

Online Appendix for How Worker Productivity and Wages Grow with Tenure and Experience: The Firm Perspective

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A Appendix: Sampling and Response Analysis

Table A1: Population of Danish firm with 5+ employees by size and industry

Industry	5-9	10-49	50-199	200+	Total
Agriculture, forestry and fishing	1,557	705	44	4	2,310
Business service	2,952	2,526	506	132	6,116
Construction	3,329	2,698	347	51	6,425
Culture and sports	1,220	942	147	28	2,337
Finance and insurance	352	337	103	67	859
Information and communication	1,109	1,099	238	52	2,498
Manufacturing, raw materials	1,935	2,563	748	239	5,485
Public, teaching and health	844	369	13	4	1,230
Real estate and rental	627	287	35	9	958
Trade and transport	8,085	6,525	963	250	15,823

Table A2: Number of invited firms by size and industry

Industry	5-9	10-49	50-199	200+	Total
Agriculture, forestry and fishing	500	250	25	0	775
Business service	851	799	353	79	2,082
Construction	1,050	850	222	32	2,154
Culture and sports	452	348	101	21	922
Finance and insurance	150	150	82	52	434
Information and communication	453	398	154	39	1,044
Manufacturing, raw materials	632	799	500	150	2,081
Public, teaching and health	400	150	10	0	560
Real estate and rental	250	138	25	2	415
Trade and transport	2,001	1,801	572	159	4,533

Table A3: Number of complete responses by size and industry

Industry	5-9	10-49	50-199	200+	Total
Agriculture, forestry and fishing	99	49	5	0	153
Business service	159	184	63	12	418
Construction	137	138	45	6	326
Culture and sports	90	119	22	6	237
Finance and insurance	17	44	25	10	96
Information and communication	73	82	30	2	187
Manufacturing, raw materials	121	173	114	34	442
Public, teaching and health	63	21	4	0	88
Real estate and rental	34	28	8	0	70
Trade and transport	281	307	115	27	730

Table A4: Response rate (in percent) by size and industry

Industry	5-9	10-49	50-199	200+	Total
Agriculture, forestry and fishing	19.8	19.6	20.0	0.0	19.7
Business service	18.7	23.0	17.8	15.2	20.1
Construction	13.0	16.2	20.3	18.8	15.1
Culture and sports	19.9	34.2	21.8	28.6	25.7
Finance and insurance	11.3	29.3	30.5	19.2	22.1
Information and communication	16.1	20.6	19.5	5.1	17.9
Manufacturing, raw materials	19.1	21.7	22.8	22.7	21.2
Public, teaching and health	15.8	14.0	40.0	0.0	15.7
Real estate and rental	13.6	20.3	32.0	0.0	16.9
Trade and transport	14.0	17.0	20.1	17.0	16.1

