

Accumulating valuable work experience: the importance of large firms and big cities

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39th meeting of the European Economic Association

Rotterdam, 26 August 2024

Background: size discussed to promote human capital accumulation

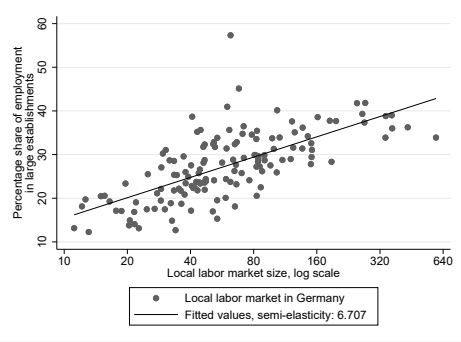
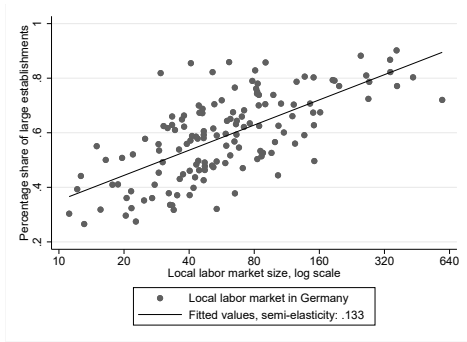
Urban economics

- Wages significantly higher in urban than in rural labour markets
- Duranton and Puga (2004): matching, sharing, *learning*
- Glaeser and Maré (2001), De La Roca and Puga (2017), and Peters (2020):
 - ▶ Labour market size promotes individual wage growth
 - ▶ Value of work experience increases with labour market size ('Learning by working in big cities')

Labour economics

- Mincer (1962), Becker (1964), and Acemoglu and Pischke (1998): role of firms for skill acquisition, training and on-the-job learning takes place inside firms
- Mion et al. (2020), Arellano-Bover and Saltiel (2021), and Jarosch et al. (2021): firm level effects on learning
- Oi and Idson (1999): firm size impacts human capital accumulation

Background II: positive correlation of labour market size and firm size



(a) Share of large establishments (>250 emp.) (b) Share of employment in large establishments

Figure: Correlation of establishment size and labor market size

This paper

- Distinguishes between learning effects related to firm size and labor market size
 - ▶ To what extent dynamic agglomeration advantages related to large firms?
- Data: administrative linked employer-employee data for Germany 1975–2011
- Identification: Exploit variation in wages and experience w.r.t. establishment size and labor market size within groups of workers with similar ability level
- Main results:
 - ▶ Almost same wage elasticity w.r.t size of previous labor markets like De La Roca and Puga (2017): 0.029
 - ▶ Effect of labor market size $\approx 28\%$ smaller (0.021), conditional on size of previous employers
 - ▶ Wage elasticity w.r.t. size of previous employers: 0.0259
 - ▶ Effect of labor market size decreases with firm size (for high ability workers)
- Descriptive evidence on potential mechanisms
 - ▶ Higher propensity of formal training in large labor markets due to spatial sorting of firms
 - ▶ Higher frequency of firm-to-firm mobility within big cities

Extension of Mincer's (1974) accounting-identity model

- Human capital of worker i at time t :

$$H_{i,t} = (1 - \theta)H_{i,t-1} + v_{i,t-1}k_{i,t-1} = (1 - \theta)^t \eta_{edu(i)} + \sum_{\tau=1}^{t-1} (1 - \theta)^{t-1-\tau} v_{i,\tau} k_{i,\tau}$$

- Decreasing learning effort to acquire new skills over time: $k_{i,t} = \kappa \left(1 - \frac{t}{T_i}\right) I(O_{i,t} = 1)$
- Return on learning effort of worker i at day t :

$$v_{i,t} = \gamma + \delta \ln(\text{emp}_{f(i,t),t}) + \rho \ln(\text{emp}_{r(i,t)-f(i,t),t}) + \omega \ln(\text{emp}_{f(i,t),t}) \times \ln(\text{emp}_{r(i,t)-f(i,t),t})$$

