86/14 split an artifact? Four stress tests

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4. **All four wage measures post-2007** (monthly/hourly $\times$ with/without bonus): between 11–16%; the Bayer–Kuhn measure gives 12.7%, ours 13.6% — the two channels (bonuses +2.0 pp, hourly –2.3 pp) nearly cancel. (appendix)

No bridge: the same picture, ladder by ladder

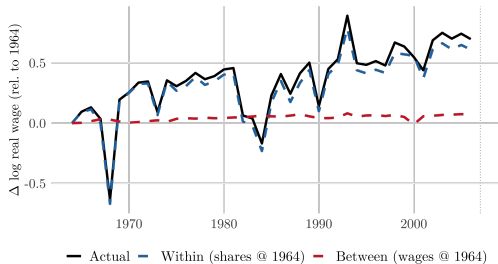
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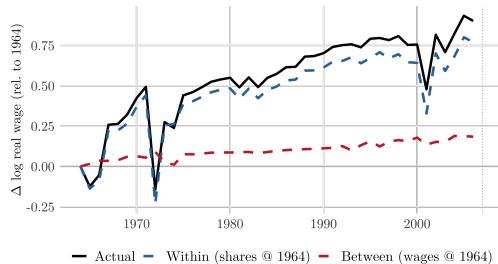
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reading

Arbeiter (raw LG 1–3)



Angestellte (raw LG 2–5)



- Each survey ladder on its own definitions — no mapping, no α , no pooling
- **Between:** Arbeiter $\approx 11\%$, Angestellte $\approx 19\%$

The most demanding test: replicate across the 2007 survey break

[why](#)[how](#)[result](#)[reading](#)

	Pre-2007 (VVE)	Post-2007 (VSE)
Window	1975–2006	2007–2021
Wage measure	monthly, no bonus	hourly, <i>with</i> bonus
LG range	2–5	1–5
Population	industry+trade+fin.	all employees
within share	86%	86%
between share	14%	14%
W between	29% _(95–06)	24%
M between	17% _(95–06)	5%
LG share of TFP	9.8%	≈ 8% _(08–20)

The most demanding test: replicate across the 2007 survey break

why

how

result

reading

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- Two surveys that share **no construction**: different population, LG definitions, wage concept.
- Same 86/14 split, same women≫men gap, same order of the TFP contribution.

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What the accounting says:

- The German workforce moved substantially up the job ladder — into work with more complexity, autonomy, responsibility — yet **mean** real wage growth was mostly rising *prices* within levels: LG premia barely widened and the climb took decades.

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why

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Use it to motivate a model of job levels? **Yes — as the disciplining moment set.** — any model of job levels must *jointly* produce (i) large within-level price growth, (ii) a slow, decades-long upward composition drift, and (iii) *stable* inter-level premia despite that drift — e.g. level-supply responses that keep relative wages pinned. The 86/14 split is the target statistic, robust to measurement.

Result 1:
Job levels inside the Solow
residual

Why we did it

why

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- Split measured TFP into “true” technology and **labour-quality** growth (Jorgenson–Griliches 1967).

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why

how

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- Split measured TFP into “true” technology and **labour-quality** growth (Jorgenson–Griliches 1967).
- Our question: is part of what growth accounting books as *technology* actually **workers climbing the job ladder**? If yes, the sectoral TFP term is **not** Hicks-neutral — it contains a labor-composition margin.
- To our knowledge, job levels have **never been connected to the productivity residual**.

How it's done: Törnqvist labour quality inside the residual

[why](#)[how](#)[result](#)[reading](#)

Sectoral Solow residual, s = sector; EU-KLEMS supplies real value added Y_s , real fixed capital stock K_s , hours L_s , and the capital income share $s_s^K = (VA_s - COMP_s)/VA_s$:

$$\Delta \log TFP_s = \Delta \log Y_s - s_s^K \Delta \log K_s - (1 - s_s^K) \Delta \log L_s$$

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Replace raw labour with the **Törnqvist efficiency aggregate** over job levels:

$$\Delta \log \tilde{L}_s = \sum_{g \in LG} \bar{\omega}_{g,s} \Delta \log L_{g,s}, \quad \bar{\omega}_{g,s} = \frac{1}{2} (\omega_{g,s,t-1} + \omega_{g,s,t})$$

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Labour quality = efficiency labour minus bodies, $\Delta \log \tilde{q}_s = \Delta \log \tilde{L}_s - \Delta \log L_s$, and

$$\underbrace{\Delta \log TFP_s}_{\text{raw residual}} = \underbrace{\Delta \log TFP_s^{\text{adj}}}_{\text{net of labour quality}} + \underbrace{(1 - s_s^K) \Delta \log \tilde{q}_s}_{\text{LG composition contribution}}$$

How it's done: Törnqvist labour quality inside the residual

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No estimation: the raw residual comes from EU-KLEMS quantities, the LG term from our panel; TFP^{adj} is *defined* as the difference. Frequency: year-over-year and chained, on *annual* data (quarterly VVE cells averaged) — capital stocks are annual, and quarterly residuals drown in utilization noise (BER 1996).