Table A5: Balance table by survey participation

	Participants	Non-participants	Difference
Number of observations	2,747	12,253	
A. Firm age in years (average)			
Firm age	28.491 (31.958)	22.54 (26.991)	5.951 (0.657)
B. Firm size (shares)			
5-9	0.391 (0.488)	0.462 (0.499)	-0.071 (0.010)
10-49	0.417 (0.493)	0.370 (0.483)	0.046 (0.010)
50-199	0.157 (0.364)	0.132 (0.338)	0.0250 (0.008)
200+	0.035 (0.185)	0.036 (0.185)	0.000 (0.004)
C. Industry (shares)			
Trade and transport	0.266 (0.442)	0.310 (0.463)	-0.045 (0.009)
Agriculture, forestry and fishing	0.056 (0.229)	0.051 (0.220)	0.005 (0.005)
Construction	0.119 (0.323)	0.149 (0.356)	-0.031 (0.007)
Culture and sports	0.086 (0.281)	0.056 (0.230)	0.030 (0.006)
Manufacturing, raw materials	0.161 (0.368)	0.134 (0.340)	0.027 (0.008)
Finance and insurance	0.035 (0.184)	0.028 (0.164)	0.007 (0.004)
Business service	0.152 (0.359)	0.136 (0.343)	0.016 (0.008)
Information and communication	0.068 (0.252)	0.070 (0.255)	-0.002 (0.005)
Public, teaching and health	0.032 (0.176)	0.039 (0.192)	-0.006 (0.004)
Real estate and rental	0.025 (0.158)	0.028 (0.165)	-0.003 (0.003)
D. Region (shares)			
Midtjylland	0.242 (0.429)	0.229 (0.420)	0.014 (0.009)
Syddanmark	0.217 (0.412)	0.205 (0.404)	0.012 (0.009)
Hovedstaden	0.326 (0.469)	0.356 (0.479)	-0.031 (0.010)
Nordjylland	0.098 (0.297)	0.100 (0.299)	-0.002 (0.006)
Sjælland	0.117 (0.321)	0.110 (0.313)	0.007 (0.007)
E. Firm type (shares)			
Sole proprietorship	0.105 (0.306)	0.100 (0.300)	0.005 (0.006)
Stock-based corporation	0.417 (0.493)	0.361 (0.480)	0.056 (0.010)
Private limited company	0.312 (0.463)	0.432 (0.495)	-0.120 (0.010)
Other	0.166 (0.372)	0.107 (0.309)	0.059 (0.008)
F. Employee characteristics (average)			
Wage	36,959.16 (12,147.58)	36,669.18 (38,036.11)	289.98 (431.72)
Tenure	5.332 (3.641)	4.479 (3.503)	0.852 (0.079)
Experience	12.171 (5.496)	10.946 (5.690)	1.225 (0.121)

Notes: 15,000 firms were invited to participate in the survey. Columns “Participants” and “Non-participants” show summary statistics for those who completed the survey and those who did not, respectively, with standard deviations in parenthesis. The “Difference” column shows the first column minus the second column, with the standard errors of a Welch two-sample t-test in parentheses. Panels B, C, D, and E report shares of firms in each category. Panel F reports employee averages from the matched employer-employee data set.

B Appendix: Survey Questions

In this Appendix, we presents the full script of the sections of the survey used in this paper (translated to English).

We will now turn to ask questions to learn about how valuable good employee matches are to your firm in terms of productivity, i.e. the part of productivity of an employee in your firm that rests on the employee having worked in your firm for some time.

To do this we would first like you to identify the most common occupation in your firm when the firm is in full operation.

Q7. *What is the most common occupation at your company among employees aged 35 years or older?*

Q8. *If relevant, please provide a finer classification of that occupation.*

We use a standard ISCO classification system and the respondents specify a 2-digit occupation, stored in the OCCUPATION variable.

Next we will ask you a series of hypothetical questions about hiring new employees in the occupation:

OCCUPATION

For this purpose, please imagine that you will be hiring employees in a situation, say 2-3 years from now, where there is herd immunity for COVID-19, a cure, or a vaccine which is widely available.

Think about a hiring a new employee in OCCUPATION. This new hire is aged 35 or older and has no prior relevant industry and/or occupation experience.

Q9a. *Suppose that this employee has worked in your firm for 1 year. Would this employee have reached close to his/her maximum productivity within your firm or would he/she have substantially more to gain in terms of productivity from additional experience and learning within you firm?*

Yes, the employee should have reached close to his/her maximum productivity by working for 1 year.

No, the employee should have substantially more to learn from additional experience after working for 1 year.

[If Q9a==Yes, define TENURE=1, and skip to Q10.]

Q9b. *[IF Q9a==No] Suppose that this employee has worked in your firm for 5 years. Would this worker have reached close to his/her maximum productivity within your firm or would he/she have substantially more to gain in terms of productivity from additional experience and learning within you firm?*

Yes, the employee should have reached close to his/her maximum productivity by working for 5 years.

