Online Appendix -- **Not intended for publication**

P. Aghion, U. Akcigit, A. Hyytinen and O. Toivanen

A Year Older, A Year Wiser (and Farther from Frontier): Invention Rents and Human Capital Depreciation

Appendix A: Data and descriptive statistics

A.1 Data sources and matching

The data used in this paper cover the period of 1988-2012 and come from Statistics Finland (SF) and European Patent Office (EPO). SF is our source of individuals' characteristics and their employers. These data come from the Finnish Linked Employer-Employee Data (FLEED) for the period of 1988-2012. FLEED is a standard administrative register-based data, collected and maintained by SF. EPO data allow us to identify Finnish inventors. Our EPO data are derived from OECD's REGPAT database, which includes patent applications to the EPO and PCT filings.

The datasets were matched as follows: SF's FLEED contains unique but anonymized individual identifiers, which are based on unique social security numbers that everybody in Finland has. EPO data, in contrast, does not contain linkable individual identifiers. Linking of patent data to individuals was done by a civil servant of SF, using the information on individual name (first and surname), employer name, individual address and/or employer's address (postcode, street name street number), and year of patent application. These were used in different combinations, also varying the year of the match to be before or after the year of application (e.g., matching a patent applied for in 1999 with the street address of the firm from the registry taken in 1998 or 2000). The match rate is 90% when calculated for the patents applied for in the years 1988-2012. The procedure follows that used in Aghion, Akcigit, Hyytinen, and Toivanen (2018).

A.2 Descriptive statistics

Tables A1 and A2 display the descriptive statistics (mean, median and standard deviation) separately for the white- and blue-collar samples. Both tables provide descriptive statistics for the respective estimation samples, as well as for the subsamples of treated and control individuals. For DTHCF, we report the descriptive statistics conditional on DTHCF not missing. As explained in the main text, DTHCF is missing for those individuals with only compulsory education. For them, we set DTHCF to be equal to age – 15, the age at which compulsory education finishes. In the regressions, we include a separate dummy for these individuals, and take a full set of interactions between that dummy and the treatment – variables.

Figures A1 and A2 display DTHCF conditional on individuals' age, separately for white- and blue-collar samples. The lines display the 10^{th} and 90^{th} percentiles and the shadow area (in gray) between the lines illustrates how much there is variation in the DTHCF -measure for a given age group of individuals in the data.

Table A3 tabulates the information on the principal occupation of the individuals in our wage estimation samples for white- and blue-collar workers.

Table A1: *Mean, median and standard deviations: White collar sample*

Descriptive statistics - whitecollar						
Lnwage estimation sample						
Estimation sample						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.53	0.00	40.45	0.64	0.23	13.19
sd	0.64	0.00	9.73	0.48	0.42	9.12
p50	10.61	0	40	1	0	12
N	2 905 759	2 788 499	2 905 759	2 905 759	2 905 759	2 588 963
Control group						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.51	0.00	40.44	0.63	0.22	13.48
sd	0.65	0.00	9.76	0.48	0.42	9.16
p50	10.60	0	40	1	0	12
N	1 421 257	1 361 997	1 421 257	1 421 257	1 421 257	1 266 292
Treatment group						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.55	0.00	40.46	0.66	0.24	12.92
sd	0.63	0.00	9.70	0.47	0.43	9.07
p50	10.63	0	40	1	0	11
N	1 484 502	1 426 502	1 484 502	1 484 502	1 484 502	1 322 671
Unemployment estimation sample						
Estimation sample						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.50	0.03	40.21	0.64	0.23	13.04
sd	0.73	0.17	9.87	0.48	0.42	9.12
p50	10.61	0	40	1	0	11
N	2 849 605	2 875 851	2 875 851	2 875 851	2 875 851	2 554 439
Control group						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.48	0.03	40.21	0.62	0.22	13.33
sd	0.73	0.17	9.90	0.49	0.41	9.16
p50	10.59	0	40	1	0	12
N	1 392 486	1 405 137	1 405 137	1 405 137	1 405 137	1 248 088
Treatment group						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.51	0.03	40.20	0.65	0.24	12.76
sd	0.72	0.17	9.85	0.48	0.43	9.07
p50	10.62	0	40	1	0	11
N	1 457 119	1 470 714	1 470 714	1 470 714	1 470 714	1 306 351

Table A2: *Mean, median and standard deviations: Blue collar sample*

Descriptive statistics - bluecollar

Lnwage estimation sample

Estimation sample

	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.26	0.00	39.67	0.08	0.01	14.77
sd	0.57	0.00	10.35	0.27	0.10	9.62
p50	10.36	0	40	0	0	14
N	2,190,592	2,115,702	2,190,592	2,190,592	2,190,592	1,438,356

Control group

	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.21	0.00	39.56	0.07	0.01	14.88
sd	0.59	0.00	10.39	0.25	0.09	9.54
p50	10.32	0	40	0	0	14
N	1,075,177	1,030,487	1,075,177	1,075,177	1,075,177	702,859

Treatment group

	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.31	0.00	39.77	0.09	0.01	14.67
sd	0.55	0.00	10.31	0.28	0.12	9.69
p50	10.40	0	40	0	0	14
N	1,115,415	1,085,215	1,115,415	1,115,415	1,115,415	735,497

