

Hiring Top Workers, Absorptive Capacity and Productivity

– Online Appendix

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APPENDIX A: ROBUSTNESS CHECK

Table A1: Pearson correlation coefficients for variables included in the estimation

<i>Variables</i>	Managers _{<i>t-1</i>}	Professionals _{<i>t-1</i>}	Others _{<i>t-1</i>} ²	Firm size(log) _{<i>t-2</i>}	Firm age	Multinational enterprise (0,1)
Managers _{<i>t-1</i>}	1					
Professionals _{<i>t-1</i>}	0.0903	1				
Others _{<i>t-1</i>} ²	0.1346	0.0203	1			
Firm size(log) _{<i>t-2</i>}	-0.0225	-0.0010	0.1311	1		
Firm age	-0.1132	-0.1335	-0.2016	0.1615	1	
Multinational enterprise (0,1)	0.0799	0.0548	0.0126	0.0894	0.0481	1

Table A2: Robustness analysis: Controlling for lay-offs

	Absorptive capacity	Managers	Professionals	Others	Obs.	<i>Adj.R</i>²
Education	High educ.	-0.00650 (0.00388)	0.00435*** (0.00110)	0.000458 (0.000480)	174 136	0.656
Knowledge-intensity	Intensive	0.00441 (0.00600)	0.00307** (0.00143)	0.00149 (0.000812)	134 571	0.662
R&D	With expenditure	-0.00189 (0.00720)	0.00564** (0.00216)	0.00173** (0.000626)	33 156	0.638

Notes: Within-firm estimation including a dummy variable that indicates that the number of remaining leading personnel in the hiring year ($t - 1$) is larger than the previous year. *Dependent Variable:* Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. Robust and firm-clustered standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A3: Robustness analysis: High educ.

	Municipality FE	Industry*Year FE	Non-linear link	TFP _{t-1}
TFP(log) _{t-1}				-0.0974*** (0.0265)
Managers and professionals _{t-1}	0.00254* (0.00109)	0.00223* (0.00118)	0.00454** (0.00175)	0.00261** (0.00146)
Managers and professionals _{t-1} ²			-0.0000529 (0.0000307)	
Others _{t-1} ²	-0.000198 (0.000486)	-0.000169 (0.000487)	-0.000208 (0.000487)	0.000374 (0.000641)
Firm size(log) _{t-2}	0.0478*** (0.00986)	0.0448*** (0.00995)	0.0452*** (0.00996)	0.0562*** (0.0130)
Firm age	0.0500* (0.0240)	0.0478 (0.0253)	0.0479 (0.0254)	0.115*** (0.00283)
Multinational enterprise (0,1)	-0.0277* (0.0120)	-0.0294* (0.0119)	-0.0296* (0.0119)	-0.0332* (0.0137)
Obs.	51 811	51 811	51 811	37 306
Adjusted R ²	0.682	0.682	0.683	0.724

Notes: Within-firm estimation. *Dependent Variable:* Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. We also include municipality specific effects and industry*year specific effects separately. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table A4: Robustness analysis: Knowledge-intensive firms in service industry

	Municipality FE	Industry*Year FE	Non-linear link	TFP _{<i>t-1</i>}
TFP(log) _{<i>t-1</i>}				-0.00401 (0.0358)
Managers and professionals _{<i>t-1</i>}	0.00395** (0.00152)	0.00345* (0.00146)	0.00891** (0.00283)	0.00477*** (0.00121)
Managers and professionals _{<i>t-1</i>} ²			-0.0000529 (0.0000307)	
Others _{<i>t-1</i>} ²	-0.00203 (0.00345)	-0.00217 (0.00364)	-0.00161 (0.00369)	0.000542 (0.00143)
Firm size(log) _{<i>t-2</i>}	0.0697** (0.0228)	0.0676** (0.0222)	0.0669** (0.0224)	0.0445*** (0.0117)
Firm age	-0.112*** (0.0240)	-0.0852*** (0.0253)	-0.0852*** (0.0254)	-0.00727 (0.0205)
Multinational enterprise (0,1)	0.0265 (0.0316)	0.0299 (0.0317)	0.0266 (0.0315)	0.00114 (0.0227)
Obs.	18 885	18 885	18 885	13 467
Adjusted R ²	0.662	0.662	0.664	0.677

Notes: Within-firm estimation. *Dependent Variable:* Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. We also include municipality specific effects and industry*year specific effects separately. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table A5: Robustness analysis: Firms with expenditure on R&D