No, the employee should have substantially more to learn from additional experience after working for 5 years.

[If Q9b==Yes, then go to Q9c. If Q9b==No, then go to Q9d.]

Q9c. *Between 2 and 5 years, how much experience at your firm do you think this employee would need to reach close to his/her maximum productivity within your firm?*

_____ years

[Accept a whole number in 2-5. Define TENURE = Q9c. Go to Q10.]

Q9d. *Suppose that this employee has worked in your firm for 10 years. Would this worker have reached close to his/her maximum productivity within your firm or would he/she have substantially more to gain in terms of productivity from additional experience and learning within you firm?*

Yes, the employee should have reached close to his/her maximum productivity by working for 10 years.

No, the employee should have substantially more to learn from additional experience after working for 10 years.

[If Q9d==Yes, then go to Q9e. If Q9d==No, then go to Q9f.]

Q9e. *Between 6 and 10 years, how much experience at your firm do you think this employee would need to reach close to his/her maximum productivity within your firm?*

_____ years

[Accept a whole number in 6-10. Define TENURE = Q9e. Go to Q10.]

Q9f. How much experience at your firm do you think this employee would need to reach close to his/her maximum productivity within your firm?

_____ years

[Accept a whole number in 11-40. Define TENURE = Q9f.]

Q10. Would this employee be paid a monthly salary, paid by the hour, or other?

Paid a monthly salary

Paid an hourly wage

Other arrangements (Specify)

[Define a string variable WAGE, as: WAGE="monthly salary" if Q10==Paid a monthly salary; WAGE="hourly wage" if Q10==Paid an hourly wage; WAGE ="total monthly compensation" if Q10==Other arrangements.]

Q10a. What would be the WAGE for this employee, with TENURE year(s) of experience within your firm?

DKK _____

[Accept a whole number in 1-1,000,000.]

Now please consider the extent to which relevant experience outside your firm can compensate for lack of experience within your specific firm.

Please consider a combination of relevant experience outside your firm and experience within your specific firm that would give rise to an employee which is equally productive or valuable to you as the employee with no prior relevant experience outside your firm and **TENURE** year(s) of experience within your specific firm.

Q11. In the table below consider workers with different levels of relevant experience prior to starting at your firm. Please state how many years of specific experience within your firm this worker would need to accumulate in order to reach the same level of productivity as the worker with no prior relevant experience and **TENURE** year(s) of specific experience within your firm.

Relevant experience outside your firm	Tenure
1-2 years	_____ year(s)
3-4 years	_____ year(s)
5-9 years	_____ year(s)
10+ years	_____ year(s)

[Activate only the first line when the table is first presented.

Activate the second line when the first line is answered, etc.

Accept a whole number in 0-**TENURE** in the first line. Define **TENURE2** based on this response.

Accept a whole number in 0- $\min(\text{TENURE}, \text{TENURE2})$ in the second line. Define **TENURE4** based on this response.

Accept a whole number in 0- $\min(\text{TENURE}, \text{TENURE4})$ in the third line. Define **TENURE9** based on this response.

Accept a whole number in 0- $\min(\text{TENURE}, \text{TENURE9})$ in the fourth line. Define **TENURE10** based on this response.]

Q12. We would now like to quantify your willingness to pay for new employees, i.e. employees who have never worked for you before, but who have some general relevant experience. How much **WAGE** would you pay such an employee depending on how much general relevant experience he/she has?

For comparison, you reported that your firm would pay the **WAGE** of **DKK Q10** to an employee with **TENURE** year(s) of experience within your firm.