Result: $\approx 10\%$ of measured TFP growth is ladder-climbing

[why](#)[how](#)[result](#)[reading](#)

Aggregate, VA-weighted, 1975–2006

	ann.	cum.
Raw Solow residual	+1.59%	+62.8%
net of LG quality	+1.42%	+55.2%
LG contribution	+0.15%	+4.9%
LG share of raw TFP		9.8%

... and it rises over time

	Δ TFP	LG share
1975–1985	+17.1%	7.0%
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[why](#)[how](#)[result](#)[reading](#)

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- Cumulative labour quality: **+17%** in efficiency labour over raw bodies, +0.5%/yr (figure in appendix).
- The channel **strengthens through and after reunification** — same timing as the wage between share ($\rightarrow 25\%$) and women's acceleration.

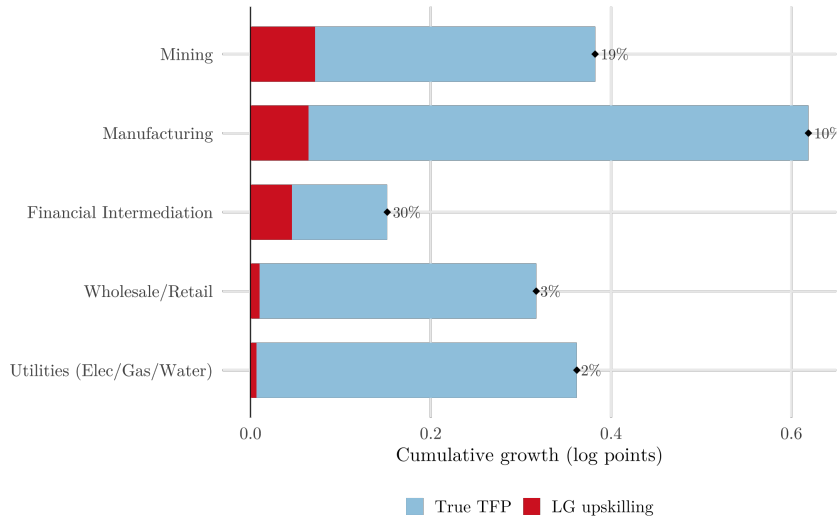
The hook is the sector heterogeneity

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reading



Objection: isn't this just education? A horse race

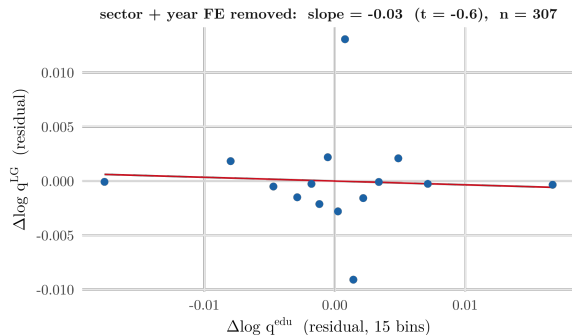
why

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the FE panel regression, as a binscatter of the FWL residuals



EU-KLEMS labour accounts split each sector's employment and pay by **educational attainment** (ISCED low/med/high, from the Mikrozensus), 1995+. Same Törnqvist machinery, count-weighted like the LG index — race the two quality indices:

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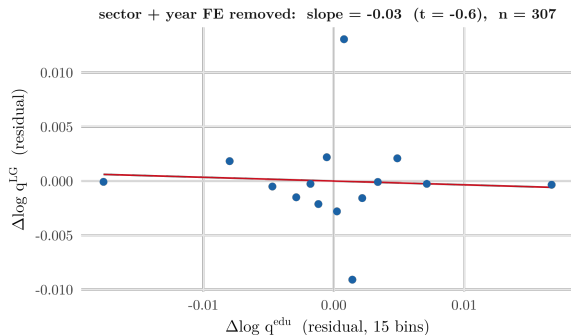
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- **the test:** annual panel, sector + year FE partialled out of *both* axes (Frisch–Waugh), 15 equal-count bin means — the fitted slope *is* the FE coefficient: -0.03 ($t = -0.6$, $n = 307$).