Unemployment estimation sample

Estimation sample

	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.22	0.04	39.45	0.08	0.01	14.55
sd	0.66	0.20	10.47	0.27	0.10	9.62
p50	10.35	0	40	0	0	14
N	2,178,294	2,209,644	2,209,644	2,209,644	2,209,644	1,444,847

Control group

	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.17	0.05	39.34	0.07	0.01	14.67
sd	0.67	0.21	10.49	0.25	0.09	9.54
p50	10.31	0	39	0	0	14
N	1,065,282	1,081,104	1,081,104	1,081,104	1,081,104	704,622

Treatment group

	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.27	0.04	39.55	0.09	0.01	14.43
sd	0.64	0.19	10.46	0.28	0.12	9.70
p50	10.39	0	40	0	0	13
N	1,113,012	1,128,540	1,128,540	1,128,540	1,128,540	740,225

Descriptive statistics - bluecollar

Lnwage estimation sample

Estimation sample

	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.26	0.00	39.67	0.08	0.01	14.77
sd	0.57	0.00	10.35	0.27	0.10	9.62
p50	10.36	0	40	0	0	14
N	2,190,592	2,115,702	2,190,592	2,190,592	2,190,592	1,438,356

Control group

	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.21	0.00	39.56	0.07	0.01	14.88
sd	0.59	0.00	10.39	0.25	0.09	9.54
p50	10.32	0	40	0	0	14
N	1,075,177	1,030,487	1,075,177	1,075,177	1,075,177	702,859
Treatment group						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.31	0.00	39.77	0.09	0.01	14.67
sd	0.55	0.00	10.31	0.28	0.12	9.69
p50	10.40	0	40	0	0	14
N	1,115,415	1,085,215	1,115,415	1,115,415	1,115,415	735,497
Unemployment estimation sample						
Estimation sample						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.22	0.04	39.45	0.08	0.01	14.55
sd	0.66	0.20	10.47	0.27	0.10	9.62
p50	10.35	0	40	0	0	14
N	2,178,294	2,209,644	2,209,644	2,209,644	2,209,644	1,444,847
Control group						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.17	0.05	39.34	0.07	0.01	14.67
sd	0.67	0.21	10.49	0.25	0.09	9.54
p50	10.31	0	39	0	0	14
N	1,065,282	1,081,104	1,081,104	1,081,104	1,081,104	704,622
Treatment group						
	lnwage	UE_d	age	BSc	MSc	DTHCF
mean	10.27	0.04	39.55	0.09	0.01	14.43
sd	0.64	0.19	10.46	0.28	0.12	9.70
p50	10.39	0	40	0	0	13
N	1,113,012	1,128,540	1,128,540	1,128,540	1,128,540	740,225

Table A.3: *Principal occupation, percentage shares*

Principal occupation	White-collar sample	Blue-collar sample
Employed	98.08	96.89
Unemployed	0.61	1.73
Student	0.92	0.77
Retirement	0.11	0.18
Military service	0.11	0.23
Unknown	0.17	0.19