- Potential earnings: $E_{i,t} = W \exp(H_{i,t})$
- Wage at day t : $\ln w_{i,t} \approx \ln E_{i,t} - k_{i,t}$

Extension of Mincer's (1974) accounting-identity model

- Wage at day t :

$$\begin{aligned}
 \ln w_{i,t} \approx & \ln W + \kappa \left(\frac{t}{T_i} - 1 \right) + \eta_{edu(i)} (1 - \theta)^t \\
 & + \gamma \kappa \sum_{\tau=1}^{t-1} (1 - \theta)^{t-\tau-1} \left(1 - \frac{\tau}{T_i} \right) I(O_{i,\tau} = 1) \\
 & + \delta \kappa \sum_{\tau=1}^{t-1} (1 - \theta)^{t-\tau-1} \left(1 - \frac{\tau}{T_i} \right) I(O_{i,\tau} = 1) \ln(\text{emp}_{f(i,\tau),\tau}) \\
 & + \rho \kappa \sum_{\tau=1}^{t-1} (1 - \theta)^{t-\tau-1} \left(1 - \frac{\tau}{T_i} \right) I(O_{i,\tau} = 1) \ln(\text{emp}_{r(i,\tau)-f(i,\tau),\tau}) \\
 & + \omega \kappa \sum_{\tau=1}^{t-1} (1 - \theta)^{t-\tau-1} \left(1 - \frac{\tau}{T_i} \right) I(O_{i,\tau} = 1) \ln(\text{emp}_{f(i,\tau),\tau}) \ln(\text{emp}_{r(i,\tau)-f(i,\tau),\tau})
 \end{aligned}$$

Microdata on labour market biographies back to 1975/1993 from IAB

- $\approx 150,000$ wages in new employment relationships starting 2005-2011 (full-time, first match of worker and establishment, workers with 'complete' emp. biography, ...)
- Information on all previous employment relationships subject to social security in (West) Germany (start and end dates, establishment and location)
- Merge local labor market size [Map](#) and establishment size
- Worker characteristics (sex, educational level, pre-employment status)
- Merge information on hiring establishment (size, workforce composition)
- Merge information on local industry and labor market conditions
- Merge worker and establishment coefficient estimates from AKM-style wage decomposition (Bellmann et al., 2020)

Empirical model estimated by non-linear least squares

$$\begin{aligned}
 \ln w_{i,t} = & \alpha + \kappa \left(\frac{t}{T_i} - 1 \right) + \eta_{edu(i)}(1 - \theta)^t + \gamma \kappa \sum_{\tau=1}^{t-1} (1 - \theta)^{t-\tau-1} \left(1 - \frac{\tau}{T_i} \right) I(O_{i,\tau} = 1) \\
 & + \delta \kappa \sum_{\tau=1}^{t-1} (1 - \theta)^{t-\tau-1} \left(1 - \frac{\tau}{T_i} \right) I(O_{i,\tau} = 1) \ln(emp_{f(i,\tau),\tau}) \\
 & + \rho \kappa \sum_{\tau=1}^{t-1} (1 - \theta)^{t-\tau-1} \left(1 - \frac{\tau}{T_i} \right) I(O_{i,\tau} = 1) \ln(emp_{r(i,\tau)-f(i,\tau),\tau}) \\
 & + \omega \kappa \sum_{\tau=1}^{t-1} (1 - \theta)^{t-\tau-1} \left(1 - \frac{\tau}{T_i} \right) I(O_{i,\tau} = 1) \ln(emp_{f(i,\tau),\tau}) \ln(emp_{r(i,\tau)-f(i,\tau),\tau}) \\
 & + FE_i \pi + FE_{f(i,t)} \phi + \mu_{r(i,t),y(t)} + x'_{i,t} \beta + \varepsilon_{i,t}
 \end{aligned}$$

FE_i and $FE_{f(i,t)}$: worker and establishment coefficient estimates from AKM-style wage decomposition (Bellmann et al., 2020), $\mu_{r(i,t),y(t)}$: region-year-FE, $x_{i,t}$: characteristics of worker, establishment, local industry and local labor market