Relevant experience outside your firm	WAGE
0 year	DKK _____
1-2 years	DKK _____
3-4 years	DKK _____
5-9 years	DKK _____
10+ years	DKK _____

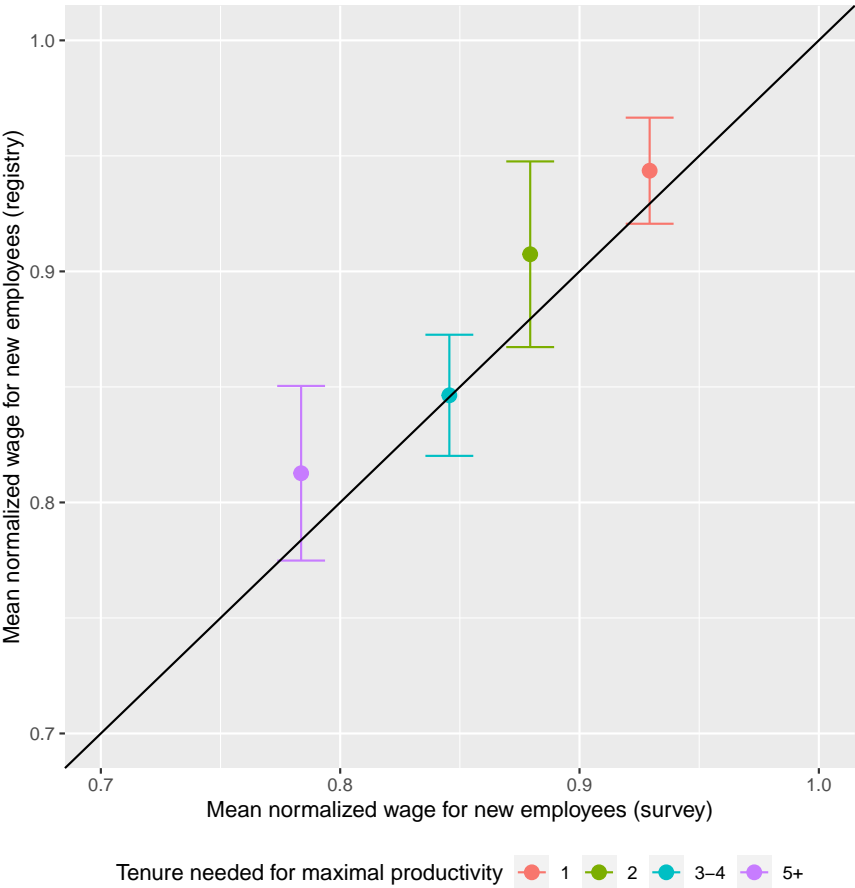
[Accept a whole number in 1-1,000,000 for each line. Do not present lines that correspond to the lines where the respondent put 0 in Q11. For example, if the respondent put 0 in ‘‘5-9 years’’ and ‘‘10+ years’’ while she put a positive number in ‘‘1-2 years’’ and ‘‘3-4 years’’, the lines to be presented in this table is the first three (‘‘0 year’’, ‘‘1-2 years’’, and ‘‘3-4 years’’).]

C Appendix: Comparisons of Normalized Wages to New Employees between the Survey and Registry data under Alternative Specifications

Figure 7 in the main text presents the comparisons of normalized wages to new employees between the survey and registry data under specific definitions of low tenure, high tenure, and little previous experience. To be specific, low tenure is defined as having lower than two years of tenure, high tenure is defined as having more than four years of tenure, and having little previous experienced is defined as having less than two years of experience in the same one-digit level occupation before joining the current firm.