	Municipality FE	Industry*Year FE	Non-linear link	TFP _{<i>t-1</i>}
TFP(log) _{<i>t-1</i>}				-0.00219** (0.0226)
Managers and professionals _{<i>t-1</i>}	0.00566* (0.00223)	0.00431* (0.00201)	0.0119** (0.00384)	0.00463** (0.00269)
Managers and professionals _{<i>t-1</i>} ²			-0.000115** (0.0000409)	
Others _{<i>t-1</i>} ²	0.00150* (0.000630)	0.00163* (0.000675)	0.0487** (0.0177)	0.00125* (0.000586)
Firm size(log) _{<i>t-2</i>}	0.0496** (0.0170)	0.0501** (0.0178)	0.0487* (0.0177)	0.0398 (0.0199)
Firm age	0.0365 (0.0380)	0.00233 (0.0164)	0.294 (0.288)	0.00136 (0.0267)
Multinational enterprise (0,1)	-0.00227 (0.0375)	0.0217 (0.0382)	-0.00735 (0.0366)	-0.00312 (0.0369)
Obs.	33 156	33 156	33 156	23 872
Adjusted R ²	0.662	0.663	0.663	0.662

Notes: Within-firm estimation. *Dependent Variable:* Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. We also include municipality specific effects and industry*year specific effects separately. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

APPENDIX B: ADDITIONAL ANALYSIS

Table B1: Descriptive statistics regarding firms' education level

	Educ.(1) (24.35%)			Educ.(2) (44.90%)			Educ.(3) (20.67%)			Educ.(4) (6.94%)		
	Mean	Median	Sd	Mean	Median	Sd	Mean	Median	Sd	Mean	Median	Sd
No. of employee	1.01	1	0.12	12.15	8	12.88	4.79	2	6.14	14.26	5	26.45
Managers and professionals (MaPs)	0.22	0	0.41	1.32	1	1.50	0.66	0	0.83	2.99	1	6.47
Other workers	0.70	1	0.47	9.98	6	11.72	3.76	2	5.56	10.57	3	22.57
Newly hired												
Managers	0.001	0	0.03	0.06	0	0.26	0.02	0	0.16	0.12	0	0.48
Professionals	0.0003	0	0.02	0.06	0	0.30	0.02	0	0.14	0.29	0	1.19
Other workers	0.006	0	0.08	1.78	1	2.85	0.61	0	1.32	2	0	5.15
Newly hired MaPs												
From enterprise group to stand-alone SMEs	0.00003	0	0.006	0.02	0	0.16	0.009	0	0.10	0.06	0	0.43
From MNE to non-MNE affiliated firm	0	0		0.02	0	0.15	0.006	0	0.08	0.07	0	0.41
From foreign trading firm to SMEs	0	0	0	0.003	0	0.06	0.0007	0	0.03	0.006	0	0.11
Other background	0.001	0	0.03	0.07	0	0.34	0.03	0	0.17	0.22	0	1.05
Firm age	9.69015	11	5.19	11.05	13	5.87	9.89	11	5.41	10.43	11	6.14
Enterprise group status	0.09	0	0.29	0.39	0	0.49	0.21	0	0.41	0.38	0	0.48
Multinational status	0.01	0	0.09	0.05	0	0.22	0.02	0	0.14	0.10	0	0.30
Value added	553	408	1 167	5 598	3 244	7 138	2 170	1 061	3 292	8 415	2 227	25 021
Physical capital stock	869	31	9 390	4 302	242	31 384	1 641	72	11 884	11 478	115	193 706

Notes: Data refers to the year 2010. Total number of firm is 167,167. Money values are in 1,000 SEK. The percentages of education level applied do not sum to 100%, since Educ.(3) and Educ.(4) are clustered in Educ.(2) (See definition in Section managers2).

Table B2: Descriptive statistics regarding firms' knowledge intensity

	Knowledge-intensive (51.23%)			Less knowledge-intensive (48.77%)		
	Mean	Median	Sd	Mean	Median	Sd
No. of employee	6.24	2	15.97	7.88	3	16.01
Managers and professionals (MaPs)	2.37	1	7.81	1.01	0	3.05
Other workers	3.58	1	11.11	6.28	2	13.60
Newly hired						
Managers	0.52	0	0.32	0.06	0	0.30
Professionals	0.29	0	0.32	0.05	0	0.36
Other workers	0.75	0	3.01	1.15	0	3.23
Newly hired MaPs						
From enterprise group to stand-alone SMEs	0.06	0	0.45	0.01	0	0.13
From MNE to non-MNE affiliated firm	0.06	0	0.44	0.01	0	0.15
From foreign trading firm to SMEs	0.004	0	0.15	0.002	0	0.15
Other background	0.19	0	1.35	0.06	0	0.39
Firm age	9.14	10	5.19	10.42	13	5.51
Enterprise group status	0.24	0	0.43	0.15	0	0.43
Multinational status	0.04	0	0.20	0.05	0	0.21
Value added	3 903	991	16 727	3 917	1 200	12 640
Physical capital stock	7 877	36	151 596	1 601	126	12 115