Figure A1: *DTHCF conditional on age: White-collar sample*

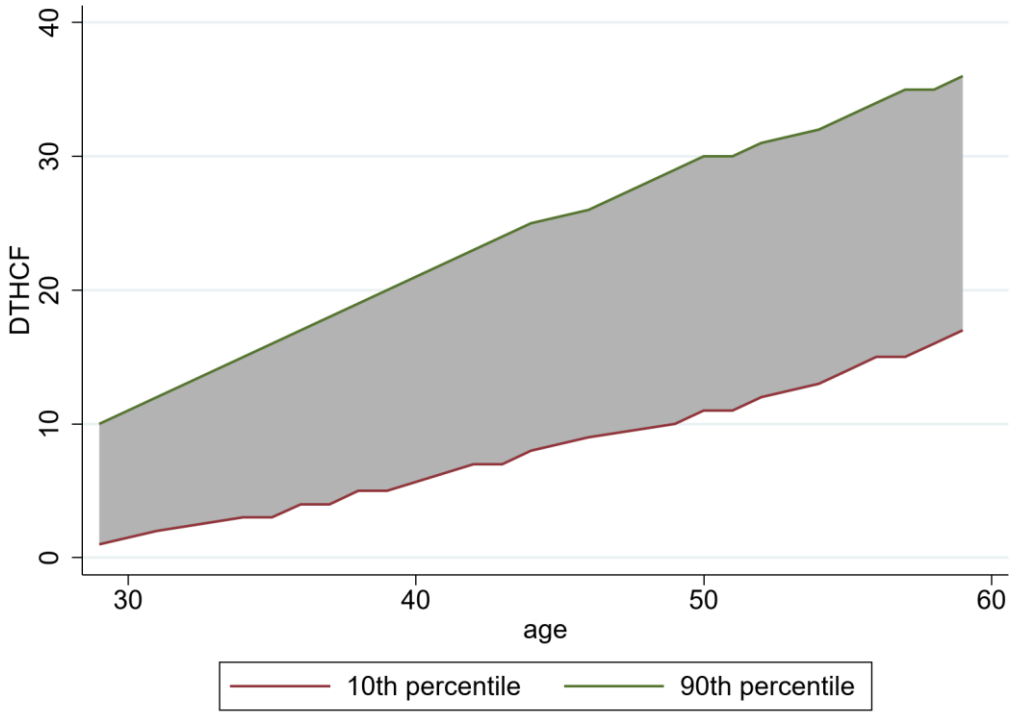
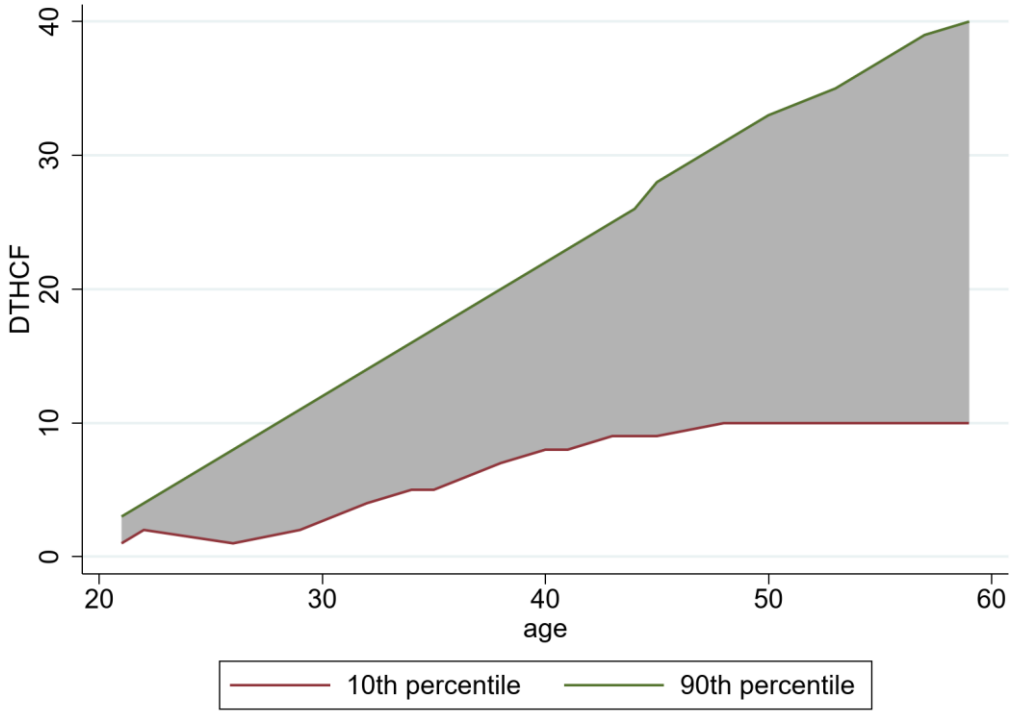


Figure A2: *DTHCF conditional on age: Blue-collar sample*



Appendix B: Institutional environment

B.1 Overall economic environment in 1988-2012

Finland has been a member of EU since 1995 and has a population of 5.5 million. It has been a member of the euro area since its introduction in 1999/2002.

During our observation period from 1988 to 2012, Finland's gross domestic product (GDP) grew on average 2.1% per year. The average masks a lot of variation (std = 3.6%), because the economy experienced boom periods in the late 1980s and late 1990s and two major economic slumps, one in the early 1990s and another in 2008/2009. In 1988/1989, unemployment rate was low, at around 3.1%. Unemployment peaked in the economic crisis of the early 1990s at around 16% (1993-1994), but decreased then to 7.7% by 2012.

At the beginning of our observation period, the employment rate among the population aged 15-74 was 67.3%. The employment rate has fluctuated somewhat, and decreased to 60.9% by 2012, mostly due to the aging of the population. Commerce, hotel and restaurant services, education, social services and health services and transport employ the greatest number of people, with the public sector (municipalities, government) being a major employer in many of these sectors.

In 1988, 51% of population aged 15 or over had basic education, but the share dropped to 31% by 2012. The share of population having higher level tertiary (ISCED 7) or doctorate level (ISCED 8) education increased from 7% (1988) to nearly 18% (2012) over our observation period. Research and development expenditures also increased steadily during our observation period, reaching their peak in 2011 when the total R&D expenditure by business sector and public sector amounted to 3.8% of the GDP. Based on its Global Competitiveness Index, World Economic Forum has quite consistently ranked Finland to be one of the ten most competitive countries in the world.

B.2 Wage setting

The Finnish labor market is characterized by widespread organization of employees (unionization) and employers, as well as by centralized wage-setting (bargaining and co-operation), which have resulted in various types of collective wage and labor agreements. A special feature of the Finnish labor market is national income policy settlements, which cover issues related to wage setting and salaries, taxation, pensions, and unemployment benefits, which are agreements between the government and the central confederations of employees and employers (the tripartite system). About three out of four Finnish employees are members of a trade union, and also those with higher education belong often to unions. In 2007, the system of centralized agreements largely ended when the private sector employers' association called for industry level negotiations. In 2011 there was a partial and temporary return to signing a national framework agreement, which was triggered by perceptions of deterioration of national price-cost competitiveness.

