Misallocation and Inequality

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IZA Workshop
The Role of Search and Matching in Macroeconomics: A Retrospective

November 18, 2021

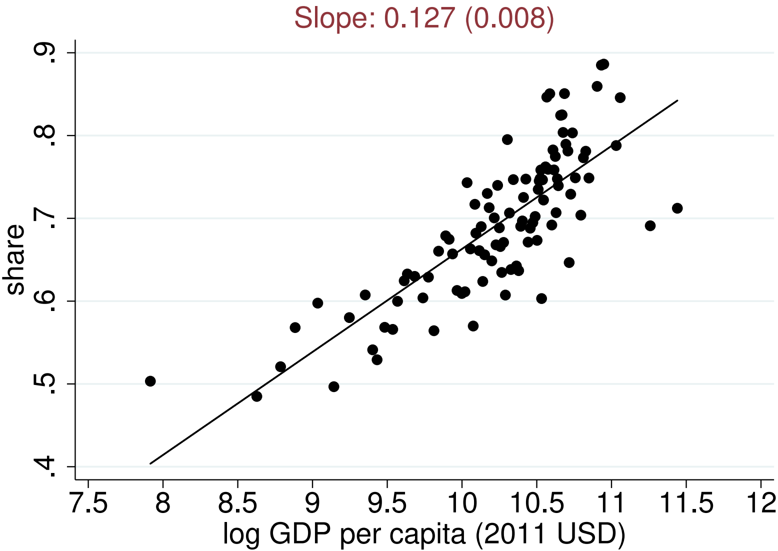
- Differences in labor earnings across individuals are key sources of income inequality (Hoffmann et al 20)
- Firms shape earnings distribution:
  - not all firms pay the same wage to workers with similar characteristics (Abowd et al 99, Card et al 13, Song et al 19)
  - large firm wage premium (Bloom et al 18)
- Firms look very different across countries. In richer countries:
  - larger firm size (Bento and Restuccia 16)
  - firms more likely to train their workers (Ma et al 20)
- How do firms affect labor earnings distribution along development?

In this paper

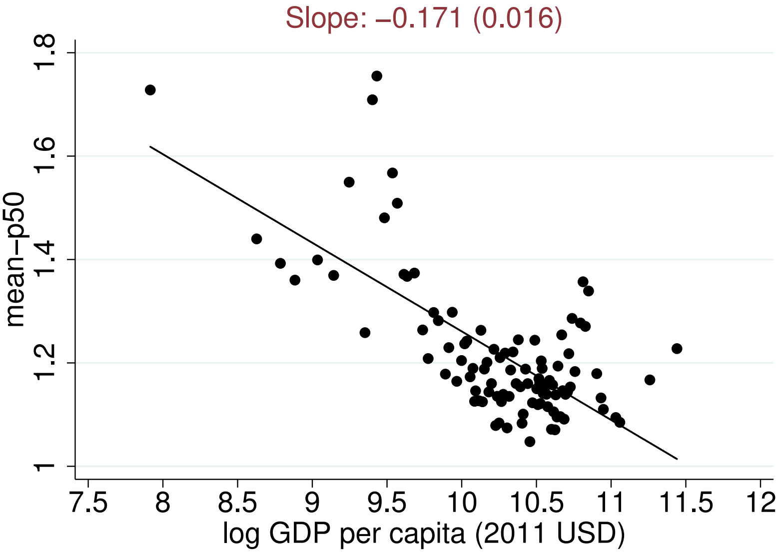
- We document how the distribution of wage and salary income varies with GDP p.c.
  - the median increases faster than the mean
  - inequality at the top shrinks, inequality at the bottom expands
  - the GINI coefficient declines
- We build a model of firm dynamics and labor market frictions to interpret this evidence
  - heterogeneous firms and workers
    - sorting of high-skill workers into more productive firms
    - on-the-job human capital accumulation (learning + training)
- Cross-country patterns can be reproduced by two sources of misallocation
  - firm-level correlated distortions
  - larger search frictions
- On-the-job training account up to 40% of changes in earnings inequality across countries

- Coverage: 55 countries, 1981-2016
  - India (2004), GDP per capita: 2955.2 (2011, USD)
  - Luxembourg (2007), GDP per capita: 97864.2 (2013, USD)
- Source: IPUMS International, Survey on Income and Living Conditions (SILC), Luxembourg Income Study Database (LIS)
- Earnings measure: gross wages and salaries (including extra pay, tips, commissions, bonuses, piece-rate payments, occasional earnings)
- Demographics: gender, age, education, labor market status, job characteristics
- Sample restrictions: all employed workers with positive wage and salary income, 18-64 y.o.

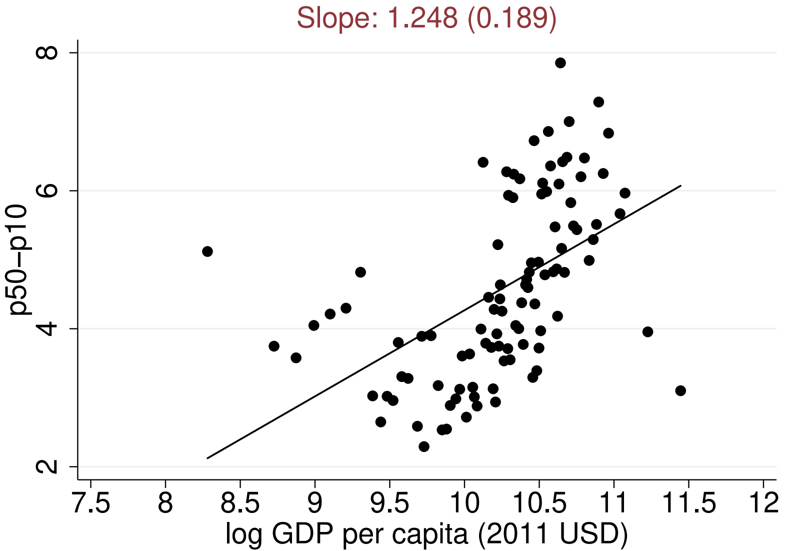
Wage and salary employees



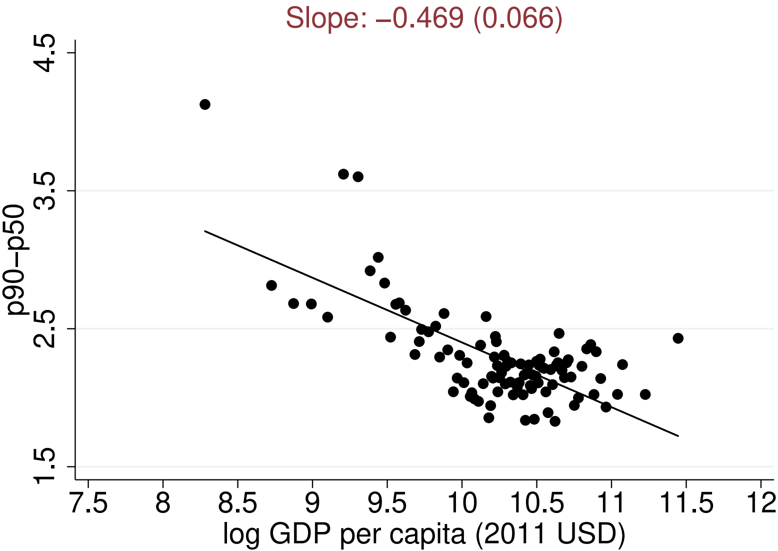
The median earnings grow faster than the mean

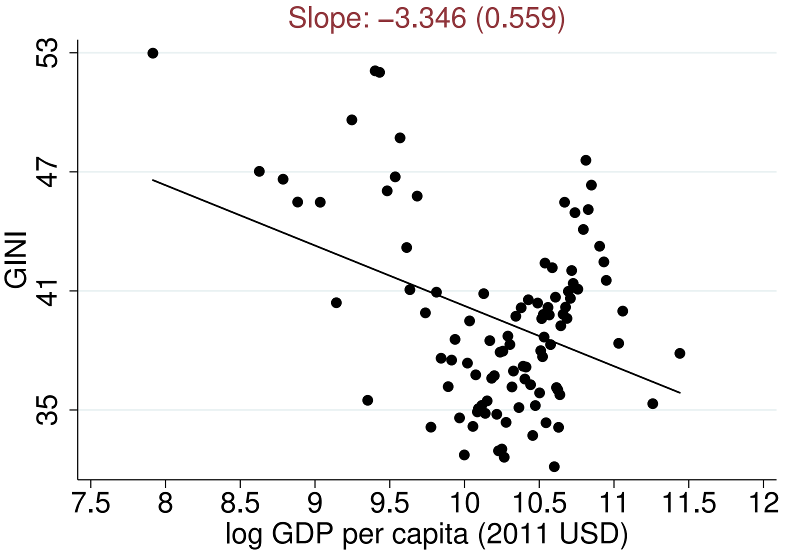


Inequality at the bottom increases...