Notes: Data refers to service industry in year 2010. Total number of knowledge-intensive firms is 60,666 and total number of less knowledge-intensive firms is 50,745. Money values are in 1,000 SEK.

Table B3: Descriptive statistics regarding firms' expenditure on R&D

	Without expenditure on R&D (90.94%)			With expenditure on R&D (9.06%)		
	Mean	Median	Sd	Mean	Median	Sd
No. of employee	7.83	3	17.44	98.28	86	59.39
Managers and professionals (MaPs)	1.54	1	5.48	23.66	13	27.46
Other workers	5.82	2	14.17	72.84	60	52.52
Newly hired						
Managers	0.06	0	0.33	0.76	0	1.14
Professionals	0.14	0	1.03	1.67	0	3.43
Other workers	1.04	0	1.03	8.44	5.5	9.81
Newly hired MaPs						
From enterprise group to stand-alone SMEs	0.03	0	0.30	0.06	0	0.82
From MNE to non-MNE affiliated firm	0.03	0	0.31	0.22	0	0.84
From foreign trading firm to SMEs	0.003	0	0.14	0.03	0	0.26
Other background	0.11	0	0.94	1.88	0	3.84
Firm age	10.16	12	5.60	22.62	21	9.01
Enterprise group status	0.24	0	0.43	0.95	1	0.21
Multinational status	0.05	0	0.21	0.72	1	0.45
Value added	4 253	1 167	15 256	75 546	52 625	116 663
Physical capital stock	4 913	99	108 832	60 329	11 231	521 415

Notes: Data refers to service industry in year 2010. Total number of firms with R&D expenditure is 2,131 and total number of firms without R&D expenditure is 22,216. Money values are in 1,000 SEK.

Table B4: Estimation results for managers and professionals, separately: Absorptive Capacity and Distance to Frontier

	Some years of Post-Sec Educ.	At least 3 years of Post-Sec Educ.
Managers _{<i>t-1</i>}	-0.00185 (0.00352)	-0.00262 (0.00350)
Professionals _{<i>t-1</i>}	0.00595*** (0.00131)	0.00501*** (0.00141)
Others _{<i>t-1</i>} ²	0.00224*** (0.000402)	0.00200*** (0.000394)
Share Post-Sec _{<i>t-1</i>}	0.00112 (0.000754)	
Share 3-year Post-Sec _{<i>t-1</i>}		0.0000194 (0.00117)
Technology gap _{<i>t-1</i>}	1.05e-07*** (1.85e-08)	1.13e-07*** (1.75e-08)
(Share Post-Sec * Tech-gap) _{<i>t-1</i>}	4.18e-09* (1.93e-09)	
(Share 3-year Post-Sec * Tech-gap) _{<i>t-1</i>}		6.39e-09 (3.28e-09)
(Managers * Tech-gap) _{<i>t-1</i>}	1.94e-08 (2.75e-08)	2.13e-08 (2.66e-08)
(Professionals * Tech-gap) _{<i>t-1</i>}	-2.09e-08* (1.15e-08)	-2.63e-08* (1.22e-08)
Firm size(log) _{<i>t-2</i>}	0.0603*** (0.00640)	0.0568*** (0.00629)
Firm age	0.0478* (0.0215)	0.0483* (0.0216)
Multinational enterprise (0,1)	-0.0367*** (0.0103)	-0.0379*** (0.0103)
Obs.	326 417	326 417
Adjusted R ²	0.686	0.686

Notes: Within-firm estimation results. *Dependent Variable:* Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table B5: Estimation results by education level, discerning the background of newly hired