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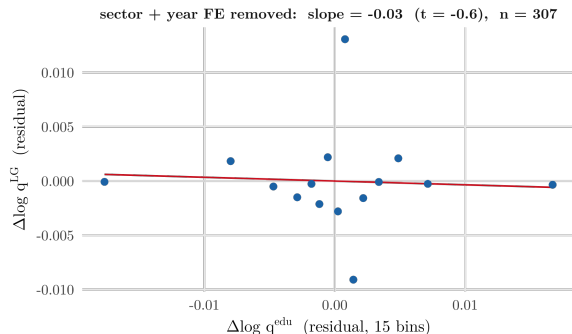
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- **The LG climb is not relabeled schooling** — workers move into more complex, autonomous, responsible jobs *within* education groups, Bayer–Kuhn's margin.

Result 2:

A labour-augmenting margin

Why we did it

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- Bayer–Kuhn: job levels explain 47% of *individual* wage variation. Does the macro cross-section echo this — does a *sector's* job-level structure predict its wages and productivity?

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- And *which margin* is it? Two candidate structural homes:
 - **labour-augmenting**: higher job levels raise what labour produces and earns;
 - **“capital–skill complementarity”** (Krusell–Ohanian–Ríos-Rull–Violante 2000): higher job levels raise the return to (equipment) capital.

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- The two have different observable signatures: if job levels work through capital complementarity, they should predict **capital productivity** too. If labour-augmenting, only **labour productivity** and wages.

How it's done: within-year binscatters

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- Sector $\times$ year panel: EU-KLEMS 2023 productivity merged with VVE/VSE LG composition; consistently-defined sectors pre-2007, all sectors post; **1996–2021, 325 observations** — the 2023 EU-KLEMS release (NACE Rev.2, the productivity side of the merge) starts in 1995, hence no earlier binscatters.

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- Two job-level measures per sector-year: **mean job level** $\sum_g s_g (6 - \text{LG}_g)$ (1 = lowest rung ... 5 = managerial) and **LG dispersion** (ordinal SD of the level distribution). Both computed on the combined Arbeiter+Angestellte workforce; pre-2007 the mean runs over LG 2–5 (managers unrecorded), post-2007 over LG 1–5 — the year FEs absorb the range change.

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Purely descriptive by design — levels, not identification. The point is *which* outcomes line up with job levels, not a causal effect.

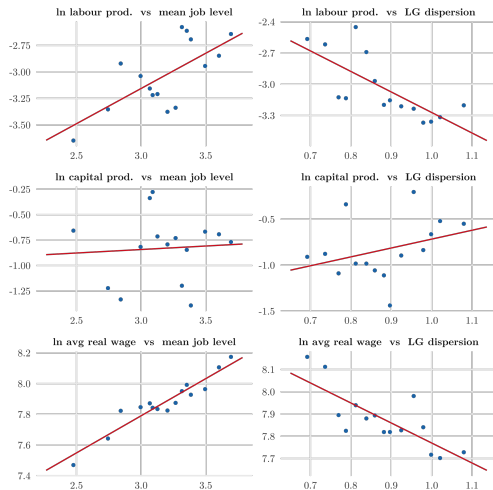
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why

how

result

reading



y (on mean job level)	slope	R^2
ln real wage	+ 0.48	0.57
ln labour prod.	+ 0.67	0.12
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TFP growth (on Δ level)	+0.03	0.00
wage growth (on Δ level)	+ 0.27	0.02