Despite these centralized features, wage setting is a mixture of collective and individual mechanisms. As Uusitalo and Vartiainen (2009) have emphasized, a key feature of the centralized agreements is that they coordinate the overall rate of wage increases. This does not prevent a firm from increasing its workers' wages by more than the coordinated overall increase. The collective agreements also restrict local bargaining by instituting agreed minimum wages for certain occupations and job levels. If a firm wants to employ somebody, the bargaining of his/her initial salary is subject to the minimum tariffs. However, as Uusitalo and Vartiainen (2009) stress, for most employees in the manufacturing sector, the minimum wages rarely bind. These features of the Finnish labor market mean that relative wages have largely been set by market forces and that wage bargaining is to a significant extent local. Moreover, various firm-specific arrangements and performance-related pay components became more widespread in the 1990s.

B.3 Remuneration of inventors and ownership of employee inventions

A specific law governs innovations made by employees ("Act on the Right in Employee Inventions", originally given in 1967, augmented in 2000). The provisions of the act apply to inventions (potentially) patentable in Finland.

The employee inventions act says, in particular, that i) an employer may acquire the right in the invention (made by its employee) if the use of the invention falls within the field of activity of the employer's enterprise; that ii) an employee who makes an invention has to notify the employer of it without delay, and that the employer has to notify the employee, if the employer wishes to acquire the right in the invention; and, finally, that iii) if the employer acquires the right in the invention, the employee is entitled to a reasonable compensation from the employer.

When determining the amount of the compensation, particular attention is to be paid to the value of the invention, the scope of the right which the employer acquires, as well as to the terms and conditions of the employment contract of the employee and the contribution which other circumstances connected with the employment had to the conception of the invention.

In sum, the act assigns the right to ownership of an employee invention, but it does *not* directly determine the amount firms have to pay if they exercise the right. Rather, the determination of the amount of compensation is largely left to the market forces. In particular, the act does not take any stance on how, if at all, the coworkers of the employee(s) who made the invention ought to be treated or compensated.

The Finnish act is by no means unique in an international comparison: for example, the Swedish "Act on the Right to Employee's Inventions" (introduced in 1949) shares many features with the corresponding Finnish act. Moreover, the German "Employee Invention Act" is in many ways similar: e.g. it states that when the

employer claims the rights to an employee-made invention, the employer owes the employee an "adequate" remuneration. Things are a bit more complex in the UK, but when an employer owns his employee's invention, it is possible for the employee to claim compensation if his invention or the patent is of outstanding benefit to his employer and it is just to award such compensation.

Appendix C: Are the results robust to excluding the largest employers of inventors from the estimation sample or using only those observations where the employer is the same as at the time of the (counterfactual) invention?

C.1 Are the results robust to excluding the largest employers of inventors from the estimation sample?

In Tables C1 – C4 we reproduce the estimations reported in Tables 1-4, but so that the individuals working for the three largest employers of inventors are excluded. The aim of this robustness check is to investigate whether some of the largest technology-oriented firms are driving our findings. This turns out not to be the case.

Table C1. Wage returns to invention, conditioning on age. Excluding top-3 employers of inventors

	whitecollar	whitecollar	bluecollar	bluecollar
post	0.0245***	0.0508***	0.000926	0.00902
	(0.00521)	(0.00745)	(0.00723)	(0.00879)
post x senior		-0.0515***		-0.0211***
		(0.00800)		(0.00961)
pre	0.0121***	0.0220***	-0.0174***	-0.0203***
	(0.00354)	(0.00497)	(0.00517)	(0.00652)
pre x senior		-0.0238***		0.00621
		(0.00581)		(0.00761)
Observations	1,884,160	1,884,160	1,395,940	1,395,940
R-squared	0.267	0.267	0.203	0.203
Number of individuals	159,300	159,300	132,763	132,763

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table C2. Wage returns to invention, conditioning on age and education.
Excluding top-3 employers of inventors

	whitecollar	whitecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)
post	0.114***	0.0999***	0.0896***	0.0449***
	(0.00863)	(0.00850)	(0.0113)	(0.0110)
post x senior	0.0173***	0.00190	0.0208***	-0.00735
	(0.00683)	(0.00673)	(0.00747)	(0.00754)
post x educ		0.0430***		0.0713***
		(0.00740)		(0.0131)
post x DTHCF	-0.00669***	-0.00602***	-0.00591***	-0.00479***
	(0.000433)	(0.000438)	(0.000555)	(0.000542)
pre	0.0441***	0.0429***	-0.0124	-0.00920
	(0.00558)	(0.00594)	(0.00863)	(0.00873)
pre x senior	0.00777	0.00355	-0.00266	-0.00886
	(0.00557)	(0.00559)	(0.00640)	(0.00645)
pre x educ		0.0104**		-0.00440
		(0.00541)		(0.0109)
pre x DTHCF	-0.00284***	-0.00273***	-0.000536	-0.000929*
	(0.000342)	(0.000353)	(0.000555)	(0.000477)
Observations	1,884,160	1,884,160	1,395,940	1,395,940
R-squared	0.271	0.280	0.204	0.221
Number of individuals	159,300	159,300	132,763	132,763

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table C3. Effect of invention on probability of unemployment. Excluding top-3 employers of inventors

	whitecollar	whitecollar	bluecollar	bluecollar
post	-0.000157	-0.00250	0.0167**	0.0161*
	(0.00334)	(0.00537)	(0.00738)	(0.00926)
post x senior		0.00483		-0.00140
		(0.00553)		(0.00800)
pre	0.00188	0.00160	0.0155***	0.0186***
	(0.00267)	(0.00390)	(0.00561)	(0.00672)
pre x senior		0.000788		-0.00943**
		(0.00420)		(0.00598)
Observations	1,862,793	1,862,793	1,414,470	1,414,470
R-squared	0.177	0.179	0.148	0.149
Number of individuals	159,256	159,256	132,740	132,740