	From enterprise group to stand-alone firm				From a MNE			
	Educ.(1)	Educ.(2)	Educ.(3)	Educ.(4)	Educ.(1)	Educ.(2)	Educ.(3)	Educ.(4)
Managers _{t-1}	0.102 (0.0937)	0.0103 (0.0167)	0.0194 (0.0181)	-0.0246 (0.0141)	0.247 (0.148)	-0.0169 (0.0219)	-0.0153 (0.0328)	-0.0245* (0.0105)
Professionals _{t-1}	-0.165 (0.143)	0.000477 (0.0126)	0.0256 (0.0264)	0.00995** (0.00343)	-0.0525 (0.228)	-0.00380 (0.0141)	0.0287 (0.0197)	0.00811* (0.00326)
Others _{t-1} ²	0.0623*** (0.0183)	0.00337** (0.00114)	0.0128*** (0.00177)	0.000428 (0.000481)	0.0643*** (0.0176)	0.00356*** (0.000997)	0.0128*** (0.00177)	0.000366 (0.000484)
Obs.	9 681	174 163	85 234	51 811	9 681	174 163	85 234	51 811
Adjusted R ²	0.600	0.775	0.614	0.705	0.600	0.775	0.614	0.705
	From a foreign-trading firm to a non-trader				Others			
	Educ.(1)	Educ.(2)	Educ.(3)	Educ.(4)	Educ.(1)	Educ.(2)	Educ.(3)	Educ.(4)
Managers _{t-1}	0.0971 (0.0665)	-0.0290 (0.0151)	-0.00648 (0.0302)	-0.0114* (0.00557)	-0.0480 (0.0700)	-0.0201 (0.0135)	0.0170 (0.0177)	-0.00307 (0.00575)
Professionals _{t-1}	-0.00257 (0.107)	0.00879 (0.00970)	0.0118 (0.0271)	0.00684*** (0.00182)	0.0389 (0.0510)	-0.0108 (0.0104)	0.0113 (0.0167)	0.00367 (0.00203)
Others _{t-1} ²	0.0636*** (0.0176)	0.00390*** (0.000931)	0.0129*** (0.00178)	0.000447 (0.000502)	0.0718** (0.0219)	0.00374*** (0.00113)	0.0146*** (0.00187)	0.00136* (0.000559)
Obs.	9 681	174 163	85 234	51 811	8 845	149 022	82 339	47 419
Adjusted R ²	0.600	0.775	0.614	0.705	0.600	0.775	0.614	0.705

Notes: Within-firm estimation. *Dependent Variable*: Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. Robust and firm-clustered standard errors in parentheses. For brevity, other covariate estimates are not reported. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table B6: Estimation results by knowledge intensity, discerning the background of newly hired

	From enterprise group to stand-alone firm		From a MNE	
	Knowledge-intensive	Less knowledge-intensive	Knowledge-intensive	Less knowledge-intensive
Managers _{t-1}	-0.0243 (0.0184)	0.0171 (0.0131)	0.000859 (0.0116)	-0.0128 (0.00870)
Professionals _{t-1}	0.00146 (0.00603)	-0.00257 (0.00427)	0.00361 (0.00451)	0.00103* (0.00505)
Others _{t-1} ²	0.00179* (0.000784)	0.000179 (0.000717)	0.00145 (0.000815)	0.000208 (0.000698)
Obs.	134 571	150 143	134 571	150 143
Adjusted R ²	0.652	0.712	0.652	0.712
	From foreign-trading to a non-trader		Others	
	Knowledge-intensive	Less knowledge-intensive	Knowledge-intensive	Less knowledge-intensive
Managers _{t-1}	-0.00476 (0.00835)	-0.00830 (0.00642)	0.00331 (0.00622)	-0.00505 (0.00637)
Professionals _{t-1}	0.00429* (0.00181)	0.00358 (0.00477)	0.00203 (0.00147)	0.00370 (0.00238)
Others _{t-1} ²	0.00140 (0.000805)	0.000301 (0.000719)	0.00143 (0.00110)	0.00139* (0.000594)
Obs.	134 571	150 143	115 093	138 427
Adjusted R ²	0.652	0.712	0.652	0.712

Notes: Within-firm estimation of *service industry*. *Dependent Variable*: Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. Robust and firm-clustered standard errors in parentheses. For brevity, other covariate estimates are not reported. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table B7: Estimation results by expenditure on R&D, discerning the background of newly hired