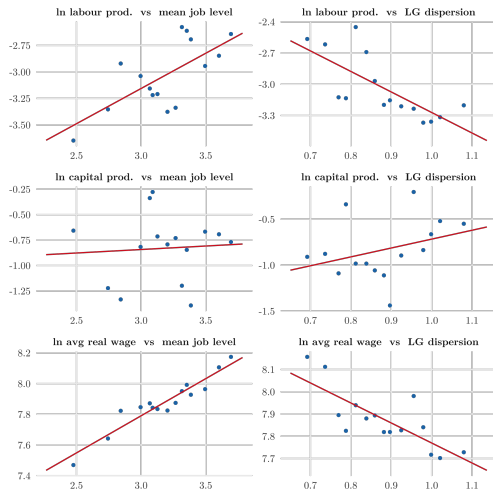
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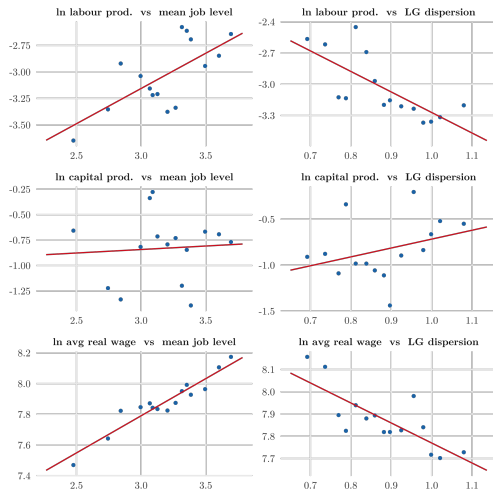
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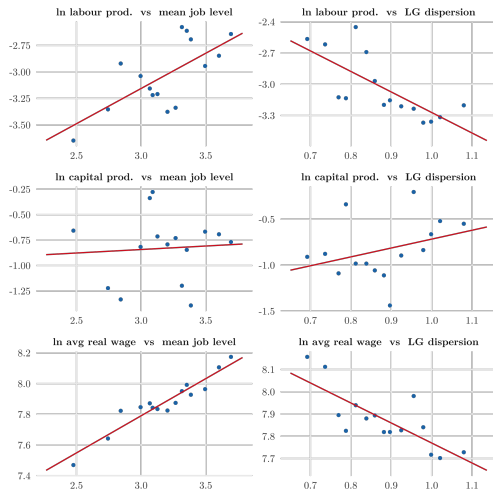
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why

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- Consistency check with dynamics: the ladder climb does *not* predict TFP growth year-to-year (slope ≈ 0) — the composition–productivity link is a slow **levels** relationship, not a business-cycle one. (the VAR will say the same)

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Use it to motivate a model of job levels? **Yes — it pins down where job levels enter.** — the data reject routing job levels through capital efficiency: a KORV-style “capital–skill complementarity” block is *not* the first-order mechanism here. Write levels as efficiency units in the labour aggregate, $\tilde{L} = \Phi(\{L_g\})$, with level-specific productivities — and let the cross-section (57%, zero on capital) discipline Φ .

Result 3: Gender convergence is compositional

why

how

result

reading

- **Olivetti–Pan–Petrongolo (2024)**: in level decompositions of the gender gap, *industry and occupation* now account for more than half — while human-capital differences have turned in women's favor. That is a *levels* statement; we can supply the *growth* side.

why

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why

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- **Bayer–Kuhn** document a model-based “gender promotion gap.” Our panel can ask the long-run aggregate version: did the German gender gap close through *prices* (within levels) or through women **climbing the ladder faster than men**?

Result: women's growth is about twice as composition-driven

[why](#)[how](#)[result](#)[reading](#)

Pre-2007 (VVE)

Period	Sex	ΔW	between
1975–2006	M	+55.7%	12.4%
1975–2006	W	+81.7%	16.0%
1985–2006	M	+41.1%	9.8%
1985–2006	W	+55.0%	20.2%
1995–2006	M	+8.2%	17.2%
1995–2006	W	+20.7%	29.4%

Where sex comes from: the survey cells are sex-specific, so shares s_g and level wages w_g are measured separately for women and men, and the decomposition runs per sex — women's between term is women's own ladder climb, not a residual.

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[why](#)[how](#)[result](#)[reading](#)

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- Crucially, this holds **within both worker types**: $\text{Ang-W} > \text{Ang-M}$ in 9/12 sections, $\text{Arb-W} > \text{Arb-M}$ in 8/11 — not an artifact of women being white-collar.

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... and it replicates natively post-2007

[why](#)[how](#)[result](#)[reading](#)

Post-2007 (VSE, LG 1–5, hourly incl. bonus)

Period	Sex	ΔW	between
2007–2021	M	+9.5%	4.9%
2007–2021	W	+16.2%	23.7%
2007–2014	M	+3.7%	14.6%
2007–2014	W	+5.8%	39.4%
2014–2021	M	+5.5%	–0.7%
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... and it replicates natively post-2007

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- Different survey, population, LG range, wage concept — **same women** $\gg$ **men composition gap**.

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- **Honest caveat:** the VVE/VSE are repeated *cross-sections*. Our “between” is a shift in the *stock* of working women — net of entry, exit, promotion — not measured individual transitions.
- No contradiction with the child penalty: the aggregate female workforce climbed faster *even as* motherhood set individuals back.