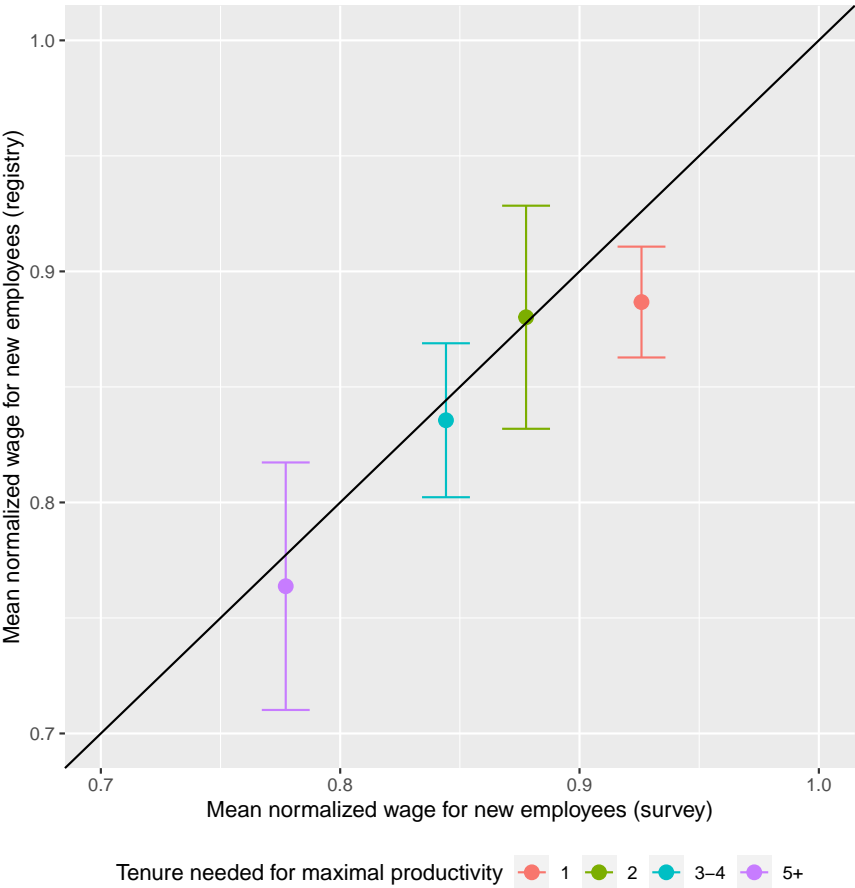
This appendix presents the same comparison under alternative definitions of these concepts. In Figure C1, we define high tenure as having more than T_M years of tenure, which varies across the groups considered. In Figure C2, we define high tenure as having more than 6 years of tenure. In Figure C3, we define the low tenure as having less than one year of tenure. Lastly, in Figure C4, we define having little previous experience as having less than four years of previous experience. All the other specifications are the same as Figure 7 in each figure. Under all these alternative specifications, it remains true that the survey measures line up very close with the administrative measures.

Figure C1: Normalized wages for new employees in the survey versus that in the registry data, with high tenure threshold = T_M



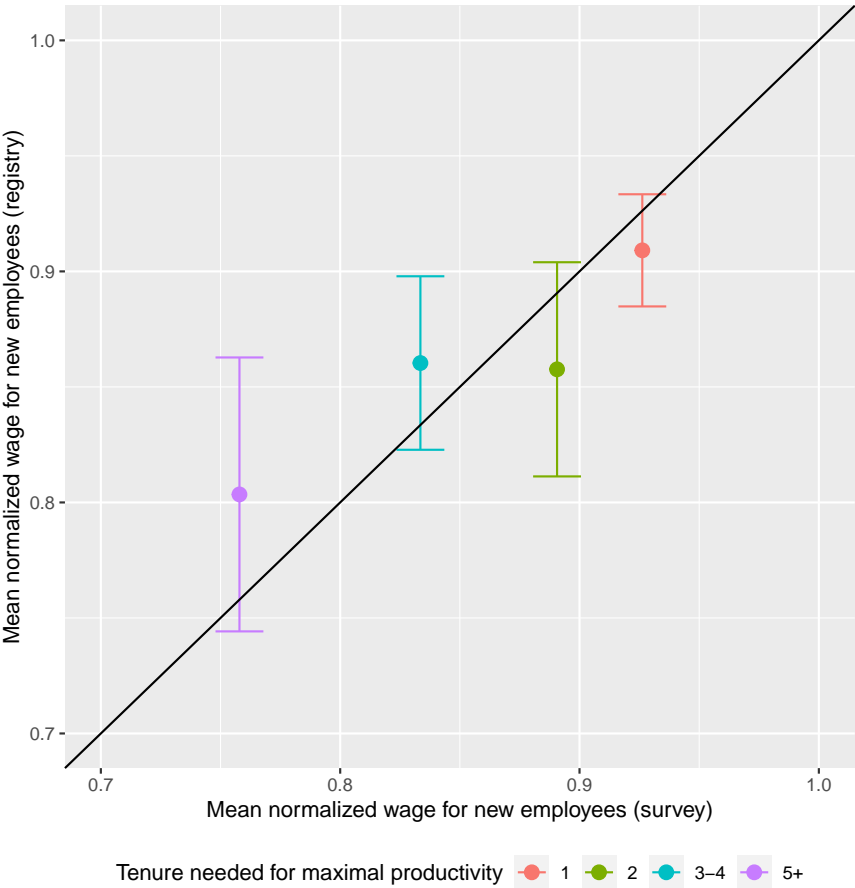
Notes: Same as Figure 7 but with high tenure defined as having more than T_M years of tenure. 534 firms are included in the analysis.