Identification I

Endogeneity concerns

- 1 Unobserved heterogeneity at the worker level: more able workers might have acquired their experience primarily in large firms and urban labor markets (sorting, sorting parents, better schooling).
- 2 Workers, who learn fast, might have acquired their experience primarily in large firms and urban labor markets.
- 3 Workers who gathered experience in large cities often continue to work in a large local labor market (reinforcing positive correlation of entry wage and size of previous labor markets)
- 4 Firms paying higher wages for any reason (e.g., higher productivity, specific wage agreements) might show recruiting strategies which aim at hiring workers who obtained their skills predominantly in large firms and large cities.

Identification II

Addressing endogeneity concerns

- 1 Observable characteristics of the worker, the hiring establishment and its location
- 2 Region-time fixed effects, proxy for individual unobserved ability and wage level of hiring establishment
- 3 Focus on wages in new employment relationships (promotion unobservable)
- 4 Estimate wage equation separately for ten distinct subsamples defined based on proxy for individual unobserved ability
 - ▶ Account for heterogeneous benefits from size
 - ▶ Account for heterogeneous learning effort
 - ▶ No significant correlation between ability level and previous firm and labor market size within groups

Correlation

Table: Baseline regression results for full sample

	(1)	(2)	(3)	(4)
$\tilde{\gamma}$ (baseline exp. effect)	0.0442*** (0.00196)	0.0432*** (0.00172)	0.0431*** (0.00163)	0.0430*** (0.00164)
$\tilde{\delta}$ (firm effect)		0.00550*** (0.000206)	0.00501*** (0.000213)	0.00493*** (0.000200)
$\tilde{\rho}$ (labor market effect)	0.00556*** (0.000404)		0.00401*** (0.000402)	0.00403*** (0.000410)
$\tilde{\omega}$ (firm x labor market)				0.000330** (0.000153)
κ (learning effort)	0.458*** (0.0117)	0.438*** (0.0112)	0.437*** (0.0112)	0.437*** (0.0112)
θ^y (annual depreciation rate)	0.206*** (0.00944)	0.201*** (0.00713)	0.200*** (0.00762)	0.201*** (0.00768)
R_{adj}^2	0.705	0.707	0.708	0.708

Note: N=47,614. Estimates refer to the value of the previous year of work experience as reflected in the entry wage about 14 years (5,185 days) after labor market entry for a worker who entered the labor market 45 years (16,266 days) prior to retirement age. Depreciation rate θ is expressed in years. ***, ** and * indicate significance at the 1, 5 and 10 percent level. Robust standard errors given in parentheses are clustered at the level of 141 labor market regions. All regressions include control variables, AKM-worker and AKM-establishment fixed effects estimated by Bellmann et al. (2020) as well as industry, occupation, and region-year fixed effects. Source: IEB, own calculations.

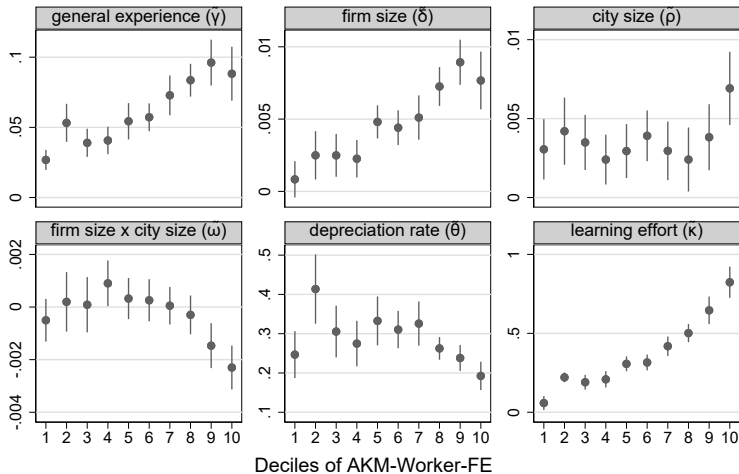


Figure: Heterogeneous effects across ability levels

further results

Table: Correlation between training provision, establishment size and local labor market size – results from a logistic regression (odds ratios) and IAB Establishment Panel data