	From enterprise group to stand-alone firm		From a MNE	
	Without expenditure on R&D	With expenditure on R&D	Without expenditure on R&D	With expenditure on R&D
Managers _{t-1}	-0.00359 (0.00974)	-0.0394 (0.0294)	-0.0105 (0.00640)	-0.0176 (0.0198)
Professionals _{t-1}	-0.000774 (0.00667)	0.0153 (0.00865)	0.00480 (0.00467)	0.00152* (0.00916)
Others _{t-1} ²	0.00132*** (0.000401)	0.00193** (0.000626)	0.00134*** (0.000403)	0.00186** (0.000628)
Obs.	332 713	33 156	332 713	33 156
Adjusted R ²	0.726	0.618	0.726	0.618
	From foreign-trading to a non-trader		Others	
	Without expenditure on R&D	With expenditure on R&D	Without expenditure on R&D	With expenditure on R&D
Managers _{t-1}	-0.00190 (0.00404)	-0.0129 (0.00950)	-0.00308 (0.00371)	-0.00990 (0.00968)
Professionals _{t-1}	0.00475 (0.00197)	0.00812* (0.00382)	0.00163 (0.00131)	0.00723* (0.00350)
Others _{t-1} ²	0.00124** (0.000408)	0.00201** (0.000643)	0.00243*** (0.000426)	0.00304** (0.000966)
Obs.	332 713	33 156	298 569	28 439
Adjusted R ²		0.726	0.618	0.726

Notes: Within-firm estimation. *Dependent Variable*: Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. Robust and firm-clustered standard errors in parentheses. For brevity, other covariate estimates are not reported. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table B8: Estimation results for managers and professionals, separately: Level of education

	Educ.(1)	Educ.(2)	Educ.(3)	Educ.(4)
Managers _{<i>t-1</i>}	0.00803 (0.0522)	-0.0154 (0.00879)	0.00248 (0.0146)	-0.00636 (0.00388)
Professionals _{<i>t-1</i>}	-0.0458 (0.0597)	-0.00129 (0.00651)	0.00435 (0.0146)	0.00438*** (0.00128)
Others _{<i>t-1</i>} ²	0.0626*** (0.0179)	0.00380*** (0.000992)	0.0128*** (0.00178)	0.000458 (0.000480)
Firm size(log) _{<i>t-2</i>}	-0.225 (0.188)	0.102*** (0.0166)	0.0967*** (0.0162)	0.0494*** (0.0102)
Firm age	0.0631* (0.0299)	0.0506** (0.0176)	-0.00560*** (0.000730)	0.0499* (0.0240)
Multinational enterprise (0,1)	-0.206** (0.0782)	-0.0977* (0.0496)	-0.0872 (0.0725)	-0.0271* (0.0120)
Obs.	9 681	174 163	85 234	51 811
Adjusted R ²	0.682	0.705	0.664	0.702

Notes: Within-firm estimation. *Dependent Variable:* Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table B9: Benchmark estimation results by level of education

	Educ(1)	Educ (2)	Educ(3)	Educ (4)
Managers and professionals _{<i>t-1</i>}	-0.0284 (0.0430)	-0.00766 (0.00570)	0.00246 (0.0104)	0.00264* (0.00118)
Others _{<i>t-1</i>} ²	0.0641*** (0.0177)	0.00365*** (0.00102)	0.0128*** (0.00177)	0.000231 (0.000485)
Firm size(log) _{<i>t-2</i>}	-0.221 (0.185)	0.101*** (0.0166)	0.0967*** (0.0162)	0.0498*** (0.0102)
Firm age	0.0623* (0.0300)	0.0506** (0.0176)	-0.00559*** (0.000728)	-0.0500* (0.0241)
Multinational enterprise (0,1)	-0.171* (0.0691)	-0.0979* (0.0497)	-0.0872 (0.0725)	-0.0275* (0.0120)
Obs.	9 681	174 163	85 234	51 811
Adjusted R ²	0.680	0.705	0.662	0.702

Notes: Within-firm estimation results of Manufacturing industry. *Dependent Variable:* Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table B10: Benchmark estimation results by knowledge intensity

	Knowledge-intensive	Less knowledge-intensive
Managers and professionals _{<i>t-1</i>}	0.00384** (0.00123)	-0.00208 (0.00262)
Others _{<i>t-1</i>} ²	0.00129 (0.000802)	0.000351 (0.000688)
Firm size(log) _{<i>t-2</i>}	0.0600*** (0.00743)	0.0600*** (0.00879)
Firm age	-0.0331 (0.0291)	0.0507** (0.0187)
Multinational enterprise (0,1)	-0.0140 (0.0199)	-0.0505** (0.0179)
Obs.	134 571	150 143
Adjusted R ²	0.702	0.706