Reading Result 3

why

how

result

reading

- The closing of the German gender gap was disproportionately **movement up the job ladder**, not faster within-level price growth — the long-run descriptive counterpart of Bayer–Kuhn's gender promotion gap, and the growth-side mirror of Olivetti–Pan–Petrongolo.

Reading Result 3

why

how

result

reading

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- The within margin still dominates for both sexes — Goldin’s hours-premium mechanism (a *price* story) and our hours results (second-order) fit that.

why

how

result

reading

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- The within margin still dominates for both sexes — Goldin’s hours-premium mechanism (a *price* story) and our hours results (second-order) fit that.



Use it to motivate a model of job levels? Yes — with a required mechanism. — a job-levels model that speaks to gender needs a *level-assignment / promotion technology that differs by sex* (or by implied hours flexibility) — and it must reconcile faster aggregate female climbing with individual child penalties, i.e. cohort entry and selection margins, which our repeated cross-section cannot separate. That separation is a job for linked worker data *plus* the model.

Taking stock

Conclusion: three results, one message



- 1 — **Job levels inside the Solow residual.** $\approx 10\%$ of measured sectoral TFP growth 1975–2006 is ladder-climbing (Finance 30%, Mining 19%, Manufacturing 10%); rising over time; *not* education in disguise ($\rho \approx 0.3$).

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2 — A labour-augmenting margin. Mean job level explains 57% of within-year cross-sector wage variation (B–K's 47% at the macro level); predicts labour productivity, *not* capital productivity.

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 **3 — Gender convergence is compositional.** Women's real wage growth $\approx 2\times$ as composition-driven as men's, within blue- and white-collar work; replicates post-2007.

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 **2 — A labour-augmenting margin.** Mean job level explains 57% of within-year cross-sector wage variation (B–K's 47% at the macro level); predicts labour productivity, *not* capital productivity.

 **3 — Gender convergence is compositional.** Women's real wage growth $\approx 2\times$ as composition-driven as men's, within blue- and white-collar work; replicates post-2007.

Underneath: real wage growth is $\approx 86\%$ within / 14% between (25% in the 1990s) — replicated across the 2007 break in two unconnected surveys. The mean moves with *prices*; the ladder matters through *slow composition* and *productivity measurement*.

What a model of job levels would have to match

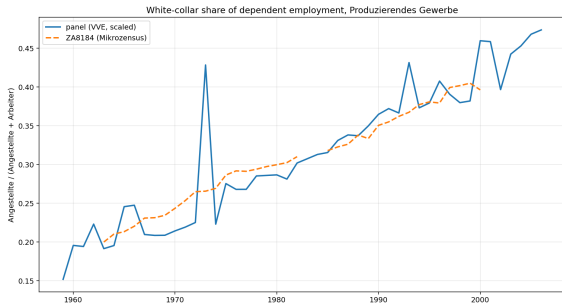
The accounting hands the theorist a moment set:

#	target	source
1	within/between split 86/14, between $\rightarrow$ 25% in the 1990s	spine
2	stable LG wage premia despite a 17 pp shift up the ladder	spine
3	LG composition $\approx$ 10% of measured TFP; Finance 30% $\gg$ Trade 3%	R1
4	LG quality orthogonal to education quality ($\rho \approx 0.3$)	R1
5	job levels predict labour — not capital — productivity; $R^2 = 0.57$ on wages	R2
6	women's between share $\approx 2\times$ men's, within both collar types	R3
7	no share $\leftrightarrow$ wage causality at quarterly frequency (except Finance)	VAR

Thank you!

Appendix: is the digitized panel reliable? Three external benchmarks

white-collar share of Arb+Ang, Produz. Gewerbe



- **Anchoring (by construction)**: national counts per worker type $\times$ sex scaled to published Bundesamt totals (ZA8184 D1.4).
- **Composition (independent, left)**: the panel's white-collar share tracks the Mikrozensus benchmark for four decades; spikes = the known bad years (1973 OCR recovery, early-60s gaps).
- **Sector trends (independent)**: 5-year employment growth correlates ≈ 0.6 with ZA8184 for C, G; real mean-pay trends track EU-KLEMS with the right-signed wedge (COMP includes employer contributions).
- **Flags**: Finance employment drifts high against *both* benchmarks (2003 wage-bill cell broken) — under investigation. Decompositions are share-based $\Rightarrow$ unaffected.