Figure C2: Normalized wages for new employees in the survey versus that in the registry data, high tenure = more than 6 years



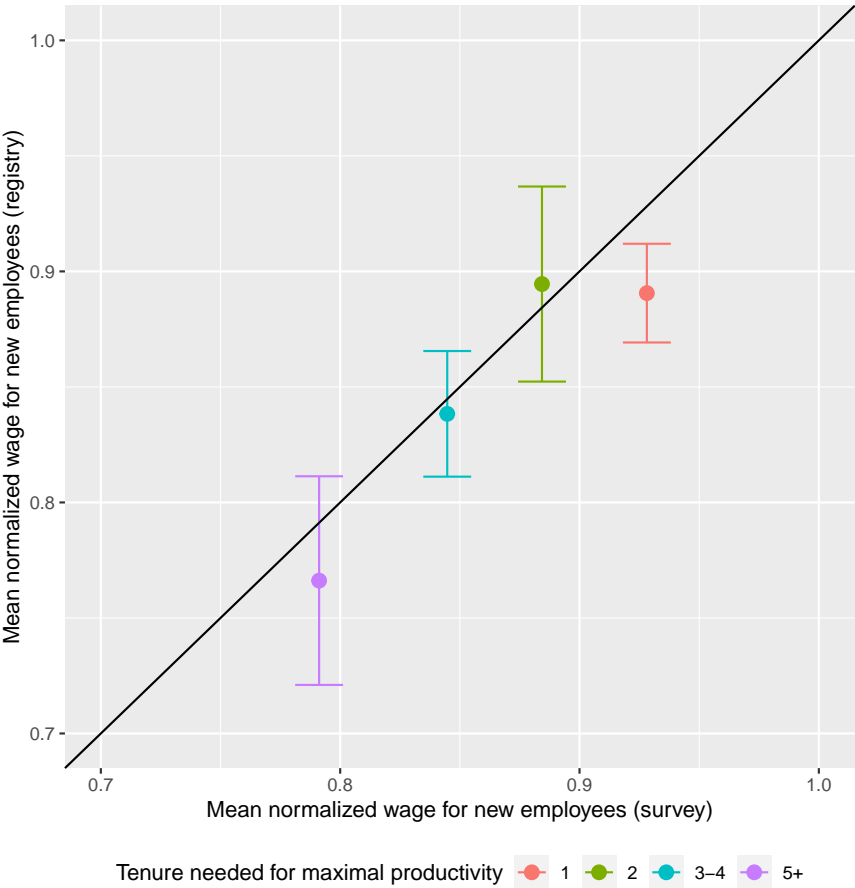
Notes: Same as Figure 7 but with high tenure defined as having more than 6 years of tenure. 445 firms are included in the analysis.