	(1)	(2)	(3)
ln(employment density)	1.067*** (0.008)	1.043*** (0.008)	0.989 (0.008)
Establishment size – reference: less than 5 workers			
5 - 9 workers		2.292***	2.234***
10 - 19 workers		3.489***	3.356***
20 - 49 workers		6.077***	5.325***
50 - 99 workers		10.727***	7.940***
100 - 199 workers		19.011***	12.199***
200 - 499 workers		34.041***	18.485***
500 - 999 workers		76.765***	34.944***
1000 - 4999 workers		143.461***	56.839***
Constant	1.761***	0.341***	0.327***
Establishment-year observations	192,371	192,371	192,371
Industry fixed effects	No	No	Yes
Indicator variables for legal form and work council	No	No	Yes
Indicator variables for the type of establishment	No	No	Yes
Information on workforce composition	No	No	Yes

Conclusions

- Value of work experience increases with size of labor markets *and* firms
 - ▶ Learning affected by size at both spatial scales
- On average, about 28% dynamic agglomeration benefits related to firm size
- Particular high ability workers benefit from size (higher learning effort)
- High ability workers: Learning opportunities in large establishments apparently compensate for lacking labor market size in smaller labor markets
 - ▶ Large firms more likely to offer formal training
 - ▶ Particularly high ability workers participate in employer-provided training
 - ▶ Access to larger establishments in smaller labor markets is difficult
- Higher frequency of firm-to-firm mobility within big cities potential mechanism underlying the benefit from gathering experience in big cities (net of firm effect)

Thank you for your attention!

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Identification III

Table: Correlation between AKM-worker fixed effects and the average size of firms and local labor markets in which experience was acquired

		Deciles of AKM-worker fixed effects									
All workers		1	2	3	4	5	6	7	8	9	10
Correlation with individual AKM-worker fixed effect: Spearman's rank correlation coefficient											
Firm size	0.2173	0.0324	0.0202	0.0061	0.0179	-0.0108	0.0202	0.0177	0.0275	0.0680	0.0743
LM size	0.1686	-0.0308	0.0080	-0.0070	0.0100	-0.0085	0.0189	0.0306	0.0571	0.0616	0.0625
Regression results, dependent variable: individual AKM-worker fixed effect											
Firm size	0.114*	0.0053	0.0017*	0.0005	0.0004	-0.0000	0.0006*	0.0001	0.0007	0.0054*	0.0027
LM size	0.0879*	-0.0351*	0.0003	-0.0006	0.0003	-0.0004	0.0006	0.0015*	0.0041*	0.0071*	0.0174*
Constant	-0.843*	-1.491*	-0.677*	-0.402*	-0.227*	-0.0627*	0.0893*	0.275*	0.515*	0.902*	1.716*
N	147,614	14,762	14,761	14,763	14,761	14,761	14,762	14,761	14,761	14,761	14,761
R ²	0.0621	0.0023	0.0006	0.0002	0.0002	0.0001	0.0007	0.0009	0.0032	0.0069	0.0022

* indicates significance at the 1 percent level. Average firm and labor market (LM) size considered in logs.

Table: Distance between the former and the new workplace by size of hiring establishment

Category of firm size	Distance in km at municipality level					
	all workers			high-skilled workers		
	p50	p75	p90	p50	p75	p90
1 (lowest)	10.3	28.9	122.9	16.7	72.0	284.5
2	11.2	31.0	128.9	17.2	71.5	254.5
3	12.2	35.3	157.5	20.5	90.0	304.7
4	13.3	39.6	181.0	21.6	103.7	311.4
5	13.7	43.5	192.5	21.7	111.2	304.3
6	13.8	47.6	199.0	22.5	112.4	316.3
7	14.3	52.8	225.4	23.9	130.0	327.0
8	13.9	54.7	233.4	23.3	130.5	321.8
9	13.4	57.3	247.5	23.3	123.0	318.3
10 (highest)	10.2	56.9	254.5	17.6	128.5	328.1
Total	12.4	42.2	194.7	20.6	112.6	312.7

Note: Based on 489,377 workers who changed the establishment from one to another year in the period 2005-2011.