...while inequality at the top declines




Slope: –3.346 (0.559)
GINI
53
47
41
35
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
log GDP per capita (2011 USD)

- How does the earnings distribution change with development?
  - mean-median earnings ratio and GINI decline with development
  - earnings inequality at the bottom increases (p50-p10 ratio) while declining at the top (p90-p50)
- Robustness:
  - across sectors: no-agriculture, only industries
  - across education: non-college, college
  - across demographics: only males, only household heads, prime age
  - other measures: p90-p60 vs p40-p10 ratios, p80-p50 vs p50-p20 ratios

A model of firm dynamics and labor market frictions

- Search frictions and sorting (Lise et al 16)
  - search frictions as a source of misallocation (Martellini and Menzio 20)
  - search frictions vary with development (Poschke 19)
  - share of wage and salary employees increases with GDP p.c.

- Human capital accumulation on-the-job (Bagger et al 14, Flinn et al 17)
  - life-cycle wage growth higher in richer countries (Lagakos et al 18)
  - on-the-job training increases with GDP p.c.

- Industry dynamics (Hsieh and Klenow 14, Fajgelbaum 20)
  - larger firms in richer countries (Bento and Restuccia 2018)
  - dispersion and skewness of firm size increase with GDP p.c. (Poschke 18)
  - larger firms pay higher wages (Bloom et al 18)
  - larger firms provide more on-the-job training

Demographics

- Discrete time
- Unitary measure of heterogeneous workers
  - stochastic life-cycle in the labor market
  - employed or non-employed
  - ex-ante exogenous skill, h^0, distributed with density $\psi_h(h) \in \mathcal{H} = \{h_0, h_1, ..., h_H\}$
  - on-the-job learning - one-step jump forward with prob. p^e
  - on-the-job training - one-step jump forward with prob. p^t
  - depreciation when non-employed - one-step jump backward with prob. p^d
  - value of non-employed, home production, b
- Endogenous measure of heterogeneous firms
  - innate productivity, z, distributed with density $\psi_z(z)$ on $\mathbb{R}^+$
  - training costs, ξ, distributed with density $\psi_\xi(\xi)$ on $\mathbb{R}^+$
  - entry-exit dynamics
  - firm growth bounded by convex vacancy costs

- Firm-level production technology

$$y = \int_0^{\ell} g(z,i)\psi_h^e(i|z,\xi)di$$

where $\psi_h^e(i|z,\xi)$ denotes the share of worker i in a firm (z,ξ) with total workforce ℓ

- Firm-worker match production:

$$g(z,i) = zh(i)$$

where $h(i)$ is the human capital of worker i

- Linearity of technology:

$$y = z\bar{h}\ell$$

where $\bar{h}$ is the average human capital of workers employed in the firm

$$\bar{h} = \int_0^{1} h(i)\psi_h^e(i|z,\xi)di$$

- Firms subject to output distortions (Bento and Restuccia 18)
  - Each firm retains a fraction $1 - \tau$ of its output, assumed to depend on firm-level productivity z
    $$\tau(z) = 1 - z^{-\zeta}$$
    where ζ is the elasticity of firm′s distortion to its productivity
- Search and matching frictions (Mortensen and Pissarides 99)
  - CRS matching functions between searchers U (only non-employed) and vacancy v
    $$m(U, v) = \frac{Uv}{(U^{\eta} + v^{\eta})^{\frac{1}{\eta}}}$$
    where η governs the elasticity of contacts to vacancies
  - Exogenous and endogenous separation

- Wages are the solution to a Nash bargaining problem

$$w(z,\xi,h) = \arg\max_{w} \left[\underbrace{J^{e,h}(z,\xi,h;w) - J^{u,h}(h)}_{\text{worker surplus}}\right]^{\beta} \left[\underbrace{V^{h}(z,\xi,h;w)}_{\text{firm surplus}}\right]^{1-\beta}$$

where $\beta \in (0,1)$ is the workers' bargaining power

- Training decision at a match level (Flinn et al 17)

$$\mathbf{1}^{t}(z,\xi,h) = \arg\max_{\mathbf{1}^{t}\in\{0,1\}} \quad \mathbf{1}^{t} p^{t}[S^{h}(z,\xi,h+1) - S^{h}(z,\xi,h)] - \mathbf{1}^{t}\xi$$

where p^t is the probability of skill jump and

$$S^{h}(z,\xi,h) = J^{e,h}(z,\xi,h) - J^{u}(h) + V^{h}(z,\xi,h)$$

- Match formation decision: $\mathbf{1}^{h}(z,\xi,h) = \begin{cases} 1 & \text{if} \quad S^{h}(z,\xi,h) \geq 0 \\ 0 & \text{otherwise} \end{cases}$

Firm vacancy posting and entry

- Per-period firm problem

$$\pi(z,\xi) = \max_{v(z,\xi)\geq 0} \quad v(z,\xi)\phi_f \sum_{h\in\mathcal{H}} \max\{0,(1-\beta)S^h(z,\xi,h)\}\psi_h^u(h) - c(v(z,\xi))$$

where

  - ψ_h^u is the distribution of ability of the unemployed
  - $c(\cdot)$ are vacancy costs, with $c' > 0$, $c'' > 0$
  - ϕ_f is the vacancy contact probability

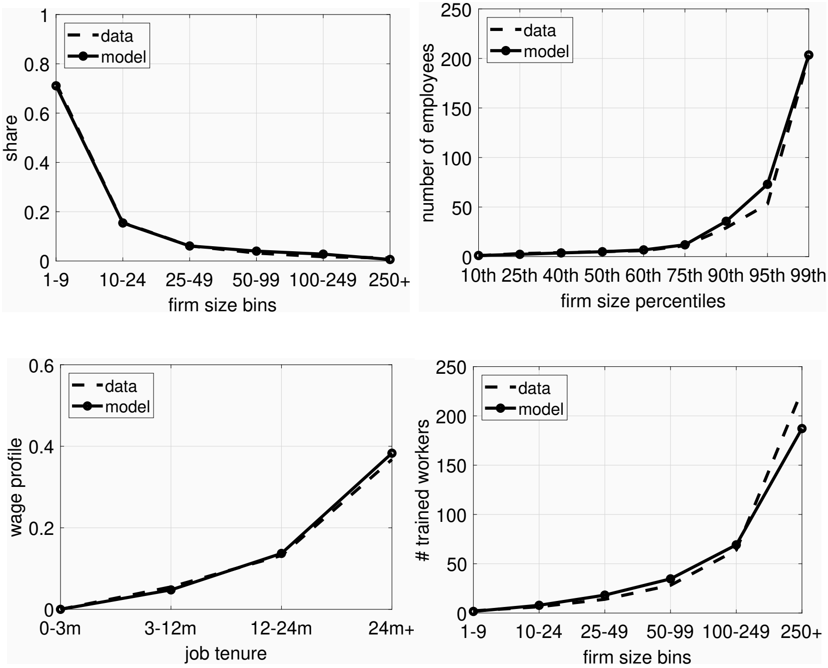
- Discounted sum of per-period aggregate profits

$$\Pi(z,\xi) = \sum_{t=0}^{\infty}\left(\frac{1-\delta_f}{1+r}\right)^t \pi(z,\xi) = \frac{1+r}{r+\delta_f}\pi(z,\xi)$$

- Entry decision: $\mathbf{1}^e(z,\xi) = \begin{cases} 1 & \text{if} \quad \Pi(z,\xi)\geq c^e \\ 0 & \text{otherwise} \end{cases}$

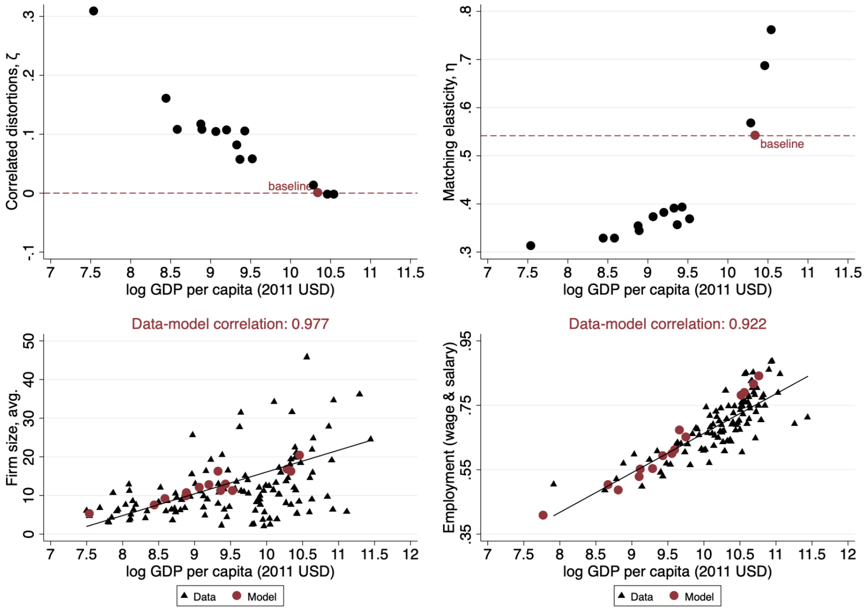
- No free entry: exogenous measure of potential entrants M