Notes: Within-firm estimation results of service industry. *Dependent Variable:* Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table B11: Benchmark estimation results by expenditure on R&D

	Without R&D	With R&D
Managers and professionals _{<i>t-1</i>}	0.00208 (0.00114)	0.00556* (0.00218)
Others _{<i>t-1</i>}	0.00116** (0.000396)	0.00146* (0.000623)
Firm size(log) _{<i>t-2</i>}	0.0761*** (0.00562)	0.0489** (0.0177)
Firm age	0.0223 (0.0125)	0.294 (0.288)
Multinational enterprise (0,1)	-0.0347*** (0.0105)	-0.00696 (0.0366)
Obs.	332 713	33 156
Adjusted R ²	0.626	0.642

Notes: Within-firm estimation results. *Dependent Variable:* Total factor productivity (log). The legal form of the firm, industry fixed effect and year fixed effect are controlled throughout. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

APPENDIX C: DIFFERENCE-IN-DIFFERENCE MATCHING METHOD

To test the robustness of the results from within-firm estimation of Eq.(1), we adopt a quasi-experiment model and perform a difference-in-difference (DiD) estimation to investigate the differences in growth impact from hiring top workers and from hiring other workers in the post-recruitment periods. Put it differently, the growth of production should result from the recruitment of managers and professionals, rather than the reverse.

In the first step of the DiD analysis, valid 'control' firms are generated to represent counter-factual cases to the 'treated' firms. We divide firms into those only recruit top workers/managers and professional (treated firm) and those instead hire other workers (candidates of control firms). To address the underlying heterogeneity between these two types of firms, propensity score matching is used to match pre-treatment characteristics. The central idea of the matching method is that the bias that arises due to differences in the pre-hiring condition of the firms are reduced. Thereafter, the comparison of outcomes is performed from the firms of similar pre-hiring condition with the same likelihood in hiring either leading personnels or other workers, whereby treatment is as if randomly assigned.

Formally, we follow the suggestions in Angrist and Pischke (2009, p. 83), using a model containing continuous covariates with a few polynomial terms to estimate the propensity scores on which the selection of the control firms will be based.

$$E(D_i = 1|a_{it}, x_{it}) = P(D_i = 1|x_{it}) = f(x_{it}) + IND_{it} + TREND_t \quad (0.1)$$

where $D_i = \begin{cases} 1, \Delta MaP_i > 0 \wedge \Delta O_i = 0 \\ 0, \Delta MaP_i = 0 \wedge \Delta O_i > 0 \end{cases}$; The selected covariates stand for the pre-hiring characteristics of the firm, including lagged firm size, value-added, firm age, share of skilled workers, share of managers and professionals, the average age of workers, as well as the squared values of the selected variables. IND_{it} is a two-digit industry indicator variable; and $TREND_t$ is a common trend variable. Based on the resulting propensity score, each treated firm is assigned with a control using nearest neighbour (one-to-one) matching, allowing replacement.

Table C1: Probit regression results for propensity score matching: High educ.

Firm size _{t-1}	-0.237*** (0.0637)
Firm size _{t-1} ²	0.0103* (0.00478)
Value added _t - 1	0.0000167 (0.0000223)
Value added _t - 1 ²	1.15e-10 (7.16e-10)
Average worker age _{t-1}	-0.177*** (0.0476)
Average worker age _{t-1} ²	-0.00436*** (0.00146)
Firm age _{t-1}	0.192*** (0.0332)
Firm age _{t-1} ²	-0.00436*** (0.00146)
Share of managers and professionals _{t-1}	0.118 0.112
Obs.	934
Pseudo R ²	0.1668
Industry	Yes
Year	Yes

Notes: Response variable is treatment indicator. Underlying Probit regression for propensity score matching with firms at education level (4). Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table C2: Probit regression results for propensity score matching: Knowledge-intensive firms

Firm size $_{t-1}$	-0.294*** (0.0686)
Firm size $^2_{t-1}$	0.0198** (0.00737)
Value added $_t - 1$	0.0000241 (0.0000203)
Value added $_t - 1^2$	3.97e-10 (5.71e-10)
Average worker age $_{t-1}$	-0.0801*** (0.0208)
Average worker age $^2_{t-1}$	0.000863*** (0.000224)
Firm age $_{t-1}$	0.170*** (0.0261)
Firm age $^2_{t-1}$	-0.00257* (0.00152)
Share of skilled workers $_{t-1}$	0.3615** (0.2568)
Share of skilled workers $^2_{t-1}$	0.118** (0.112)
Share of managers and professionals $_{t-1}$	-0.275 (0.449)
Share of managers and professionals $^2_{t-1}$	0.237 (0.450)
Obs.	1 927
Pseudo R^2	0.1238
Industry	Yes
Year	Yes