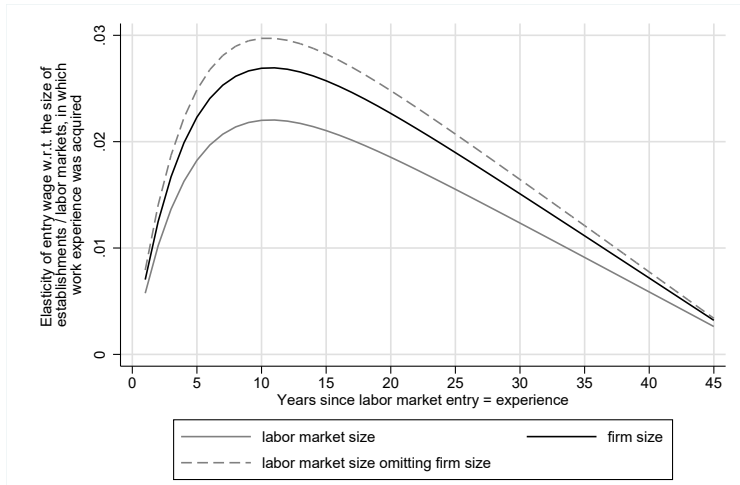


Figure: Elasticity of entry wage w.r.t. the size of the establishment and of the local labor market in which experience was acquired in the course of working life, full sample

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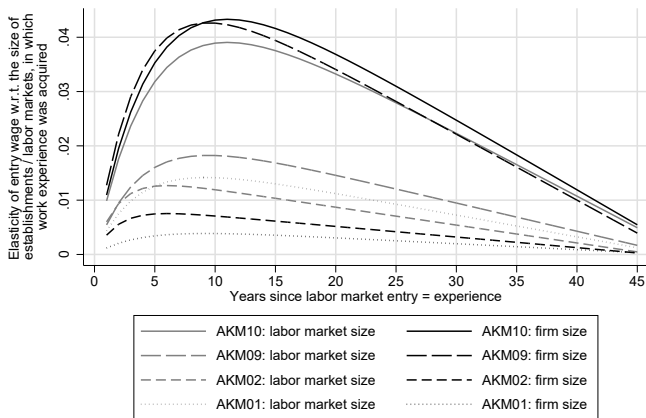


Figure: Elasticity of entry wage w.r.t. the size of the establishment and of the local labor market in which experience was acquired in the course of working life, by ability level

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	(1)	(2)	(3)	(4)	(5)
$\bar{\gamma}$	0.0430*** (0.00164)	0.0433*** (0.000927)	0.0466*** (0.00135)	0.0442*** (0.00131)	0.0455*** (0.00165)
$\bar{\delta}$	0.00493*** (0.000200)	0.00442*** (0.000134)	0.00425*** (0.000166)	0.00384*** (0.000152)	0.00550*** (0.000207)
$\bar{\rho}$	0.00403*** (0.000410)	0.00395*** (0.000220)	0.00380*** (0.000341)	0.00373*** (0.000328)	0.00414*** (0.000436)
$\bar{\omega}$	0.000330** (0.000153)	0.000341*** (0.0000785)	0.000289** (0.000133)	0.000262** (0.000122)	0.000361** (0.000175)
κ	0.437*** (0.0112)	0.420*** (0.0151)	0.540*** (0.0196)	0.529*** (0.0188)	0.446*** (0.0118)
θ^y	0.201*** (0.00768)	0.103*** (0.00289)	0.118*** (0.00399)	0.118*** (0.00408)	0.200*** (0.00711)
N	147,614	347,894	147,614	147,614	147,614
$R^2_{adj.}$	0.708	0.644	0.650	0.672	0.688
R^2	0.710	0.645	0.654	0.675	0.691
RSS	10767.957	27974.272	12882.796	12088.330	11479.643
Only obs. for which AKM-FE available	Yes	No	Yes	Yes	Yes
AKM-establishments fixed effects	Yes	No	No	Yes	No
AKM-worker fixed effects	Yes	No	No	No	Yes

Note: $\bar{\gamma}$, $\bar{\delta}$, $\bar{\rho}$ and $\bar{\omega}$ have been computed according to Equations (10) to (13) based on the results for Equation (9). Depreciation rate θ is expressed in years. ***, ** and * indicate significance at the 1, 5 and 10 percent level. Robust standard errors given in parentheses are clustered at the level of 141 local labor markets. Specification (1) is identical to Model (4) in Table 2. See Table 2 for additional notes.