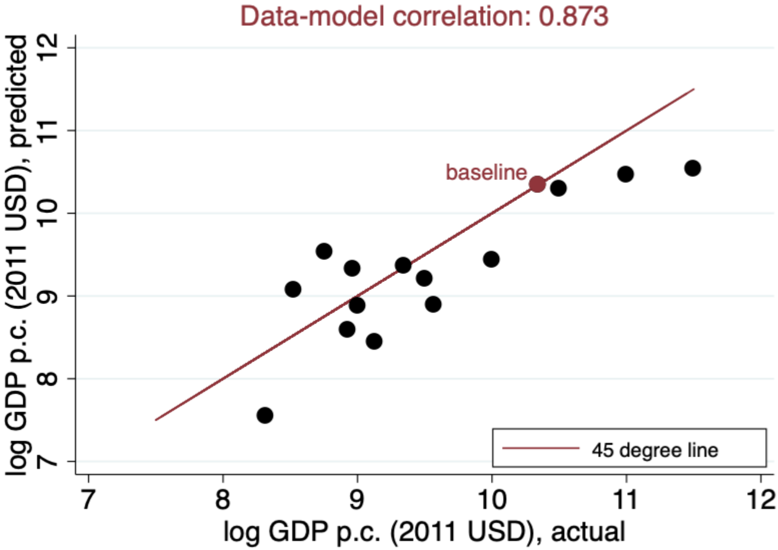
- Baseline economy: UK, 2010-2016
  - Five-Quarter Longitudinal Labor Force Survey: workers age, employment status, job tenure, hours worked, OTJ training
  - The Employer Skill Survey: firm size, OTJ training
- Functional form: hiring costs, initial workers' human capital, firm-level productivity, firm-level training costs
- Assumptions:
  - stationary equilibrium
  - baseline economy, $\zeta = 0$
- Matching elasticity η estimated outside the model using GMM
- 13 parameters estimated using MCMC (Chernozhukov and Hong 2003)
- 45 worker- and firm-level targets, non-targeted moments, estimation fit



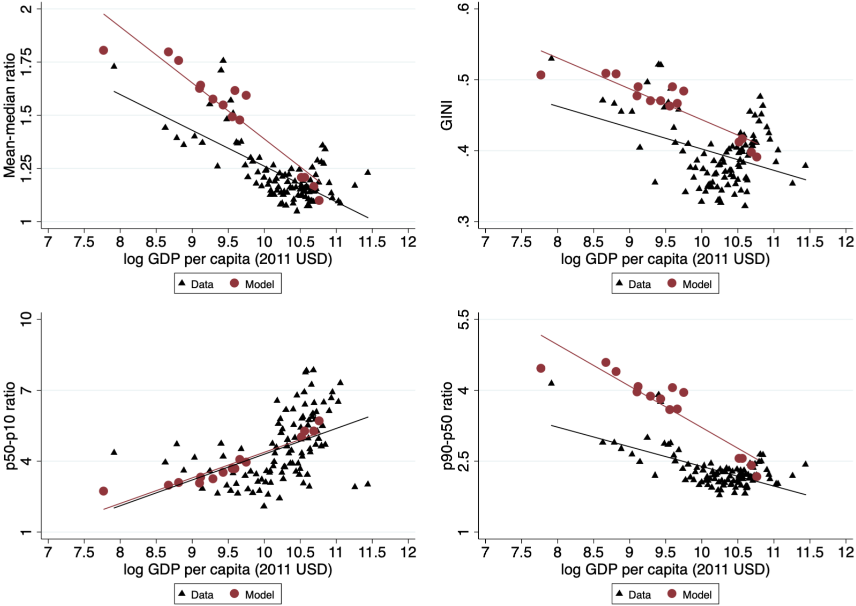
data
model
share
firm size bins
1-9
10-24
25-49
50-99
100-249
250+
number of employees
firm size percentiles
10th 25th 40th 50th 60th 75th 90th 95th 99th
wage profile
job tenure
0-3m
3-12m
12-24m
24m+
trained workers
firm size bins

Estimated distortions across countries

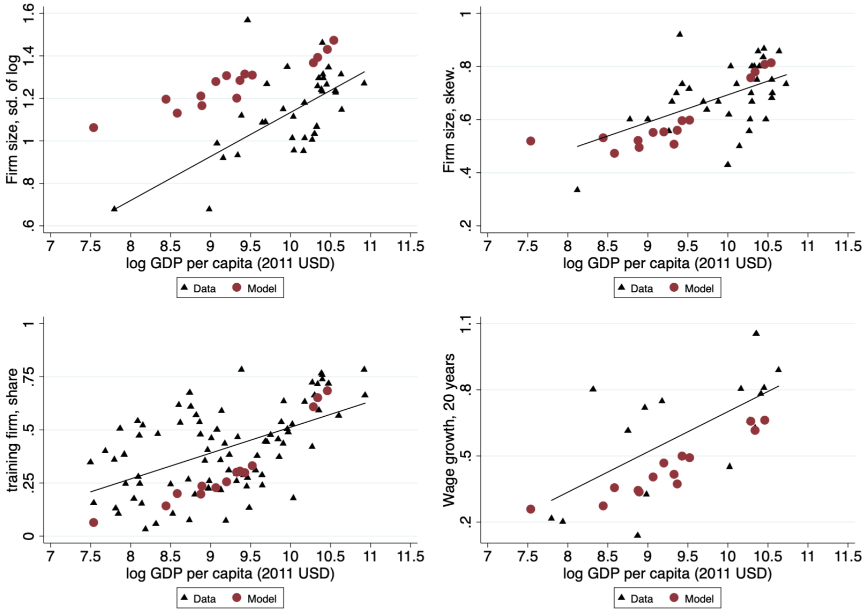


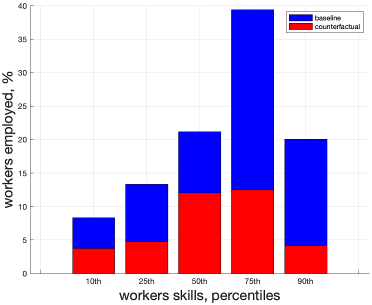

Data-model correlation: 0.873
log GDP p.c. (2011 USD), predicted
12
11
10
9
8
7
baseline
45 degree line
7
8
9
10
11
12
log GDP p.c. (2011 USD), actual

Earnings inequality across countries

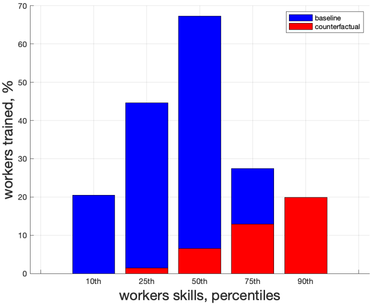


Beyond earnings inequality...





Employment



OTJ Training

- UK vs Indonesia
- OTJ training explains up to 40% of changes in earnings inequality
- Large scale re-training program increases average wage by 16%

- We document how the distribution of labor earnings varies with development
    - inequality at the top shrinks, inequality at the bottom expands
    - the median increases faster than the mean
    - GINI declines
- We build a model of labor market to interpret this evidence
    - positive sorting between workers and firms
    - OTJ training provided by larger (and more productive) firms
- Cross-country patterns can be reproduced by two sources of misallocation
    - firm-level correlated distortions
    - lower labor market visibility
- OTJ training account up to 40% of changes in earnings inequality
- Alternative mechanisms...

Data Source

Country	Year	Source	Country	Year	Source
Austria	2005, 2010	EU-SILC	Latvia	2006, 2010	EU-SILC
Belgium	2005, 2009	EU-SILC	Lithuania	2006, 2009	EU-SILC
Bulgaria	2007	EU-SILC	Luxembourg	2005, 2010	EU-SILC
Croatia	2010	EU-SILC	Malta	2007, 2010	EU-SILC
Cyprus	2005, 2010	EU-SILC	Netherlands	2006, 2010	EU-SILC
Czech republic	2006, 2009	EU-SILC	Norway	2005, 2010	EU-SILC
Denmark	2005, 2009	EU-SILC	Panama	1970	IPUMS
Dominican Republic	1981	IPUMS	Poland	2005, 2009	EU-SILC
Estonia	2005, 2010	EU-SILC	Portugal	2005, 2010	EU-SILC
Finland	2005, 2009	EU-SILC	Puerto Rico	1990, 2000, 2005	IPUMS
France	2005, 2010	EU-SILC	Romania	2007, 2009	EU-SILC
Germany	2005, 2009	EU-SILC	Slovakia	2006, 2009	EU-SILC
Greece	2005, 2009	EU-SILC	Slovenia	2006, 2009	EU-SILC
Hungary	2006, 2010	EU-SILC	Spain	2005, 2009	EU-SILC
Iceland	2005, 2010	EU-SILC	Sweden	2005, 2009	EU-SILC
Israel	1995	IPUMS	Switzerland	2007, 2009	EU-SILC
Italy	2005 2009	EU-SILC	Trinidad and Tobago	2000	IPUMS
India	1993, 1999	IPUMS	USA	2000, 2005, 2010	IPUMS
Indonesia	1976, 1995	IPUMS	Uruguay	2006	IPUMS
Ireland	2005, 2009	EU-SILC	United Kingdom	2005, 2009	EU-SILC
Jamaica	1981, 1991, 2001	IPUMS			