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table C4. Effect of invention on probability of unemployment, conditioning on age and education. Excluding top-3 employers of inventors

	whitecollar	whitecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)
post	-0.0333***	-0.0461***	-0.0617***	-0.0558***
	(0.00618)	(0.00649)	(0.0107)	(0.0107)
post x senior	0.00758***	0.00256	0.00224	0.00649
	(0.00334)	(0.00324)	(0.00559)	(0.00556)
post x educ		0.0346***		0.0228***
		(0.00332)		(0.00708)
post x DTCHF	0.00242***	0.00284***	0.00539***	0.00518***
	(0.000245)	(0.000268)	(0.000424)	(0.000422)
pre	-0.0332***	-0.0425***	-0.0430***	-0.0449***
	(0.00461)	(0.00502)	(0.00796)	(0.00809)
pre x senior	0.0124***	0.00692***	0.00780*	0.00805**
	(0.00292)	(0.00286)	(0.00460)	(0.00460)
pre x educ		0.0311***		0.0276***
		(0.00299)		(0.00632)
pre x DTHCF	0.00266***	0.00299***	0.00440***	0.00445***
	(0.000222)	(0.000239)	(0.000349)	(0.000352)
Observations	1,862,793	1,862,793	1,414,470	1,414,470
R-squared	0.180	0.183	0.150	0.154
Number of individuals	159,256	159,256	132,740	132,740

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

C.2 Are the results robust to only including observations where the employer is the same as at the time of invention?

In Table C5 – C6 we reproduce the estimations reported in Tables 1-2, but so that the estimation sample only includes observations where the employer is the same as at the time of invention. The aim of this robustness check is to investigate whether those exiting employment or switching to new jobs are driving our (wage) return estimates. We obtain smaller returns to invention throughout. The returns to invention for our base group are of the order of 2 – 4 per cent instead of 4 - 10 per cent; the depreciation of returns through DTHCF is now 0.3 - 0.4 percentage points per year rather than 0.5 as in the main results.

Table C5. Wage returns to invention, conditioning on age. Observations where employer same as at time of invention

	whitecollar	whitecollar	bluecollar	bluecollar
post	0.00673*	0.0193***	-0.0169***	-0.0218***
post x senior		-0.0226***		0.00662
pre	0.00303	0.00846	-0.0215***	-0.0310***
pre x senior		-0.0107		0.0199**
Observations	1,047,946	1,047,946	826,835	826,835
R-squared	0.203	0.204	0.185	0.185
Number of individuals	159,424	159,424	132,776	132,776

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table C6. Wage returns to invention, conditioning on age and education. Observations where employer same as at time of invention

	whitecollar (1)	whitecollar (2)	bluecollar (3)	bluecollar (4)
post	0.0605***	0.0419***	0.0414***	0.0194**
post x senior	0.00545	-0.00502	0.0286***	0.0156**
post x educ		0.0552***		0.0649***
post x DTHCF	-0.00345***	-0.00289***	-0.00423***	-0.00376***
pre	0.0212***	0.0155**	-0.00936	-0.0125
pre x senior	0.00553	0.00215	0.0219***	0.0179***
pre x educ		0.0219***		0.0120
pre x DTHCF	-0.00137***	-0.00124***	-0.00137***	-0.00139***
Observations	1,047,946	1,047,946	826,835	826,835
R-squared	0.205	0.209	0.186	0.194
Number of individuals	159,424	159,424	132,776	132,776

Standard errors clustered at the individual level. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Appendix D: Are the results robust using only the first inventions of an employee?

Table D1. Wage returns to invention, conditioning on age. Only first invention included

	whitecollar	whitecollar	bluecollar	bluecollar
post	0.0295***	0.0324**	0.0126	0.0144
	(0.0107)	(0.0146)	(0.0139)	(0.0161)
post x senior		-0.0103		-0.0104
		(0.0133)		(0.0179)
pre	0.0226***	0.0371***	0.00746	0.00632
	(0.00460)	(0.00674)	(0.0126)	(0.0149)
pre x senior		-0.0338***		0.000150
		(0.00834)		(0.0162)
Observations	1,127,934	1,127,934	854,582	854,582
R-squared	0.254	0.255	0.189	0.189
Number of individuals	99,204	99,204	81,866	81,866

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table D2. Wage returns to invention, conditioning on age and education. Only first invention included

	whitecollar	whitecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)
post	0.0680***	0.0748***	0.121***	0.0710**
	(0.0205)	(0.0205)	(0.0282)	(0.0286)
post x senior	0.00365	0.00282	0.0353*	0.0110
	(0.0125)	(0.0125)	(0.0193)	(0.0193)
post x educ		0.000842		0.159***
		(0.0202)		(0.0410)
post x DTHCF	- 0.00379***	- 0.00435***	- 0.00803***	- 0.00617***
	(0.000990)	(0.000985)	(0.00174)	(0.00171)
pre	0.0608***	0.0657***	0.0312	0.0216
	(0.00894)	(0.00976)	(0.0270)	(0.0282)
pre x senior	0.00368	0.00602	0.00705	0.000308
	(0.00975)	(0.0100)	(0.0181)	(0.0180)
pre x educ		-0.0135		0.0765*
		(0.00956)		(0.0390)
pre x DTHCF	- 0.00333***	- 0.00356***	-0.00203	-0.00181
	(0.000601)	(0.000629)	(0.00158)	(0.00159)
Observations	1,127,934	1,127,934	854,582	854,582
R-squared	0.258	0.269	0.190	0.201
Number of individuals	99,204	99,204	81,866	81,866