Scripts: `validate_z8184.py`, `validate_macro_aggregates.py`; tables and plots in

`7_Results/plots/validation/`.

Appendix: sections excluded from the sectoral analysis — and why

Section(s)	Name	Why excluded
A, I, L, P, Q, R	Agric., Accom., Real Estate, Educ., Health, Arts	essentially absent pre-2007 — the VVE covers industry, trade, finance (Education: < 35 recorded Angestellte)
M, N	Professional, Admin services	lose their business-service content (legal, accounting, agencies) at the 1996 reclassification
H	Transport	Bundespost inside Transport only 1982–95 — a $\sim 10\times$ artificial step at each boundary
S	Other services	intermittently under-reported after 1996
F	Construction	coverage collapse at 2000 ($\sim 14\times$ employment drop), never recovers
O	Public admin	outside the survey frame

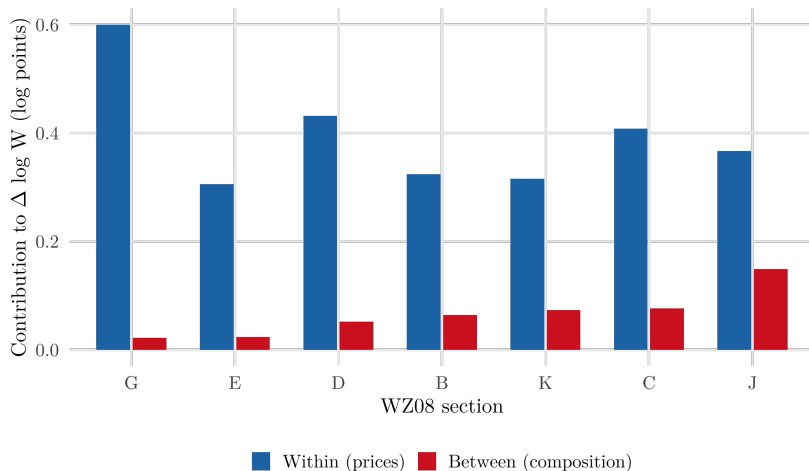
Sections that are clean in the modern all-employee VSE stay in post-2007 cuts (only their inconsistent pre-2007 years are dropped). The aggregate 86/14 and the national Solow numbers are **immune by construction** — they are national by job level and use no industry information.

Appendix: covariance attribution — the split is not a weighting choice

Period	Method	within	between	cov
1975–2006	Stuart symmetric	85.7%	14.3%	—
1975–2006	Paasche (cov → between)	84.8%	15.2%	—
1975–2006	Laspeyres (cov → within)	86.5%	13.5%	—
1975–2006	Three-way (explicit cov)	84.8%	13.5%	1.6%
1995–2006	Stuart symmetric	75.3%	24.7%	—
1995–2006	Paasche	74.2%	25.8%	—
1995–2006	Laspeyres	76.4%	23.6%	—

LG 2 contributes positive covariance (share +8 pp, fastest within-wage growth +60%); LG 4 negative; net small. Between spans 1.7 pp across attributions.

Appendix: sectoral within/between, 1975–2006



Within dominates everywhere; between highest in Information (J, 29% of sector growth), Finance (19%), Mining (17%), Manufacturing (16%).

Appendix: Arbeiter vs. Angestellte, and monthly vs. hourly

No bridge: raw panels separately

Period	Group	ΔW	between
75-06	Arb (LG 1-3)	+45.9%	11.3%
75-06	Ang (LG 2-5)	+58.7%	17.9%
95-06	Arb	+21.7%	6.2%
95-06	Ang	+11.7%	19.2%

Arbeiter only: hours per LG exist

Period	Measure	ΔW	between
75-06	monthly	+42.0%	2.1%
75-06	hourly	+41.9%	3.4%
85-06	monthly	+31.9%	1.7%
85-06	hourly	+32.7%	5.0%

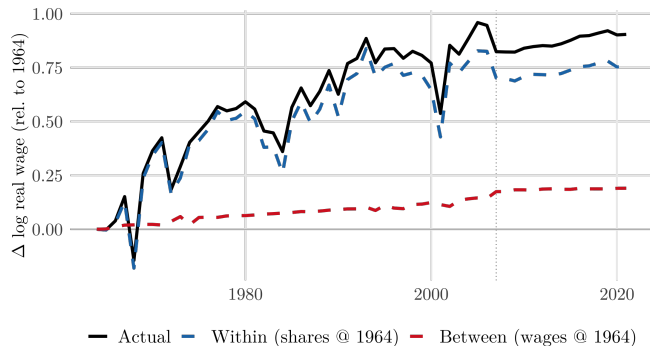
White-collar upgrading is the more visible composition margin; the paid work week compressed only $\approx 4\%$ over thirty years and fairly uniformly across LGs, so the hours channel moves the between share by a couple of pp at most.