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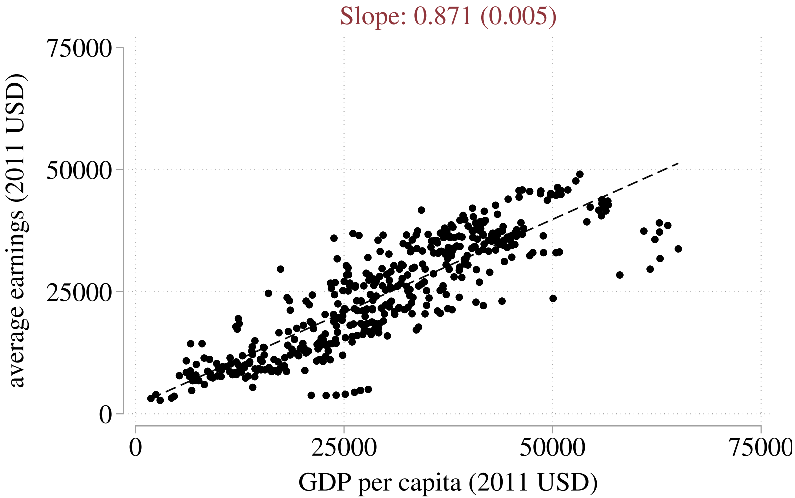
Average wage and salary earnings



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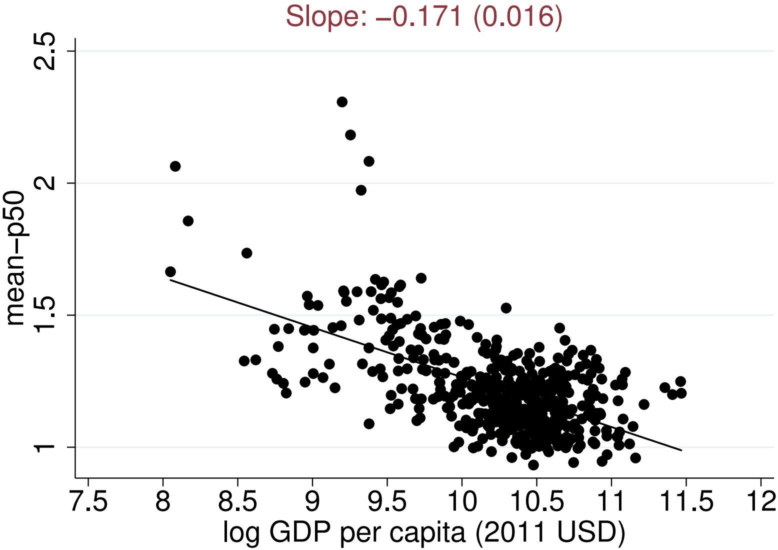
The median earnings grow faster than the mean



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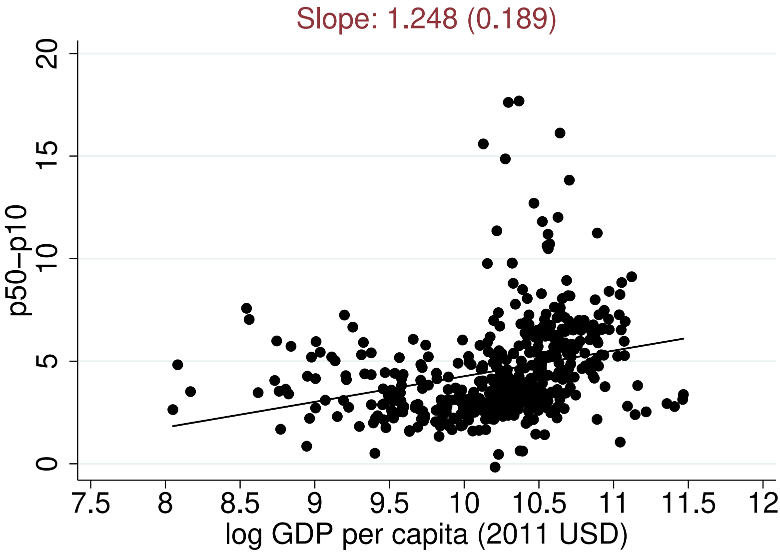
Inequality at the bottom increases...



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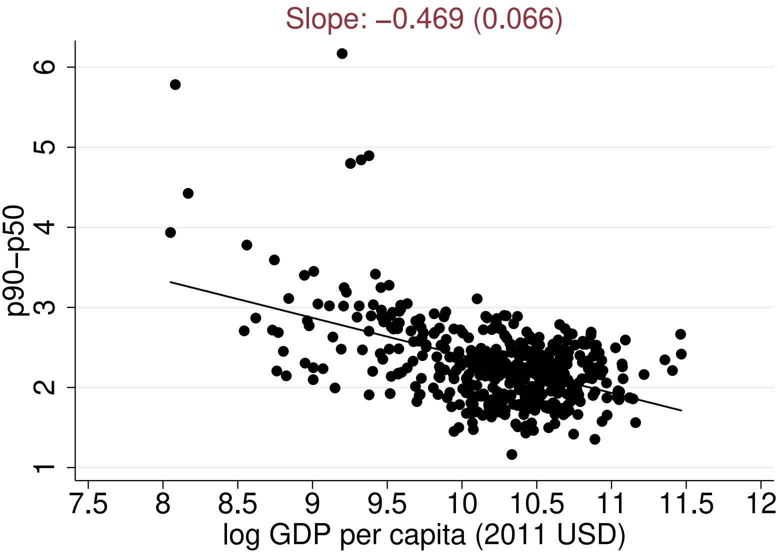
...while inequality at the top declines



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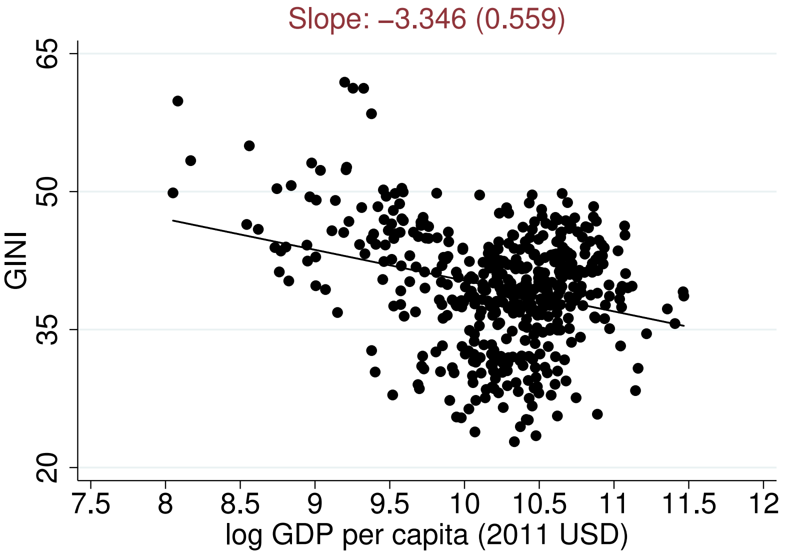
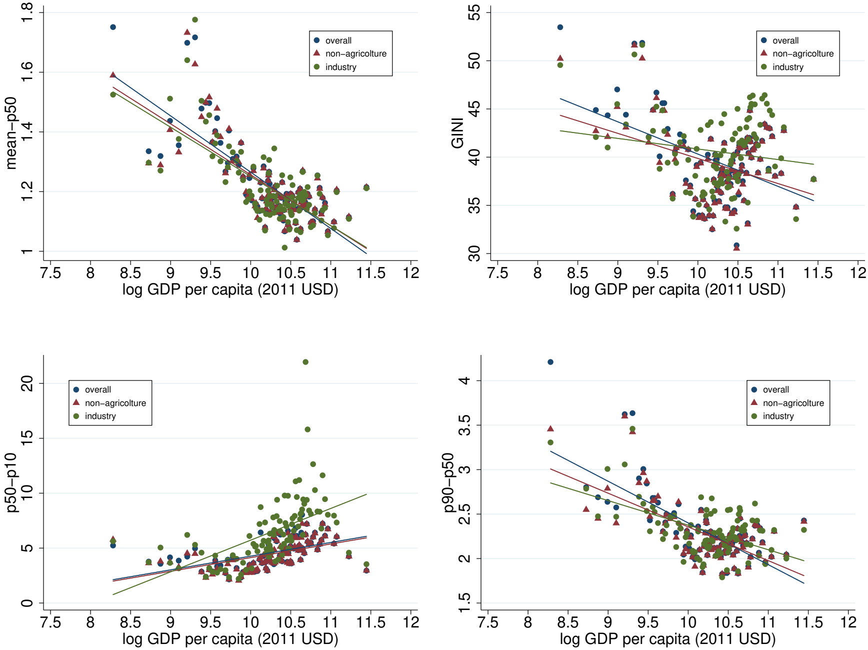

Slope: –3.346 (0.559)
GINI
65
50
35
20
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
log GDP per capita (2011 USD)

back



mean−p50
GINI
p50−p10
p90−p50
log GDP per capita (2011 USD)
overall
non−agricolture
industry