Source: IEB and Bellmann et al. (2020), own calculations.

Figure: Specifications with and without AKM-fixed effect

	(1)	(2)	(3)	(4)	(5)
$\hat{\gamma}$	0.0430*** (0.00164)	0.0408*** (0.00157)	0.0375*** (0.00181)	0.0347*** (0.00204)	0.0440*** (0.00167)
$\hat{\delta}$	0.00493*** (0.000200)	0.00484*** (0.000191)	0.00490*** (0.000208)	0.00500*** (0.000235)	0.00511*** (0.000197)
$\hat{\rho}$	0.00403*** (0.000410)	0.00385*** (0.000428)	0.00373*** (0.000430)	0.00386*** (0.000400)	0.00412*** (0.000475)
$\hat{\omega}$	0.000330** (0.000153)	0.000138 (0.000161)	-0.0000274 (0.000167)	-0.000109 (0.000174)	0.000315* (0.000169)
κ	0.437*** (0.0112)	0.428*** (0.0117)	0.425*** (0.0144)	0.430*** (0.0183)	0.448*** (0.0108)
θ^y	0.201*** (0.00768)	0.197*** (0.00754)	0.191*** (0.00863)	0.185*** (0.0101)	0.202*** (0.00824)
N	147,614	126,624	100,678	78,412	128,468
$R^2_{adj.}$	0.708	0.716	0.723	0.728	0.700
R^2	0.710	0.719	0.727	0.733	0.703
RSS	10767.957	9237.808	7496.838	5977.956	9755.868
Reference (cf. Table 2)	x				
Hiring establishments ≥ 10 workers only		x			
Hiring establishments ≥ 25 workers only			x		
Hiring establishments ≥ 50 workers only				x	
Grouped-FE instead of establishment-FE					x

Note: $\hat{\gamma}$, $\hat{\delta}$, $\hat{\rho}$ and $\hat{\omega}$ have been computed according to Equations (10) to (13) based on the results for Equation (9). Depreciation rate θ is expressed in years. ***, ** and * indicate significance at the 1, 5 and 10 percent level. Robust standard errors given in parentheses are clustered at the level of 141 local labor markets. See Table 2 for additional notes. Specification (1) is the reference and identical to Model (4) in Table 2. In specifications (2)-(4), we exclude small establishments based on different thresholds and in specification (5), we use fixed effects estimates for 100 clusters of establishments with similar wage structure as control variable instead of estimates of AKM-establishment effects to address the limited mobility bias in AKM models (see Section A1.3 in this Appendix).

Source: IEB and Bellmann et al. (2020), own calculations.

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Figure: Specifications addressing the limited mobility bias of AKM-establishment effects estimates

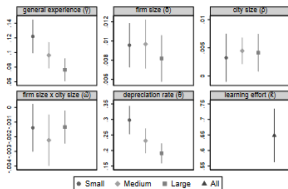
	(1) all workers	(2) AKM09	(3) AKM10
$\tilde{\gamma}$	0.0361*** (0.00194)	0.0927*** (0.00870)	0.0916*** (0.0108)
$\tilde{\delta}_{in}$	0.000361*** (0.0000363)	0.000293*** (0.000102)	0.000155*** (0.0000482)
$\tilde{\delta}_{sq}$	-0.00000687*** (0.00000103)	-0.00000365 (0.00000332)	-0.00000296** (0.00000117)
$\tilde{\rho}_{in}$	0.00298*** (0.000764)	0.00356*** (0.000956)	0.00368*** (0.000899)
$\tilde{\rho}_{sq}$	-0.0000983 (0.0000626)	-0.000146** (0.0000710)	-0.000142*** (0.0000540)
κ	0.456*** (0.0110)	0.681*** (0.0446)	0.883*** (0.0489)
θ^y	0.212*** (0.00860)	0.247*** (0.0176)	0.207*** (0.0205)
N	147,614	14,761	14,761
R^2_{adj}	0.706	0.536	0.482
R^2	0.709	0.576	0.526
RSS	10837.810	1369.841	2103.871