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table D3. Effect of invention on probability of unemployment. Only first invention included

	whitecollar	whitecollar	bluecollar	bluecollar
post	0.0254***	0.0209***	0.0119	0.00387
	(0.00589)	(0.00788)	(0.0109)	(0.0142)
post x senior		-0.00408		0.00789
		(0.00697)		(0.0137)
pre	0.0315***	0.0475***	0.00861	0.0142
	(0.00256)	(0.00367)	(0.00912)	(0.0115)
pre x senior		-0.0414***		-0.0194
		(0.00415)		(0.0118)
Observations	1,112,822	1,112,822	868,156	868,156
R-squared	0.154	0.156	0.133	0.134
Number of individuals	99,192	99,192	81,858	81,858

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table D4. Effect of invention on probability of unemployment. Only first invention included

	whitecollar	whitecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)
post	-0.0143	-0.0292**	-0.0901***	-0.0809***
	(0.0118)	(0.0129)	(0.0222)	(0.0222)
post x senior	0.0110**	0.0110**	0.00913	0.0143
	(0.00544)	(0.00558)	(0.0133)	(0.0131)
post x educ		0.0129*		-0.0195
		(0.00776)		(0.0244)
post x DTCHF	0.00104**	0.00138**	0.00580***	0.00541***
	(0.000512)	(0.000546)	(0.00112)	(0.00111)
pre	0.0246***	0.0199***	-0.0467**	-0.0422**
	(0.00490)	(0.00532)	(0.0187)	(0.0189)
pre x senior	-0.00420	-0.00431	0.00379	0.00639
	(0.00395)	(0.00406)	(0.0125)	(0.0124)
pre x educ		0.00317		-0.0254
		(0.00384)		(0.0230)
pre x DTHCF	0.000463	0.000591*	0.00387***	0.00368***
	(0.000295)	(0.000310)	(0.00104)	(0.00104)
Observations	1,112,822	1,112,822	868,156	868,156
R-squared	0.156	0.160	0.134	0.137
Number of individuals	99,192	99,192	81,858	81,858

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Appendix E: Are the results different for those with and without a STEM education?

Table E1. Wage returns to invention, conditioning on age. STEM and non-STEM educated separately

	STEM-educated		non-STEM-educated		STEM-educated		non-STEM-educated	
	whitecollar	whitecollar	whitecollar	whitecollar	bluecollar	bluecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
post	-0.00112	0.0134*	0.0479***	0.0274***	-0.00831	-0.00669	0.00537	0.0149
	(0.00520)	(0.00691)	(0.00830)	(0.00776)	(0.00721)	(0.00897)	(0.0101)	(0.0125)
post x senior		-0.0251***		-0.0248***		-0.00633		-0.0254*
		(0.00861)		(0.00882)		(0.0112)		(0.0134)
pre	0.00540	0.0157***	0.0181***	0.0778***	-0.0132**	-0.0175**	-0.0169**	-0.0156
	(0.00388)	(0.00544)	(0.00563)	(0.0116)	(0.00555)	(0.00715)	(0.00738)	(0.00979)
pre x senior		-0.0215***		-0.0634***		0.0107		-0.00504
		(0.00696)		(0.0120)		(0.00923)		(0.0112)
Observations	1,009,382	1,009,382	876,131	876,131	790,215	790,215	605,989	605,989
R-squared	0.189	0.189	0.257	0.258	0.191	0.191	0.179	0.179
Number of individuals	87,520	87,520	84,810	84,810	76,393	76,393	65,226	65,226

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table E2. Wage returns to invention, conditioning on age and education. STEM and non-STEM educated separately