Notes: Response variable is treatment indicator. Underlying Probit regression for propensity score matching with knowledge-intensive firms in service industry. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table C3: Probit regression results for propensity score matching: Firms with R&D expenditure

Firm size _{t-1}	-0.246*** (0.0523)
Firm size ² _{t-1}	0.012** (0.00625)
Value added _{t-1}	0.0000125 (0.0000116)
Value added _{t-1} ²	5.97e-10 (6.23e-10)
Average worker age _{t-1}	-0.0562*** (0.0302)
Average worker age ² _{t-1}	0.000213*** (0.000263)
Firm age _{t-1}	0.326*** (0.0623)
Firm age ² _{t-1}	-0.00156* (0.00136)
Share of skilled workers _{t-1}	0.4126** (0.2146)
Share of skilled workers ² _{t-1}	0.116** (0.136)
Share of managers and professionals _{t-1}	-0.369 (0.216)
Share of managers and professionals ² _{t-1}	0.369 (0.457)
Obs.	1 007
Pseudo R ²	0.1238
Industry	Yes
Year	Yes

Notes: Response variable is treatment indicator. Underlying Probit regression for propensity score matching with knowledge-intensive firms in service industry. Robust and firm-clustered standard errors in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table C4: Results of balancing test: High educ.

	Mean		t-test of the equality of the means		Reduced bias(%)
	Treated firms	Control firms	t-value	p-value	
Firm size _{t-1}	3.45	3.66	-0.57	0.57	64.1
Firm size _{t-1} ²	14.76	21.92	-1.02	0.31	20.5
Value added _{t-1}	2765.9	1953.1	1.16	0.25	13.3
Value added _{t-1} ²	4.3e+07	9.8e+06	0.98	0.33	10.1
Average worker age _{t-1}	12.63	12.64	0.46	0.64	72.9
Average worker age _{t-1} ²	144.65	169.23	0.46	0.64	64.4
Firm age _{t-1}	7.19	6.89	0.65	0.52	80.9
Firm age _{t-1} ²	61	58.66	0.24	0.81	83.4
Share of managers and professionals _{t-1}	0.56	0.51	2.51	0.89	37.7

Notes: The treated firms are firms that only hire managers and professionals and no other workers. The control firms only hire other workers. The average and median bias per variable before matching is 28.6% and 25.7%, respectively, and after matching 15.9% and 12.4%, respectively.

Table C5: Results of balancing test: Knowledge-intensive firms

	Mean		t-test of the equality of the means		Reduced bias(%)
	Treated firms	Control firms	t-value	p-value	
Firm size _{t-1}	3.44	3.54	-0.57	0.57	64.1
Firm size _{t-1} ²	14.12	18.92	-1.02	0.31	20.5
Value added _{t-1}	2763.9	7783.1	1.16	0.25	13.3
Value added _{t-1} ²	6.3e+07	9.2e+06	0.98	0.33	10.1
Average worker age _{t-1}	10.63	12.52	0.86	0.38	-10.9
Average worker age _{t-1} ²	111.64	144.23	0.62	0.64	-4.4
Firm age _{t-1}	7.18	6.78	0.65	0.52	80.9
Firm age _{t-1} ²	55.12	62.13	0.24	0.81	83.4
Share of skilled workers _{t-1}	0.24	0.26	2.15	0.04	32.7
Share of skilled workers _{t-1} ²	0.03	0.04	2.51	0.04	36.6
Share of managers and professionals _{t-1}	0.36	0.42	1.11	0.23	32.7
Share of managers and professionals _{t-1} ²	0.12	0.23	1.21	0.24	37.7

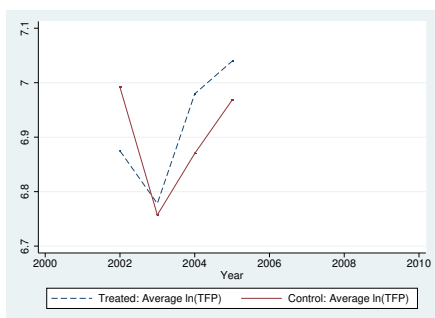
Notes: The treated firms are firms that only hire managers and professionals and no other workers. The control firms only hire other workers. The average and median bias per variable before matching is 35.6% and 27.8%, respectively, and after matching 13.4% and 10.1%, respectively.