Note: The table contains results for an alternative specification of Equation (9). Specifically, the regression is based on an alternative learning function which includes – instead of the *logarithm* of establishment and labor market size – establishment and labor market size as well as the respective square: $v_{i,t} = \gamma + \delta_{in} emp_{f(i,t),t} + \delta_{sq} emp_{f(i,t),t}^2 + \rho_{in} emp_{r(i,t)-f(i,t),t} + \rho_{sq} emp_{r(i,t)-f(i,t),t}^2$. Establishment and labor market size are measured in terms of 100 workers in this specification. $\tilde{\gamma}$, $\tilde{\delta}_{in}$, $\tilde{\delta}_{sq}$, $\tilde{\rho}_{in}$, $\tilde{\rho}_{sq}$, $\tilde{\phi}$ and $\tilde{\omega}$ have been computed according to Equations (10) to (13) based on the regression results. ***, ** and * indicate significance at the 1, 5 and 10 percent level. Robust standard errors given in parentheses are clustered at the level of 141 local labor markets. AKM09 and AKM10 refer to the two groups at the top of the ability distribution as indicated by the AKM-worker fixed effects estimated by Bellmann et al. (2020). To define the sub-samples we consider the deciles of AKM-worker fixed effects as thresholds. The reported negative association between wage and squared size supports our assumption that the value of work experience increases with the size of establishments and labor markets in which it was acquired, but at a decreasing rate (see Section 3). The explanatory power of this specification is slightly lower than the one of our main specification considering size in logarithmic form (cf. Table 2).

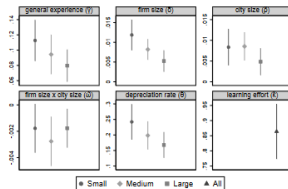
Source: IEB and Bellmann et al. (2020), own calculations.

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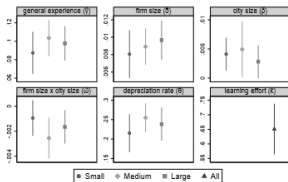
Figure: Specification considering the square of establishment size and city size



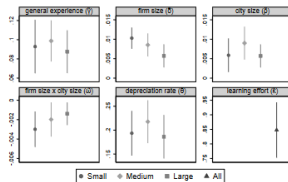
(a) By the size of the hiring establishment, AKM09



(b) By the size of the hiring establishment, AKM10



(c) By size of the labor market in which the hiring establishment is located, AKM09



(d) By size of the labor market in which the hiring establishment is located, AKM10

Figure: Effects across different types of hiring establishments

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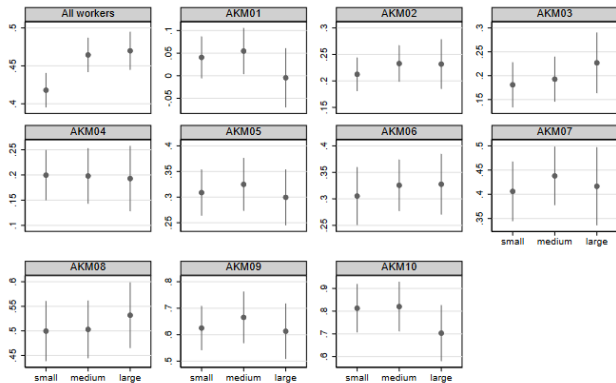


Figure: Estimates for learning effort κ depending on the average size of the firms in which experience was acquired