Appendix: post-2007, all four wage measures (LG 2–5)

Measure (2007–2021)	$\Delta \log W$	within sh.	between sh.
(A) Monthly, no bonus (<i>project</i>)	0.083	86.4%	13.6%
(B) Monthly, with bonus	0.076	84.4%	15.6%
(C) Hourly, no bonus	0.097	88.8%	11.2%
(D) Hourly, with bonus (<i>Bayer–Kuhn</i>)	0.090	87.3%	12.7%

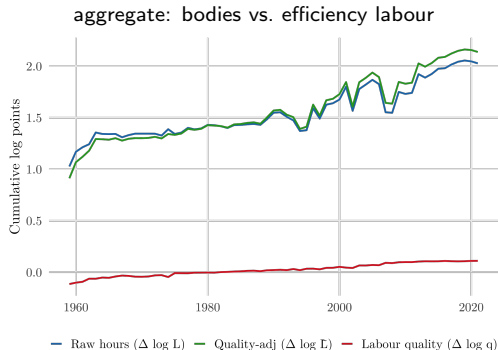
Bonuses concentrate in upper LGs (+2.0 pp on between); hourly compresses the LG premium (−2.3 pp); the two nearly cancel. The project's monthly-no-bonus measure mirrors the pre-2007 pay concepts (monthly is the natural measure for salaried staff) and is not a driver of the headline.

Appendix: why we never splice across 2007



- Post-2007 LG 2 absorbs *Vorarbeiter/Meister* who were Arbeiter LG 1 before — a naive splice drops mean LG 2 wages $\approx 23\%$ at the dashed line.
- The step is a survey artifact, not economics; hence the native two-regime comparison in the body.
- The one bridge parameter ($\alpha = 0.095$ of Arb-1 to LG 2, fitted at the 2006Q4/2007Q1 boundary) is used for illustration only.

Appendix: labour quality and its sector spread

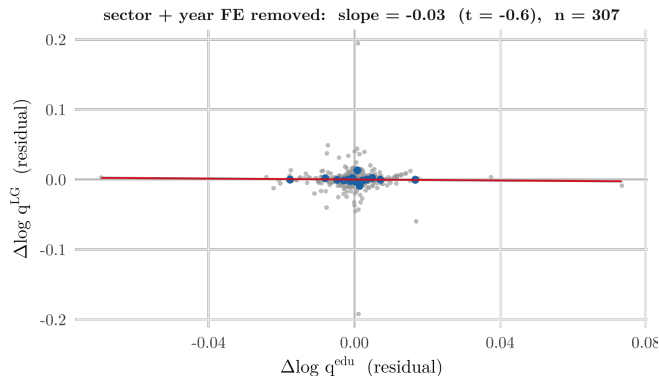


cumulative $\Delta \log \tilde{q}$ by sector, 1975–2006

K Finance	+33.4%	D Energy	+6.9%
J Information	+16.1%	E Water	+3.2%
C Manufact.	+11.9%	G Trade	+2.0%
B Mining	+9.6%		

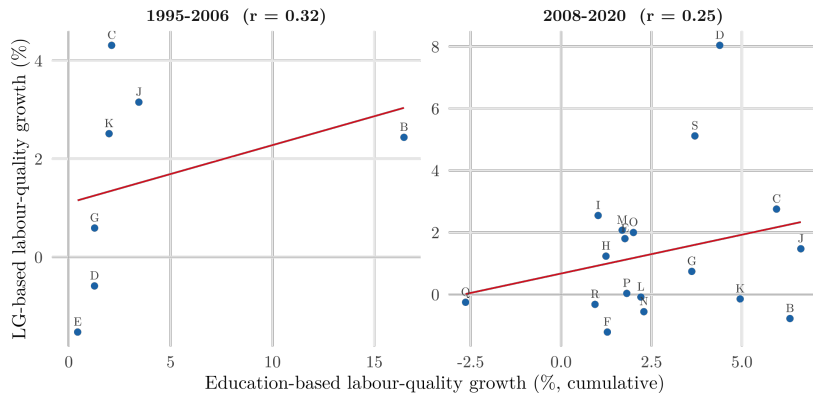
Ranking matches the sectoral wage between shares
— two lenses on the same climb.