Table C6: Results of balancing test: Firms with R&D expenditure

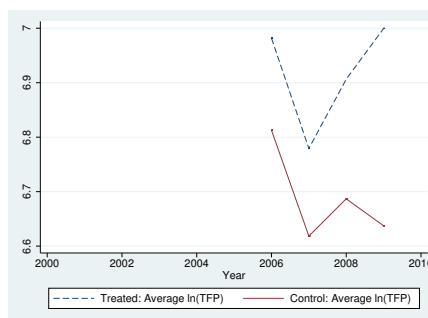
	Mean		t-test of the equality of the means		Reduced bias(%)
	Treated firms	Control firms	t-value	p-value	
Firm size _{t-1}	3.65	3.42	-0.54	0.39	72.1
Firm size _{t-1} ²	12.76	13.92	-0.93	0.25	30.3
Value added _{t-1}	4326.9	3941.1	1.16	0.24	20.2
Value added _{t-1} ²	5.36+07	5.12e+07	0.89	0.56	10.5
Average worker age _{t-1}	14.63	16.12	0.56	0.05	80.6
Average worker age _{t-1} ²	156.74	163.24	0.37	0.75	50.6
Firm age _{t-1}	8.14	7.56	0.72	0.41	60.2
Firm age _{t-1} ²	70.22	66.12	0.36	0.46	70.5
Share of skilled workers _{t-1}	0.52	0.50	3.18	0.04	20.5
Share of skilled workers _{t-1} ²	0.23	0.21	3.12	0.03	36.6
Share of managers and professionals _{t-1}	0.23	0.18	1.45	0.18	26.7
Share of managers and professionals _{t-1} ²	0.39	0.25	1.21	0.76	21.3

Notes: The treated firms are firms that only hire managers and professionals and no other workers. The control firms only hire other workers. The average and median bias per variable before matching is 42.6% and 36.1%, respectively, and after matching 12.9% and 16.4%, respectively.

Figure C1: DiD matching estimator results of high educ. - Average treatment on the treated

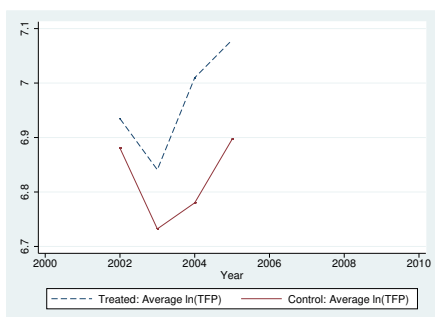


(a) Years 2002-2005

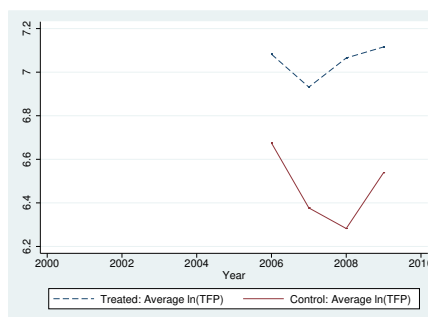


(b) Years 2006-2009

Figure C2: DiD matching estimator results of knowledge-intensive firms in service industry - Average treatment on the treated

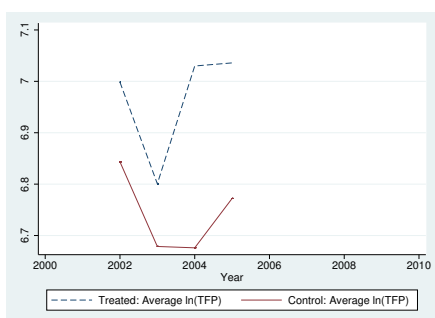


(a) Years 2002-2005

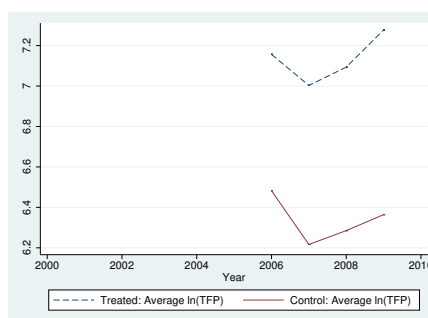


(b) Years 2006-2009

Figure C3: DiD matching estimator results of firms with R&D expenditure - Average treatment on the treated



(a) Years 2002-2005



(b) Years 2006-2009