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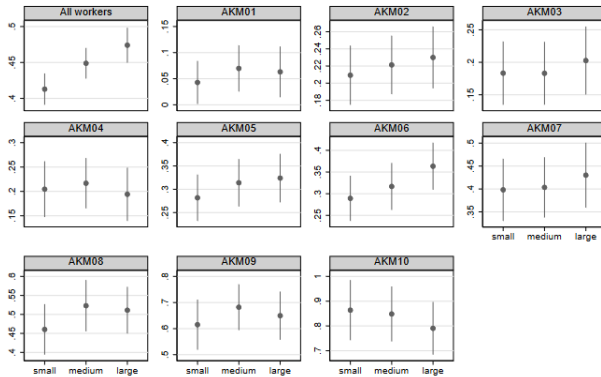


Figure: Estimates for learning effort κ depending on the average size of the labour markets in which experience was acquired

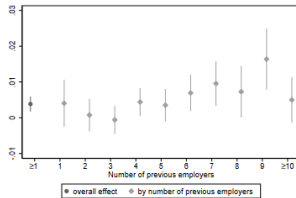
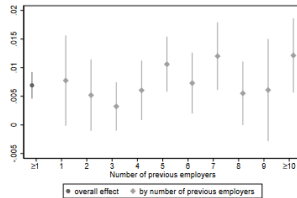
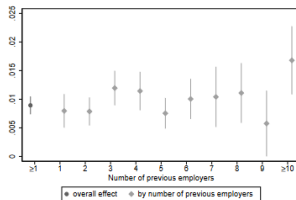
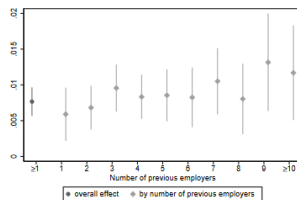
(a) City size effect ($\bar{\rho}$), AKM09(b) City size effect ($\bar{\rho}$), AKM10(c) Firm size effect ($\bar{\delta}$), AKM09(d) Firm size effect ($\bar{\delta}$), AKM10

Figure: Effect of previous city and firm size on the return on experience along the job ladder

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	(1)	(2)	(3)	(4)
Total experience	0.0170*** (0.000685)	0.0172*** (0.000694)	0.0161*** (0.000655)	0.0133*** (0.000620)
Total experience ²	-0.000373*** (0.0000222)	-0.000379*** (0.0000235)	-0.000356*** (0.0000220)	-0.000401*** (0.0000228)
Experience by labor market size categories, reference: experience acquired in small labor markets (<75 workers/km ²)				
75-199 workers/km ²	0.00103*** (0.000308)	0.00107*** (0.000293)	0.00110*** (0.000276)	0.000615** (0.000268)
200-499 workers/km ²	0.00139*** (0.000373)	0.00135*** (0.000344)	0.00150*** (0.000325)	0.000818** (0.000318)
≥ 500 workers/km ²	0.00499*** (0.000514)	0.00471*** (0.000489)	0.00436*** (0.000444)	0.00317*** (0.000428)
Experience by establishment size categories, reference: experience acquired in small establishments (<10 workers)				
10-49 workers				0.00313*** (0.000311)
50-249 workers				0.00509*** (0.000271)
≥ 250 workers				0.00759*** (0.000378)
N	147614	147614	147614	147614
R ² _{adj.}	0.669	0.677	0.703	0.705
R ²	0.672	0.680	0.706	0.708
RSS	12191.109	11907.928	10945.528	10874.005
Considered firm characteristics				
Size of current employer	No	Yes	Yes	Yes
Workforce composition of current employer	No	No	Yes	Yes
AKM-establishment fixed effect of current employer	No	No	Yes	Yes
Size of previous employers (by experience categories)	No	No	No	Yes

Notes: ***, ** and * indicate significance at the 1, 5 and 10 percent level. Robust standard errors given in parentheses are clustered at the level of 141 labor market regions. All regressions include control variables referring to the individual worker, the local labor market and the local industry (see Table A8) as well as establishment characteristics as indicated in the Table. Furthermore, all models comprise pre-determined AKM-worker fixed effects estimated by Bellmann et al. (2020) as well as industry, occupation, and region-year fixed effects.
Source: IEB, own calculations.








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Figure: Results conditional on different firm characteristics

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