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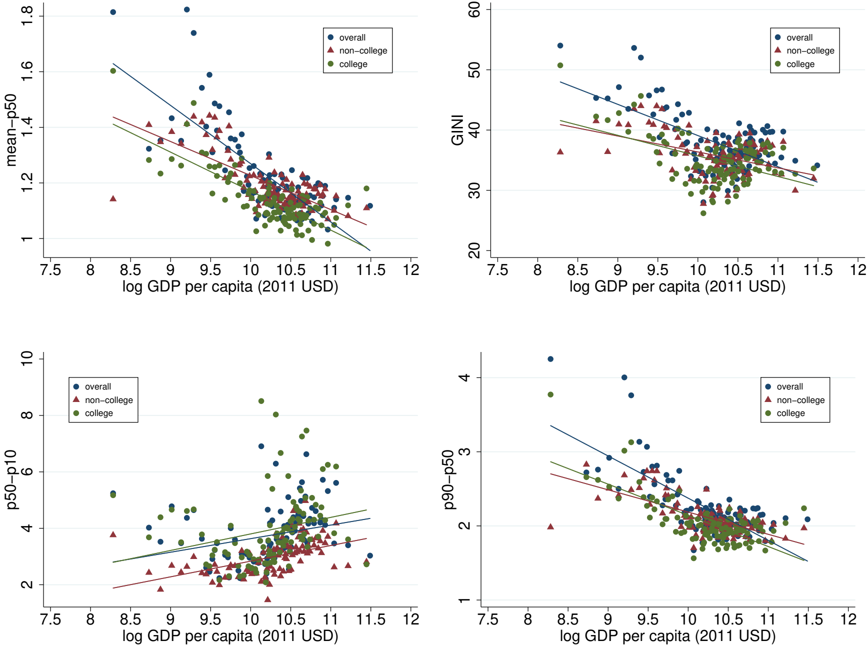
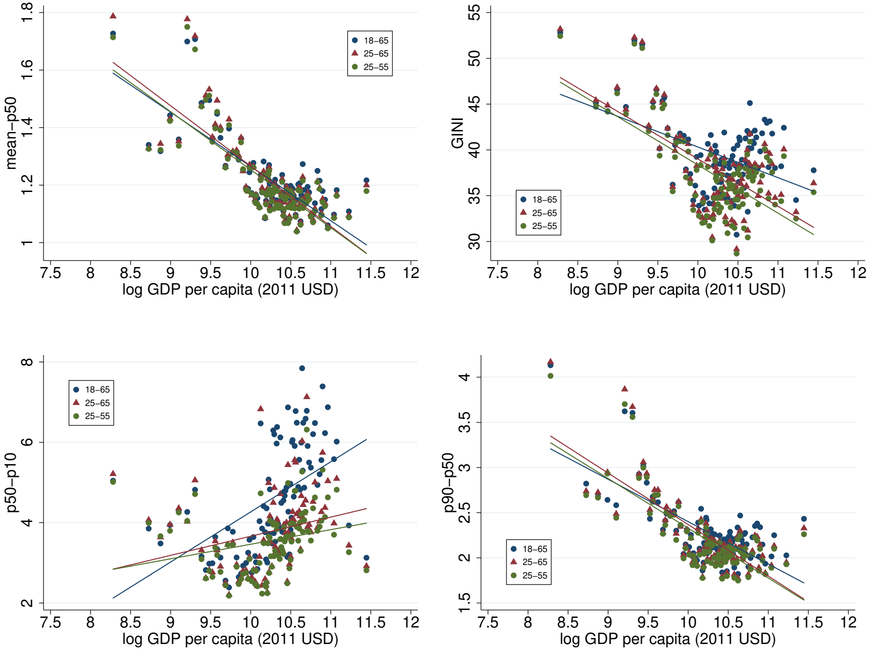
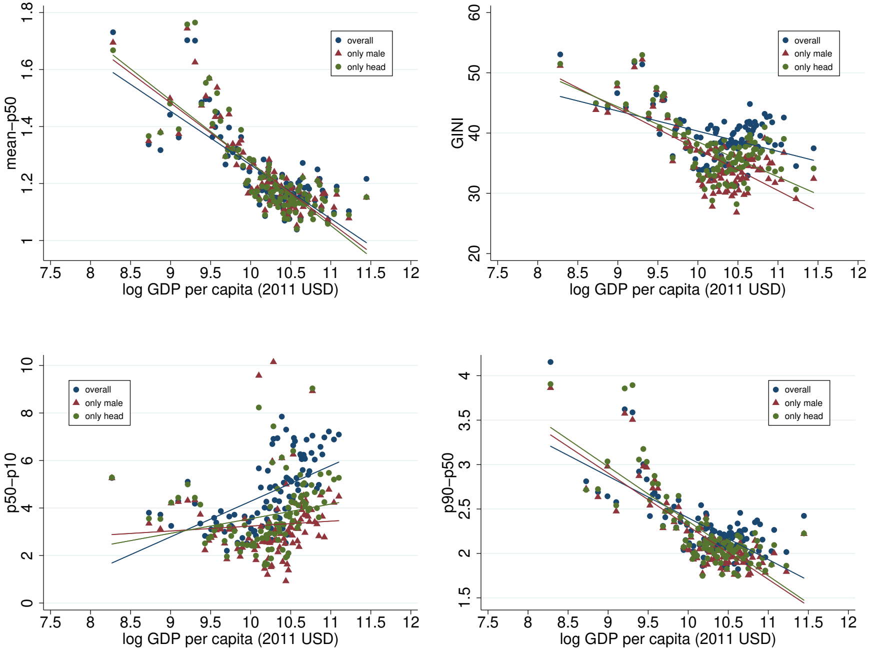

mean−p50
1.8
1.6
1.4
1.2
1
overall
non−college
college
7.5 8 8.5 9 9.5 10 10.5 11 11.5 12
log GDP per capita (2011 USD)
GINI
60
50
40
30
20
overall
non−college
college
7.5 8 8.5 9 9.5 10 10.5 11 11.5 12
log GDP per capita (2011 USD)
p50−p10
10
8
6
4
2
overall
non−college
college
7.5 8 8.5 9 9.5 10 10.5 11 11.5 12
log GDP per capita (2011 USD)
p90−p50
4
3
2
1
overall
non−college
college
7.5 8 8.5 9 9.5 10 10.5 11 11.5 12
log GDP per capita (2011 USD)

back

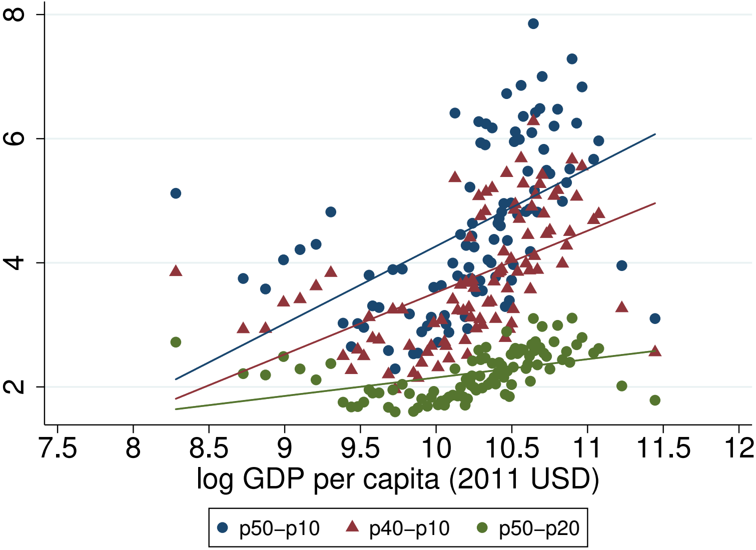

mean−p50
log GDP per capita (2011 USD)
18−65
25−65
25−55
GINI
log GDP per capita (2011 USD)
18−65
25−65
25−55
p50−p10
log GDP per capita (2011 USD)
18−65
25−65
25−55
p90−p50
log GDP per capita (2011 USD)
18−65
25−65
25−55

back



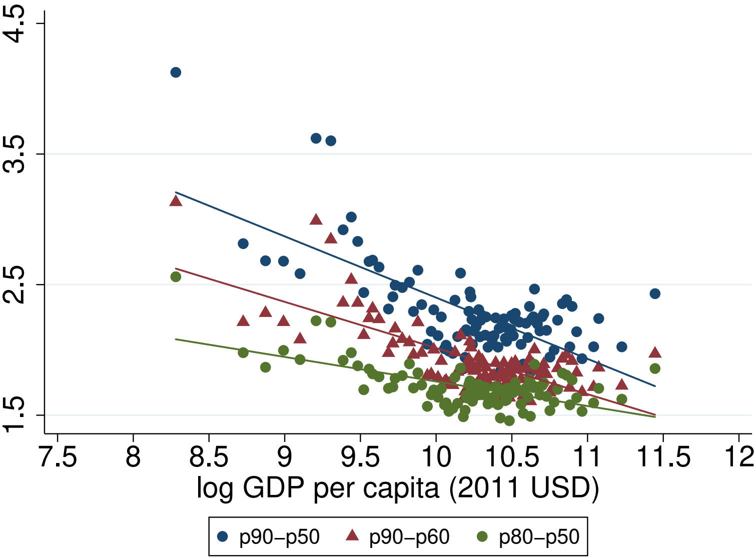
mean−p50
overall
only male
only head
log GDP per capita (2011 USD)
GINI
overall
only male
only head
log GDP per capita (2011 USD)
p50−p10
overall
only male
only head
log GDP per capita (2011 USD)
p90−p50
overall
only male
only head
log GDP per capita (2011 USD)

back



8
6
4
2
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
log GDP per capita (2011 USD)
p50−p10
p40−p10
p50−p20