	STEM-educated		non-STEM-educated		STEM-educated		non-STEM-educated	
	whitecollar	whitecollar	whitecollar	whitecollar	bluecollar	bluecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
post	0.0681***	0.0526***	0.166***	0.154***	0.0645***	0.0523***	0.157***	0.0877***
	(0.00847)	(0.00896)	(0.0143)	(0.0146)	(0.0118)	(0.0120)	(0.0185)	(0.0188)
post x senior	0.0512***	0.0393***	0.00778	-0.0114	0.0709***	0.0592***	0.00169	-0.0285***
	(0.00850)	(0.00864)	(0.0102)	(0.00990)	(0.00991)	(0.00986)	(0.0101)	(0.0102)
post x educ		0.0505***		0.0331***		0.0534***		0.0486**
		(0.00909)		(0.0115)		(0.0160)		(0.0216)
post x DTHCF	-0.00640***	-0.00557***	-0.00901***	-0.00815***	-0.00714***	-0.00667***	-0.00896***	-0.00781***
	(0.000534)	(0.000542)	(0.000704)	(0.000730)	(0.000661)	(0.000663)	(0.00101)	(0.000975)
pre	0.0319***	0.0275***	0.0589***	0.0600***	0.00448	0.00850	-0.00169	-0.0146
	(0.00647)	(0.00691)	(0.00906)	(0.00988)	(0.00973)	(0.0101)	(0.0155)	(0.0159)
pre x senior	0.0196***	0.0156**	-0.00192	-0.00404	0.0229***	0.0235***	-0.0150*	-0.0231***
	(0.00706)	(0.00725)	(0.00817)	(0.00816)	(0.00890)	(0.00900)	(0.00833)	(0.00832)
pre x educ		0.0172**		-0.00292		-0.0257**		0.00825
		(0.00673)		(0.00858)		(0.0130)		(0.0185)
pre x DTHCF	-0.00268***	-0.00242***	-0.00354***	-0.00344***	-0.00202***	-0.00225***	-0.00125	-0.00129
	(0.000447)	(0.000460)	(0.000533)	(0.000556)	(0.000594)	(0.000605)	(0.000919)	(0.000907)
Observations	1,009,382	1,009,382	876,131	876,131	790,215	790,215	605,989	605,989
R-squared	0.190	0.191	0.261	0.270	0.192	0.198	0.181	0.191
Number of individuals	87,520	87,520	84,810	84,810	76,393	76,393	65,226	65,226

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table E3. Effect of invention on probability of unemployment. STEM and non-STEM educated separately

	STEM-educated		non-STEM-educated		STEM-educated		non-STEM-educated	
	whitecollar	whitecollar	whitecollar	whitecollar	bluecollar	bluecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
post	0.0121***	0.0143***	-0.0149***	-0.0209***	0.0236***	0.0267***	0.0152	0.0146
	(0.00269)	(0.00426)	(0.00504)	(0.00785)	(0.00677)	(0.00831)	(0.00966)	(0.0128)
post x senior		-0.00542		0.0147*		-0.0126		0.000214
		(0.00433)		(0.00806)		(0.00789)		(0.0114)
pre	0.00738***	0.00868***	-0.00580	-0.00791	0.0168***	0.0215***	0.0167**	0.0199**
	(0.00223)	(0.00335)	(0.00406)	(0.00570)	(0.00528)	(0.00648)	(0.00745)	(0.00934)
pre x senior		-0.00342		0.00607		-0.0156**		-0.00789
		(0.00360)		(0.00612)		(0.00670)		(0.00870)
Observations	996,442	996,442	842,888	842,888	797,683	797,683	605,182	605,182
R-squared	0.091	0.092	0.178	0.180	0.117	0.118	0.151	0.152
Number of individuals	87,580	87,580	76,960	76,960	76,440	76,440	61,542	61,542

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table E4. Effect of invention on probability of unemployment, conditioning on age and education. STEM and non-STEM educated separately

	STEM-educated		non-STEM-educated		STEM-educated		non-STEM-educated	
	whitecollar	whitecollar	whitecollar	whitecollar	bluecollar	bluecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
post	-0.00812*	-0.0143***	-0.0732***	-0.0728***	-0.0420***	-0.0446***	-0.104***	-0.102***
	(0.00487)	(0.00524)	(0.0101)	(0.0101)	(0.0105)	(0.0107)	(0.0173)	(0.0172)
post x senior	0.00283	-0.000386		0.00144	-0.0350***	-0.0361***		0.0140*
	(0.00299)	(0.00298)		(0.00529)	(0.00642)	(0.00662)		(0.00799)
post x educ		0.0184***	0.0418***	0.0414***		0.0310***	0.0332***	0.0321***
		(0.00336)	(0.00546)	(0.00550)		(0.00867)	(0.0118)	(0.0117)
post x DTCHF	0.00115***	0.00140***	0.00421***	0.00413***	0.00518***	0.00531***	0.00849***	0.00809***
	(0.000238)	(0.000250)	(0.000444)	(0.000447)	(0.000507)	(0.000525)	(0.000813)	(0.000791)
pre	-0.0130***	-0.0170***	-0.0592***	-0.0585***	-0.0344***	-0.0384***	-0.0686***	-0.0661***
	(0.00382)	(0.00415)	(0.00780)	(0.00779)	(0.00823)	(0.00848)	(0.0131)	(0.0130)
pre x senior	0.00807***	0.00560**		0.00476	-0.0231***	-0.0258***		0.0185***
	(0.00276)	(0.00278)		(0.00459)	(0.00590)	(0.00607)		(0.00670)
pre x educ		0.0135***	0.0391***	0.0381***		0.0361***	0.0288***	0.0273**
		(0.00298)	(0.00478)	(0.00489)		(0.00758)	(0.0107)	(0.0107)
pre x DTHCF	0.00129***	0.00146***	0.00399***	0.00381***	0.00426***	0.00443***	0.00652***	0.00596***
	(0.000215)	(0.000226)	(0.000362)	(0.000382)	(0.000434)	(0.000447)	(0.000644)	(0.000662)
Observations	996,442	996,442	842,888	842,888	797,683	797,683	605,182	605,182
R-squared	0.093	0.094	0.184	0.184	0.119	0.122	0.155	0.155
Number of individuals	87,580	87,580	76,960	76,960	76,440	76,440	61,542	61,542

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Appendix F: Are the results robust to excluding those who eventually obtain a PhD?