Figure C3: Normalized wages for new employees in the survey versus that in the registry data, low tenure = less than 1 year



Notes: Same as Figure 7 but with low tenure defined as having less 1 year of tenure. 411 firms are included in the analysis.

Figure C4: Normalized wages for new employees in the survey versus that in the registry data, less than 4 years of previous experience



Notes: Same as Figure 7 but with less than 4 years of previous experience. 549 firms are included in the analysis.

D Appendix: Separation Rates Estimated from the Registry Data

This Appendix reports the separation rates by occupation group and tenure estimated from the registry data. We use employees between 35 and 54 years old to be consistent with hypothetical employees used in the survey. Separation rates are typically decreasing with tenure. Initial separation rates are lower for management occupations and also for occupations that require a high or medium level of knowledge.

Table D1: Separation rates (λ_T^0 , %) by occupation and tenure

Occupation	Tenure									
	1	2	3	4	5	6	7	8	9	10+
Management	24.4	22.0	21.4	19.4	16.1	14.7	15.1	12.1	10.6	7.3
Require high knowledge	26.6	20.9	17.8	16.2	15.3	14.5	13.2	10.9	9.0	6.3
Require medium knowledge	27.7	22.3	20.0	17.8	16.1	14.7	13.2	11.1	9.9	6.3
Office & customer services	31.7	22.6	19.3	16.4	14.4	13.8	11.7	11.0	9.8	7.1
Sales & service	37.3	28.4	23.7	17.9	16.2	14.6	14.2	11.3	9.6	5.8
Farming	37.4	27.8	24.0	17.6	17.9	9.7	26.0	15.4	11.6	7.5
Manual labor, skilled	37.6	25.3	20.4	17.9	15.8	12.5	10.7	12.1	10.3	7.0
Operator and assembly	36.1	23.4	19.0	17.8	15.4	13.8	10.5	14.1	11.5	7.0
Manual labor, unskilled	41.8	27.1	21.6	17.7	15.1	15.6	13.4	11.1	10.4	6.6

E Appendix: Most Common Occupation Comparison between the Survey and Registry Data without Aggregation

Table E1 is a version of Table 8 that do not aggregate Management, Office & customer services, Farming, and Unskilled manual labor into “other.”

Table E1: Most common occupations

Survey	N	Registry										% exactly aligned
		1	2	3	4	5	6	7	8	9	unknown	
1. Management	119	5	16	11	7	26	6	13	2	16	17	4.2
2. Require high knowledge	701	12	308	133	65	36	6	50	15	17	59	43.9
3. Require medium knowledge	404	12	78	100	56	35	6	45	16	22	34	24.8
4. Office & customer services	192	3	20	42	54	21	0	5	6	29	12	28.1
5. Sales & service	338	5	14	49	32	105	1	31	15	44	42	31.1
6. Farming	126	1	5	1	4	9	43	6	4	15	38	34.1
7. Manual labor, skilled	525	1	8	14	10	29	9	320	22	57	55	61.0
8. Operator and assembly	202	1	1	8	16	6	0	39	100	23	8	49.5
9. Manual labor, unskilled	138	1	5	5	15	14	10	12	17	44	15	31.9
Unknown	2							1		1		

Source: [Danish Firm Survey \(2020\)](#) and [Danish Registry Data \(2020\)](#) as explained in text.

Notes: The first two columns in this table report the distribution of the most common occupation, at the first-digit level in Danish ISCO, based on the survey responses. The next ten columns are cross-tabulations between the most common occupations from the survey and the registry data, with the cell with the most observations in each row in bold. The last column reports the fraction of firms in each row where the most common occupation from the registry data belongs to the same occupation group as the most common occupation from the survey (using the sampling weights).