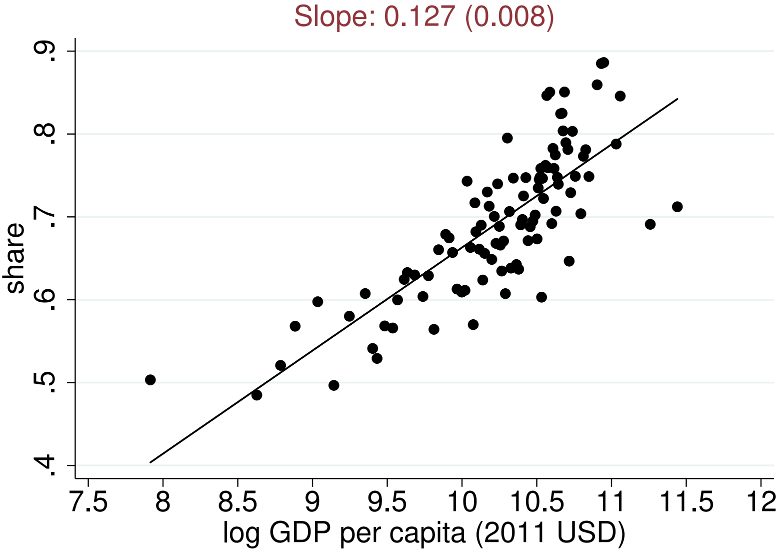
back



4.5
3.5
2.5
1.5
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
log GDP per capita (2011 USD)
p90−p50
p90−p60
p80−p50

back

Wage and salary employees



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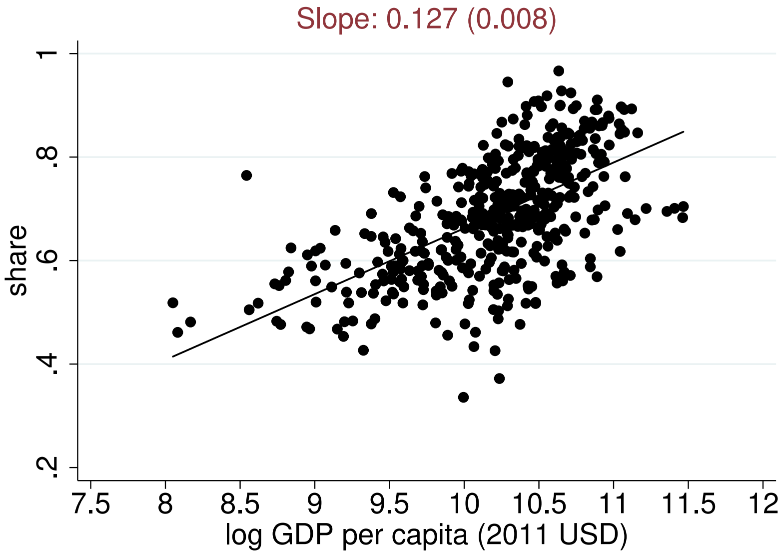
Wage and salary employees



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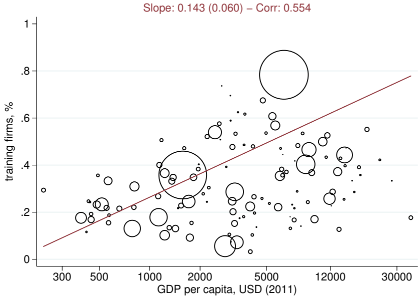
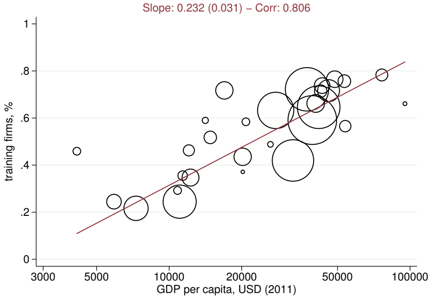
Share of training firms



Source: WB Enterprise Survey



Source: EC Education and Training Dataset

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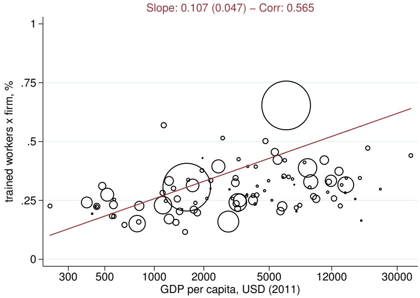
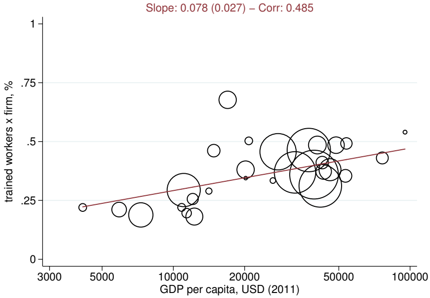
Share of workers trained in the firms



Source: WB Enterprise Survey



Source: EC Education and Training Dataset

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Share of training firms, by firm size

	Training firms, %						
	WB-ES					CVTS	
	LAC	ME+AFR	ASIA	others		EU15	non-EU15
Firm size (# employees)					Firm size (# employees)		
<20	34.84	18.42	19.32	26.35	<20	44.79	29.18
20-49	54.31	31.99	33.63	38.48	20-49	56.00	39.36
50-249	66.94	41.31	47.02	46.47	50-249	71.67	52.82
250-449	81.13	56.86	47.32	56.65	250-449	86.29	67.64
≥500	92.12	68.45	52.28	68.88	500-999	88.00	78.45
					≥1000	96.36	88.73

Source: World-Bank Enterprise Survey and Eurostat Education and Training Dataset.

back

Share of trained workers, by firm size

	Trained workers within firms, %						
	WB-ES					CVTS	
	LAC	ME+AFR	ASIA	others		EU15	non-EU15
Firm size (# employees)					Firm size (# employees)		
<20	34.36	21.01	27.95	29.63	<50	29.31	21.96
20-49	40.06	25.56	29.72	30.18	50-249	37.92	30.13
50-249	44.35	26.68	35.51	30.36	≥500	49.71	46.25
250-449	52.51	30.30	32.22	28.86			
≥500	50.73	32.37	34.34	28.98			

Source: World-Bank Enterprise Survey and Eurostat Education and Training Dataset.

back

- The value of being not-employed

$$J^u(h) = (1-\phi_w)[p^d J^{u,h}(h-1) + (1-p^d)J^{u,h}(h)]$$
$$+\phi_w \int_{z\in\mathcal{Z}}\int_{\xi\in\mathcal{E}} [\mathbf{1}^h(z,\xi,h)J^{e,h}(z,\xi,h) + (1-\mathbf{1}^h(z,\xi,h))J^{u,h}(h)]\psi_v(z,\xi)d\xi dz,$$

where

$$J^{u,h}(h) = b + \frac{(1-\delta^w)}{1+r}J^u(h).$$

back

- The value of being employed:

$$J^e(z,\xi,h) = \mathbf{1}^h(z,\xi,h)J^{e,h}(z,\xi,h) + (1-\mathbf{1}^h(z,\xi,h))J^{u,h}(h),$$

where

$$J^{e,h}(z,\xi,h) = w(z,\xi,h) + \frac{(1-\delta^w)}{1+r}(\delta_f + (1-\delta_f)\delta_s)J^{u,h}(h) + \frac{(1-\delta^w)}{1+r}(1-\delta_f)(1-\delta_s)\tilde{J}^{e,h}(z,\xi,h)$$

and

$$\tilde{J}^{e,h}(z,\xi,h) = [p^h(z,\xi,h)J^e(z,\xi,h+1) - (1-p^h(z,\xi,h))J^e(z,\xi,h)]$$

back

- The value of a match

$$V(z,\xi,h) = \mathbf{1}^h(z,\xi,h)V^h(z,\xi,h),$$

where

$$V^h(z,\xi,h) = r(z,h) - w(z,\xi,h) + \frac{(1-\delta_w)}{1+r}(1-\delta_f)(1-\delta_s)\tilde{V}^h(z,\xi,h)$$

and

$$\tilde{V}^h(z,\xi,h) = \left[\mathbf{1}^t(z,\xi,h)\xi + p^h(z,\xi,h)V(z,\xi,h+1) + (1-p^h(z,\xi,h))V(z,\xi,h)\right]$$

back

Equilibrium

A stationary RCE consists of workers' and firms' value functions, policy functions for job creation, training, firms' entry and vacancy posted, wage schedule, job contact probabilities for workers and firms, unemployment rate, distribution of employed and unemployed workers across states, distribution of vacancies and firms across states, s.t.:

- *optimality*: the value functions attain their maximum;
- *bargaining*: the wage schedule is the solution of the bargaining problem;
- *training*: training policies maximise surplus;
- *market clearing*: goods and labor market are cleared;
- *measure of entrants*: for all Borel sets $\mathcal{Z} \times \mathcal{E} \subset \mathcal{R}^+ \times \mathcal{R}^+$ it must be that

$$E(\mathcal{Z} \times \mathcal{E}) = M_e \int_{z \in \mathcal{Z}} \int_{\xi \in \mathcal{E}} \mathbf{1}^e(z, \xi) \psi_z(z) \psi_\xi(\xi) dz d\xi$$

  where M_e is the measure of potential entrants
- *measure of incumbent*: for all Borel sets $\mathcal{Z} \times \mathcal{E} \subset \mathcal{R}^+ \times \mathcal{R}^+$ it must be that

$$\Gamma(\mathcal{Z} \times \mathcal{E}) = \frac{1}{\delta_f} E(\mathcal{Z} \times \mathcal{E})$$

- *aggregate consistency*: workers′ and vacancies′ distributions replicate themselves through workers′ and firms′ policy functions. back

- Matching function b/w job seekers U, and vacancies, v:

$$m(U,v) = \frac{Uv}{(U^{\eta} + v^{\eta})^{\frac{1}{\eta}}}, \quad \eta > 0$$

- Convex hiring costs:

$$c(v) = \lambda^{-1} v^{\lambda}, \quad \lambda > 1$$

- Initial human capital distribution:

$$h \sim \log\mathcal{N}(0, \sigma_h), \quad \sigma_h > 0$$

- Firm-level productivity distribution:

$$z \sim \log\mathcal{N}(0, \sigma_z), \quad \sigma_z > 0$$

- Firm-level training costs:

$$\xi \sim \mathcal{U}(\underline{\xi}, \overline{\xi}), \quad \underline{\xi}, \overline{\xi} > 0$$

back

- η is estimated to minimize the following objective function:

$$\arg \max_{\{x_0,x_1,x_2,x_3\}} \left[\left(\frac{1}{T} \sum_{t=1}^{T} Z_t' \epsilon_t(x) \right)' W_T \left(\frac{1}{T} \sum_{t=1}^{T} Z_t' \epsilon_t(x) \right) \right]$$

where $\epsilon_t(x)$ denotes the moment conditions, i.e.

$$\epsilon_t(x) = \left[h_t - \frac{u_t v_t}{(u_t^{x_0} + v_t^{x_0})^{\frac{1}{x_0}}} - \sum_{i=1}^{4} x_i \mathbf{1}_t^{\mathrm{q}=i} \right]$$

with h_t equal to the number of new hirings at time t, v_t the number of open vacancy and u_t the number of non-employed workers

- Seasonal effects removed by including dummies for quarters
- The vector of instruments, Z_t' includes fourth lags for non-employment and active vacancies
- Two-step GMM: estimate of $\hat{\eta} = \hat{x}_0$ =0.5417 with a s.e.=0.0134

back

Summary statistics

	Mean	SD	Min	Max	N
Employed workers					
Age	41.629950	11.638060	22	62	85,524
Female	0.5054908	0.4999703	0	1	85,524
Full-time	0.7559546	0.4295223	0	1	85,524
Hours worked	37.043440	12.098500	1	97	85,524
Log Hourly pay	2.385007	0.5989295	0.025252	7.247456	85,524
Log Quarterly Earnings	8.456721	0.8237451	3.955738	13.39207	85,524
Training	0.2442638	0.4296524	0	1	85,524
Tenure$<$3 months	0.0377040	0.1904806	0	1	85,524
Tenure$\in$[3,12) months	0.0385089	0.1924224	0	1	85,524
Tenure$\in$[12,24) months	0.1085912	0.3111274	0	1	85,524
Tenure$\geq$24 months	0.8151959	0.3881409	0	1	85,524

Source: Five-Quarter Longitudinal LFS

back

Estimates and standard errors

Parameters	Description	Value	Source/Targets		
r	Interest rate	0.0033	annual return of 4%		
δ_w	Workers retirement	0.0099	life-span of 40 years, ages 25-65		
δ_f	Firm exit	0.0253	annual exit rate of 10.50% (ONS)		
Parameters	Description	Estimates	St.Dev.	95% C.I.	
δ_s	Match separation	0.01235	0.0012	0.010065	0.014859
b	Home production	20.9430	1.8241	17.589	25.057
M_e	Measure of potential entrants	0.01272	0.0444	0.0008	0.1493
c_e	Entry cost	39.262	3.6646	33.186	47.613
$\underline{\xi}$	Training cost (lower bound)	1.7346	0.1569	1.4546	2.1103
$\bar{\xi}$	Training cost (upper bound)	26.668	2.3036	22.124	31.580
λ_1	Hiring costs, convexity	2.5246	0.1656	2.0633	2.7461
β	Bargaining power	0.4573	0.0416	0.3789	0.5497
σ_h	Initial human capital dispersion	1.1950	0.1110	0.9767	1.4246
σ_z	Firm-productivity dispersion	1.2044	0.1060	1.0178	1.4697
p^e	Experience jump	0.2233	0.0194	0.1836	0.2709
p^t	Training jump	0.0282	0.0030	0.0233	0.0347
p^d	Depreciation jump	0.4318	0.0400	0.3455	0.5142

back

Targeted moments

	Data	Model		Data	Model
Firm-level moments			*Worker wage distribution*		
Number of firms (over population)	0.171	0.158	Wage at entry, $\mathrm{E}[\log(w_1/\bar{w})]$	-0.5176	-0.5048
$\mathrm{E}(\ell_t)$	16.423	16.185	Wage after 20 y.o., $\mathrm{E}[\log(w_{20}/\bar{w})]$	0.1071	0.1093
$\mathrm{E}(\log \ell_t)$	1.7393	1.6996	Wage at re-emp, $\mathrm{E}[\log(w_R/\bar{w})]$	-0.3010	-0.1695
$\mathrm{std}(\log \ell_t)$	1.2198	1.3922	Dispersion at entry, $\mathrm{sd}[\log w_1]$	0.5818	0.6749
			Dispersion after 20 y.o., $\mathrm{sd}[\log w_{20}]$	0.7959	0.7954
Firm-size distribution			Dispersion at re-emp, $\mathrm{sd}[\log w_R]$	0.8335	0.8329
1-9 employees	72.12	71.08			
10-24 employees	15.95	15.43	*Trained workers*		
25-49 employees	6.12	6.09	$E\left(\frac{\#\text{trained workers}}{\#\text{workers}}\right)$	0.2114	0.24715
50-99 employees	3.21	4.00			
100-249 employees	1.73	2.78	*Worker-level training return*		
250+ employees	0.88	0.62	$\log w_{it} = \beta_1 \mathbf{1}^t_{it} + \epsilon_{it}$	0.1991	0.20773

back

Targeted moments

	Data	Model		Data	Model
Firm-size percentiles			*Job tenure return*		
10th percentile	1	1.083	tenure<3 months	1	1
25th percentile	3	2.285	tenure∈[3,12) months	1.0551	1.0539
40th percentile	4	3.696	tenure∈[12,24) months	1.1320	1.1434
50th percentile	5	4.900	tenure≥24 months	1.3675	1.3893
60th percentile	6	6.732			
75th percentile	11	11.893	*Workers trained within the firm*		
90th percentile	29	35.631	overall	9.121	7.953
95th percentile	53	72.979	1-9 employees	2.229	1.625
99th percentile	202	203.50	10-24 employees	6.381	7.850
			25-49 employees	13.951	18.054
Firm training provision			50-99 employees	28.150	34.395
$E\left(\frac{\#training\ firms}{\#firms}\right)$			100-249 employees	63.816	69.194
overall	0.646	0.650	250+ employees	225.70	186.17
1-49 employees	0.611	0.644			
20-249 employees	0.776	0.714	*Aggregate moments*		
250+ employees	0.855	0.888	Job duration	5.360	5.036
$E\left(\frac{\#trained\ employees}{\#employees}\right)$			Employment rate	0.776	0.788
overall	0.4588	0.4843			

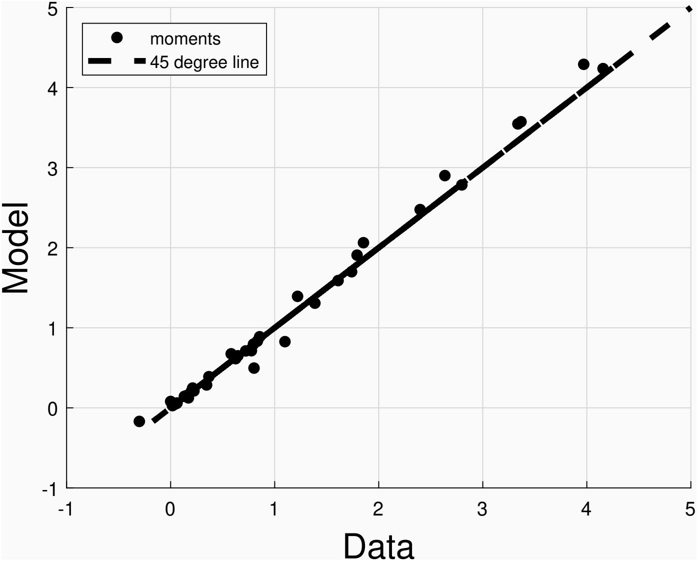
back

Non-targeted moments

	Data	Model
Wage-size regression		
$<$10 employees	0	0
$\in [10, 25)$ employees	0.151	0.183
$\in [25, 50)$ employees	0.244	0.342
$\in [50, 250)$ employees	0.407	0.680
$\geq$250 employees	0.586	1.039
Wage inequality		
Log-wage dispersion, $\text{sd}[\log w_{it}]$	0.7788	0.9317
Mean-median wage ratio, $\text{E}[w_{it}]/\text{p}^{50}[w_{it}]$	1.2763	1.2067
90-50 pct. wage ratio, $\text{p}^{90}[w_{it}]/\text{p}^{50}[w_{it}]$	2.4100	2.5506
50-10 pct. wage ratio, $\text{p}^{50}[w_{it}]/\text{p}^{10}[w_{it}]$	2.9384	3.2618