Appendix: the residual cloud behind the horse-race binscatter



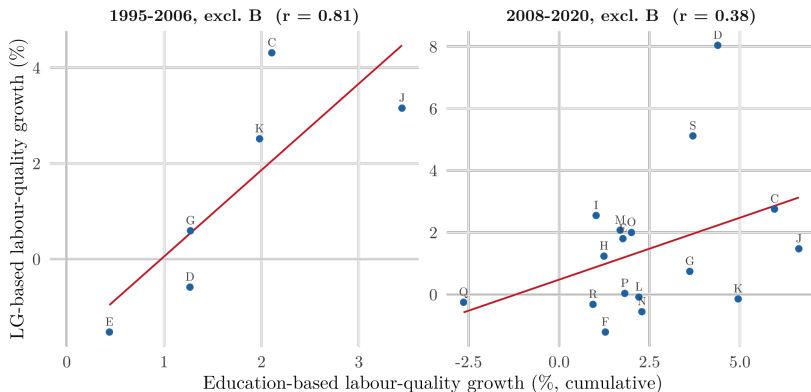
The same FWL residuals with the full sector-year cloud (grey): 307 observations, slope -0.03 . The binned view in the body recovers exactly this line — binscatter-on-residuals is the FWL partial relation (Stata `binscatter` with `absorb()`).

Appendix: the cumulative horse race (all sectors)



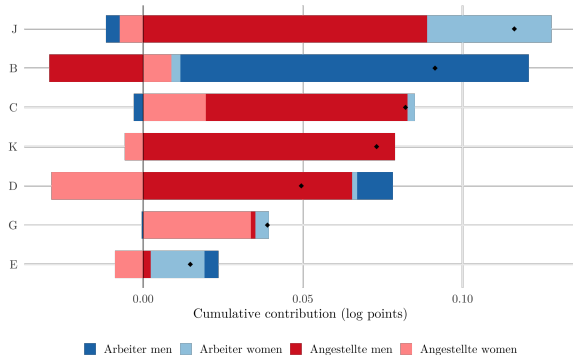
Cumulative LG-based vs education-based labour-quality growth by sector, on the two EU-KLEMS overlap windows: $r = 0.32$ (1995–2006, 7 sectors) and 0.25 (2008–2020, 18 sectors).

Appendix: the horse race without Mining (B)



Leave-one-out: B has by far the largest education upgrading but middling LG quality, so it *attenuates* the correlation. Without it, $r = 0.81$ pre-2007 — but on six sectors — and 0.38 post-2007 (17 sectors). The cross-section is too small to settle it either way; the orthogonality evidence that carries weight is the added-variable plot in the body, where the slope is zero with sector+year FE.

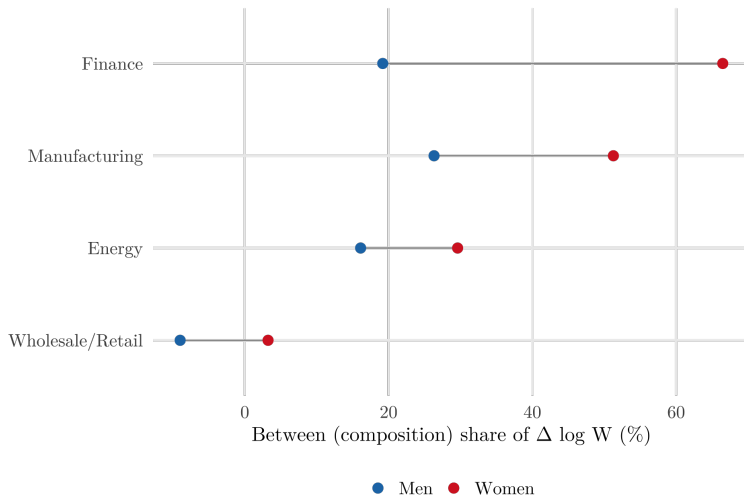
Appendix: who carries the labour-quality growth



Cell-level Törnqvist contributions summed by group (1975–2006):

- Ang men +47%, Arb men +39%, Ang women +26%, Arb women +7%;
- Mining climbed via blue-collar men (survival of the *Fachkräfte*);
- Information and Finance via white-collar men.

Appendix: gender $\times$ sector, 1995–2006



In every consistently-defined sector with $|\Delta \log W| > 0.05$ for both sexes, women's between share exceeds men's. Highest: Information (69%), Finance (66%), Manufacturing (51%)