Table F1. Wage returns to invention, conditioning on age. Excluding those who obtain a PhD

	whitecollar	whitecollar	bluecollar	bluecollar
post	0.0211***	0.0474***	0.000553	0.00819
	(0.00520)	(0.00744)	(0.00723)	(0.00878)
post x senior		-0.0508***		-0.0200**
		(0.00807)		(0.00961)
pre	0.0110***	0.0208***	-0.0174***	-0.0204***
	(0.00360)	(0.00505)	(0.00517)	(0.00651)
pre x senior		-0.0233***		0.00666
		(0.00592)		(0.00760)
Observations	1,829,071	1,829,071	1,395,382	1,395,382
R-squared	0.267	0.267	0.202	0.203
Number of individuals	154,607	154,607	132,709	132,709

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table F2. Wage returns to invention, conditioning on age and education. Excluding those who obtain a PhD

	whitecollar	whitecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)
post	0.111***	0.101***	0.0880***	0.0441***
	(0.00889)	(0.00863)	(0.0113)	(0.0110)
post x senior	0.0170**	0.00342	0.0205***	-0.00743
	(0.00708)	(0.00698)	(0.00745)	(0.00753)
post x educ		0.0348***		0.0714***
		(0.00764)		(0.0131)
post x DTHCF	- 0.00642***	- 0.00594***	- 0.00586***	- 0.00476***
	(0.000454)	(0.000453)	(0.000552)	(0.000540)
pre	0.0436***	0.0434***	-0.0125	-0.00944
	(0.00585)	(0.00605)	(0.00860)	(0.00872)
pre x senior	0.00969*	0.00610	-0.00262	-0.00886
	(0.00587)	(0.00586)	(0.00639)	(0.00644)
pre x educ		0.00792		-0.00331
		(0.00578)		(0.0108)
pre x DTHCF	- 0.00282***	- 0.00277***	-0.000541	-0.000924*
	(0.000365)	(0.000369)	(0.000476)	(0.000475)
Observations	1,829,071	1,829,071	1,395,382	1,395,382
R-squared	0.270	0.280	0.204	0.221
Number of individuals	154,607	154,607	132,709	132,709

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table F3. Effect of invention on probability of unemployment. Excluding those who obtain a PhD

	whitecollar	whitecollar	bluecollar	bluecollar
post	0.000358	-0.00153	0.0169**	0.0165*
	(0.00331)	(0.00531)	(0.00738)	(0.00926)
post x senior		0.00378		-0.00176
		(0.00549)		(0.00800)
pre	0.00197	0.00200	0.0156***	0.0188***
	(0.00266)	(0.00382)	(0.00562)	(0.00672)
pre x senior		5.72e-05		-0.00967
		(0.00410)		(0.00598)
Observations	1,810,140	1,810,140	1,413,874	1,413,874
R-squared	0.178	0.179	0.148	0.149
Number of individuals	154,566	154,566	132,686	132,686

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Table F4. Effect of invention on probability of unemployment, conditioning of age and education. Excluding those who obtain a PhD

	whitecollar	whitecollar	bluecollar	bluecollar
	(1)	(2)	(3)	(4)
post	-0.0339***	-0.0451***	-0.0609***	-0.0552***
	(0.00627)	(0.00645)	(0.0107)	(0.0107)
post x senior	0.00362	0.00126	0.00241	0.00660
	(0.00334)	(0.00333)	(0.00559)	(0.00556)
post x educ		0.0331***		0.0226***
		(0.00325)		(0.00707)
post x DTCHF	0.00259***	0.00285***	0.00535***	0.00516***
	(0.000265)	(0.000277)	(0.000424)	(0.000422)
pre	-0.0347***	-0.0420***	-0.0426***	-0.0446***
	(0.00470)	(0.00494)	(0.00797)	(0.00809)
pre x senior	0.00802***	0.00498*	0.00782*	0.00808*
	(0.00287)	(0.00290)	(0.00460)	(0.00460)
pre x educ		0.0287***		0.0273***
		(0.00295)		(0.00631)
pre x DTHCF	0.00288***	0.00306***	0.00438***	0.00444***
	(0.000241)	(0.000248)	(0.000349)	(0.000352)
Observations	1 810 140	1,810,140	1,413,874	1,413,874
R-squared	0.180	0.183	0.150	0.154
Number of individuals	154,566	154,566	132,686	132,686

Standard errors, clustered at the employer level (at τ=0) level in parentheses. All specifications include individual fixed effects, treatment and calendar year dummies, age fixed effects, dummies for the relevant interaction variables (senior, educ, DTHCF), a dummy for missing DTHCF (for those with compulsory education only) and its interactions, the number of employees in the firm, and a dummy for missing number of employees.

Appendix references

Aghion, P., U. Akcigit, A. Hyytinen, and O. Toivanen: 2018, 'On the Returns to Invention within Firms: Evidence from Finland'. *American Economic Review, Papers and Proceedings*. vol. 108, pp. 208-212.

Uusitalo, R. and J. Vartiainen: 2009, 'Firm Factors in Wages and Wage Changes'. In: *The Structure of Wages: An International Comparison* (Edited by: Edward P. Lazear and Kathryn L. Shaw), University of Chicago Press, pp. 149–178.