back

Estimation fit



back

The role of OTJ training

	Baseline	Counterfactual		Explained
Elasticity of matching function: η	0.54167	0.54167	0.31281	-
Distortion correlation: ζ	0	0.30841	0	-
Home production: b	20.9430	20.9430	3.5047	-
Training policy: $\mathbf{1}^t(z, \xi, h)$	baseline	counterfactual		-
Aggregates				
Non-employment rate	0.2116	0.2361	0.5925	6.432%
Average wage	1	0.9323	0.1241	7.729%
Income per capita	1	0.9030	0.0611	10.331%
Wage profile over experience/tenure				
Wage growth, $\mathrm{E}[\log(w_{25}/\bar{w}_1)]$	0.8013	0.7596	0.2797	7.994%
Wage at tenure, $\geq$24 months	0.3893	0.4241	0.5833	17.938%
Wage inequality				
Mean-median wage ratio	1.2067	1.2687	1.8047	10.367%
GINI	0.4160	0.4255	0.5061	10.543%

back

A world without OTJ training

	Baseline	Counterfactual	Baseline	Counterfactual	Explained
	with OTJ training		w/o OTJ training		
Elasticity of matching function: η	0.54167	0.31281	0.54167	0.31281	-
Distortion correlation: ζ	0	0.30841	0	0.30841	-
Home production: b	20.9430	3.5047	20.9430	3.5047	-
Aggregates					
Non-employment rate	0.2116	0.5925	0.2028	0.4391	37.962%
Average wage	1	0.1241	1	0.1402	1.838%
Income per capita	1	0.0611	1	0.0864	2.694%
Wage profile over experience/tenure					
Wage growth, $E[\log(w_{25}/\bar{w}_1)]$	0.8013	0.2797	0.7308	0.3628	29.447%
Wage at tenure$\geq$24 months	0.3893	0.4241	0.3697	0.4768	32.492%
Wage inequality					
Mean-median wage ratio	1.2067	1.8047	1.2795	1.6674	35.133%
GINI	0.4160	0.5061	0.4162	0.4874	20.987%

back

Implications for wage inequality

	UK	Indonesia	
	Baseline	Counterfactual	Data
Elasticity of matching function: η	0.54167	0.31281	-
Distortion correlation: ζ	0	0.30841	-
Home production: b	20.9430	3.5047	-
Mean-median wage ratio, $\mathrm{E}[w_{it}]/\mathrm{p}^{50}[w_{it}]$	1.2067	1.8047	1.6872
GINI	0.4160	0.5061	0.5023
90-50 pct. wage ratio, $\mathrm{p}^{90}[w_{it}]/\mathrm{p}^{50}[w_{it}]$	2.5506	4.4619	3.1818
50-10 pct. wage ratio, $\mathrm{p}^{50}[w_{it}]/\mathrm{p}^{10}[w_{it}]$	5.2618	2.7292	1.9342

back

	UK Baseline	Indonesia Counterfactual
Elasticity of matching function: η	0.54167	0.31281
Distortion correlation: ζ	0	0.30841
Home production: b	20.9430	3.5047
Firm-level moments		
Average firm size, $\mathrm{E}(\ell_t)$	16.1854	5.1789
Firm size dispersion, $\mathrm{std}(\ell_t)$	37.1581	4.5762
Firm size skewness, $\mathrm{skew}(\ell_t)$	5.1774	1.6518
Firm training provision		
$\mathrm{E}\left(\frac{\#\text{training firms}}{\#\text{firms}}\right)$, %	65.02	6.21
Wage profile over experience/tenure		
Wage growth, $\mathrm{E}[\log(w_{25}/w_1)]$	0.8013	0.2797
Wage at tenure$\geq$24 months	0.3893	0.5833
Worker-level firm-size wage premium		
$\log w_{it} = \beta_1 \log \ell_{it} + \epsilon_{it}$	0.0663	0.1388
Training firm wage premium		
$\log w_{jt} = \beta_1 \mathbf{1}^t_{jt} + \epsilon_{jt}$	0.0397	0.0828
Aggregates		
Non-employment rate	0.2116	0.5925
Average wage	1	0.1241
Income per capita	1	0.0611

back

Re-training program for non-employed (Alfonsi et al 21)

- Assumptions: a share of non-employed workers have the option of either searching for job or participating to a re-training program while postponing job search
- Value of being not-employed for a worker with ability h is now equal to

$$J^u(h) = \gamma \max\{J^r(h), J^s(h)\} + (1-\gamma)J^s(h) \quad \gamma \in (0,1)$$

where

  - γ: probability of being eligible for re-training
  - value of re-training equal to

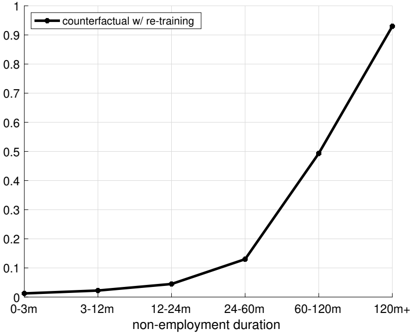
$$J^r(h) = p^t J^{u,h}(h+1) + (1-p^t)J^{u,h}(h)$$

  - value of searching for a job

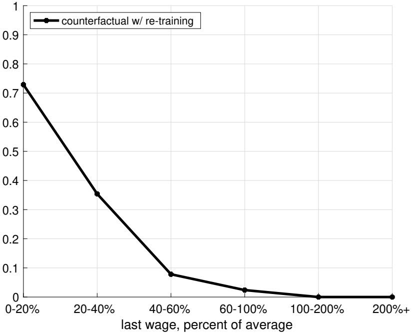
$$J^s(h) = J^{u,h}(h) + (1-\phi_w)p^d[J^{u,h}(h-1) - J^{u,h}(h)] + \phi_w \int_{z,\xi} \mathbf{1}^h(z,\xi,h)[J^{e,h}(z,\xi,h;w) - J^{u,h}(h)]\psi_v(z,\xi)d\xi dz,$$

back

Re-training attainment



by unemployment duration



by wage of last job

- Long-term non-employed more likely to re-train
- Low-wage workers more like to re-train

back

	U.K. Baseline	Indonesia Counterfactual	
Elasticity of matching function: η	0.54167	0.31281	0.31281
Distortion correlation: ζ	0	0.30841	0.30841
Home production: b	20.9430	3.5047	3.5047
Re-training under non-employment	no	yes	no
Eligibility: γ	0%	100%	0%
Total cost per re-trained individual:	-	510 USD	-
Re-trained workers			
$E\left(\frac{\#\text{re-trained workers}}{\#\text{non-employed workers}}\right)$, %	0	42.77	0
Aggregates			
Non-employment rate	0.2116	0.2679	0.5925
Average wage	1	0.1403	0.1241
Income per capita	1	0.0946	0.0611
Income per capita (net of re-training costs)	1	0.0759	0.0611
Wage profile over experience			
Wage growth, $E[\log(w_{25}/\bar{w}_1)]$	0.8013	0.3289	0.2797
Wage inequality			
GINI	0.4160	0.4998	0.5061
Mean-median wage ratio	1.2067	1.7871	1.8047

back

Alternative mechanisms

	U.K. Baseline	Indonesia Counterfactual			
		Joint (η, ζ)	Only δ_s (1)	Only δ_f (2)	Joint (δ_s, ζ) (3)
Elasticity of matching function: η	0.54167	0.31281	0.54167	0.54167	0.54167
Distortion correlation: ζ	0	0.30841	0	0	0.65942
Separation rate: δ_s, %	1.235	1.235	5.179	1.235	5.179
Firm exit rate: δ_f, %	2.526	2.526	2.526	3.253	2.526
Home production: b	20.9430	3.5047	15.9428	19.4512	1.4002
Average firm size, $E[\ell_t]$	16.1854	5.1774	10.2731	15.545	4.4207
Employment rate	0.7884	0.4075	0.6224	0.7411	0.6659
Income per capita	1	0.0611	0.5630	0.8900	0.0504
Training provision, overall %	65.02	6.21	50.08	60.31	0
Wage growth, $E[\log(w_{25}/w_1)]$	0.8013	0.2797	0.5678	0.7561	0.6143
Mean-median wage ratio	1.2067	1.8047	1.4818	1.2686	1.3267
GINI	0.4160	0.5061	0.4614	0.4297	0.4267

- (1): reduction in worker separation over development (Donovan et al. 2020)
- (2): larger firm turnover in less developed countries (Bartelsman et al. 2009)
- (3): reduction in separation (Donovan et al. 2020) + correlated distortions

back